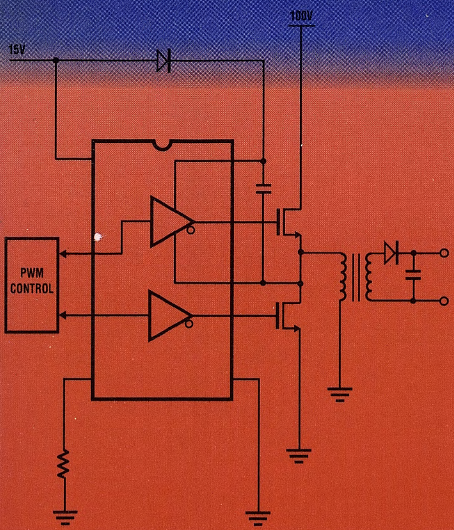
# 1995 Power Products Data Book




## *High Performance CMOS Integrated Power Circuits*

**CCD Drivers**

**Half Bridge Drivers**

**High Side Drivers**

**IGBT Drivers**

**Rising Edge Delay Drivers**

**MOSFET Drivers**

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# CMOS Power Products

## SALES OFFICES

*EAST*
**Elantec, Inc.**
Mark 128 Office Park
140 Wood Road, Suite 104
Braintree, MA 02184
Telephone: (617) 849-9181
Fax: (617) 849-0285

*WEST*
**Elantec, Inc.**
1996 Tarob Court
Milpitas, CA 95035
Telephone: (408) 945-1323
Fax: (408) 945-9305
800-333-6314

*EUROPE*
**Elantec, Inc.**
Gordon House Business Centre
First Floor
6 Lissenden Gardens
London NW5 1LX
Telephone: 44-71-482-4596
Fax: 44-71-207-1026

*ASIA*
**Elantec, Inc.**
Raffine Maison,
Nakano #401
2-7-2 Arai,
Nakano-Ku
Tokyo, Japan T165
Telephone: 81-3-3388-6959
Fax: 81-3-3388-6956

## FACTORY

**Elantec, Inc.**
1996 Tarob Court
Milpitas, CA 95035
Telephone: (408) 945-1323
Fax: (408) 945-9305

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US Patent Numbers: 4,746,877 • 4,827,223 • 4,837,523 • 4,833,424 • 4,935,704 • 4,910,477 • 5,128,564 • 4,878,034 • 4,963,802 • 5,179,355 • 5,321,371 • 5,334,883 • 5,341,047

UK Patent Numbers: 2217135 • 2217134

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# CMOS Power MOSFET Drivers

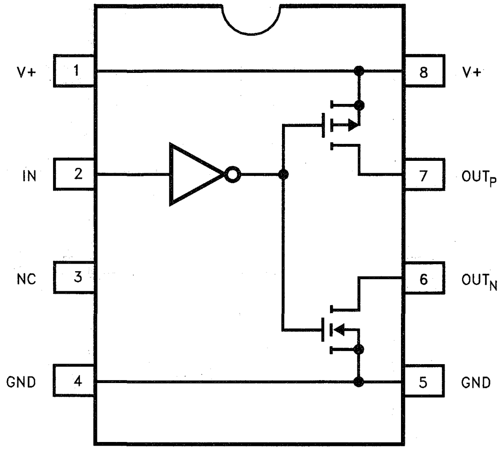
| ELANTEC Part Number | Description | Configuration | Peak Current | Max "ON" Resistance | $T_{D1}/T_{D2}$ (ns) | $T_R/T_F$ (ns) | $I_S$ mA | Package |
|---|---|---|---|---|---|---|---|---|
| EL7104 | High Current/ Single Channel | Non-Inverting/ Iso-Drains | 4.0A | 3Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7114 | High Current/ Single Channel | Inverting/Iso-Drains | 4.0A | 3Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7134 | High Current/ Single Channel | 3-State | 4.0A | 3Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7144 | High Current/ Single Channel | 2-Input Logic AND | 4.0A | 3Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7154 | Low Cost Pin Driver | Adjustable $V_H/V_L$ 3-State Output | 4.0A | 3Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Pin SOIC |
| EL7182 | 2-Phase CCD Driver | Complementary Outputs | 2.0A | 6Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7202 | Dual Channel | Non-Inverting | 2.0A | 6Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7212 | Dual Channel | Inverting | 2.0A | 6Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7222 | Dual Channel | Complementary Outputs | 2.0A | 6Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7232 | Dual Channel | 3-State | 2.0A | 6Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7242 | Dual Channel | 2-Input Logic AND | 2.0A | 6Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7243 | Dual Channel CCD and General Purpose Driver in Power Package | Logic AND, Can Be Wired Inverting/ Non-Inverting | 2.0A | 6Ω | 20/20 | 20/20 | 5.0 | 20 Pin Power SO |
| EL7252 | Dual Channel | 2-Input Logic NAND | 2.0A | 6Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7262 | Dual Channel | Inverting/Iso-Drain | 2.0A | 6Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7272 | Dual Channel | Non-Inverting/ Iso-Drain | 2.0A | 6Ω | 20/20 | 20/20 | 5.0 | 8 Pin DIP, 8 Lead SO |
| EL7412 | 4-Channel Driver in Power Package | Inverting | 2.0A | 6Ω | 20/20 | 20/20 | 10.0 | 20 Pin Power SO |
| EL7661 | 100V Full Bridge | Non-Inverting | 1.0A | 10Ω | Var/150 | 40 | 12.0 | 18 Pin DIP |
| EL7761 | 100V ½ Bridge | High Side Inv Lo Side Inv/Non | 1.0A | 10Ω | Var/150 | 40 | 11.5 | 16 Pin DIP |
| EL7501 | 100V High Side | User Definable Polarity | 1.0A | 10Ω | 140/140 | 40 | 4.0 | 8 Pin DIP 8 Pin SOIC |
| EL7961 | Dual Channel Dependent Delay | Non-Inverting | 1.0A | 10Ω | Var/50 | 40 | 10.0 | 8 Pin DIP 8 Pin SOIC |
| EL7971 | Dual Channel Dependent Delay | Inverting | 1.0A | 10Ω | Var/50 | 40 | 10.0 | 8 Pin DIP 8 Pin SOIC |

## CMOS Power MOSFET Drivers — Contd.

| ELANTEC Part Number | Description | Configuration | Peak Current | Max "ON" Resistance | $T_{D1}/T_{D2}$ (ns) | $T_R/T_F$ (ns) | $I_S$ mA | Package |
|---|---|---|---|---|---|---|---|---|
| EL7981 | Dual Channel Dependent Delay | Complementary | 1.0A | 10Ω | Var/50 | 40 | 10.0 | 8 Pin DIP<br>8 Pin SOIC |
| EL7962 | Dual Channel Independent Delay | Non-Inverting | 1.0A | 10Ω | Var/50 | 40 | 10.0 | 8 Pin DIP<br>8 Pin SOIC |
| EL7972 | Dual Channel Independent Delay | Inverting | 1.0A | 10Ω | Var/50 | 40 | 10.0 | 8 Pin DIP<br>8 Pin SOIC |
| EL7982 | Dual Channel Independent Delay | Complementary | 1.0A | 10Ω | Var/50 | 40 | 10.0 | 8 Pin DIP<br>8 Pin SOIC |
| EL7861 | Single Channel Delay | User Definable Polarity | 1.0A | 10Ω | Var/50 | 40 | 7.5 | 8 Pin DIP<br>8 Pin SOIC |

## Single Channel, 4.0 Amps Output

### EL7104

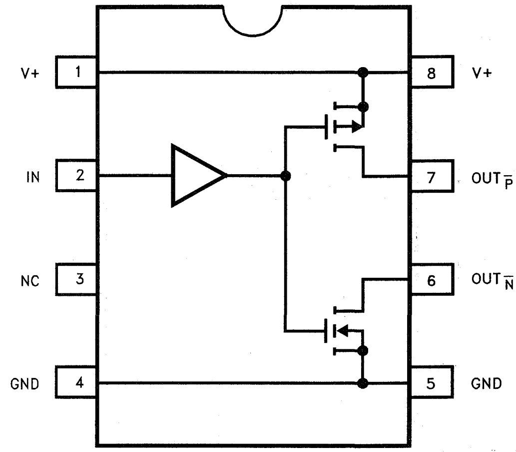



0934–1

**Non-Inverting**

- Isolated Drains
- 20 ns Switching Time

### EL7114



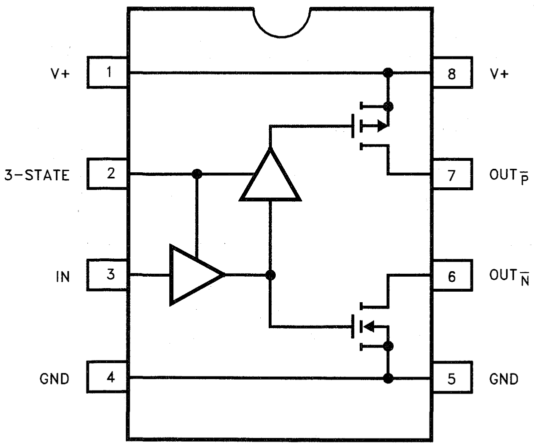

0934–2

**Inverting**

- Isolated Drains
- 20 ns Switching Time

## 3-State Line Driver/Dual Input Line Driver, 4.0 Amps Output

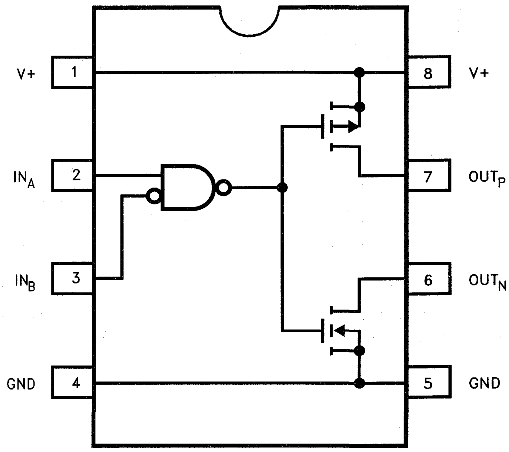
### EL7134




0934–3

- 20 ns Prop Delay
- 20 ns Switching Time

### EL7144



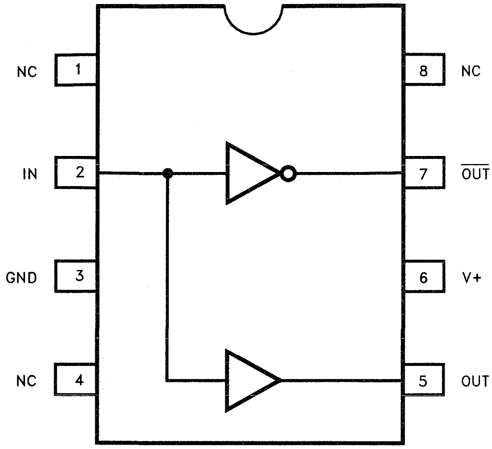

0934–4

- 20 ns Prop Delay
- 20 ns Switching Time

# *MOSFET Driver Selector Guide*

## CCD Driver/Dual Channel 3-State Line Driver

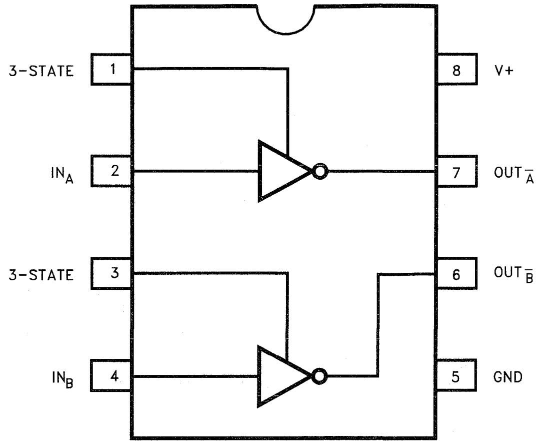
### EL7182




0934-5

- Reduced Clock Skew
- 20 ns Switching Time

### EL7232

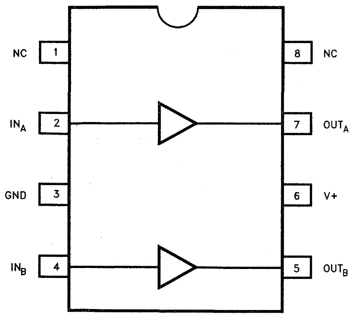



0934-6

- 20 ns Prop Delay
- 20 ns Switching Time

## Dual Channel, 2.0 Amps Output

### EL7202

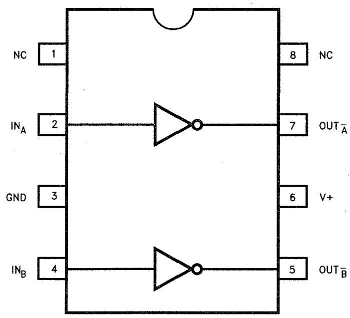



0934-7

**Non-Inverting**

- 20 ns Prop Delay
- 20 ns Switching Time

### EL7212

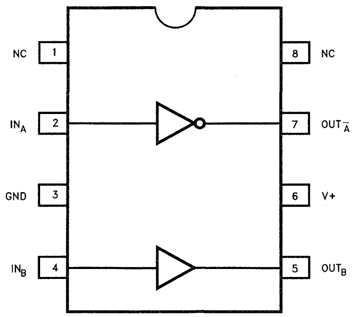



0934-8

**Inverting**

- 20 ns Prop Delay
- 20 ns Switching Time

### EL7222



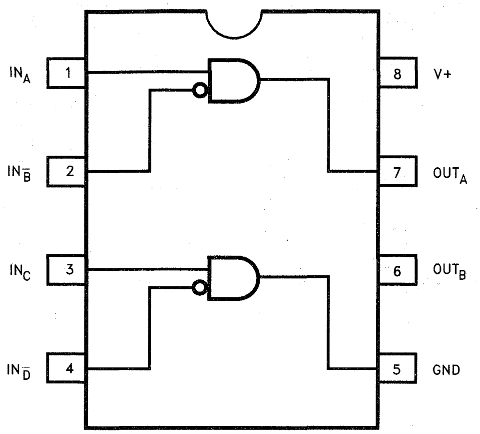

0934-9

**Complementary**

- 20 ns Prop Delay
- 20 ns Switching Time

## Dual Channel/Dual Input, 2.0 Amps

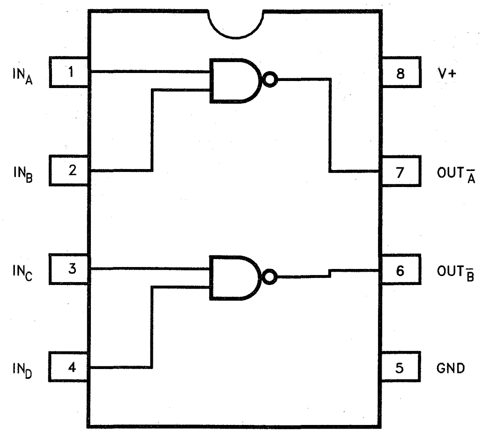
### EL7242




0934-10

- 20 ns Prop Delay
- 20 ns Switching Time

### EL7252

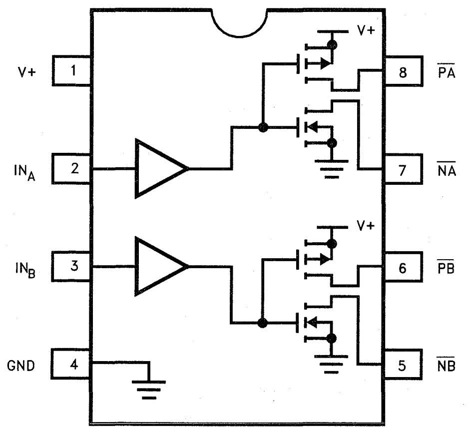



0934-11

- 20 ns Prop Delay
- 20 ns Switching Time

## Dual Channel—Isolated Drains, 2.0 Amps

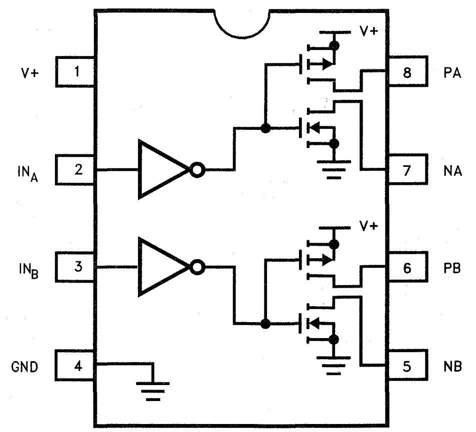
### EL7262




0934-12

- 20 ns Prop Delay
- 20 ns Switching Time

### EL7272




0934-13

- 20 ns Prop Delay
- 20 ns Switching Time

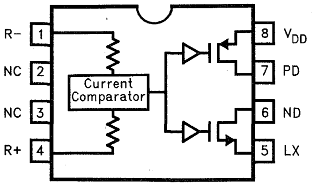
## Applications

• Clock Drivers • Line Drivers • CCD Drivers • Ultrasound Transducer Drivers • Switching Power Supplies • Bus Driver • Motor Control • Charge Pumps • Pin Drivers • EPROM Programming • Resonant Charging Non-overlapped Switching

# MOSFET Driver Selector Guide

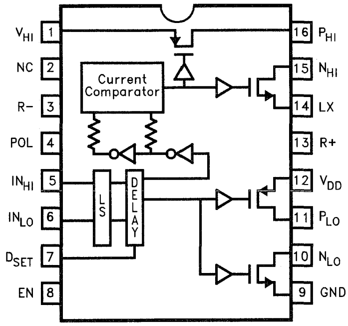
## High Side Drivers—Isolated Drains, 1.0 Amp

### EL7501



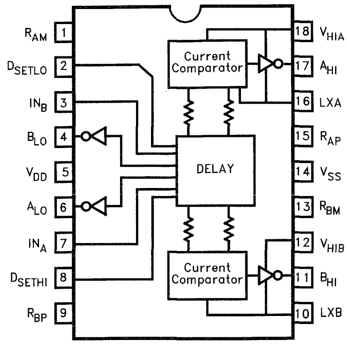

0934–14

### EL7761




0934–15

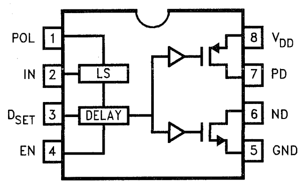
### EL7661




0934–23

## Single Channel Delay Driver—Isolated Drain, 1.0 Amp

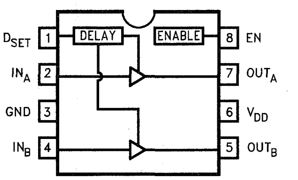
### EL7861




0934–16

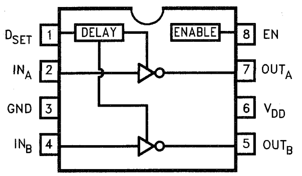
## Dual Channel—Dependent Delay Drivers, 1.0 Amp

### EL7961



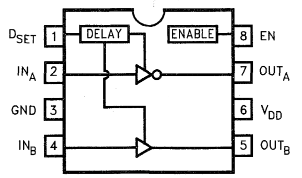

0934–17

### EL7971




0934–18

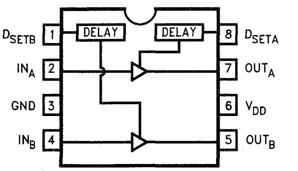
### EL7981




0934–19

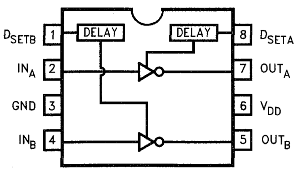
## Dual Channel—Independent Delay Drivers, 1.0 Amp

### EL7962



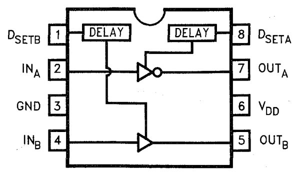

0934–20

### EL7972




0934–21

### EL7982



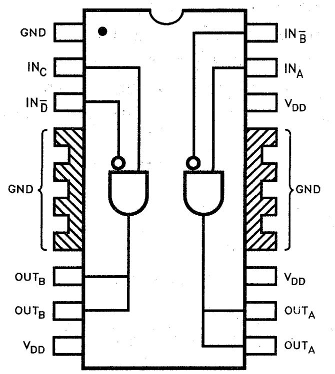

0934–22

## Applications

• Uninterruptable Power Supplies • Distributed Power Systems • ICBT Drive • DC-DC Convertors • Motor Control • Power MOSFET Drive • Switch Mode Power Supplies

## Power Packages

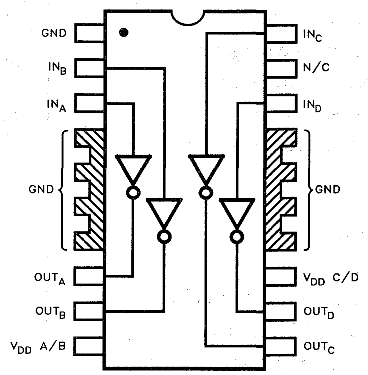
### EL7243




0934-24

• 1.5 Watts Rating
• Up to 20 MHz

### EL7412

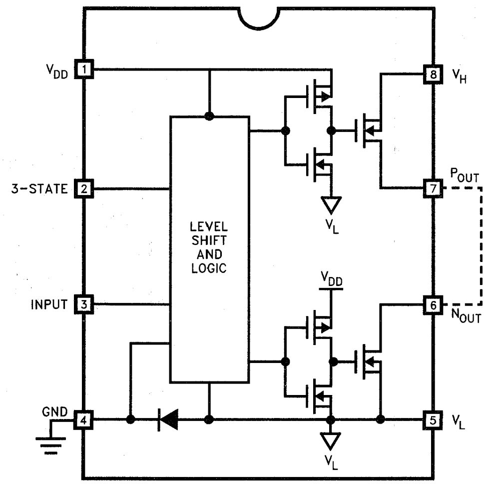



0934-25

• 1.5 Watts Rating
• Up to 20 MHz

## Pin Drivers

### EL7154




• 20 ns Switching
• Adjustable Source/Sink
• 3-State Output

0934-26

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HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# EL7104C/EL7114C

*High Speed, Single Channel, Power MOSFET Drivers*

## Features

- Industry standard driver replacement
- Improved response times
- Matched rise and fall times
- Reduced clock skew
- Low output impedance
- Low input capacitance
- High noise immunity
- Improved clocking rate
- Low supply current
- Wide operating range
- Separate drain connections

## Applications

- Clock/line drivers
- CCD Drivers
- Ultra-sound transducer drivers
- Power MOSFET drivers
- Switch mode power supplies
- Resonant charging
- Cascoded drivers

## Ordering Information

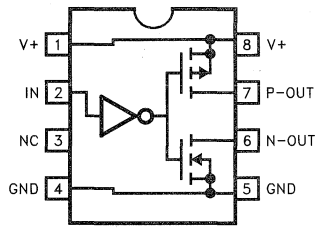
| Part No. | Temp. Range | Pkg. | Outline # |
|---|---|---|---|
| EL7104CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7104CS | −40°C to +85°C | 8-Pin SOIC | MDP0027 |
| EL7114CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7114CS | −40°C to +85°C | 8-Pin SOIC | MDP0027 |

## General Description

The EL7104C/EL7114C ICs are matched driver ICs that improve the operation of the industry standard TC-4420/29 clock drivers. The Elantec versions are very high speed drivers capable of delivering peak currents of 4A into highly capacitive loads. The high speed performance is achieved by means of a proprietary "Turbo-Driver" circuit that speeds up input stages by tapping the wider voltage swing at the output. Improved speed and drive capability are enhanced by matched rise and fall delay times. These matched delays maintain the integrity of input-to-output pulse-widths to reduce timing errors and clock skew problems. This improved performance is accompanied by a 10 fold reduction in supply currents over bipolar drivers, yet without the delay time problems commonly associated with CMOS devices.

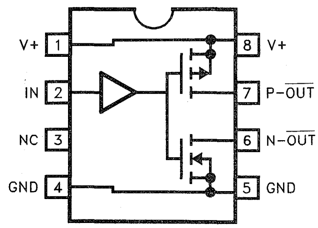
## Connection Diagrams

EL7104C
Non-Inverting Driver




7104-1

EL7114C
Inverting Driver




7104-2

Manufactured under U.S. Patent Nos. 5,334,883, #5,341,047

December 1993 Rev. A

# EL7104C/EL7114C

## High Speed, Single Channel, Power MOSFET Drivers



## Absolute Maximum Ratings

| | |
|---|---|
| Supply (V+ to Gnd) | 16.5V |
| Input Pins | −0.3V to +0.3V above V+ |
| Peak Output Current | 4A |
| Storage Temperature Range | −65°C to +150°C |
| Ambient Operating Temperature | −40°C to +85°C |
| Operating Junction Temperature | 125°C |
| Power Dissipation | |
| SOIC | 670 mW |
| PDIP | 1050 mW |

**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, therefore $T_J = T_C = T_A$.**

| 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. |

## DC Electrical Characteristics $T_A = 25°C$, V+ = 15V unless otherwise specified

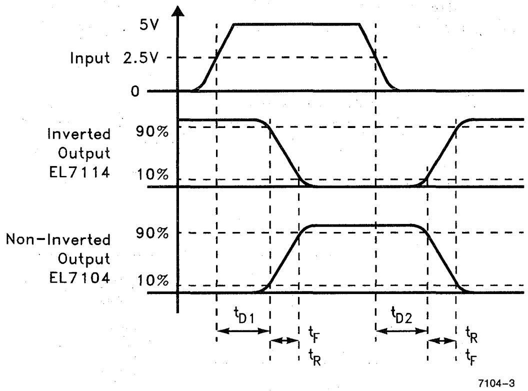
| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 2.4 | | | I | V |
| $I_{IH}$ | Logic "1" Input Current | @V+ | | 0.1 | 10 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | @0V | | 0.1 | 10 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.3 | | V | V |
| **Output** | | | | | | | |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT} = -100$ mA | | 1.5 | 4 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT} = +100$ mA | | 2 | 4 | I | Ω |
| $I_{OUT}$ | Output Current | V+/GND | | 0.2 | 10 | I | μA |
| $I_{PK}$ | Peak Output Current | Source<br>Sink | | 4<br>4 | | IV | A |
| $I_{DC}$ | Continuous Output Current | Source/Sink | 200 | | | I | mA |
| **Power Supply** | | | | | | | |
| $I_S$ | Power Supply Current | Input = V+ EL7104<br>EL7114 | | 4.5<br>1 | 7.5<br>2.5 | I | mA |
| $V_S$ | Operating Voltage | | 4.5 | | 16 | I | V |

# EL7104C/EL7114C
## High Speed, Single Channel, Power MOSFET Drivers

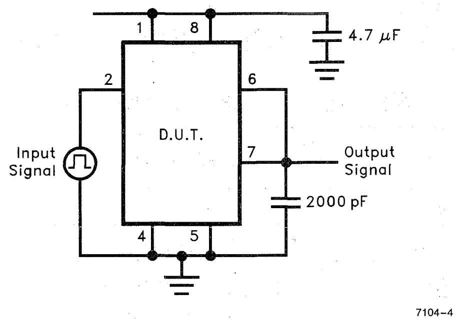
## AC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 1000 pF<br>$C_L$ = 2000 pF | | 7.5<br>10 | <br>20 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 1000 pF<br>$C_L$ = 2000 pF | | 10<br>15 | <br>20 | IV | ns |
| $t_{D\text{-}ON}$ | Turn-On Delay Time | See Timing Table | | 18 | 25 | IV | ns |
| $t_{D\text{-}OFF}$ | Turn-Off Delay Time | See Timing Table | | 18 | 25 | IV | ns |

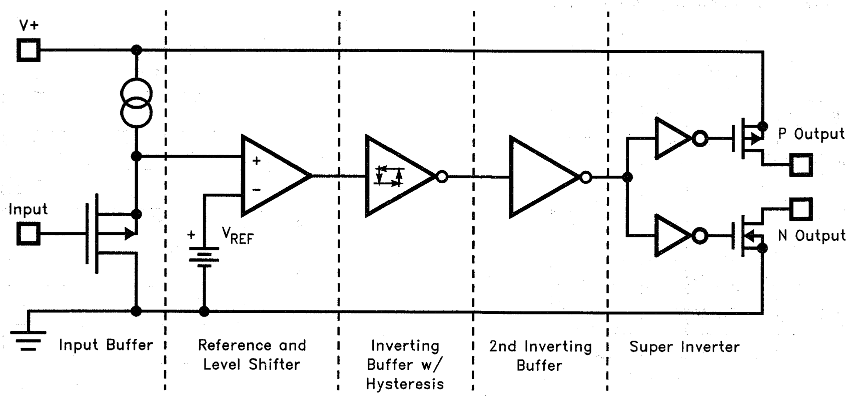
### Timing Table




### Standard Test Configuration

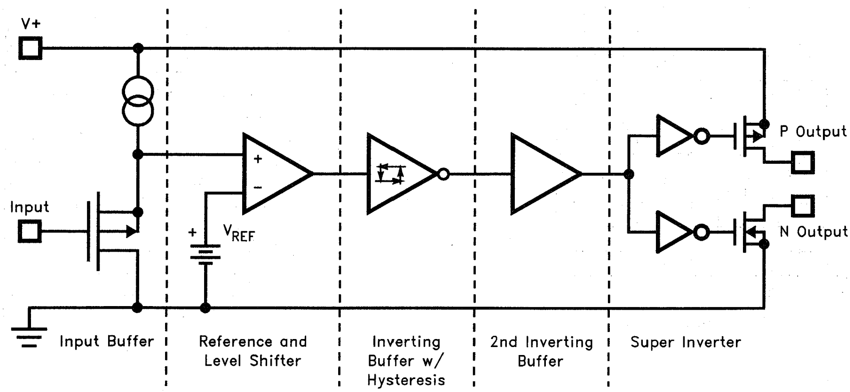


**7104C Simplified Schematic**




7104-5

**7114C Simplified Schematic**

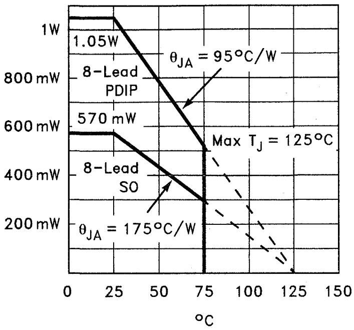



7104-6

# EL7104C/EL7114C
## High Speed, Single Channel, Power MOSFET Drivers

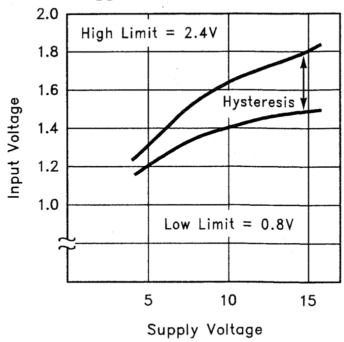
## Typical Performance Curve

**Max Power/Derating Curves**



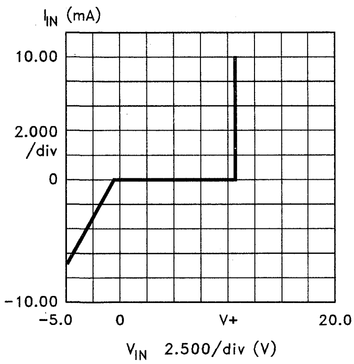

7104-7

**Switch Threshold vs Supply Voltage**



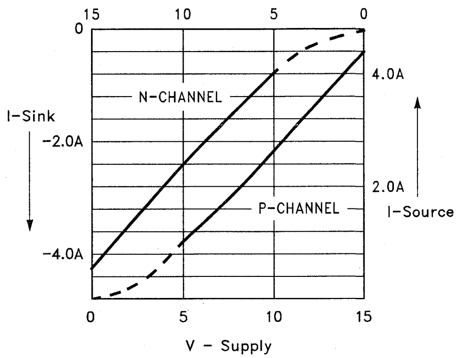

7104-8

**Input Current vs Voltage**



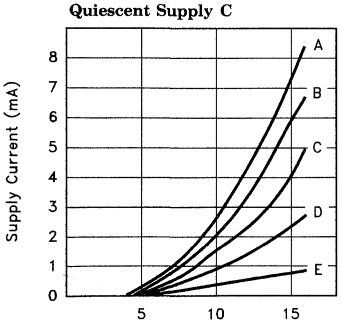

7104-9

**Peak Drive vs Supply Voltage**




7104-10

**Quiescent Supply C**

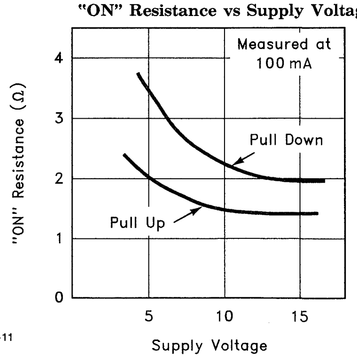



CASE:

| Device | Input Level | Curve |
|---|---|---|
| EL7104 | GND | A |
| EL7104 | V+ | C |
| EL7114 | GND | C |
| EL7114 | V+ | E |

7104-11

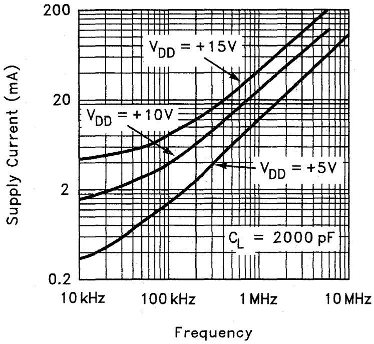
**"ON" Resistance vs Supply Voltage**




7104-12

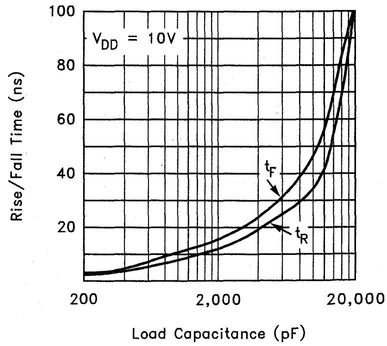
## Typical Performance Curve — Contd.

**Average Supply Current vs Voltage and Frequency**



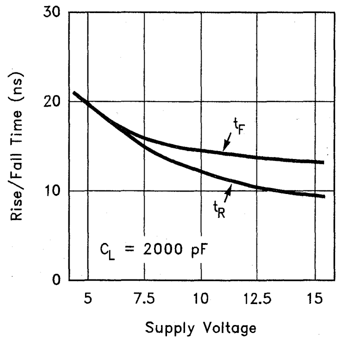

7104-13

**Rise/Fall Time vs Load**




7104-15

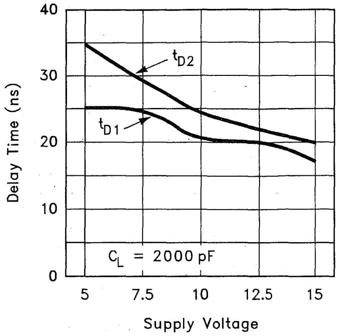
**Rise/Fall Time vs Supply Voltage**




7104-16

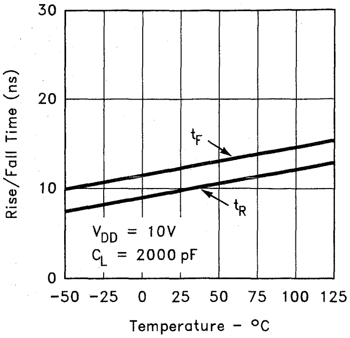
## Typical Performance Curve — Contd.

**Propagation Delay vs Supply Voltage**



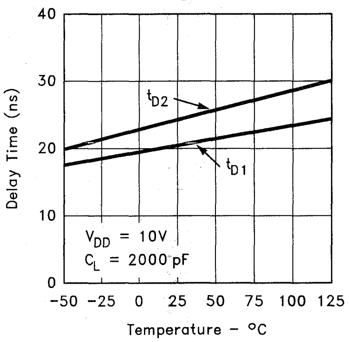

7104-17

**Rise/Fall Time vs Temperature**




7104-18

**Delay vs Temperature**




7104-19

# EL7134C

*High Speed, High Current, Line Driver w/3-State*



## Features

- 3-State output
- 3V and 5V Input compatible
- Clocking speeds up to 10 MHz
- 20 ns Switching/delay time
- 4A Peak drive
- Isolated drains
- Low output impedance—2.5Ω
- Low quiescent current—5 mA
- Wide operating voltage—4.5V–16V

## Applications

- Parallel bus line drivers
- EPROM and PROM programming
- Motor controls
- Charge pumps
- Sampling circuits
- Pin drivers

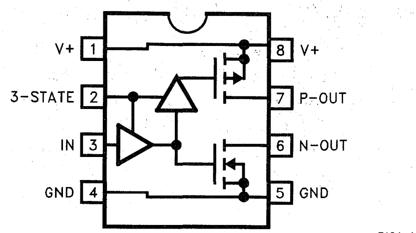
## Ordering Information

| Part No. | Temp. Range | Pkg. | Outline # |
|---|---|---|---|
| EL7134CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7134CS | −40°C to +85°C | 8-Pin SOIC | MDP0027 |

## General Description

The EL7134C 3-state driver is particularly well suited for ATE and microprocessor based applications. The low quiescent power dissipation makes this part attractive in battery applications. The 4A peak drive capability, makes the EL7134C an excellent choice when driving high speed capacitive lines.

## Connection Diagram




Top View

## Truth Table

| 3-State | Input | P-Out | N-Out |
|---|---|---|---|
| 0 | 0 | Open | Open |
| 0 | 1 | Open | Open |
| 1 | 0 | HIGH | Open |
| 1 | 1 | Open | LOW |

Manufactured under U.S. Patent Nos. 5,334,883, #5,341,047

December 1993 Rev. A

# EL7134C

## High Speed, High Current, Line Driver w/3-State

## Absolute Maximum Ratings

| | |
|---|---|
| Supply (V+ to Gnd) | 16.5V |
| Input Pins | −0.3V to +0.3V above V+ |
| Peak Output Current | 4A |
| Storage Temperature Range | −65°C to +150°C |
| Ambient Operating Temperature | −40°C to +85°C |
| Operating Junction Temperature | 125°C |
| Power Dissipation | |
| SOIC | 670 mW |
| PDIP | 1050 mW |

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, therefore $T_J = T_C = T_A$.

| 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. |

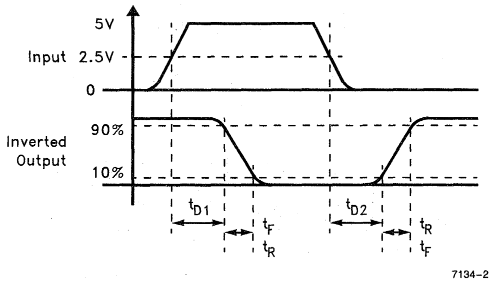
## DC Electrical Characteristics $T_A$ = 25°C, V+ = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 2.4 | | | I | V |
| $I_{IH}$ | Logic "1" Input Current | $V_{IH} = V^+$ | | 0.1 | 10 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | $V_{IL}$ = 0V | | 0.1 | 10 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.3 | | V | V |
| **Output** | | | | | | | |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT}$ = −100 mA | | 1.5 | 4 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT}$ = +100 mA | | 2 | 4 | I | Ω |
| $I_{OUT}$ | Output Leakage Current | V+/GND | | 0.2 | 10 | I | μA |
| $I_{PK}$ | Peak Output Current | Source<br>Sink | | 4.0<br>4.0 | | V | A |
| $I_{DC}$ | Continuous Output Current | Source/Sink | 200 | | | I | mA |
| **Power Supply** | | | | | | | |
| $I_S$ | Power Supply Current | Inputs = V+ | | 1 | 2.5 | I | mA |
| $V_S$ | Operating Voltage | | 4.5 | | 16 | I | V |

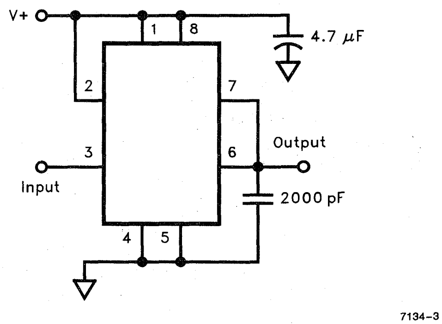
## AC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 1000 pF<br>$C_L$ = 2000 pF | | 7.5<br>10 | <br>20 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 1000 pF<br>$C_L$ = 2000 pF | | 10<br>13 | <br>20 | IV | ns |
| $t_{D\text{-}ON}$ | Turn-On Delay Time | | | 18 | 25 | IV | ns |
| $t_{D\text{-}OFF}$ | Turn-Off Delay Time | | | 18 | 25 | IV | ns |

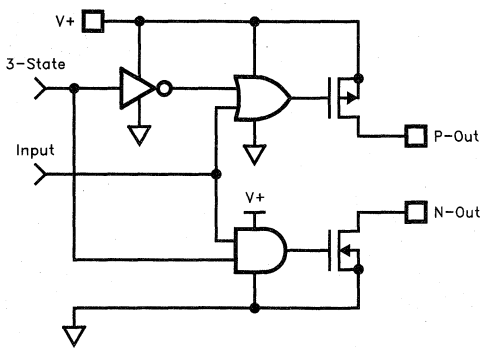
### Timing Table




### Standard Test Configuration




### Simplified Schematic

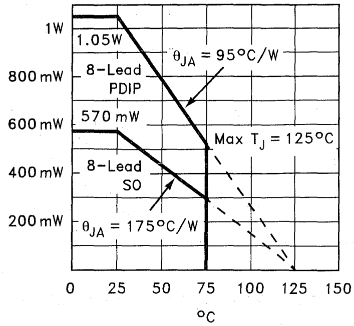


# EL7134C

## *High Speed, High Current, Line Driver w/3-State*

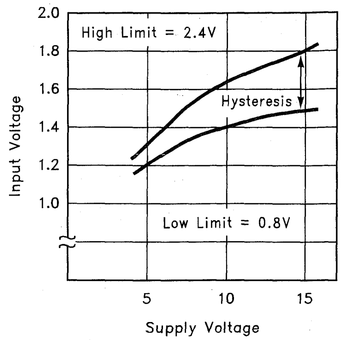
## Typical Performance Curve

**Max Power/Derating Curves**



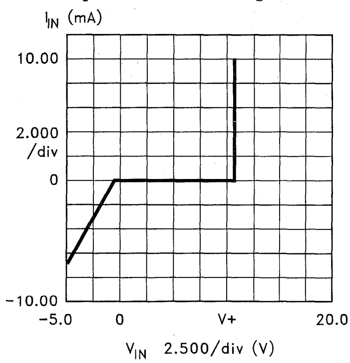

7134-5

**Switch Threshold vs Supply Voltage**



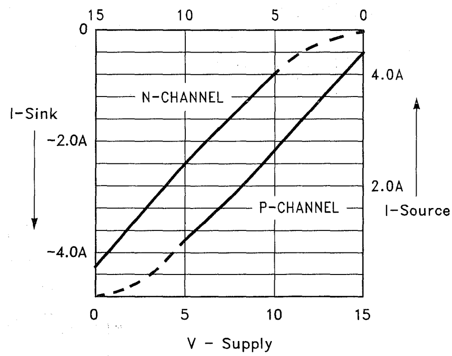

7134-6

**Input Current vs Voltage**



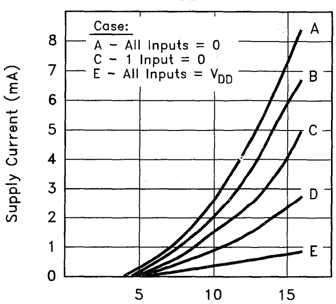

7134-7

**Peak Drive vs Supply Voltage**



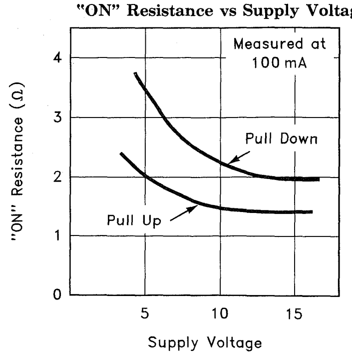

7134-8

**Quiescent Supply C**




7134-9

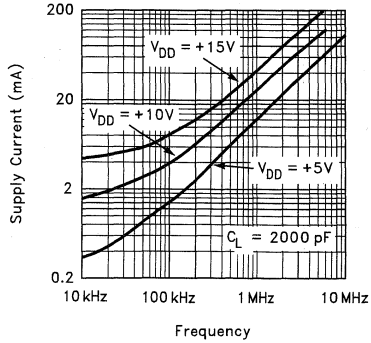
**"ON" Resistance vs Supply Voltage**




7134-10

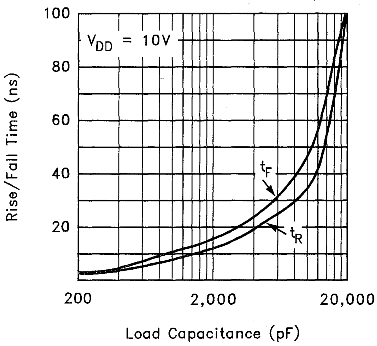
# Typical Performance Curve — Contd.

**Average Supply Current vs Voltage and Frequency**



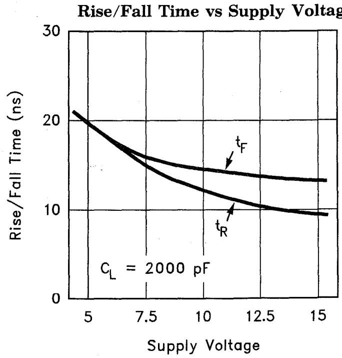

7134-11

**Rise/Fall Time vs Load**




7134-13

**Rise/Fall Time vs Supply Voltage**

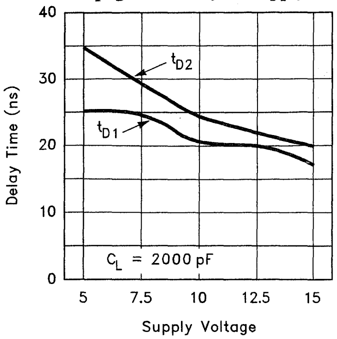



7134-14

# EL7134C
## High Speed, High Current, Line Driver w/3-State

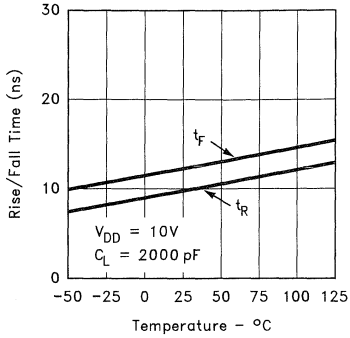
### Typical Performance Curve — Contd.

Propagation Delay vs Supply Voltage



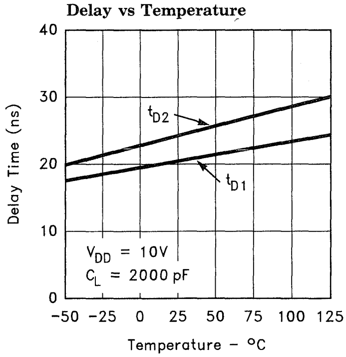

7134-15

Rise/Fall Time vs Temperature




7134-16

Delay vs Temperature




7134-17

# EL7144C

***Dual Input, High Speed, High Current Power MOSFET Driver***



## Features

- Logic and input
- 3V and 5V Input compatible
- Clocking speeds up to 10 MHz
- 20 ns Switching/delay time
- 4A Peak drive
- Isolated drains
- Low output impedance—2.5Ω
- Low quiescent current—5 mA
- Wide operating voltage—4.5V–16V

## Applications

- Short circuit protected switching
- Under-voltage shut-down circuits
- Switch-mode power supplies
- Motor controls
- Power MOSFET switching
- Switching capacitive loads
- Asymmetrical switching
- Resonant charging
- Cascoded switching

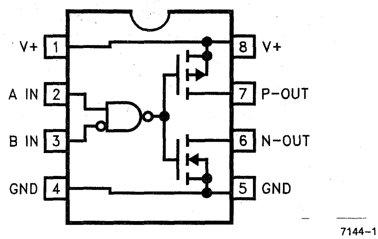
## Ordering Information

| Part No. | Temp. Range | Pkg. | Outline # |
|---|---|---|---|
| EL7144CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7144CS | −40°C to +85°C | 8-Pin SOIC | MDP0027 |

## General Description

The EL7144C dual input, driver achieves excellent switching while providing added flexibility. The 2-input logic and configuration coupled with the "isolated drains" makes this part well suited for various driver applications requiring an asymmetrical drive, resonant charging, and gated control. Providing twice as much drive as the EL7242 family, the EL7144C is excellent for driving large power MOSFET's and other capacitive loads.

## Connection Diagram




**Top View**

Manufactured under U.S. Patent Nos. 5,334,883, #5,341,047

# EL7144C

## Dual Input, High Speed, High Current Power MOSFET Driver

## Absolute Maximum Ratings

| | |
|---|---|
| Supply (V+ to Gnd) | 16.5V |
| Input Pins | −0.3V to +0.3V above V+ |
| Peak Output Current | 4A |
| Storage Temperature Range | −65°C to +150°C |
| Ambient Operating Temperature | −40°C to +85°C |
| Operating Junction Temperature | 125°C |
| Power Dissipation | |
| SOIC | 670 mW |
| PDIP | 1050 mW |

**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, therefore $T_J = T_C = T_A$.**

| 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. |

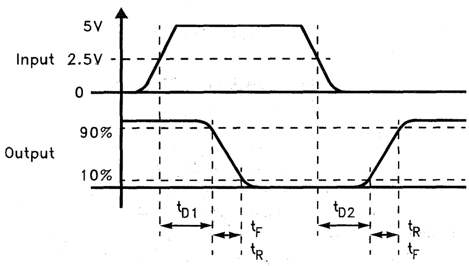
## DC Electrical Characteristics $T_A$ = 25°C, V+ = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 2.4 | | | I | V |
| $I_{IH}$ | Logic "1" Input Current | $V_{IH}$ = V+ | | 0.1 | 10 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | $V_{IL}$ = GND | | 0.1 | 10 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.3 | | V | V |
| **Output** | | | | | | | |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT}$ = −100 mA | | 1.5 | 4 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT}$ = +100 mA | | 2 | 4 | I | Ω |
| $I_{OUT}$ | Output Leakage Current | V+/GND | | 0.2 | 10 | I | μA |
| $I_{PK}$ | Peak Output Current | Source<br>Sink | | 4<br>4 | | V | A |
| $I_{DC}$ | Continuous Output Current | Source/Sink | 200 | | | I | mA |
| **Power Supply** | | | | | | | |
| $I_S$ | Power Supply Current | Inputs V+ | | 1 | 2.5 | I | mA |
| $V_S$ | Operating Voltage | | 4.5 | | 16 | I | V |

## AC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

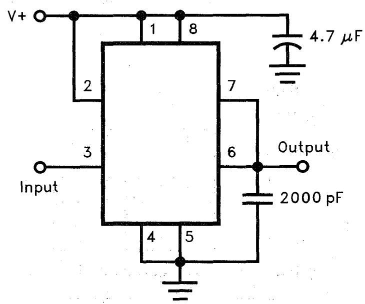
| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 1000 pF<br>$C_L$ = 2000 pF | | 7.5<br>10 | <br>20 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 1000 pF<br>$C_L$ = 2000 pF | | 10<br>13 | <br>20 | IV | ns |
| $t_{D-ON}$ | Turn-On Delay Time | See Timing Table | | 18 | 25 | IV | ns |
| $t_{D-OFF}$ | Turn-Off Delay Time | See Timing Table | | 20 | 25 | IV | ns |

### Timing Table



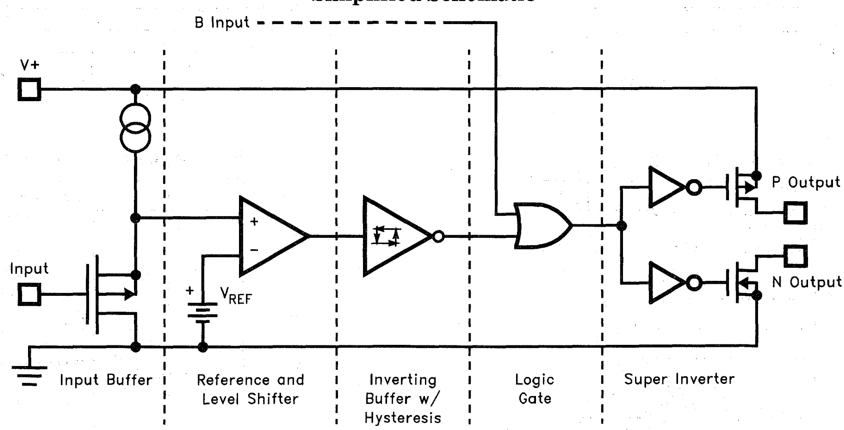

7144-2

### Standard Test Configuration




7144-3

### Simplified Schematic



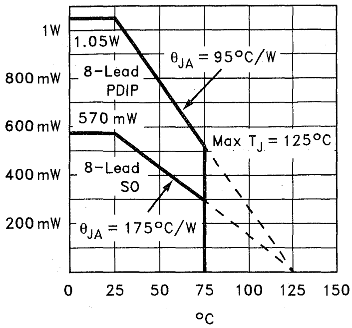

7144-4

# EL7144C

## Dual Input, High Speed, High Current Power MOSFET Driver

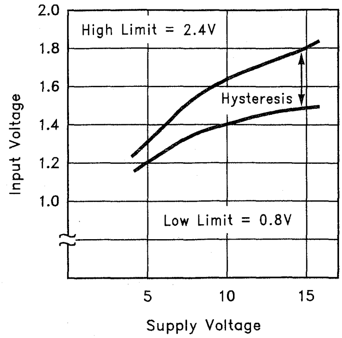
## Typical Performance Curve

**Max Power/Derating Curves**



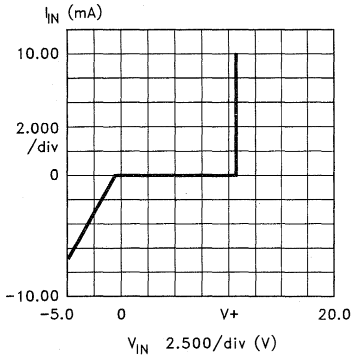

7144-5

**Switch Threshold vs Supply Voltage**



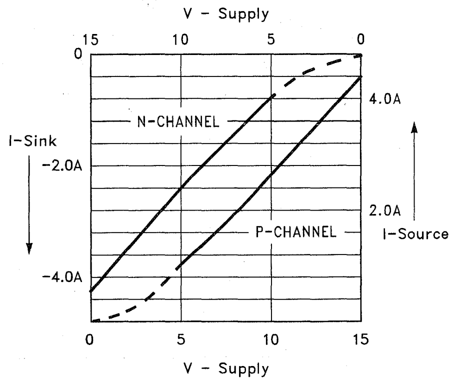

7144-6

**Input Current vs Voltage**



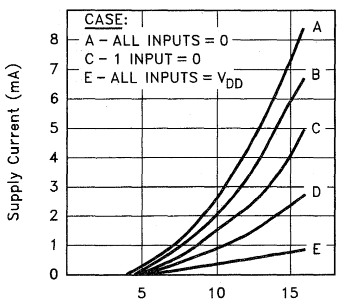

7144-7

**Peak Drive vs Supply Voltage**



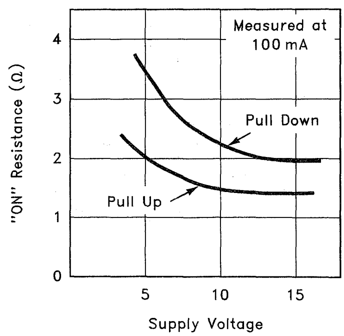

7144-8

**Quiescent Supply C**



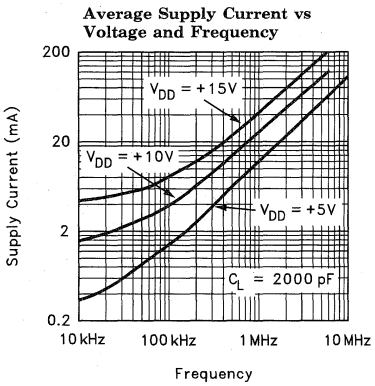

7144-9

**"ON" Resistance vs Supply Voltage**

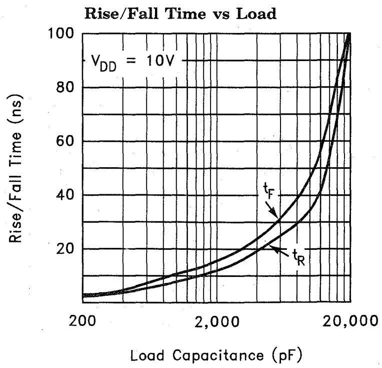



7144-10

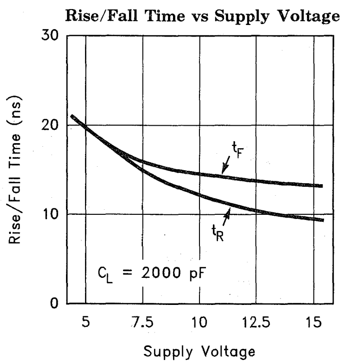
## Typical Performance Curve — Contd.




7144-11

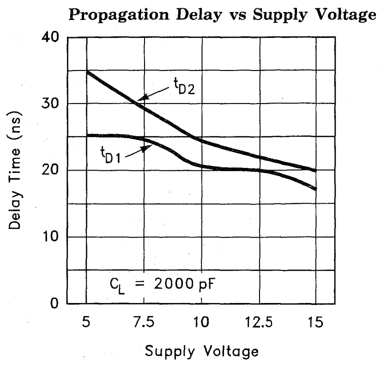



7144-13

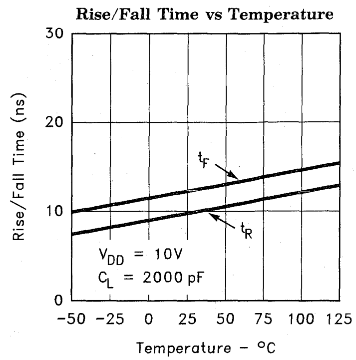



7144-14

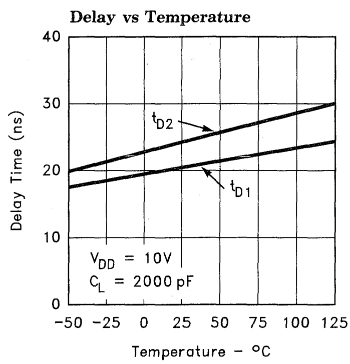
## Typical Performance Curve — Contd.




7144-15




7144-16




7144-17

élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# EL7154C

*High Speed, Monolithic Pin Driver*

## Features

- 3-State output
- 3V and 5V Input compatible
- Clocking speeds up to 10 MHz
- 20 ns Switching/delay time
- 4A Peak drive
- Isolated drains
- Low output impedance—2.5Ω
- Low quiescent current—5 mA
- Wide operating voltage—4.5V–16V

## Applications

- Loaded circuit board testers
- Digital testers
- Level shifting below GND

## Ordering Information

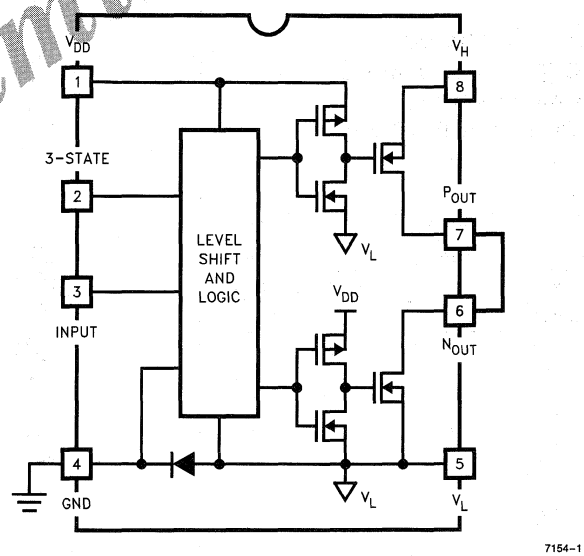
| Part No. | Temp. Range | Pkg. | Outline # |
|---|---|---|---|
| EL7154CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7154CS | −40°C to +85°C | 8-Pin SOIC | MDP0027 |

## General Description

The EL7154C 3-state pin driver is particularly well suited for ATE and level shifting applications. The low quiescent power dissipation makes this part attractive in battery applications. The 4A peak drive capability, makes the EL7154C an excellent choice when driving high speed capacitive lines.

## Connection Diagram

**EL7154 CMOS Pin Driver**




$(V_{DD} - V_L) = 5V–15V$
$(GND - V_L) = 0V–5V$

**Top View**

## Truth Table

| 3-State | Input | $P_{OUT}$ | $N_{OUT}$ |
|---|---|---|---|
| 0 | 0 | Open | Open |
| 0 | 1 | Open | Open |
| 1 | 0 | HIGH | Open |
| 1 | 1 | Open | LOW |

Manufactured under U.S. Patent Nos. 5,334,883, #5,341,047



August 1994 Preliminary

**élantec** HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# *EL7182C*

## *2-Phase, High Speed CCD Driver*

## Features

- 3V and 5V Input compatible
- Clocking speeds up to 10 MHz
- Reduced clock skew
- 20 ns Switching/delay time
- 2A Peak drive
- Low quiescent current
- Wide operating voltage—4.5V–16V

## Applications

- CCD Drivers requiring high-contrast imaging
- Differential line drivers
- Push-pull circuits

## Ordering Information

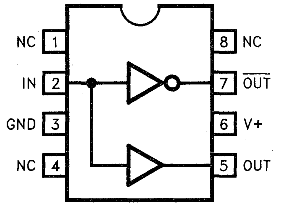
| Part No. | Temp. Range | Pkg. | Outline # |
|---|---|---|---|
| EL7182CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7182CS | −40°C to +85°C | 8-Pin SO | MDP0027 |

## General Description

The EL7182C is extremely well suited for driving CCD's, especially where high contrast imaging is desirable. The 16V supply rating is attractive for higher voltage CCD applications, as in color fax machines. The input is TTL and 3V compatible. The low quiescent current requirement is advantageous in portable/battery powered systems. The EL7182 is available in 8-pin P-DIP and 8-lead SO packages.

## Connection Diagram

EL7182C




7182-1

Manufactured under U.S. Patent Nos. 5,334,883, #5,341,047

December 1993 Rev. A

# EL7182C
## 2-Phase, High Speed CCD Driver

## Absolute Maximum Ratings

| | |
|---|---|
| Supply (V+ to Gnd) | 16.5V |
| Input Pins | −0.3V to +0.3V above V+ |
| Combined Peak Output Current | 4A |
| Storage Temperature Range | −65°C to +150°C |
| Ambient Operating Temperature | −40°C to +85°C |
| Operating Junction Temperature | 125°C |
| Power Dissipation | |
| SOIC | 670 mW |
| PDIP | 1050 mW |

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, therefore $T_J = T_C = T_A$.

| 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. |

## DC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

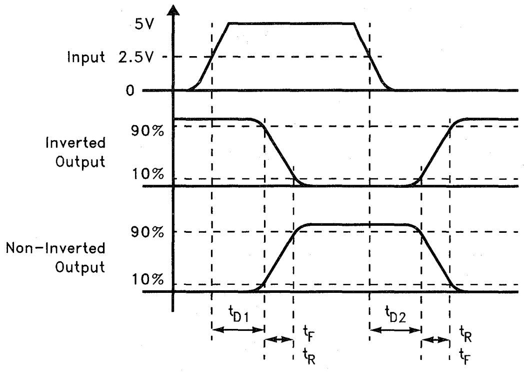
| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 2.4 | | | I | V |
| $I_{IH}$ | Logic "1" Input Current | @V+ | | 0.1 | 10 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | @0V | | 0.1 | 10 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.3 | | V | V |
| **Output** | | | | | | | |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT}$ = −100 mA | | 3 | 6 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT}$ = +100 mA | | 4 | 6 | I | Ω |
| $I_{PK}$ | Peak Output Current | Source<br>Sink | | 2<br>2 | | IV | A |
| $I_{DC}$ | Continuous Output Current | Source/Sink | 100 | | | I | mA |
| **Power Supply** | | | | | | | |
| $I_S$ | Power Supply Current | Input High | | 2.5 | 5 | I | mA |
| $V_S$ | Operating Voltage | | 4.5 | | 16 | I | V |

# EL7182C
## 2-Phase, High Speed CCD Driver

## AC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

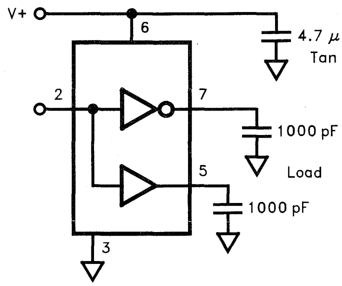
| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 7.5<br>10 | <br>20 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 10<br>13 | <br>20 | IV | ns |
| $t_{D\text{-}ON}$ | Turn-On Delay Time | | | 18 | 25 | IV | ns |
| $t_{D\text{-}OFF}$ | Turn-Off Delay Time | | | 20 | 25 | IV | ns |

### Timing Table



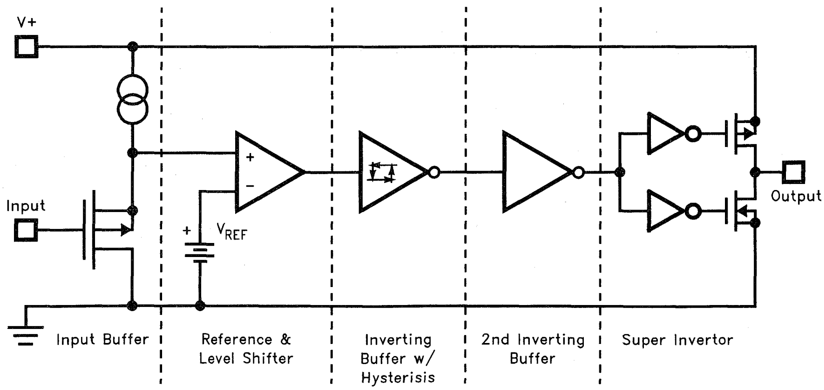

7182-2

### Standard Test Configuration




7182-3

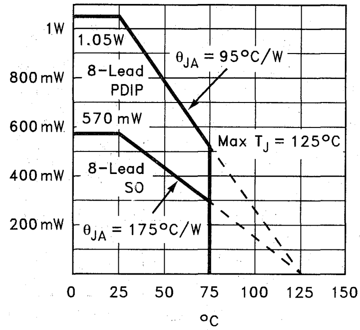
### Simplified Schematic




7182-17

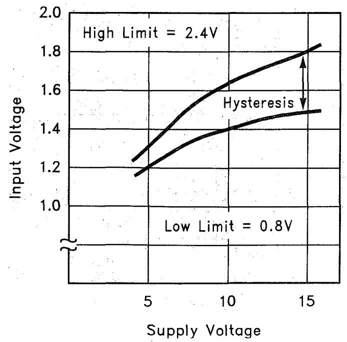
# Typical Performance Curve

**Max Power/Derating Curves**



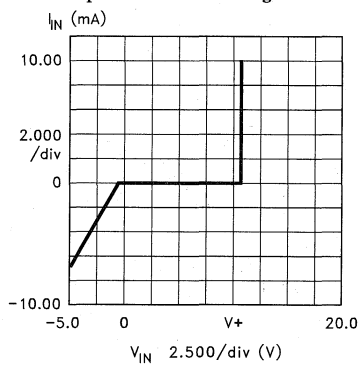

7182-15

**Switch Threshold vs Supply Voltage**



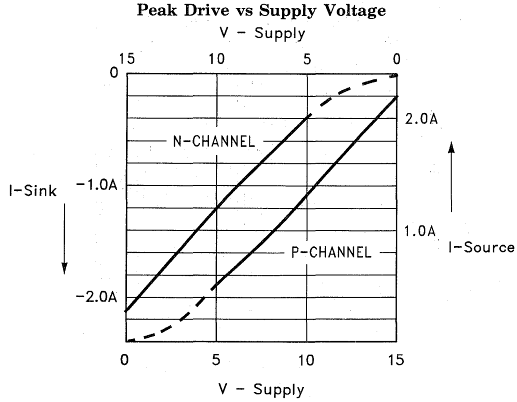

7182-4

**Input Current vs Voltage**



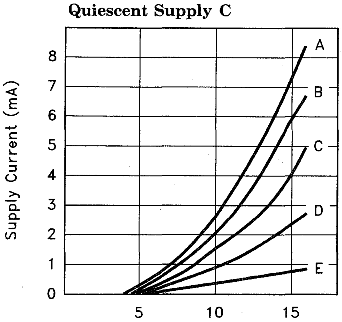

7182-5

**Peak Drive vs Supply Voltage**




7182-6

**Quiescent Supply C**

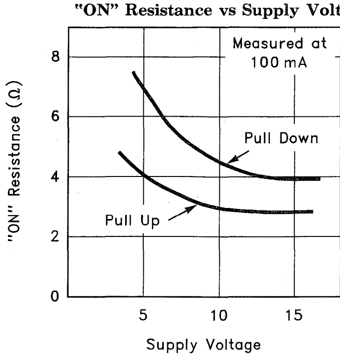



**CASE:**

| Input Level | Curve |
|---|---|
| GND | B |
| V+ | D |

7182-7

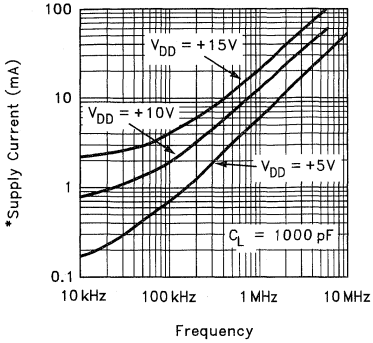
**"ON" Resistance vs Supply Voltage**




7182-16

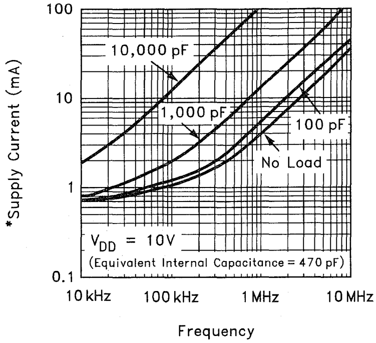
## Typical Performance Curve — Contd.

**Average Supply Current vs Voltage and Frequency**



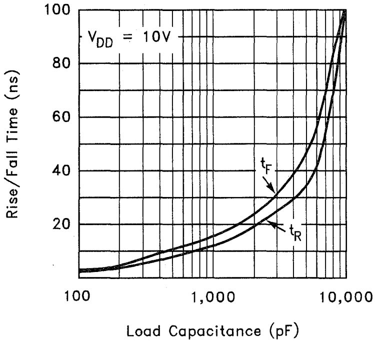

7182-8

**Average Supply Current vs Capacitive Load**



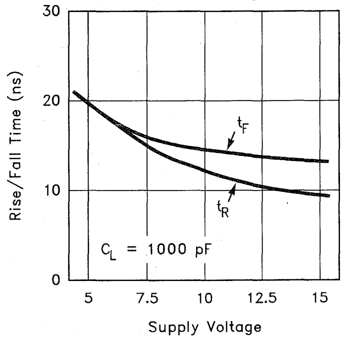

7182-9

**Rise/Fall Time vs Load**




7182-14

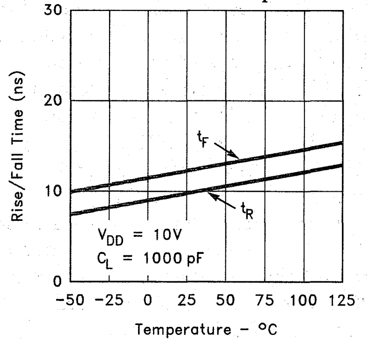
**Rise/Fall Time vs Supply Voltage**




7182-10

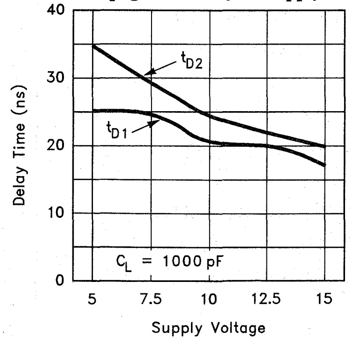
## Typical Performance Curve — Contd.

**Rise/Fall Time vs Temperature**



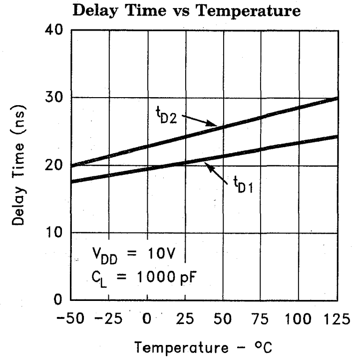

7182-12

**Propagation Delay vs Supply Voltage**




7182-11

**Delay Time vs Temperature**




7182-13

élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# EL7202C/7212C/7222C

***High Speed, Dual Channel Power MOSFET Drivers***

## Features

- Industry standard driver replacement
- Improved response times
- Matched rise and fall times
- Reduced clock skew
- Low output impedance
- Low input capacitance
- High noise immunity
- Improved clocking rate
- Low supply current
- Wide operating voltage range

## Applications

- Clock/line drivers
- CCD Drivers
- Ultra-sound transducer drivers
- Power MOSFET drivers
- Switch mode power supplies
- Class D switching amplifiers
- Ultrasonic and RF generators
- Pulsed circuits

## Ordering Information

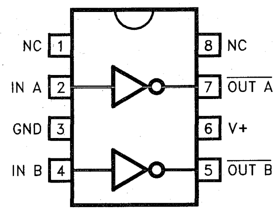
| Part No. | Temp. Range | Pkg. | Outline # |
|---|---|---|---|
| EL7202CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7202CS | −40°C to +85°C | 8-Pin SOL | MDP0027 |
| EL7212CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7212CS | −40°C to +85°C | 8-Pin SOL | MDP0027 |
| EL7222CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7222CS | −40°C to +85°C | 8-Pin SOL | MDP0027 |

## General Description

The EL7202C/EL7212C/EL7222C ICs are matched dual-drivers ICs that improve the operation of the industry standard DS0026 clock drivers. The Elantec Versions are very high speed drivers capable of delivering peak currents of 2.0 amps into highly capacitive loads. The high speed performance is achieved by means of a proprietary "Turbo-Driver" circuit that speeds up input stages by tapping the wider voltage swing at the output. Improved speed and drive capability are enhanced by matched rise and fall delay times. These matched delays maintain the integrity of input-to-output pulse-widths to reduce timing errors and clock skew problems. This improved performance is accompanied by a 10 fold reduction in supply currents over bipolar drivers, yet without the delay time problems commonly associated with CMOS devices. Dynamic switching losses are minimized with non-overlapped drive techniques.

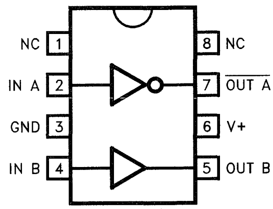
## Connection Diagrams

EL7212C



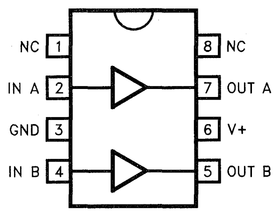

Inverting Drivers 7202-1

EL7222C




7202-2
Complementary Drivers

EL7202C




7202-3
Non-Inverting Drivers

Manufactured under U.S. Patent Nos. 5,334,883, #5,341,047

December 1993 Rev. A

# EL7202C/EL7212C/EL7222C

## High Speed, Dual Channel Power MOSFET Drivers

## Absolute Maximum Ratings

| | |
|---|---|
| Supply (V+ to Gnd) | 16.5V |
| Input Pins | −0.3V to +0.3V above V+ |
| Combined Peak Output Current | 4A |
| Storage Temperature Range | −65°C to +150°C |
| Ambient Operating Temperature | −40°C to +85°C |
| Operating Junction Temperature | 125°C |
| Power Dissipation | |
| SOIC | 670 mW |
| PDIP | 1050 mW |

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, therefore $T_J = T_C = T_A$.

| 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. |

## DC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

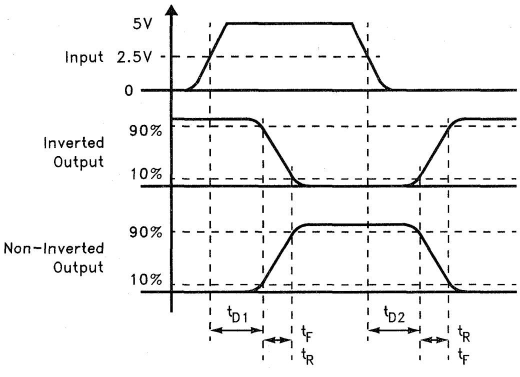
| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 2.4 | | | I | V |
| $I_{IH}$ | Logic "1" Input Current | @V+ | | 0.1 | 10 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | @0V | | 0.1 | 10 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.3 | | V | V |
| **Output** | | | | | | | |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT}$ = −100 mA | | 3 | 6 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT}$ = +100 mA | | 4 | 6 | I | Ω |
| $I_{PK}$ | Peak Output Current | Source<br>Sink | | 2<br>2 | | IV | A |
| $I_{DC}$ | Continuous Output Current | Source/Sink | 100 | | | I | mA |
| **Power Supply** | | | | | | | |
| $I_S$ | Power Supply Current | Inputs High/7202<br>Inputs High/7212<br>Inputs High/7222 | | 4.5<br>1<br>2.5 | 7.5<br>2.5<br>5.0 | I<br>I<br>I | mA |
| $V_S$ | Operating Voltage | | 4.5 | | 15 | I | V |

# EL7202C/EL7212C/EL7222C
## High Speed, Dual Channel Power MOSFET Drivers

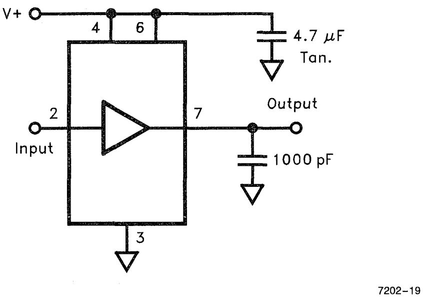
## AC Electrical Characteristics $T_A = 25°C$, V = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 7.5<br>10 | <br>20 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 10<br>13 | <br>20 | IV | ns |
| $t_{D1}$ | Turn-On Delay Time | See Timing Table | | 18 | 25 | IV | ns |
| $t_{D2}$ | Turn-Off Delay Time | See Timing Table | | 20 | 25 | IV | ns |

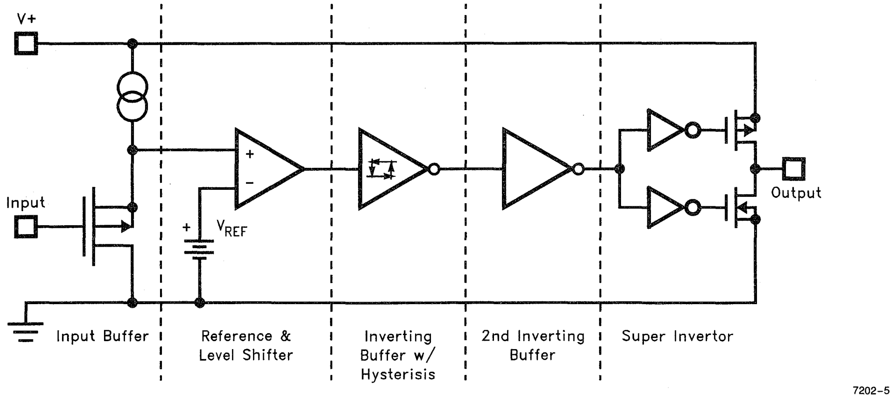
### Timing Table




### Standard Test Configuration

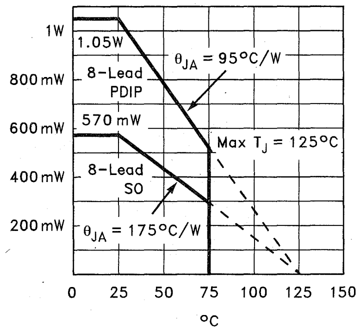



### Simplified Schematic



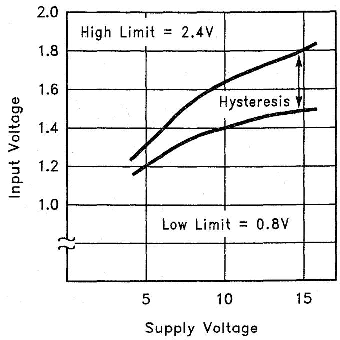
## Typical Performance Curve

**Max Power/Derating Curves**



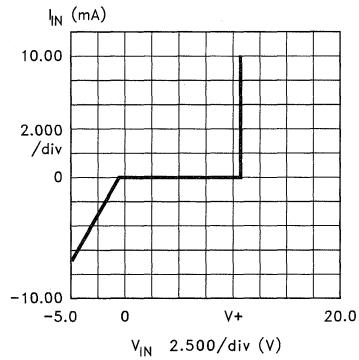

7202-6

**Switch Threshold vs Supply Voltage**



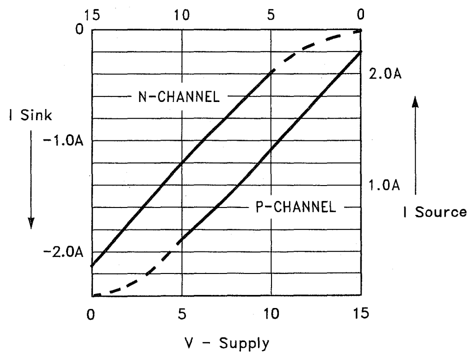

7202-7

**Input Current vs Voltage**



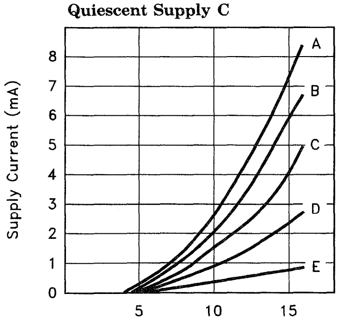

7202-8

**Peak Drive vs Supply Voltage**




7202-9

**Quiescent Supply C**

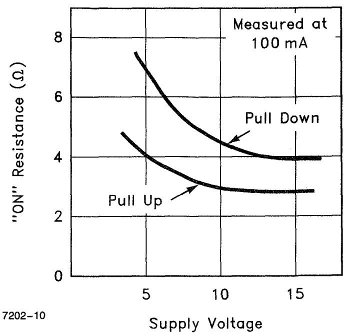



CASE:

| Device | Input Level | Curve |
|---|---|---|
| EL7202 | GND | A |
| EL7202 | GND, V+ | B |
| EL7202 | V+ | C |
| EL7212 | GND | C |
| EL7212 | GND, V+ | D |
| EL7212 | V+ | E |
| EL7222 | GND | B |
| EL7222 | GND, V+ | C |
| EL7222 | V+ | D |

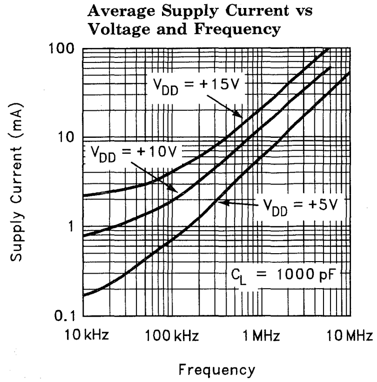
7202-10

**"ON" Resistance vs Supply Voltage**

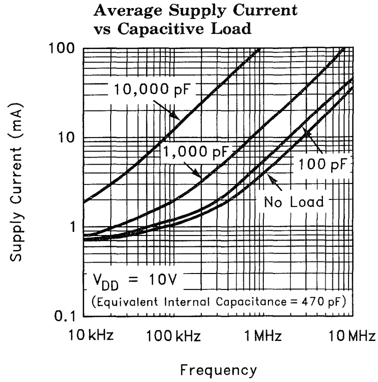



7202-11

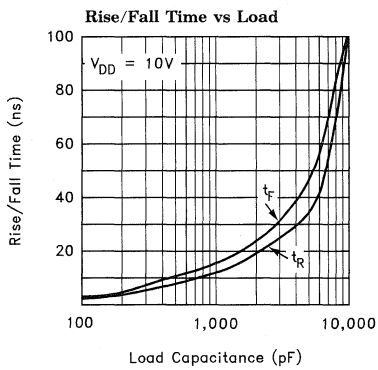
## Typical Performance Curve — Contd.



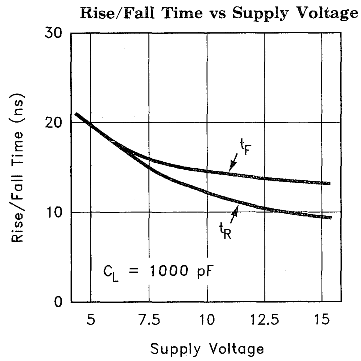

7202-12




7202-13



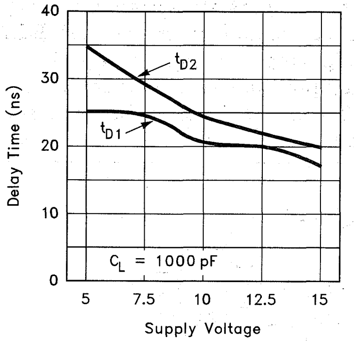

7202-14




7202-15

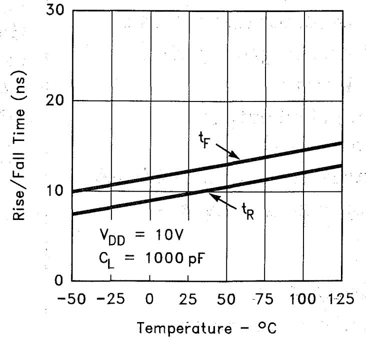
## Typical Performance Curve — Contd.

**Propagation Delay vs Supply Voltage**



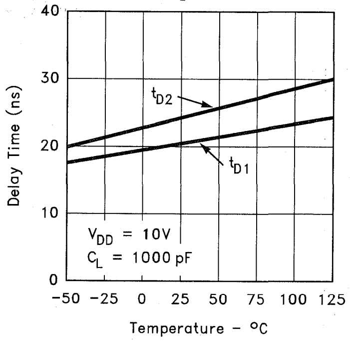

7202-16

**Rise/Fall Time vs Temperature**




7202-17

**Delay vs Temperature**




7202-18

**élantec**
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# *EL7232C*

*Dual Channel, High Speed, High Current Line Driver w/3-State*

## Features

- 3-State output
- 3V and 5V input compatible
- Clocking speeds up to 10 MHz
- 20 ns Switching/delay time
- 2A Peak drive
- Low, matched output impedance—5Ω
- Low quiescent current—2.5 mA
- Wide operating voltage—4.5V--16V

## Applications

- Parallel bus line drivers
- EPROM and PROM programming
- Motor controls
- Charge pumps
- Sampling circuits
- Pin drivers
- Bridge circuits

## Ordering Information

| Part No. | Temp. Range | Pkg. | Outline # |
|---|---|---|---|
| EL7232CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7232CS | −40°C to +85°C | 8-Pin SO | MDP0027 |

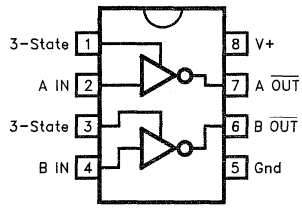
## Truth Table

| 3-State | Input | Output |
|---|---|---|
| 1 | 0 | 1 |
| 1 | 1 | 0 |
| 0 | 0 | Open |
| 0 | 1 | Open |

## General Description

The EL7232C 3-state drivers are particularly well suited for ATE and microprocessor based applications. The low quiescent power dissipation makes this part attractive in battery applications. The 2A peak drive capability, makes the EL7232C an excellent choice when driving high speed capacitive lines, as well. The input circuitry provides level shifting from TTL levels to the supply rails. The EL7232C is available in 8-pin P-DIP and 8-lead SO packages.

## Connection Diagram




7232-1

Manufactured under U.S. Patent Nos. 5,334,883, #5,341,047

December 1993 Rev. A

# EL7232C
## Dual Channel, High Speed, High Current Line Driver w/3-State



## Absolute Maximum Ratings

| | |
|---|---|
| Supply (V+ to Gnd) | 16.5V |
| Input Pins | −0.3V to +0.3V above V+ |
| Combined Peak Output Current | 4A |
| Storage Temperature Range | −65°C to +150°C |
| Ambient Operating Temperature | −40°C to +85°C |
| Operating Junction Temperature | 125°C |
| Power Dissipation | |
| SOIC | 670 mW |
| PDIP | 1050 mW |

**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, therefore $T_J = T_C = T_A$.**

| 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. |

## DC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

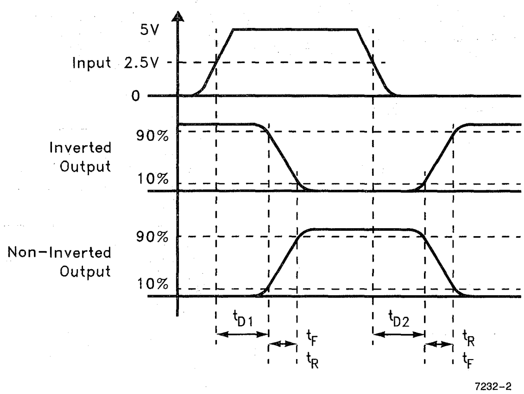
| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 2.4 | | | I | V |
| $I_{IH}$ | Logic "1" Input Current | @V+ | | 0.1 | 10 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | @0V | | 0.1 | 10 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.3 | | V | V |
| **Output** | | | | | | | |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT}$ = −100 mA | | 3 | 6 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT}$ = +100 mA | | 4 | 6 | I | Ω |
| $I_{OFF}$ | 3-State Output Leakage | $V_{OUT}$ = V+<br>$V_{OUT}$ = 0V | 0.2 | | 10 | I | μA |
| $I_{PK}$ | Peak Output Current | Source<br>Sink | | 2.0<br>2.0 | | IV | A |
| $I_{DC}$ | Continuous Output Current | Source/Sink | 100 | | | I | mA |
| **Power Supply** | | | | | | | |
| $I_S$ | Power Supply Current | Inputs High | | 1 | 2.5 | I | mA |
| $V_S$ | Operating Voltage | | 4.5 | | 16 | I | V |

# EL7232C
## Dual Channel, High Speed, High Current Line Driver w/3-State

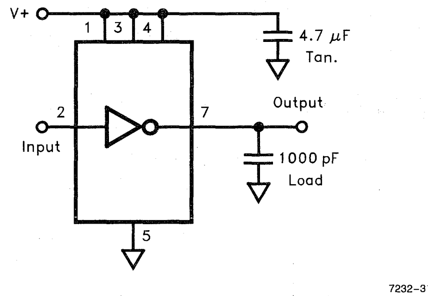
### AC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 7.5<br>10 | | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 10<br>13 | <br>20 | IV | ns |
| $t_{D\text{-}ON}$ | Turn-On Delay Time | | | 18 | 25 | IV | ns |
| $t_{D\text{-}OFF}$ | Turn-Off Delay Time | | | 20 | 25 | IV | ns |

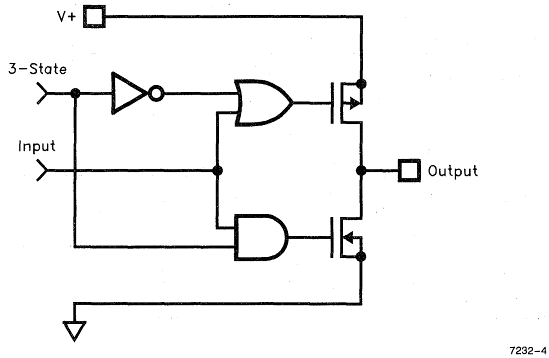
### Timing Table




### Standard Test Configuration

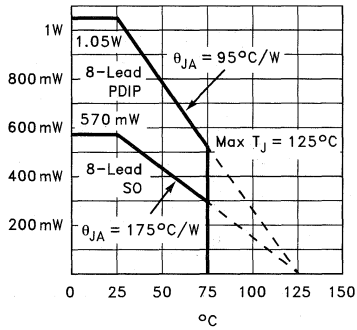



### Simplified Schematic



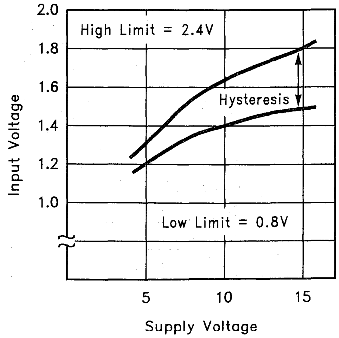
## Typical Performance Curve

**Max Power/Derating Curves**



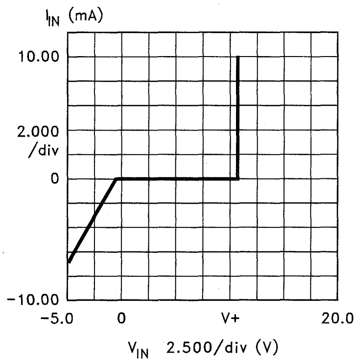

7232-6

**Switch Threshold vs Supply Voltage**



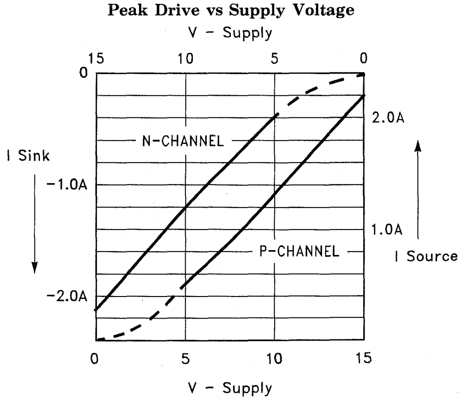

7232-7

**Input Current vs Voltage**



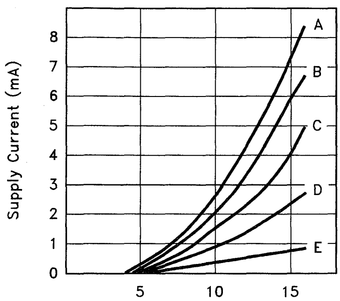

7232-8

**Peak Drive vs Supply Voltage**




7232-9

**Quiescent Supply C**

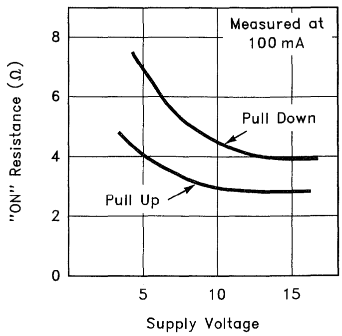



CASE:

| Device | Input Level | Curve |
|---|---|---|
| EL7202 | GND | A |
| EL7202 | GND, V+ | B |
| EL7202 | V+ | C |
| EL7212 | GND | C |
| EL7212 | GND, V+ | D |
| EL7212 | V+ | E |
| EL7222 | GND | B |
| EL7222 | GND, V+ | C |
| EL7222 | V+ | D |

7232-10

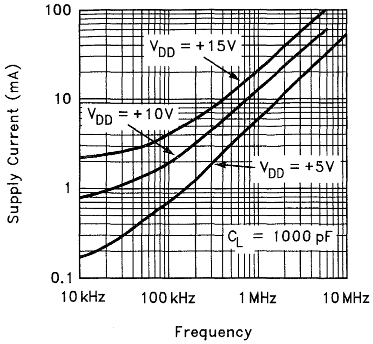
**"ON" Resistance vs Supply Voltage**




7232-17

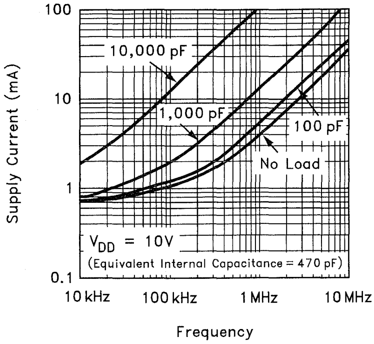
## Typical Performance Curve — Contd.

**Average Supply Current vs Voltage and Frequency**



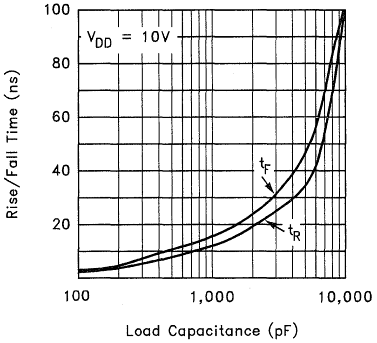

7232-11

**Average Supply Current vs Capacitive Load**



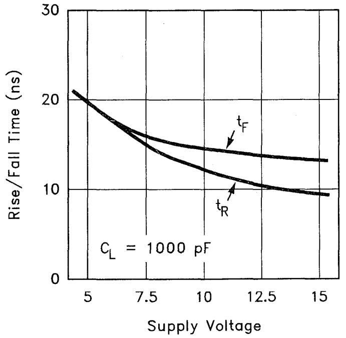

7232-12

**Rise/Fall Time vs Load**




7232-5

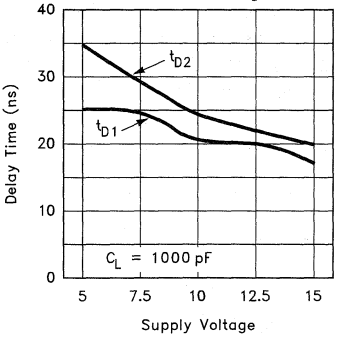
**Rise/Fall Time vs Supply Voltage**




7232-13

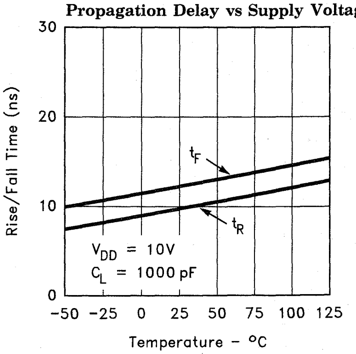
## Typical Performance Curve — Contd.

**Rise/Fall Time vs Temperature**



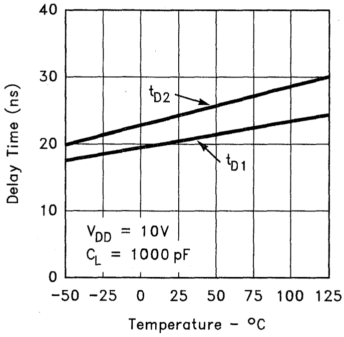

7232-14

**Propagation Delay vs Supply Voltage**




7232-15

**Propagation Delay vs Temperature**




7232-16

élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# EL7242C/EL7252C

*Dual Input, High Speed, Dual Channel Power MOSFET Driver*

## Features

- Logic AND/NAND input
- 3V and 5V Input compatible
- Clocking speeds up to 10 MHz
- 20 ns Switching/delay time
- 2A Peak drive
- Isolated drains
- Low output impedance
- Low quiescent current
- Wide operating voltage—4.5V–16V

## Applications

- Short circuit protected switching
- Under-voltage shut-down circuits
- Switch-mode power supplies
- Motor controls
- Power MOSFET switching
- Switching capacitive loads
- Shoot-thru protection
- Latching drivers

## Ordering Information

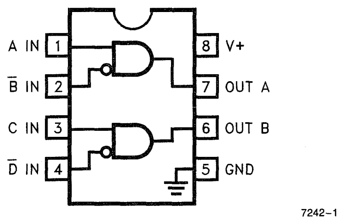
| Part No. | Temp. Range | Pkg. | Outline # |
|---|---|---|---|
| EL7242CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7242CS | −40°C to +85°C | 8-Pin SOIC | MDP0027 |
| EL7252CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7252CS | −40°C to +85°C | 8-Pin SOIC | MDP0027 |

## General Description

The EL7242C/EL7252C dual input, 2-channel drivers achieve the same excellent switching performance of the EL7212 family while providing added flexibility. The 2-input logic and configuration is applicable to numerous power MOSFET drive circuits. As with other Elantec drivers, the EL7242C/EL7252C are excellent for driving large capacitive loads with minimal delay and switching times. "Shoot-thru" protection and latching circuits can be implemented by simply "cross-coupling" the 2-channels.

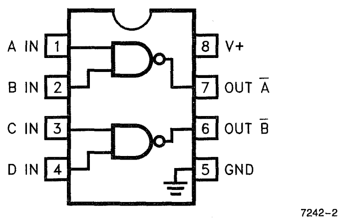
## Connection Diagrams

EL7242C




7242–1

EL7252C




7242–2

Manufactured under U.S. Patent Nos. 5,334,883, #5,341,047

December 1993 Rev. A

# EL7242C/EL7252C
## Dual Input, High Speed, Dual Channel Power MOSFET Driver

## Absolute Maximum Ratings

| | |
|---|---|
| Supply (V+ to Gnd) | 16.5V |
| Input Pins | −0.3V to +0.3V above V+ |
| Combined Peak Output Current | 4A |
| Storage Temperature Range | −65°C to +150°C |
| Ambient Operating Temperature | −40°C to +85°C |
| Operating Junction Temperature | 125°C |
| Power Dissipation | |
| SOIC | 670 mW |
| PDIP | 1050 mW |

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, therefore $T_J = T_C = T_A$.

| 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. |

## DC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 2.4 | | | I | V |
| $I_{IH}$ | Logic "1" Input Current | @V+ | | 0.1 | 10 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | @0V | | 0.1 | 10 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.3 | | V | V |
| **Output** | | | | | | | |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT}$ = −100 mA | | 3 | 6 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT}$ = +100 mA | | 4 | 6 | I | Ω |
| $I_{PK}$ | Peak Output Current | Source<br>Sink | | 2<br>2 | | IV | A |
| $I_{DC}$ | Continuous Output Current | Source/Sink | 100 | | | I | mA |
| **Power Supply** | | | | | | | |
| $I_S$ | Power Supply Current | Inputs High | | 1 | 2.5 | I | mA |
| $V_S$ | Operating Voltage | | 4.5 | | 16 | I | V |

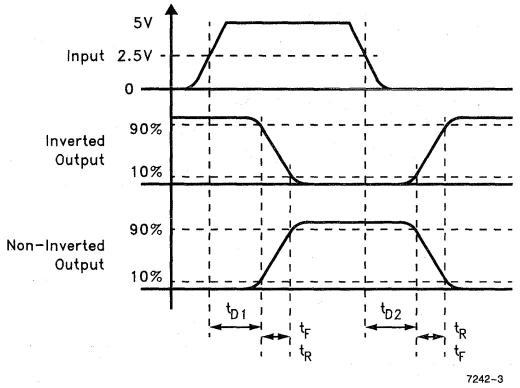
# EL7242C/EL7252C

## Dual Input, High Speed, Dual Channel Power MOSFET Driver

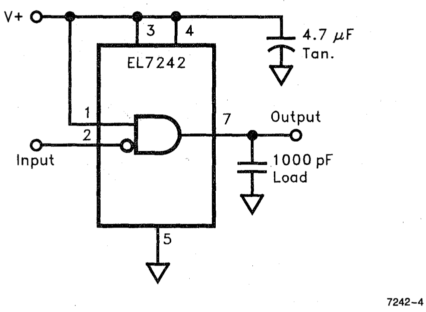
## AC Electrical Characteristics $T_A = 25°C$, V = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | | 10<br>20 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | | 10<br>20 | IV | ns |
| $t_{D\text{-}ON}$ | Turn-On Delay Time | | | 20 | 25 | IV | ns |
| $t_{D\text{-}OFF}$ | Turn-Off Delay Time | | | 20 | 25 | IV | ns |

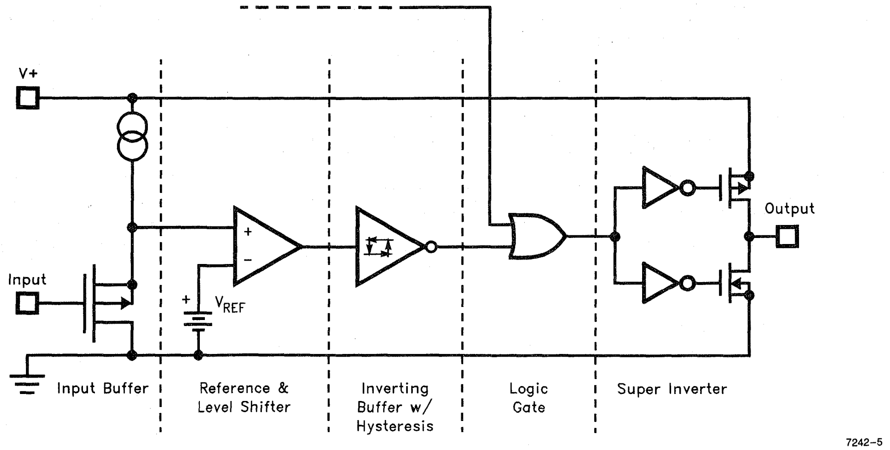
### Timing Table




### Standard Test Configuration

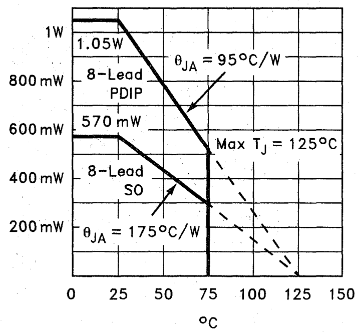



### Simplified Schematic



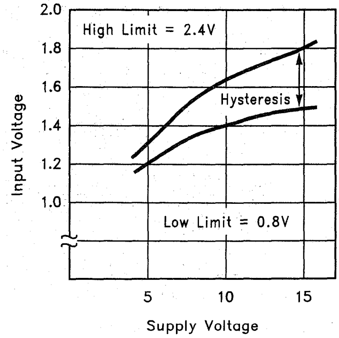
## Typical Performance Curve

**Max Power/Derating Curves**



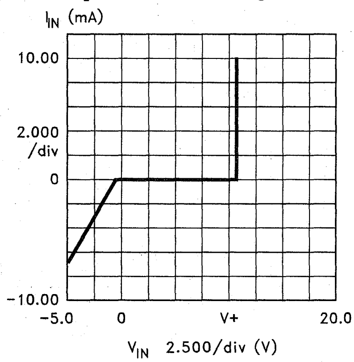

7242-17

**Switch Threshold vs Supply Voltage**



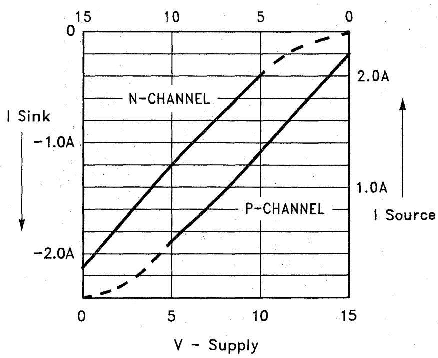

7242-6

**Input Current vs Voltage**



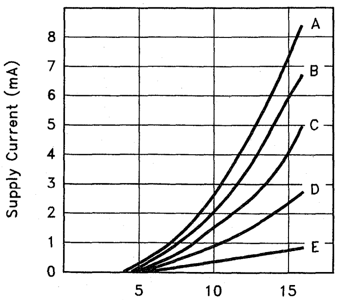

7242-7

**Peak Drive vs Supply Voltage**




7242-8

**Quiescent Supply C**

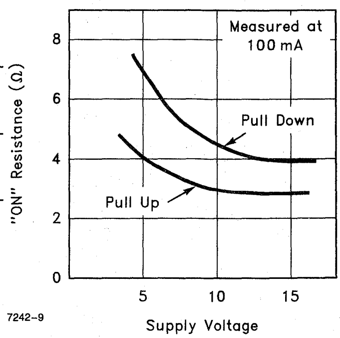



CASE:

| Device | Input Level | Curve |
|---|---|---|
| EL7202 | GND | A |
| EL7202 | GND, V+ | B |
| EL7202 | V+ | C |
| EL7212 | GND | C |
| EL7212 | GND, V+ | D |
| EL7212 | V+ | E |
| EL7222 | GND | B |
| EL7222 | GND, V+ | C |
| EL7222 | V+ | D |

7242-9

**"ON" Resistance vs Supply Voltage**

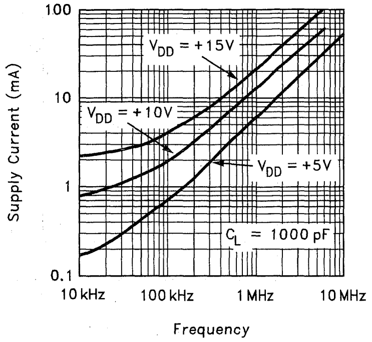



7242-18

# EL7242C/EL7252C
## Dual Input, High Speed, Dual Channel Power MOSFET Driver

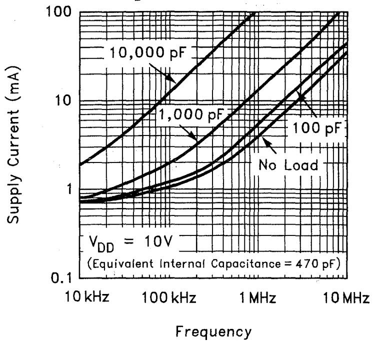
## Typical Performance Curve — Contd.

**Average Supply Current vs Voltage and Frequency**



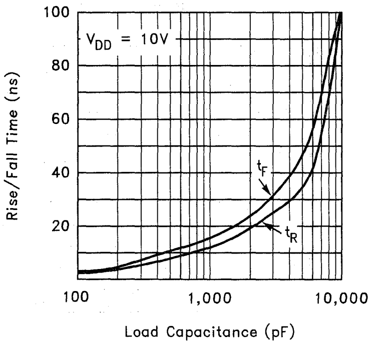

7242-10

**Average Supply Current vs Capacitive Load**



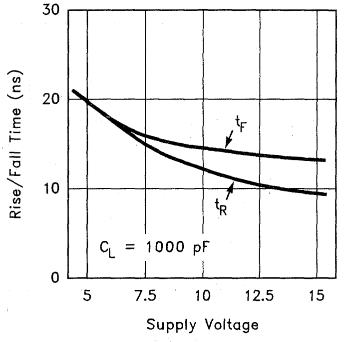

7242-11

**Rise/Fall Time vs Load**



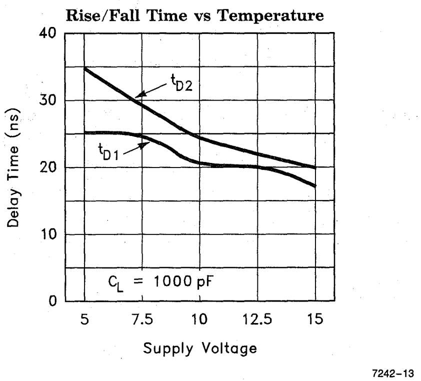

7242-16

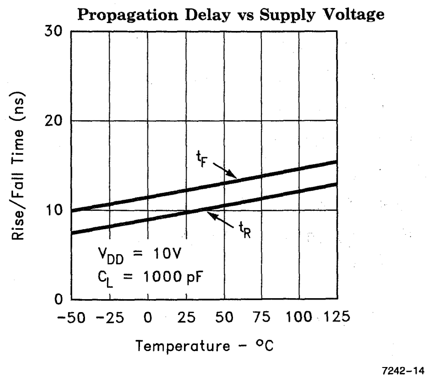
**Rise/Fall Time vs Supply Voltage**

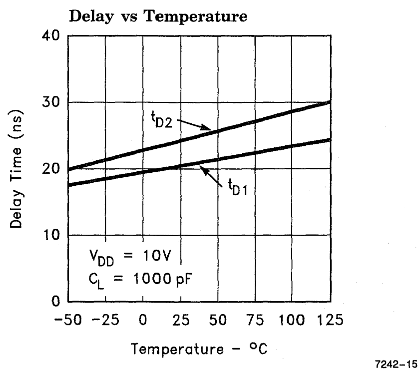



7242-12

## Typical Performance Curve — Contd.



élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# EL7243C

*Dual Input, High Speed, Dual Channel CCD Driver*

## Features

- Logic AND/NAND input
- 3V and 5V Input compatible
- Clocking speeds up to 20 MHz
- 20 ns Switching/delay time
- 2A Peak drive
- Isolated drains
- Low output impedance
- Low quiescent current
- Wide operating voltage— 4.5V–16V

## Applications

- CCD Drivers
- Short circuit protected switching
- Under-voltage shut-down circuits
- Switch-mode power supplies
- Motor controls
- Power MOSFET switching
- Switching capacitive loads
- Shoot-thru protection
- Latching drivers

## Ordering Information

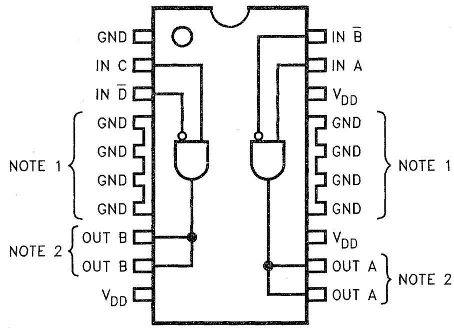
| Part No. | Temp. Range | Pkg. | Outline # |
|---|---|---|---|
| EL7243CM | −40°C to +85°C | 20-Lead Thermal SOL | MDP0027* |

## General Description

The EL7243C dual input, 2-channel driver achieves the same excellent switching performance of the EL7212 family while providing added flexibility. The power package makes this part extremely well suited for high frequency and heavy loads as in CCD applications. The 2-input logic and configuration is applicable to numerous power MOSFET drive circuits. As with other Elantec drivers, the EL7243C is excellent for driving large capacitive loads with minimal delay and switching times. "Shoot-thru" protection and latching circuits can be implemented by simply "cross-coupling" the 2-channels.

## Connection Diagram

**20-Lead Thermal SOL Package**
**EL7243C**




7243-1

Note 1: Pins 4–7 and 14–17 are electrically connected.
Note 2: Output pins must be tied together.

Manufactured under U.S. Patent Nos. 5,334,883, #5,341,047

August 1994 Rev A

# EL7243C

## Dual Input, High Speed, Dual Channel CCD Driver

## Absolute Maximum Ratings

| | |
|---|---|
| Supply (V+ to Gnd) | 16.5V |
| Input Pins | −0.3V to +0.3V above V+ |
| Combined Peak Output Current | 4A |
| Storage Temperature Range | −65°C to +150°C |
| Ambient Operating Temperature | −40°C to +85°C |
| Operating Junction Temperature | 125°C |
| Power Dissipation | |
| 20-pin "Batwing" SOIC | 1500 mW |

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, therefore $T_J = T_C = T_A$.

| 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. |

## DC Electrical Characteristics $T_A = 25°C$, $V_{DD} = 15V$ unless otherwise specified

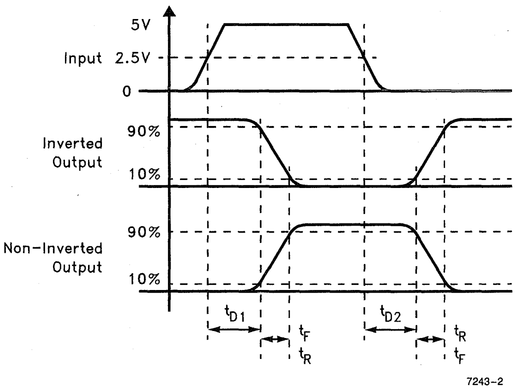
| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 2.4 | | | I | V |
| $I_{IH}$ | Logic "1" Input Current | @$V_{DD}$ | | 0.1 | 10 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | @0V | | 0.1 | 10 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.3 | | V | V |
| **Output** | | | | | | | |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT} = -100$ mA | | 3 | 6 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT} = +100$ mA | | 4 | 6 | I | Ω |
| $I_{PK}$ | Peak Output Current | Source<br>Sink | | 2<br>2 | | IV | A |
| $I_{DC}$ | Continuous Output Current | Source/Sink | 200 | | | I | mA |
| **Power Supply** | | | | | | | |
| $I_S$ | Power Supply Current | Inputs High | | 1 | 2.5 | I | mA |
| $V_S$ | Operating Voltage | | 4.5 | | 16 | I | V |

# EL7243C
## Dual Input, High Speed, Dual Channel CCD Driver

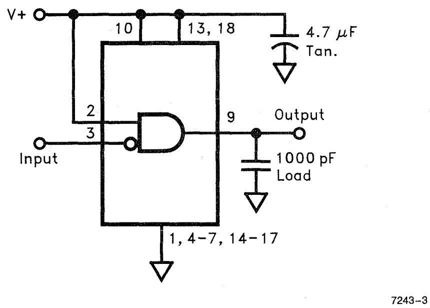
## AC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | | 10<br>20 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | | 10<br>20 | IV | ns |
| $t_{D\text{-}ON}$ | Turn-On Delay Time | | | 20 | 25 | IV | ns |
| $t_{D\text{-}OFF}$ | Turn-Off Delay Time | | | 20 | 25 | IV | ns |

### Timing Table

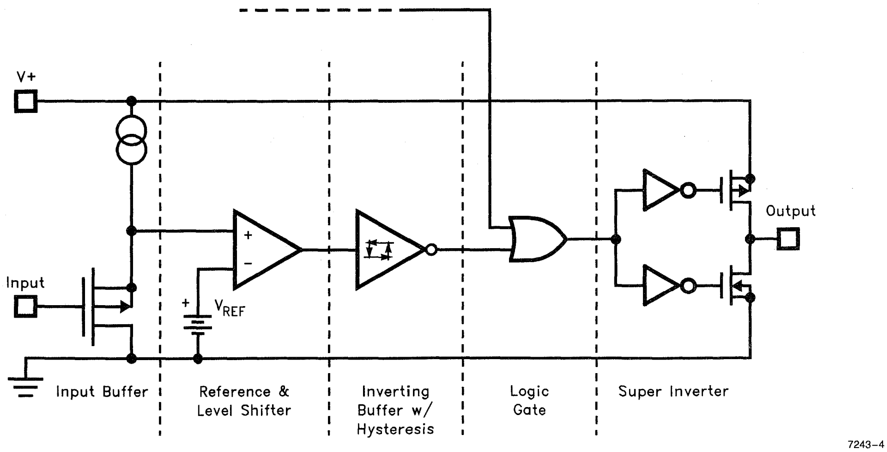



### Standard Test Configuration



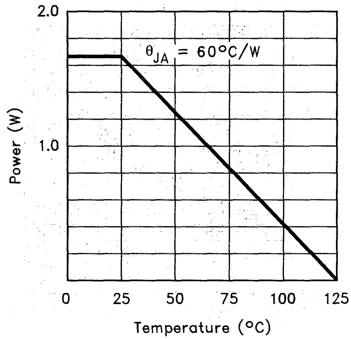

Pins 19, 20 connected to V+.

### Simplified Schematic



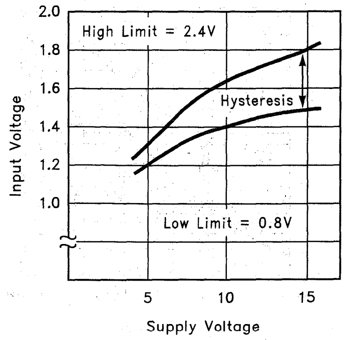
## Typical Performance Curves

**Max Power/Derating Curves**



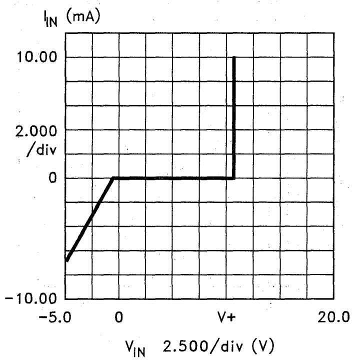

7243-5

**Switch Threshold vs Supply Voltage**



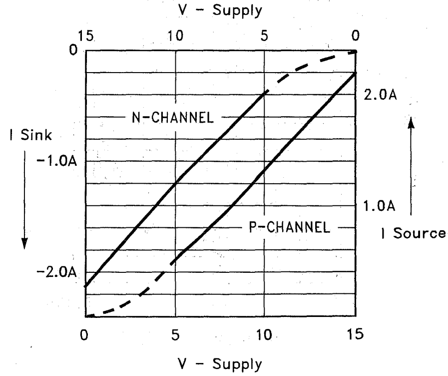

7243-6

**Input Current vs Voltage**



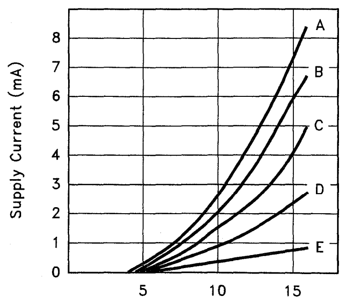

7243-7

**Peak Drive vs Supply Voltage**




7243-8

**Quiescent Supply C**

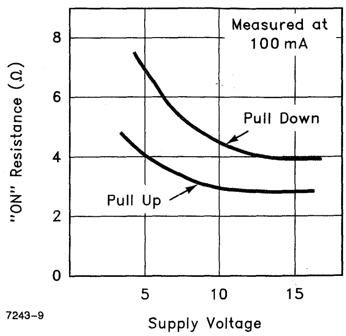



CASE:

| | |
|---|---|
| A | ALL INPUTS GND |
| B | 3 INPUTS GND |
| C | 2 INPUTS GND |
| D | 1 INPUT GND |
| E | ALL INPUTS V+ |

7243-9

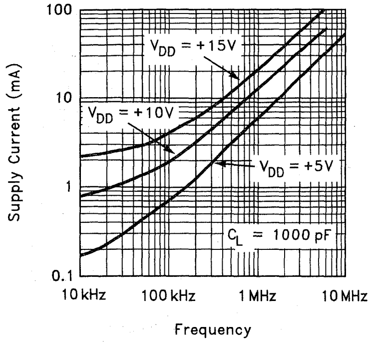
**"ON" Resistance vs Supply Voltage**




7243-10

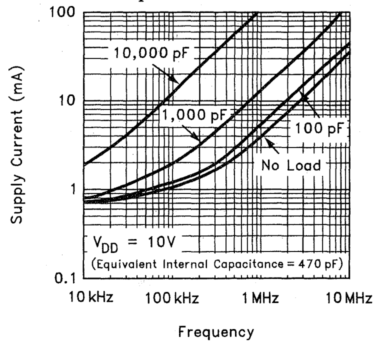
## Typical Performance Curves — Contd.

**Average Supply Current vs Voltage and Frequency**



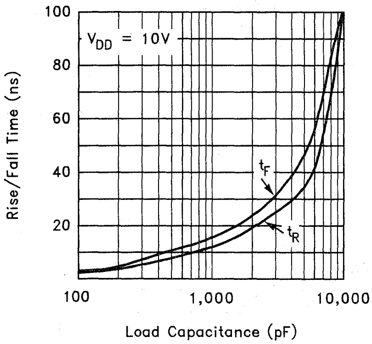

7243-11

**Average Supply Current vs Capacitive Load**



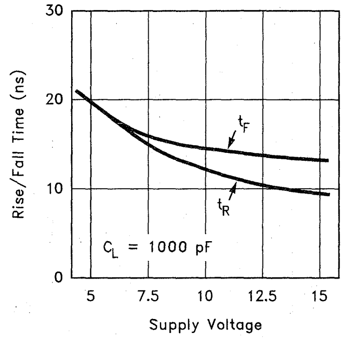

7243-12

**Rise/Fall Time vs Load**




7243-13

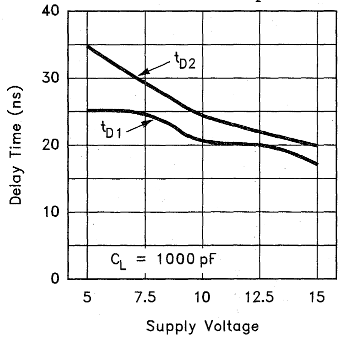
**Rise/Fall Time vs Supply Voltage**




7243-14

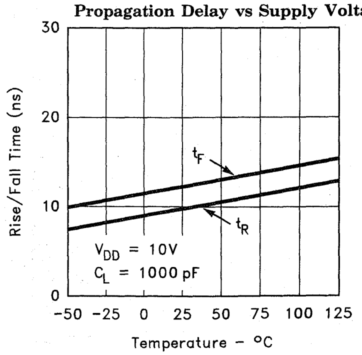
## Typical Performance Curves — Contd.

Rise/Fall Time vs Temperature



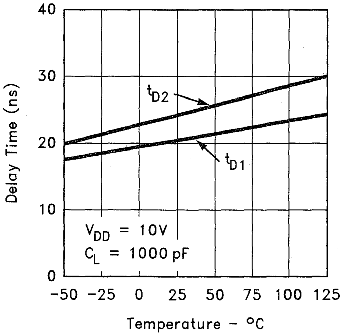

7243-15

Propagation Delay vs Supply Voltage




7243-16

Delay vs Temperature



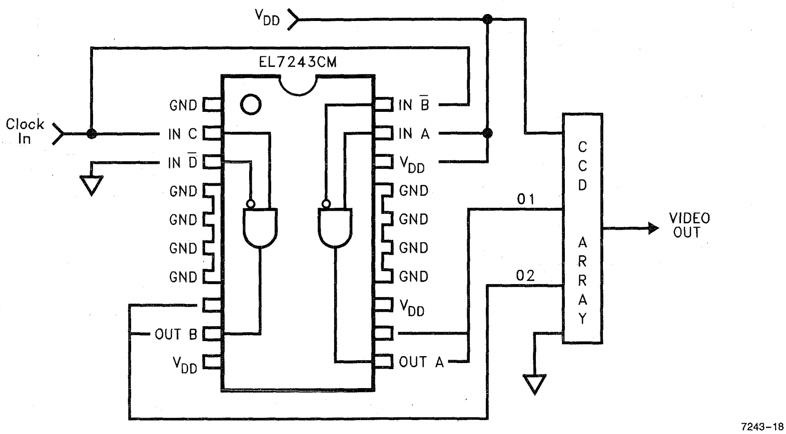

7243-17

# EL7243C

## Dual Input, High Speed, Dual Channel CCD Driver

## Applications Information

### Typical CCD Configuration



# EL7262C/EL7272C

*Dual Channel, High Speed, Power MOSFET w/Isolated Drains*



## Features

- Separate drain connections
- 3V and 5V Input compatible
- Clocking speeds up to 10 MHz
- 20 ns Switching/delay time
- 2A Peak drive
- Low output impedance
- Low quiescent current
- Wide operating voltage

## Applications

- Asymetrical switching
- Cascoded switching
- Resonant charging
- Floating load circuits
- Bridge circuits

## Ordering Information

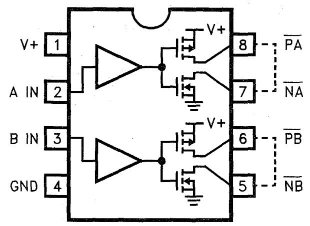
| Part No. | Temp. Range | Pkg. | Outline # |
|---|---|---|---|
| EL7262CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7262CS | −40°C to +85°C | 8-Pin SO | MDP0027 |
| EL7272CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7272CS | −40°C to +85°C | 8-Pin SO | MDP0027 |

## General Description

The EL7262C/EL7272C, dual channel, power MOSFET drivers achieve the same excellent switching performance of the EL7202 family, with the added flexibility derived through the isolated drain architecture. The outputs can be configured in numerous ways, depending upon the application. The EL7262C and EL7272C are available in 8-pin P-DIP and 8-lead SO packages.

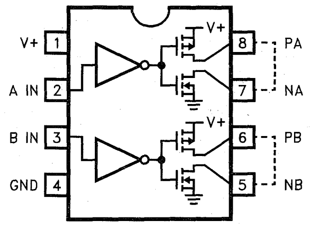
## Connection Diagrams

EL7262C




7262-1

EL7272C




7262-2

Manufactured under U.S. Patent Nos. 5,334,883, #5,341,047

# EL7262C/EL7272C

## *Dual Channel, High Speed, Power MOSFET w/Isolated Drains*

## Absolute Maximum Ratings

| | |
|---|---|
| Supply (V+ to Gnd) | 16.5V |
| Input Pins | −0.3V to +0.3V above V+ |
| Combined Peak Output Current | 4A |
| Storage Temperature Range | −65°C to +150°C |
| Ambient Operating Temperature | −40°C to +85°C |
| Operating Junction Temperature | 125°C |
| Power Dissipation | |
| SOIC | 670 mW |
| PDIP | 1050 mW |

**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, therefore $T_J = T_C = T_A$.**

| 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. |

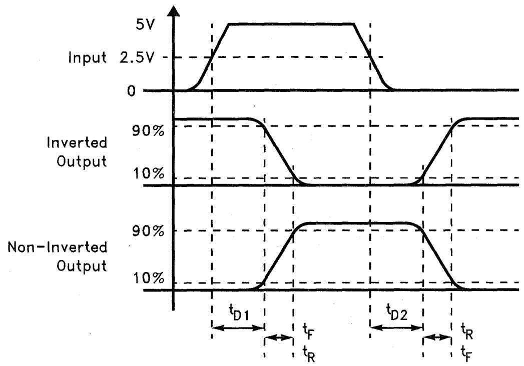
## DC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 2.4 | | | I | V |
| $I_{IH}$ | Logic "1" Input Current | @V+ | | 0.1 | 10 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | @0V | | 0.1 | 10 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.3 | | V | V |
| **Output** | | | | | | | |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT}$ = −100 mA | | 3 | 6 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT}$ = +100 mA | | 4 | 6 | I | Ω |
| $I_{OFF}$ | Output Leakage | $V_{OUT}$ = V+<br>$V_{OUT}$ = 0V | | 0.2 | 10 | I | μA |
| $I_{PK}$ | Peak Output Current | Source<br>Sink | | 2<br>2 | | IV | A |
| $I_{DC}$ | Continuous Output Current | Source/Sink | 100 | | | I | mA |
| **Power Supply** | | | | | | | |
| $I_S$ | Power Supply Current | Inputs High EL7262<br>EL7272 | | 1<br>4.5 | 2.5<br>7.5 | I | mA |
| $V_S$ | Operating Voltage | | 4.5 | | 16 | I | V |

## AC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

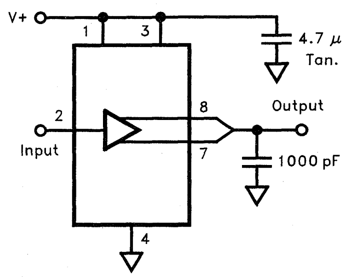
| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 7.5<br>10 | <br>20 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 10<br>13 | <br>20 | IV | ns |
| $t_{D\text{-}ON}$ | Turn-On Delay Time | See Timing Table | | 18 | 25 | IV | ns |
| $t_{D\text{-}OFF}$ | Turn-Off Delay Time | See Timing Table | | 20 | 25 | IV | ns |

### Timing Table



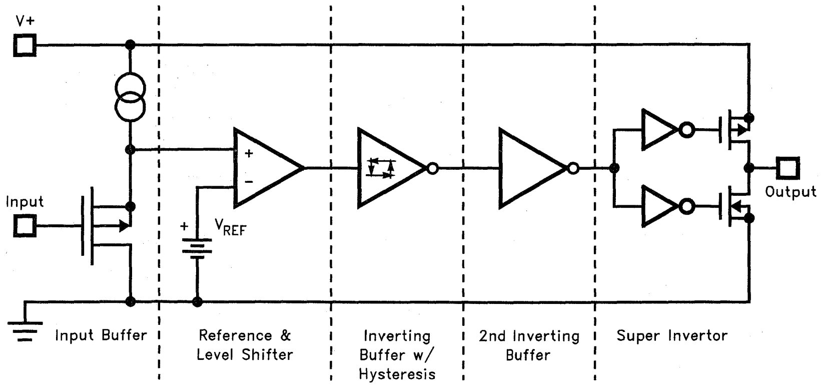

7262-3

### Standard Test Configuration




7262-4

### Simplified Schematic



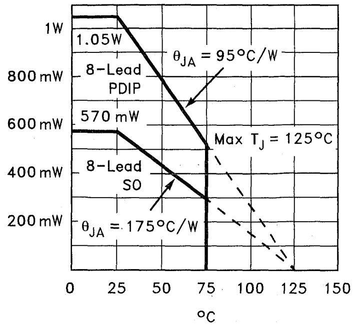

7262-5

# EL7262C/EL7272C

## Dual Channel, High Speed, Power MOSFET w/Isolated Drains

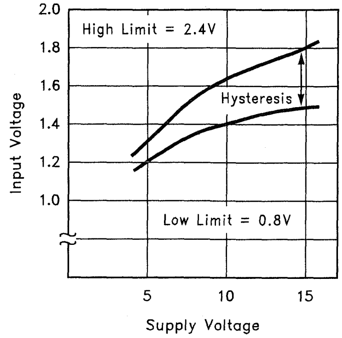
### Typical Performance Curve

**Max Power/Derating Curves**



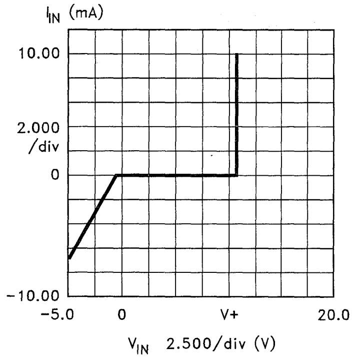

7262-12

**Switch Threshold vs Supply Voltage**



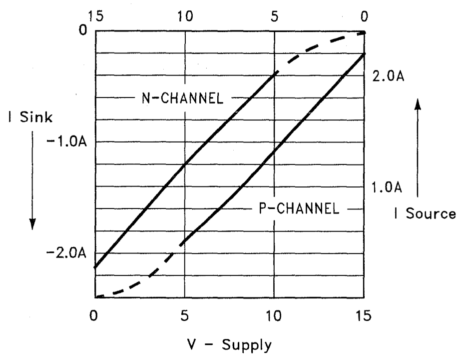

7262-6

**Input Current vs Voltage**



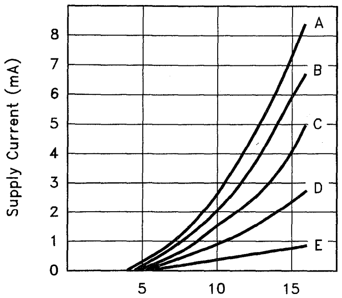

7262-7

**Peak Drive vs Supply Voltage**




7262-8

**Quiescent Supply C**

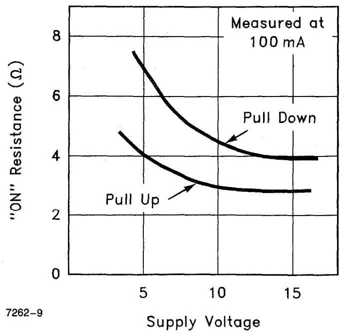



CASE:

| Device | Input Level | Curve |
|---|---|---|
| EL7262 | GND | C |
| EL7262 | GND, V+ | D |
| EL7262 | V+ | E |
| EL7272 | GND | A |
| EL7272 | GND, V+ | B |
| EL7272 | V+ | C |

7262-9

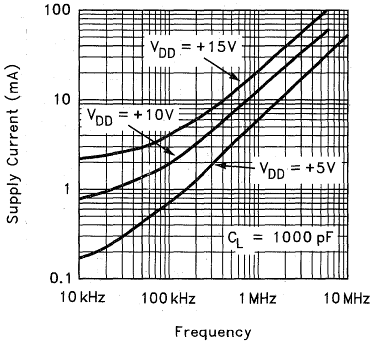
**"ON" Resistance vs Supply Voltage**




7262-10

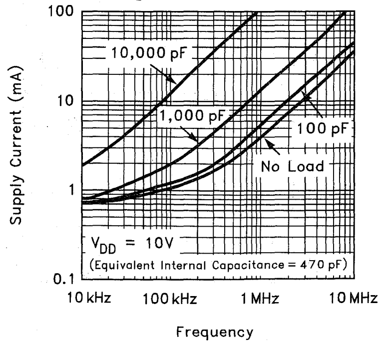
## Typical Performance Curve — Contd.

**Average Supply Current vs Voltage and Frequency**



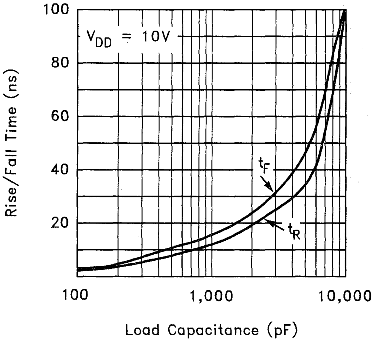

7262-13

**Average Supply Current vs Capacitive Load**



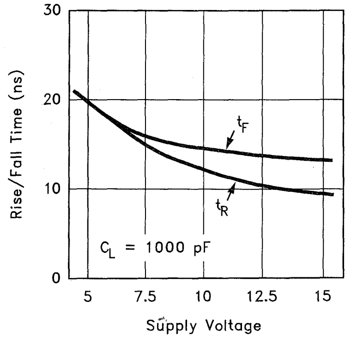

7262-14

**Rise/Fall Time vs Load**




7262-11

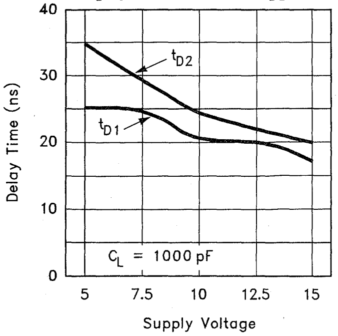
**Rise/Fall Time vs Supply Voltage**




7262-15

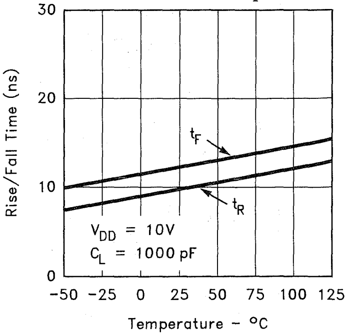
## Typical Performance Curve — Contd.

**Propagation Delay vs Supply Voltage**



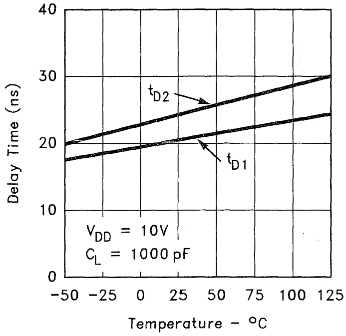

7262-16

**Rise/Fall Time vs Temperature**




7262-17

**Delay vs Temperature**




7262-18

# EL7412C

*High Speed, Four Channel Power MOSFET Drivers*



## Features

- Excellent response times
- Matched rise and fall times
- Reduced clock skew
- Low output impedance
- Low input capacitance
- High noise immunity
- Improved clocking rate
- Low supply current
- Wide operating voltage range

## Applications

- Full bridge drivers
- Clock/line drivers
- CCD Drivers
- Ultra-sound transducer drivers
- Power MOSFET drivers
- Switch mode power supplies
- Class D switching amplifiers
- Ultrasonic and RF generators
- Pulsed circuits

## Ordering Information

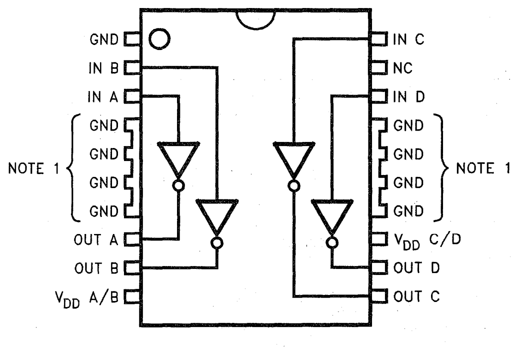
| Part No. | Temp. Range | Pkg. | Outline # |
|---|---|---|---|
| EL7412CM | −40°C to +85°C | 20 Lead Thermal SOL | MDP0027 |

## General Description

The EL7412C contains (4) high performance matched drivers. These very high speed drivers are capable of delivering peak currents of 2.0 amps into highly capacitive loads and are ideally suited for "Full bridge" and ultrasound applications. The high speed performance is achieved by means of a proprietary "Turbo-Driver" circuit that speeds up input stages by tapping the wider voltage swing at the output. Improved speed and drive capability are enhanced by matched rise and fall delay times. The matched delays maintain the integrity of input-to-output pulse-widths to reduce timing errors and clock skew problems. This improved performance is accompanied by a 10 fold reduction in supply currents over bipolar drivers, yet without the delay time problems commonly associated with CMOS devices. Dynamic switching losses are minimized with non-overlapped drive techniques.

## Connection Diagram

**20 Lead Thermal SOL Package**




Note 1: Pins 4–7 and 14–17 are electrically connected.

Manufactured under U.S. Patent Nos. 5,334,883, #5,331,047

August 1994 Rev A

# EL7412C
## High Speed, Four Channel Power MOSFET Drivers

## Absolute Maximum Ratings

| | |
|---|---|
| Supply (V+ to Gnd) | 16.5V |
| Input Pins | −0.3V to +0.3V above V+ |
| Combined Peak Output Current | 8A |
| Storage Temperature Range | −65°C to +150°C |
| Ambient Operating Temperature | −40°C to +85°C |
| Operating Junction Temperature | 125°C |
| Power Dissipation | |
| 20-Pin "Batwing" SOIC | 1500 mW |

**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, therefore $T_J = T_C = T_A$.**

| 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. |

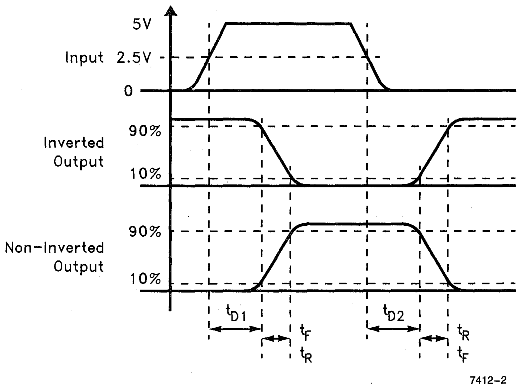
## DC Electrical Characteristics $T_A$ = 25°C, $V_{DD}$ = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 2.4 | | | I | V |
| $I_{IH}$ | Logic "1" Input Current | @$V_{DD}$ | | 0.1 | 10 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | @0V | | 0.1 | 10 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.3 | | V | V |
| **Output** | | | | | | | |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT}$ = −100 mA | | 3 | 6 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT}$ = +100 mA | | 4 | 6 | I | Ω |
| $I_{PK}$ | Peak Output Current | Source<br>Sink | | 2<br>2 | | IV | A |
| $I_{DC}$ | Continuous Output Current | Source/Sink | 100 | | | I | mA |
| **Power Supply** | | | | | | | |
| $I_S$ | Power Supply Current | Inputs High | | 2 | 5 | I | mA |
| $V_S$ | Operating Voltage | | 4.5 | | 15 | I | V |

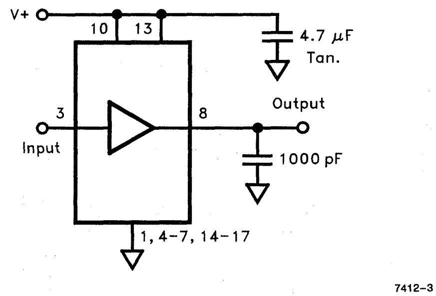
## AC Electrical Characteristics $T_A$ = 25°C, V = 15V unless otherwise specified

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 7.5<br>10 | <br>20 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 10<br>13 | <br>20 | IV | ns |
| $t_{D1}$ | Turn-On Delay Time | See Timing Table | | 18 | 25 | IV | ns |
| $t_{D2}$ | Turn-Off Delay Time | See Timing Table | | 20 | 25 | IV | ns |

### Timing Table

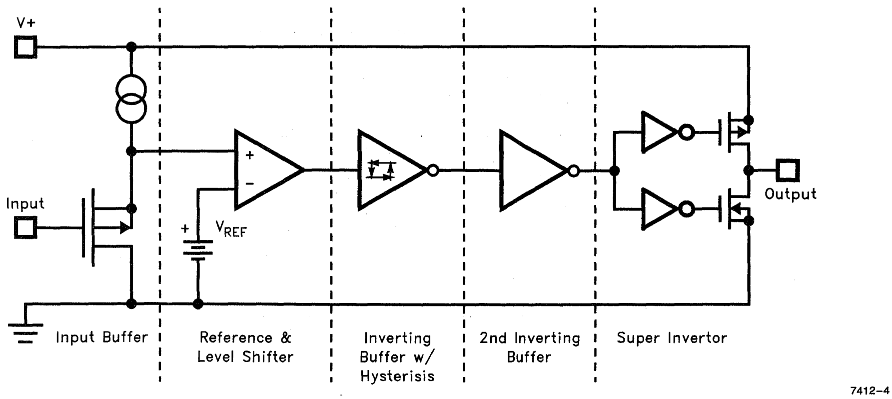



### Standard Test Configuration




Pins 2, 18, 20 connected to $V_{DD}$

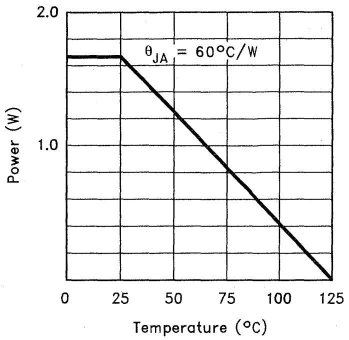
### Simplified Schematic



# EL7412C
## High Speed, Four Channel Power MOSFET Drivers

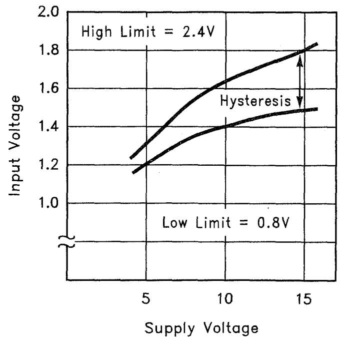
## Typical Performance Curves

**Max Power/Derating Curves**



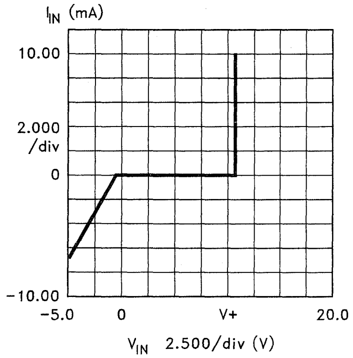

7412-5

**Switch Threshold vs Supply Voltage**



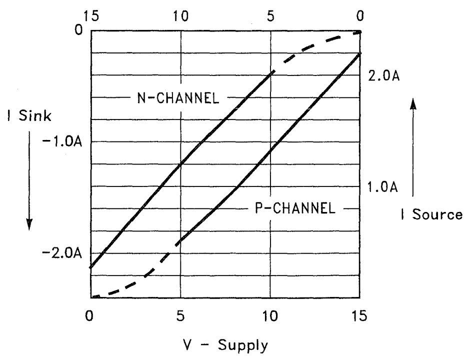

7412-6

**Input Current vs Voltage**



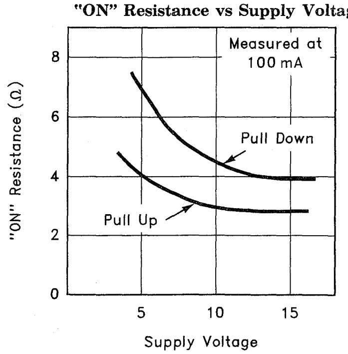

7412-7

**Peak Drive vs Supply Voltage**




7412-8

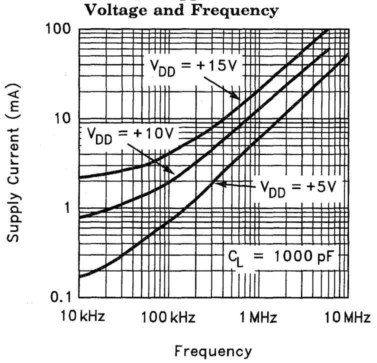
**"ON" Resistance vs Supply Voltage**




7412-10

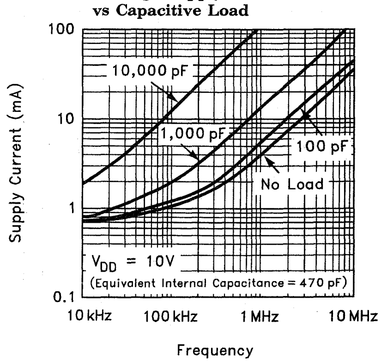
## Typical Performance Curves — Contd.

**Average Supply Current vs Voltage and Frequency**



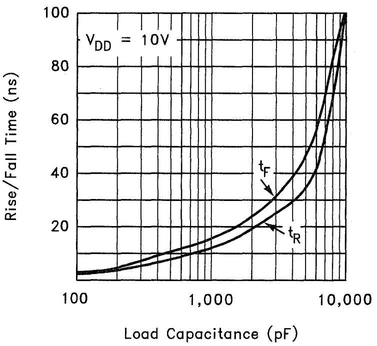

7412-11

**Average Supply Current vs Capacitive Load**



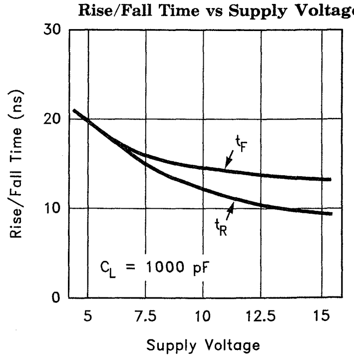

7412-12

**Rise/Fall Time vs Load**




7412-13

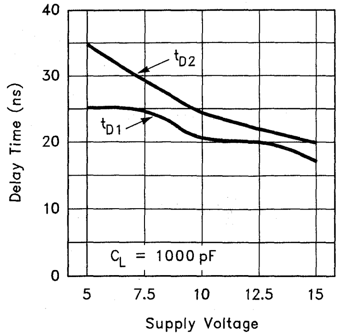
**Rise/Fall Time vs Supply Voltage**




7412-14

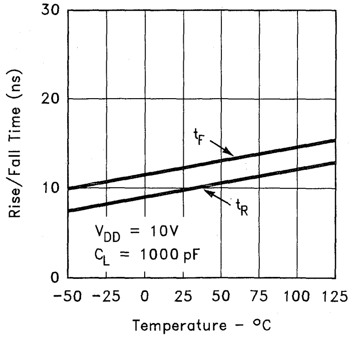
## Typical Performance Curves — Contd.

**Propagation Delay vs Supply Voltage**



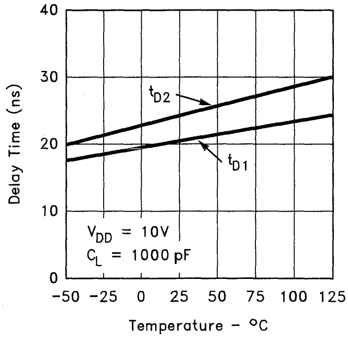

7412-15

**Rise/Fall Time vs Temperature**




7412-16

**Delay vs Temperature**




7412-17

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HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# EL7501C
## *100V High Side Driver*

## Features
- 100V High Side Voltage
- Rail to Rail Output
- 1 MHz Operation
- 1.0A Peak Current
- Matched Rise and Fall Times
- Direct Coupled
- No Start Up Ambiquity

## Applications
- Uninterruptible Power Supplies
- DC-DC Converters
- Motor Control
- Power MOSFET Driver

## Ordering Information

| Part No. | Temp. Range | Package | Outline # |
|---|---|---|---|
| EL7501CN | −40°C to +85°C | 8-Pin P-Dip | MDP0031 |
| EL7501CS | −40°C to +85°C | 8-Lead SO | MDP0027 |

## General Description
The EL7501 provides a low cost solution to many high side drive applications. The EL7501 is DC coupled so there are no start up problems associated with AC coupled schemes. The EL7501 is driven by user supplied complementary signals.

## Connection Diagram

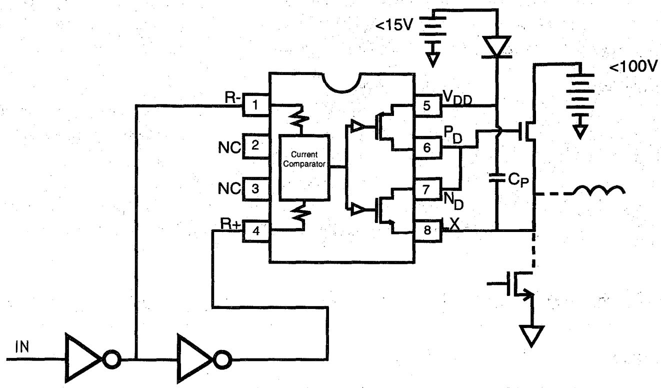
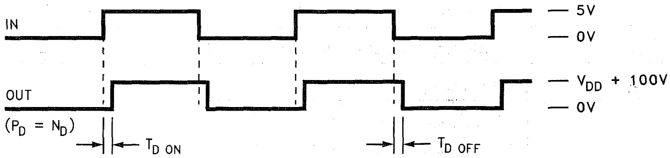



**Figure 1**

**7501 Waveform Example**






August 1994 Rev A

# EL7501C
## 100V High Side Driver

## Absolute Maximum Ratings ($T_A$ = 25°C)

| | | | | |
|---|---|---|---|---|
| Supply ($V_{DD}$ or LX to R− or R+) | 100V | Ambient Operating Temperature | | −40°C to +85°C |
| Supply ($V_{DD}$ to LX) | 16.5V | Storage Temperature Range | | −65°C to +150°C |
| Output Pins | −0.3V below GND, +0.3V above $V_{DD}$ | Operating Junction Temperature | | 125°C |
| | | Power Dissipation | SOIC | 670 mW |
| Peak Output Current | 2A | | PDIP | 1050 mW |

**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, therefore $T_J = T_C = T_A$.

| 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. |

## DC Electrical Characteristics ($T_A$ = 25°C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000 pF, unless otherwise specified)

| Parameter | Description | Test Conditions | Min. | Typ. | Max. | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input/Output** | | | | | | | |
| $V_{DIFF\ (Min)}$ | Minimum Differential Input Signal to Switch Output | | 1.0 | | | I | V |
| $I_{DS\ OFF}$ | Output Leakage | GND < $V_{OUT}$ < $V_{DD}$ | −10.0 | 0.2 | +10.0 | I | μA |
| $R_{OH}$ | Pull-up Resistance | $I_{OUT}$ = −100 mA | | 5.0 | 10.0 | I | Ω |
| $R_{OL}$ | Pull-down Resistance | $I_{OUT}$ = +100 mA | | 5.0 | 10.0 | I | Ω |
| $I_{PK}$ | Peak Output Current | | | 1.0 | | IV | A |
| $I_{DC}$ | Continuous Output Current Source/Sink | | 50.0 | | | IV | mA |
| **Power Supply** | | | | | | | |
| $I_{DD}$ | Supply Current into $V_{DD}$ | | | | 4.0 | I | mA |
| $V_{DD}$ | Operating Voltage | | 4.5 | | 15.0 | I | V |

## AC Electrical Characteristics ($T_A$ = 25°C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000 pF, unless otherwise specified)

| Parameter | Description | Test Conditions | Min. | Typ. | Max. | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 15.0<br>20.0 | <br>40.0 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 15.0<br>20.0 | <br>40.0 | IV | ns |
| $t_{D\ OFF}$ | Turn Off Delay Time | | | 90.0 | 140.0 | IV | ns |
| $t_{D\ ON}$ | Turn On Delay Time | | | 90.0 | 140.0 | IV | ns |

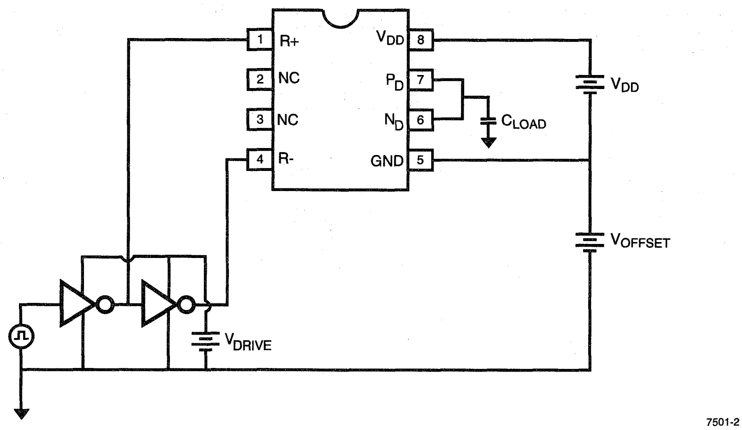



Figure 2. EL7501 Test Circuit

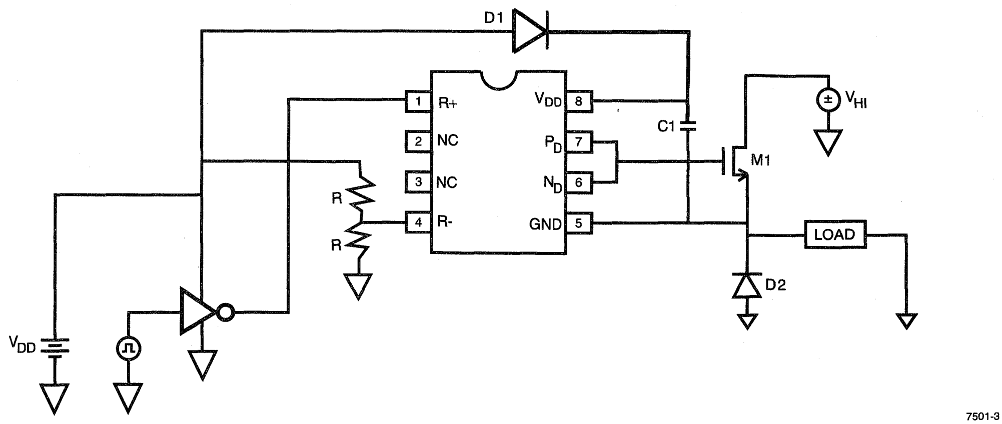
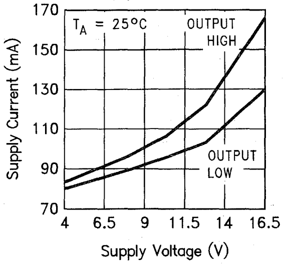



Figure 3. EL7501 Alternate Drive Method

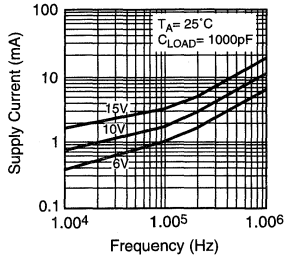
# EL7501C
## 100V High Side Driver

## Typical Performance Curves

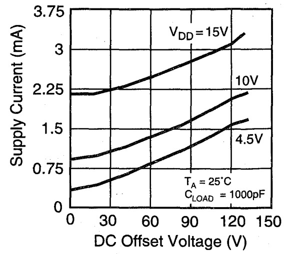
**Quiescent Supply Current vs Supply Voltage**



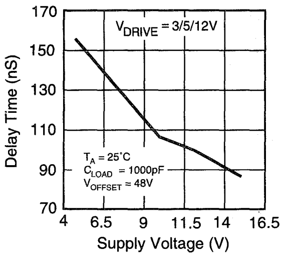

**Average Supply Current vs Voltage and Frequency**



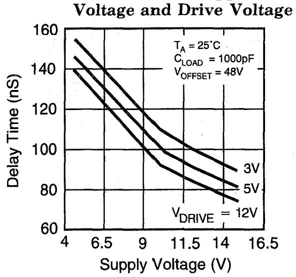

**Supply Current vs DC Offset Voltage and $V_{DD}$**



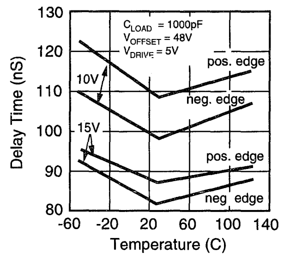

**Output Rising Edge Delay Time vs Supply Voltage and Drive Voltage**




**Output Falling Edge Delay Time vs Supply Voltage and Drive Voltage**



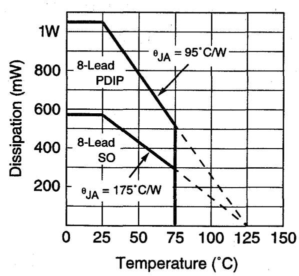

**Delay Time vs Temperature and Supply Voltage**



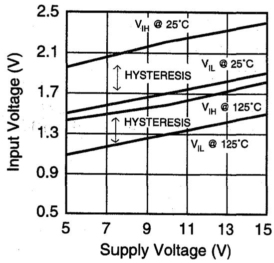

7501-4

# Typical Performance Curves — Contd.

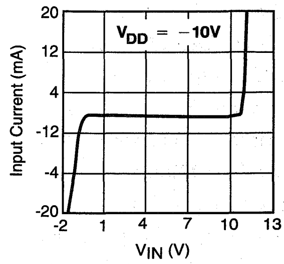
**Max. Power/ Derating Curves 8-Pin Package**



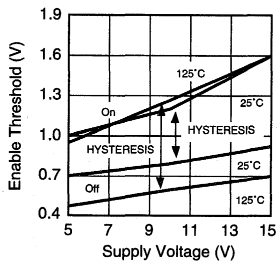

**Input Threshold vs Supply Voltage**



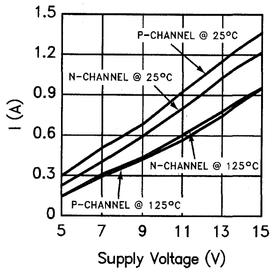

**Input Current vs Input Voltage**



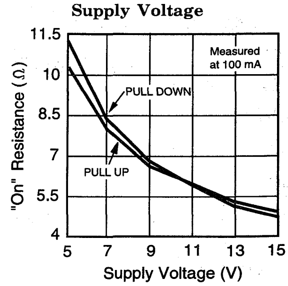

**Enable Threshold vs Supply Voltage**



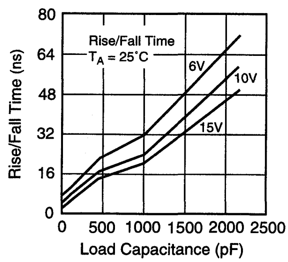

**Peak Drive vs Supply Voltage**



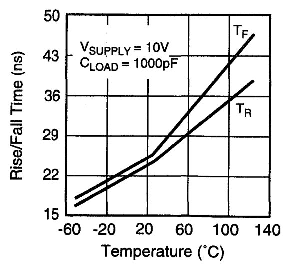

**"On" Resistance vs Supply Voltage**




**Rise/Fall Time vs Load and Supply**




**Rise/Fall Time vs Temperature**




7501-5

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HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# EL7661C
## *100V Full Bridge Driver*



## Features

- 100V High Side Voltage
- Programmable Delay
- Direct Coupled
- No Start Up Ambiguity
- Rail to Rail Output
- 1 MHz Operation
- 1.0 Amp Peak Current
- Improved Response Times
- Matched Rise and Fall Times
- Low Supply Current
- Low Output Impedance
- Low Input Capacitance

## Applications

- Uninterruptible Power Supplies
- Distributed Power Systems
- IGBT Drive
- DC-DC Converters
- Motor Control
- Power MOSFET Drive
- Switch Mode Power Supplies

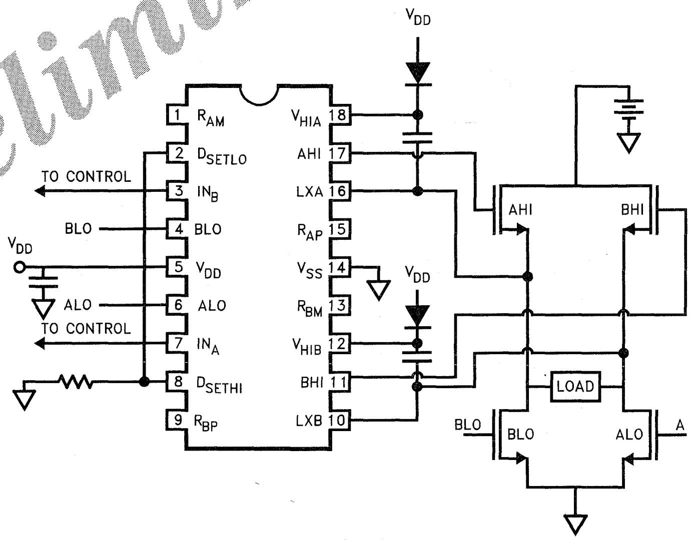
## Ordering Information

| Part No. | Temp. Range | Package | Outline # |
|---|---|---|---|
| EL7661CN | −40°C to +85°C | 18-Pin P-DIP | MDP0031 |
| EL7661CS | −40°C to +85°C | 18-Pin SOIC | MDP0027 |

## General Description

The EL7661 provides a low cost solution to many full bridge applications. The EL7661 is DC coupled so that there are no start up problems associated with AC coupled schemes. A single resistor from the $D_{SET}$ pins to GND provides "dead time" programmability. Shorting the $D_{SET}$ pins to $V_{DD}$ gives the minimum delay (~100 ns).

## Connection Diagram




7661-1

EL7661C

## Absolute Maximum Ratings ($T_A$ = 25°C)

| | |
|---|---|
| Supply ($V_{HI}$ to GND) | 100V |
| Supply ($V_{DD}$ to GND) | 18V |
| Input Pins | −0.3V below GND, +0.3V above $V_{DD}$ |
| Operating Junction Temperature | 125°C |
| Combined Peak Output Current | 4A |
| Storage Temperature Range | −65°C to +150°C |
| Ambient Operating Temperature | 0°C to +75°C |
| Power Dissipation SOIC | 910 mW |
| Power Dissipation PDIP | 1400 mW |

**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, therefore $T_J = T_C = T_A$.**

| 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. |

## DC Electrical Characteristics ($T_A$ = 25C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000 pF, unless otherwise specified)

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input/Output** | | | | | | | |
| $V_{IL}$ | Logic "1" Input Voltage | | 3.0 | | | I | V |
| $I_{IH}$ | Logic "1" Input Current | | | 0.1 | 10.0 | I | µA |
| $V_{IL}$ | Logic "0" Input Voltage | | | | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | | | 0.1 | 10.0 | I | µA |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT}$ = −100 mA | | 5.0 | 10.0 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT}$ = +100 mA | | 5.0 | 10.0 | I | Ω |
| $I_{PK}$ | Peak Output Current | | | 1.0 | | IV | A |
| $I_{DC}$ | Continuous Output Current Source/Sink | | 100.0 | | | IV | mA |
| **Power Supply** | | | | | | | |
| $I_{DD}$ | Supply Current into $V_{DD}$ | $R_{SET}$ = 5.1k, Inputs = 15V | | | 10.0 | I | mA |
| $I_{HIA}$ | Supply Current into $V_{HIA}$ | | | | 4.0 | I | mA |
| $I_{HIB}$ | Supply Current into $V_{HIB}$ | | | | 4.0 | I | mA |
| $V_{DD}$ | Operating Voltage | | 4.5 | | 15.0 | I | V |

# EL7661C
## 100V Full Bridge Driver

## AC Electrical Characteristics ($T_A$ = 25C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000 pF, unless otherwise specified)

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 15.0<br>20.0 | <br>40.0 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 15.0<br>20.0 | <br>40.0 | IV | ns |
| $t_{D\ ON\ HI}$ | High Side Turn On Delay Time | $D_{SETHI}$ = $V_{DD}$<br>$D_{SETHI}$ = 5.1k<br>$D_{SETHI}$ = 400k | 50.0<br>50.0<br>1000.0 | 100.0<br>100.0<br>1100.0 | 150.0<br>150.0<br>1200.0 | IV<br>I<br>I | ns |
| $t_{D\ ON\ LO}$ | Low Side Turn On Delay Time | $D_{SETLO}$ = $V_{DD}$<br>$D_{SETLO}$ = 5.1k<br>$D_{SETLO}$ = 400k | 50.0<br>50.0<br>1000.0 | 100.0<br>100.0<br>1100.0 | 150.0<br>150.0<br>1200.0 | IV<br>I<br>I | ns |
| $t_{D\ OFF\ HI}$ | High Side Turn Off Delay Time | $D_{SET}$ = $V_{DD}$ | | 100.0 | 150.0 | IV | ns |
| $t_{D\ OFF\ LO}$ | Low Side Turn Off Delay Time | $D_{SET}$ = $V_{DD}$ | | 100.0 | 150.0 | IV | ns |
| $t_{D\ MISMATCH}$ | High to Lo Side Turn On Delay Mismatch | $D_{SET}$ = 400k | | | +/-10.0 | I | % |

# EL7761C

## *100V Half Bridge Driver*



## Features

- 100V High Side Voltage
- Programmable Delay
- Direct Coupled
- No Start Up Ambiguity
- Rail to Rail Output
- 1 MHz Operation
- Shutdown Function
- 1.0 Amp Peak Current
- Improved Response Times
- Matched Rise and Fall Times
- Low Supply Current
- Low Output Impedance
- Low Input Capacitance

## Applications

- Uninterruptible Power Supplies
- Distributed Power Systems
- IGBT Drive
- DC-DC Converters
- Motor Control
- Power MOSFET Drive
- Switch Mode Power Supplies

## Ordering Information

| Part No. | Temp. Range | Package | Outline # |
|---|---|---|---|
| EL7761CN | −40°C to +85°C | 16-Pin P-DIP | MDP0031 |
| EL7761CS | −40°C to +85°C | 16-Pin SOIC | MDP0027* |

*Contact factory

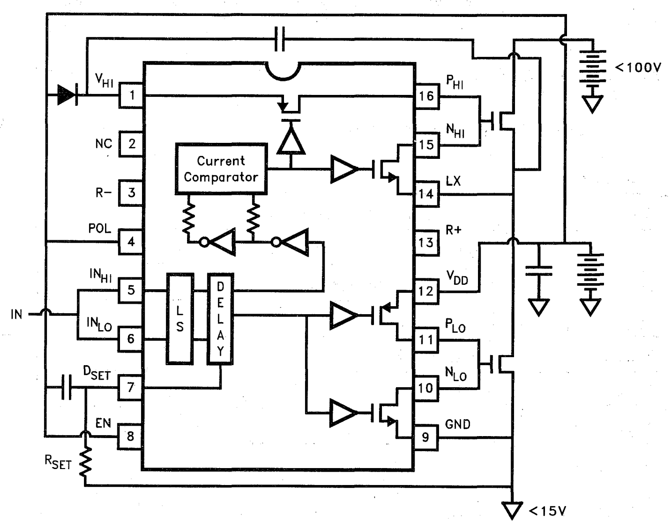
| | POL | Polarity |
|---|---|---|
| Low Side | GND<br>$V_{DD}$ | Inverting<br>Non-Inverting |
| Hi Side | X | Inverting |

## General Description

The EL7761 provides a low cost solution to many half bridge applications. The EL7761 is DC coupled so that there are no start up problems associated with AC coupled schemes. A single resistor from $D_{SET}$ to GND provides "dead time" programmability. Shorting $D_{SET}$ to $V_{DD}$ gives the shortest delay (~100 ns).

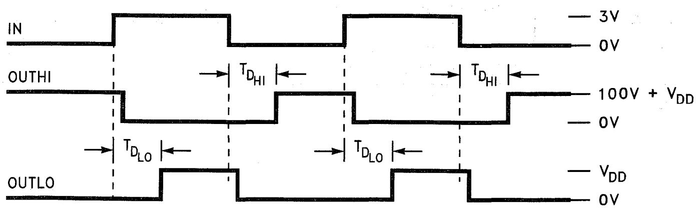
The POL pin controls the polarity of the low side driver. The polarity of the upper driver is always inverting. The EN pin, when low, forces the high and low side outputs into their low state.

## Connection Diagram




7761-1

### EL7761 Waveform Example




7761-4

$T_{DLO} = T_{DHI}$
POL = $V_{DD}$

July 1995 Rev B

# EL7761C
## 100V Half Bridge Driver

## Absolute Maximum Ratings ($T_A$ = 25°C)

| | | | | |
|---|---|---|---|---|
| Supply ($V_{HI}$ to GND) | 100V | Storage Temperature Range | | −65°C to +150°C |
| Supply ($V_{DD}$ to GND) | 16.5V | Ambient Operating Temperature | | −40°C to +85°C |
| Input Pins | −0.3V below GND, +0.3V above $V_{DD}$ | Operating Junction Temperature | | 125°C |
| | | Power Dissipation | SOIC | 1100 mW |
| Peak Current per Output | 2A | | PDIP | 1800 mW |

**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, therefore $T_J = T_C = T_A$.**

| 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. |

## DC Electrical Characteristics ($T_A$ = 25°C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000pF, unless otherwise specified)

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input/Output** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 3.0 | 2.4 | | I | V |
| $I_{IH}$ | Logic "1" Input Current | | | 0.1 | 10.0 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | 1.8 | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | | | 0.1 | 10.0 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.5 | | V | V |
| $V_{EN_H}$ | Enable Threshold | Positive Edge | 2.8 | 1.6 | | I | V |
| $V_{EN_L}$ | Disable Threshold | Negative Edge | | 0.9 | 0.6 | I | V |
| $V_{EN\ HYS}$ | Enable Hysteresis | | | 0.7 | | V | V |
| $I_{DS\ OFF}$ | Output Leakage | GND ≤ $V_{OUT}$ ≤ $V_{DD}$ | −10.0 | 0.2 | 10.0 | I | μA |
| $R_{OH}$ | Pull-up Resistance | $I_{OUT}$ = −100 mA | | 5.0 | 10.0 | I | Ω |
| $R_{OL}$ | Pull-down Resistance | $I_{OUT}$ = +100 mA | | 5.0 | 10.0 | I | Ω |
| $I_{PK}$ | Peak Output Current | | | 1.0 | | IV | A |
| $I_{DC}$ | Continuous Output Current Source/Sink | | 50.0 | | | IV | mA |

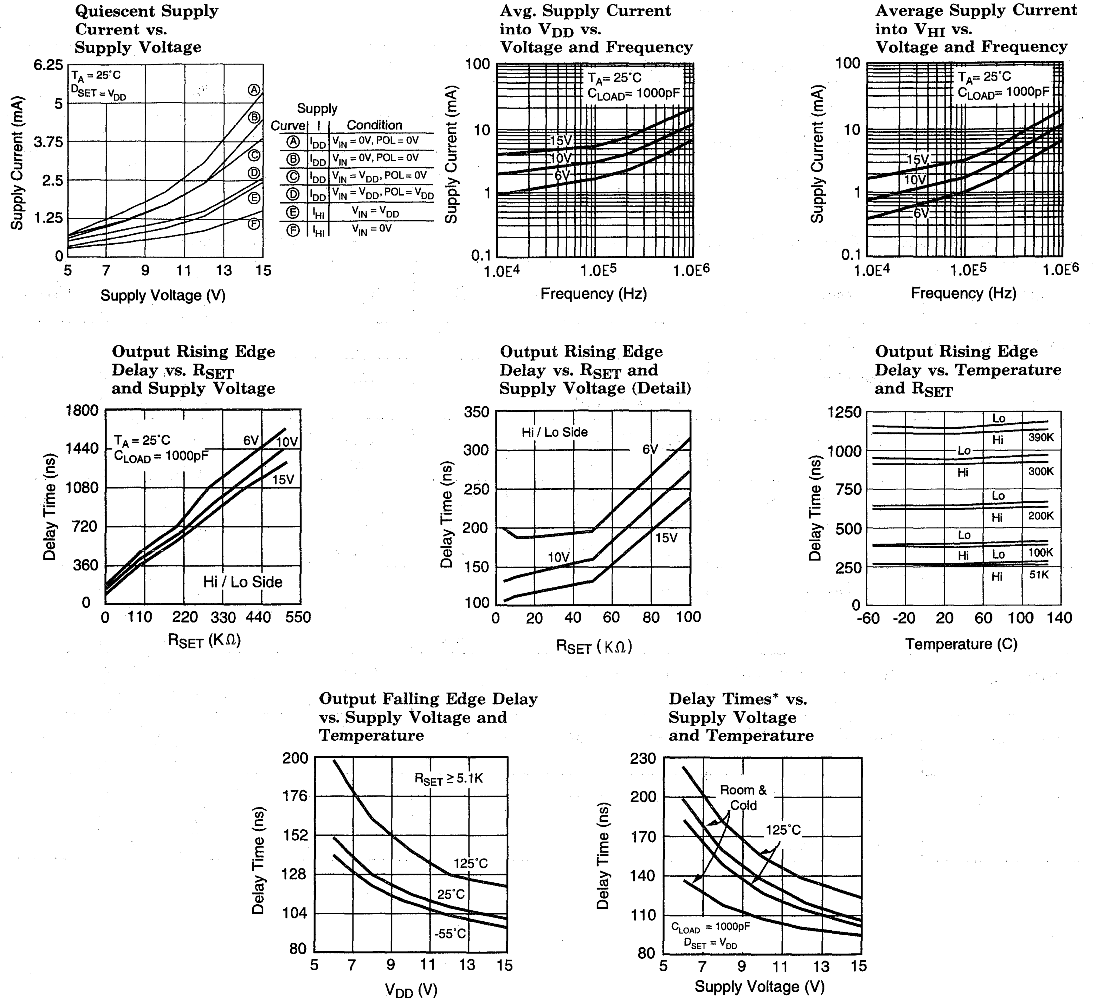
## DC Electrical Characteristics ($T_A$ = 25°C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000pF, unless otherwise specified)

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Power Supply** | | | | | | | |
| $I_{DD}$ | Supply Current into $V_{DD}$ | $R_{SET}$ = 5.1k | | 6.0 | 10.0 | I | mA |
| $I_{HI}$ | Supply Current into $V_{HI}$ | | | 2.0 | 4.0 | I | mA |
| $I_{DD\ OFF}$ | Supply Current into $V_{DD}$ | $V_{EN}$ = 0.6V | | | 750.0 | I | uA |
| $V_{DD}$ | Operating Voltage | | 4.5 | | 15.0 | I | V |

## AC Electrical Characteristics ($T_A$ = 25°C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000pF, unless otherwise specified)

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500pF<br>$C_L$ = 1000pF | | 15.0<br>20.0 | <br>40.0 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500pF<br>$C_L$ = 1000pF | | 15.0<br>20.0 | <br>40.0 | IV | ns |
| $t_{D\ ON\ HI}$ | High Side Turn On Delay Time | $D_{SET}$ = $V_{DD}$<br>$R_{SET}$ = 5.1k<br>$R_{SET}$ = 400k | 50.0<br>75.0<br>750.0 | 100.0<br>125.0<br>1150.0 | 150.0<br>200.0<br>1500.0 | IV<br>I<br>I | ns |
| $t_{D\ ON\ LO}$ | Low Side Turn On Delay Time | $D_{SET}$ = $V_{DD}$<br>$R_{SET}$ = 5.1k<br>$R_{SET}$ = 400k | 50.0<br>75.0<br>750.0 | 100.0<br>125.0<br>1150.0 | 150.0<br>200.0<br>1500.0 | IV<br>I<br>I | ns |
| $t_{D\ OFF\ HI}$ | High Side Turn Off Delay Time | $D_{SET}$ = $V_{DD}$ | | 100.0 | 150.0 | IV | ns |
| $t_{D\ OFF\ LO}$ | Low Side Turn Off Delay Time | $D_{SET}$ = $V_{DD}$ | | 100.0 | 150.0 | IV | ns |
| $t_{D\ MISMATCH}$ | High to Lo Side Turn On Delay Mismatch | $R_{SET}$ = 400k | | | ±10.0 | I | % |

## Typical Performance Curves

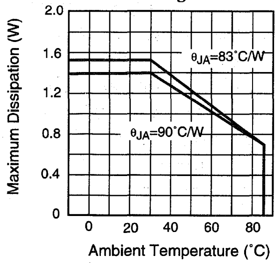



7761-2

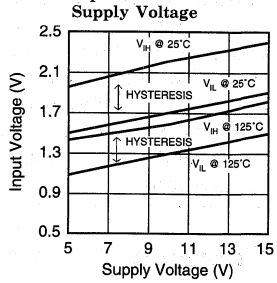
*Minimum Rising and Falling Edge Delay Times

## Typical Performance Curves — Contd.

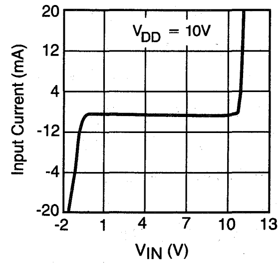
**Max. Power/Derating Curves 16 Pin Package**



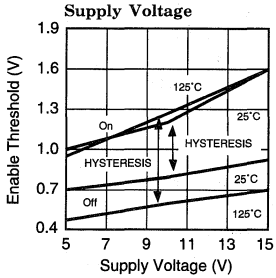

**Input Threshold vs. Supply Voltage**



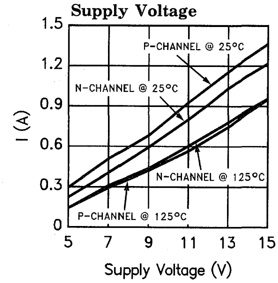

**Input Current vs. Input Voltage**



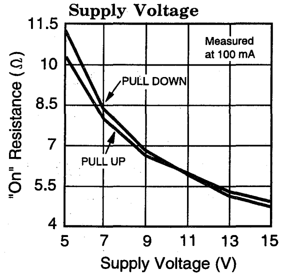

**Enable Threshold vs. Supply Voltage**



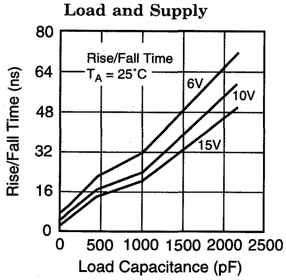

**Peak Drive vs. Supply Voltage**



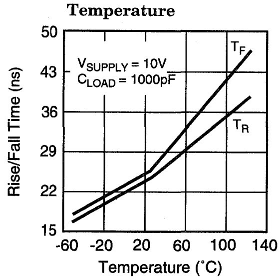

**"On" Resistance vs. Supply Voltage**




**Rise/Fall Time vs. Load and Supply**




**Rise/Fall Time vs. Temperature**




7761-3

HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# EL7861C
## *Rising Edge Delay Driver*

## Features
- Programmable Delay
- 1 MHz Operation
- Shutdown Function
- 1.0 Amp Peak Current
- Matched Rise and Fall Times
- Low Supply Current
- Low Output Impedance
- Low Input Capacitance

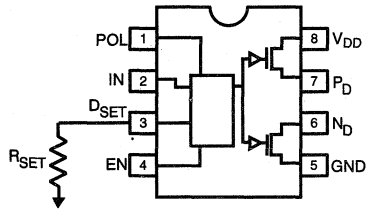
## Applications
- Uninterruptible Power Supplies
- Distributed Power Systems
- IGBT Drive
- DC-DC Converters
- Motor Control
- Power MOSFET Drive
- Switch Mode Power Supplies

## Ordering Information

| Part No. | Temp. Range | Package | Outline # |
|---|---|---|---|
| EL7861CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7861CS | −40°C to +85°C | 8-Pin SOIC | MDP0027 |

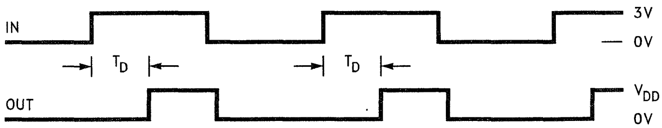
## General Description
The EL7861 provides 1.0A of peak current for many driver applications. The rising edge of the output can be delayed up to 1.5 μs from the corresponding input edge. A single resistor from $D_{SET}$ to GND sets the delay time. Connecting the $D_{SET}$ pin to $V_{DD}$ disenables the delay block giving approximately 30 ns delay times. The circuit contains an enable feature as well as user definable polarity. The programmable delay is useful in applications requiring compensation for long switch turn off times and applications using resonant mode technology.

## Connection Diagram




7861-1

**7861 Waveform Example**
**POL = $V_{DD}$**




($P_D$ shorted to $N_D$)

7861-4

| POL | Polarity |
|---|---|
| $V_{DD}$ | Non-Inverting |
| GND | Inverting |

July 1994 Rev A

## Absolute Maximum Ratings ($T_A = 25°C$)

| | |
|---|---|
| Supply ($V_{DD}$ to GND) | 16.5V |
| Input Pins | −0.3V below GND, +0.3V above $V_{DD}$ |
| Operating Junction Temperature | 125°C |
| Peak Output Current | 2A |
| Ambient Operating Temperature | −40°C to +85°C |
| Storage Temperature Range | −65°C to +150°C |
| Power Dissipation SOIC | 670 mW |
| Power Dissipation PDIP | 1050 mW |

**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, therefore $T_J = T_C = T_A$.

| 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. |

## DC Electrical Characteristics ($T_A = 25°C$, $V_{DD} = 15V$, $C_{LOAD} = 1000$ pF, unless otherwise specified)

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input/Output** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 3.0 | 2.4 | | I | V |
| $I_{IH}$ | Logic "1" Input Current | | | 0.1 | 10.0 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | 1.6 | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | | | 0.1 | 10.0 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.5 | | V | V |
| $V_{ENH}$ | Enable Threshold | Positive Edge | 2.8 | 1.6 | | I | V |
| $V_{ENL}$ | Disable Threshold | Negative Edge | | 0.9 | 0.6 | I | V |
| $V_{EN\ HYS}$ | Enable Hysteresis | | | 0.7 | | V | V |
| $I_{DS\ OFF}$ | Output Leakage | $GND \le V_{OUT} \le V_{DD}$ | | 0.2 | 10.0 | I | μA |
| $R_{OH}$ | Pull-Up Resistance | $I_{OUT} = -100$ mA | | 5.0 | 10.0 | I | Ω |
| $R_{OL}$ | Pull-Down Resistance | $I_{OUT} = +100$ mA | | 5.0 | 10.0 | I | Ω |
| $I_{PK}$ | Peak Output Current | | | 1.0 | | IV | A |
| $I_{DC}$ | Continuous Output Current Source/Sink | | 50.0 | | | IV | mA |
| **Power Supply** | | | | | | | |
| $I_{DD}$ | Supply Current into $V_{DD}$ | $R_{SET} = 5.1k$ | | 6.0 | 10.0 | I | mA |
| $I_{DD\ OFF}$ | Supply Current into $V_{DD}$ | $V_{EN} = 0.6V$ | | | 750.0 | I | μA |
| $V_{DD}$ | Operating Voltage | | 4.5 | | 15.0 | I | V |

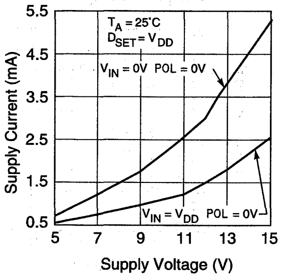
# EL7861C
## Rising Edge Delay Driver

## AC Electrical Characteristics ($T_A$ = 25°C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000 pF, unless otherwise specified)

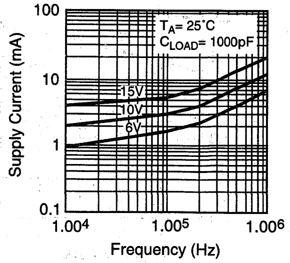
| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Power Supply** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 15.0<br>20.0 | <br>40.0 | IV | ns |
| $t_R$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 15.0<br>20.0 | <br>40.0 | IV | ns |
| $t_{D\ ON}$ | Turn On Delay Time | $D_{SET}$ = $V_{DD}$<br>$R_{SET}$ = 5.1k<br>$R_{SET}$ = 400k | 10.0<br>25.0<br>750.0 | 30.0<br>50.0<br>1150.0 | 150.0<br>200.0<br>1500.0 | IV<br>I<br>I | ns |
| $t_{D\ OFF}$ | Turn Off Delay Time | $D_{SET}$ = $V_{DD}$ | | 30.0 | 50.0 | IV | ns |

## Typical Performance Curves

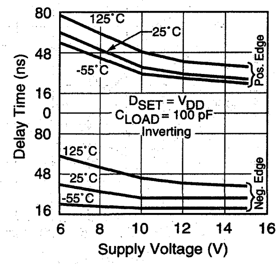
**Quiescent Supply Current vs Supply Voltage**



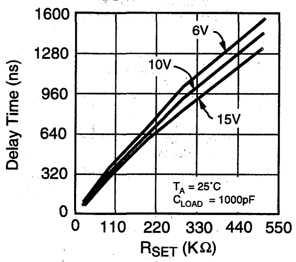

**Average Supply Current vs Voltage and Frequency**



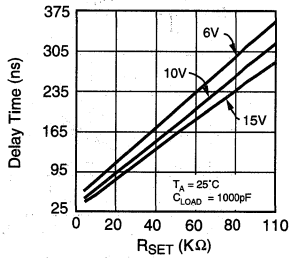

**Delay Times vs Supply Voltage and Temp**



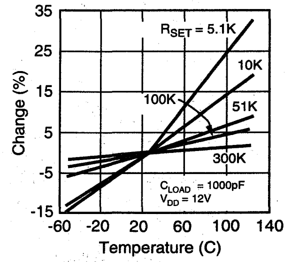

**Output Rising Edge Delay vs $R_{SET}$ and Supply Voltage**



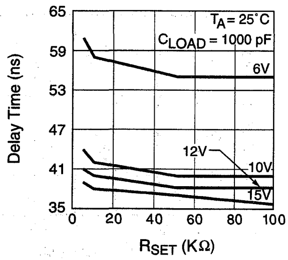

**Output Rising Edge Delay vs $R_{SET}$ and Supply Voltage (Detail)**



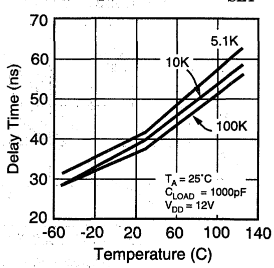

**Output Rising Edge Delay Change vs Temperature**




**Output Falling Edge Delay vs $R_{SET}$ and $V_{DD}$**



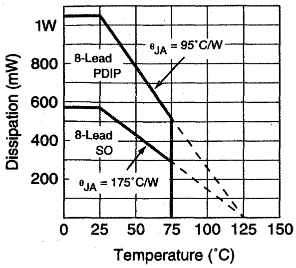

**Output Falling Edge Delay vs Temperature and $R_{SET}$**



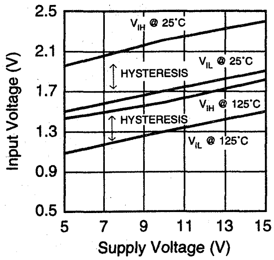

7861-2

## Typical Performance Curves — Contd.

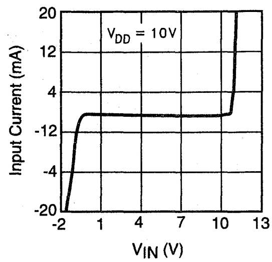
**Max. Power/Derating Curves 8-Pin Package**



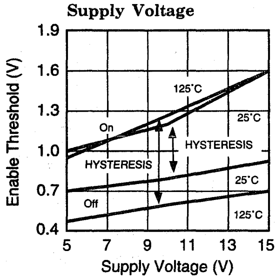

**Input Threshold vs. Supply Voltage**



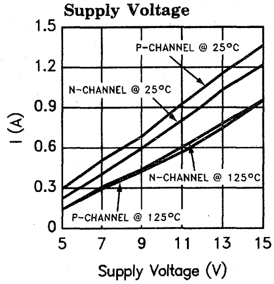

**Input Current vs Input Voltage**



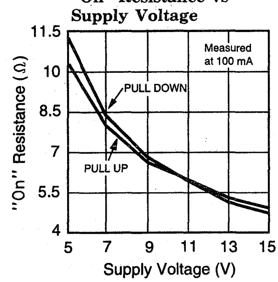

**Enable Threshold vs Supply Voltage**



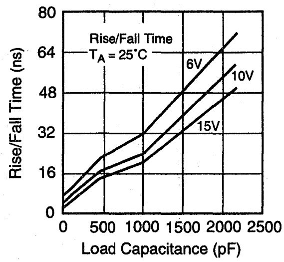

**Peak Drive vs Supply Voltage**



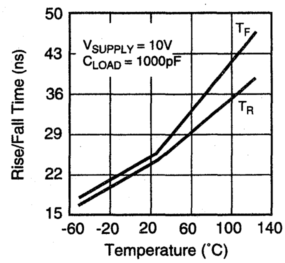

**"On" Resistance vs Supply Voltage**




**Rise/Fall Time vs Load and Supply**




**Rise/Fall Time vs Temperature**




7861-3

# EL7961C/EL7971C/EL7981C
## Dual Rising Edge Delay Driver



July 1994 Rev A

## Features

- Programmable delay
- 1 MHz operation
- 1.0A peak current
- Matched rise/fall times
- Low power
- Rail to rail output
- Low output impedance
- Low input capacitance

## Applications

- Uninterruptible power supplies
- IGBT driver
- DC-DC converters
- Motor control
- Power MOSFET drivers
- Switch mode power supplies

## Ordering Information

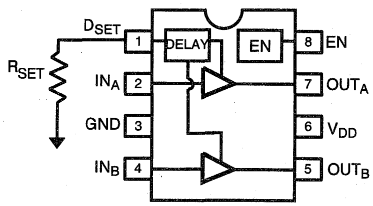
| Part No. | Temp. Range | Package | Outline # |
|---|---|---|---|
| EL7961CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7961CS | −40°C to +85°C | 8-Lead SO | MDP0027 |
| EL7971CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7971CS | −40°C to +85°C | 8-Lead SO | MDP0027 |
| EL7981CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7981CS | −40°C to +85°C | 8-Lead SO | MDP0027 |

## General Description

The EL7961/EL7971/EL7981 provides 1.0A peak current for many driver applications. The rising edge of the output can be delayed up to 1.5 μs from the input edge. A resistor from $D_{SET}$ to GND sets the delay time for both channel A and B. This programmable delay is useful in applications requiring compensation for long switch turn off times. Pulling $D_{SET}$ high disables the delay block giving approximately 30 ns delay times.

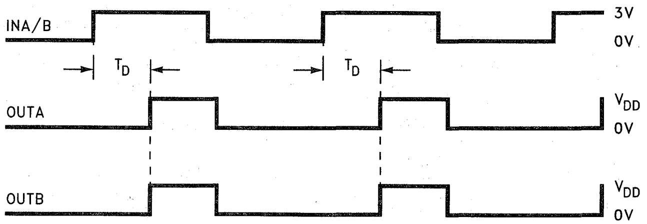
EL7961 - Non-Inverting
EL7971 - Inverting
EL7981 - Channel A - Inverting
Channel B - Non-Inverting

## Connection Diagram




7961-1

### 7961 Waveform Example




7961-4

# EL7961C/EL7971C/EL7981C

## Dual Rising Edge Delay Driver

## Absolute Maximum Ratings ($T_A$ = 25°C)

| | | | |
|---|---|---|---|
| Supply ($V_{DD}$ to GND) | 16.5V | Ambient Operating Temperature | −40°C to +85°C |
| Input Pins | −0.3V below GND, +0.3V above $V_{DD}$ | Storage Temperature Range | −65°C to +150°C |
| Operating Junction Temperature | 125°C | Power Dissipation SOIC | 670 mW |
| Peak Output Current | 2A | PDIP | 1050 mW |

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, therefore $T_J = T_C = T_A$.

| 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. |

## DC Electrical Characteristics ($T_A$ = 25°C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000 pF unless otherwise specified)

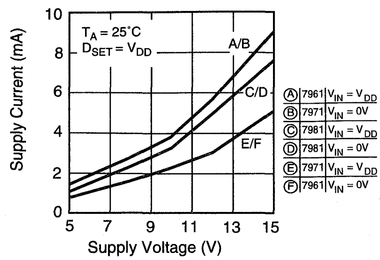
| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input/Output** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 3.0 | 2.4 | | I | V |
| $I_{IH}$ | Logic "1" Input Current | | | 0.1 | 10.0 | I | μA |
| $V_{IL}$ | Logic "0" Input Voltage | | | 1.8 | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | | | 0.1 | 10.0 | I | μA |
| $V_{HVS}$ | Input Hysteresis | | | 0.5 | | V | V |
| $V_{ENH}$ | Enable Threshold | Positive Edge | 2.8 | 1.6 | | I | V |
| $V_{ENL}$ | Disable Threshold | Negative Edge | | 0.9 | 0.6 | I | V |
| $V_{EN\ HYS}$ | Enable Hysteresis | | | 0.7 | | V | V |
| $R_{OH}$ | Pull-up Resistance | $I_{OUT}$ = −100 mA | | 5.0 | 10.0 | I | Ω |
| $R_{OL}$ | Pull-down Resistance | $I_{OUT}$ = +100 mA | | 5.0 | 10.0 | I | Ω |
| $I_{PK}$ | Peak Output Current | | | 1.0 | | IV | A |
| $I_{DC}$ | Continuous Output Current Source/Sink | | 50.0 | | | IV | mA |
| **Power Supply** | | | | | | | |
| $I_{DD}$ | Supply Current into $V_{DD}$ | $R_{SET}$ = 5.1k Inputs = 15V | | | 10.0 | I | mA |
| $I_{DD\ OFF}$ | Supply Current into $V_{DD}$ | $V_{EN}$ = 0V | | | 1.0 | I | mA |
| $V_{DD}$ | Operating Voltage | | 4.5 | | 15.0 | I | V |

## AC Electrical Characteristics ($T_A$ = 25C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000 pF unless otherwise specified)

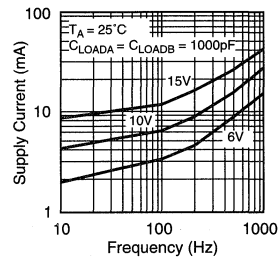
| Parameter | Description | Test Conditions | Min. | Typ. | Max. | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 15.0<br>20.0 | 40.0 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 15.0<br>20.0 | 40.0 | IV | ns |
| $t_{D\ ON}$ | Turn On Delay Time | $D_{SET}$ = $V_{DD}$<br>$R_{SET}$ = 5.1k<br>$R_{SET}$ = 200k | 10.0<br>30.0<br>750.0 | 30.0<br>60.0<br>1150.0 | 50.0<br>120.0<br>1500.0 | IV<br>I<br>I | ns<br>ns<br>ns |
| $t_{D\ OFF}$ | Turn Off Delay Time | $D_{SET}$ = $V_{DD}$ | | 30.0 | 50.0 | IV | ns |
| $t_{D\ MISMATCH}$ | Channel A to B Turn On Delay Mismatch | $R_{SET}$ = 200k | | | ±15.0 | I | % |

## Typical Performance Curves

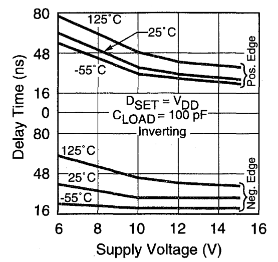
**Quiescent Supply Current vs Supply Voltage**



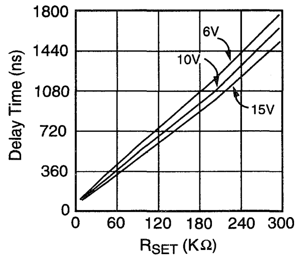

**Average Supply Current vs Voltage and Frequency**



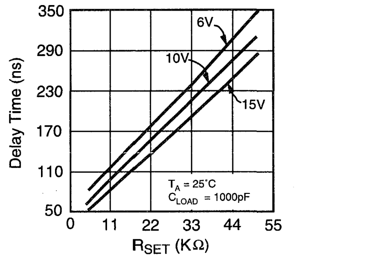

**Delay Times vs Supply Voltage and Temperature**



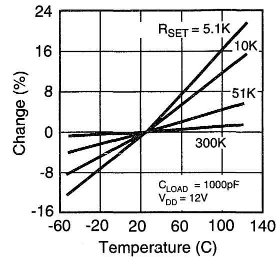

**Output Rising Edge Delay vs $R_{SET}$ and Supply Voltage**



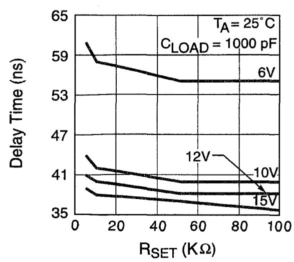

**Output Rising Edge Delay vs $R_{SET}$ and Supply Voltage (Detail)**



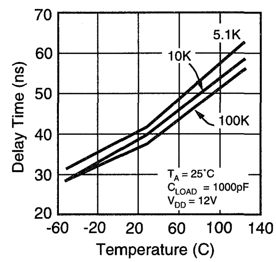

**Output Rising Edge Delay Percentage Change vs Temperature**



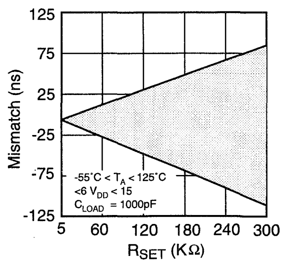

**Output Falling Edge Delay vs $R_{SET}$ vs $V_{DD}$**




**Output Falling Edge Delay vs Temperature and $R_{SET}$**




**Output Rising Edge Delay Channel to Channel Mismatch vs $R_{SET}$**

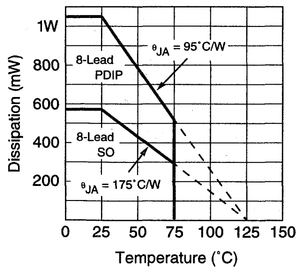



7961-2

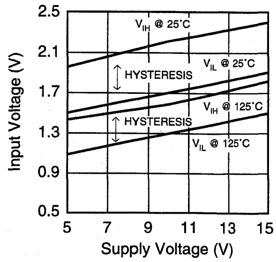
EL7961C/EL7971C/EL7981C

## Typical Performance Curves — Contd.

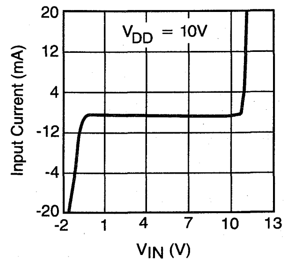
**Max Power/Derating Curves**
**8-Pin Package**



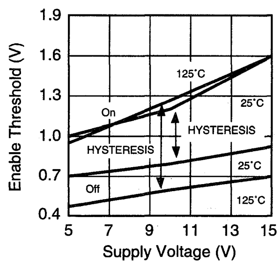

**Input Threshold**
**vs Supply Voltage**



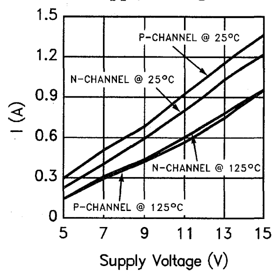

**Input Current**
**vs Input Voltage**



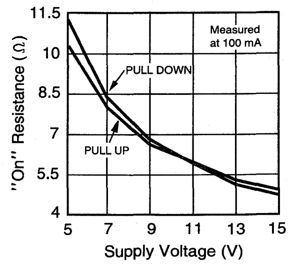

**Enable Threshold**
**vs Supply Voltage**



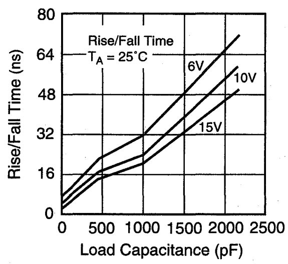

**Peak Drive**
**vs Supply Voltage**



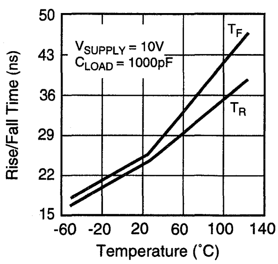

**"On" Resistance**
**vs Supply Voltage**




**Rise/Fall Time**
**vs Load and Supply**




**Rise/Fall Time**
**vs Temperature**




7961-3

# EL7962C/EL7972C/EL7982C
## Dual Rising Edge Delay Driver

HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

## Features

- Programmable delay
- 1 MHz operation
- 1.0A peak current
- Matched rise and fall times
- Low supply current
- Rail-to-Rail output
- Low output impedance
- Low input capacitance

## Applications

- Uninterruptible power supplies
- Distributed power systems
- IGBT drive
- DC-DC converters
- Motor control
- Power MOSFET drive
- Switch mode power supplies

## Ordering Information

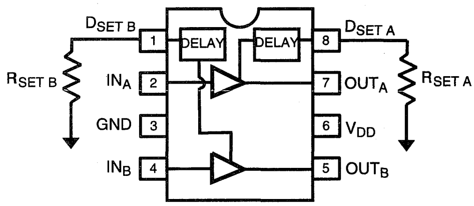
| Part No. | Temp. Range | Package | Outline # |
|---|---|---|---|
| EL7962CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7972CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7982CN | −40°C to +85°C | 8-Pin P-DIP | MDP0031 |
| EL7762CS | −40°C to +85°C | 8-Pin SOIC | MDP0027 |
| EL7772CS | −40°C to +85°C | 8-Pin SOIC | MDP0027 |
| EL7782CS | −40°C to +85°C | 8-Pin SOIC | MDP0027 |

## General Description

The EL7962/72/82 provides 1.0A of peak current for many driver applications. The rising edge of the output can be delayed up to 1.5 μs from the corresponding input edge. A resistor from $D_{SET\ A}$ to GND sets the delay time for channel A. Likewise a resistor from $D_{SET\ B}$ to GND sets the delay time for channel B. Connecting the $D_{SET\ A}$ pin to $V_{DD}$ disenables the delay blocks, giving approximately 30 ns delay times for both channels. This programmable delay is useful in applications requiring compensation for long switch turn off times and applications using resonant mode technology

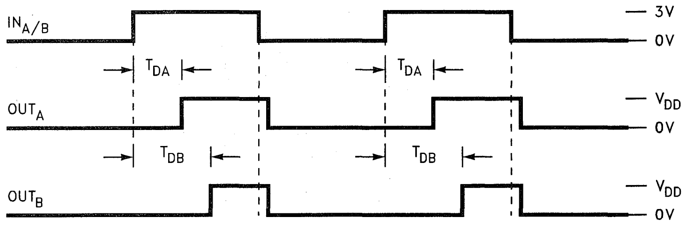
EL7962 - both channels non-inverting
EL7972 - both channels inverting
EL7982 - channel A inverting
channel B non-inverting

## Connection Diagram




7962-1

**7962 Waveform Example**
**$T_{DA} \neq T_{DB}$**




7962-4

**$R_{SET\ B} > R_{SET\ A} \rightarrow T_{DB} > T_{DA}$**

July 1994 Rev A

# EL7962C/EL7972C/EL7982C
## Dual Rising Edge Delay Driver

## Absolute Maximum Ratings ($T_A$ = 25°C)

| | | | |
|---|---|---|---|
| Supply ($V_{DD}$ to GND) | 16.5V | Operating Junction Temperature | 125°C |
| Input Pins | −0.3V below GND, +0.3V above $V_{DD}$ | Storage Temperature Range | −65°C to +150°C |
| Peak Current per Output | 2A | Power Dissipation | |
| Ambient Operating Temperature | −40°C to +85°C | SOIC | 670 mW |
| | | PDIP | 1050 mW |

**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, therefore $T_J = T_C = T_A$.

| 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. |

## DC Electrical Characteristics ($T_A$ = 25°C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000 pF, unless otherwise specified)

| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Input/Output** | | | | | | | |
| $V_{IH}$ | Logic "1" Input Voltage | | 3.0 | 2.4 | | I | V |
| $I_{IH}$ | Logic "1" Input Current | | | 0.1 | 10.0 | I | µA |
| $V_{IL}$ | Logic "0" Input Voltage | | | 1.8 | 0.8 | I | V |
| $I_{IL}$ | Logic "0" Input Current | | | 0.1 | 10.0 | I | µA |
| $V_{HVS}$ | Input Hysteresis | | | 0.5 | | V | V |
| $R_{OH}$ | Pull-up Resistance | $I_{OUT}$ = −100 mA | | 5.0 | 10.0 | I | Ω |
| $R_{OL}$ | Pull-down Resistance | $I_{OUT}$ = +100 mA | | 5.0 | 10.0 | I | Ω |
| $I_{PK}$ | Peak Output Current | | | 1.0 | | IV | A |
| $I_{DC}$ | Continuous Output Current Source/Sink | | 50 | | | IV | mA |
| **Power Supply** | | | | | | | |
| $I_{DD}$ | Supply Current into $V_{DD}$ | $R_{SET}$ = 5.1k<br>Inputs = 15V | | | 12.0 | I | mA |
| $V_{DD}$ | Operating Voltage | | 4.5 | | 15.0 | I | V |

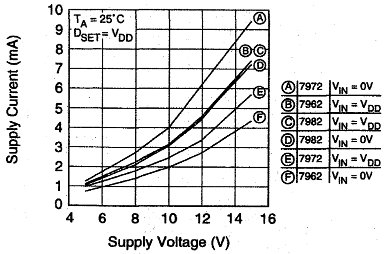
# EL7962C/EL7972C/EL7982C
## Dual Rising Edge Delay Driver

### AC Electrical Characteristics ($T_A$ = 25C, $V_{DD}$ = 15V, $C_{LOAD}$ = 1000 pF, unless otherwise specified)

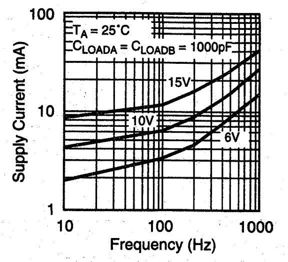
| Parameter | Description | Test Conditions | Min | Typ | Max | Test Level | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_R$ | Rise Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 15.0<br>20.0 | <br>40.0 | IV | ns |
| $t_F$ | Fall Time | $C_L$ = 500 pF<br>$C_L$ = 1000 pF | | 15.0<br>20.0 | <br>40.0 | IV | ns |
| $t_{D\ ON}$ | Turn On Delay Time | $D_{SET}$ = $V_{DD}$<br>$R_{SET}$ = 5.1k<br>$R_{SET}$ = 400k | 10.0<br>30.0<br>750.0 | 30.0<br>60.0<br>1150.0 | 50.0<br>120.0<br>1500.0 | IV<br>I<br>I | ns<br>ns<br>ns |
| $t_{D\ OFF}$ | Turn Off Delay Time | $D_{SET}$ = $V_{DD}$ | | 30.0 | 50.0 | IV | ns |
| $t_{D\ MISMATCH}$ | Channel A to B Turn On Delay Mismatch | $R_{SET}$ = 400k<br>$R_{SET\ A}$ = $R_{SET\ B}$ | | | ±10.0 | I | % |

## Typical Performance Curves

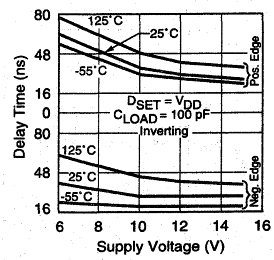
**Quiescent Supply Current vs Supply Voltage**



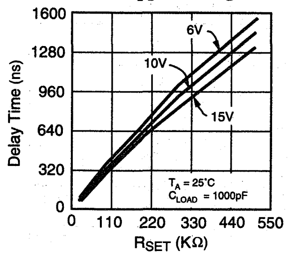

**Average Supply Current vs Voltage and Frequency**



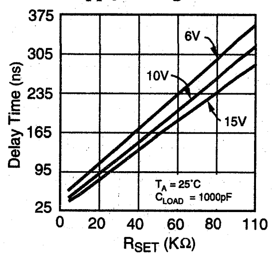

**Delay Times vs Supply Voltage and Temp.**



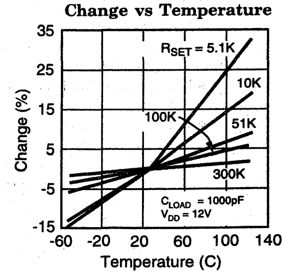

**Output Rising Edge Delay vs $R_{SET}$ and Supply Voltage**



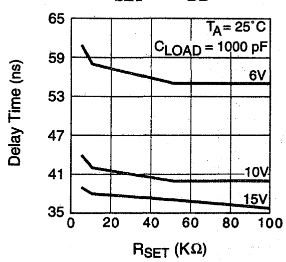

**Output Rising Edge Delay vs $R_{SET}$ and Supply Voltage (Detail)**



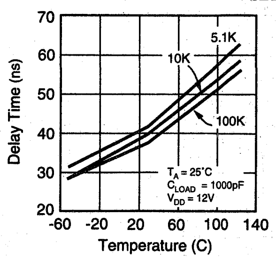

**Output Rising Edge Delay Percentage Change vs Temperature**



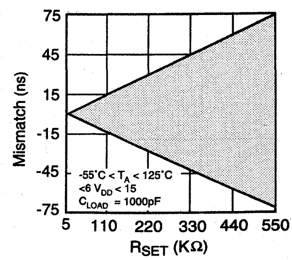

**Output Falling Edge Delay vs $R_{SET}$ vs $V_{DD}$**




**Output Falling Edge Delay vs Temperature and $R_{SET}$**




**Output Rising Edge Delay Channel to Channel Mismatch**

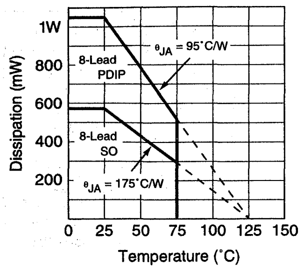



7962–2

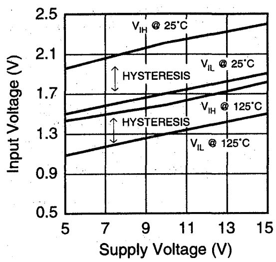
# EL7962C/EL7972C/EL7982C
## Dual Rising Edge Delay Driver

## Typical Performance Curves — Contd.

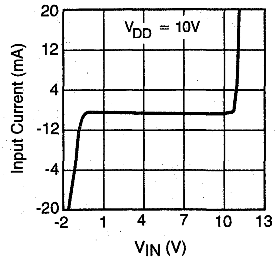
**Max Power/Derating Curves 8-Pin Package**



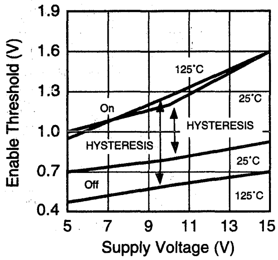

**Input Threshold vs Supply Voltage**



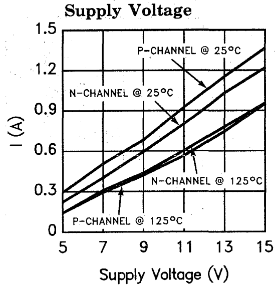

**Input Current vs Input Voltage**



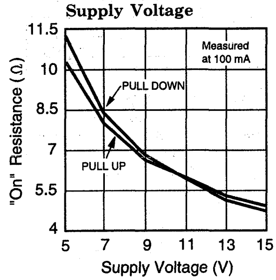

**Enable Threshold vs Supply Voltage**



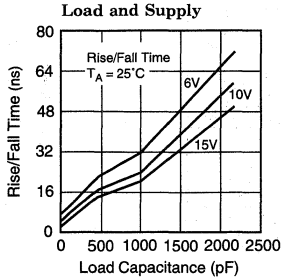

**Peak Drive vs Supply Voltage**



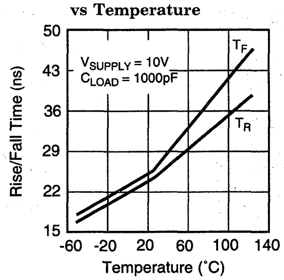

**"On" Resistance vs Supply Voltage**




**Rise/Fall Time vs Load and Supply**




**Rise/Fall Time vs Temperature**




7962-3

## Variable Pulse Width Variable Frequency Pulse Generator

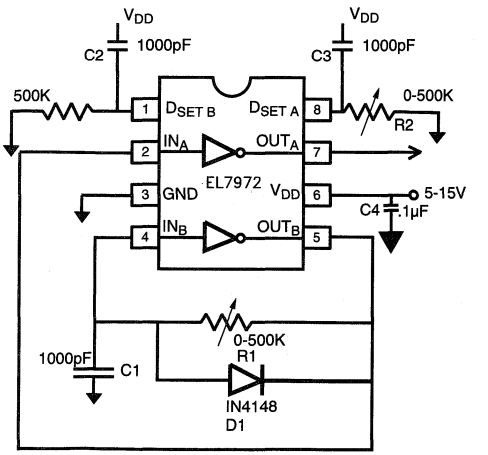
This application uses the "B" driver of the EL7972 as an oscillator to drive the "A" driver. The frequency is set using R1 and C1. The pulse width is set by adjusting R2. Capacitors C2, C3 and C4 are decoupling capacitors. A fixed pulse width output is available at pin 5 while the variable pulse width signal is available at pin 7. For these particular component values a maximum pulse width of 2 $\mu$s is available at pin 7.

The frequency is approximated by the relation:

$$f(Hz) = \frac{(1.5)\sqrt{V_{DD}}}{(R1)\,(C1)}$$

The pulse width is approximated by the relation:

$$T_{width}\,(S) = \frac{(4.5 \times 10^{-6})\left(1 - \frac{R2}{500K}\right)}{\sqrt{V_{DD}}} - 100\text{ ns}$$

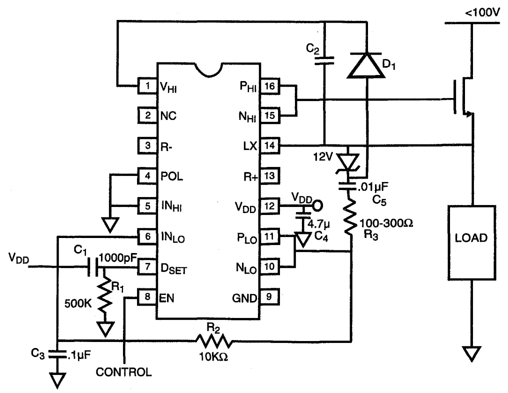



0942-1

## 100V DC Stable High Switch

This application uses an EL7761 to drive the gate of an NMOS FET above the FET's source and drain voltage. This circuit would be useful in applications where the load must be energized continuously as in an automobile headlight circuit or a high side switch to a 48V bus in a distributed power application.

The low side driver self oscillates at a frequency determined by its input hysteresis in conjunction with R2 and C3. The output of the oscillator (pins 10 and 11) drive a charge pump which powers the high side drive section of the EL7761. A low voltage at the EN pin shuts the drive to the external FET off as well as shutting down the charge pump oscillator and putting the chip into a low supply current mode. Capacitors C1 and C4 are used to decouple the supplies. $V_{DD}$ must be at least a diode drop higher than the desired enhancement of the external FET. The reverse breakdown of the zener diode should be less than 15V in order to avoid an overvoltage of the high side driver. Depending on the exact nature of the circuit a zener diode is not always necessary.




C1 - 1000pF ceramic
C2 - .1µF ceramic
C3 - .1µF ceramic
C4 - 1-4.7µF Tant.
C5 - .01µF ceramic 100V

D1, D2 - IN4148
R1 - 500KΩ 1/4w
R2 - 10KΩ 1/4w
R3 - 100Ω - 300Ω 1/4w

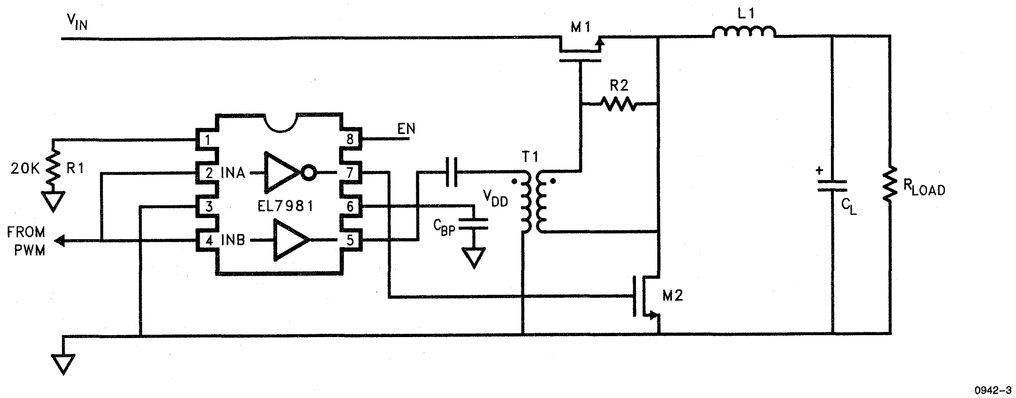
100V, Single chip, DC stable high side switch

0942-2

# Applications Information

## Synchronous Buck Regulator Driver

In this application one driver of the EL7981 is used to drive the main switch of a buck regulator while the other driver drives the synchronous switch. A transformer is used to obtain the high side switching voltage for M1. R1 sets the dead time delay between the on times of M1 and M2. The adjustable delay is perfect for devices with long turn off times such as IGBT's.



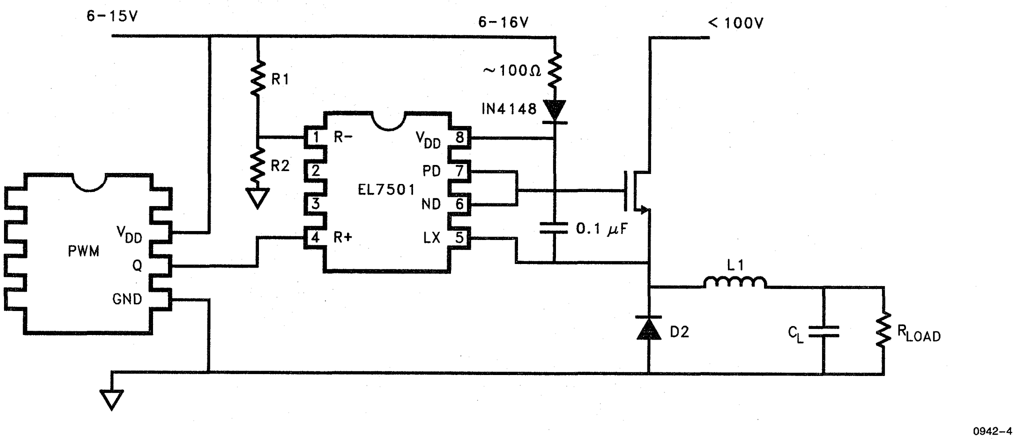

Set dead time with R1.
M1 and M2 can be IGBT's.

**Synchronous Buck Regulator**

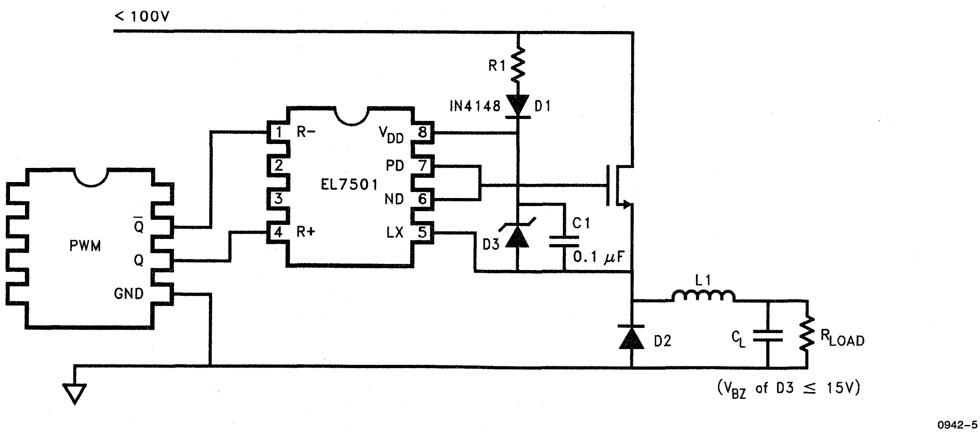
## Buck Regulator High Side Drive Using the EL7501

These circuits show two ways of using the EL7501 to drive the high side switch in a buck converter application. The first method uses resistors R1 and R2 to bias pin 1 in the middle of the drive voltage swing at pin 4. This allows the use of a single sided PWM drive. The high side voltage is pumped up from the $V_{DD}$ supply.

The second method uses a complementary drive signal at pins 1 and 4 of the EL7501. It derives its high side supply voltage by charging capacitor C1 through resistor R1 and then using the external FET to pump that voltage above the high side supply.




**EL7501 Buck Regulator with High Side Drive First Method**

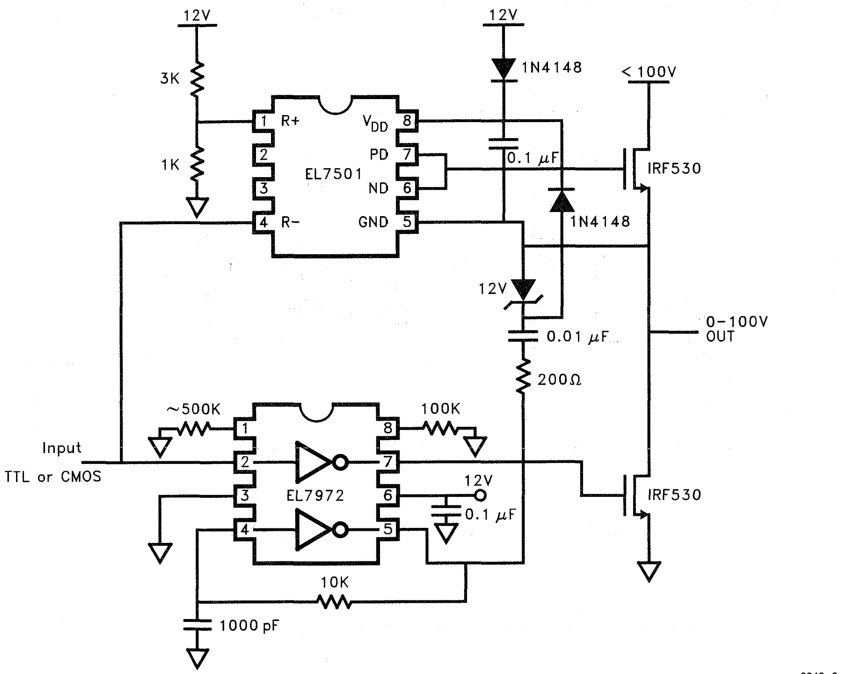



**EL7501 Buck Regulator with High Side Drive (Alternate Biasing Scheme) Second Method**

# Applications Information

## Self Powered DC Stable 100V Half Bridge Driver

This circuit uses one driver of an EL7972 to provide low side drive and the other driver as a charge pump oscillator. The output of the charge pump oscillator drives a capacitor diode network to provide high side supply voltage to the EL7501. The EL7501 drives a high side external N-FET. Due to the addition of the charge pump this circuit will work at any driving frequency from DC to >1 MHz.

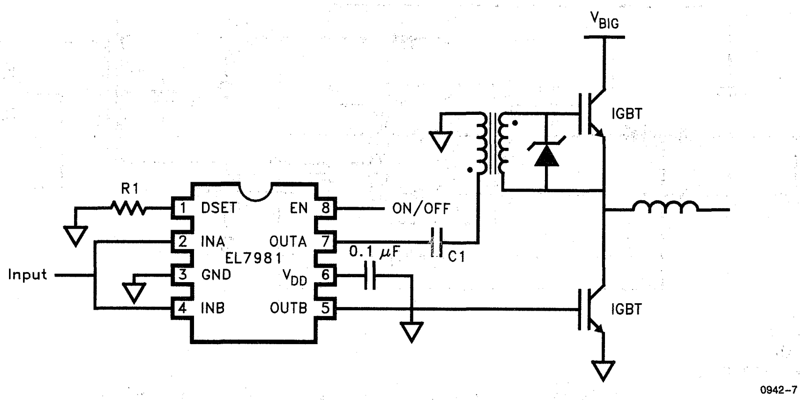



Can substitute an EL7961 if an enable feature is desired.

**DC Functional Half Bridge Driver**

## IGBT Half Bridge Driver

This circuit shows the EL7981 being used to drive an IGBT half bridge. The high side IGBT is transformer coupled to the driver. The value of R1 is chosen so that the two IGBT's never conduct at the same time. If the IGBT's have different turn off characteristics then the EL7982 could be used instead of the EL7981. The EL7982 has independent control of each of its driver's rising edge delay.

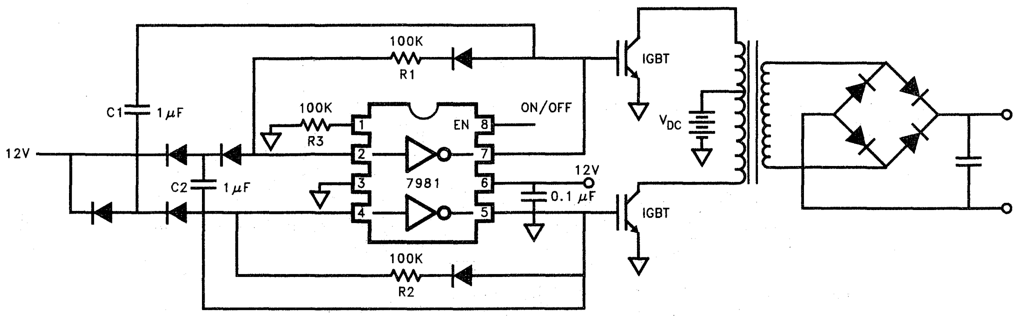



IGBT Half Bridge Driver

*Applications Information*

## Self Oscillating IGBT Driver

This circuit self oscillates at approximately 25 KHz. The on times of each driver depend on the values of R1, C1, R2 and C2. In order to ensure equal on times accurate component values may need to be used. The resistor, R3, controls the dead time between the on times of both drivers.

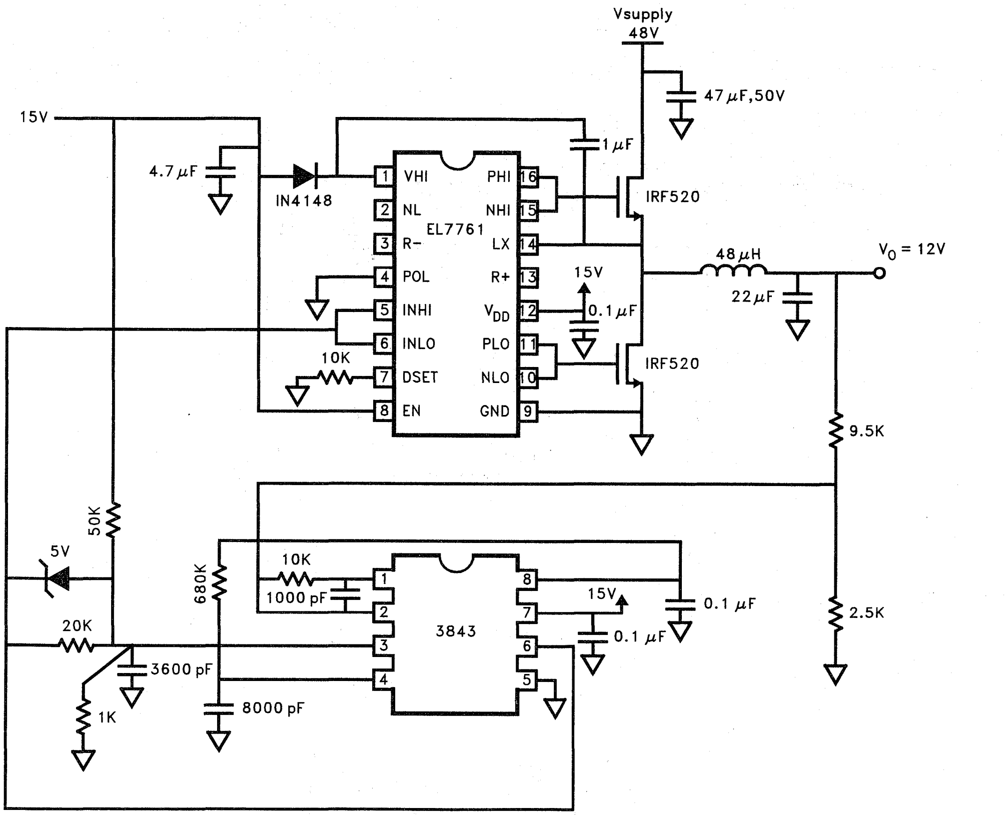



Diodes - 1N4148
R3 sets dead time
Approximately 25 KHz oscillation

**Self Oscillating IGBT Driver, DC-DC Step Up (or Down)**

## 40 Watt-12V Step Down Regulator Using a Synchronous Switch

This circuit shows how the EL7761 could be used as a half bridge driver for a step down converter. The circuit switches at 250 KHz.




**12V Step Down Synchronous Switches**

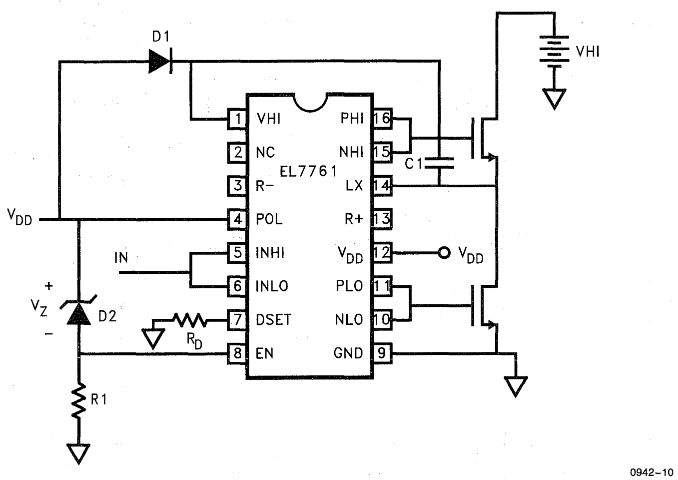
# *Applications Information*

## Simple Undervoltage Lockout Circuit

By using a zener diode and a pull down resistor the user can implement a simple UVLO circuit. As $V_{DD}$ increases above the zener voltage the EN pin rises above ground. When EN reaches $V_{ton}$ the chip is enabled. As $V_{DD}$ is lowered such that the voltage at EN falls below $V_{toff}$, the chip is disenabled. The threshold tolerances are as follows:

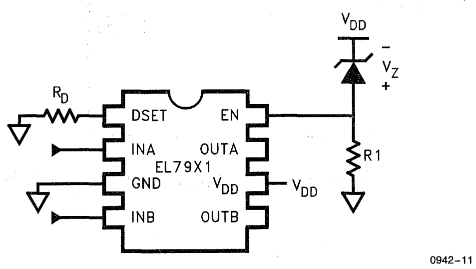
$1.0V < V_{ton} < 1.6V$

$0.3V < V_{ton} - V_{toff} < 1.0V$




$V_{turn\text{-}on} = V_Z + V_{ton}$
$V_{turn\text{-}off} = V_Z + V_{toff}$

**Simple UVLO Circuit for the EL7761**

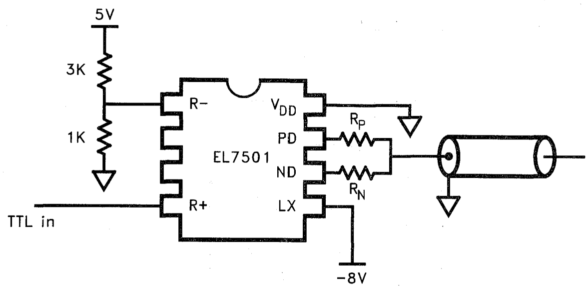



$V_{turn\text{-}on} = V_Z + V_{ton}$
$V_{turn\text{-}off} = V_Z + V_{toff}$

**Simple UVLO Circuit for the EL79X1**

## Video Sync Pulse Generator

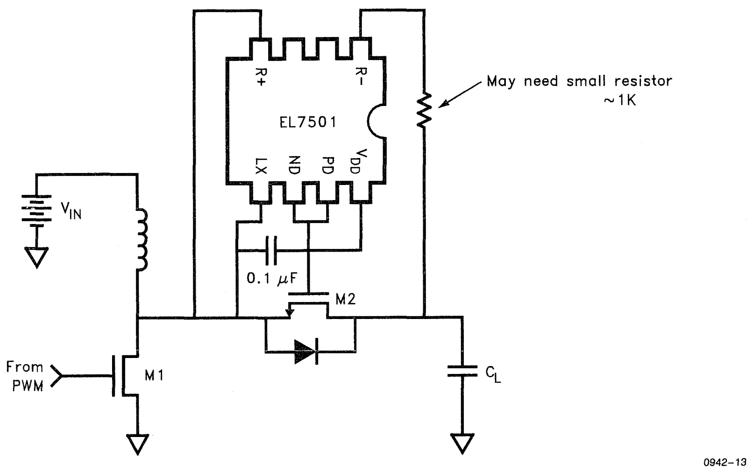
The EL7501 inputs function outside the power supply rails, allowing a ground referenced TTL signal to control a ground to −8V output swing. The output resistors can be adjusted to tailor the rise and fall times of the circuit.




0942-12

## Synchronous Switch Increases Boost Efficiency

The EL7501 plus a N-FET replaces the catch diode in a boost regulator. When the R+ pin is higher than the R− pin, the FET is turned on, effectively shorting out the parasitic diode of the FET. A small resistor may be added in series with the R− pin in order to "tune" the turn-on delay of the FET.



## Resonant Gate Driver

Resonant gate driver can be used to boost the gate voltage swing while increasing driver efficiency. In Figure 1, an EL7501 is configured with (2) external "ring" diodes and resonating inductor $L_R$. For tutorial purposes, the power mosfet load was replaced by a 1000 pF capacitor ($C_L$). The "ring" diodes are fast switching diodes capable of withstanding the 1 amp peak current, such as the 1N914. Standard de-coupling techniques are applied with 5V applied to $V_{DD}$, the circuit delivers +10V to −5V output. In "5V only" systems, sufficient output swing is available so as to eliminate the need for costly "logic level" power FETs, and provides below ground swing for superior turn-off.

## Principle of Operation

When the input drops below 2.4V, pin 7 pulls high, allowing current to flow from $V_{DD}$ thru D1 and $L_R$, thus charging $C_L$. Initially the full voltage appears across the inductor, but as the current starts to flow, $C_L$ begins to charge. When $C_L$ reaches the supply voltage, current continues to flow as the inductor $L_R$ reverses direction and continues to charge the capacitor beyond the supply voltage. When $C_L$ reaches it's peak, the "ring" diode disconnects, holding that potential across $C_L$. The peak voltage can be controlled by adjusting the circuit "Q". Typically this is accomplished by varying the size of inductor $L_R$, since the "on" resistance of the driver can limit the circuit "Q". This is governed by the expression:

$$Q = \frac{\omega L}{R}$$

where: $\omega = \frac{1}{\sqrt{LC}}$ or $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

Thus, higher "Q", and higher voltage swing can be maintained by making $\sqrt{L/C}$ large compared to R. ($R \approx 5\Omega$ typ. for the EL7501.)

Similarly, when pin-6 pulls low, the output resonates below ground to provide good turn-off. Since charge is transferred mostly thru the inductor, rather than a resistor efficiency is much higher. The circuit performance is summarized below.

| | Conditions: $V_{DD}$ = 5V $F_C$ = 220 kHz | | | |
|---|---|---|---|---|
| | (L) Inductance | $V_{OUT}$ (+) | $V_{OUT}$ − | $T_R/T_F$ |
| Case 1 | 1 μH | 7V | −2.1V | 60 ns |
| Case 2 | 47 μH | 18V | −12V | 300 ns |

The power consumption was measured for Case 2, at 40 mW. Using "resistive" charging a power dissipation/consumption of 200 mW is anticipated, thus resulting in a (5) fold improvement in efficiency.

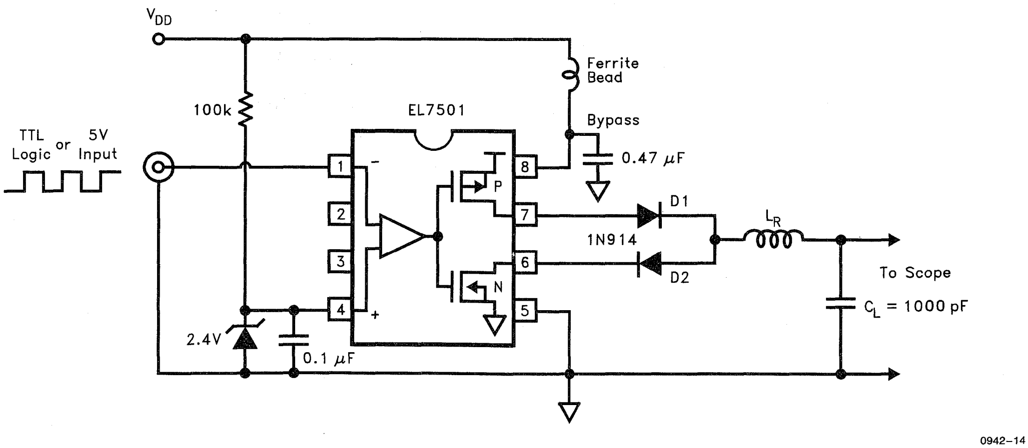
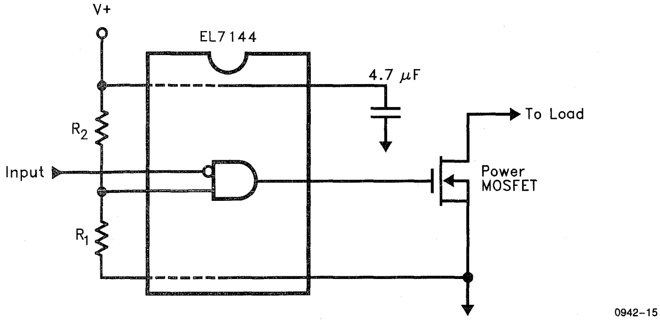



**Figure 1. Resonant Gate Driver**

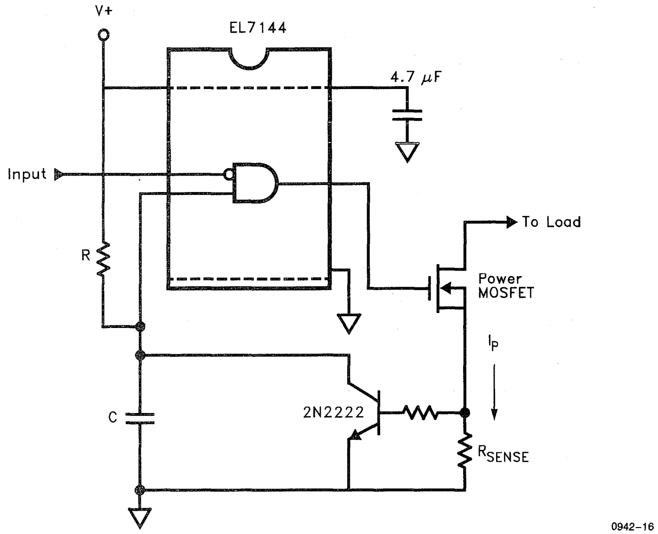
# Applications Information

### MOS Driver with Under-Voltage Lock-Out



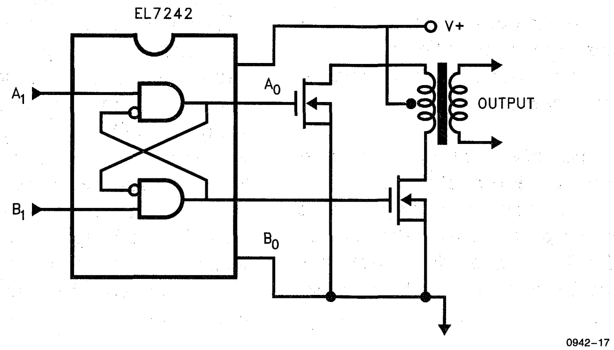

$$UV \approx (1.5)\frac{R_1 + R_2}{R_1}$$

### Over-Current Protected Driver




$$I_P \approx \frac{0.6}{R_{SENSE}}$$ Recovery Time $T_R \sim RC$

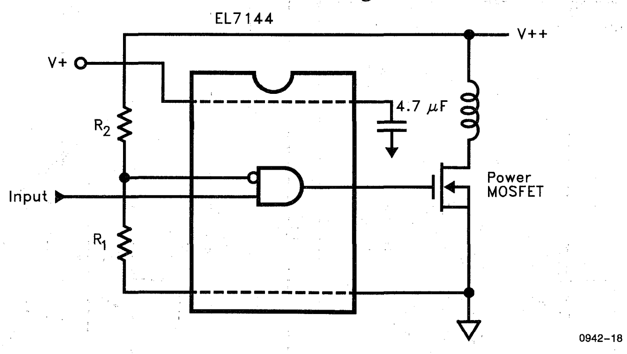
## MOS Driver with Simultaneous Conduction Lock-Out




### Truth Table

| $A_1$ | $B_1$ | $A_0$ | $B_0$ |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 0 | 1/0 | 0/1 |

## MOS Driver with Over-Voltage Protection




$$0V \approx (1.5)\frac{R_1 + R_2}{R_1}$$

## Mosfet Driver Generates its own +12V supply

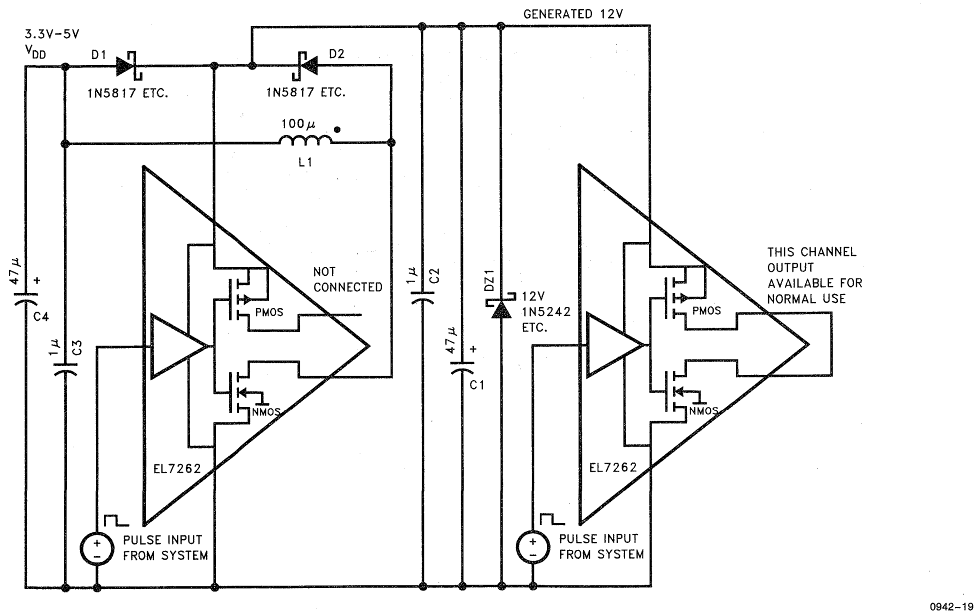
When you want to drive one power Mosfet, from a 5V or a 3.3V system, generating the one extra +12V supply can involve quite a large number of both active and passive components.

Here is a solution that uses the spare second Mosfet Driver channel to derive its own +12V supply. By using a driver with the drains brought out to separated pins, one can connect an inductor between the N-channel drain and the logic supply, without having the P-channel device connected.

In operation, it works as a standard flyback style switched mode circuit. When the output N-channel device is on, current starts flowing in the inductor, storing energy. When the N-channel device is turned off, the current has to continue flowing, so it flows through the diode D2 to charge up capacitors C1 and C2. As the cycle repeats, the voltage on C1 and C2 rises until the zener diode prevents further voltage rise. This is needed to prevent the drivers' derived supply from exceeding the parts' maximum voltage rating.

Since the objective was to minimize the number of external components and cost, additional components which would allow the circuit to self oscillate and regulate were omitted. The logic system was able to supply a drive pulse waveform to the supply generator. With the 5V system, I was using a 1.5 μs pulse every 9 μs. This gave a very solid +12.4V, and the system supply current went up by about 11 mA. The 3.3V system used a 300 kHz square wave, for a similar 12V derived supply, but with nearly 40 mA extra supply current. In both systems, when the Mosfet Driver was not being used, it could be "powered down" by simply stopping the pulses to the switching channel.

Any dual Mosfet Driver can be used, but if the drains of the output stage are not separated, there may be some protection and other parasitic devices that may prevent satisfactory operation. In these cases an external fet can be used to drive the inductor, provided a low threshold device is used. By altering the inductor value and the controlling pulses, enough power can be derived for further Mosfet Drivers or other peripheral devices requiring +12V.




**Self Charge Pumping Mosfet Driver**

## Super Inverters

CMOS is often equated with low power, however dynamic losses can be significant, particularly as the frequency of operation increases. Losses can be attributed to the parasitic capacitance on all internal nodes which toggle (described by $P = CV^2f$), and from simultaneous conduction through CMOS gates during switching. Parasitic capacitance is reduced by shrinking feature sizes and using low overlap, self aligned silicon-gate process technology. Simultaneous conduction (shoot-thru) can be controlled or eliminated completely with "super-inverter" technology. A standard CMOS inverter is shown in Figure 2A. Here, with every transition, there is an interval during which both the NMOS and PMOS transistors are conducting and dissipating energy.

Thus the integral of the instantaneous shoot-thru current, multiplied by the supply voltage and clock frequency describes the power loss.

$$P = 2fV\int_{o}^{t} I_S\,(t)dt$$

These losses can be significant, and are illustrated in Figure 2B. The super-inverter shown in Figure 3A overcomes the "shoot-thru" problem with "break before make" asymmetric drive, thereby controlling or eliminating simultaneous conduction. The designer can trade-off shoot-thru current for added propagation delay. The results demonstrated in Figure 3B represent about a 4× improvement. An added benefit is the reduced power supply bounce resulting from the large di/dt and stray inductance.

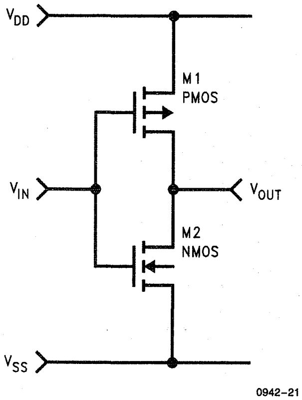



**Figure 2A. Standard CMOS Inverter**

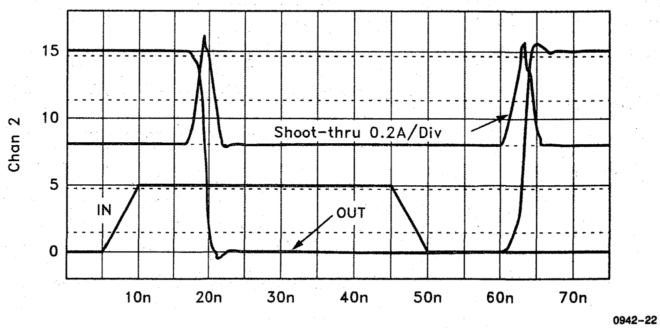



**Figure 2B. CMOS Inverter Switching Losses**

# Applications Information

## Super Inverters — Contd.

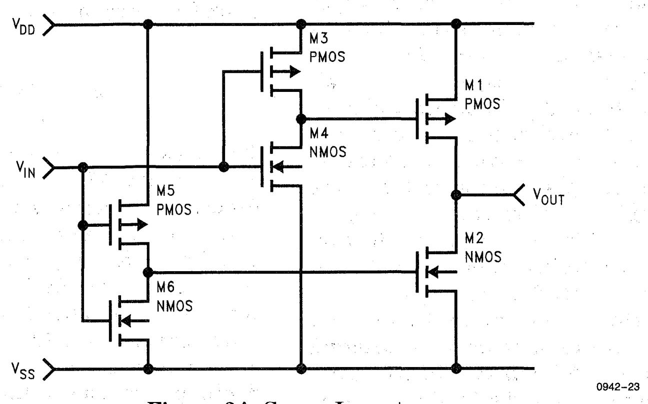



Figure 3A. Super Inverter

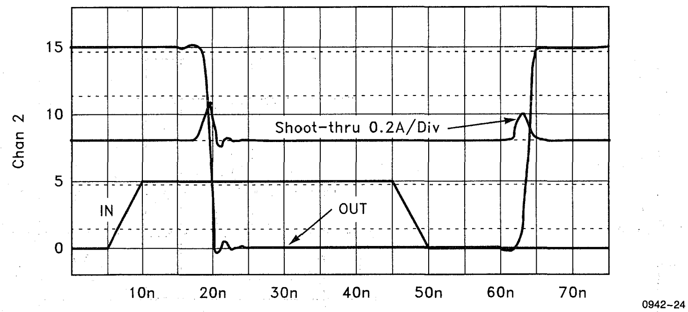



Figure 3B. Super Inverter Switching Losses

## Input Source Follower

To accommodate moderately high source inpedances, a source follower input stage similar to the circuit shown in Figure 4 is used. This eliminates both the "Miller" gate capacitance, and gate to source capacitance seen in typical designs. The "boot-strapping" effect eliminates all but the gate-drain capacitance. This feature allows direct drive from low current logic, without any degradation in performance.

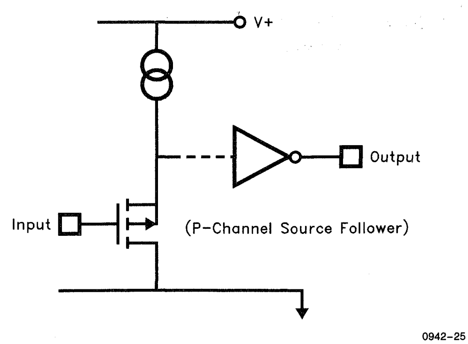



Figure 4. Low Input Capacitance Source Follower

## Precision Level Shifting

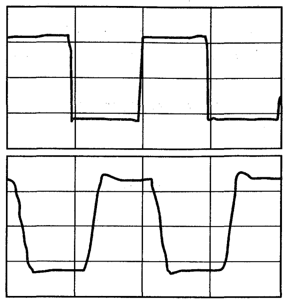
Generating rail to rail drive from a logic level input is accomplished with a Class AB push-pull amplifier and internal 1.2V reference. This produces a well controlled threshold with minimal propagation delay. The known switch point can be used to generate under-voltage lock-out protection. Hysterisis is also introduced to boost the noise immunity.

## 3-State and Gated Inputs

Additional logic functions are also provided to insure greater flexibility. 3-State control is often useful in "Bridge" and "Bus" applications. Gated inputs can be used for chip enable/shut-down, latching, and various other functions.

## Overall Performance

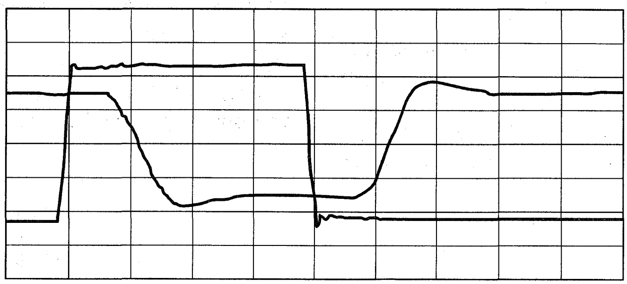
The resulting CMOS Drivers offer both functionality and performance. Figure 5 shows the switching characteristics into a 1000 pF load. Rise time, fall time, and delay are all matched to minimize pulse distortion, and are less than 20 ns. Figure 6 illustrates the waveform integrity at 5 MHz, into 1000 pF.



0942–27

Ch. 1 = 2.000V/div
Ch. 2 = 4.000V/div
Timebase = 100 ns/div

**Figure 6. 5 MHz Output into 1000 pF Load**



0942–26

Ch. 1 = 1.000V/div
Ch. 2 = 5.000V/div
Timebase = 20.0 ns/div

**Figure 5. Step Response into 1000 pF Load**

# Applying Power MOSFET Drivers
## by Bruce Rosenthal

## Overview

The EL7xxx series of high speed power MOSFET drivers achieve noteworthy improvements in speed, efficiency, input impedance, and functionality thru the application of advanced CMOS technology and novel circuit design. However, their ability to deliver high peak currents with rapid $d_V/d_T$'s makes them susceptible to over stress. Recommended design practices will be discussed to assist the designer in achieving reliable operation.

## Common Causes Resulting in MOSFET Driver Problems

### Cause 1

CMOS Latch-up: Inherent to CMOS integrated circuitry, is a parasitic SCR which can be triggered by injecting current thru any input or output pad. This occurs whenever the input/output pins exceed the supply rails by more than 0.6V. This condition may exist for any one of the following reasons.

1. During the power up/power down sequence, when voltage is applied to an input without supply voltage.
2. Ground or $V_{DD}$ "bounce" (relative to the input) during switching. This is often attributed to inductance in the current path.
3. Inductive kick-back from the output load.

### Cause 2

Over-Voltage Spikes: Power line spikes will occur when a rapid change in current (typical during switching) is present on an inductive supply line. Exceeding the maximum supply voltage can rupture the internal transistor gate oxide, causing catastrophic failure.

### Cause 3

Insufficient Overdrive: During switching, some ground bounce is going to occur. If the ground bounce is greater than the overdrive to the input, oscillation may result as the effective drive to the input is modulated. Since the typical input delay is only 20 ns, a slowly rising drive waveform will still be very close to the threshold when the output switches. The ensuing ground bounce may be enough to toggle the input.

### Cause 4

Thermal Overload: The high peak drive capability of the Elantec power MOSFET drivers, far exceeds their continuous rating. Limited by the high thermal resistance associated with PDIP and SOIC packages, junction temperatures can exceed the 125°C rated maximum. Users should be aware of those factors which contribute to the total power dissipated, including quiescent current, conduction losses, and switching losses.

## Guidelines for Improved Operation

The most important thing to remember in applying CMOS drivers is to minimize inductance to the power pins as illustrated in Figure 1.

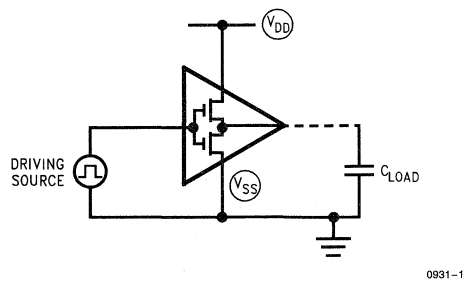



**Figure 1. Trouble Prone Configuration**

## Guidelines for Improved Operation — Contd.

To prevent CMOS latch-up restrict the inputs/outputs from exceeding the power rails. This may require the use of clamping diodes, output snubbers, power supply bypassing and decoupling. Effective bypassing requires a minimum path length between capacitor and supply pins. Choose a capacitor with good high frequency characteristics, such as ceramic and/or tantalum construction. Refer to Figure 2.

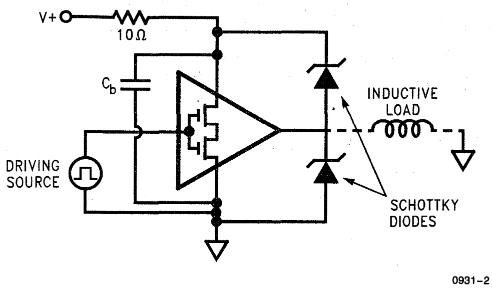
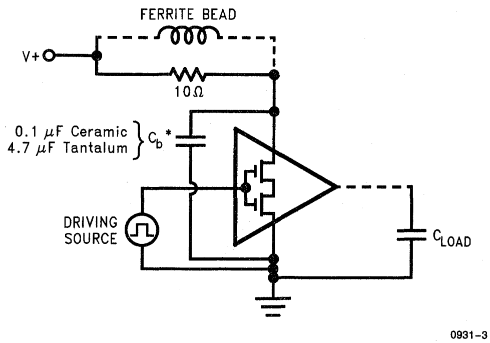



**Figure 2. Suggested Configuration for Driving Inductive Loads**

Overvoltage spikes can be controlled with decoupling. A small resistor (10Ω) from the supply, or a ferrite bead, followed by a 4.7 μF tantalum capacitor with short leads to the power pins is very effective. The suggested configuration is shown in Figure 3.




*$C_b$ should be physically located close to the power pins.

**Figure 3. Suggested Decoupling/Bypassing**

Sensitivity to insufficient drive is most pronounced at supply voltages greater than 12V due to the higher internal peak currents. Where high supply voltage operation is required, 0V to 5V input drive is suggested, with a minimum rise/fall time of 200 ns.

Excessive power dissipation typically results when driving large capacitive loads at high frequencies. These losses are described by:

$$P = CV^2F \quad \text{where}$$

P = Power
C = Capacitance (Internal and External)
V = Supply Voltage
F = Clock Frequency

Internal dissipation can be reduced by adding an external resistor or inductor, as shown in Figure 4. Since the power varies as the square of the voltage, a reduction in supply voltage from 15V to 12V results in a 33% power savings.

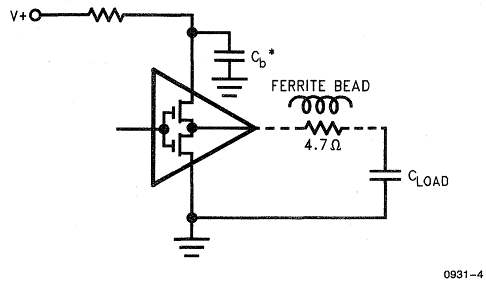



**Figure 4. Reducing $CV^2F$ Losses**

élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# *High Side Driver Simplifies Active Clamp Zero Voltage Switching Design*

## Introduction:

Recently, the active resonant reset or active clamp techniques have quietly emerged as the next generation of switching mode power conversion topology. The active clamp has resolved many problems associated with the traditional PWM and resonant converters. It merges the advantages of the simple control scheme of the traditional PWM technology and the unique soft switching features of the resonant technology. It utilizes the parasitic capacitance of the switching MOSFET and the magnetizing inductance of the power transformer and a reset switch to return the energy stored in the magnetizing inductance back to the supplies; as a result, no passive resistor-capacitor-diode clamp is necessary. Zero voltage switching also reduces voltage stress on the switching MOSFET and significantly decreases the turn-on transient switching current loss and improves efficiency. The consequence is a lower dV/dT across the switch and the output rectifier and lower EMI emission.

## Active Clamp ZVS Topology:

Figure 1 shows the schematic of a single ended zero voltage switching PWM in a forward configuration. Its basic operation is described in the following time step fashion. The gate drive timing diagrams and drain voltage and source current waveforms are depicted in Figure 2.

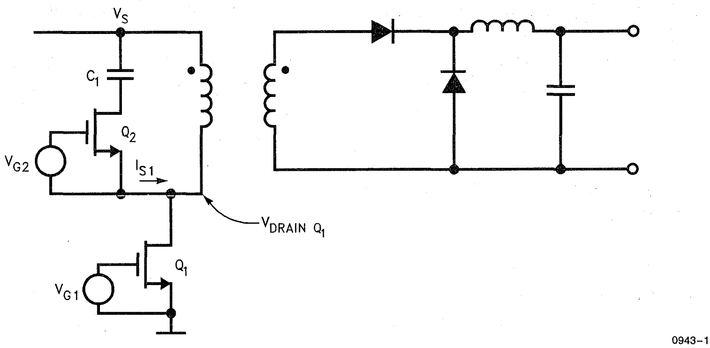



**Figure 1. Single-ended Forward Converter with Active Clamp**

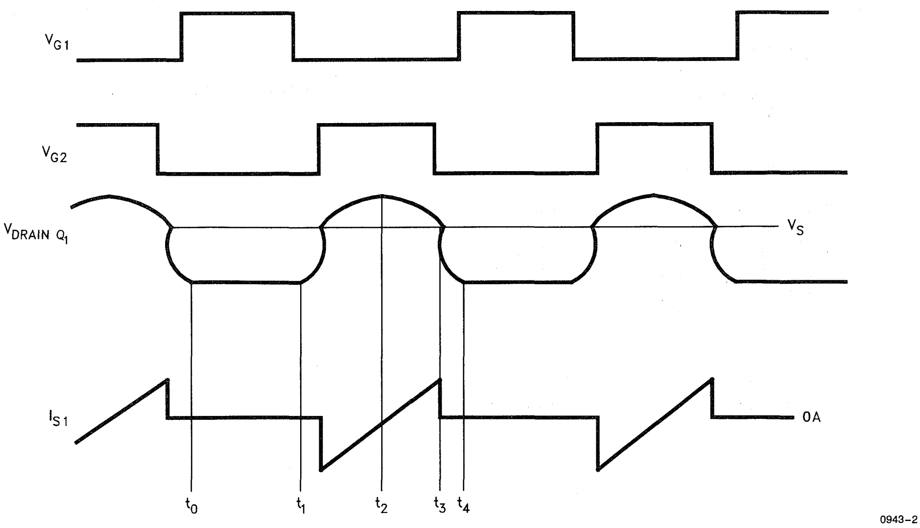



**Figure 2. Active Clamp Timing Diagram**

Step 1. $t_0$ to $t_1$. Initially, the main FET $Q_1$ is turned on. Current flows from the supply through the transformer and the drain of $Q_1$ to ground. Simultaneously, power is being transferred to the secondary output.

Step 2. $t_1$ to $t_2$. At $t_1$, $Q_1$ is switched off, current continues to flow through the magnetizing inductance of the power transformer which produces a positive flyback voltage and pulls the drain of $Q_1$ above the supply. The body diode of the reset FET $Q_2$ is forward biased and $C_1$ is charged. Before the drain voltage of $Q_1$ reaches its peak at $t_2$, the $Q_2$ switch is turned on to allow current to flow in the reverse direction.

Step 3. $t_2$ to $t_3$. This is the negative half cycle of the resonant swing. The $Q_1$ drain voltage starts to resonate downward and the magnetizing inductance current switches direction. It flows from the drain of $Q_1$ to the supply.

Step 4. $t_3$ to $t_4$. Some time prior to $Q_1$ turning on, the resonant switch $Q_2$ is switched off, transformer magnetizing inductance current continues to flow from the drain of $Q_1$ to the supply. Since $C_1$ is now disconnected from the resonant loop, this current will discharge the drain to source parasitic capacitance of $Q_1$. If the time ($t_3 - t_4$) between $Q_2$ switching off and $Q_1$ turning on is properly set, then the drain of $Q_1$ will be discharged close to ground immediately before $Q_1$ is turned on. Consequently, zero voltage switching is achieved.

## Elantec High Side Drivers With Delay Adjust:

To ease the implementation of zero voltage switching, elantec has introduced a new family of MOSFET drivers, the EL7761 series. The EL77XX has incorporated both the gate drive delay function and high side driving capability into one single $I_C$. Figure 3 shows its functional block diagram in a typical application configuration. The rising edge gate drive delay time is simply set by the Rdelay value. Figure 4 shows the relationship between the rising edge gate drive delay time and Rdelay value. The high side driving capability is achieved by using an external diode $D_P$ and capacitor $C_P$ to create the charge pump voltage level shifting function necessary to drive the upper MOSFET. The EL7761 can be disabled by shorting the EN pin to ground. When the device is disabled, the $P_{LO}$ and $N_{LO}$ pins are internally shorted to the GND pin and the $P_{HI}$ and $N_{HI}$ pins are shorted to the LX pin. A low voltage at POL puts the low side driver in an inverting configuration, a high voltage at POL puts the low side driver in a non-inverting application. The high side driver is always inverting.

# *High Side Driver Simplifies Active Clamp Zero Voltage Switching Design*

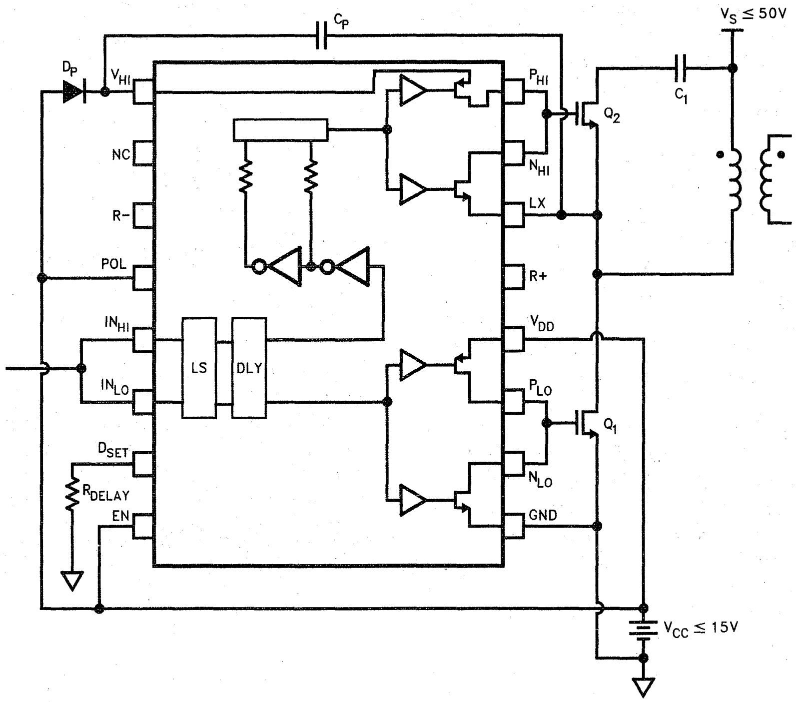



**Figure 3. EC7761 Typical Application**

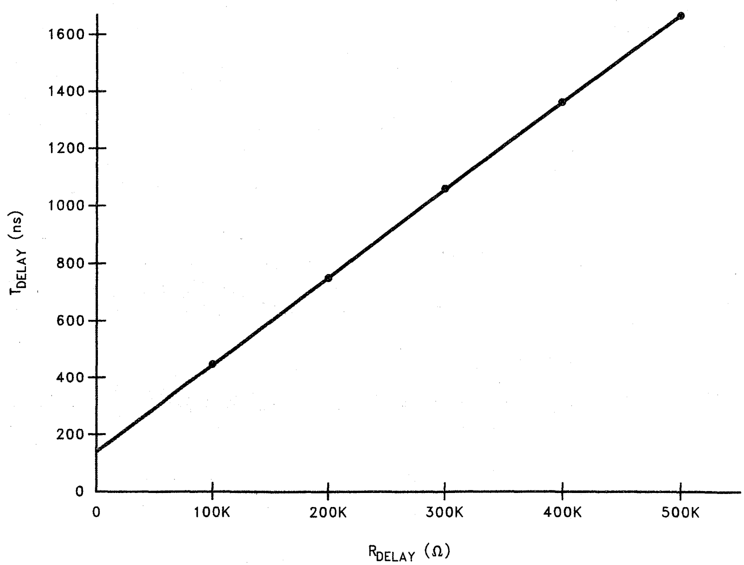



**Figure 4. $T_{DELAY}$ vs $R_{DELAY}$**

## Design Considerations:

The two main components in creating zero voltage switching are $C_1$, the resonant capacitor, and the delay time between the reset and main switches. $C_1$ value sets the frequency of the resonant oscillation. The period of the oscillation should be short enough to allow the drain voltage of the main switch to swing in the negative direction and the magnetizing inductance current to flow from the main switch drain to the supply before the reset switch is turned off. The following equation sets the basic criterion,

$$\tfrac{1}{4}\,T_{res} > (1 - D_{max})\,T_{SW} > \tfrac{1}{2}\,T_{res}$$

where

$T_{res} = 2\pi\sqrt{(L_m \times C_1)}$

$L_m$ is the primary inductance of the power transformer.

$C_1$ is the resonance capacitor.

$T_{SW} = 1/f_{sw}$. It is the period of the converter switching frequency.

$D_{MAX}$ is the maximum duty cycle of the PWM.

Time delay from reset switch turning off to the main switch turning on can be adjusted by selecting the appropriate $R_{DELAY}$ resistor value. Figure 4 shows the time delay vs $R_{DELAY}$ relationship. The optimum time delay is a quarter of the resonant period created by the magnetizing inductance and the drain to source parasitic capacitance of the main switch. A quarter cycle is the amount of time necessary for the capacitor to be discharged to its minimum level.

$$T_{DELAY} = \tfrac{1}{4}\left(2\pi\sqrt{(L_m \times C_{OSS})}\right)$$

where

$L_m$ is the primary inductance of the power transformer.

$C_{OSS}$ is the output drain to source parasitic capacitance of the main switch.

## Test Result:

An experiment has been completed with the circuit shown in Figure 5 . The primary inductance of the power transformer is 700 $\mu$H, and the output parasitic capacitance of the MOSFET is 250 pF. Using the equations discussed above, the calculated resonant frequency is,

$$f_{c1} = 1/(2\pi\sqrt{L_m \times C_1}\,) = 190\ \text{KHz}$$

The resonant frequency created by the primary inductance and the parasitic capacitance of $Q_1$ is

$$f_{q1} = 1/(2\pi\sqrt{L_m \times C_{OSS}}) = 380\ \text{KHz}$$

# High Side Driver Simplifies Active Clamp Zero Voltage Switching Design

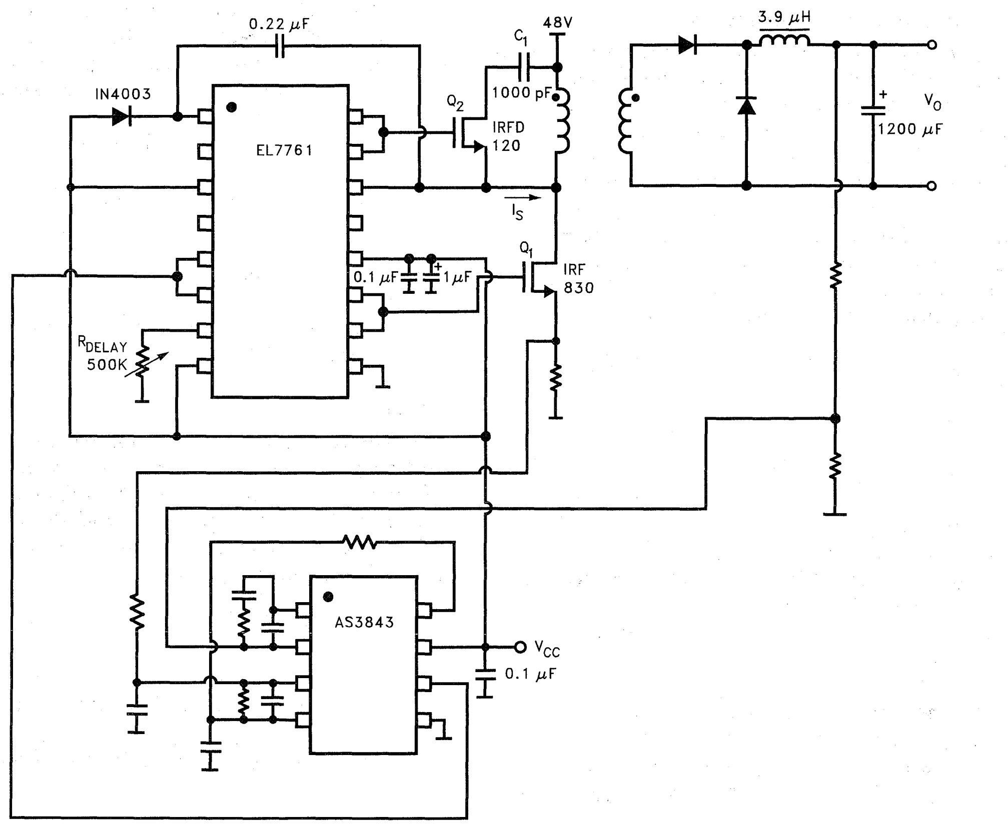



**Figure 5. A 48V to 5V DC-DC Converter**

Figure 6 shows the resonance waveforms created by the primary inductance and the parasitic capacitance. The resonant frequencies are also measured,

$fc_1 = 186$ KHz
$fq_1 = 416$ KHz

## Other Topologies:

The EL7761 can also be used in other converter topologies. Figures 7 to 9 are a collection of power converters using the EL7761 and zero-voltage switching techniques.

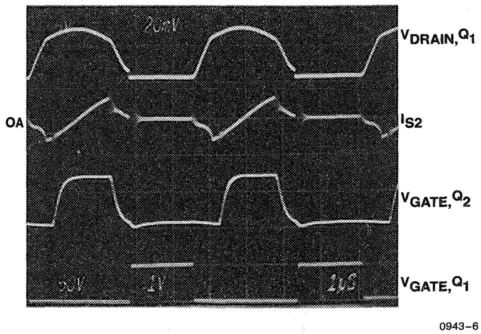



Figure 6. Gate Drive Voltage and Source Current Waveforms

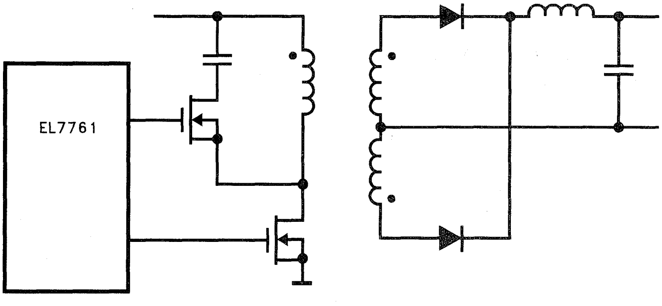



Figure 7. Double-ended Forward Converter

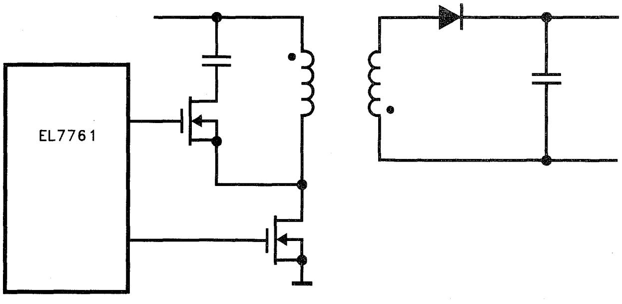



Figure 8. Fly-back Converter

# *High Side Driver Simplifies Active Clamp Zero Voltage Switching Design*

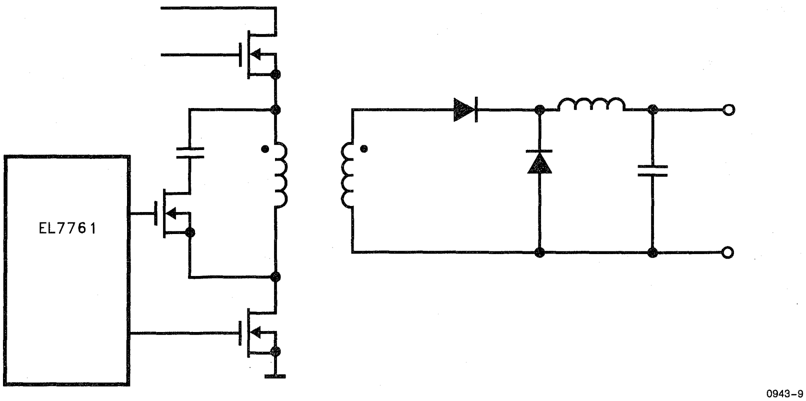
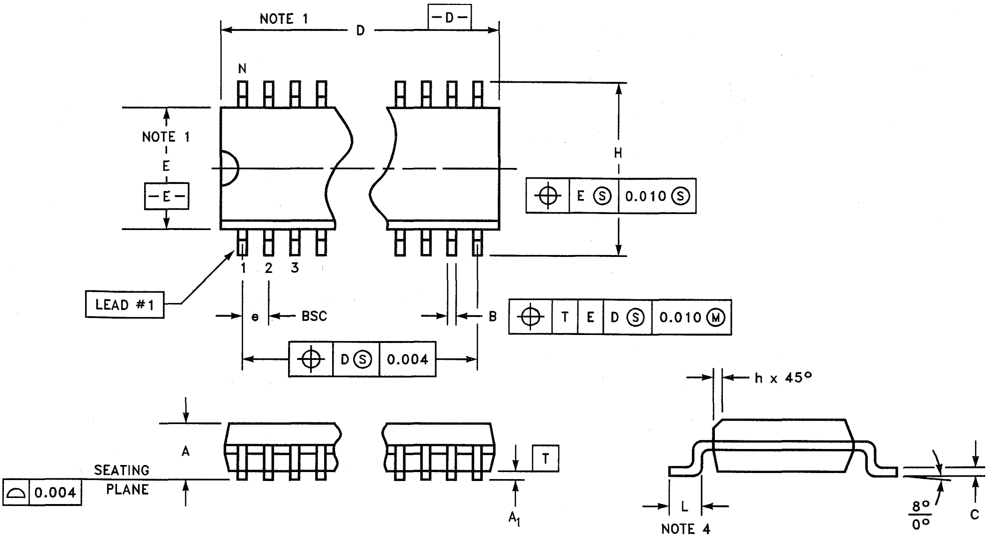



**Figure 9. Two FET Forward Single-ended**

## Conclusion:

Zero voltage switching is achieved by using a second reset switch. The internal operation of the zero voltage switching technique is described. A design example is given and zero voltage switching is demonstrated. The EL7761 is also shown to simplify the implementation of zero voltage switching.




REV. C

Note 1: These dimensions do not include mold flash or protrusions. Mold flash protrusion shall not exceed .006″ on any side.
Note 2: 8 and 14 leads are narrow body.
Note 3: Dimensions and tolerancing per ANSI Y14.5M-1982.
Note 4: Flat area of lead foot.
Note 5: SOL-24T2 (thermal package) has 2 fused leads on each side of package.

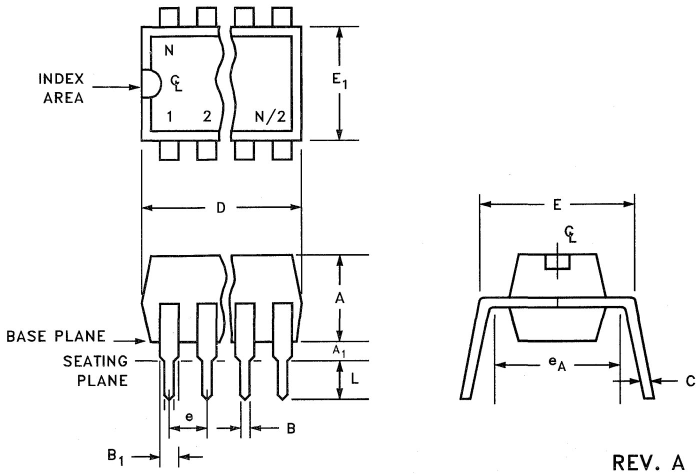
**MDP0027 Rev. C**

**Package Outline—SOIC**

Lead Finish—Solder Plate

| Symbol | Lead Count | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SOL-28 | | SOL-20 | | SOL-16 | | SO-16 | | SO-14 | | SO-8 | | SOL-24 | |
| | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| A | 0.096 | 0.104 | 0.096 | 0.104 | 0.096 | 0.104 | 0.061 | 0.068 | 0.061 | 0.068 | 0.061 | 0.068 | 0.096 | 0.104 |
| $A_1$ | 0.004 | 0.011 | 0.004 | 0.011 | 0.004 | 0.011 | 0.004 | 0.010 | 0.004 | 0.010 | 0.004 | 0.010 | 0.004 | 0.011 |
| B | 0.014 | 0.019 | 0.014 | 0.019 | 0.014 | 0.019 | 0.014 | 0.019 | 0.014 | 0.019 | 0.014 | 0.019 | 0.014 | 0.019 |
| C | 0.009 | 0.012 | 0.009 | 0.012 | 0.009 | 0.012 | 0.008 | 0.010 | 0.008 | 0.010 | 0.008 | 0.010 | 0.009 | 0.012 |
| D | 0.696 | 0.712 | 0.498 | 0.510 | 0.397 | 0.430 | 0.386 | 0.394 | 0.337 | 0.344 | 0.189 | 0.196 | 0.598 | 0.614 |
| E | 0.291 | 0.299 | 0.291 | 0.299 | 0.291 | 0.299 | 0.150 | 0.157 | 0.150 | 0.157 | 0.150 | 0.157 | 0.291 | 0.299 |
| e | 0.050 BSC | | 0.050 BSC | | 0.050 BSC | | 0.050 BSC | | 0.050 BSC | | 0.050 BSC | | 0.050 BSC | |
| H | 0.398 | 0.414 | 0.398 | 0.414 | 0.398 | 0.414 | 0.230 | 0.244 | 0.230 | 0.244 | 0.230 | 0.244 | 0.398 | 0.414 |
| h | 0.010 | 0.016 | 0.010 | 0.016 | 0.010 | 0.016 | 0.010 | 0.016 | 0.010 | 0.016 | 0.010 | 0.016 | 0.010 | 0.016 |
| L | 0.016 | 0.024 | 0.016 | 0.024 | 0.016 | 0.024 | 0.016 | 0.024 | 0.016 | 0.024 | 0.016 | 0.024 | 0.016 | 0.024 |

# *Package Outlines*




**MDP0031 Rev. A**
**Plastic Package**
Lead Finish—Hot Solder DIP

| Common Dimensions | Min | Max | Min | Max | Min | Max | Min | Max |
|---|---|---|---|---|---|---|---|---|
| $A_1$ | 0.020 | 0.040 | 0.020 | 0.040 | 0.020 | 0.040 | 0.020 | 0.040 |
| A | 0.125 | 0.145 | 0.125 | 0.145 | 0.125 | 0.145 | 0.125 | 0.145 |
| B | 0.016 | 0.020 | 0.016 | 0.020 | 0.016 | 0.020 | 0.015 | 0.021 |
| $B_1$ | 0.050 | 0.070 | 0.050 | 0.070 | 0.050 | 0.070 | 0.050 | 0.070 |
| C | 0.008 | 0.012 | 0.008 | 0.012 | 0.008 | 0.012 | 0.008 | 0.012 |
| D | 0.350 | 0.385 | 0.750 | 0.770 | 0.745 | 0.755 | 0.925 | 1.045 |
| E | 0.290 | 0.310 | 0.300 | 0.320 | 0.300 | 0.325 | 0.300 | 0.320 |
| $E_1$ | 0.245 | 0.255 | 0.245 | 0.255 | 0.245 | 0.255 | 0.245 | 0.255 |
| e | 0.100 Typ | | 0.100 Typ | | 0.100 Typ | | 0.100 Typ | |
| $e_A$ | 0.300 Ref | | 0.300 Ref | | 0.300 Ref | | 0.300 Ref | |
| L | 0.130 | 0.150 | 0.115 | 0.150 | 0.125 | 0.150 | 0.130 | 0.150 |
| N | 8 | | 14 | | 16 | | 20 | |

# *Ordering Information*



In North America, Elantec has three levels of sales support. Regional Sales Managers are located in the Boston and San Jose areas. Field Applications Engineers are located in the Boston and San Jose offices. Elantec also maintains a network of sales representatives covering the United States and Canada. Finally, major nationwide and regional distributors provide local stock. Elantec maintains an up-to-date distributor inventory status and provides an inventory referral service through Distribution Sales in San Jose. Orders may be placed through the sales representatives or distributors. A list of sales representatives and distributors is included with this Elantec 1994 Databook, or please contact any of the regional sales offices.

In Europe, Elantec has a Regional Sales Office in London. Local sales support is provided through stocking representatives in all of the major countries. A current list of representatives and distributors may be obtained from the London office.

Elantec has stocking agents in all Pacific Rim Countries, Australia, and New Zealand. A list may be obtained from Elantec's headquarters in Milpitas, California.

In Asia, Elantec has a regional sales office in Tokyo. Local sales support is provided through stocking representatives in all of the major countries. A current list of representatives may be obtained by contacting the Tokyo sales office.

## Elantec Proprietary and NSC Alternate Source

E L 2006 A G /883B

PREFIX
ELANTEC

FAMILY
- LH NSC Alternate Source
- L Proprietary Linear
- P PNP Array
- N NPN Array

PART
NUMBER

OPTIONAL SUFFIX
- A Selected Electrical Performance
- C −0°C to +75°C or −40°C to +85°C
- E −40°C to +150°C
- None −55°C to +125°C

RELIABILITY PROGRAM
/883B 100% MIL-STD-883 Class B, Current Revision Processing

PACKAGE
- B Sidebraze
- G TO-8 Metal Can
- H TO-5 or TO-99 Metal Can
- J CerDIP
- K TO-3
- N Plastic DIP
- T TO-220
- M Large Body SOIC
- S Narrow Body SOIC

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THIS ACKNOWLEDGEMENT AND ACCEPTANCE IS EXPRESSLY LIMITED TO AND MADE CONDITIONAL UPON THE TERMS AND CONDITIONS CONTAINED HEREIN AND ANY OF THE BUYER'S TERMS AND CONDITIONS WHICH ARE IN ADDITION TO OR DIFFERENT FROM THOSE CONTAIN HEREIN WHICH ARE NOT SEPARATELY AND SPECIFICALLY AGREED TO IN WRITING ARE HEREBY OBJECTED TO AND SHALL BE OF NO EFFECT.

Only those orders accepted by Seller as its home office in Milpitas, California shall be binding upon Seller.

## 2. PRICES

Irrespective of any prices quoted by Seller or listed on Buyer's order, Seller's acceptance of any order is subject to the prices shown on Seller's acknowledgment. Said prices are firm and are not subject to adjustment other that "precious metals adjustments" or "precious metals surcharges" at Seller's option to cover Seller's cost of fluctuations in the price of precious metals utilized in the manufacture of Seller's products.

## 3. TAXES

All prices are exclusive of all federal, state and local excise, sales, use and similar taxes. Such taxes shall be paid by Buyer, or in lieu thereof Buyer shall provide Seller with a tax exemption certificate acceptable to the taxing authorities. When applicable, such taxes will appear as separate additional items on the invoice unless Seller receives a proper tax-exemption certificate from Buyer prior to shipment.

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Unless Seller has extended credit to Buyer as described below, Buyer shall pay Seller, at Seller's option either by: Cash with Order, C.O.D., Letter of Credit or Sight Draft.

Should Seller elect to extend credit to Buyer, payment shall be made in full within thirty (30) days of the date of Seller's invoice. Seller reserves the right at any time to change the amount of or to withdraw any credit extended to Buyer.

Any payments made in excess of thirty (30) days may be subject to late charges.

## 5. TITLE AND DELIVERY

Seller shall deliver products sold hereunder to Buyer F.O.B. Seller's factory. Partial deliveries shall be permitted. Upon such delivery to a carrier at Seller's factory, title to the products and all risk of loss or damage shall pass to Buyer.

## 6. SHIPMENT

All shipping charges and expenses shall be paid by Buyer. Seller will not insure the products sold hereunder unless requested by Buyer in which case Buyer will pay for such insurance.

Shipments will be made, at Seller's option, either by Parcel Post, Railway Express. Air Express, Air Freight, or as otherwise determined by Seller.

Shipping dates are approximate and are dependent upon Seller's prompt receipt of all necessary information from Buyer.

## 7. PATENTS

With respect to products manufactured soley to Seller's designs and specifications, Seller shall defend any suit or proceeding brought against Buyer insofar as such suit or proceeding is based on a claim that any such products furnished hereunder infringe any patent of the United States. If Seller is notified promptly in writing of such suit or proceeding and given full and complete authority, information, and assistance by Buyer for such defense, Seller shall pay all damages and costs finally awarded against Buyer in any such suit or proceeding, but Seller shall not be responsible for any compromise thereof made by Buyer without the written consent of Seller. In the event that such products are held in such suit or proceeding to infringe a patent of the United States and their use is enjoined, or if in the opinion of Seller such products are likely to become the subject of a claim of infringement of a patent of the United States, Seller, in its sole discretion and at its won expense, may either: (a) procedure for Buyer the right to continue using such products with noninfringing products; or (b) modify such products so that they become noninfringing; or (c) replace such products with noninfringing products; or (d) accept the return of such products, granting Buyer a refund therefor equal to the depreciated value thereof.

Seller shall have no liability to Buyer under any provision hereof if any patent infringement or claim thereof is based upon (a) a modification of the products not introduced by or approved by Seller; or (b) the interconnection or use of the products in combination with products with other devices not made by Seller; or (c) the use of the products in other than an application recommended by Seller.

The foregoing states the entire liability of Seller for infringement of patents by Seller's products or any part(s) thereof.

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Buyer shall indemnify, defend, and hold Seller harmless from and against any and all liability, damages, expenses, costs or losses resulting from any suit or proceeding brought for infringement of a patent(s), copyright(s), or trademark(s), or for a misappropriation of use of any trade secret(s), or for unfair competition arising from Seller's compliance with Buyer's design, specifications or instructions.

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Notwithstanding passage of title of products sold hereunder to Buyer F.O.B. Seller's factory, Seller shall retaln a security interest in the products until payment has been made in full by Buyer for such products. Buyer shall perform all acts necessary to perfect and maintaln such security interest.

## 10. WARRANTIES

Seller warrants to Buyer that Seller's standard products sold hereunder (and any services furnished therewith) which are not used in any medical or life support application shall be free from defects in material and workmanship and shall conform to the applicable specifications (if any) for a period of one year from the date of shipment. For products which are not standard products of Seller, such as dice and developmental or custom designed products. Seller warrants to Buyer that such products sold hereunder (and any services furnished therewith) shall be free from defects in material and workmanship and shall conform to the applicable specifications (if any) for a period of thirty (30) days from the date of shipment.

Should products sold hereunder fall to meet the above applicable warranty, Seller, at its option, shall repair or replace such products or issue Buyer a credit provided that (a) Seller is notified in writing by Buyer within thirty (30) days after discovery of such failure; (b)Buyer obtains a Return Material Authorization from Seller prior to returning any defective products to Seller; (c) the defective products are returned to Seller, transportations charges prepaid by Buyer; (d) the defective products are received by Seller for adjustment no later than four (4) weeks following the last day of the warranty period, and (e) Seller's examination of such products shall disclose, to its satisfaction, that such failures have not been caused by misuse, abuse, neglect, improper installation or application repair, alteration, accident or negligency in use, storage, transportation or handling.

In the event of failure to meet the above applicable warranty with respect to products sold hereunder cannot be corrected by Seller's reasonable efforts, the Seller and Buyer shall negotiate an equitable adjustment in price.

The foregoing warranty provisions set forth the Seller's sole liability and the Buyer's exclusive remedies for claims (except as to title) based on defects in or failure of any products sold hereunder or services furnished hereunder whether the claim is based in contact, tort, (including negligence), warranty or otherwise and however instituted. Upon the expiration of the applicable warranty for any products sold hereunder, all such liability shall terminate.

# Terms and Conditions

The above warranty periods shall not be extended by the repair or replacement of products pursuant to any of the above warranties. The above warranties shall apply only to Buyer and shall not apply to Buyer's customers or any other third parties.

SELLER PRODUCTS ARE NOT DESIGNED FOR AND SHOULD NOT BE USED WITHIN LIFE SUPPORT SYSTEMS WITHOUT THE SPECIFIC WRITTEN CONSENT OF THE PRESIDENT OF ELANTEC. LIFE SUPPORT SYSTEMS ARE EQUIPMENT INTENDED TO SUPPORT OR SUSTAIN LIFE AND WHOSE FAILURE TO PERFORM WHEN PROPERLY USED IN ACCORDANCE WITH INSTRUCTIONS PROVIDED CAN BE REASONABLY EXPECTED TO RESULT IN SIGNIFICANT PERSONAL INJURY OR DEATH. USERS CONTEMPLATING APPLICATION OF SELLER PRODUCTS IN LIFE SUPPORT SYSTEMS ARE REQUESTED TO CONTACT SELLER FACTORY HEADQUARTERS TO ESTABLISH SUITABLE TERMS AND CONDITIONS FOR THESE APPLICATIONS. SELLER'S WARRANTY IS LIMITED TO REPLACEMENT OF DEFECTIVE COMPONENTS AND DOES NOT COVER INJURY TO PERSONS OR PROPERTY OR OTHER CONSEQUENTIAL DAMAGES.

## 11. LIMITATION OF LIABILITY

In no event, whether as a result of breach of contract, warranty or tort (including negligence) or otherwise shall Seller be liable for any special, consequential, incidental or penal damages, including but not limited to, loss of profit or revenues, loss of the product or any associated equipment, damaged to associated equipment, cost of captial, cost of substitute products, facilities, service or replacement power, down time costs or claims of Buyer's customers for such damages. If Buyer transfers title to or leases products sold hereunder to any third party, Buyer shall obtain from such third party a provision affording the Seller the protection of the preceding sentence.

Except as provided in the above "Patents" article, whether a claim is based in contract, tort (including negligence) or otherwise, the Seller's liability for any loss or damage arising out of, or resulting from any products sold hereunder or services furnished hereunder shall in no case exceed the price of the specific product(s) or service(s) which gives rise to the claim. Except as to title, any such liability shall terminate upon the expiration of the applicable warranty period specified in the above "Warranties" article.

## 12. U.S. GOVERNMENT CONTRACTS

If the products to be furnished hereunder are to be used in the performance of a U.S. Government contract or subcontract, no Government requirments or regulations shall be binding upon Seller unless specifically agreed to by Seller in writing.

If the Government terminates such a contract or subcontract in whole or in part through no fault of or failure to perform by Buyer, this order may be canceled in writing in the same proportion, and the liability of Buyer for termination allowances shall be determined by the then applicable regulations of the Government regarding termination of contracts.

## 13. EXCUSABLE DELAYS

Seller shall not be liable for delays in delivery or performance due to any cause beyond its reasonable control, including, without limitation, acts of God, acts of Buyer, strikes or other labor disturbances, inability to obtain necessary materials, components, services or facilities.

## 14. CANCELLATIONS OF STANDARD PRODUCTS

Should Buyer terminate any order accepted hereunder or should Seller terminate any order accepted hereunder due to Buyer's nonperformance of its obligations hereunder, then Buyer shall pay Seller its reasonable termination charges within fifteen (15) days from the date of invoice of same.

Buyer may request rescheduling or cancellation by providing thirty (30) days written notice to Elantec provided however, that elantec is not obligated to accept such notice, but if such notice is given and accepted by Elantec, then Elantec has the right to deliver and be paid by Buyer for:

1. 100% of quantity of devices scheduled for delivery within thirty (30) days following receipt of said notice.

2. 50% of quantity of devices scheduled for delivery within 30–60 days following receipt of said notice.

## 15. CANCELLATION OF PRODUCTS MANUFACTURED TO BUYER'S DESIGN/SPECIFICATIONS INCLUDING ALL NON-STANDARD AND DISK DRIVE PRODUCTS

Charge for engineering, design, generation of data, lot charges or any other special charges that are not for product are non-cancelable except with prior written permission from Seller.

Buyer may request rescheduling or cancellation of product by providing 60 day notice to Elantec provided, however, that Elantec is not obligated to accept such notice but if such notice is given and is accepted by Elantec, then Elantec has the right to deliver and be paid by the Buyer for:

1. 100% quantity within 60 days following written receipt of said notice;
2. All additional work in process scheduled within the 16 week delivery time period shall be paid for by Buyer at a price based on the percentage of completion of such inventory applied to the price for the finished product. Buyer shall also promptly pay to Elantec; (a) costs of settling and paying claims arising out of termination of work under Elantec's subcontracts or vendors; (b) reasonable costs of settlement, including engineering, development, accounting, legal and clerical costs; (c) twenty percent (20%) of the purchase price of the purchase order to be canceled.

## 16. ASSIGNMENT

Any assignment by Buyer of this order or of any rights or obligations in connection therewith shall be void without the written prior consent of the Seller.

## 17. EXPORT TO NON-APPROVED COUNTRIES

Buyer agrees to take all reasonable and necessary precautions to prevent ultimate exportation of Elantec products to countries prohibited by rules or regulations of the United States Government, and to obtain all export licenses and other governmental approvals necessary prior to the export of any Elantec products.

## 18. MISCELLANEOUS

The validity, performance and construction of these terms and conditions of sale and any sale hereunder shall be governed by the laws of the state of California.

The invalidity, in whole or in part, of a y provision herein shall not affect the validity or enforce ability of any other provision herein.

Any representation, warranty, course of dealing or trade usage not contained or referenced herein shall not be binding on Seller.

No modification, amendment, recision, waiver or other change in these terms and conditions shall be binding on Seller unless assented to in writing by Seller's duly authorized representative.

Seller reserves the right to manufacture and/or assemble its products in any of its worldwide facilities unless otherwise agreed to in writing with Buyer.

élantec HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

# *Making Applications and Sample Requests Easier*

## Elantec's Policy

Elantec receives many applications inquiries every day which vary widely in nature. We believe that Application assistance is as inherently important to our customers as the performance and quality of our products. To assist our customers in getting the best and fastest support possible, the following information is provided.

## Sample and Literature Requests

If you know what product sample or literature you need, probably the best and fastest way to obtain them is to call Elantec's local sales office, sales representative, or distributor. A complete listing is on pages 19-3 through 19-14 of this book. If you are not sure what you need, call our Applications hot line 1 (800) 333-6314. For literature only, touch or request extension 234. For applications assistance, touch or request extension 311.

## New Applications Assistance

Technical assistance for a new application is a toll free phone call away. Call 1 (800) 333-6314 and touch or request extension 311. Probably the most important information that Elantec needs to assist you is a clear picture of what the circuit needs to do. What we mean by that is the cost and performance objectives of the circuit or system. If you have a preliminary topology or schematic, feel free to FAX that to the Factory at 1 (408) 945-9305 in confidence. The following is a check list which will expedite our assistance to you:

What does the circuit need to do?

What power supply voltages are available?

What is the temperature range?

What is the load?

What are the key specs: bandwidth, slew rate, settling time, noise, output voltage, etc. and what are your expectations?

## Problems with an Existing Circuit and Other Issues

Applications assistance for an existing application is a toll free phone call away. Call 1 (800) 333-6314 and touch or request extension 311. Probably the most important information that Elantec needs to assist you is a clear picture of what the circuit is doing or not doing. The following is a check list which will expedite our assistance to you:

What is the part number?

What is the device's date code?

What are the symptoms?

Are scope photos or frequency plots available?

How many devices are involved?

## Unreleased Product

As a general rule, Elantec does not sample new devices that have not completed our rigorous formal release cycle. However, occasionally we will "beta " site customers with advanced Engineering samples. We view this as a productive exchange between our Factory and customer Engineering teams to pin point problems and issues. In all instances, these devices will be marked "Engineering Sample." If you are interested in such a device, call your nearest Elantec sales office, local sales representative, or the Factory at 1 (800) 333-6314 and touch or request extension 252.

## Demo Boards

Contact factory applications for demo board availability.

## Quality or Reliability Issues

On the rare occasion that you experience what may be a Reliability or Quality issue, please contact the nearest Elantec sales office, local sales representative, or distributor. You may choose to call the Factory directly at 1 (800) 333-6314, and touch or request extension 310 or 279.

## Price Quotes/Delivery Status

For pricing and delivery information, please contact the appropriate full service representative or local Elantec franchised distributor as listed on page 19-6. For additional information you may contact the Elantec Customer Service Department @ 1 (800) 333-6314.

# United States Manufacturers Representatives

## ALABAMA
Group 2000 Sales, Inc
655 Gallatin St #100
Huntsville, AL 35801
PHONE 205-536-2000
FAX 205-533-5525

## ARIZONA
Reptronix, Ltd
1661 E. Camelback Rd
Phoenix, AZ 85016
PHONE 602-230-2630
FAX 602-230-7730

## CALIFORNIA
Bestronics
9683 Tierra Grande St #102
San Diego, CA 92126
PHONE 619-693-1111
FAX 619-693-1963

Brooks Technical Group
883 North Shoreline Blvd
Mountain View, CA 94043
PHONE 415-960-3880
FAX 415-960-3615

Brooks Technical Group
10120 Fair Oaks Blvd #D
Fair Oaks, CA 95628
PHONE 916-965-3255
FAX 916-965-4204

L.A. Area
Contact 1-800-333-6314

## COLORADO
Thom Luke Sales
9085 E. Mineral Circle #240
Englewood, CO 80112
PHONE 303-649-9717
FAX 303-649-9719

## CONNECTICUT
John E. Boeing
Bldg 1A 101 Harvest Pk No
Wallingford, CT 06492
PHONE 203-265-1318
FAX 203-265-0235

## FLORIDA
Photon Sales, Inc
1600 Sarno Rd, S-21
Melbourne, FL 32935
PHONE 407-259-8999
FAX 407-259-1323

Photon Sales Inc
715 Florida St
Orlando, FL 32806
PHONE 407-896-6064
FAX 407-896-6197

## GEORGIA
Group 2000 Sales, Inc
5390 Peachtree Indust #210B
Norcross, GA 30071
PHONE 404-729-1889
FAX 404-729-1896

## IDAHO
First Source
10451 W. Garverdale Ct
Boise, ID 83704
PHONE 208-378-4680
FAX 208-323-9386

## ILLINOIS
MicroTex
2400 West Central Rd
Hoffman Estates, IL 60196
PHONE 708-765-3000
FAX 708-765-3010

## INDIANA
Mohrfield Marketing
4173 Millersville Rd
Indianapolis, IN 46205
PHONE 317-546-6969
FAX 317-545-4504

## United States Manufacturers Representatives — Contd.

### INDIANA — Contd.
Morfield Marketing, Inc
9415 Teke Dr
Leo, IN 46765
PHONE 219-627-5355
FAX 219-627-2953

### KANSAS
Midtec Associates, Inc
11900 W. 87th St Pkwy #220
Lenexa, KS 66215
PHONE 913-541-0505
FAX 913-541-1729

### KENTUCKY
Mohrfield Marketing, Inc
2265 Harrodsburg Rd #200
Lexington, KY 40504
PHONE 606-276-0478
FAX 606-278-6182

John E. Boeing
10 North Rd
Chelmsford, MA 01824
PHONE 508-256-5800
FAX 508-256-8939

### MARYLAND
DGR
1447 York Rd #401
Lutherville, MD 21093
PHONE 410-583-1360
FAX 410-825-5579

### MASSACHUSETTS
John E. Boeing
10 North Rd
Chelmsford, MA 01824
PHONE 508-256-5800
FAX 508-256-8939

### MICHIGAN
Electronic Sources Inc
8002 W. Grand River Ave #B
Brighton, Ml 48116
PHONE 313-227-3598
FAX 313-227-5655

### MINNESOTA
High Technology Sls
4801 W. 81st St #115
Bloomington, MN 55437
PHONE 612-844-9933
FAX 612-844-9930

### MISSOURI
Midtec Associates, Inc
55 Westport Plaza #614
St. Louis, MO 63146
PHONE 314-275-8666
FAX 314-275-8859

### NEW JERSEY
BGR Associates
525 Route 73 Suite 100
Marlton, NJ 08053
PHONE 609-983-1020
FAX 609-983-1879

### NEW MEXICO
Reptronix Ltd.
237 C Eubank North East
Albuquerque, NM 87123
PHONE 505-292-1718
FAX 505-299-1611

### NEW YORK
Astrorep Inc
103 Cooper St
Babylon, NY 11702
PHONE 516-422-2500
FAX 516-422-2504

### NORTH CAROLINA
Group 2000 Sales, Inc
875 Walnut St #310
Cary, NC 27511
PHONE 919-481-1530
FAX 919-481-1958

### OHIO
Hester Associates
8177 Chagrin Mills Rd
Chagrin Falls, OH 44022
PHONE 216-338-5103
FAX 216-338-5926

## United States Manufacturers Representatives — Contd.

### OREGON
Electronic Solutions
P.O. Box 91428
Portland, OR 97291
PHONE 503-292-8204
FAX 503-292-8204

### TEXAS
O M Associates
690 W. Campbell Rd #150
Richardson, TX 75080
PHONE 214-690-6746
FAX 214-690-8721

O M Associates
10777 Westheimer #845
Houston, TX 77042
PHONE 713-789-4426
FAX 713-789-4825

O M Associates
11044 Research Blvd #A103
Austin, TX 78759
PHONE 512-794-9971
FAX 512-794-9987

### UTAH
First Source
2688 Willow Bend
Sandy, UT 84093
PHONE 801-943-6894
FAX 801-943-6896

### WASHINGTON
E2
13333 Bel-Red Rd Suite 239
Bellevue, WA 98005
PHONE 206-637-0302
FAX 206-646-8893

### WISCONSIN
Micro-Tex
22660 Broadway #4A
Waukesha, WI 53186
PHONE 414-542-5352
FAX 414-542-7934

## Canadian Manufacturers Representatives

### BRITISH COLUMBIA
Leister Blake Enterprises Ltd
570 Ballantree Rd
West Vancover, B. C. V7S 1W3
PHONE 604-926-6127
FAX 604-926-0372

### ONTARIO
Har-Tech Electronics Ltd
20 Staffern Dr #10
Concord, Ontario, Canada L4K 2Z7
PHONE 416-660-3419
FAX 416-660-5102

Har-Tech Electronics Ltd
One Bonner St
Nepean, Ontario, Canada K2H 7S9
PHONE 613-726-9410
FAX 613-726-8834

### QUEBEC
Har-Tech Electronics Ltd
6600 Trans-Canada Hwy #460
Pointe Claire, Quebec, Canada H9R 4S2
PHONE 514-694-6110
FAX 514-694-8501

## United States Distributors

### ALABAMA

Marshall Industries
3313 Memorial Pkwy South
Huntsville, AL 35801
PHONE 205-881-9235
FAX 205-881-1490

Nu Horizons
4801 University Square #11
Huntsville, AL 35816
PHONE 205-722-9330
FAX 205-722-9348

### ARIZONA

Insight Electronics Inc
1515 W. University #103
Tempe, AZ 85281
PHONE 602-829-1800
FAX 602-967-2658

Marshall Industries
9830 S. 51st St #C107-109
Phoenix, AZ 85044
PHONE 602-496-0290
FAX 602-893-9029

### CALIFORNIA

Insight Electronics Inc
2 Venture Plaza #340
Irvine, CA 92718
PHONE 714-727-3291
FAX 714-727-1804

Insight Electronics Inc
9980 Huennekens St
San Diego, CA 92121
PHONE 619-587-1100
FAX 619-587-1380

Insight Electronics Inc
1295 Oakmead Parkway
Sunnyvale, CA 94086
PHONE 408-720-9222
FAX 408-720-8390

Insight Electronics, Inc
4333 Park Terrance Dr #101
Westlake Village, CA 91361
PHONE 818-707-2101
FAX 818-707-0321

Marshall Industries
9320 Telstar Ave
El Monte, CA 91731-3004
PHONE 818-307-6000
FAX 818-307-6297

Marshall Industries
One Morgan
Irvine, CA 92718-1994
PHONE 714-458-5395
FAX 714-581-5255

Marshall Industries
336 Los Coches St
Milpitas, CA 95035
PHONE 408-942-4600
FAX 408-262-1224

Marshall Industries
10105 Carroll Cyn Rd
San Diego, CA 92131
PHONE 619-578-9600
FAX 619-627-4163

Marshall Industries
3039 Kilgore Ave #140
Rancho Cordova, CA 95670
PHONE 916-635-9700
FAX 916-635-6044

Marshall Industries
26637 W. Agoura Rd
Calabasas, CA 91302
PHONE 818-876-7000
FAX 818-880-6846

## United States Distributors — Contd.

### CALIFORNIA — Contd.

Zeus Electronics
6276 San Ingacio Ave #E
San Jose, CA 95119
PHONE 408-629-4789
FAX 408-629-4792

Zeus Electronics
22700 Savi Ranch Pkwy
Yorba Linda, CA 92687-2715
PHONE 714-921-9000
FAX 714-921-2715

### COLORADO

Insight Electronics
384 Inverness Dr S. #105
Englewood, CO 80112
PHONE 303-649-1800
FAX 303-649-1818

Marshall Industries
12351 N Grant
Thornton, CO 80241
PHONE 303-451-8383
FAX 303-457-2899

### CONNECTICUT

Marshall Industries
20 Sterling Dr
Wallingford, CT 06492-0200
PHONE 203-265-3822
FAX 203-284-9285

### FLORIDA

Marshall Industries
2840 Scherer Dr #410
St. Petersburg, FL 33716
PHONE 813-573-1399
FAX 813-573-0069

Marshall Industries
2700 W. Cypress Creek Rd #D114
Ft. Lauderdale, FL 33309
PHONE 305-977-4880
FAX 305-977-4887

Marshall Industries
380-S Northlake Blvd #1024
Altamonte Springs, FL 32701-5260
PHONE 407-767-8585
FAX 407-767-8676

Nu Horizons
3421 NW 55th St
Ft. Lauderdale, FL 33309
PHONE 305-735-2555
FAX 305-735-2880

Zeus Electronics
37 Skyline Dr Bldg D #1301
Lake Mary, FL 32746
PHONE 407-333-3055
FAX 407-333-9681

### GEORGIA

Marshall Industries
5300 Oakbrook Pkwy #140
Norcross, GA 30093-9990
PHONE 404-923-5750
FAX 404-923-2743

Nu Horizons
5555 Oakbrook Pkwy #340
Norcross, GA 30093
PHONE 404-416-8666
FAX 404-416-9060

### ILLINOIS

Insight Electronics
1365 Wiley Rd #142
Schaumburg, IL 60173
PHONE 708-885-9700
FAX 708-885-9701

Marshall Industries
50 E. Commerce Unit 1
Schaumburg, IL 60173
PHONE 708-490-0155
FAX 708-490-0569

## United States Distributors — Contd.

### INDIANA
Marshall Industries
6990 Corporate Dr
Indianapolis, IN 46278
PHONE 317-297-0483
FAX 317-297-2787

### KANSAS
Marshall Industries
10413 W. 84th Terrace
Lenexa, KS 66214
PHONE 913-492-3121
FAX 913-492-6205

### MARYLAND
Marshall Industries
2221 Broadbirch Dr #G
Silver Springs, MD 20904
PHONE 301-622-1118
FAX 301-622-0451

Nu Horizons
8975 Guilford Rd #120
Columbia, MD 21046
PHONE 410-995-6330
FAX 410-995-6332

### MASSACHUETTS
Gerber Electronics
128 Carnegie Row
Norwood, MA 02062
PHONE 617-769-6000
FAX 617-762-8931

Marshall Industries
33 Upton Dr
Wilmington, MA 01887
PHONE 508-658-0810
FAX 508-657-5931

Nu Horizons
107 Audubon Rd Bldg 1
Wakefield, MA 01880
PHONE 617-246-4442
FAX 617-246-4462

Zeus Electronics
25 Upton Dr
Wilmington, MA 01887
PHONE 508-658-4776
FAX 508-694-2199

### MIGHIGAN
Marshall Industries
31067 Schoolcraft
Livonia, Ml 48150
PHONE 313-525-5850
FAX 313-525-5855

### MINNESOTA
Marshall Industries
14800 28th Ave, N. #175
Plymouth, MN 55447
PHONE 612-559-2211
FAX 612-559-8321

### MISSOURI
Marshall Industries
3377 Hollenberg
Bridgeton, MO 63044
PHONE 314-291-4650
FAX 314-291-5391

### NEW JERSEY
Marshall Industries
158 Gaither Dr
Mt. Laurel, NJ 08054
PHONE 609-234-9100
FAX 609-778-1819

Marshall Industries
101 Fairfield Rd
Fairfield, NJ 07006
PHONE 201-882-0320
FAX 201-882-0095

Nu Horizons
39 US Route 46
Pine Brook, NJ 07058
PHONE 201-882-8300
FAX 201-882-8398

## United States Distributors — Contd.

### NEW JERSEY — Contd.

Nu Horizons
18000 Horizons Way #200
Mt. Laurel, NJ 08054
PHONE 609-231-0900
FAX 609-231-9510

### NEW YORK

Marshall Industries
100 Marshall Dr
Endicott, NY 13760
PHONE 607-796-2345
FAX 607-785-5546

Marshall Industries
1250 Scottsville Rd
Rochester, NY 14624
PHONE 716-235-7620
FAX 716-235-0052

Marshall Industries
275 Oser Ave
Hauppauge, NY 11788
PHONE 516-273-2053
FAX 516-434-4775

Nu Horizons
333 Metro Park
Rochester, NY 14623
PHONE 716-292-0777
FAX 716-292-0750

Nu Horizons
6000 New Horizons Blvd
N Amityville, NY 11701
PHONE 516-226-6000
FAX 516-226-6140

Zeus Electronics
100 Midland Ave
Port Chester, NY 10573
PHONE 914-937-7400
FAX 914-937-2553

### NORTH CAROLINA

Marshall Industries
5224 Green Dairy Rd
Raleigh, NC 27604
PHONE 919-878-9882
FAX 919-872-2431

### OHIO

Marshall Industries
30700 Bainbridge Rd Unit A
Solon, OH 44139
PHONE 216-248-1788
FAX 216-248-2312

Marshall Industries
3520 Park Center Dr
Dayton, OH 45414-2573
PHONE 513-898-4480
FAX 513-898-9363

Nu Horizons Electronics
6200 SOM Center Road
Solon, OH 44139
PHONE 216-349-2008
FAX 216-349-2086

### OREGON

Insight Electronics Inc
8705 S.W. Nimbus Ave #200
Beaverton, OR 97005
PHONE 503-644-3300
FAX 503-641-4530

Marshall Industries
9705 S.W. Gemini Dr
Beaverton, OR 97005
PHONE 503-644-5050
FAX 503-646-8256

### PENNSYLVANIA

Marshall Industries
401 Parkway View Drive
Pittsburgh, PA 15205
PHONE 412-788-0441
FAX 412-788-0447

## United States Distributors — Contd.

### TEXAS

Insight Electronics Inc
12701 Research Blvd #301
Austin, TX 78759
PHONE 512-467-0800
FAX 512-331-5811

Insight Electronics Inc
1778 Plano Rd #320
Richardon, TX 75081
PHONE 214-783-0800
FAX 214-680-2402

Insight Electronics Inc
15437 McKaskle
Sugarland, TX 77478
PHONE 713-448-0800
FAX 713-879-1074

Marshall Industries
10681 Haddington Dr #160
Houston, TX 77040
PHONE 713-467-1666
FAX 713-462-6714

Marshall Industries
8504 Cross Park Dr
Austin, TX 76754
PHONE 512-837-1991
FAX 512-923-2743

Marshall Industries
1551 N. Glenville Dr
Richardson, TX 75081
PHONE 214-705-0600
FAX 214-770-0675

Zeus Electronics
3220 Commander Dr
Carrollton, TX 75006
PHONE 214-380-4330
FAX 214-447-2222

### UTAH

Marshall Industries
2355 S. 1070 West #D
Salt Lake City, UT 84119
PHONE 801-973-2288
FAX 801-487-0936

### WASHINGTON

Insight Electronics Inc
12002 115th Ave N.E.
Kirkland, WA 98034
PHONE 206-820-8100
FAX 206-821-2976

Marshall Industries
11715 N. Creek Pkwy S. #112
Bothell, WA 98011
PHONE 206-486-5747
FAX 206-486-6964

### WISCONSIN

Marshall Industries
20900 Swenson Dr #150
Waukesha, WI 53186-4050
PHONE 414-797-8400
FAX 414-797-8270

## Canadian Distributors

### ALBERTA
Future Electronics
4606 97th St
Edmonton, Alberta, T6E 5N9 Canada
PHONE 403-438-2858
FAX 403-294-1206

Future Electronics
3833 29th St N.E.
Calgary, Alberta, T1Y 6B5 Canada
PHONE 403-250-5550
FAX 403-291-7054

### BRITISH COLUMBIA
Future Electronics
1695 Boundary Rd
Vancouver, B. C., V5R 5J7 Canada
PHONE 604-294-1166
FAX 604-294-1206

### MANITOBA
Future Electronics
106 King Edward St E.
Winnipeg, Manitoba, R3H 0N8 Canada
PHONE 204-786-7711
FAX 204-294-1206

### ONTARIO
Future Electronics
1050 Baxter Rd
Ottawa, Ontario, K2C 3P2 Canada
PHONE 613-820-8313
FAX 613-820-3271

Future Electronics
5935 Airport Rd #200
Mississauga, Ontario, L4V 1W5 Canada
PHONE 416-612-5200
FAX 416-612-9155

Marshall Industries
4 Paget Rd #10 & 11 Building 1112
Brampton, Ontario, L6T 5G3 Canada
PHONE 416-458-8046
FAX 416-458-1613

### QUEBEC
Future Electronics
237 Hymus Blvd
Pointe Claire, Quebec, H9R 5C7 Canada
PHONE 514-694-7710
FAX 514-695-3707

Future Electronics
1000 Ave St. Jean Baptiste #100
Quebec City, Quebec, G2E 5G5 Canada
PHONE 418-877-6666
FAX 418-877-6671

Marshall Industries
148 Brunswick Blvd
Pointe Claire, Quebec, H9R 5P9 Canada
PHONE 514-694-8142
FAX 514-694-6989

## International Representives and Distributors

### AUSTRALIA
Reptechnic
3/36 Bydown St
Neutral Bay N5W 2089
Australia
PHONE 011-61-2-953-9844
FAX 011-61-2-953-9683

### BELGIUM
Microtron
Generaal Dewittelann 7
2800 Mechelen
Belgium
PHONE 011-32-15-212223
FAX 011-32-15-210069

### DENMARK
C-88
Kokkedal Industripark 101
DK-2980 Kokkedal
Denmark
PHONE 45-42-244888
FAX 45-42-244889

### FINLAND
Perel Oy
Kehakuja 6
SF-05830 Hyvinkaan
Finland
PHONE 011-358-14-434 600
FAX 011-358-14-434 609

### FRANCE
Microel
Immeuble Micro
Av. de la Baltique
BP3
91941 Les Ulis Cedex, France
PHONE 011-33-1-69-07-08-24
FAX 011-33-1-69-07-17-23

### HONG KONG
Lestina International Ltd
14th Floor, Park Tower
15 Austin Road, Tsimshatsui
Hong Kong
PHONE 011-852-735-1736
FAX 011-852-730-5260/7538

### INDIA
IRYS Engineering Services
26 ½ Plot #4 & 5 Baner Rd
Silver Oak Park
Baner Pune
411 008
India
PHONE 91-212-339-836
FAX 91-212-436-798

### ISRAEL
Gallium Electronic
5 Ussishkin Str
P.O.B. 1379
47100
Ramat Hashron, Israel
PHONE 011-972-3-540-2242
FAX 011-972-3-540-2425

### ITALY
Eurelecttronica
Via Enrico Fermi, 8
20090 Assago Mi
Italy
PHONE 39-2-457841
FAX 39-2-4880275

## International Representatives and Distributors — Contd.

### JAPAN

Bill Black-Hogins
Raffine Maison Nakano, #401
2-7-2 Arai, Nakano-Ku,
Tokyo Japan
T165
PHONE 011-81-3-3388-6959
FAX 011-81-3-3388-6956

Internix, Inc
Shinjuku Hamada Bldg 7F
7-4-7 Nishi Shinjuku
Shinjuku-Ku T160
Tokyo 160
Japan
PHONE 011-81-3-3369-1105
FAX 011-81-3-3366-8566

Microtek Inc
Itoh Buld, 6F
7-9-17, Nishi-Shinjuku
Shinjuku-Ku,
Tokyo 160
Japan
PHONE 81-3-3371-4071
FAX 81-3-3361-6921

### KOREA

Mainsail Mercantile, Ltd
1-29 Gahoe-Dong
Chongro-Ku
Seoul
110-260
Korea
PHONE 011-82-2-745-2761
FAX 011-82-2-745-2766

### NEW ZEALAND

Professional Elect
26 L Penning Rd
Milford, Auckland
New Zealand
PHONE 011-64-9-410-9690
FAX 011-64-9-486-3045

### NORWAY

Hefro Eletronikk
Konowsgt 8
0135 Oslo Norway
PHONE 011-47-22-67-68-00
FAX 011-47-22-67-73-80

### SINGAPORE

Desner Electronics
42 Mactaggart Rd
#04-01 Mactaggart Bldg
Singapore
1336
PHONE 011-65-285-1566
FAX 011-65-284-9466

### SPAIN

ADM Electronica S.A.
Tomas Breton, No. 50, 3-2
28045 Madrid
Spain
PHONE 011-34-1-5304121
FAX 011-34-1-5300164

### SWEDEN

NC Nordcomp Sweden AB
Hemvarnsgatan 13
PO Box 4115
S-17104
Solna
Sweden
PHONE 011-46-8-7646710
FAX 011-46-8-7644730

### SWITZERLAND

W. Stolz AG
Tafernstrasse 15
CH-5405 Baden
Dattwill
Switzerland
PHONE 011-41-56-84-90-00
FAX 011-41-56-83-19-63

## International Representatives and Distributors — Contd.

### TAIWAN

Don Business Corp
6F #33, Alley 24, Lane 251
Nanking E. Rd Sec 5
Taipei Taiwan
R.O.C.
PHONE 011-886-2-763-6676
FAX 011-886-2-763-1241

Shaw-Fuu Enterprises Co, Ltd
3F-2, 63, Lane 122, Sec 4
Jen-Ai Rd
Taipei
Taiwan
R.O.C.
PHONE 011-886-2-708-5061
FAX 011-886-2-708-5413

### THE NETHERLANDS

Microtron Holland
Beneluxweg 37
4904 SJ OOSTERHOUT
Holland
The Netherlands
PHONE 31/01620-60308
FAX 31/01620-60633

### UNITED KINGDOM

Eltek
Nelson Rd Industrial Estate
Dartmouth, Devon
England
TO6 9LA
U.K.
PHONE 44-803-83-4455
FAX 44-803-83-3011

Kudos Thame Ltd
55 Suttons Park
London Rd
Reading, Berks
RG6 1AZ
U.K.
PHONE 44-734-351010
FAX 44-734-351030

Microelectronics Technology
Unit 2, Gt Haseley Trading Estate
Great Haseley
Oxfordshire Ox97PF
OX9 7PF
England U.K.
PHONE 011-44-844-278781
FAX 011-44-844-278746

### WEST GERMANY

Scantec
Behringstrasse 10
82152 Planegg
West Germany
PHONE 011-49-89-859-8021
FAX 011-49-89-857-6574

Scantec
Tannenbergstrasse 103
7312 Kirchheim/Teck
West Germany
PHONE 011-49-70-215-4027
FAX 011-49-70-218-2568

Scantec
Fliedersteig 28
8501 Ruckersdorf
West Germany
PHONE 011-49-91-157-7529
FAX 011-49-91-157-6829

Topas
Striehlstrasse 18
30159 Hanover
West Germany
PHONE 011-49-51-113-1217
FAX 011-49-51-113-1216