

## 7-bit Integrated Motor and Relay Driver

Check for Samples: [DRV777](#)

### FEATURES

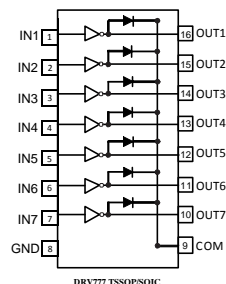
- Supports up to 20V Output Pull-up Voltage
- –40°C to 125°C Operating Temperature Range
- Supports Wide Range of Stepper Motors, DC Motors, Relays, and Inductive Coils
- Low Output VOL of 0.4V (Typical) With
  - 140mA Current Sink per Channel at 5.0V Logic Input<sup>(1)</sup>
  - 1A Current Output when all 7 Channels Tied in Parallel<sup>(1)</sup>
- Compatible to 1.8V, 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 Environment
- Low Input and Output Leakage Currents
- Easy to use Parallel Interface
- ESD Protection Exceeds JESD 22
  - 2kV HBM, 500V CDM
- Available in 16-pin SOIC and TSSOP Packages

<sup>(1)</sup> Total current sink may be limited by the internal junction temperature, absolute maximum current levels etc - refer to the Electrical Specifications section for details.

### APPLICATIONS

- Unipolar Stepper Motor Drivers
- Relay and Inductive Load Drivers
- Solenoid Drivers
- Lamp and LED Displays
- Logic Level Shifter
- General Low-Side Switch Applications

### Functional Diagram



### DESCRIPTION

DRV777 motor driver features 7 low output impedance drivers that minimize on-chip power dissipation. DRV777 supports 1.8V to 5V CMOS logic input interface thus making it compatible to a wide range of micro-controllers and other logic interfaces. DRV777 features an improved input interface that minimizes the input DC current drawn from the external drivers. Device also features an input RC snubber that greatly improves its performance in noisy operating conditions. All channel inputs feature an internal input pull-down resistor thus allowing input logic to be tri-stated. DRV777 also supports other logic input levels, e.g. TTL and 1.8V; see typical characteristics section for details.

As shown in the Functional Diagram, each output of the DRV777 features an internal free-wheeling diode connected in a common-cathode configuration at the COM pin.

Device provides flexibility of increasing current sink capability through combining several adjacent channels in parallel. Under typical conditions DRV777 can support up to 1.0A of load current when all 7-channels are connected in parallel. DRV777 is available in 16-pin SOIC and 16-pin TSSOP packages.

**Table 1. DRV777 Function Table<sup>(1)</sup>**

INPUT (IN1 – IN7)	OUTPUT (OUT1–OUT7)
L	H <sup>+(2)</sup>
H	L
Z	H <sup>+(2)</sup>

(1) L = Low-level (GND); H= High-level; Z= High-impedance;  
(2) H<sup>+</sup> = Pull-up-level



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This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

**ORDERING INFORMATION<sup>(1)</sup>**

T <sub>J</sub>	PART NUMBER	PACKAGE		TOP-SIDE MARKING
-40°C to 125°C	DRV777DR	16-Pin SOIC	Reel of 2500	DRV777
	DRV777PWR	16-Pin TSSOP	Reel of 2000	DRV777

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).

**DEVICE INFORMATION**

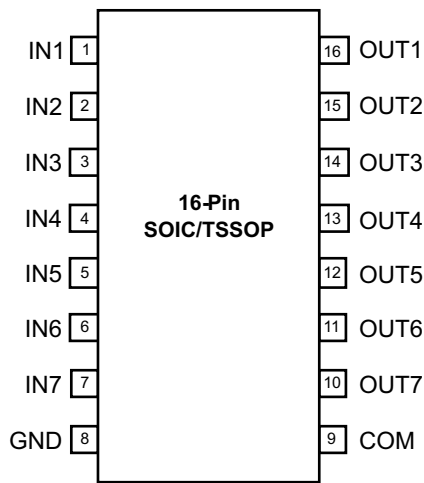


Figure 1. DRV777 PINOUT

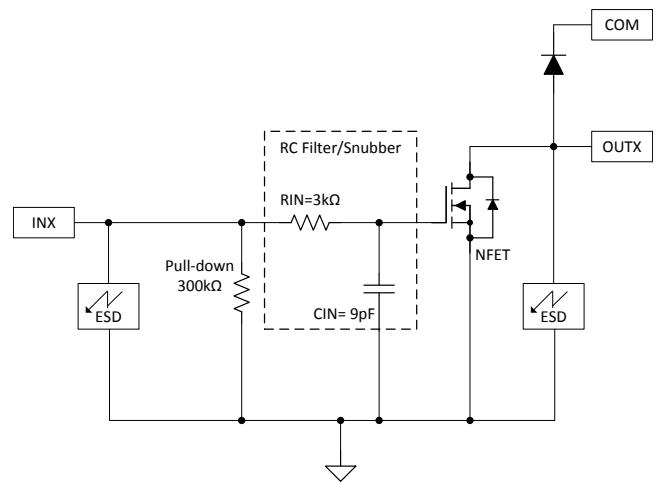


Figure 2. Channel Block Diagram

**DRV777 PIN DESCRIPTION**

NAME	PIN NUMBER		DESCRIPTION
	16-SOIC	16-TSSOP	
IN1 – IN7	1–7	1–7	Logic Input Pins IN1 through IN7
GND	8	8	Ground Reference Pin
COM	9	9	Internal Free-Wheeling Diode Common Cathode Pin
OUT7 – OUT1	10–16	10–16	Channel Output Pins OUT7 through OUT1

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

 Specified at  $T_J = -40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  unless otherwise noted.

		VALUE		UNIT
		MIN	MAX	
$V_{IN}$	Pins 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 ( $100^{\circ}\text{C} < T_J < +125^{\circ}\text{C}$ )		700	mA
	Max GND-pin continuous current ( $T_J < +100^{\circ}\text{C}$ )		1.0	A
$P_D$	Total device power dissipation at $T_A = 85^{\circ}\text{C}$	16 Pin - SOIC	0.86	W
		16 Pin - TSSOP	0.68	W
ESD	ESD Rating – HBM		2	kV
	ESD Rating – CDM		500	V
$T_J$	Operating virtual junction temperature	-55	150	$^{\circ}\text{C}$
$T_{stg}$	Storage temperature range	-55	150	$^{\circ}\text{C}$

- (1) Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

## DISSIPATION RATINGS<sup>(1)(2)</sup>

BOARD	PACKAGE	$\theta_{JC}$	$\theta_{JA}$ <sup>(3)</sup>	DERATING FACTOR ABOVE $T_A = 25^{\circ}\text{C}$	$T_A < 25^{\circ}\text{C}$	$T_A = 70^{\circ}\text{C}$	$T_A = 85^{\circ}\text{C}$	$T_A = 105^{\circ}\text{C}$
High-K	16-Pin SOIC	46 $^{\circ}\text{C}/\text{W}$	75 $^{\circ}\text{C}/\text{W}$	13.33 mW/ $^{\circ}\text{C}$	1.66 W	1.06 W	0.86 W	0.59 W
High-K	16-Pin TSSOP	49 $^{\circ}\text{C}/\text{W}$	95 $^{\circ}\text{C}/\text{W}$	10.44 mW/ $^{\circ}\text{C}$	1.31 W	0.84 W	0.68 W	0.47 W

- (1) Maximum dissipation values for retaining device junction temperature of  $150^{\circ}\text{C}$   
 (2) Refer to TI's design support web page at [www.ti.com/thermal](http://www.ti.com/thermal) for improving device thermal performance  
 (3) Operating at the absolute  $T_{J,max}$  of  $150^{\circ}\text{C}$  can affect reliability– for higher reliability it is recommended to ensure  $T_J < 125^{\circ}\text{C}$

## RECOMMENDED OPERATING CONDITIONS

over operating free-air temperature range (unless otherwise noted)

PARAMETER		MIN	TYP	MAX	UNIT
$V_{OUT}$	Channel off-state 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 <sup>(1)</sup>	mA
		VINx = 5.0V		140 <sup>(1)</sup>	
$T_J$	Operating junction temperature	-40		125	$^{\circ}\text{C}$

- (1) 1) Refer to [ABSOLUTE MAXIMUM RATINGS](#) for  $T_J$  dependent absolute maximum GND-pin current

## ELECTRICAL CHARACTERISTICS

Specified over the recommended junction temperature range  $T_J = -40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  and over recommended operating conditions unless otherwise noted. Typical values are at  $T_J = 25^{\circ}\text{C}$ .

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT		
<b>INPUTS IN1 THROUGH IN7 PARAMETERS</b>							
$V_{I(ON)}$	IN1–IN7 logic high input voltage	$V_{\text{pull-up}} = 3.3\text{ V}$ , $R_{\text{pull-up}} = 1\text{ k}\Omega$ , $I_{\text{OUTX}} = 3.2\text{ mA}$		1.65	V		
$V_{I(OFF)}$	IN1–IN7 logic low input voltage	$V_{\text{pull-up}} = 3.3\text{ V}$ , $R_{\text{pull-up}} = 1\text{ k}\Omega$ , ( $I_{\text{OUTX}} < 20\text{ }\mu\text{A}$ )		0.4	0.6	V	
$I_{I(ON)}$	IN1–IN7 ON state input current	$V_{\text{pull-up}} = 3.3\text{ V}$ , $V_{\text{INx}} = 3.3\text{ V}$		12	25	$\mu\text{A}$	
$I_{I(OFF)}$	IN1–IN7 OFF state input leakage	$V_{\text{pull-up}} = 3.3\text{ V}$ , $V_{\text{INx}} = 0\text{ V}$			250	nA	
<b>OUTPUTS OUT1 THROUGH OUT7 PARAMETERS</b>							
$V_{OL}$	OUT1–OUT7 low-level output voltage	$V_{\text{INX}} = 3.3\text{ V}$ , $I_{\text{OUTX}} = 100\text{ mA}$		0.36	0.49	V	
		$V_{\text{INX}} = 5.0\text{ V}$ , $I_{\text{OUTX}} = 140\text{ mA}$		0.40			
$I_{\text{OUT(ON)}}$	OUT1–OUT7 ON-state continuous current <sup>(1)</sup> (2) at $V_{\text{OUTX}} = 0.4\text{ V}$	$V_{\text{INX}} = 3.3\text{ V}$ , $V_{\text{OUTX}} = 0.4\text{ V}$		80	100	mA	
		$V_{\text{INX}} = 5.0\text{ V}$ , $V_{\text{OUTX}} = 0.4\text{ V}$		95	140		
$I_{\text{OUT(OFF)(ICEX)}}$	OUT1–OUT7 OFF-state leakage current	$V_{\text{INX}} = 0\text{ V}$ , $V_{\text{OUTX}} = V_{\text{COM}} = 16\text{ V}$			0.5	$\mu\text{A}$	
<b>SWITCHING PARAMETERS<sup>(3)(4)</sup></b>							
$t_{\text{PHL}}$	OUT1–OUT7 logic high propagation delay	$V_{\text{INX}} = 3.3\text{ V}$ , $V_{\text{pull-up}} = 12\text{ V}$ , $R_{\text{pull-up}} = 1\text{ k}\Omega$		50	70	ns	
$t_{\text{PLH}}$	OUT1–OUT7 logic low propagation delay	$V_{\text{INX}} = 3.3\text{ V}$ , $V_{\text{pull-up}} = 12\text{ V}$ , $R_{\text{pull-up}} = 1\text{ k}\Omega$		121	140	ns	
$t_{\text{CHANNEL}}$	Channel to Channel delay	Over recommended operating conditions and with same test conditions on channels.		15	50	ns	
$R_{\text{PD}}$	IN1–IN7 input pull-down Resistance			210k	300k	390k	$\Omega$
$\zeta$	IN1–IN7 Input filter time constant			9			ns
$C_{\text{OUT}}$	OUT1–OUT7 output capacitance	$V_{\text{INX}} = 3.3\text{ V}$ , $V_{\text{OUTX}} = 0.4\text{ V}$		15			pF
<b>FREE-WHEELING DIODE PARAMETERS<sup>(5)(4)</sup></b>							
$V_F$	Forward voltage drop	$I_{\text{F-peak}} = 140\text{ mA}$ , $V_F = V_{\text{OUTX}} - V_{\text{COM}}$		1.2			V
$I_{\text{F-peak}}$	Diode peak forward current			140			mA

- (1) The typical continuous current rating is limited by  $V_{OL} = 0.4\text{ V}$ . Whereas, absolute maximum operating continuous current may be limited by the Thermal Performance parameters listed in the Dissipation Rating Table and other Reliability parameters listed in the Recommended Operating Conditions Table.
- (2) Refer to the Absolute Maximum Ratings Table for  $T_J$  dependent absolute maximum GND-pin current.
- (3) Rise and Fall propagation delays,  $t_{\text{PHL}}$  and  $t_{\text{PLH}}$ , are measured between 50% values of the input and the corresponding output signal amplitude transition.
- (4) Guaranteed by design only. Validated during qualification. Not measured in production testing.
- (5) Not rated for continuous current operation – for higher reliability use an external freewheeling diode for inductive loads resulting in more than specified maximum free-wheeling. diode peak current across various temperature conditions

## APPLICATION INFORMATION

### TTL and other Logic Inputs

DRV777 input interface is specified for standard 1.8V, 3V and 5V CMOS logic interface. Refer to [Figure 8](#) and [Figure 9](#) to establish VOL and the corresponding typical load current levels for various input voltage ranges. Application Information section shows an implementation to drive 1.8V relays using DRV777.

### Input RC Snubber

DRV777 features an input RC snubber that helps prevent spurious switching in noisy environment. Connect an external 1kΩ to 5kΩ resistor in series with the input to further enhance DRV777's noise tolerance.

### High-impedance Input Drivers

DRV777 features a 300kΩ input pull-down resistor. The presence of this resistor allows the input drivers to be tri-stated. When a high-impedance driver is connected to a channel input the DRV777 detects the channel input as a low level input and remains in the OFF position. The input RC snubber helps improve noise tolerance when input drivers are in the high-impedance state.

### On-chip Power Dissipation

Use the below equation to calculate DRV777 on-chip power dissipation  $P_D$ :

$$P_D = \sum_{i=1}^N V_{OLi} \times I_{Li}$$

Where:

N is the number of channels active together.

$V_{OLi}$  is the  $OUT_i$  pin voltage for the load current  $I_{Li}$ .

(1)

### Thermal Reliability

It is recommended to limit DRV777 IC's die junction temperature to less than 125°C. The IC junction temperature is directly proportional to the on-chip power dissipation. Use the following equation to calculate the maximum allowable on-chip power dissipation for a target IC junction temperature:

$$PD_{(MAX)} = \frac{(T_{J(MAX)} - T_A)}{\theta_{JA}}$$

Where:

$T_{J(MAX)}$  is the target maximum junction temperature.

$T_A$  is the operating ambient temperature.

$\theta_{JA}$  is the package junction to ambient thermal resistance.

(2)

### Improving Package Thermal Performance

The package  $\theta_{JA}$  value under standard conditions on a High-K board is listed in the [DISSIPATION RATINGS](#).  $\theta_{JA}$  value depends on the PC board layout. An external heat sink and/or a cooling mechanism, like a cold air fan, can help reduce  $\theta_{JA}$  and thus improve device thermal capabilities. Refer to TI's design support web page at [www.ti.com/thermal](http://www.ti.com/thermal) for a general guidance on improving device thermal performance.

## Application Examples

### One Amp Unipolar DC Motor Driver

An implementation of DRV777 for driving a unipolar DC motor is shown in [Figure 3](#). With all of the channels tied together and the input being driven at 5V, the driver can sink 1A of current. With a VOL of 0.4V this creates a driver with 400mΩ. The input snubber circuitry is great for PWM applications that need high noise immunity. These two features make DRV777 an ideal choice for power efficient high duty cycle motor driving applications.

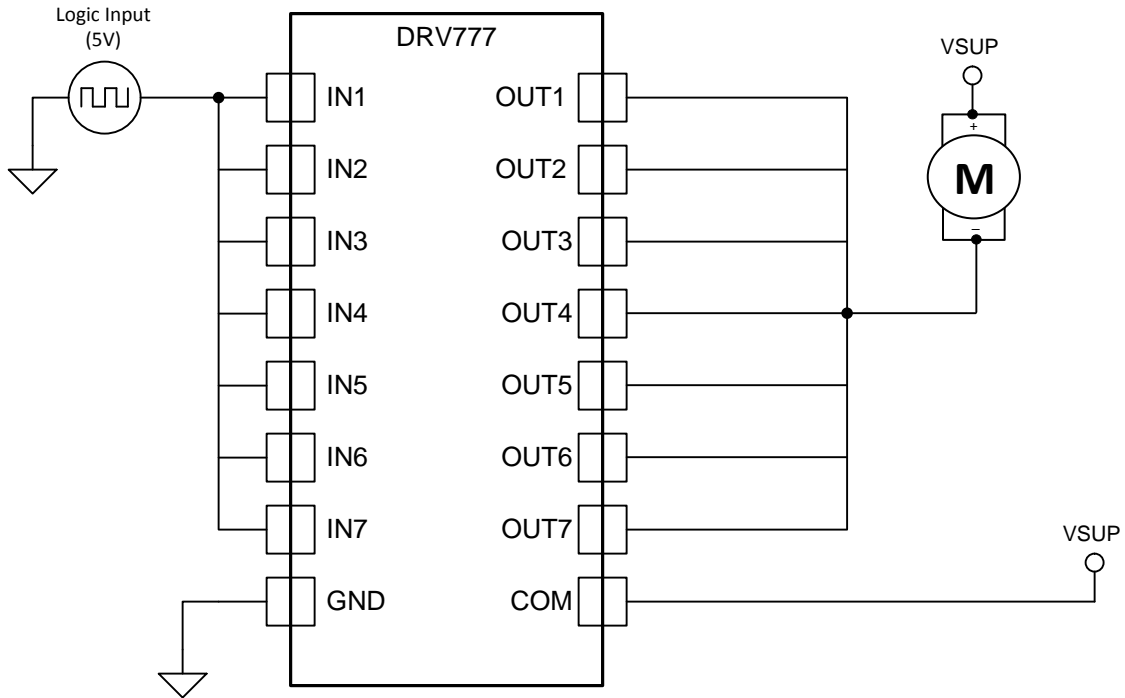


Figure 3. DRV777 as a DC Motor Driver

### Unipolar Stepper Motor Driver

Figure 4 shows an implementation of DRV777 for driving a unipolar stepper motor. The unconnected input channels can be used for other functions. When an input pin is left open the internal 300kΩ pull down resistor pulls the respective input pin to GND potential. For higher noise immunity use an external short across an unconnected input and GND pins.

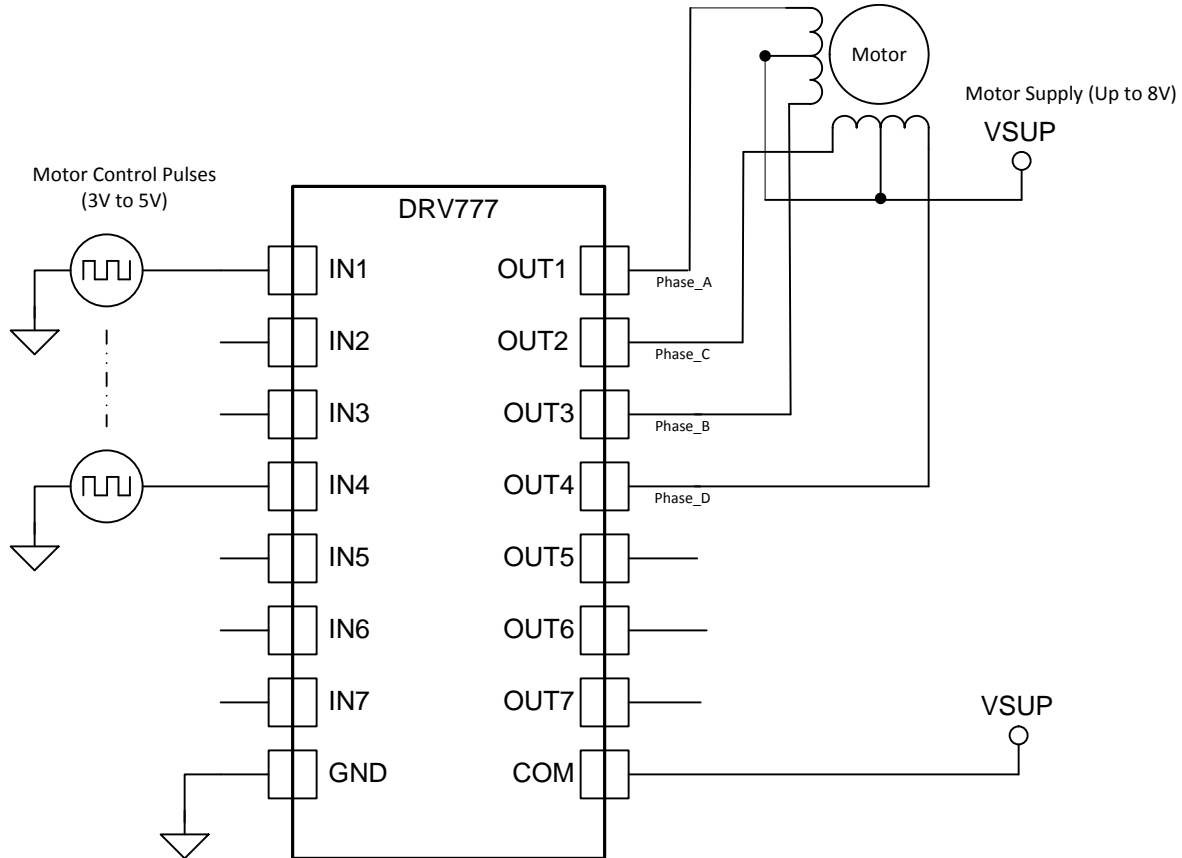
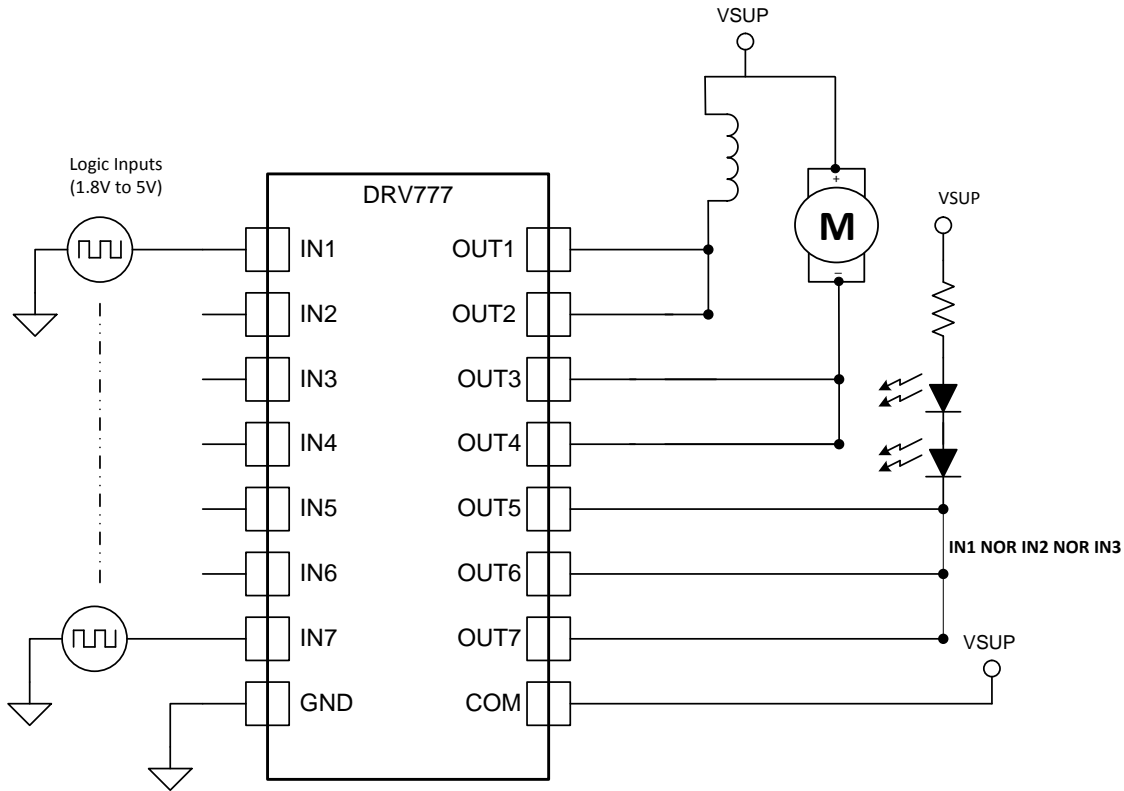


Figure 4. DRV777 as a Stepper Motor Driver

**Multi-Purpose Sink Driver**

When configured as per [Figure 5](#) DRV777 can be used as a multi-purpose driver. The output channels can be tied together to sink more current. DRV777 can easily drive motors, relays & LEDs with little power dissipation. The COM pin must be tied to the supply of whichever inductive load is to be protected by the free-wheeling diode.



**Figure 5. DRV777 Multi-Purpose Sink Driver Application**



### 1.8V Relay Driver

To drive lower voltage relays, like 1.8V, connect two or more adjacent channels in parallel as shown in [Figure 6](#). Connecting several channels in parallel lowers the channel output resistance and thus minimizes VOL for a fixed current. DRV777 can be used for driving 3V, 5V and 12V relays with similar implementation.

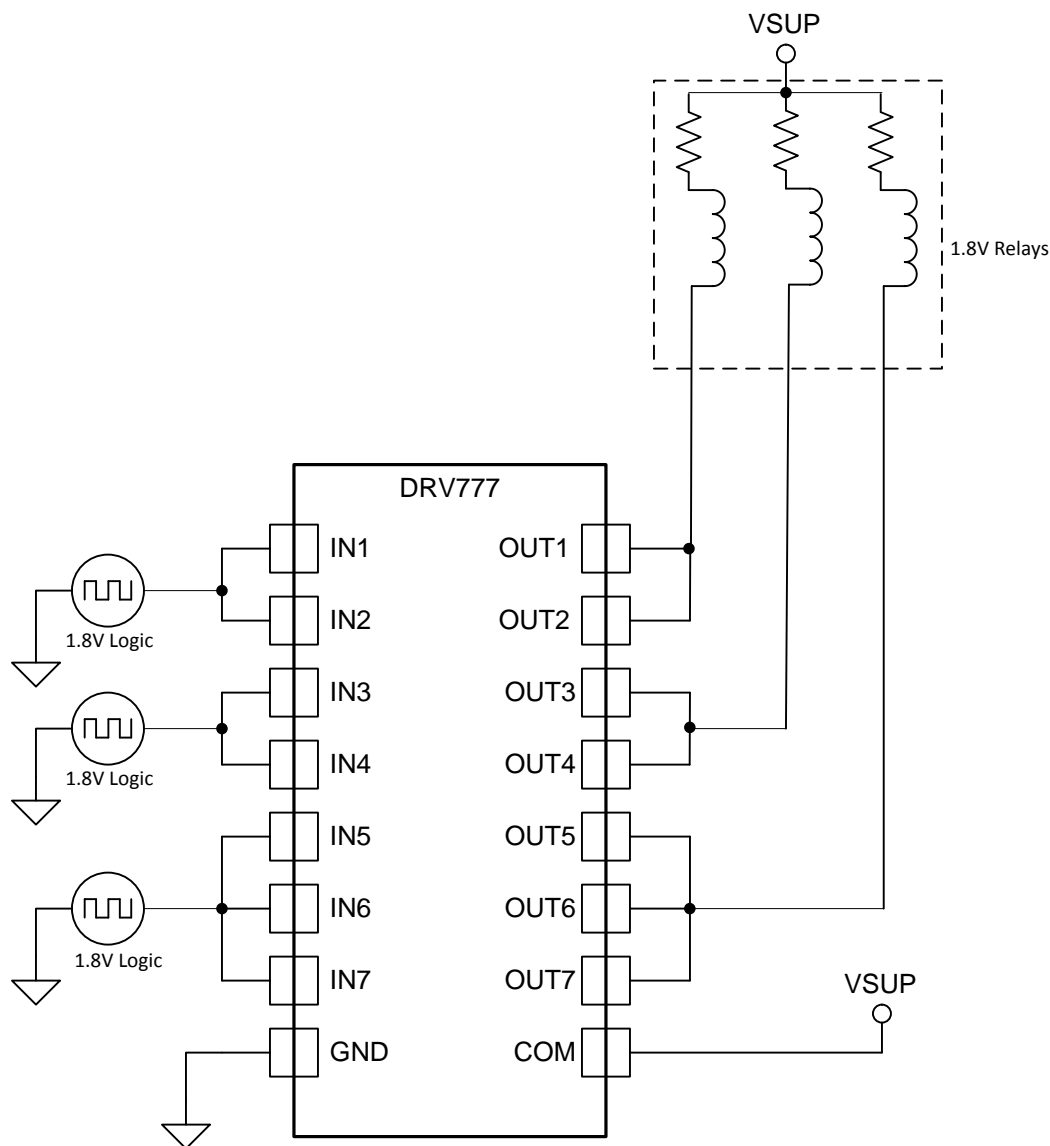


Figure 6. DRV777 Driving 1.8V Relays

TYPICAL CHARACTERISTICS

$T_A = +25^\circ\text{C}$

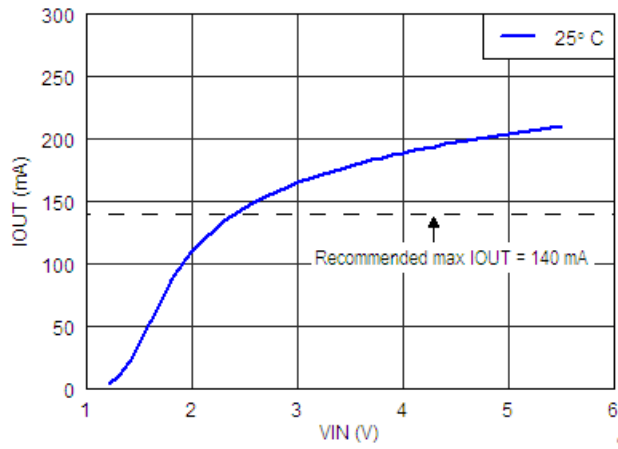


Figure 7. Load Current 1-Channel; VOL=0.4V

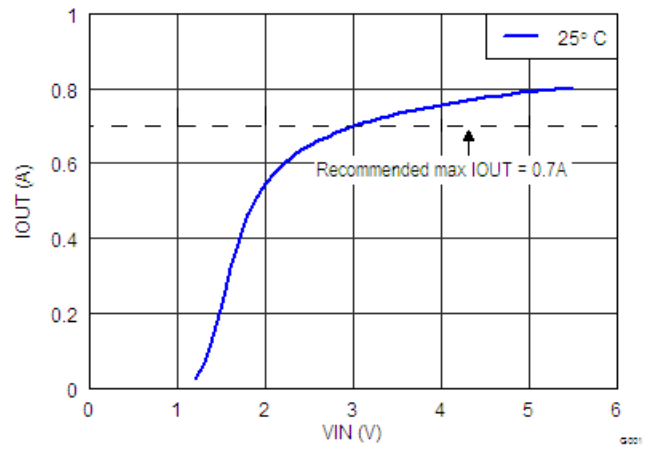


Figure 8. Load Current 7-Channels in parallel; VOL=0.4V

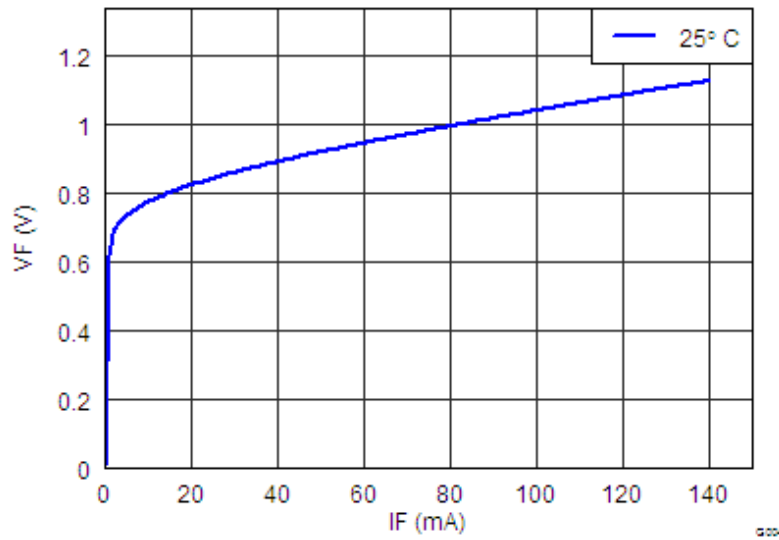


Figure 9. Freewheeling Diode VF versus IF

**PACKAGING INFORMATION**

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">DRV777DR</a>	Active	Production	SOIC (D)   16	2500   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	DRV777
DRV777DR.B	Active	Production	SOIC (D)   16	2500   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	DRV777
<a href="#">DRV777PWR</a>	Active	Production	TSSOP (PW)   16	2000   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	DRV777
DRV777PWR.B	Active	Production	TSSOP (PW)   16	2000   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	DRV777

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DRV777DR	SOIC	D	16	2500	330.0	16.8	6.5	10.3	2.1	8.0	16.0	Q1
DRV777PWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

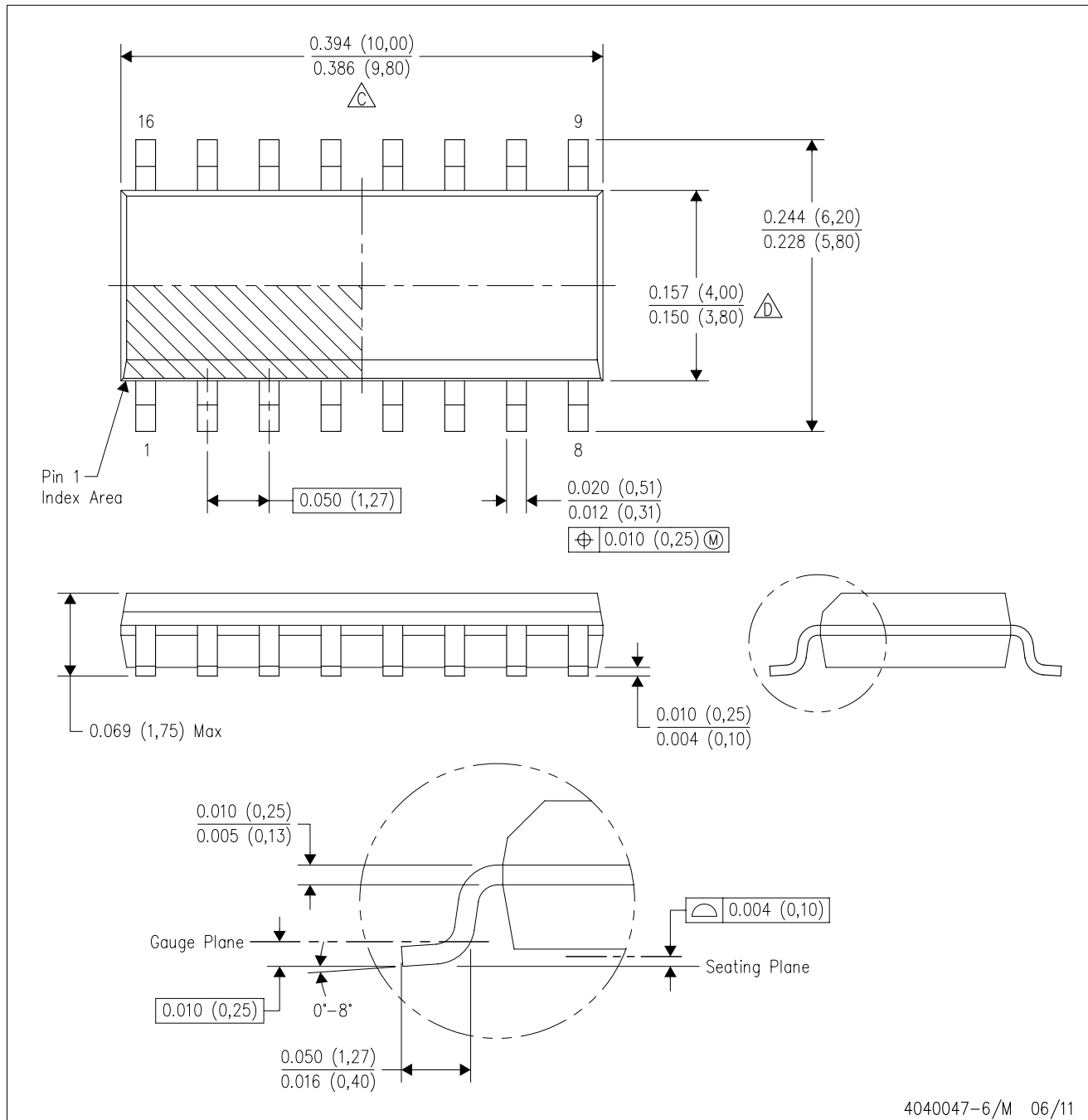
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

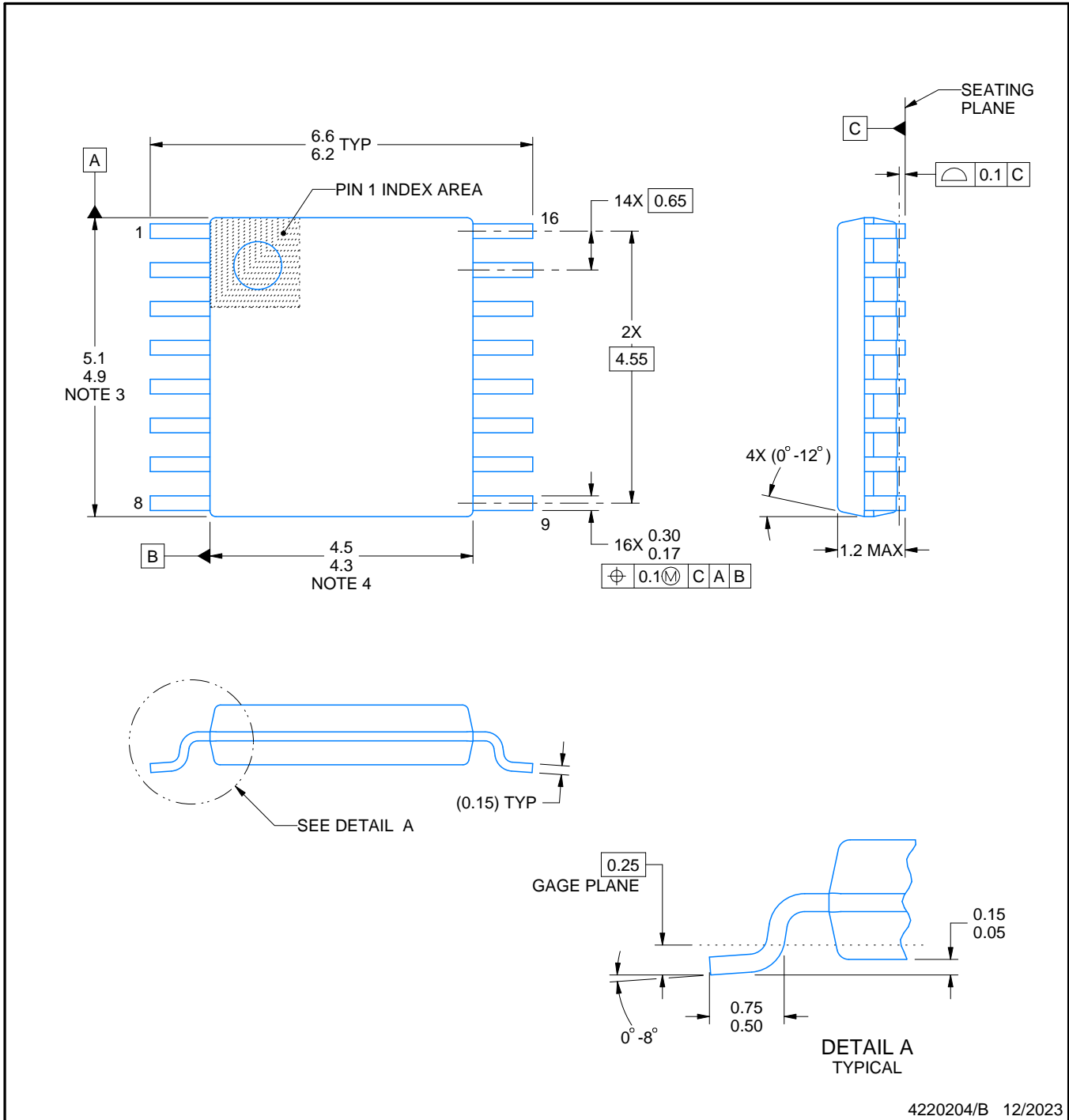
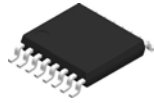
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DRV777DR	SOIC	D	16	2500	364.0	364.0	27.0
DRV777PWR	TSSOP	PW	16	2000	364.0	364.0	27.0

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AC.



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NOTES:

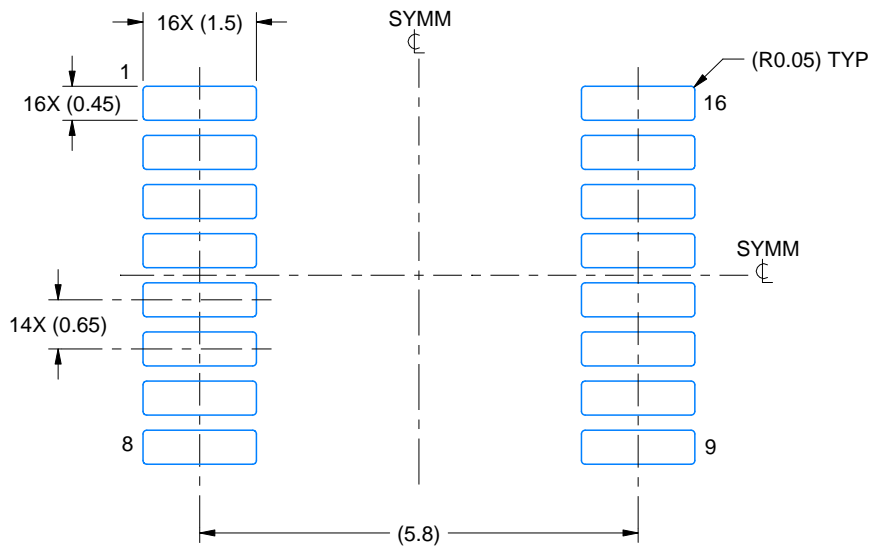
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

# EXAMPLE BOARD LAYOUT

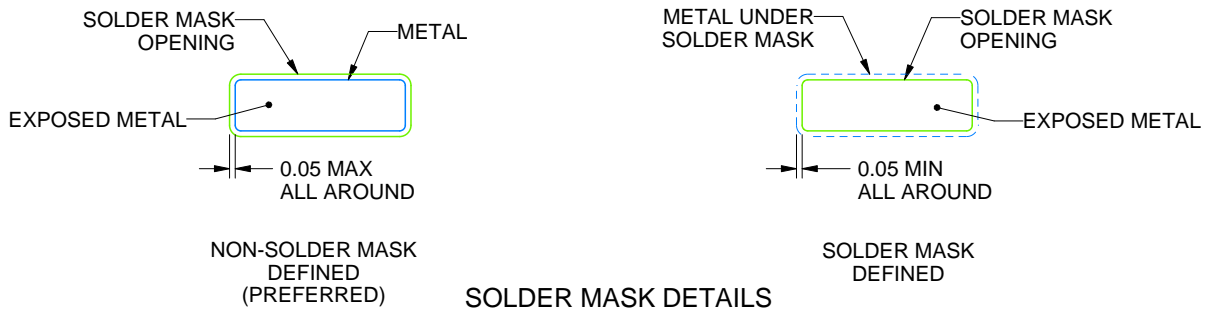
PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



SOLDER MASK DETAILS

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NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

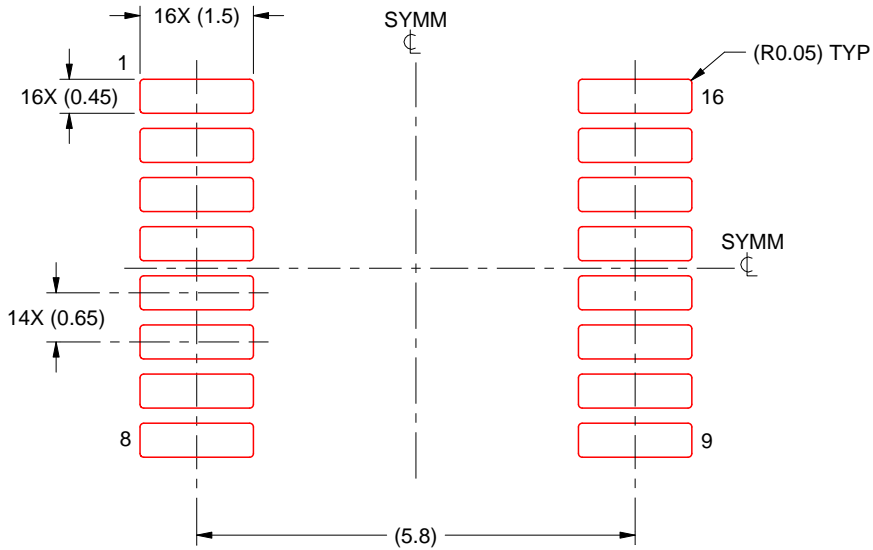


# EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

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NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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