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February 1994
Revised April 2001

74LCX16652
Low Voltage Transceiver/Register with 5V Tolerant Inputs and Outputs

General Description

The LCX16652 contains sixteen non-inverting bidirectional bus transceivers with 3-STATE outputs providing multiplexed transmission of data directly from the input bus or from the internal registers. Data on the A or B bus will be clocked into the registers as the appropriate clock pin goes to the HIGH logic level. Output Enable pins (OEAB, $\overline{OEBA}$) are provided to control the transceiver function (see Functional Description).

The LCX16652 is designed for low-voltage (2.5V or 3.3V) V_{CC} applications with capability of interfacing to a 5V signal environment.

The LCX16652 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

Features

- 5V tolerant inputs and outputs
- 2.3V–3.6V V_{CC} specifications provided
- 5.7 ns t_{PD} max (V_{CC} = 3.3V), 20 μA I_{CC} max
- Power down high impedance inputs and outputs
- Supports live insertion/withdrawal (Note 1)
- ±24 mA output drive (V_{CC} = 3.0V)
- Implements patented noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V

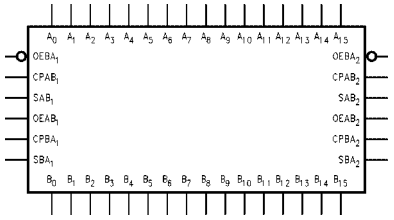
Note 1: To ensure the high-impedance state during power up or down, $\overline{OE}$ should be tied to V_{CC} and OE tied to GND through a resistor: the minimum value or the resistor is determined by the current-sourcing capability of the driver.

Ordering Code:

Order Number	Package Number	Package Description
74LCX16652MEA	MS56A	56-Lead Shrink Small Outline Package (SSOP), JEDEC MO-118, 0.300 Wide
74LCX16652MTD	MTD56	56-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

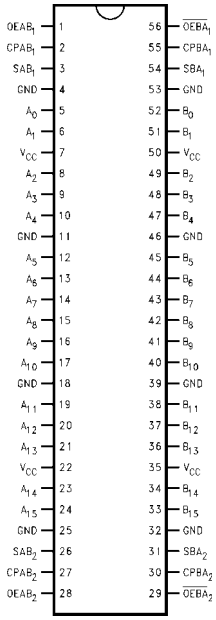
Logic Symbol



Pin Descriptions

Pin Names	Description
A_0–A_{15}	Data Register A Inputs/3-STATE Outputs
B_0–B_{15}	Data Register B Inputs/3-STATE Outputs
$CPAB_n$, $CPBA_n$	Clock Pulse Inputs
SAB_n, SBA_n	Select Inputs
$OEAB_n$, $\overline{OEBA}_n$	Output Enable Inputs

Connection Diagram



Truth Table

(Note 2)

Inputs						Inputs/Outputs		Operating Mode
OEAB	**$\overline{OEBA_1}$**	**$CPAB_1$**	**$CPBA_1$**	**SAB_1**	**SBA_1**	**A_0 thru A_7**	**B_0 thru B_7**	
L	H	H or L	H or L	X	X	Input	Input	Isolation
L	H	⌐	⌐	X	X			Store A and B Data
X	H	⌐	H or L	X	X	Input	Not Specified	Store A, Hold B
H	H	⌐	⌐	X	X	Input	Output	Store A in Both Registers
L	X	H or L	⌐	X	X	Not Specified	Input	Hold A, Store B
L	L	⌐	⌐	X	X	Output	Input	Store B in Both Registers
L	L	X	X	X	L	Output	Input	Real-Time B Data to A Bus
L	L	X	H or L	X	H			Store B Data to A Bus
H	H	X	X	L	X	Input	Output	Real-Time A Data to B Bus
H	H	H or L	X	H	X			Stored A Data to B Bus
H	L	H or L	H or L	H	H	Output	Output	Stored A Data to B Bus and Stored B Data to A Bus

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial
⌐ = LOW-to-HIGH Clock Transition

Note 2: The data output functions may be enabled or disabled by various signals at OEAB or $\overline{OEBA}$ inputs. Data input functions are always enabled, i.e., data at the bus pins will be stored on every LOW-to-HIGH transition on the clock inputs. This also applies to data I/O (A and B: 8–15) and #2 control pins.

Functional Description

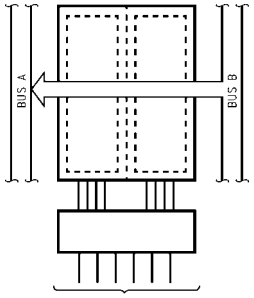
In the transceiver mode, data present at the HIGH impedance port may be stored in either the A or B register or both.

The select (SAB_n, SBA_n) controls can multiplex stored and real-time.

The examples below demonstrate the four fundamental bus-management functions that can be performed with the 74LCX16652.

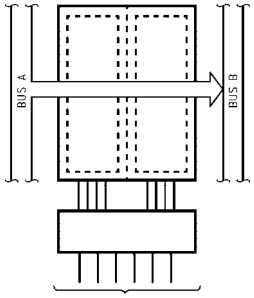
Data on the A or B data bus, or both can be stored in the internal D flip-flop by LOW-to-HIGH transitions at the appropriate Clock Inputs ($CPAB_n$, $CPBA_n$) regardless of the Select or Output Enable Inputs. When SAB and SBA are in the real time transfer mode, it is also possible to store data without using the internal D flip-flops by simultaneously enabling $OEAB_n$ and $\overline{OEBA}_n$. In this configuration each Output reinforces its Input. Thus when all other data sources to the two sets of bus lines are in a HIGH impedance state, each set of bus lines will remain at its last state.

Real-Time
Transfer Bus B to Bus A



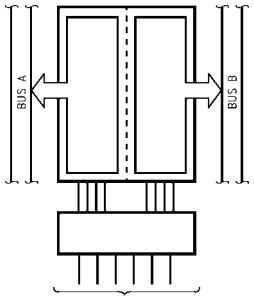
$OEAB_1$	$\overline{OEBA}_1$	$CPAB_1$	$CPBA_1$	SAB_1	SBA_1
L	L	X	X	X	L

Real-Time
Transfer Bus A to Bus B



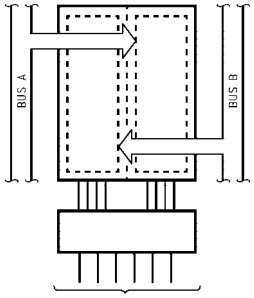
$OEAB_1$	$\overline{OEBA}_1$	$CPAB_1$	$CPBA_1$	SAB_1	SBA_1
H	H	X	X	L	X

Transfer Storage
Data to A or B



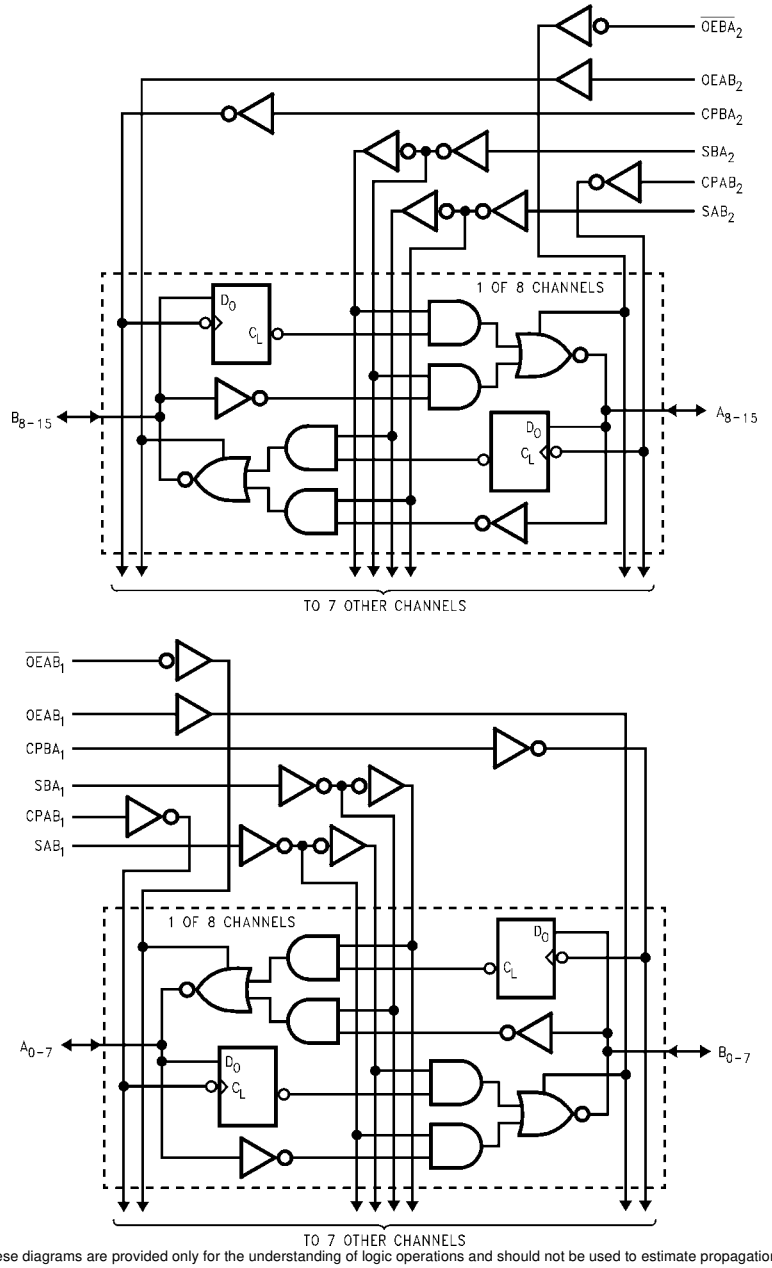
$OEAB_1$	$\overline{OEBA}_1$	$CPAB_1$	$CPBA_1$	SAB_1	SBA_1
H	L	H or L	H or L	H	H

Storage



$OEAB_1$	$\overline{OEBA}_1$	$CPAB_1$	$CPBA_1$	SAB_1	SBA_1
X	H	⌐	X	X	X
L	X	X	⌐	X	X
L	H	⌐	⌐	X	X

Logic Diagram



Please note that these diagrams are provided only for the understanding of logic operations and should not be used to estimate propagation delays.

Absolute Maximum Ratings(Note 3)

Symbol	Parameter	Value	Conditions	Units
V_{CC}	Supply Voltage	−0.5 to +7.0		V
V_I	DC Input Voltage	−0.5 to +7.0		V
V_O	DC Output Voltage	−0.5 to +7.0 −0.5 to V_{CC} + 0.5	Output in 3-STATE Output in HIGH or LOW State (Note 4)	V
I_{IK}	DC Input Diode Current	−50	V_I < GND	mA
I_{OK}	DC Output Diode Current	−50 +50	V_O < GND V_O > V_{CC}	mA
I_O	DC Output Source/Sink Current	±50		mA
I_{CC}	DC Supply Current per Supply Pin	±100		mA
I_{GND}	DC Ground Current per Ground Pin	±100		mA
T_{STG}	Storage Temperature	−65 to +150		°C

Recommended Operating Conditions (Note 5)

Symbol	Parameter		Min	Max	Units
V_{CC}	Supply Voltage	Operating	2.0	3.6	V
		Data Retention	1.5	3.6	
V_I	Input Voltage		0	5.5	V
V_O	Output Voltage	HIGH or LOW State	0	V_{CC}	V
		3-STATE	0	5.5	
I_{OH}/I_{OL}	Output Current	V_{CC} = 3.0V − 3.6V		±24	mA
		V_{CC} = 2.7V − 3.0V		±12	
		V_{CC} = 2.3V − 2.7V		±8	
T_A	Free-Air Operating Temperature		−40	85	°C
$\Delta t/\Delta V$	Input Edge Rate, V_{IN} = 0.8V–2.0V, V_{CC} = 3.0V		0	10	ns/V

Note 3: The Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the Absolute Maximum Ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

Note 4: I_O Absolute Maximum Rating must be observed.

Note 5: Unused (inputs or I/O's) must be held HIGH or LOW. They may not float.

DC Electrical Characteristics

Symbol	Parameter	Conditions	V_{CC} (V)	T_A = −40°C to +85°C		Units
				Min	Max	
V_{IH}	HIGH Level Input Voltage		2.3 – 2.7	1.7		V
			2.7 – 3.6	2.0		
V_{IL}	LOW Level Input Voltage		2.3 – 2.7		0.7	V
			2.7 – 3.6		0.8	
V_{OH}	HIGH Level Output Voltage	I_{OH} = −100 µA	2.3 – 3.6	V_{CC} − 0.2		V
		I_{OH} = −8 mA	2.3	1.8		
		I_{OH} = −12 mA	2.7	2.2		
		I_{OH} = −18 mA	3.0	2.4		
		I_{OH} = −24 mA	3.0	2.2		
V_{OL}	LOW Level Output Voltage	I_{OL} = 100 µA	2.3 – 3.6		0.2	V
		I_{OL} = 8 mA	2.3		0.6	
		I_{OL} = 12 mA	2.7		0.4	
		I_{OL} = 16 mA	3.0		0.4	
		I_{OL} = 24 mA	3.0		0.55	
I_I	Input Leakage Current	0 ≤ V_I ≤ 5.5V	2.3 – 3.6		±5.0	µA
I_{OZ}	3-STATE I/O Leakage	0 ≤ V_O ≤ 5.5V V_I = V_{IH} or V_{IL}	2.3 – 3.6		±5.0	µA
I_{OFF}	Power-Off Leakage Current	V_I or V_O = 5.5V	0		10	µA

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V_{CC} (V)	$T_A = -40°C$ to $+85°C$		Units
				Min	Max	
I_{CC}	Quiescent Supply Current	$V_I = V_{CC}$ or GND	2.3 – 3.6		20	μA
		$3.6V \le V_I$, $V_O \le 5.5V$ (Note 6)	2.3 – 3.6		±20	
ΔI_{CC}	Increase in I_{CC} per Input	$V_{IH} = V_{CC} - 0.6V$	2.3 – 3.6		500	μA

Note 6: Outputs disabled or 3-STATE only.

AC Electrical Characteristics

Symbol	Parameter	$T_A = -40°C$ to $+85°C$, $R_L = 500\Omega$						Units
		$V_{CC} = 3.3V \pm 0.3V$		$V_{CC} = 2.7V$		$V_{CC} = 2.5V \pm 0.2V$		
		$C_L = 50$ pF		$C_L = 50$ pF		$C_L = 30$ pF		
		Min	Max	Min	Max	Min	Max	
f_{MAX}	Maximum Clock Frequency	170						MHz
t_{PHL}	Propagation Delay	1.5	5.7	1.5	6.2	1.5	6.8	ns
t_{PLH}	Bus to Bus	1.5	5.7	1.5	6.2	1.5	6.8	
t_{PHL}	Propagation Delay	1.5	6.2	1.5	7.0	1.5	7.4	ns
t_{PLH}	Clock to Bus	1.5	6.2	1.5	7.0	1.5	7.4	
t_{PHL}	Propagation Delay	1.5	6.5	1.5	7.0	1.5	7.8	ns
t_{PLH}	Select to Bus	1.5	6.5	1.5	7.0	1.5	7.8	
t_{PZL}	Output Enable Time	1.5	7.0	1.5	8.0	1.5	9.1	ns
t_{PZH}		1.5	7.0	1.5	8.0	1.5	9.1	
t_{PLZ}	Output Disable Time	1.5	6.5	1.5	7.0	1.5	7.8	ns
t_{PHZ}		1.5	6.5	1.5	7.0	1.5	7.8	
t_S	Setup Time	2.5		2.5		3.0		ns
t_H	Hold Time	1.5		1.5		2.0		ns
t_W	Pulse Width	3.0		3.0		3.5		ns
t_{OSHL}	Output to Output Skew (Note 7)		1.0					ns
t_{OSLH}			1.0					

Note 7: Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW (t_{OSHL}) or LOW-to-HIGH (t_{OSLH}). Parameter guaranteed by design.

Dynamic Switching Characteristics

Symbol	Parameter	Conditions	V_{CC} (V)	$T_A = 25°C$ Typical	Units
V_{OLP}	Quiet Output Dynamic Peak V_{OL}	$C_L = 50$ pF, $V_{IH} = 3.3V$, $V_{IL} = 0V$	3.3	0.8	V
		$C_L = 30$ pF, $V_{IH} = 2.5V$, $V_{IL} = 0V$	2.5	0.6	
V_{OLV}	Quiet Output Dynamic Valley V_{OL}	$C_L = 50$ pF, $V_{IH} = 3.3V$, $V_{IL} = 0V$	3.3	–0.8	V
		$C_L = 30$ pF, $V_{IH} = 2.5V$, $V_{IL} = 0V$	2.5	–0.6	

Capacitance

Symbol	Parameter	Conditions	Typical	Units
C_{IN}	Input Capacitance	V_{CC} = Open, $V_I = 0V$ or V_{CC}	7	pF
$C_{I/O}$	Input/Output Capacitance	$V_{CC} = 3.3V$, $V_I = 0V$ or V_{CC}	8	pF
C_{PD}	Power Dissipation Capacitance	$V_{CC} = 3.3V$, $V_I = 0V$ or V_{CC}, f = 10 MHz	20	pF

AC LOADING and WAVEFORMS Generic for LCX Family

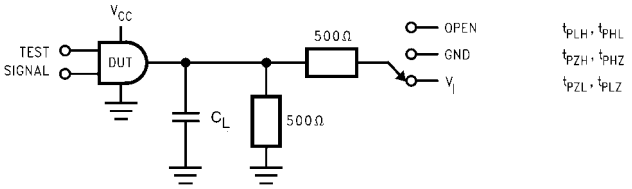
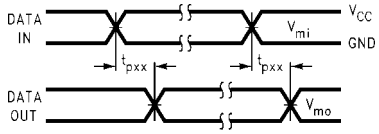
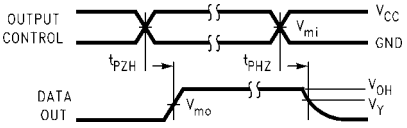


FIGURE 1. AC Test Circuit (C_L includes probe and jig capacitance)

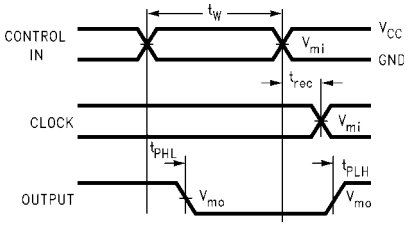
Test	Switch
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ}	6V at V_{CC} = 3.3 ± 0.3V V_{CC} x 2 at V_{CC} = 2.5 ± 0.2V
t_{PZH},t_{PHZ}	GND



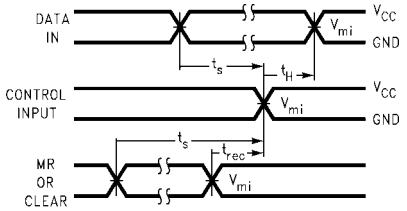
Waveform for Inverting and Non-Inverting Functions



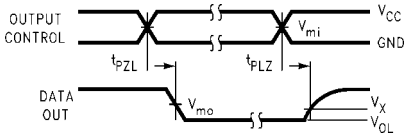
3-STATE Output High Enable and Disable Times for Logic



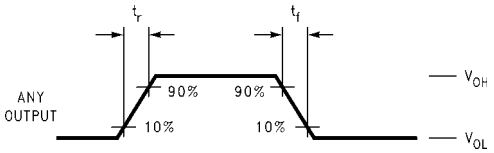
Propagation Delay. Pulse Width and t_{rec} Waveforms



Setup Time, Hold Time and Recovery Time for Logic



3-STATE Output Low Enable and Disable Times for Logic

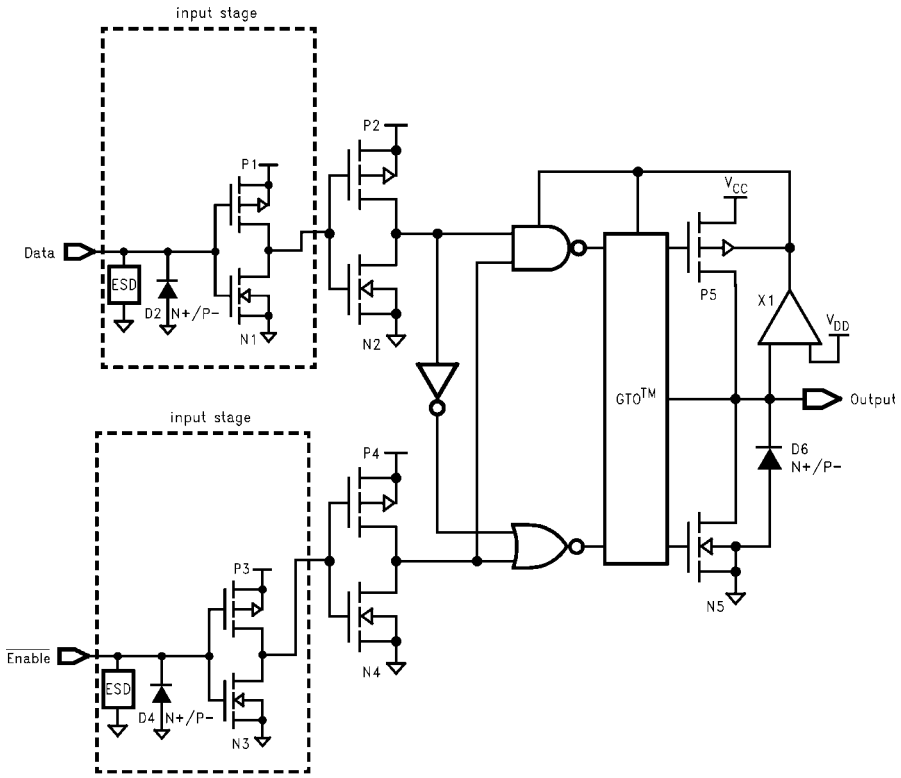


t_{rise} and t_{fall}

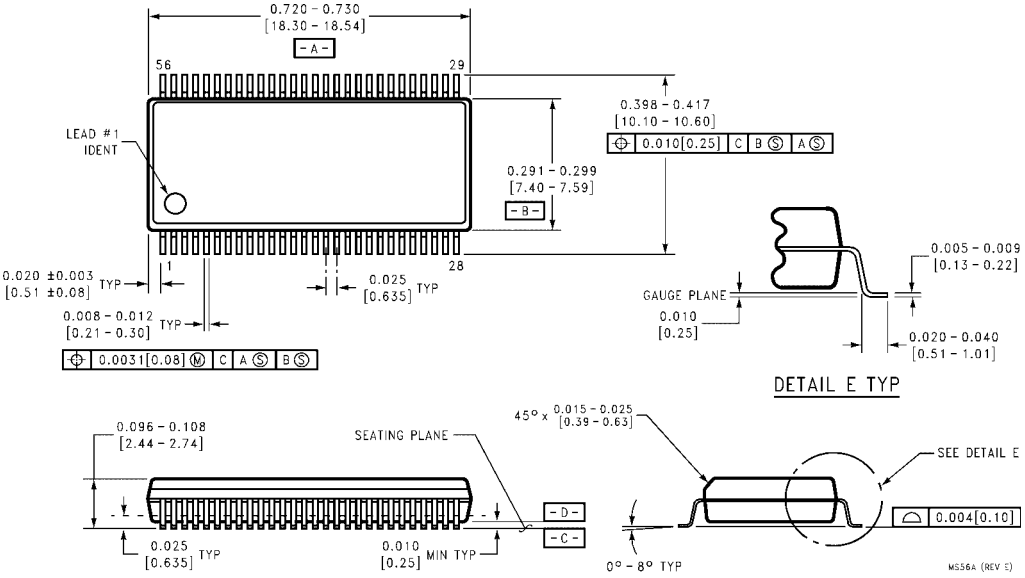
FIGURE 2. Waveforms
(Input Characteristics; f =1MHz, t_R = t_F = 3ns)

Symbol	V_{CC}		
	3.3V ± 0.3V	2.7V	2.5V ± 0.2V
V_{mi}	1.5V	1.5V	V_{CC}/2
V_{mo}	1.5V	1.5V	V_{CC}/2
V_x	V_{OL} + 0.3V	V_{OL} + 0.3V	V_{OL} + 0.15V
V_y	V_{OH} − 0.3V	V_{OH} − 0.3V	V_{OH} − 0.15V

Schematic Diagram Generic for LCX Family

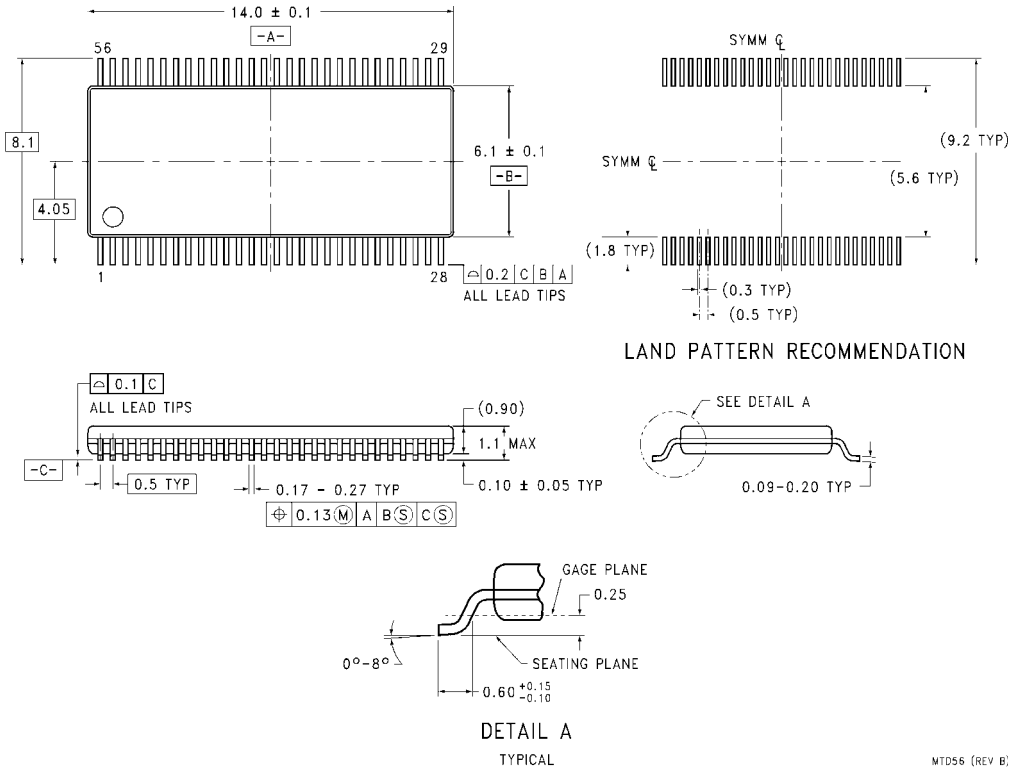


Physical Dimensions inches (millimeters) unless otherwise noted



56-Lead Shrink Small Outline Package (SSOP), JEDEC MO-118, 0.300 Wide
Package Number MS56A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



56-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide
Package Number MTD56

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