Description

The ULN2003V12 and ULN2003F12 are multi-channel sink drivers comprised of 7-channel and 4-channel output stages respectively. The ULN2003V12 sink driver features 7 low output impedance drivers that minimize on-chip power dissipation and an actual low power upgrade version for popular ULN2003A family in real applications. When driving a typical 12V relay coil, a ULN2003V12 will dissipate 12 times lower power compared to ULN2003A. ULN2003F12 is a lower power variant benefiting from fewer channel integration and a better fit for applications requiring only 4-channel drivers, such as driving low voltage stepping motors, etc.

The ULN2003V12 and ULN2003F12 both support 3.3V to 5V CMOS logic input interface, thus making it compatible to a wide range of micro-controllers and other logic interfaces, and also feature an improved input interface that minimizes the input DC current drawn from the external drivers. The input RC snubber circuit integrated at ULN2003V12 and ULN2003F12 improves the performance in noisy operating conditions, and the internal pull-down resistor at input stage helps allow input logic to be tri-stated.

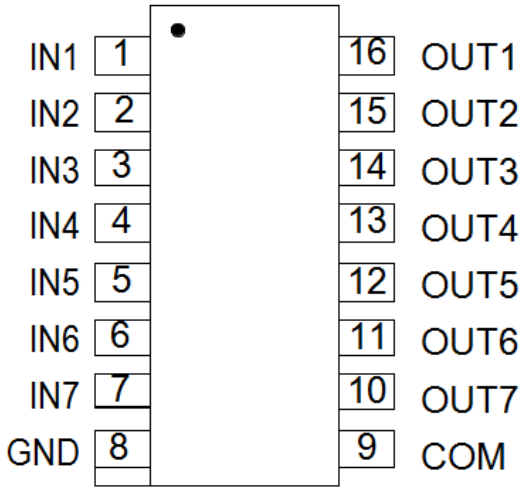
As shown in the Functional Diagram, each output of the ULN2003V12 and ULN2003F12 features an internal free-wheeling diode connected in a common-cathode configuration at the COM pin which provides flexibility of increasing current sink capability through combining several adjacent channels in parallel. Under typical conditions the ULN2003V12 can support up to 1.0A of load current when all 7-channels are connected in parallel.

Features

- 4- and 7-Channel High Current Sink Drivers
- Supports up to 20V Output Pull-up Voltage
- Low Output VOL of 0.6V (Typical) with
  - 100mA (Typ.) Current Sink per Channel at 3.3V Logic Input
  - 140mA (Typ.) Current Sink per Channel at 5.0V Logic Input
- Compatible to 3.3V and 5.0V Micro-Controllers and Logic Interface
- Internal Free-Wheeling Diodes for Inductive Kick-back Protection
- Input Pull-down Resistors Allows Tri-Stating the Input Driver
- Input RC-Snubber to Eliminate Spurious Operation in Noisy Environments
- ESD: 4kV HBM, 1kV CDM
- Available in 16-Pin SOIC, 16-Pin TSSOP and 10-Pin DFN3030 packages
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative. https://www.diodes.com/quality/product-definitions/**

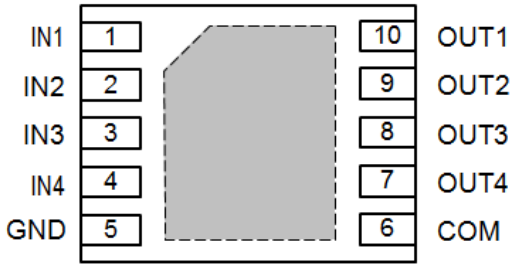
Pin Assignments

(Top View)



SO-16 / TSSOP-16

(Top View)



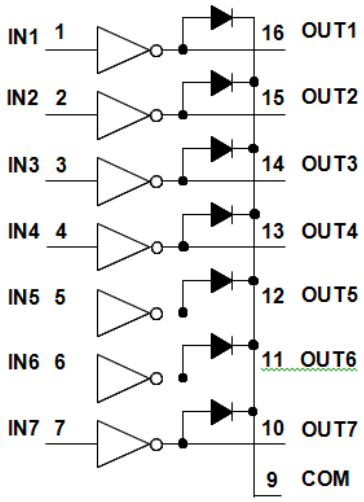
U-DFN3030-10

Applications

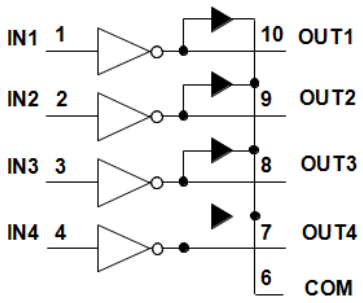
- Inputs Compatible with Popular Logic Types
- Relay Driver Applications
- Stepping Motor Applications
- Logic Level Shifter

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Functional Diagram



ULN2003V12

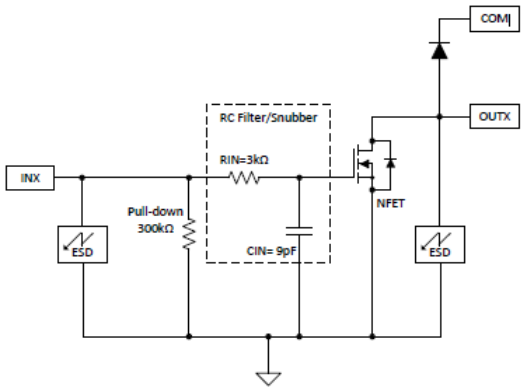


ULN2003F12

Pin Descriptions

Pin Name	Package Number			Description
	SO16	TSSOP16	DFN3030-10	
IN1 ~ IN7	1~7	1~7	1~4	Logic Input Pins IN1 through IN7
GND	8	8	5	Ground Reference Pin
COM	9	9	6	Internal Free-Wheeling Diode Common Cathode Pin
OUT7 ~ OUT1	10~16	10~16	7~10	Channel Output Pins OUT7 through OUT1

Functional Block Diagram (Single Channel)



Absolute Maximum Ratings (@ T_A = +25°C, unless otherwise specified.)

Symbol	Parameter		Rating Min	Rating Max	Unit
V_{IN}	Pin2 IN1~IN7 to GND Voltage		-0.3	5.5	V
V_{OUT}	Pins OUT1~OUT7 to GND Voltage		—	20	V
V_{COM}	Pin COM to GND Voltage		—	20	V
I_{GND}	Max GND-Pin Continuous Current (+100°C <T_J < +125°C)		—	700	mA
	Max GND-Pin Continuous Current (T_J < +100°C)		—	1.0	A
P_D	Total Device Power Dissipation at T_A = +85°C	16 Pin – SOIC	0.412		W
		16 Pin – TSSOP	0.277		W
		10 Pin – DFN3030	0.615		W
θ_{JA}	Thermal Resistance Junction-to-Ambient (Note 6)	16 Pin – SOIC	97		°C/W
		16 Pin – TSSOP	144		
		10 Pin – DFN3030	65		
θ_{JC}	Thermal Resistance Junction-to-Case (Note 7)	16 Pin – SOIC	41		°C/W
		16 Pin – TSSOP	61		
		10 Pin – DFN3030	17		
ESD	HBM		—	4	kV
	CDM		—	1	kV
T_J	Junction Temperature		-55	150	°C
T_{STG}	Storage Temperature		-55	150	°C

Notes:
4. Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
5. All voltage values are with respect to the emitter/substrate terminal E, unless otherwise noted.
6. Maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of +150°C can affect reliability.
7. Maximum power dissipation is a function of T_J(max), θ_{JC}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_C)/\theta_{JA}$. Operating at the absolute maximum T_J of +150°C can affect reliability.

Recommended Operating Conditions (@ T_A = +25°C, unless otherwise specified.)

Symbol	Parameter		Min	Max	Unit
V_{OUT}	Channel Off-Stage Output Pull-Up Voltage		—	—	V
V_{COM}	COM Pin Voltage		—	—	V
$I_{OUT(ON)}$	Per Channel Continuous Sink Current	VINx = 3.3V	—	—	mA
		VINx = 5.0V	—	—	
T_J	Operating Junction Temperature		-40	—	°C

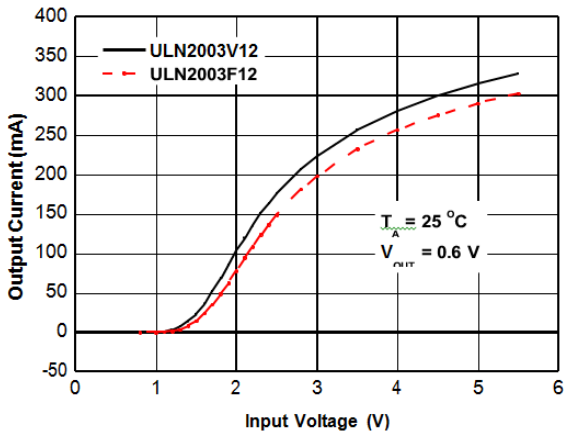
Electrical Characteristics (@ T_A = +25°C, unless otherwise specified.)

Specified over the recommended junction temperature range T_J = -40°C to +125°C and over recommended operating conditions unless otherwise noted. Typical values are at T_J = +25°C.

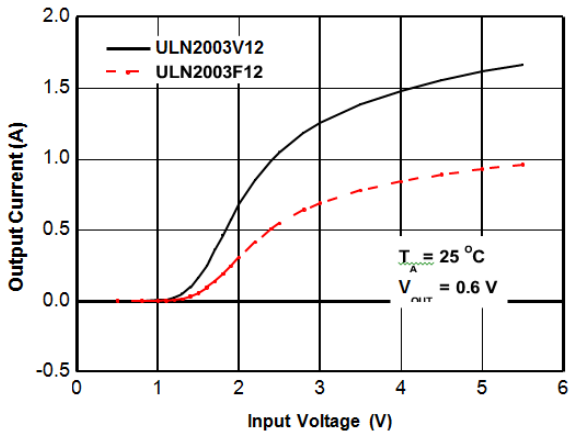
Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
INPUTS IN1 THROUGH IN7 PARAMETERS						
$V_{I(on)}$	IN1~IN7 logic high input voltage	V_{CE} = 2V, I_C = 300mA	1.65	—	—	V
$V_{I(off)}$	IN1~IN7 logic low input voltage	I_I = 250μA, I_C = 100mA	—	—	0.6	V
$I_{I(on)}$	IN1~IN7 ON state input current	I_F = 350mA	—	12	25	μA
$I_{I(off)}$	IN1~IN7 OFF state input leakage	—	—	—	250	nA
OUTPUTS OUT1 THROUGH OUT7 PARAMETERS						
$V_{OL(vce-sat)}$	OUT1~OUT7 low-level output voltage	V_{INX} = 3.3V, I_{OUTX} = 20mA	—	0.12	0.15	V
		V_{INX} = 3.3V, I_{OUTX} = 100mA	—	0.6	0.75	
		V_{INX} = 5.0V, I_{OUTX} = 20mA	—	0.09	0.11	
		V_{INX} = 5.0V, I_{OUTX} = 140mA	—	0.6	0.75	
$I_{OUT(on)}$	OUT1~OUT7 ON-state continuous current at V_{OUTX} = 0.6V	V_{INX} = 3.3V, V_{OUTX} = 0.6V	80	100	—	V
		V_{INX} = 5.0V, V_{OUTX} = 0.6V	80	140	—	A
$I_{OUT(on)}$	OUT1~OUT7 OFF-state leakage current	V_{INX} = 0V, V_{OUTX} = V_{COM} =16V	—	0.5	—	μA
SWITCHING PARAMETERS						
t_{PHL}	OUT1~OUT7 logic high propagation delay	V_{INX} = 3.3V, $V_{pull-up}$ = 12V, $R_{pull-up}$ = 1kΩ	—	50	70	ns
t_{PLH}	OUT1~OUT7 logic low propagation delay	V_{INX} = 3.3V, $V_{pull-up}$ = 12V, $R_{pull-up}$ = 1kΩ	—	121	140	ns
$t_{CHANNEL}$	Channel-to-channel delay	Over recommended operating conditions and with same test conditions on channels.	—	15	50	ns
R_{PD}	IN1~IN7 input pull-down resistance	—	210k	300k	390k	Ω
ζ	IN1~IN7 input filter time constant	—	—	9	—	ns
C_{OUT}	OUT1~OUT7 output capacitance	V_{INX} = 3.3V, V_{OUTX} = 0.4V	—	15	—	pF
FREE-WHEELING DIODE PARAMETERS						
VF	Forward voltage drop	I_{F-peak} = 140mA, VF = V_{OUTx} -V_{COM}	—	1.2	—	V
I_{F-peak}	Diode peak forward current	—	—	140	—	mA

Performance Characteristics

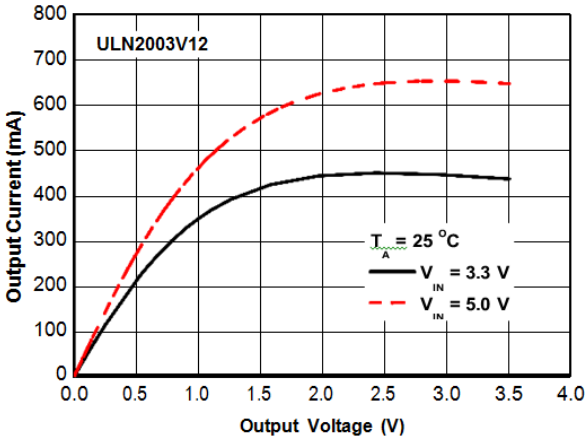
Output Current vs. Input Voltage (One Darlington)



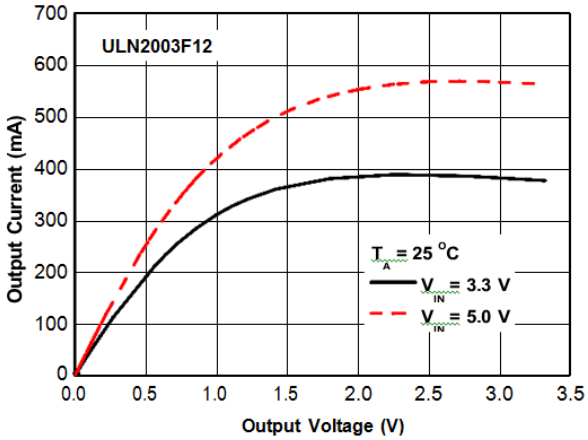
Output Current vs. Input Voltage (All Darlingtons in Parallel)



Output Current vs. Output Voltage

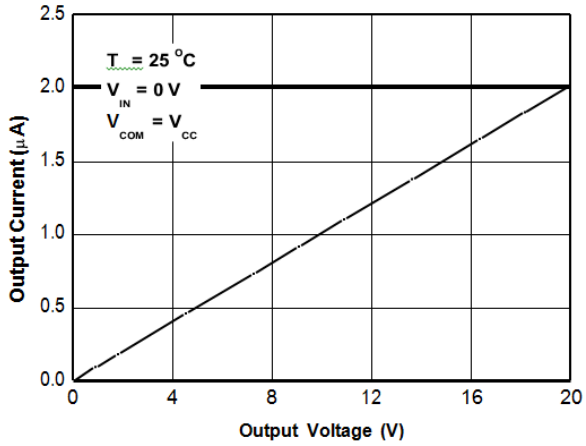


Output Current vs. Output Voltage

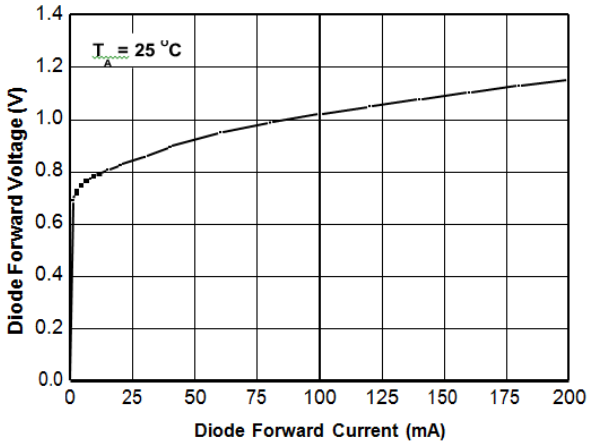


Performance Characteristics (continued)

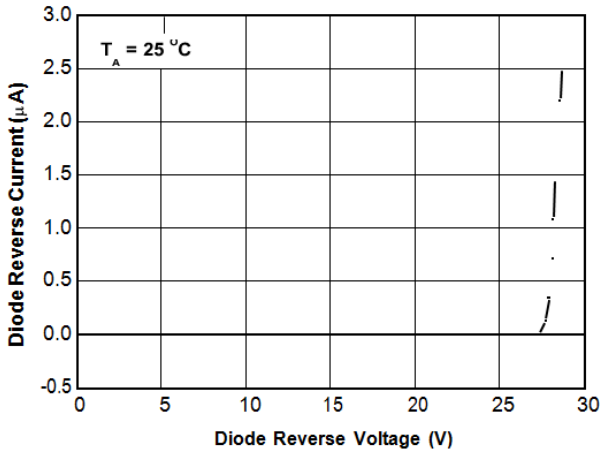
Output Current vs. Output Voltage



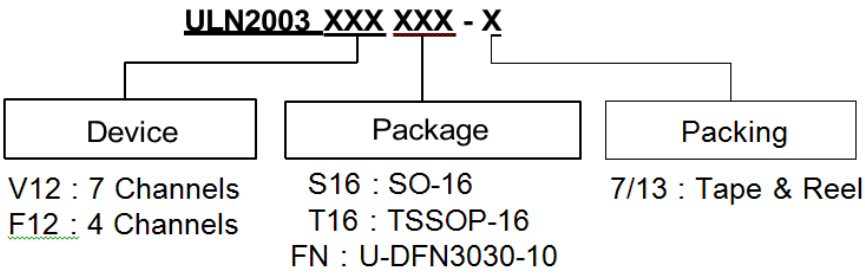
Diode Forward Voltage vs. Diode Forward Current



Diode Reverse Current vs. Diode Reverse Voltage



Ordering Information



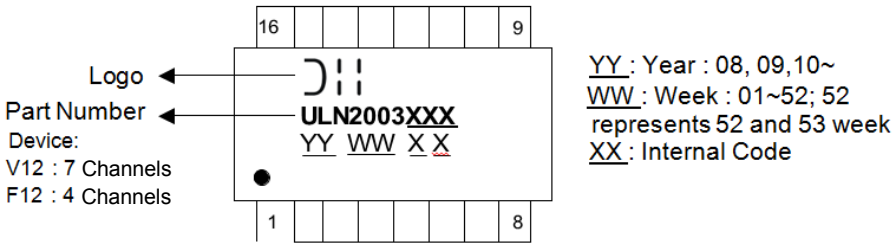
Device	Package Code	Packaging (Note 8)	7"/13" Tape and Reel	
			Quantity	Part Number Suffix
ULN2003V12S16-13	S16	SO-16	2,500/Tape & Reel	-13
ULN2003V12T16-13	T16	TSSOP-16	2,500/Tape & Reel	-13
ULN2003F12FN-7	FN	DFN3030-10	3,000/Tape & Reel	-7

Note: 8. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

Marking Information

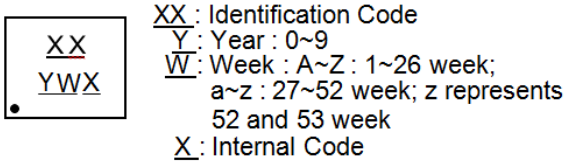
(1) SO-16 and TSSOP-16

(Top View)



(2) DFN3030-10

(Top View)

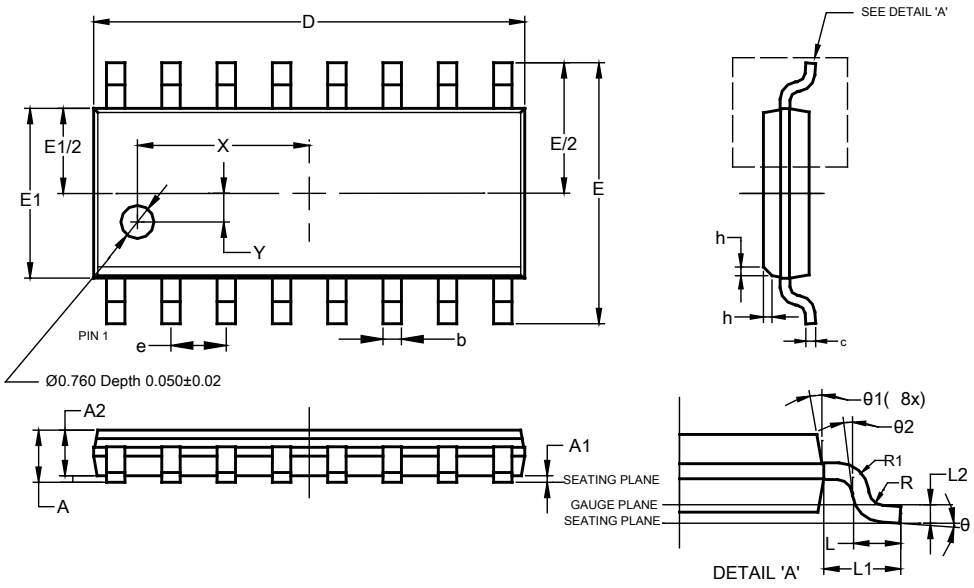


Part Number	Package	Identification Code
ULN2003F12FN-7	DFN3030-10	A3

Package Outline Dimensions

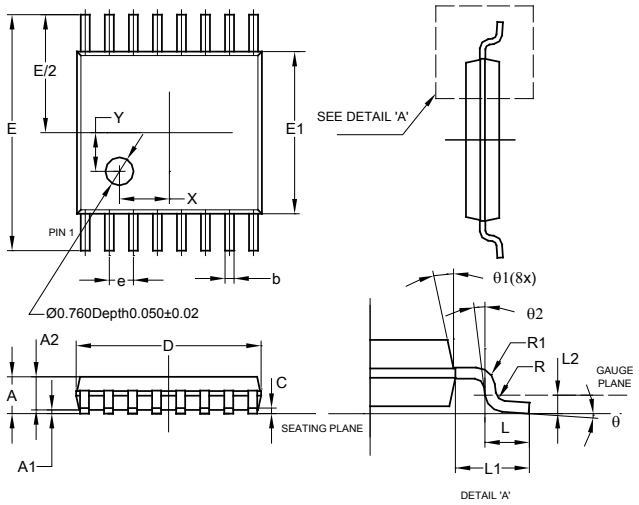
Please see http://www.diodes.com/package-outlines.html for the latest version.

SO-16



SO-16			
Dim	**Min**	**Max**	**Typ**
A	--	1.260	--
A1	0.10	0.23	--
A2	1.02	--	--
b	0.31	0.51	--
c	0.10	0.25	--
D	9.80	10.00	--
E	5.90	6.10	--
E1	3.80	4.00	--
e	1.27 BSC		
h	0.15	0.25	0.20
L	0.40	1.27	--
L1	1.04 REF		
L2	0.25 BSC		
R	0.07	--	--
R1	0.07	--	--
X	3.945 REF		
Y	0.661 REF		
θ	0°	8°	--
θ1	5°	15°	--
θ2	0°	--	--
All Dimensions in mm			

TSSOP-16

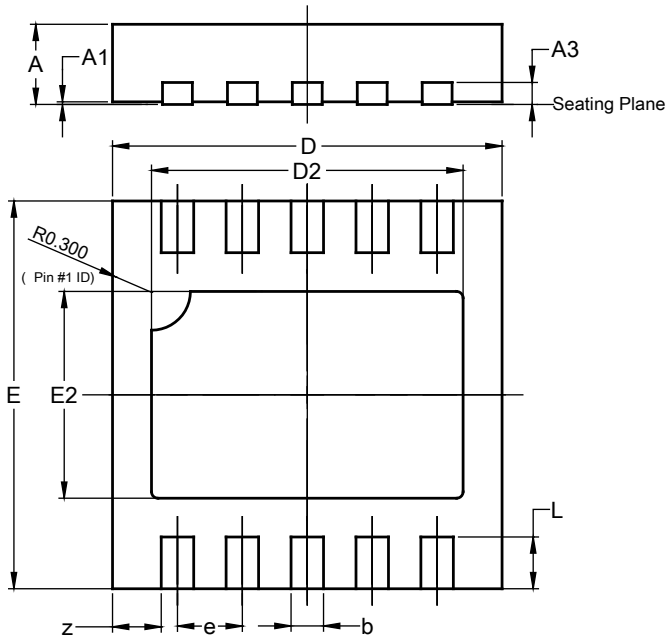


TSSOP-16			
Dim	**Min**	**Max**	**Typ**
A	-	1.08	-
A1	0.05	0.15	-
A2	0.80	0.93	-
b	0.19	0.30	-
c	0.09	0.20	-
D	4.90	5.10	-
E	6.40 BSC		
E1	4.30	4.50	-
e	0.65 BSC		
L	0.45	0.75	-
L1	1.00 REF		
L2	0.25 BSC		
R / R1	0.09	-	-
X	-	-	1.350
Y	-	-	1.050
θ	0°	8°	-
θ1	5°	15°	-
θ2	0°	-	-
All Dimensions in mm			

Package Outline Dimensions (continued)

Please see http://www.diodes.com/package-outlines.html for the latest version.

U-DFN3030-10

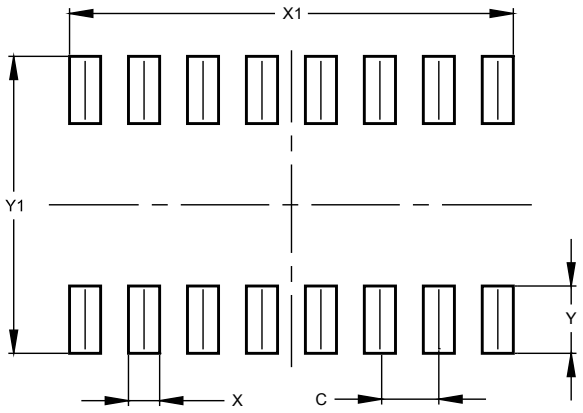


U-DFN3030-10			
Dim	**Min**	**Max**	**Typ**
A	0.57	0.63	0.60
A1	0.00	0.05	0.02
A3	—	—	0.15
b	0.20	0.30	0.25
D	2.90	3.10	3.00
D2	2.30	2.50	2.40
E	2.90	3.10	3.00
E2	1.50	1.70	1.60
e	--	--	0.50
L	0.25	0.55	0.40
z	—	—	0.375
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

SO-16

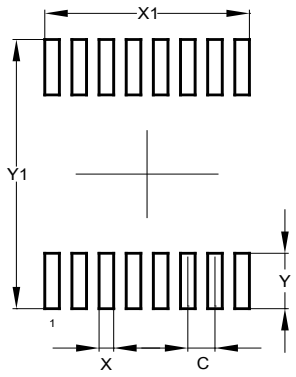


Dimensions	Value (in mm)
C	1.270
X	0.670
X1	9.560
Y	1.450
Y1	6.400

Suggested Pad Layout (continued)

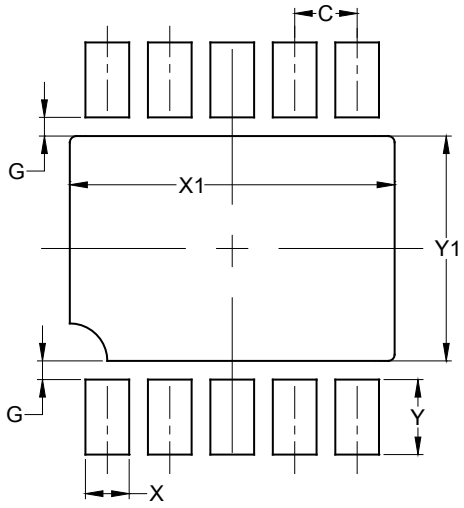
Please see http://www.diodes.com/package-outlines.html for the latest version.

TSSOP-16



Dimensions	Value (in mm)
C	0.650
X	0.350
X1	4.900
Y	1.400
Y1	6.800

U-DFN3030-10



Dimensions	Value (in mm)
C	0.50
G	0.15
X	0.35
X1	2.60
Y	0.60
Y1	1.80

Mechanical Data

- Moisture Sensitivity: Level 3 per J-STD-020
- Terminals:
  - **SO-16** and **TSSOP-16**: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 e3
  - **DFN3030-10**: Finish NiPdAu over Copper Lead-Frame, Solderable per MIL-STD-202, Method 208 e3
- Weight:
  - **SO-16**: 0.129 grams (Approximate)
  - **TSSOP-16**: 0.055 grams (Approximate)
  - **DFN3030-10**: 0.016 grams (Approximate)

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