

# NB100LVEP91

## 2.5 V/3.3 V Any Level Positive Input to -2.5 V/-3.3 V LVNECL Output Translator

### Description

The NB100LVEP91 is a triple any level positive input to NECL output translator. The device accepts LVPECL, LVTTTL, LVCMOS, HSTL, CML or LVDS signals, and translates them to differential LVNECL output signals ( $-2.5\text{ V} / -3.3\text{ V}$ ).

To accomplish the level translation the LVEP91 requires three power rails. The  $V_{CC}$  pins should be connected to the positive power supply, and the  $V_{EE}$  pin should be connected to the negative power supply. The GND pins are connected to the system ground plane. Both  $V_{EE}$  and  $V_{CC}$  should be bypassed to ground via  $0.01\ \mu\text{F}$  capacitors.

Under open input conditions, the  $\bar{D}$  input will be biased at  $V_{CC}/2$  and the D input will be pulled to GND. These conditions will force the Q outputs to a low state, and Q outputs to a high state, which will ensure stability.

The  $V_{BB}$  pin, an internally generated voltage supply, is available to this device only. For single-ended input conditions, the unused differential input is connected to  $V_{BB}$  as a switching reference voltage.  $V_{BB}$  may also rebias AC coupled inputs. When used, decouple  $V_{BB}$  and  $V_{CC}$  via a  $0.01\ \mu\text{F}$  capacitor and limit current sourcing or sinking to  $0.5\text{ mA}$ . When not used,  $V_{BB}$  should be left open.

### Features

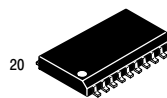
- Maximum Input Clock Frequency > 2.0 GHz Typical
- Maximum Input Data Rate > 2.0 Gb/s Typical
- 500 ps Typical Propagation Delay
- Operating Range:  $V_{CC} = 2.375\text{ V}$  to  $3.8\text{ V}$ ;  
 $V_{EE} = -2.375\text{ V}$  to  $-3.8\text{ V}$ ;  $GND = 0\text{ V}$
- Q Output will Default LOW with Inputs Open or at GND
- Pb-Free Packages are Available\*



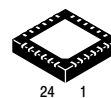
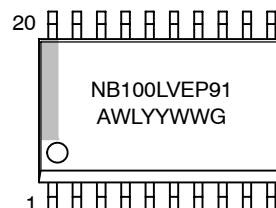
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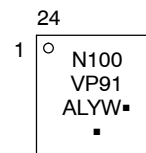
### MARKING DIAGRAMS\*



SO-20 WB  
DW SUFFIX  
CASE 751D



24 PIN QFN  
MN SUFFIX  
CASE 485L



A = Assembly Location  
WL, L = Wafer Lot  
YY, Y = Year  
WW, W = Work Week  
G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

\*For additional marking information, refer to Application Note AND8002/D.

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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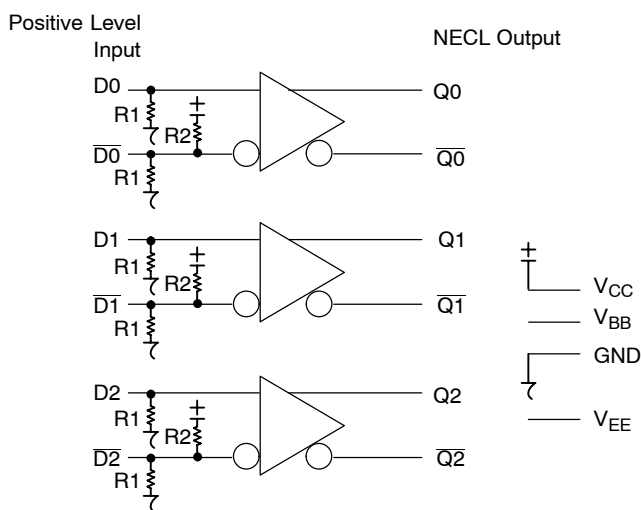


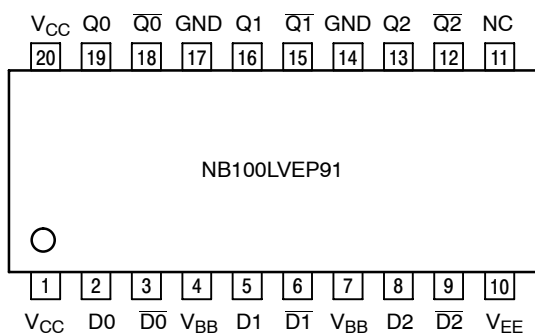
Figure 1. Logic Diagram

Table 1. PIN DESCRIPTION

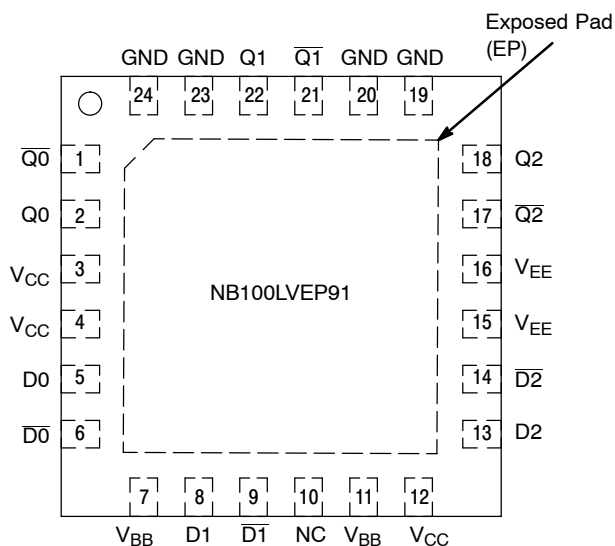
Pin		Name	I/O	Default State	Description
SOIC	QFN				
1, 20	3, 4, 12	V <sub>CC</sub>	-	-	Positive Supply Voltage. All V <sub>CC</sub> Pins must be Externally Connected to Power Supply to Guarantee Proper Operation.
10	15, 16	V <sub>EE</sub>	-	-	Negative Supply Voltage. All V <sub>EE</sub> Pins must be Externally Connected to Power Supply to Guarantee Proper Operation.
14, 17	19, 20, 23, 24	GND	-	-	Ground.
4, 7	7, 11	V <sub>BB</sub>	-	-	ECL Reference Voltage Output
2, 5, 8	5, 8, 13	D[0:2]	LVPECL, LVDS, LVTTTL, LVCMOS, CML, HSTL Input	Low	Noninverted Differential Inputs [0:2]. Internal 75 kΩ to V <sub>EE</sub> .
3, 6, 9	6, 9, 14	$\overline{D[0:2]}$	LVPECL, LVDS, LVTTTL, LVCMOS, CML, HSTL Input	High	Inverted Differential Inputs [0:2]. Internal 75 kΩ to V <sub>EE</sub> and 75 kΩ to V <sub>CC</sub> . When Inputs are Left Open They Default to $(V_{CC} - V_{EE}) / 2$ .
19,16,13	2, 18, 22	Q[0:2]	LVNECL Output	-	Noninverted Differential Outputs [0:2]. Typically Terminated with 50 Ω to V <sub>TT</sub> = V <sub>CC</sub> - 2 V
18,15,12	1, 21, 17	$\overline{Q[0:2]}$	LVNECL Output	-	Inverted Differential Outputs [0:2]. Typically Terminated with 50 Ω to V <sub>TT</sub> = V <sub>CC</sub> - 2 V
11	10	NC	-	-	No Connect. The NC Pin is NOT Electrically Connected to the Die and may Safely be Connected to Any Voltage from V <sub>EE</sub> to V <sub>CC</sub> .
N/A	-	EP	-	-	Exposed Pad. (Note 1)

1. The thermally conductive exposed pad on the package bottom (see case drawing) must be attached to a heat-sinking conduit.

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**Figure 2. SOIC-20 Lead Pinout (Top View)**



**Figure 3. QFN-24 Lead Pinout (Top View)\***

\*All V<sub>CC</sub>, V<sub>EE</sub> and GND pins must be externally connected to a power supply and the underside exposed pad must be attached to an adequate heat-sinking conduit to guarantee proper operation.

**Table 2. ATTRIBUTES**

Characteristics		Value	
Internal Input Pulldown Resistor	(R1)	75 kΩ	
Internal Input Pullup Resistor	(R2)	75 kΩ	
ESD Protection	Human Body Model Machine Model Charged Device Model	> 2 kV > 150 V > 2 kV	
Moisture Sensitivity (Note 2)		Pb Pkg	Pb-Free Pkg
	SO-20 WB QFN-24	Level 1 Level 1	Level 3 Level 1
Flammability Rating	Oxygen Index: 28 to 34	UL 94 V-0 @ 0.125 in	
Transistor Count		446 Devices	
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test			

2. For additional information, see Application Note AND8003/D.

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**Table 3. MAXIMUM RATINGS**

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
V <sub>CC</sub>	Positive Power Supply	GND = 0 V		3.8 to 0	V
V <sub>EE</sub>	Negative Power Supply	GND = 0 V		-3.8 to 0	V
V <sub>I</sub>	Positive Input Voltage	GND = 0 V	V <sub>I</sub> ≤ V <sub>CC</sub>	3.8 to 0	V
V <sub>OP</sub>	Operating Voltage	GND = 0 V	V <sub>CC</sub> - V <sub>EE</sub>	7.6 to 0	V
I <sub>out</sub>	Output Current	Continuous		50	mA
		Surge		100	mA
I <sub>BB</sub>	PECL V <sub>BB</sub> Sink/Source			± 0.5	mA
T <sub>A</sub>	Operating Temperature Range			-40 to +85	°C
T <sub>stg</sub>	Storage Temperature Range			-65 to +150	°C
θ <sub>JA</sub>	Thermal Resistance (Junction-to-Ambient) JESD 51-3 (1S-Single Layer Test Board)	0 lfpm 500 lfpm	SOIC-20 SOIC-20	90 60	°C/W °C/W
θ <sub>JA</sub>	Thermal Resistance (Junction-to-Ambient) JESD 51-6 (2S2P Multilayer Test Board) with Filled Thermal Vias	0 lfpm 500 lfpm	QFN-24 QFN-24	37 32	°C/W °C/W
θ <sub>JC</sub>	Thermal Resistance (Junction-to-Case)	Standard Board	SOIC-20 QFN-24	30 to 35 11	°C/W °C/W
T <sub>sol</sub>	Wave Solder	Pb Pb-Free		225 225	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

**Table 4. DC CHARACTERISTICS POSITIVE INPUTS** V<sub>CC</sub> = 2.5 V, V<sub>EE</sub> = -2.375 to -3.8 V, GND = 0 V (Note 3)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
I <sub>CC</sub>	Positive Power Supply Current	10	14	20	10	14	20	10	14	20	mA
V <sub>IH</sub>	Input HIGH Voltage (Single-Ended)	1335		V <sub>CC</sub>	1335		V <sub>CC</sub>	1335		V <sub>CC</sub>	mV
V <sub>IL</sub>	Input LOW Voltage (Single-Ended)	GND		875	GND		875	GND		875	mV
V <sub>IHCMR</sub>	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 4)	0		2.5	0		2.5	0		2.5	V
I <sub>IH</sub>	Input HIGH Current (@ V <sub>IH</sub> )			150			150			150	μA
I <sub>IL</sub>	Input LOW Current (@ V <sub>IL</sub> )	D D̄	0.5 -150		0.5 -150			0.5 -150			μA

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

3. Input parameters vary 1:1 with V<sub>CC</sub>. V<sub>CC</sub> can vary +1.3 V / -0.125 V.

4. V<sub>IHCMR</sub> min varies 1:1 with GND. V<sub>IHCMR</sub> max varies 1:1 with V<sub>CC</sub>.

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**Table 5. DC CHARACTERISTICS POSITIVE INPUT**  $V_{CC} = 3.3\text{ V}$ ;  $V_{EE} = -2.375\text{ V}$  to  $-3.8\text{ V}$ ;  $GND = 0\text{ V}$  (Note 5)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{CC}$	Positive Power Supply Current	10	16	24	10	16	24	10	16	24	mA
$V_{IH}$	Input HIGH Voltage (Single-Ended)	2135		$V_{CC}$	2135		$V_{CC}$	2135		$V_{CC}$	mV
$V_{IL}$	Input LOW Voltage (Single-Ended)	GND		1675	GND		1675	GND		1675	mV
$V_{BB}$	PECL Output Voltage Reference	1775	1875	1975	1775	1875	1975	1775	1875	1975	mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 6)	0		3.3	0		3.3	0		3.3	V
$I_{IH}$	Input HIGH Current (@ $V_{IH}$ )			150			150			150	$\mu\text{A}$
$I_{IL}$	Input LOW Current (@ $V_{IL}$ )	$\frac{D}{D}$ 0.5 -150			0.5 -150			0.5 -150			$\mu\text{A}$

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

5. Input parameters vary 1:1 with  $V_{CC}$ .  $V_{CC}$  can vary +0.5 / -0.925 V.

6.  $V_{IHCMR}$  min varies 1:1 with GND.  $V_{IHCMR}$  max varies 1:1 with  $V_{CC}$ .

**Table 6. DC CHARACTERISTICS NECL OUTPUT**  $V_{CC} = 2.375\text{ V}$  to  $3.8\text{ V}$ ;  $V_{EE} = -2.375\text{ V}$  to  $-3.8\text{ V}$ ;  $GND = 0\text{ V}$  (Note 7)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	Negative Power Supply Current	40	50	60	38	50	68	38	50	68	mA
$V_{OH}$	Output HIGH Voltage (Note 8)	-1145	-1020	-895	-1145	-1020	-895	-1145	-1020	-895	mV
$V_{OL}$	Output LOW Voltage (Note 8)	-1945	-1770	-1600	-1945	-1770	-1600	-1945	-1770	-1600	mV

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

7. Output parameters vary 1:1 with GND.

8. All loading with 50  $\Omega$  resistor to GND - 2.0 V.

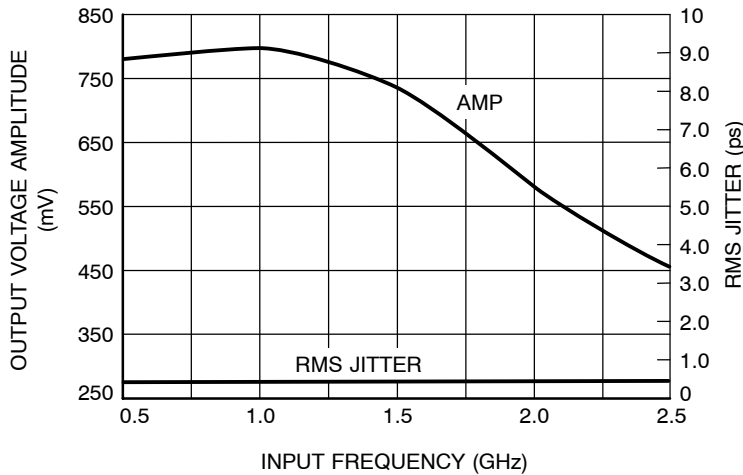
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**Table 7. AC CHARACTERISTICS**  $V_{CC} = 2.375\text{ V to }3.8\text{ V}$ ;  $V_{EE} = -2.375\text{ V to }-3.8\text{ V}$ ;  $GND = 0\text{ V}$

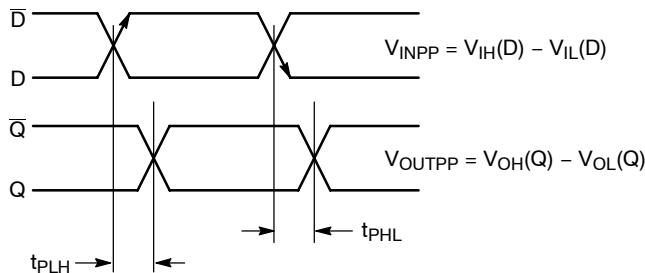
Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$V_{OUTPP}$	Output Voltage Amplitude (Figure 4) (Note 9) $f_{in} \leq 1.0\text{ GHz}$ $f_{in} \leq 1.5\text{ GHz}$ $f_{in} \leq 2.0\text{ GHz}$	575	800		600	800		550	800		mV
$t_{PLH}$ $t_{PHL0}$	Propagation Delay D to Q Differential Single-Ended	375	500	600	375	500	600	400	550	650	ps
$t_{SKEW}$	Pulse Skew (Note 10) Output-to-Output (Note 11) Part-to-Part (Diff) (Note 11)		15	75		15	75		15	80	ps
$t_{JITTER}$	RMS Random Clock Jitter (Note 12) $f_{in} = 2.0\text{ GHz}$ Peak-to-Peak Data Dependant Jitter $f_{in} = 2.0\text{ Gb/s}$ (Note 13)		0.5	2.0		0.5	2.0		0.5	2.0	ps
$V_{INPP}$	Input Voltage Swing (Differential Configuration) (Note 14)	200	800	1200	200	800	1200	200	800	1200	mV
$t_r, t_f$	Output Rise/Fall Times @ 50 MHz (20% – 80%) Q, $\bar{Q}$	75	150	250	75	150	250	75	150	275	ps

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

9. Measured using a 750 mV source, 50% duty cycle clock source. All loading with 50  $\Omega$  to GND – 2.0 V. Input edge rates 150 ps (20% – 80%).
10. Pulse Skew =  $|t_{PLH} - t_{PHL}|$
11. Skews are valid across specified voltage range, part-to-part skew is for a given temperature.
12. RMS Jitter with 50% Duty Cycle Input Clock Signal.
13. Peak-to-Peak Jitter with input NRZ PRBS  $2^{31}-1$  at 2.0 Gb/s.
14. Input voltage swing is a single-ended measurement operating in differential mode. The device has a DC gain of  $\approx 50$ .



**Figure 4. Output Voltage Amplitude ( $V_{OUTPP}$ ) / RMS Jitter vs. Input Frequency ( $f_{in}$ ) at Ambient Temperature (Typical)**



**Figure 5. AC Reference Measurement**

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## Application Information

All NB100LVEP91 inputs can accept LVPECL, LVTTTL, LVCMOS, HSTL, CML, or LVDS signal levels. The limitations for differential input signal (LVDS, HSTL, LVPECL, or CML) are the minimum input swing of 150 mV

and the maximum input swing of 3.0 V. Within these conditions, the input voltage can range from  $V_{CC}$  to GND. Examples interfaces are illustrated below in a 50  $\Omega$  environment ( $Z = 50 \Omega$ )

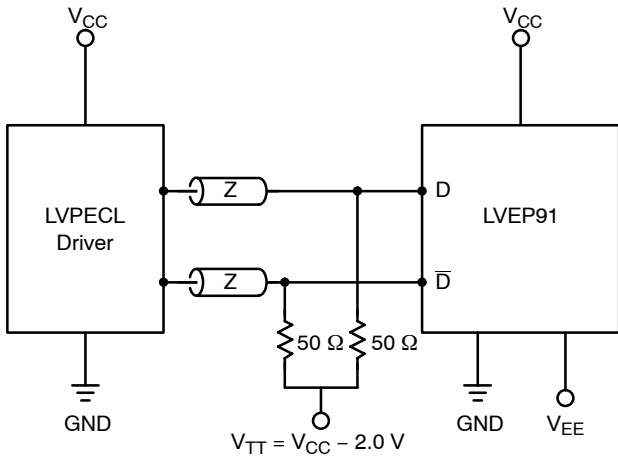


Figure 6. Standard LVPECL Interface

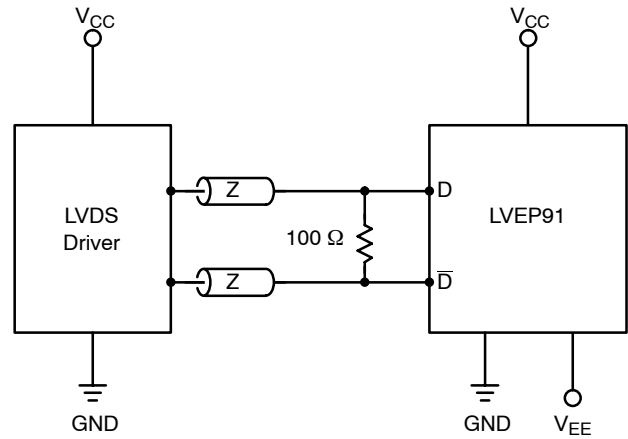


Figure 7. Standard LVDS Interface

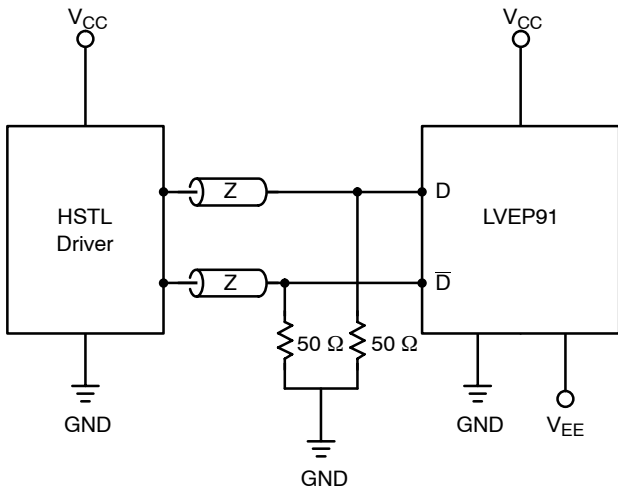


Figure 8. Standard HSTL Interface

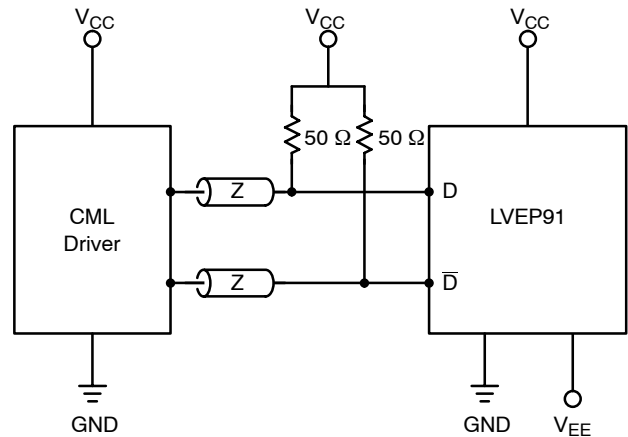


Figure 9. Standard 50  $\Omega$  Load CML Interface

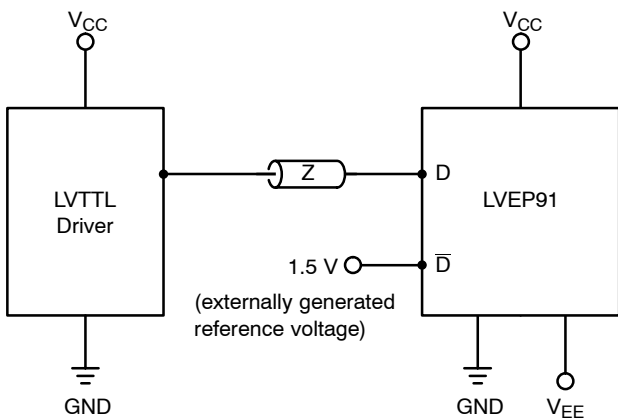


Figure 10. Standard LVTTTL Interface

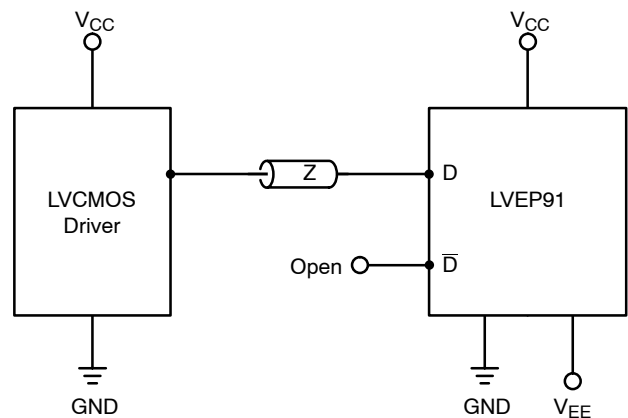


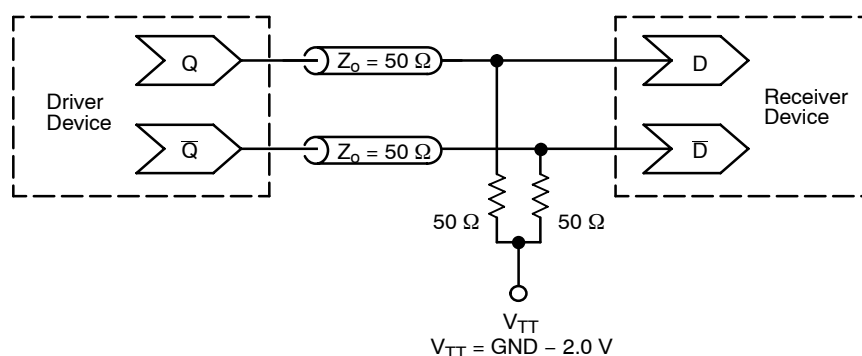
Figure 11. Standard LVCMOS Interface ( $\bar{D}$  will default to  $V_{CC}/2$  when left open. A reference voltage of  $V_{CC}/2$  should be applied to D input, if  $\bar{D}$  is interfaced to CMOS signals.)

# NB100LVEP91

## ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
NB100LVEP91DW	SO-20	38 Units / Rail
NB100LVEP91DWG	SO-20 (Pb-Free)	38 Units / Rail
NB100LVEP91DWR2	SO-20	1000 / Tape & Reel
NB100LVEP91DWR2G	SO-20 (Pb-Free)	1000 / Tape & Reel
NB100LVEP91MN	QFN-24	92 Units / Rail
NB100LVEP91MNG	QFN-24 (Pb-Free)	92 Units / Rail
NB100LVEP91MNR2	QFN-24	3000 / Tape & Reel
NB100LVEP91MNR2G	QFN-24 (Pb-Free)	3000 / Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



**Figure 12. Typical Termination for Output Driver and Device Evaluation  
(See Application Note AND8020/D – Termination of ECL Logic Devices.)**

### Resource Reference of Application Notes

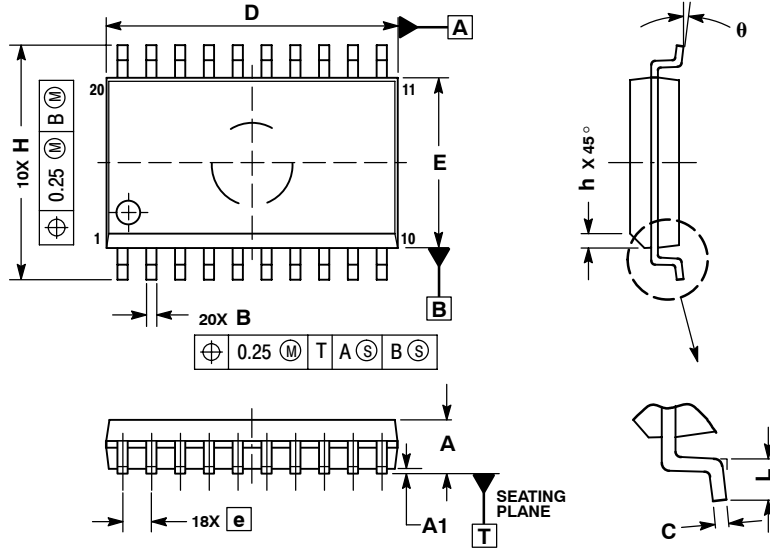
- AN1405/D** – ECL Clock Distribution Techniques
- AN1406/D** – Designing with PECL (ECL at +5.0 V)
- AN1503/D** – ECLinPS™ I/O SPiCE Modeling Kit
- AN1504/D** – Metastability and the ECLinPS Family
- AN1568/D** – Interfacing Between LVDS and ECL
- AN1672/D** – The ECL Translator Guide
- AND8001/D** – Odd Number Counters Design
- AND8002/D** – Marking and Date Codes
- AND8020/D** – Termination of ECL Logic Devices
- AND8066/D** – Interfacing with ECLinPS
- AND8090/D** – AC Characteristics of ECL Devices



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## PACKAGE DIMENSIONS

SO-20 WB  
CASE 751D-05  
ISSUE G



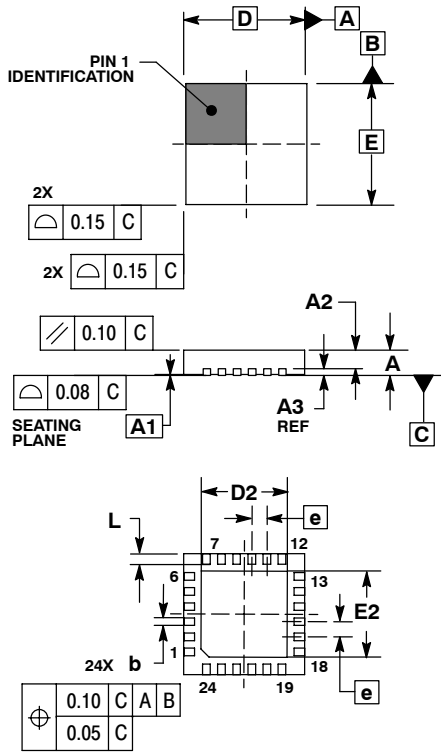
- NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
  3. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
  5. DIMENSION B DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF B DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS	
	MIN	MAX
A	2.35	2.65
A1	0.10	0.25
B	0.35	0.49
C	0.23	0.32
D	12.65	12.95
E	7.40	7.60
e	1.27 BSC	
H	10.05	10.55
h	0.25	0.75
L	0.50	0.90
θ	0°	7°

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## PACKAGE DIMENSIONS

**QFN 24**  
**MN SUFFIX**  
 24 PIN QFN, 4x4  
 CASE 485L-01  
 ISSUE O



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

DIM	MILLIMETERS	
	MIN	MAX
A	0.80	1.00
A1	0.00	0.05
A2	0.60	0.80
A3	0.20	REF
b	0.23	0.28
D	4.00	BSC
D2	2.70	2.90
E	4.00	BSC
E2	2.70	2.90
e	0.50	BSC
L	0.35	0.45

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