



# 3.3V CMOS 18-BIT REGISTERED TRANSCEIVER WITH 3-STATE OUTPUTS, 5 VOLT TOLERANT I/O

IDT74LVC16501A

### FEATURES:

- Typical  $t_{SK(O)}$  (Output Skew) < 250ps
- ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
- $V_{CC} = 3.3V \pm 0.3V$ , Normal Range
- $V_{CC} = 2.7V$  to  $3.6V$ , Extended Range
- CMOS power levels ( $0.4\mu W$  typ. static)
- All inputs, outputs, and I/O are 5V tolerant
- Supports hot insertion
- Available in SSOP and TSSOP packages

### DRIVE FEATURES:

- High Output Drivers:  $\pm 24mA$
- Reduced system switching noise

### APPLICATIONS:

- 5V and 3.3V mixed voltage systems
- Data communication and telecommunication systems

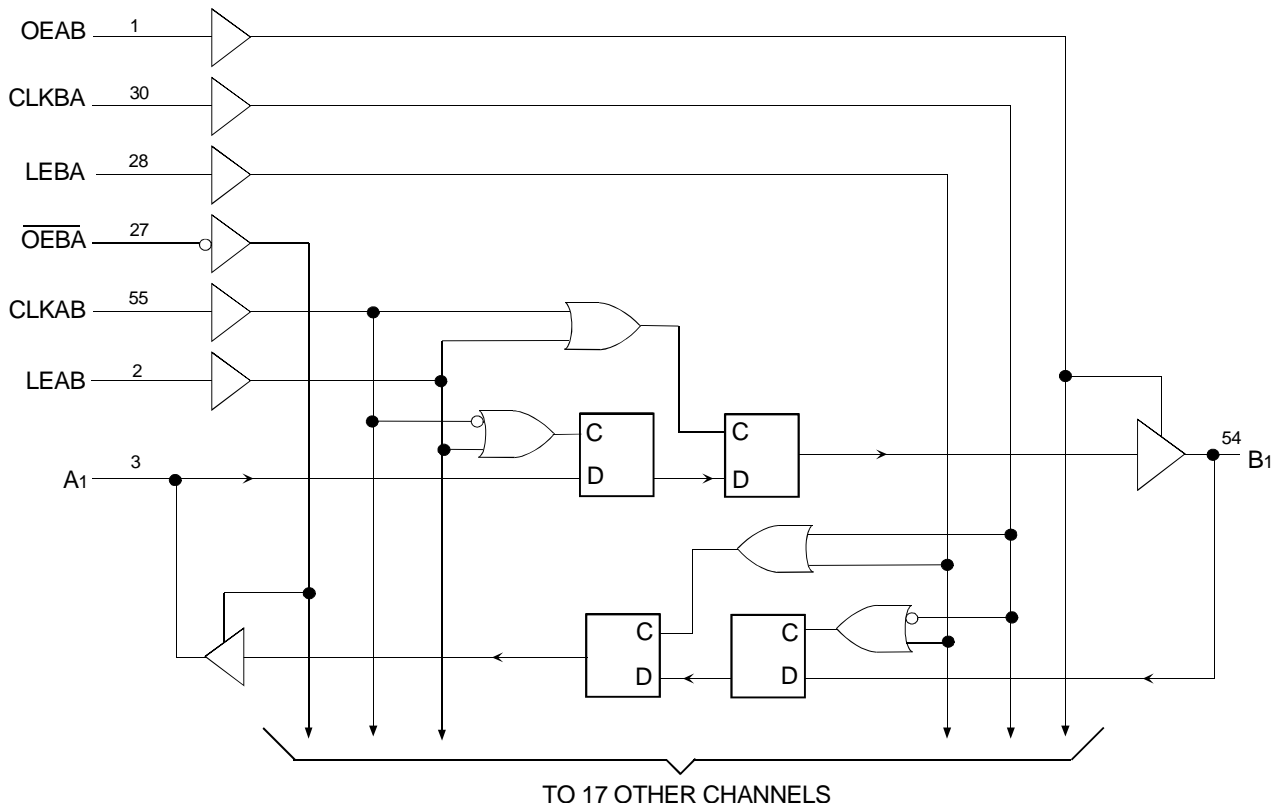
### DESCRIPTION:

The LVC16501A is built using advanced dual metal CMOS technology. This high-speed, low power 18-bit registered bus transceiver combines D-type latches and D-type flip-flops to allow data flow in transparent, latched, and clocked modes. Data flow in each direction is controlled by output-enable (OEAB and  $\overline{OEBA}$ ), latch enable (LEAB and LEBA) and clock (CLKAB and CLKBA) inputs. For A-to-B data flow, the device operates in transparent mode when LEAB is high. When LEAB is low, the A data is latched if CLKAB is held at a high or low logic level. If LEAB is low, the A bus data is stored in the latch/flip-flop on the low-to-high transition of CLKAB. OEAB performs the output enable function on the B port. Data flow from B port to A port is similar but requires using  $\overline{OEBA}$ , LEBA and CLKBA. Flow-through organization of signal pins simplifies layout. All inputs are designed with hysteresis for improved noise margin.

The LVC16501A has been designed with a  $\pm 24mA$  output driver. This driver is capable of driving a moderate to heavy load while maintaining speed performance.

Inputs can be driven from either 3.3V or 5V devices. This feature allows the use of this device as a translator in a mixed 3.3V/5V supply system.

### FUNCTIONAL BLOCK DIAGRAM

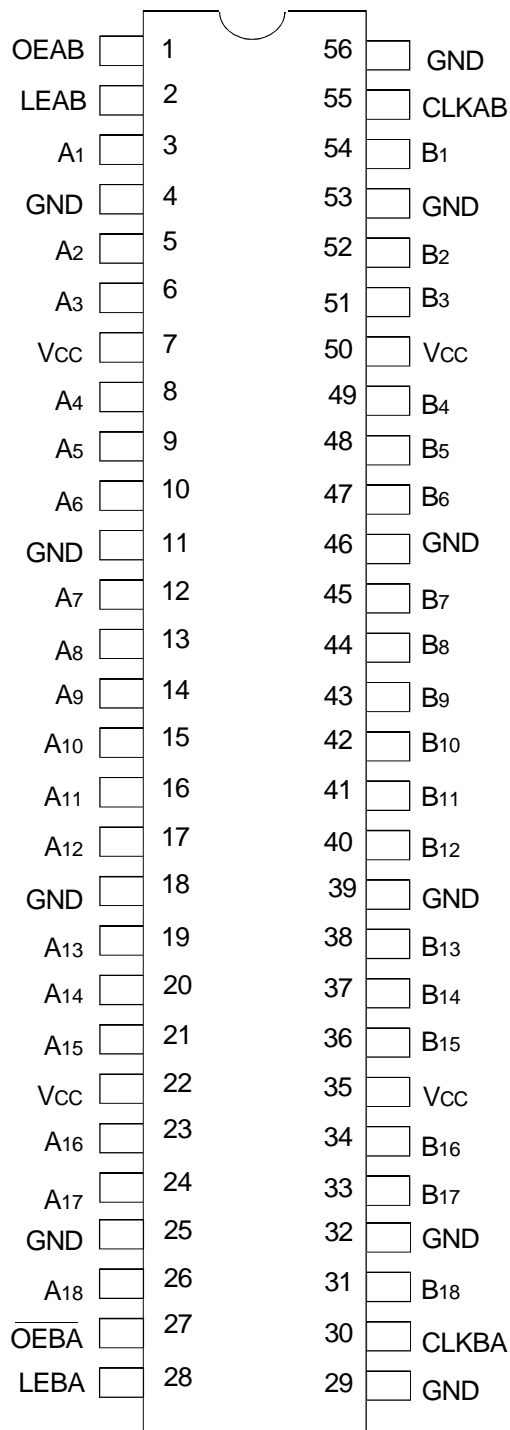


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INDUSTRIAL TEMPERATURE RANGE

JANUARY 2004

## PIN CONFIGURATION



SSOP/ TSSOP  
TOP VIEW

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

Symbol	Description	Max	Unit
VTERM	Terminal Voltage with Respect to GND	-0.5 to +6.5	V
TSTG	Storage Temperature	-65 to +150	°C
I <sub>OUT</sub>	DC Output Current	-50 to +50	mA
I <sub>IK</sub> I <sub>OK</sub>	Continuous Clamp Current, V <sub>I</sub> < 0 or V <sub>O</sub> < 0	-50	mA
I <sub>CC</sub> I <sub>SS</sub>	Continuous Current through each V <sub>CC</sub> or GND	±100	mA

### NOTE:

- Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

## CAPACITANCE (T<sub>A</sub> = +25°C, F = 1.0MHz)

Symbol	Parameter <sup>(1)</sup>	Conditions	Typ.	Max.	Unit
C <sub>IN</sub>	Input Capacitance	V <sub>IN</sub> = 0V	4.5	6	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>OUT</sub> = 0V	6.5	8	pF
C <sub>I/O</sub>	I/O Port Capacitance	V <sub>IN</sub> = 0V	6.5	8	pF

### NOTE:

- As applicable to the device type.

## PIN DESCRIPTION

Pin Names	Description
OEAB	A-to-B Output Enable Input (Active HIGH)
$\overline{\text{OEBA}}$	B-to-A Output Enable Input (Active LOW)
LEAB	A-to-B Latch Enable Input
LEBA	B-to-A Latch Enable Input
CLKAB	A-to-B Clock Input
CLKBA	B-to-A Clock Input
A <sub>x</sub>	A-to-B Data Inputs or B-to-A 3-State Outputs
B <sub>x</sub>	B-to-A Data Inputs or A-to-B 3-State Outputs

FUNCTION TABLE<sup>(1,2)</sup>

Inputs				Outputs
OEAB	LEAB	CLKAB	Ax	Bx
L	X	X	X	Z
H	H	X	L	L
H	H	X	H	H
H	L	↑	L	L
H	L	↑	H	H
H	L	L	X	B <sup>(3)</sup>
H	L	H	X	B <sup>(4)</sup>

NOTES:

1. H = HIGH Voltage Level  
X = Don't Care  
L = LOW Voltage Level  
Z = High-Impedance  
↑ = LOW-to-HIGH transition
2. A-to-B data flow is shown. B-to-A data flow is similar but uses  $\overline{OEBA}$ , LEBA, and CLKBA.
3. Output level before the indicated steady-state input conditions were established.
4. Output level before the indicated steady-state input conditions were established, provided that CLKAB was HIGH before LEAB went LOW.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:

Operating Condition: TA = -40°C to +85°C

Symbol	Parameter	Test Conditions		Min.	Typ. <sup>(1)</sup>	Max.	Unit
V <sub>IH</sub>	Input HIGH Voltage Level	V <sub>CC</sub> = 2.3V to 2.7V		1.7	—	—	V
		V <sub>CC</sub> = 2.7V to 3.6V		2	—	—	
V <sub>IL</sub>	Input LOW Voltage Level	V <sub>CC</sub> = 2.3V to 2.7V		—	—	0.7	V
		V <sub>CC</sub> = 2.7V to 3.6V		—	—	0.8	
I <sub>IH</sub> I <sub>IL</sub>	Input Leakage Current	V <sub>CC</sub> = 3.6V	V <sub>I</sub> = 0 to 5.5V	—	—	±5	μA
I <sub>OZH</sub> I <sub>OZL</sub>	High Impedance Output Current (3-State Output pins)	V <sub>CC</sub> = 3.6V	V <sub>O</sub> = 0 to 5.5V	—	—	±10	μA
I <sub>OFF</sub>	Input/Output Power Off Leakage	V <sub>CC</sub> = 0V, V <sub>IN</sub> or V <sub>O</sub> ≤ 5.5V		—	—	±50	μA
V <sub>IK</sub>	Clamp Diode Voltage	V <sub>CC</sub> = 2.3V, I <sub>IN</sub> = -18mA		—	-0.7	-1.2	V
V <sub>H</sub>	Input Hysteresis	V <sub>CC</sub> = 3.3V		—	100	—	mV
I <sub>CC1</sub> I <sub>CCH</sub> I <sub>CCZ</sub>	Quiescent Power Supply Current	V <sub>CC</sub> = 3.6V	V <sub>IN</sub> = GND or V <sub>CC</sub>	—	—	10	μA
			3.6 ≤ V <sub>IN</sub> ≤ 5.5V <sup>(2)</sup>	—	—	10	
ΔI <sub>CC</sub>	Quiescent Power Supply Current Variation	One input at V <sub>CC</sub> - 0.6V, other inputs at V <sub>CC</sub> or GND		—	—	500	μA

NOTES:

1. Typical values are at V<sub>CC</sub> = 3.3V, +25°C ambient.
2. This applies in the disabled state only.

## OUTPUT DRIVE CHARACTERISTICS

Symbol	Parameter	Test Conditions <sup>(1)</sup>		Min.	Max.	Unit
VOH	Output HIGH Voltage	VCC = 2.3V to 3.6V	IOH = - 0.1mA	VCC - 0.2	—	V
		VCC = 2.3V	IOH = - 6mA	2	—	
		VCC = 2.3V	IOH = - 12mA	1.7	—	
		VCC = 2.7V		2.2	—	
		VCC = 3V		2.4	—	
		VCC = 3V		IOH = - 24mA	2.2	
VOL	Output LOW Voltage	VCC = 2.3V to 3.6V	IOL = 0.1mA	—	0.2	V
		VCC = 2.3V	IOL = 6mA	—	0.4	
			IOL = 12mA	—	0.7	
		VCC = 2.7V	IOL = 12mA	—	0.4	
		VCC = 3V	IOL = 24mA	—	0.55	

**NOTE:**  
1. VIH and VIL must be within the min. or max. range shown in the DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE table for the appropriate VCC range. TA = - 40°C to + 85°C.

## OPERATING CHARACTERISTICS, VCC = 3.3V ± 0.3V, TA = 25°C

Symbol	Parameter	Test Conditions	Typical	Unit
CPD	Power Dissipation Capacitance per Transceiver Outputs enabled	CL = 0pF, f = 10Mhz		pF
CPD	Power Dissipation Capacitance per Transceiver Outputs disabled			

## SWITCHING CHARACTERISTICS<sup>(1)</sup>

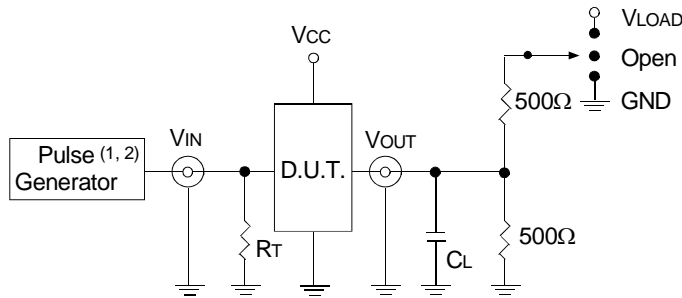
Symbol	Parameter	VCC = 2.7V		VCC = 3.3V ± 0.3V		Unit
		Min.	Max.	Min.	Max.	
fMAX		150	—	150	—	MHz
tPLH tPHL	Propagation Delay Ax to Bx or Bx to Ax	1.5	5.1	1.5	4.6	ns
tPLH tPHL	Propagation Delay LEBA to Ax, LEAB to Bx	1.5	5.6	1.5	5.3	ns
tPLH tPHL	Propagation Delay CLKBA to Ax, CLKAB to Bx	1.5	5.6	1.5	5.3	ns
tPZH tPZL	Output Enable Time OEBA to Ax, OEAB to Bx	1.5	6	1.5	5.6	ns
tPHZ tPLZ	Output Disable Time OEBA to Ax, OEAB to Bx	1.5	5.6	1.5	5.2	ns
tSU	Set-up Time HIGH or LOW, Ax to CLKAB, Bx to CLKBA	3	—	3	—	ns
tH	Hold Time HIGH or LOW, Ax to CLKAB, Bx to CLKBA	0	—	0	—	ns
tSU	Set-up Time HIGH or LOW Ax to LEAB, Bx to LEBA	Clock LOW	2.5	—	2.5	ns
		Clock HIGH	2.5	—	2.5	
tH	Hold Time HIGH or LOW, Ax to LEAB, Bx to LEBA	1.5	—	1.5	—	ns
tW	LEAB or LEBA Pulse Width HIGH or LOW	3	—	3	—	ns
tW	CLKAB or CLKBA Pulse Width HIGH or LOW	3	—	3	—	ns
tsk(o)	Output Skew <sup>(2)</sup>	—	—	—	500	ps

**NOTES:**  
1. See TEST CIRCUITS AND WAVEFORMS. TA = - 40°C to + 85°C.  
2. Skew between any two outputs of the same package and switching in the same direction.

## TEST CIRCUITS AND WAVEFORMS

### TEST CONDITIONS

Symbol	V <sub>CC</sub> <sup>(1)</sup> =3.3V±0.3V	V <sub>CC</sub> <sup>(1)</sup> =2.7V	V <sub>CC</sub> <sup>(2)</sup> =2.5V±0.2V	Unit
V <sub>LOAD</sub>	6	6	2 x V <sub>CC</sub>	V
V <sub>IH</sub>	2.7	2.7	V <sub>CC</sub>	V
V <sub>T</sub>	1.5	1.5	V <sub>CC</sub> / 2	V
V <sub>LZ</sub>	300	300	150	mV
V <sub>HZ</sub>	300	300	150	mV
C <sub>L</sub>	50	50	30	pF



Test Circuit for All Outputs

#### DEFINITIONS:

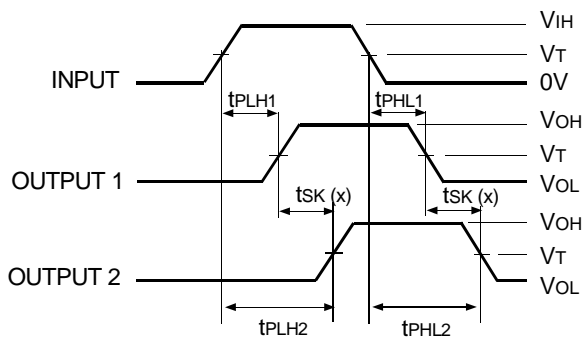
C<sub>L</sub> = Load capacitance: includes jig and probe capacitance.  
R<sub>T</sub> = Termination resistance: should be equal to Z<sub>OUT</sub> of the Pulse Generator.

#### NOTES:

1. Pulse Generator for All Pulses: Rate ≤ 10MHz; t<sub>r</sub> ≤ 2.5ns; t<sub>r</sub> ≤ 2.5ns.
2. Pulse Generator for All Pulses: Rate ≤ 10MHz; t<sub>r</sub> ≤ 2ns; t<sub>r</sub> ≤ 2ns.

### SWITCH POSITION

Test	Switch
Open Drain Disable Low Enable Low	V <sub>LOAD</sub>
Disable High Enable High	GND
All Other Tests	Open

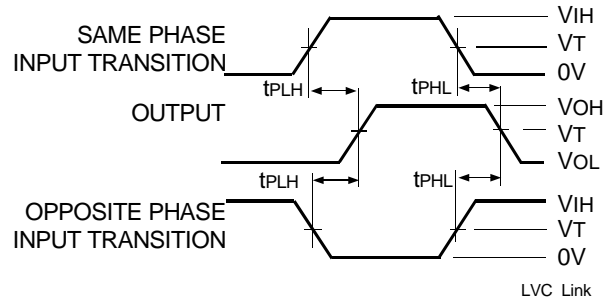


$$tsk(x) = |t_{PLH2} - t_{PLH1}| \text{ or } |t_{PHL2} - t_{PHL1}|$$

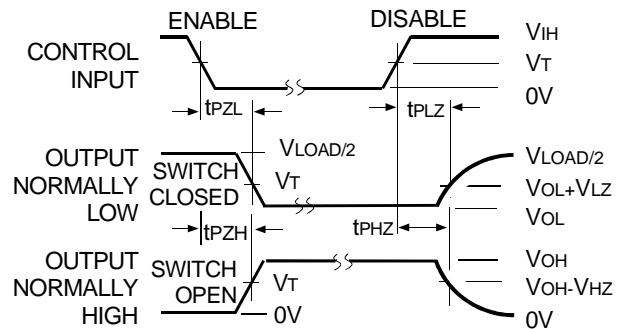
Output Skew - tsk(x)

#### NOTES:

1. For tsk(o) OUTPUT1 and OUTPUT2 are any two outputs.
2. For tsk(b) OUTPUT1 and OUTPUT2 are in the same bank.



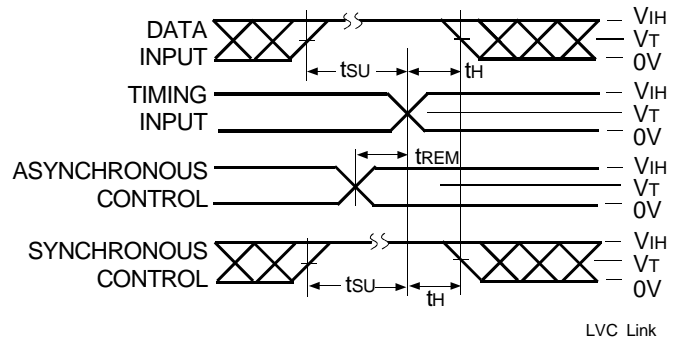
Propagation Delay



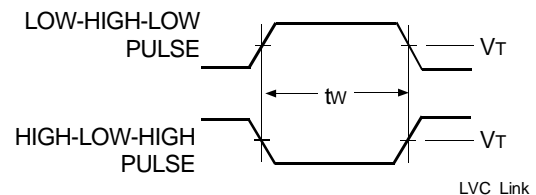
Enable and Disable Times

#### NOTE:

1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH.

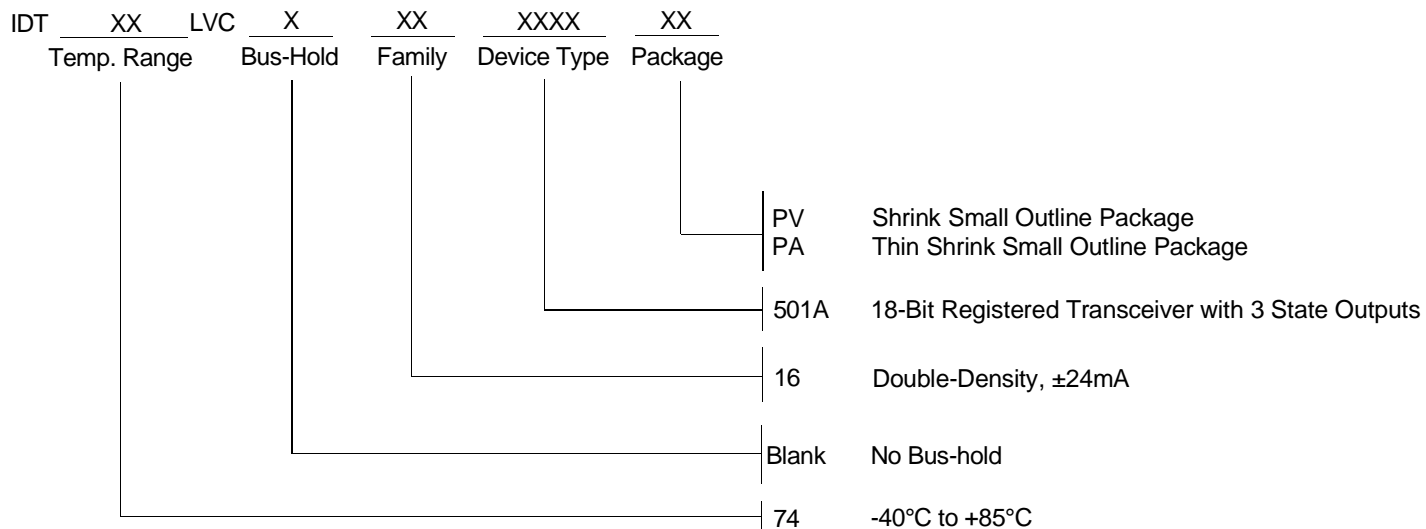


Set-up, Hold, and Release Times



Pulse Width

## ORDERING INFORMATION



**CORPORATE HEADQUARTERS**  
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