

MC10EP116, MC100EP116

3.3 V / 5 V Hex Differential Line Receiver/Driver

Description

The MC10EP116/100EP116 is a 6-bit differential line receiver based on the EP16 device. The 3.0 GHz bandwidth provided by the high frequency outputs makes the device ideal for buffering of very high speed oscillators.

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 μ F capacitor and limit current sourcing or sinking to 0.5 mA. When not used, V_{BB} should be left open.

The design incorporates two stages of gain, internal to the device, making it an excellent choice for use in high bandwidth amplifier applications.

The differential inputs have internal clamp structures which will force the Q output of a gate in an open input condition to go to a LOW state. Thus, inputs of unused gates can be left open and will not affect the operation of the rest of the device. Note that the input clamp will take affect only if both inputs fall 2.5 V below V_{CC} .

The 100 Series contains temperature compensation.

Features

- 260 ps Typical Propagation Delay
- Maximum Frequency > 3 GHz Typical
- PECL Mode Operating Range: $V_{CC} = 3.0$ V to 5.5 V with $V_{EE} = 0$ V
- NECL Mode Operating Range: $V_{CC} = 0$ V with $V_{EE} = -3.0$ V to -5.5 V
- Open Input Default State
- Safety Clamp on Inputs
- Q Output Will Default LOW with Inputs Open or at V_{EE}
- V_{BB} Output
- Pb-Free Packages are Available



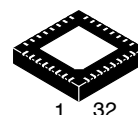
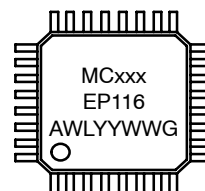
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MARKING DIAGRAM*



**LQFP-32
FA SUFFIX
CASE 873A**



**QFN32
MN SUFFIX
CASE 488AM**



xxx = 10 or 100
A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week
G or ■ = Pb-Free Package

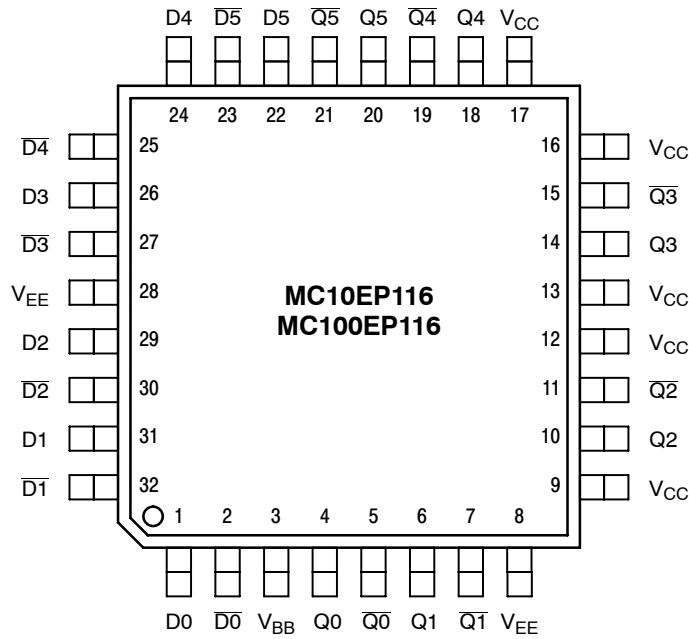
(Note: Microdot may be in either location)

*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 9 of this data sheet.

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Warning: All V_{CC} and V_{EE} pins must be externally connected to Power Supply to guarantee proper operation.

Figure 1. 32-Lead LQFP Pinout (Top View)

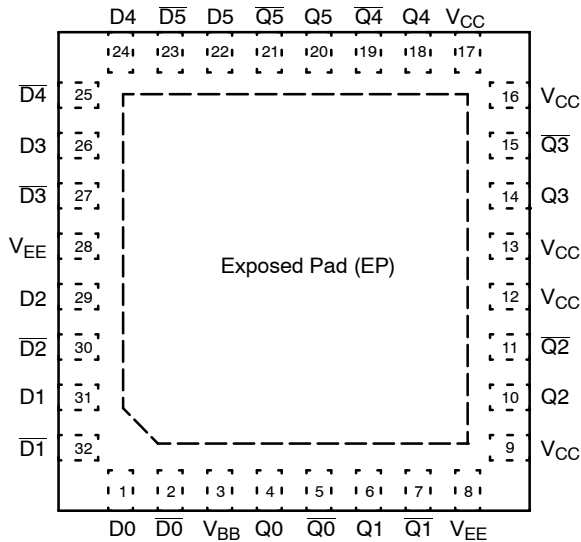


Figure 2. 32-Lead QFN Pinout (Top View)

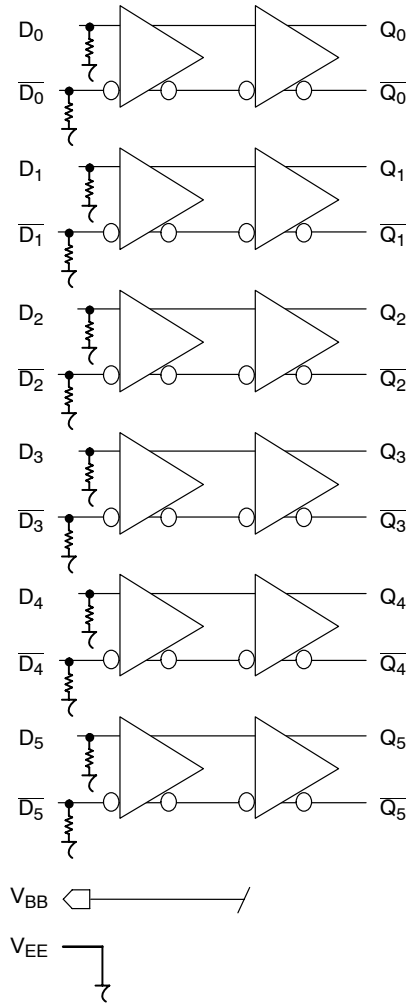


Figure 3. Logic Diagram

Table 1. PIN DESCRIPTION

PIN	FUNCTION
D[0:5]*, $\overline{D}$ [0:5]*	ECL Differential Data Inputs
Q[0:5], $\overline{Q}$ [0:5]	ECL Differential Data Outputs
V_{BB}	Reference Voltage Output
V_{CC}	Positive Supply
V_{EE}	Negative Supply

* Pins will default LOW when left open.

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Table 2. ATTRIBUTES

Characteristics	Value	
Internal Input Pulldown Resistor	75 kΩ	
Internal Input Pullup Resistor	N/A	
ESD Protection	Human Body Model	> 2 kV
	Machine Model	> 100 V
	Charged Device Model	> 2 kV
Moisture Sensitivity, Indefinite Time Out of Drypack (Note 1)	Pb Pkg	Pb-Free Pkg
LQFP-32	Level 2	Level 2
QFN-32	–	Level 1
Flammability Rating	Oxygen Index: 28 to 34	
	UL-94 V-0 @ 0.125 in	
Transistor Count	729 Devices	
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test		

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

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Table 3. MAXIMUM RATINGS

Symbol	Parameter	Condition 1	Condition 2	Rating	Units
V _{CC}	PECL Mode Power Supply	V _{EE} = 0 V		6	V
V _{EE}	NECL Mode Power Supply	V _{CC} = 0 V		–6	V
V _I	PECL Mode Input Voltage NECL Mode Input Voltage	V _{EE} = 0 V V _{CC} = 0 V	V _I ≤ V _{CC} V _I ≥ V _{EE}	6 –6	V
I _{out}	Output Current	Continuous Surge		50 100	mA
I _{BB}	V _{BB} Sink/Source			± 0.5	mA
T _A	Operating Temperature Range			–40 to +85	°C
T _{stg}	Storage Temperature Range			–65 to +150	°C
θ _{JA}	Thermal Resistance (Junction–to–Ambient)	0 lfpm 500 lfpm	32 LQFP 32 LQFP	80 55	°C/W
θ _{JC}	Thermal Resistance (Junction–to–Case)	Standard Board	32 LQFP	12 to 17	°C/W
θ _{JA}	Thermal Resistance (Junction–to–Ambient)	0 lfpm 500 lfpm	32 QFN 32 QFN	31 27	°C/W
θ _{JC}	Thermal Resistance (Junction–to–Case)	2S2P	32 QFN	12	°C/W
T _{sol}	Wave Solder Pb Pb–Free			265 265	°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. 10EP DC CHARACTERISTICS, PECL V_{CC} = 3.3 V, V_{EE} = 0 V (Note 2)

Symbol	Characteristic	–40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
I _{EE}	Power Supply Current	60	75	90	60	80	95	60	85	95	mA
V _{OH}	Output HIGH Voltage (Note 3)	2165	2290	2415	2230	2355	2480	2290	2415	2540	mV
V _{OL}	Output LOW Voltage (Note 3)	1365	1490	1615	1430	1555	1680	1490	1615	1740	mV
V _{IH}	Input HIGH Voltage (Single–Ended)	2090		2415	2155		2480	2215		2540	mV
V _{IL}	Input LOW Voltage (Single–Ended)	1365		1690	1460		1755	1490		1815	mV
V _{BB}	Output Voltage Reference	1790	1890	1990	1855	1955	2055	1915	2015	2115	mV
V _{IHCMR}	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 4)	2.0		3.3	2.0		3.3	2.0		3.3	V
I _{IH}	Input HIGH Current			150			150			150	μA
I _{IL}	Input LOW Current	0.5			0.5			0.5			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.

2. Input and output parameters vary 1:1 with V_{CC}. V_{EE} can vary +0.3 V to –2.2 V.

3. All loading with 50 Ω to V_{CC} – 2.0 V.

4. V_{IHCMR} min varies 1:1 with V_{EE}. V_{IHCMR} max varies 1:1 with V_{CC}. The V_{IHCMR} range is referenced to the most positive side of the differential input signal.

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Table 5. 10EP DC CHARACTERISTICS, PECL $V_{CC} = 5.0\text{ V}$, $V_{EE} = 0\text{ V}$ (Note 5)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
I_{EE}	Power Supply Current	60	75	90	60	80	95	60	85	95	mA
V_{OH}	Output HIGH Voltage (Note 6)	3865	3990	4115	3930	4055	4180	3990	4115	4240	mV
V_{OL}	Output LOW Voltage (Note 6)	3065	3190	3315	3130	3255	3380	3190	3315	3440	mV
V_{IH}	Input HIGH Voltage (Single-Ended)	3790		4115	3855		4180	3915		4240	mV
V_{IL}	Input LOW Voltage (Single-Ended)	3065		3390	3130		3455	3190		3515	mV
V_{BB}	Output Voltage Reference	3490	3590	3690	3555	3655	3755	3615	3715	3815	mV
V_{IHCMR}	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 7)	2.0		5.0	2.0		5.0	2.0		5.0	V
I_{IH}	Input HIGH Current			150			150			150	μA
I_{IL}	Input LOW Current	0.5			0.5			0.5			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 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.

5. Input and output parameters vary 1:1 with V_{CC} . V_{EE} can vary +2.0 V to -0.5 V.

6. All loading with 50 Ω to $V_{CC} - 2.0\text{ V}$.

7. V_{IHCMR} min varies 1:1 with V_{EE} , V_{IHCMR} max varies 1:1 with V_{CC} . The V_{IHCMR} range is referenced to the most positive side of the differential input signal.

Table 6. 10EP DC CHARACTERISTICS, NECL $V_{CC} = 0\text{ V}$, $V_{EE} = -5.5\text{ V}$ to -3.0 V (Note 8)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
I_{EE}	Power Supply Current	60	75	90	60	80	95	60	85	95	mA
V_{OH}	Output HIGH Voltage (Note 9)	-1135	-1010	-885	-1070	-945	-820	-1010	-885	-760	mV
V_{OL}	Output LOW Voltage (Note 9)	-1935	-1810	-1685	-1870	-1745	-1620	-1810	-1685	-1560	mV
V_{IH}	Input HIGH Voltage (Single-Ended)	-1210		-885	-1145		-820	-1085		-760	mV
V_{IL}	Input LOW Voltage (Single-Ended)	-1935		-1610	-1870		-1545	-1810		-1485	mV
V_{BB}	Output Voltage Reference	-1510	-1410	-1310	-1445	-1345	-1245	-1385	-1285	-1185	mV
V_{IHCMR}	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 10)	$V_{EE}+2.0$		0.0	$V_{EE}+2.0$		0.0	$V_{EE}+2.0$		0.0	V
I_{IH}	Input HIGH Current			150			150			150	μA
I_{IL}	Input LOW Current	0.5			0.5			0.5			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 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.

8. Input and output parameters vary 1:1 with V_{CC} .

9. All loading with 50 Ω to $V_{CC} - 2.0\text{ V}$.

10. V_{IHCMR} min varies 1:1 with V_{EE} , V_{IHCMR} max varies 1:1 with V_{CC} . The V_{IHCMR} range is referenced to the most positive side of the differential input signal.

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Table 7. 100EP DC CHARACTERISTICS, PECL $V_{CC} = 3.3\text{ V}$, $V_{EE} = 0\text{ V}$ (Note 11)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
I_{EE}	Power Supply Current	60	75	90	60	80	95	60	85	95	mA
V_{OH}	Output HIGH Voltage (Note 12)	2155	2280	2405	2155	2280	2405	2155	2280	2405	mV
V_{OL}	Output LOW Voltage (Note 12)	1355	1480	1605	1355	1480	1605	1355	1480	1605	mV
V_{IH}	Input HIGH Voltage (Single-Ended)	2075		2420	2075		2420	2075		2420	mV
V_{IL}	Input LOW Voltage (Single-Ended)	1355		1675	1490		1675	1490		1675	mV
V_{BB}	Output Voltage Reference	1775	1875	1975	1775	1875	1975	1775	1875	1975	mV
V_{IHCMR}	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 13)	2.0		3.3	2.0		3.3	2.0		3.3	V
I_{IH}	Input HIGH Current			150			150			150	μA
I_{IL}	Input LOW Current	0.5			0.5			0.5			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 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.

11. Input and output parameters vary 1:1 with V_{CC} . V_{EE} can vary +0.3 V to -2.2 V.

12. All loading with 50 Ω to $V_{CC} - 2.0\text{ V}$.

13. V_{IHCMR} min varies 1:1 with V_{EE} , V_{IHCMR} max varies 1:1 with V_{CC} . The V_{IHCMR} range is referenced to the most positive side of the differential input signal.

Table 8. 100EP DC CHARACTERISTICS, PECL $V_{CC} = 5.0\text{ V}$, $V_{EE} = 0\text{ V}$ (Note 14)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
I_{EE}	Power Supply Current	60	75	90	60	80	95	60	85	95	mA
V_{OH}	Output HIGH Voltage (Note 15)	3855	3980	4105	3855	3980	4105	3855	3980	4105	mV
V_{OL}	Output LOW Voltage (Note 15)	3055	3180	3305	3055	3180	3305	3055	3180	3305	mV
V_{IH}	Input HIGH Voltage (Single-Ended)	3775		4120	3775		4120	3775		4120	mV
V_{IL}	Input LOW Voltage (Single-Ended)	3790		3375	3190		3375	3190		3375	mV
V_{BB}	Output Voltage Reference	3475	3575	3675	3475	3575	3675	3475	3575	3675	mV
V_{IHCMR}	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 16)	2.0		5.0	2.0		5.0	2.0		5.0	V
I_{IH}	Input HIGH Current			150			150			150	μA
I_{IL}	Input LOW Current	0.5			0.5			0.5			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 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.

14. Input and output parameters vary 1:1 with V_{CC} . V_{EE} can vary +2.0 V to -0.5 V.

15. All loading with 50 Ω to $V_{CC} - 2.0\text{ V}$.

16. V_{IHCMR} min varies 1:1 with V_{EE} , V_{IHCMR} max varies 1:1 with V_{CC} . The V_{IHCMR} range is referenced to the most positive side of the differential input signal.

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Table 9. 100EP DC CHARACTERISTICS, NECL $V_{CC} = 0\text{ V}$, $V_{EE} = -5.5\text{ V}$ to -3.0 V (Note 17)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
I_{EE}	Power Supply Current	60	75	90	60	80	95	60	85	95	mA
V_{OH}	Output HIGH Voltage (Note 18)	-1145	-1020	-895	-1145	-1020	-895	-1145	-1020	-895	mV
V_{OL}	Output LOW Voltage (Note 18)	-1945	-1820	-1695	-1945	-1820	-1695	-1945	-1820	-1695	mV
V_{IH}	Input HIGH Voltage (Single-Ended)	-1225		-880	-1225		-880	-1225		-880	mV
V_{IL}	Input LOW Voltage (Single-Ended)	-1945		-1625	-1945		-1625	-1945		-1625	mV
V_{BB}	Output Voltage Reference	-1525	-1425	-1325	-1525	-1425	-1325	-1525	-1425	-1325	mV
V_{IHCMR}	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 19)	$V_{EE}+2.0$		0.0	$V_{EE}+2.0$		0.0	$V_{EE}+2.0$		0.0	V
I_{IH}	Input HIGH Current			150			150			150	μA
I_{IL}	Input LOW Current	0.5			0.5			0.5			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 lpm. 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.

17. Input and output parameters vary 1:1 with V_{CC} .

18. All loading with $50\ \Omega$ to $V_{CC} - 2.0\text{ V}$.

19. V_{IHCMR} min varies 1:1 with V_{EE} , V_{IHCMR} max varies 1:1 with V_{CC} . The V_{IHCMR} range is referenced to the most positive side of the differential input signal.

Table 10. AC CHARACTERISTICS $V_{CC} = 0\text{ V}$; $V_{EE} = -3.0\text{ V}$ to -5.5 V or $V_{CC} = 3.0\text{ V}$ to 5.5 V ; $V_{EE} = 0\text{ V}$ (Note 20)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$f_{\max}$	Maximum Frequency (See Figure 4 $F_{\max}/\text{JITTER}$)		> 3			> 3			> 3		GHz
t_{PLH} , t_{PHL}	Propagation Delay to Output Differential	160	250	340	160	260	340	190	300	380	ps
t_{SKEW}	Duty Cycle Skew (Note 21)		5.0	20		5.0	20		5.0	20	ps
t_{SKEW}	Within Device Skew Device to Device Skew (Note 21)			100 180			100 180			100 190	ps
t_{JITTER}	Cycle-to-Cycle Jitter (See Figure 4 $F_{\max}/\text{JITTER}$)		0.2	< 1		0.2	< 1		0.2	< 1	ps
V_{PP}	Input Voltage Swing (Differential Configuration)	150	800	1200	150	800	1200	150	800	1200	mV
t_r , t_f	Output Rise/Fall Times (20% – 80%) $Q, \bar{Q}$	90	150	220	90	160	240	90	160	250	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 lpm. 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.

20. Measured using a 750 mV source, 50% duty cycle clock source. All loading with $50\ \Omega$ to $V_{CC} - 2.0\text{ V}$.

21. Skew is measured between outputs under identical transitions. Duty cycle skew is defined only for differential operation when the delays are measured from the cross point of the inputs to the cross point of the outputs.

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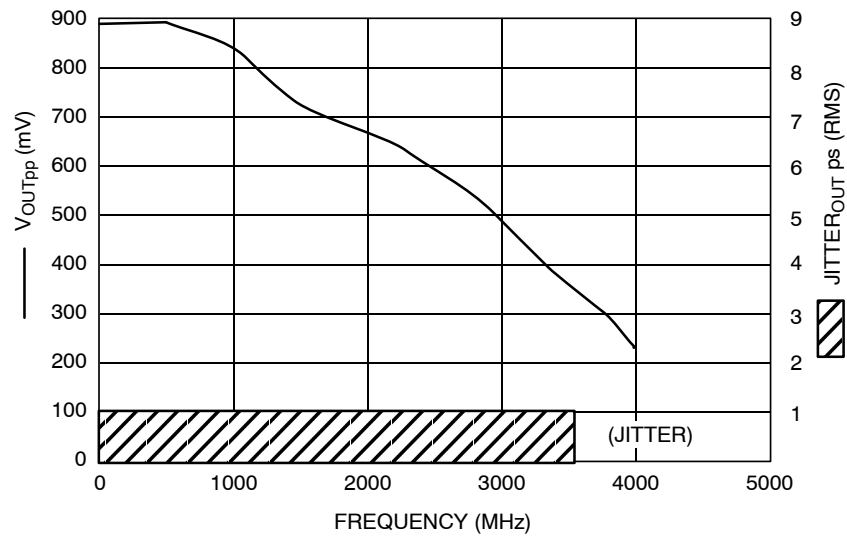


Figure 4. $F_{max}/Jitter$

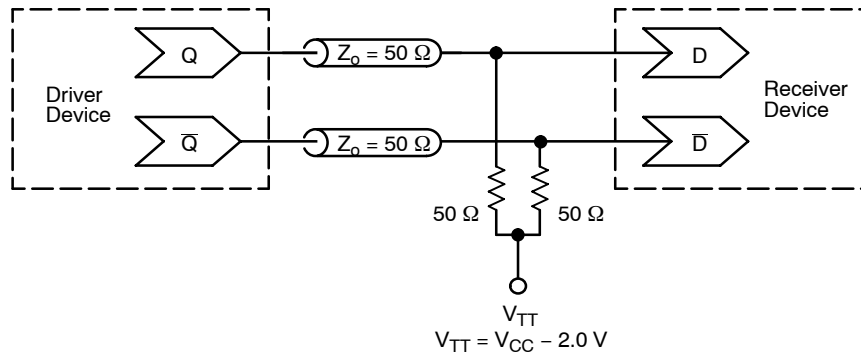


Figure 5. Typical Termination for Output Driver and Device Evaluation
(See Application Note AND8020/D – Termination of ECL Logic Devices.)

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ORDERING INFORMATION

Device	Package	Shipping [†]
MC10EP116FA	LQFP-32	250 Units / Tray
MC10EP116FAG	LQFP-32 (Pb-Free)	250 Units / Tray
MC10EP116FAR2	LQFP-32	2000 / Tape & Reel
MC10EP116FAR2G	LQFP-32 (Pb-Free)	2000 / Tape & Reel
MC10EP116MNG	QFN-32 (Pb-Free)	74 Units / Rail
MC10EP116MNR4G	QFN-32 (Pb-Free)	1000 / Tape & Reel
MC100EP116FA	LQFP-32	250 Units / Tray
MC100EP116FAG	LQFP-32 (Pb-Free)	250 Units / Tray
MC100EP116FAR2	LQFP-32	2000 / Tape & Reel
MC100EP116FAR2G	LQFP-32 (Pb-Free)	2000 / Tape & Reel
MC100EP116MNG	QFN-32 (Pb-Free)	74 Units / Rail
MC100EP116MNR4G	QFN-32 (Pb-Free)	1000 / Tape & Reel

[†]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.

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

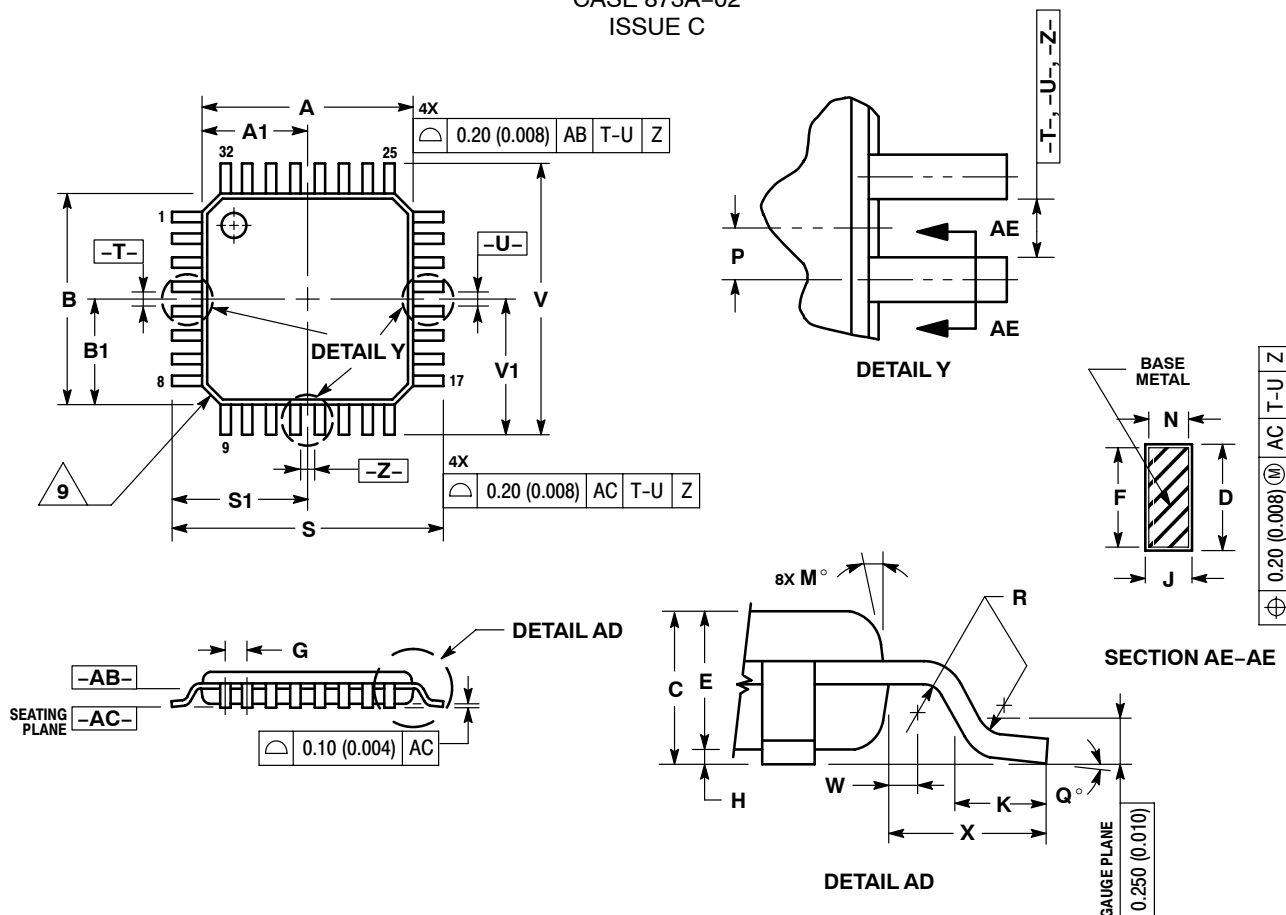
MC10EP116, MC100EP116

PACKAGE DIMENSIONS

32 LEAD LQFP

CASE 873A-02

ISSUE C



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DATUM PLANE -AB- IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.
4. DATUMS -T-, -U-, AND -Z- TO BE DETERMINED AT DATUM PLANE -AB-.
5. DIMENSIONS S AND V TO BE DETERMINED AT SEATING PLANE -AC-.
6. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.250 (0.010) PER SIDE. DIMENSIONS A AND B DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -AB-.
7. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. DAMBAR PROTRUSION SHALL NOT CAUSE THE D DIMENSION TO EXCEED 0.520 (0.020).
8. MINIMUM SOLDER PLATE THICKNESS SHALL BE 0.0076 (0.0003).
9. EXACT SHAPE OF EACH CORNER MAY VARY FROM DEPICTION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.000	BSC	0.276	BSC
A1	3.500	BSC	0.138	BSC
B	7.000	BSC	0.276	BSC
B1	3.500	BSC	0.138	BSC
C	1.400	1.600	0.055	0.063
D	0.300	0.450	0.012	0.018
E	1.350	1.450	0.053	0.057
F	0.300	0.400	0.012	0.016
G	0.800	BSC	0.031	BSC
H	0.050	0.150	0.002	0.006
J	0.090	0.200	0.004	0.008
K	0.450	0.750	0.018	0.030
M	12°	REF	12°	REF
N	0.090	0.160	0.004	0.006
P	0.400	BSC	0.016	BSC
Q	1°	5°	1°	5°
R	0.150	0.250	0.006	0.010
S	9.000	BSC	0.354	BSC
S1	4.500	BSC	0.177	BSC
V	9.000	BSC	0.354	BSC
V1	4.500	BSC	0.177	BSC
W	0.200	REF	0.008	REF
X	1.000	REF	0.039	REF

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