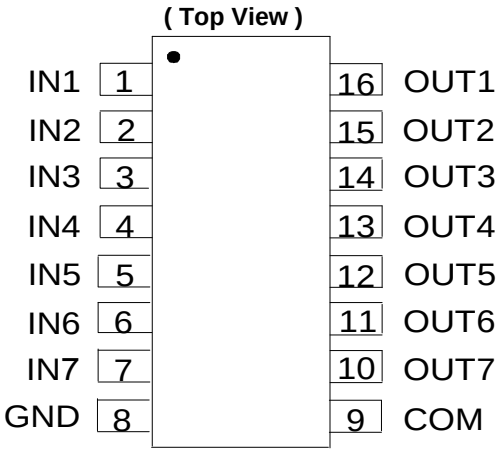
Description

The ULN2003LV and ULN2003LVF are multi-channel sink drivers comprised of 7-channel and 4-channel output stages respectively. T he ULN2003LV 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 ULN2003LV will dissipate 12 times lower power compared to ULN2003A. ULN2003LVF 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.

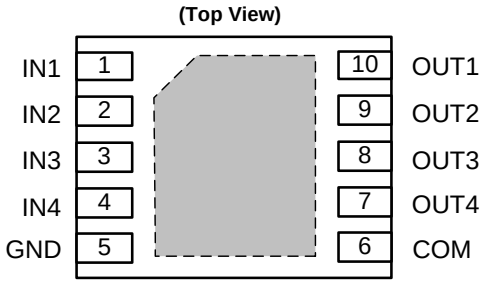
The ULN2003LV and ULN2003LVF both support 3.3V to 5V CMOS logic input interface, thus making it compatible to a wide range of micro-controllers and other logic interfaces, and also feature an improved input interface that minimizes the input DC current drawn from the external drivers. The input RC snubber circuit integrated at ULN2003LV and ULN2003LVF 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 ULN2003LV and ULN2003LVF 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 ULN2003LV can support up to 1.0A of load current when all 7-channels are connected in parallel.

Pin Assignments



SO-16 / TSSOP-16



DFN3030-10

ORDERING INFORMATION

DEVICE	Package Type	MARKING	Packing	Packing Qty
ULN2003LVN	DIP16	ULN2003LV	TUBE	1000/box
ULN2003LVM/TR	SOP16	ULN2003LV	REEL	2500/reel
ULN2003LVF	DFN10	ULN2003LV	REEL	2500/reel

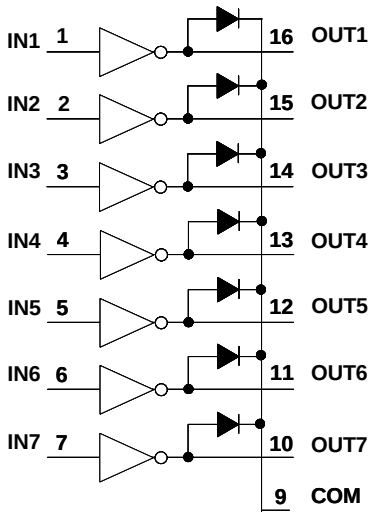
Features

- 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

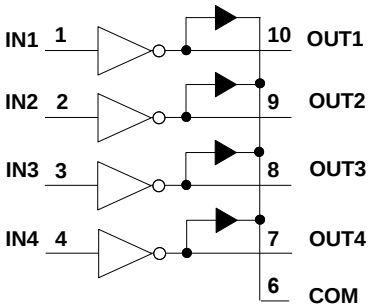
Applications

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

Functional Diagram



ULN2003LV

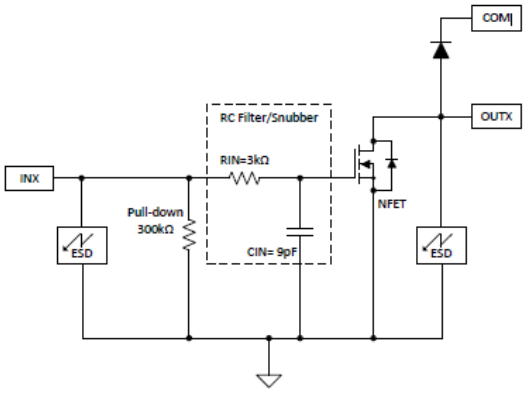


ULN2003LVF

Pin Descriptions

Pin Name	Pin 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	TBD		W
		16 Pin – TSSOP	TBD		W
		10 Pin – DFN3030	TBD		W
θ_{JA}	Thermal Resistance Junction-to-Ambient (Note 6)	16 Pin – SOIC	TBD		°C/W
		16 Pin – TSSOP	TBD		
		10 Pin – DFN3030	TBD		
θ_{JC}	Thermal Resistance Junction-to-Case (Note 7)	16 Pin – SOIC	TBD		°C/W
		16 Pin – TSSOP	TBD		
		10 Pin – DFN3030	TBD		
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	TYP	Max	Unit
V_{OUT}	Channel Off-Stage Output Pull-Up Voltage		—	—	16	V
V_{COM}	COM Pin Voltage		—	—	16	V
$I_{OUT(ON)}$	Per Channel Continuous Sink Current	VINx = 3.3V	—	—	100(5)	mA
		VINx = 5.0V	—	—	140(5)	
T_J	Operating Junction Temperature		-40	—	125	°C

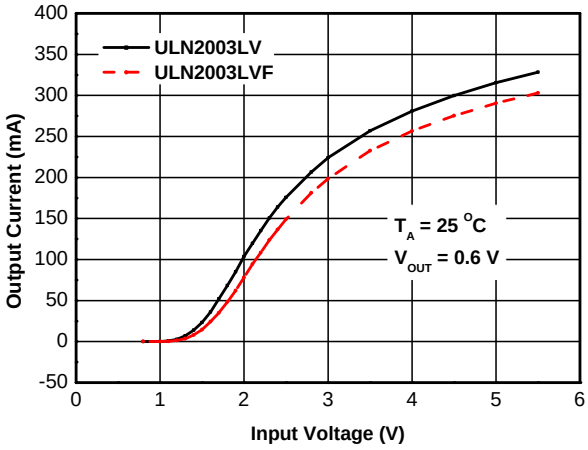
Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

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.

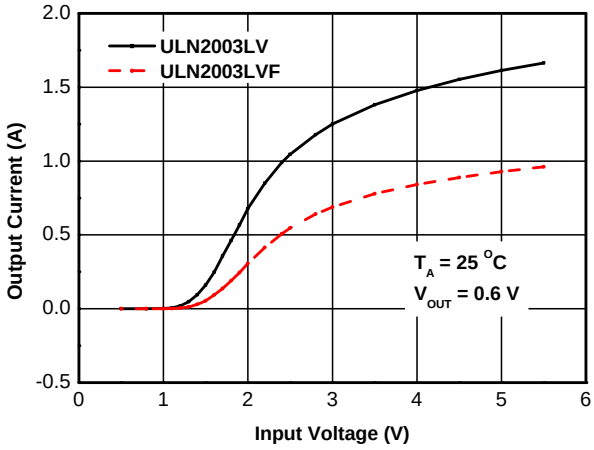
Parameter		Test conditions	Min	Typ.	Max	Unit
INPUTS IN1 THROUGH IN7 PARAMETERS						
$V_{I(on)}$	IN1~IN7 logic high input voltage	V_{CE} = 2V, I_C = 300mA	1.65	—	—	V
$V_{I(OFF)}$	IN1~IN7 logic low input voltage	I_I = 250μA, I_C = 100mA	—	—	0.6	V
$I_{I(ON)}$	IN1~IN7 ON state input current	I_F = 350mA	—	12	25	uA
$I_{I(OFF)}$	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	—	mA
		V_{INX} = 5.0V, V_{OUTX} = 0.6V	95	140	—	
$I_{OUT(ON)}$	OUT1~OUT7 OFF-state leakage current	V_{INX} = 0V, V_{OUTX} = V_{COM} =16V	—	0.5	—	uA
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

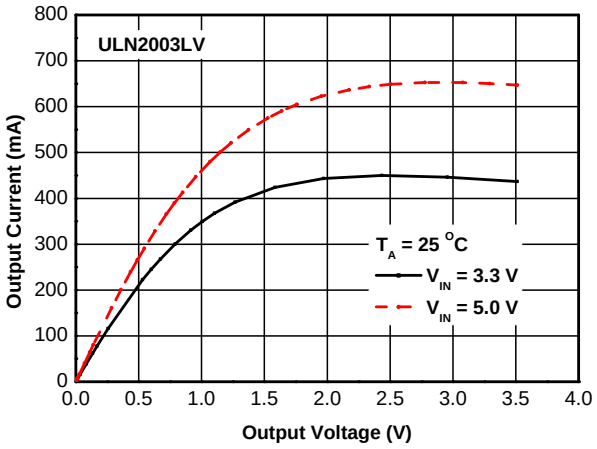
Output Current vs. Input Voltage (One Darlington)



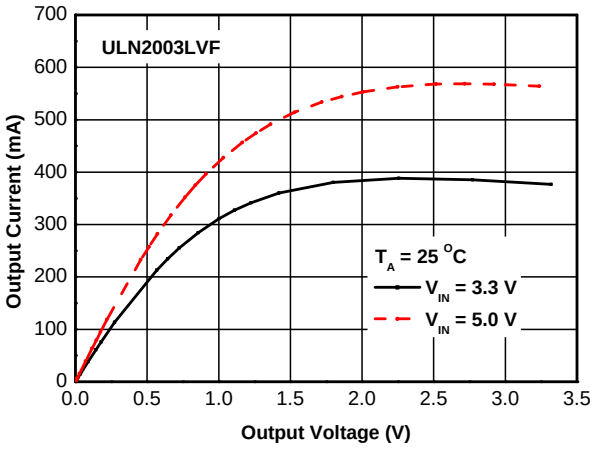
Output Current vs. Input Voltage (All Darlingtons in Parallel)



Output Current vs. Output Voltage

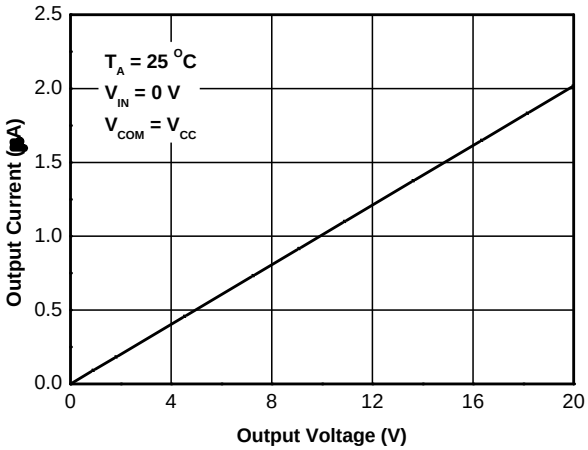


Output Current vs. Output Voltage

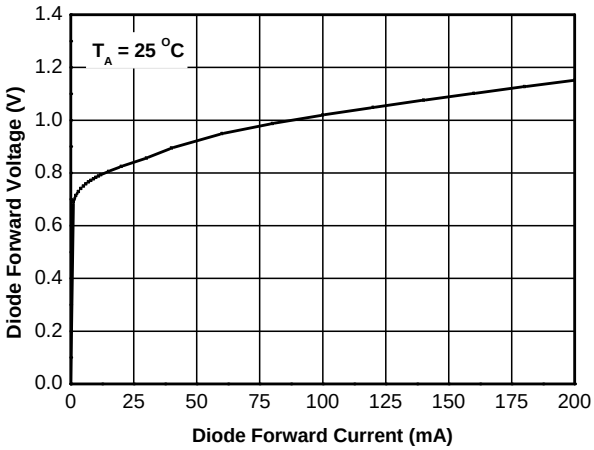


Performance Characteristics (Cont.)

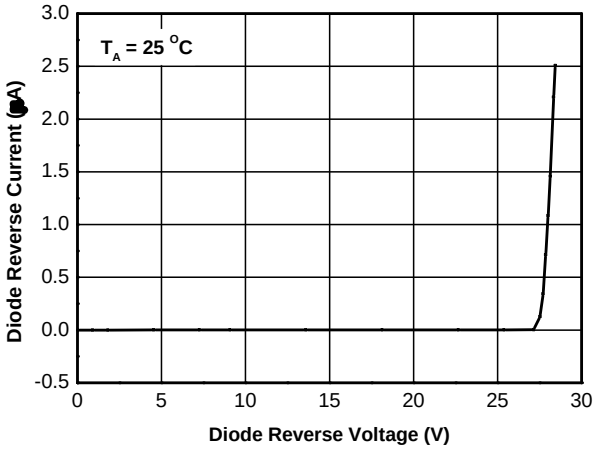
Output Current vs. Output Voltage



Diode Forward Voltage vs. Diode Forward Current



Diode Reverse Current vs. Diode Reverse Voltage



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