Programmable Micropower Hex Translator/ Receiver/Driver

FEATURES

- Efficiently Translate Voltage Levels
- Internal Hysteresis for Noise Immunity
- Output Latches Included
- Three-State Outputs
- Programmable Power/Speed
- Power Can Be Completely Shut Off
- ±50V on Inputs with External 100k Limit Resistor
- 1.2µs Response at 100µA Supply Current

APPLICATIONS

- TTL/CMOS to ±5V Analog Switch Drive
- TTL to CMOS (3V to 15V V_{CC})
- ECL to CMOS (3V to 15V V_{CC})
- Ground Isolation Buffer
- Low Power RS232 Line Receiver

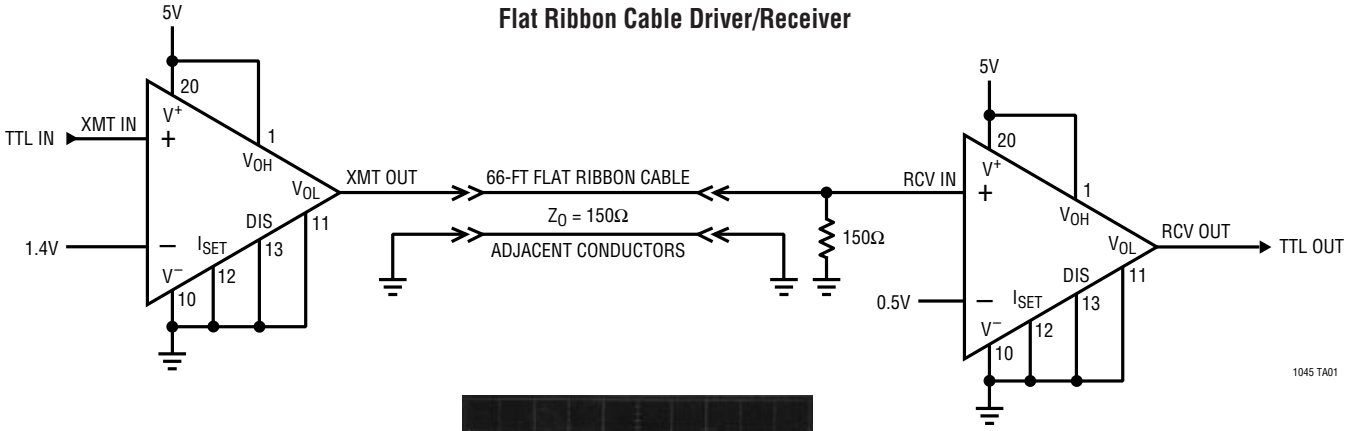
DESCRIPTION

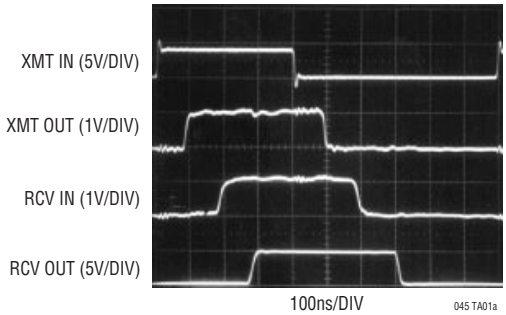
The LTC®1045 is a hex level translator manufactured using Linear Technology's enhanced LTCMOS™ silicon gate process. It consists of six high speed comparators with output latches and three-state capability. Each comparator's plus input is brought out separately. The minus inputs of comparators 1 to 4 are tied to V_{TRIP1} while 5 and 6 are tied to V_{TRIP2}.

The I_{SET} pin has several functions. When taken to V^+ the outputs are latched and power is completely shut off. Power/speed can be programmed by connecting I_{SET} to V^- through an external resistor.

TYPICAL APPLICATION

Flat Ribbon Cable Driver/Receiver



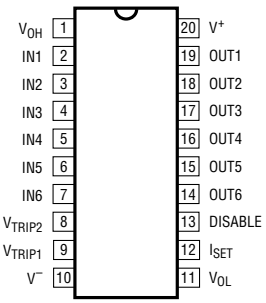


ABSOLUTE MAXIMUM RATINGS

(Notes 1, 2)

Total Supply Voltage (V^+, V_{OH} to V^-, V_{OL}) 18V
Output High Voltage (V_{OH}) ..... $\leq V^+$
Input Voltage ..... 18V to (V^- – 0.3V)
Output Short-Circuit Duration
($V_{OH} – V_{OL} \leq 10V$) ..... Continuous
ESD (MIL-STD-883, Method 3015) 2000V
Operating Temperature Range ..... –40°C to 85°C
Storage Temperature Range ..... –55°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

PACKAGE/ORDER INFORMATION



N PACKAGE 20-LEAD PDIP
SW PACKAGE 20-LEAD SO WIDE
T_{JMAX} = 110°C, θ_{JA} = 90°C/W (N)
T_{JMAX} = 110°C, θ_{JA} = 90°C/W (SW)

J PACKAGE
20-LEAD CERDIP
T_{JMAX} = 150°C, θ_{JA} = 70°C/W (J)

OBSOLETE PACKAGE
Consider N Package for Alternate Source

ORDER PART NUMBER
LTC1045CN LTC1045CSW
LTC1045CJ

Consult LTC Marketing for parts specified with wider operating temperature ranges.

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. $V^+ = V_{OH}$ = 5V, $V^- = V_{OL}$ = 0Vunless otherwise specified. (Note 3) .

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
I_B	Input Bias Current	$V^- \leq V_{IN} \leq V^+$			±1		nA
			●			0.5	µA
	Trip Voltage Range (Pins 8, 9)		●	V^-		$V^+ – 2$	V
I_S	V^+ to V^- Supply Current	DISABLE = V^+, R_{SET} = 10k			2.5	3.5	mA
			●			4.5	mA
I_{OFF}	V^+ to V^- Supply Current in Shutdown	DISABLE = I_{SET} = V^+			10		nA
			●			1	µA
V_{REF}	Voltage on I_{SET} (Pin 12)	R_{SET} = 10k			0.9		V
			●	0.6		1.25	V
V_{OH}	TTL Output High Voltage	I_{OUT} = –360µA, V^+ = 4.5V	●	2.4	4.4		V
V_{OL}	TTL Output Low Voltage	I_{OUT} = 1.6mA, V^+ = 4.5V	●		0.2	0.4	V
I_{SINK}	Output Short-Circuit Sink Current	$V_{IN} = V_{TRIP} – 100mV$, $V_{OUT} = V^+$		7.5	15		mA
			●	5.5			mA
I_{SOURCE}	Output Short-Circuit Source Current	$V_{IN} = V_{TRIP} + 100mV$, $V_{OUT} = V^-$		4.0	8.0		mA
			●	3.2			mA
I_{OZ}	Three-State Leakage Current	DISABLE = V^+, $V_{OL} \leq V_{OUT} \leq V_{OH}$			0.005		µA
			●			1	µA
R_{OH}	Output Resistance to V_{OH}	$\lvert I_{OUT} \rvert \leq 100µA$			260	475	Ω
			●			600	Ω
R_{OL}	Output Resistance to V_{OL}	$\lvert I_{OUT} \rvert \leq 100µA$			100	180	Ω
			●			250	Ω
	I_{SET} Voltage for Shutdown		●	$V^+ – 0.5$			V
	DISABLE Input Logic Levels						
V_{IH}		V^+ = 4.5V, V^- = 0V	●	2.0			V
V_{IL}		V^+ = 5.5V, V^- = 0V	●			0.8	V
	Input Supply Differential ($V^+ – V^-$) (Note 3)		●	4.5		15	V
	Output Supply Differential ($V_{OH} – V_{OL}$) (Note 3)		●	3		15	V

AC ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. $V^+ = V_{OH}$ = 5V, $V^- = V_{OL}$ = 0V, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
t_d	Response Time	Test Circuit Figure 1 R_{SET} = 10k, ±100mV Drive	 ●			250 350	ns ns
t_{SETUP}	Time Before Rising Edge of I_{SET} that Data Must Be Present	Test Circuit Figure 2			80		ns
t_{HOLD}	Time After Rising Edge of I_{SET} that Data Must Be Present	Test Circuit Figure 2			0		ns
t_{ACC}	Falling Edge of DISABLE to Logic Level (from Hi-Z State)	Test Circuit Figure 3			165		ns
t_{IH}, t_{OH}	Rising Edge of DISABLE to Hi-Z State	Test Circuit Figure 3			200		ns

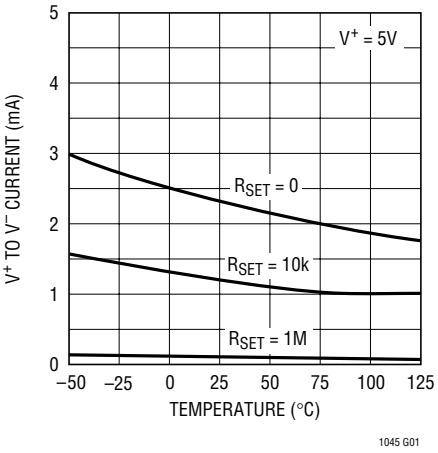
Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: The maximum differential voltage between any two power pins (V^+, V^-, V_{OH} and V_{OL}) must not exceed 18V. The maximum recommended operating differential is 15V.

Note 3: During operation near the maximum supply voltage limit, care should be taken to avoid or suppress power supply turn-on and turn-off transients, power supply ripple or ground noise; any of these conditions must not cause a supply differential to exceed the absolute maximum rating.

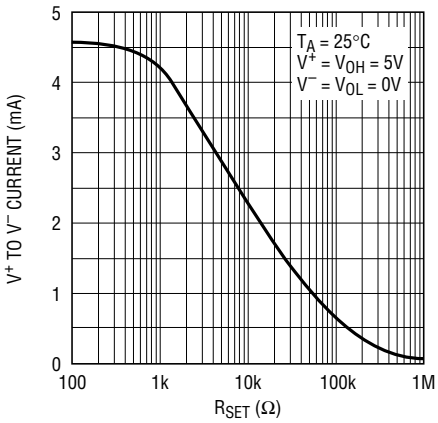
TYPICAL PERFORMANCE CHARACTERISTICS

I^+ vs Temperature



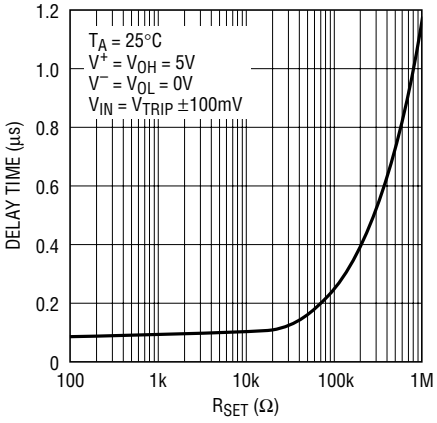
1045 G01

I^+ vs R_{SET}



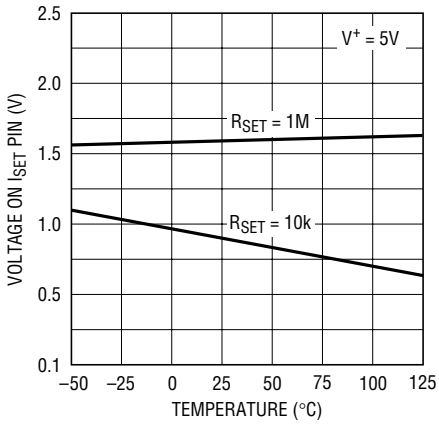
1045 G02

Delay Time vs R_{SET}



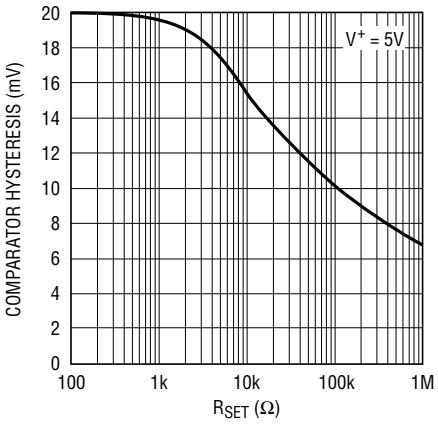
1045 G03

V_{REF} vs Temperature



1045 G04

Hysteresis vs R_{SET}



1045 G05

PIN FUNCTIONS

V_{OH} (Pin 1): High Level to which the Output Switches.

IN1 to IN7 (Pins 2 to 7): Six Comparator Inputs; Voltage Range = V^- to V^- + 18V.

V_{TRIP2} (Pin 8): Trip Point for Last Two Comparators (Inputs 5,6); Voltage Range = V^- to V^+ – 2V.

V_{TRIP1} (Pin 9): Trip Point for First Four Comparators (Inputs 1 to 4); Voltage Range = V^- to V^+ – 2V.

V^- (Pin 10): Comparator Negative Supply.

V_{OL} (Pin 11): Low Level to which the Output Switches.

I_{SET} (Pin 12): This has three functions: 1) R_{SET} from this pin to V^- sets bias current, 2) when forced to V^+ power is shut off completely and 3) when forced to V^+ outputs are latched.

DISABLE (Pin 13): When high, outputs are Hi-Z.

OUT6 to OUT1 (Pins 14 to 19): Six Driver Outputs.

V^+ (Pin 20): Comparator Positive Supply.

TEST CIRCUITS

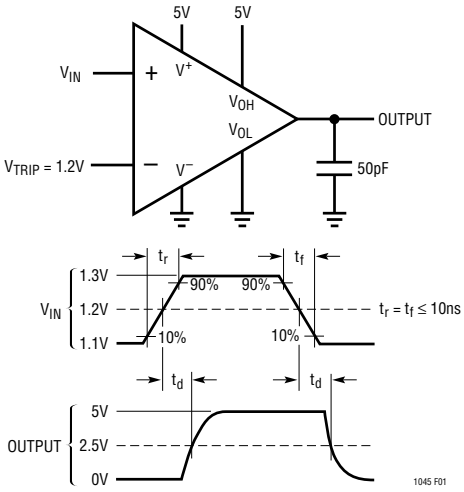


Figure 1. Response Time Test Circuit

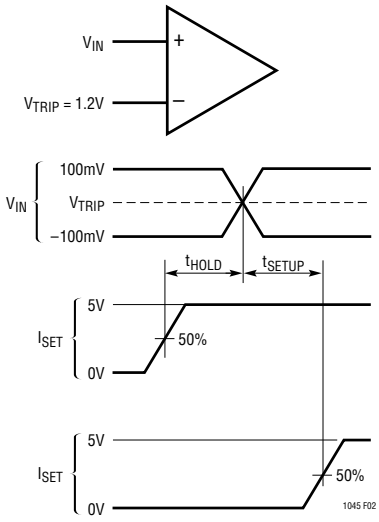


Figure 2. Latch Test Circuit

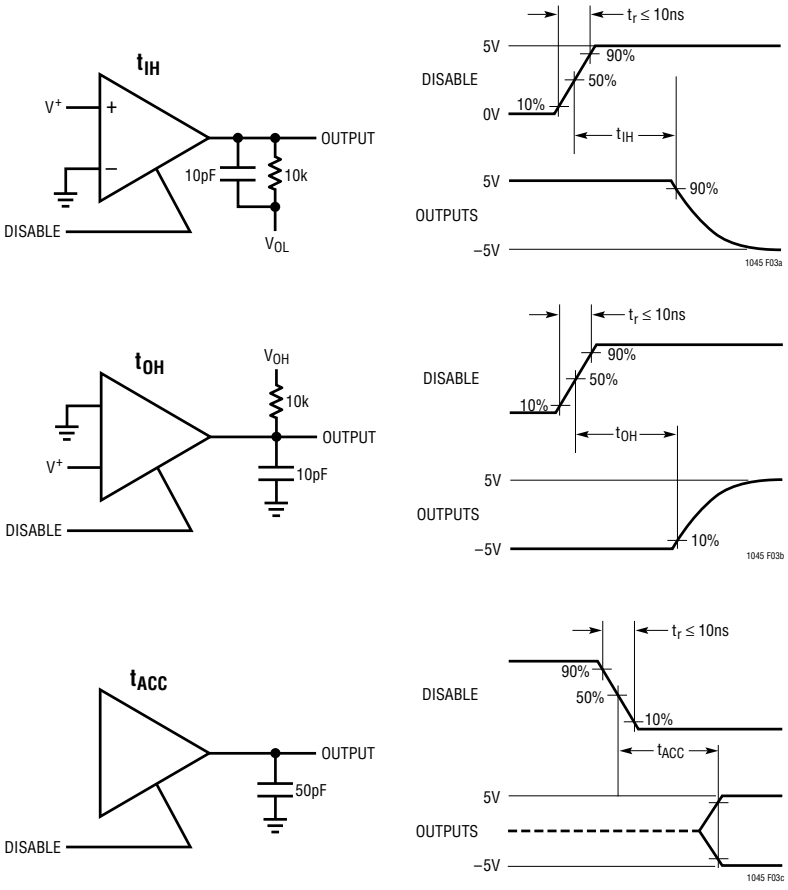
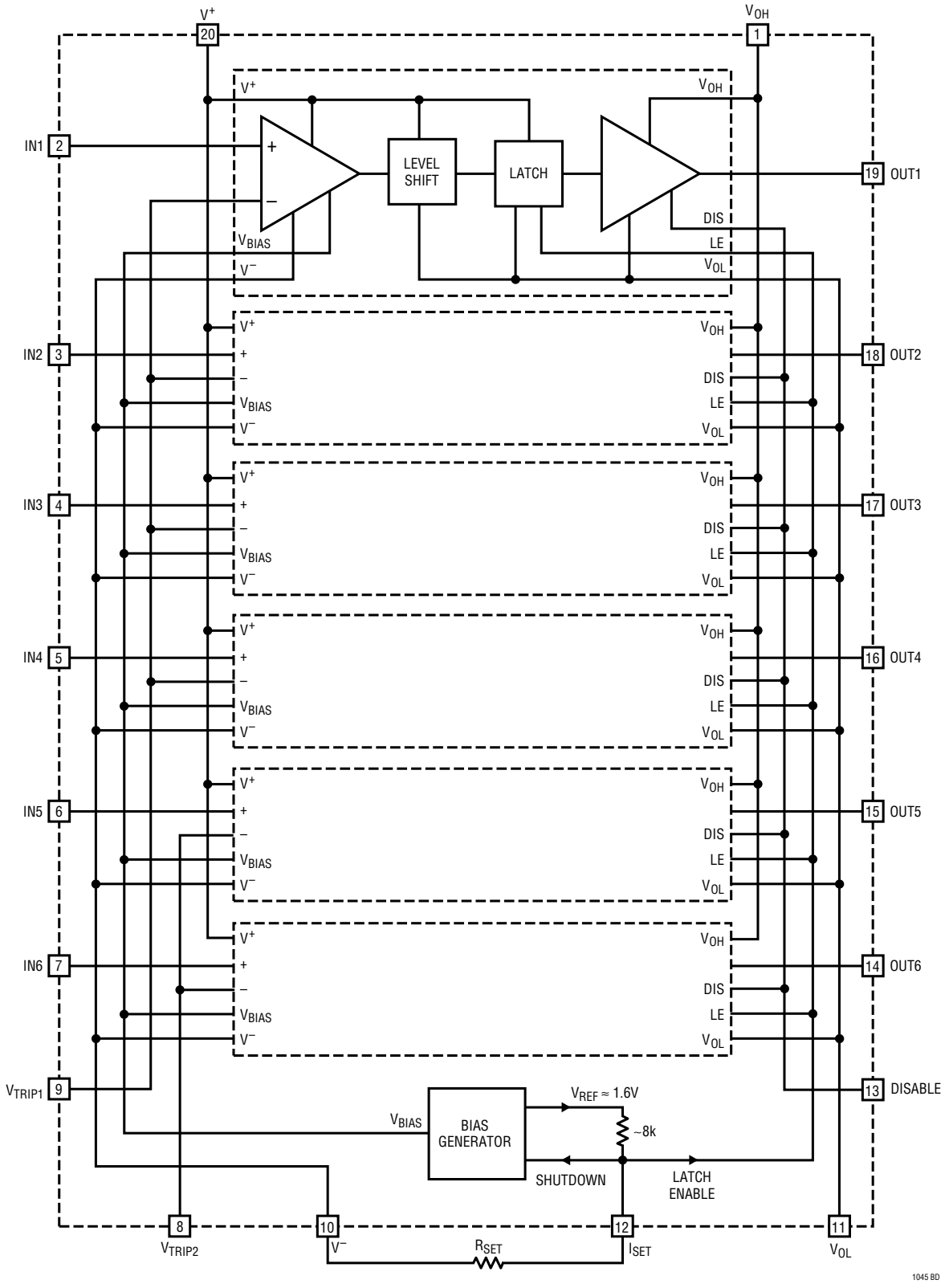


Figure 3. Three-State Output Test Circuit
Conditions: $V^+ = V_{OH} = 5V$, $V^- = V_{OL} = 0V$

BLOCK DIAGRAM



APPLICATIONS INFORMATION

The LTC1045 consists of six voltage translators and associated control circuitry (see Block Diagram). Each translator has a linear comparator input stage with the positive input brought out separately. The negative inputs of the first four comparators are tied in common to V_{TRIP1} and the negative inputs of the last two comparators are tied in common to V_{TRIP2}. With these inputs the switching point of the comparators can be set anywhere within the common mode range of V^- to $V^+ – 2V$. To improve noise immunity each comparator has a small built-in hysteresis. Hysteresis varies with bias current from 7mV at low bias current to 20mV at high bias current (see typical curve of Hysteresis vs R_{SET}).

Setting the Bias Current

Unlike CMOS logic, any linear CMOS circuit must draw some quiescent current. The bias generator (Block Diagram) allows the quiescent current of the comparators to be varied. Bias current is programmed with an external resistor (see typical curve of I^+ vs R_{SET}). As the bias current is decreased, the LTC1045 slows down (see typical curve of Delay Time vs R_{SET}).

Shutting Power Off and Latching the Outputs

In addition to setting the bias current, the I_{SET} pin shuts power completely off and latches the translator outputs. To do this, the I_{SET} pin must be forced to $V^+ – 0.5V$. As shown in Figure 4, a CMOS gate or a TTL gate with a resistor pull-up does this quite nicely. Even though power is turned off to the linear circuitry, the CMOS output logic is powered and maintains the output state. With no DC load on the output, power dissipation, for all practical purposes, is zero.

Latching the output is fast—typically 80ns from the rising edge of I_{SET}. Going from the latched to flow-through state is much slower—typically 1.5µs from the falling edge of I_{SET}. This time is set by the comparator's power-up time. During the power-up time, the output can assume false states. To avoid problems, the output should not be considered valid until 2µs to 5µs after the falling edge of I_{SET}.

Putting the Outputs in Hi-Z State

A DISABLE input sets the six outputs to a high impedance state. This allows the LTC1045 to be interfaced to a data bus. When DISABLE = "1" the outputs are high impedance and when DISABLE = "0" they are active. With TTL supplies, $V^+ = 4.5V$ to 5.5V and $V^- = GND$, the DISABLE input is TTL compatible.

Power Supplies

There are four power supplies on the LTC1045: V^+, V^-, V_{OH} and V_{OL}. They can be connected almost arbitrarily, but there are a few restrictions. A minimum differential must exist between V^+ and V^- and V_{OH} and V_{OL}. The V^+ to V^- differential must be at least 4.5V and the V_{OH} to V_{OL} differential must be at least 3V. Another restriction is caused by the internal parasitic diode D1 (see Figure 5).

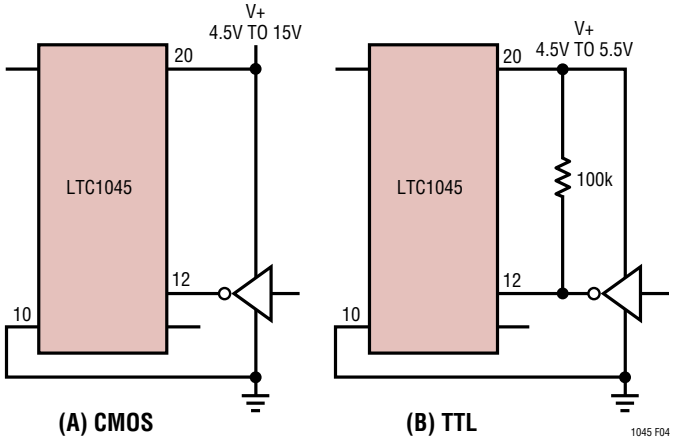


Figure 4. Driving the I_{SET} Pin with Logic

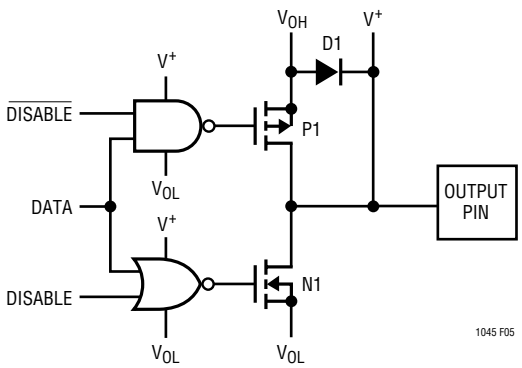


Figure 5. Output Driver

APPLICATIONS INFORMATION

Because of this diode, V_{OH} must not be greater than V^+. Lastly, the maximum voltage between any two power supply pins must not exceed 15V operating or 18V absolute maximum. For example, if $V^+ = 5V$, V^- or V_{OL} should be no more negative than –10V. Note that V_{OL} should not be more negative than –10V even if the V_{OH} to V_{OL} differential does not exceed the 15V maximum. In this case the V^+ to V_{OL} differential sets the limit.

Input Voltage

The LTC1045 has no upper clamp diodes as do conventional CMOS circuits. This allows the inputs to exceed the V^+ supply. The inputs will break down approximately 30V above the V^- supply. If the input current is limited with 100kΩ, the input voltage can be driven to at least ±50V with no adverse effects for any combination of allowed power supply voltages. Output levels will be correct even under these conditions (i.e., if the input voltage is above the trip point, the output will be high and if it is below, the output will be low).

Output Drive

Output drive characteristics of the LTC1045 will vary with the power supply voltages that are chosen. Output impedance is affected by V^+, V_{OH} and V_{OL}. V^- has no effect on output impedance. Guaranteed drive characteristics are specified in the table of electrical characteristics for $V^+ = V_{OH} = 5V$ and $V^- = V_{OL} = 0V$. Figures 6 and 7 show relative output impedance for other supply combinations. In general, output impedance is minimized if V^+ to V_{OH} is minimized and V_{OH} to V_{OL} is maximized.

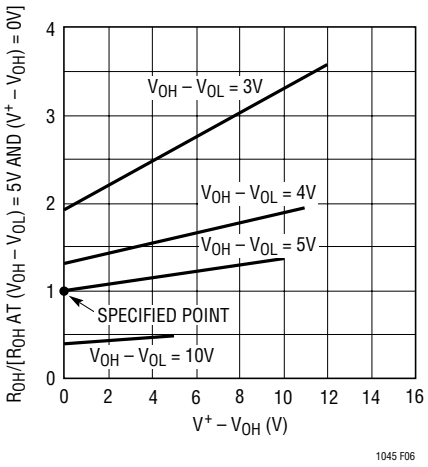


Figure 6. Relative Output Sourcing Resistance (R_{OH}) vs $V^+ - V_{OH}$

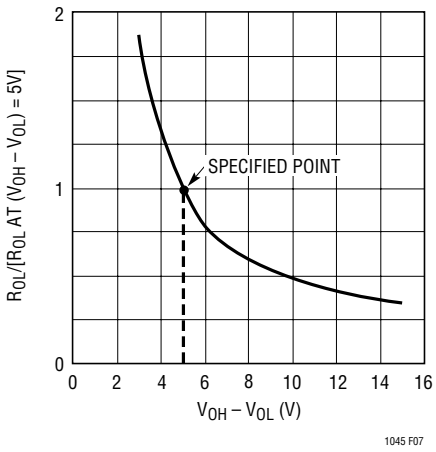
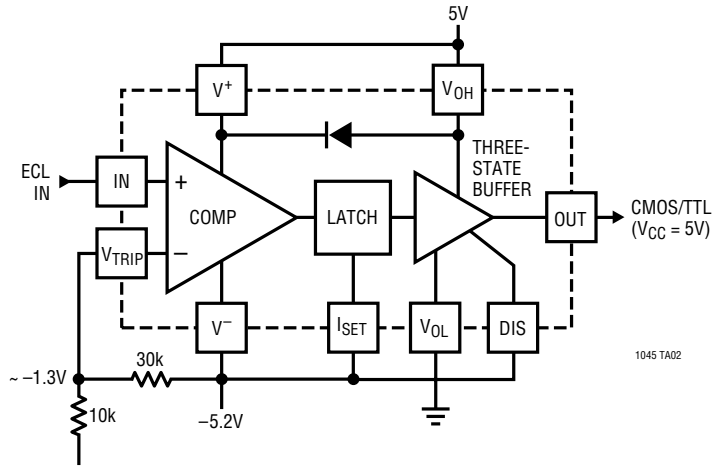


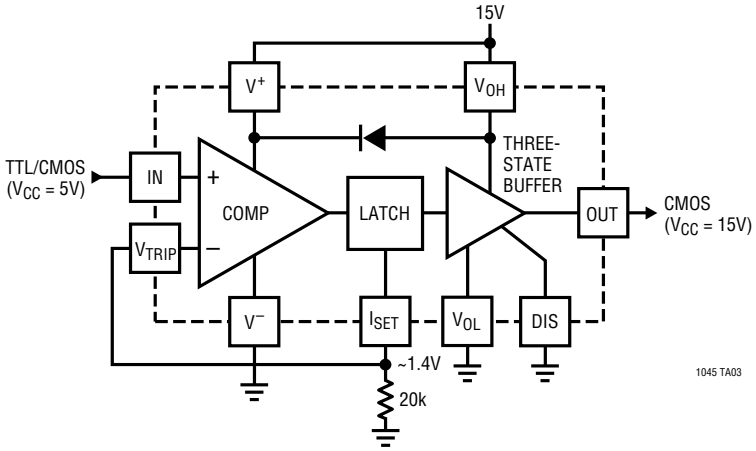
Figure 7. Relative Output Sinking Resistance (R_{OL}) vs $V_{OH} - V_{OL}$

TYPICAL APPLICATIONS

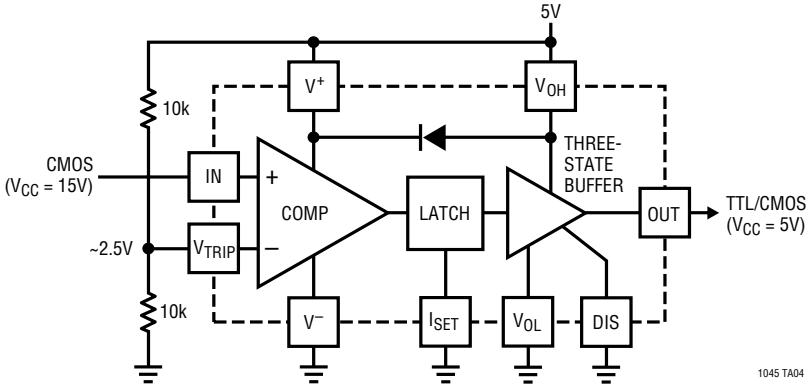
ECL to CMOS/TTL Logic



TTL/CMOS (V_{CC} = 5V) to High Voltage CMOS (V_{CC} = 15V)

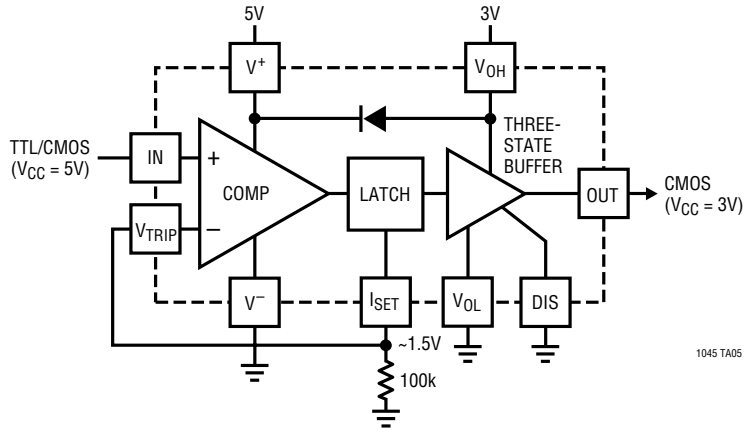


High Voltage CMOS (V_{CC} = 15V) to TTL/CMOS (V_{CC} = 5V)

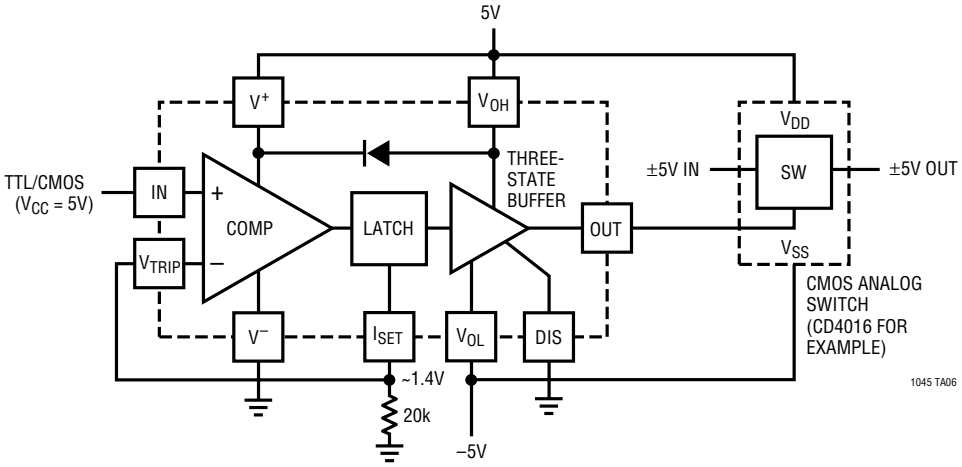


TYPICAL APPLICATIONS

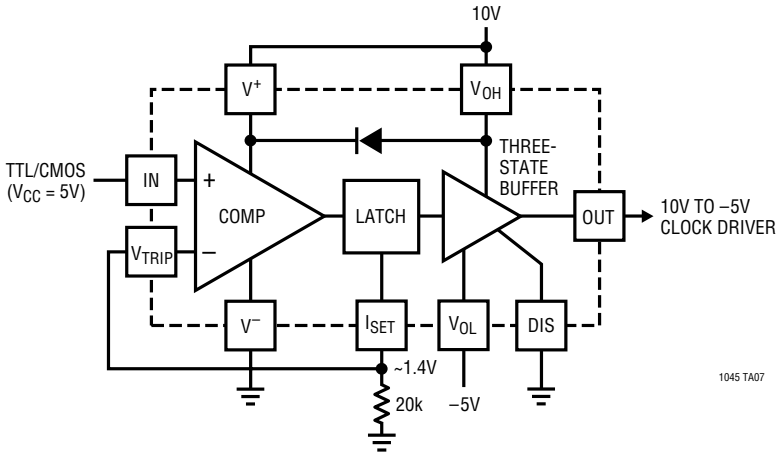
TTL/CMOS (V_{CC} = 5V) to Low Voltage CMOS (V_{CC} = 3V)



TTL/CMOS Logic Levels to ±5V Analog Switch Driver

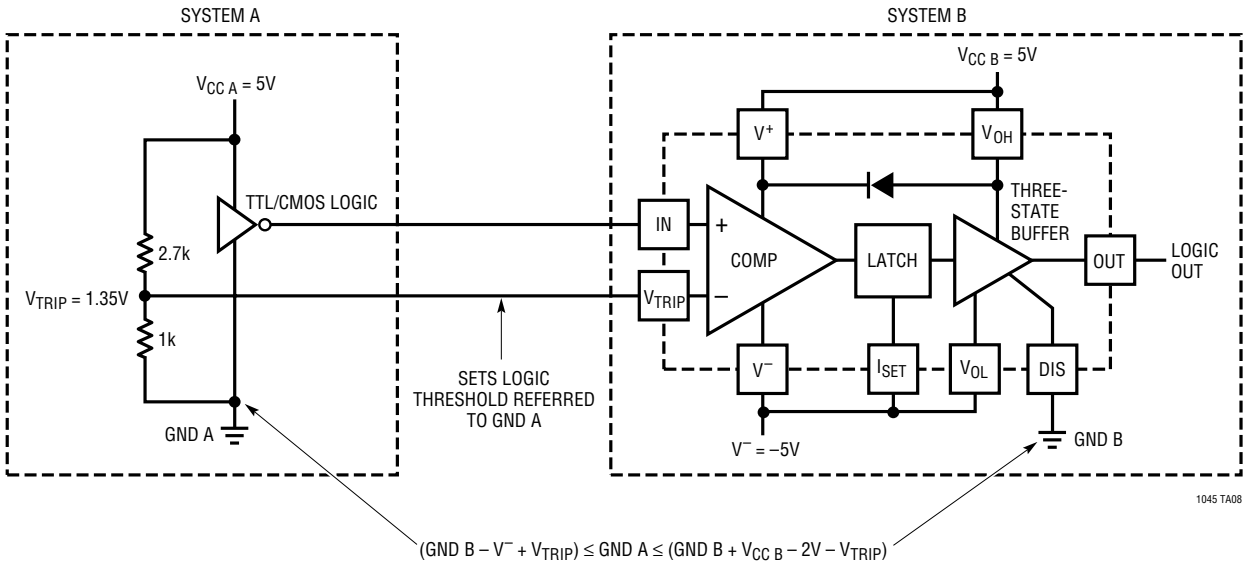


TTL/CMOS (V_{CC} = 5V) to 10V/–5V Clock Driver

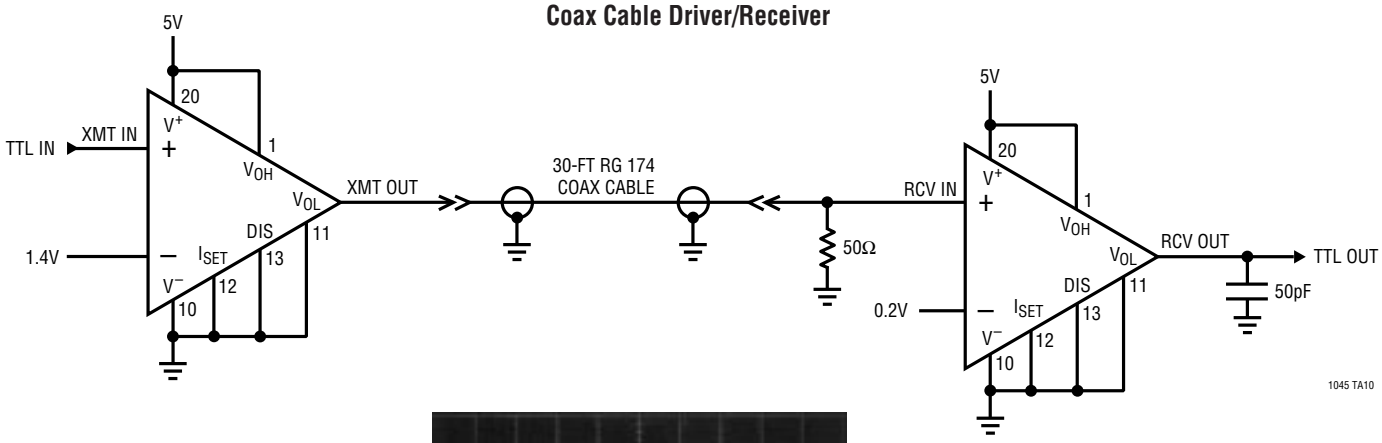


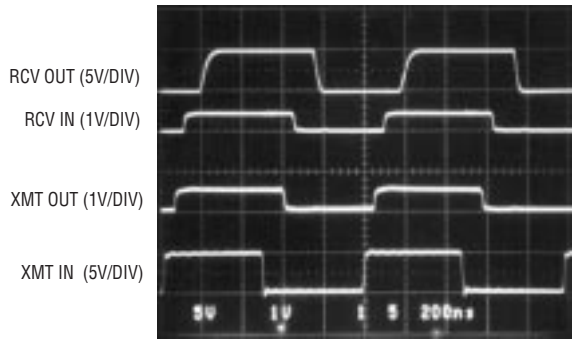
TYPICAL APPLICATIONS

Logic Ground Isolation when Two Grounds are within LTC1045 Common Mode Range



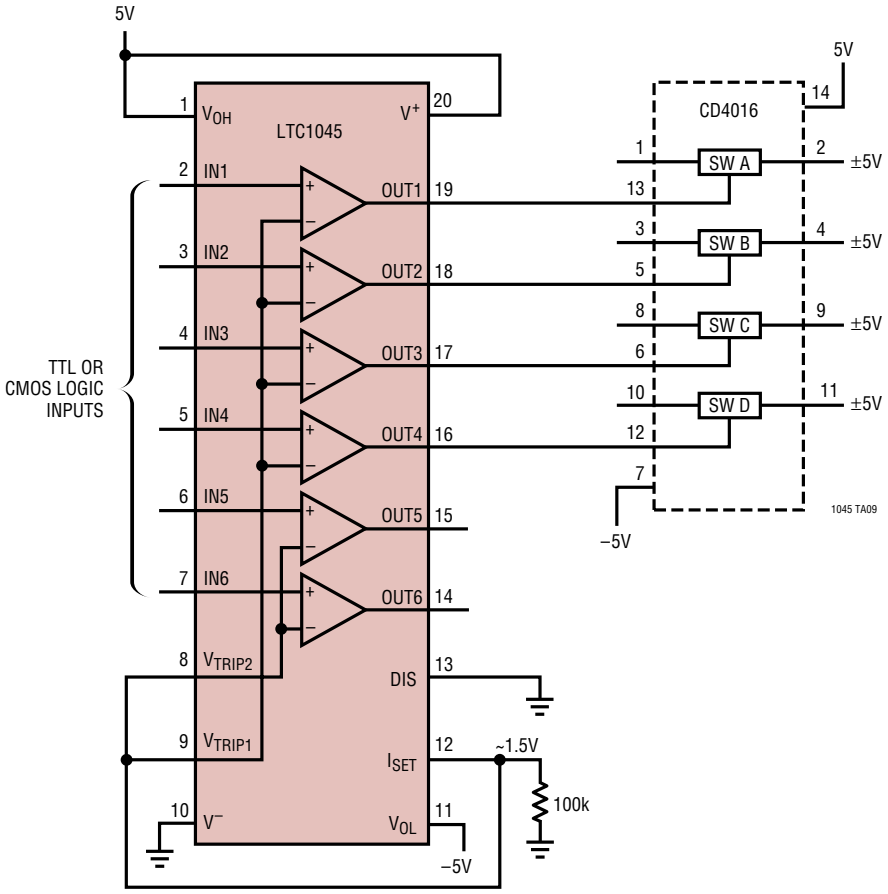
Coax Cable Driver/Receiver





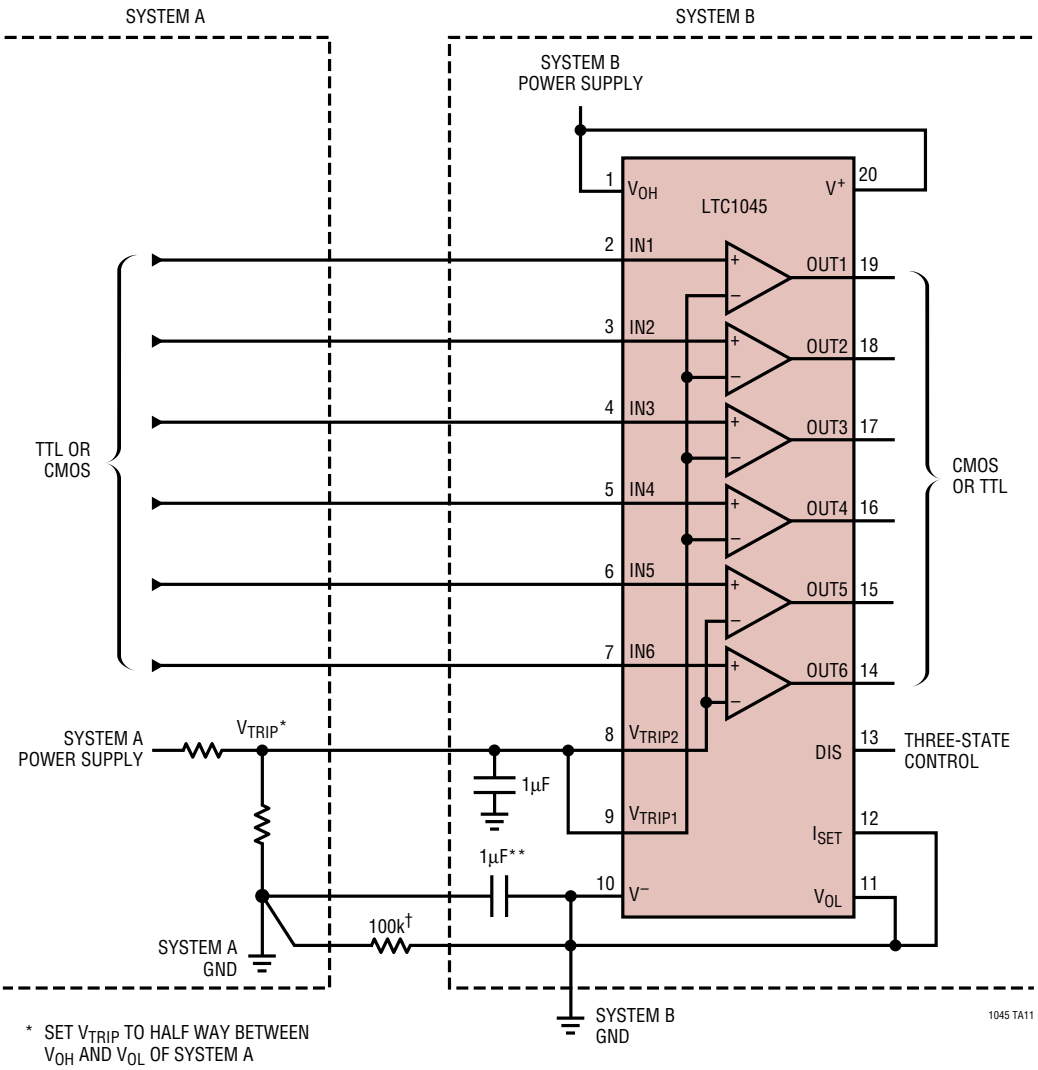
TYPICAL APPLICATIONS

±5V Analog Switch Driver



TYPICAL APPLICATIONS

Logic Systems DC Isolation



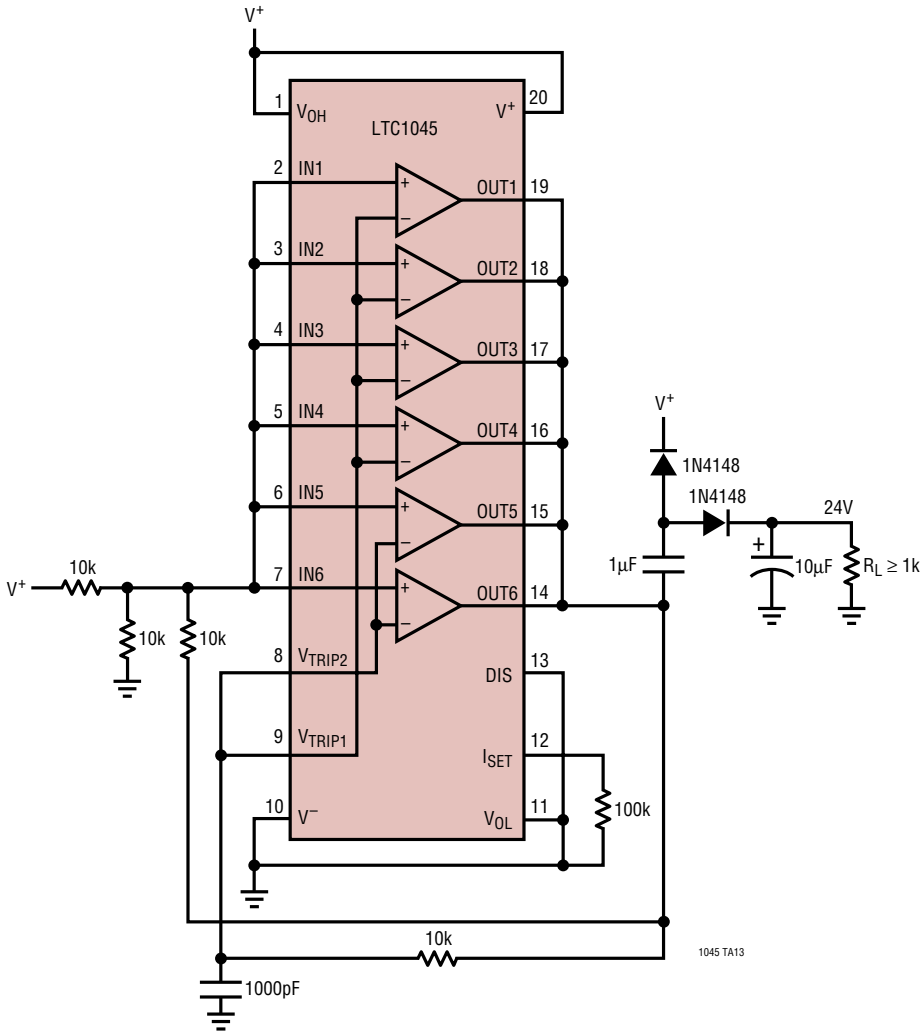
* SET V_{TRIP} TO HALF WAY BETWEEN V_{OH} AND V_{OL} OF SYSTEM A

** SHUNTS COMMON MODE SIGNAL

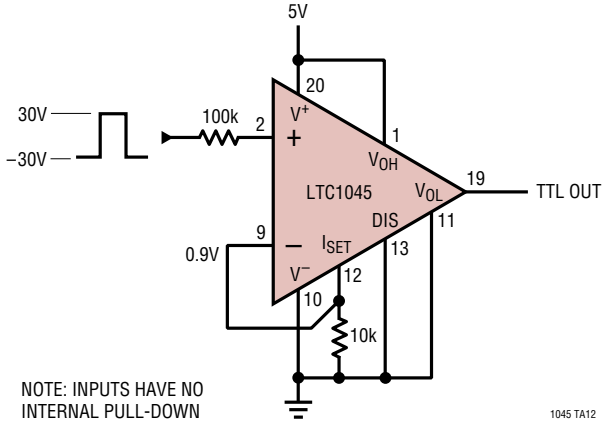
† PROVIDES LEAKAGE PATH FOR TOTALLY ISOLATED SYSTEMS

TYPICAL APPLICATIONS

24V Relay Supply from 12V/15V Supply

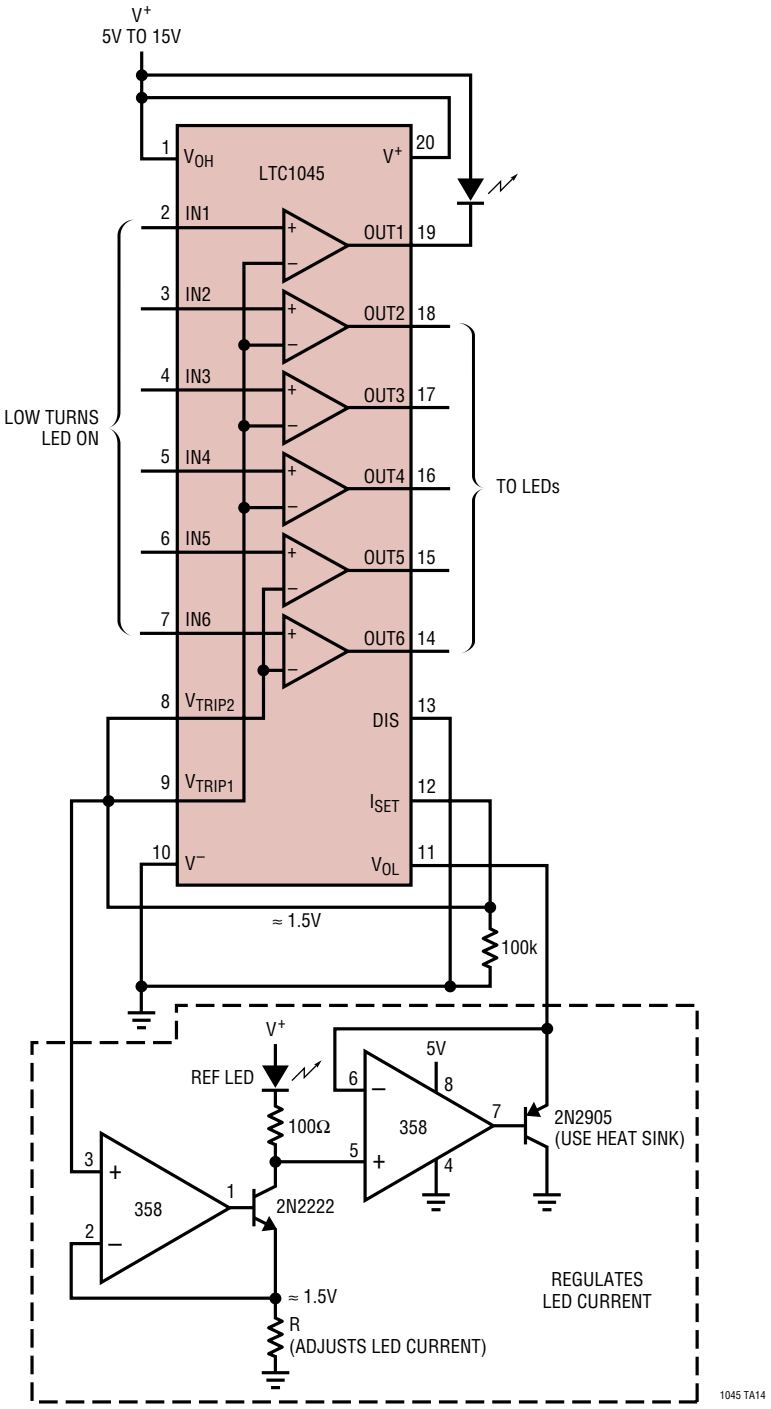


RS232 Receiver



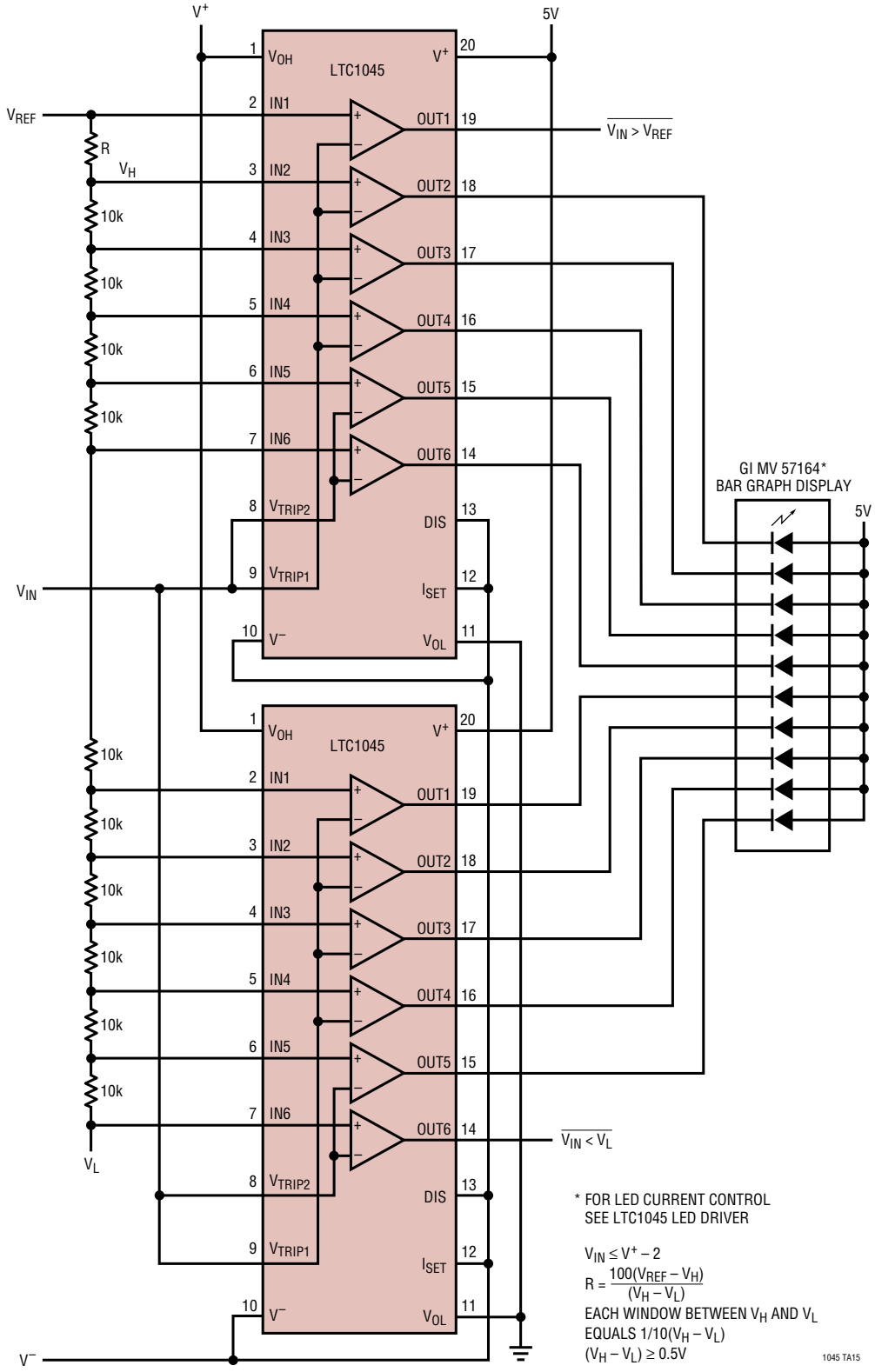
TYPICAL APPLICATIONS

LED Driver



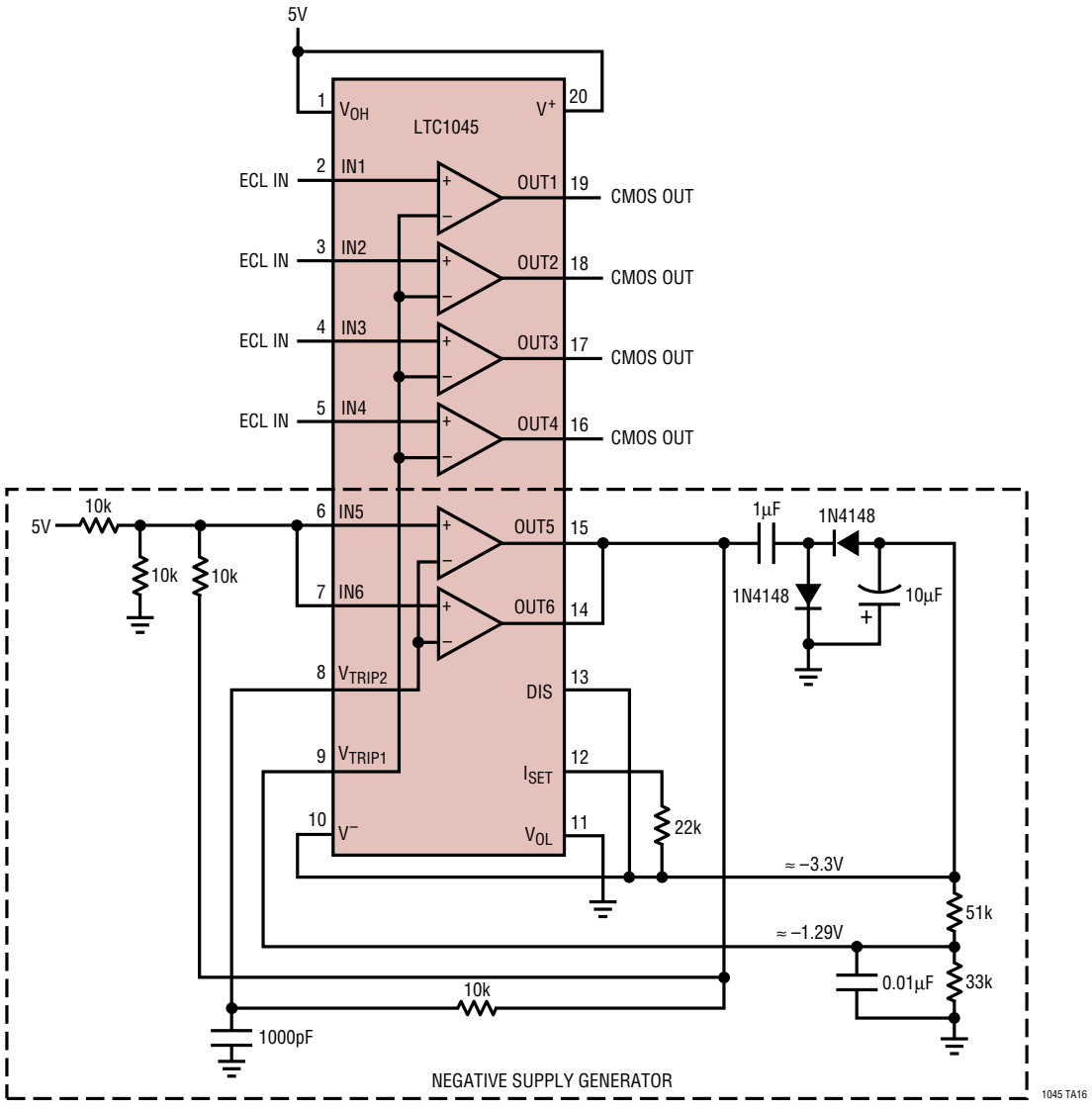
TYPICAL APPLICATIONS

Multiwindow Comparator and Display



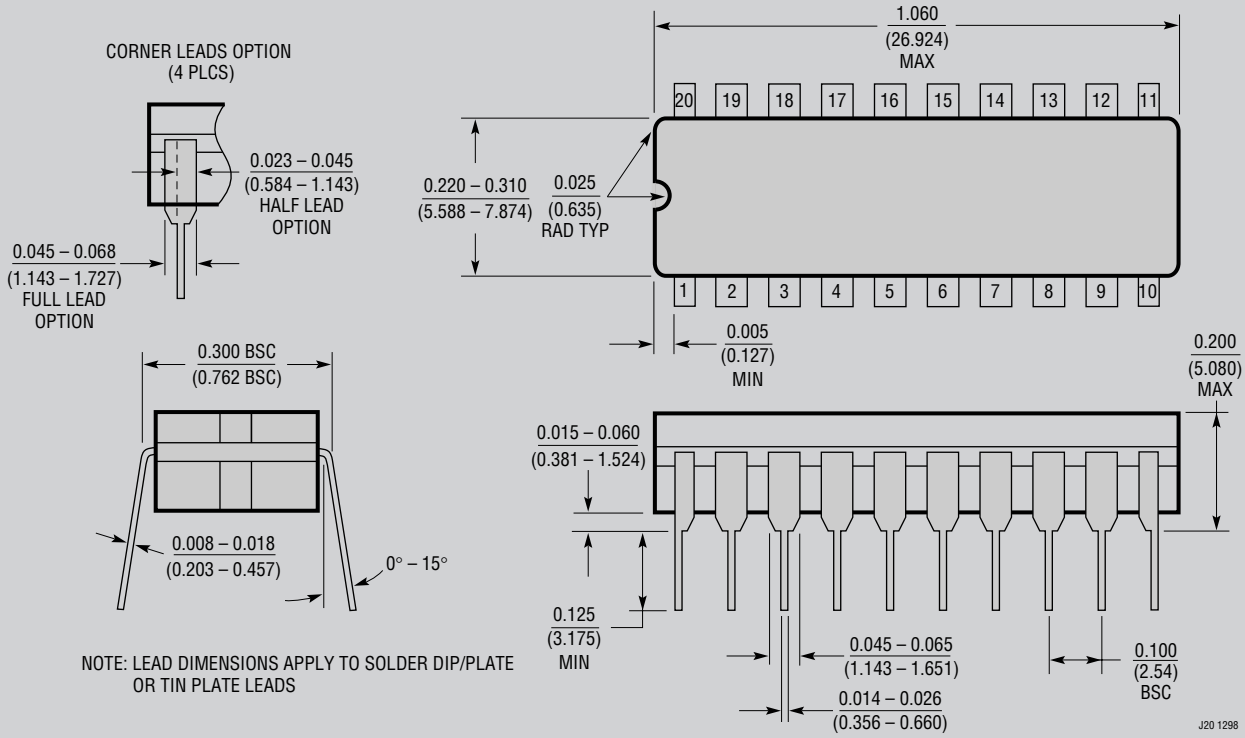
TYPICAL APPLICATIONS

ECL to CMOS from Single 5V Supply



PACKAGE DESCRIPTION

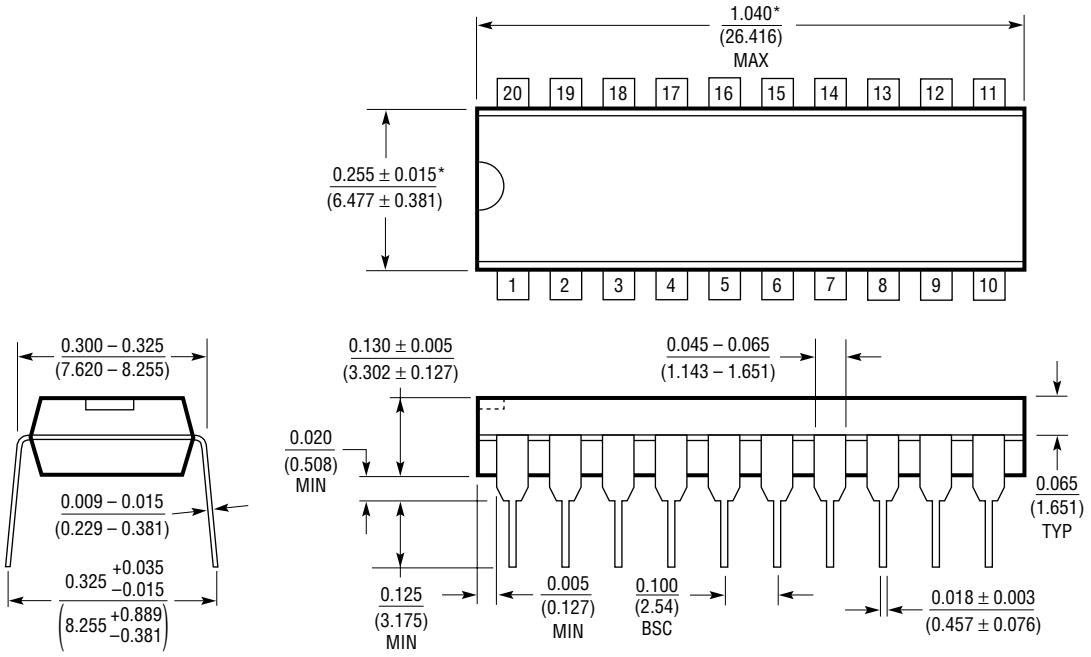
J Package
20-Lead CERDIP (Narrow .300 Inch, Hermetic)
(Reference LTC DWG # 05-08-1110)



OBSOLETE PACKAGE

PACKAGE DESCRIPTION

N Package
20-Lead PDIP (Narrow .300 Inch)
(Reference LTC DWG # 05-08-1510)

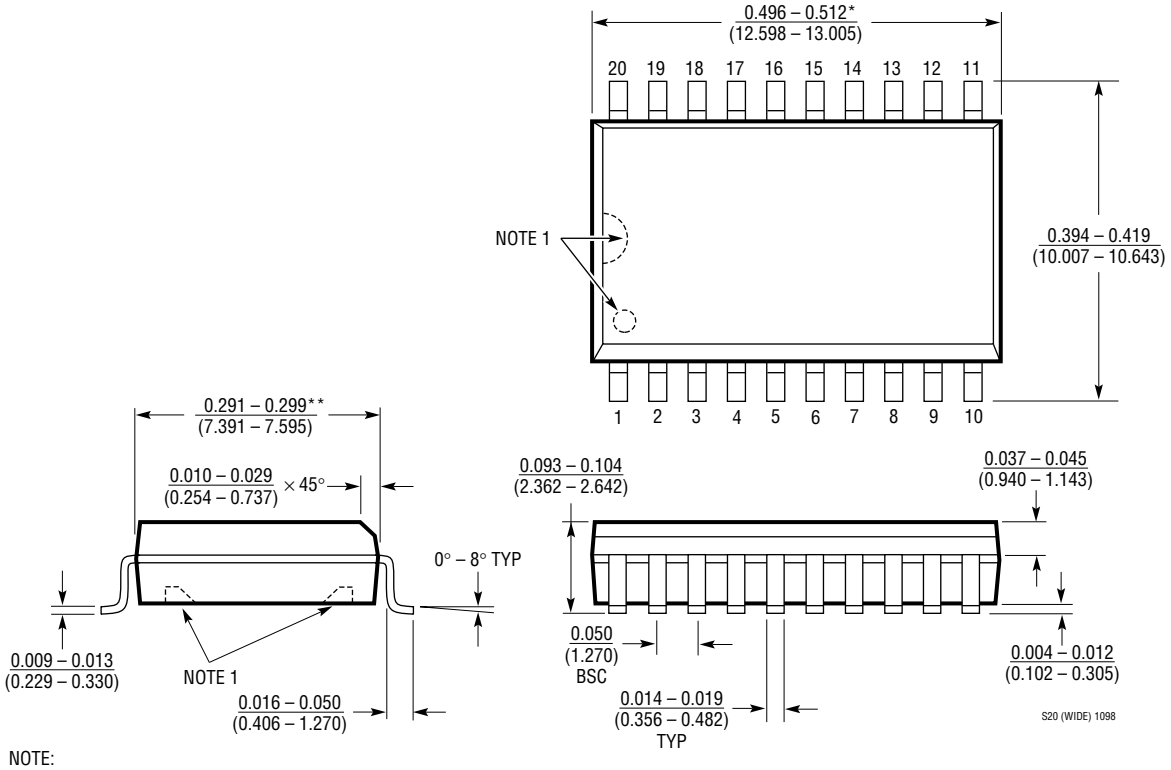


*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.010 INCH (0.254mm)

N20 1098

PACKAGE DESCRIPTION

SW Package
20-Lead Plastic Small Outline (Wide .300 Inch)
(Reference LTC DWG # 05-08-1620)



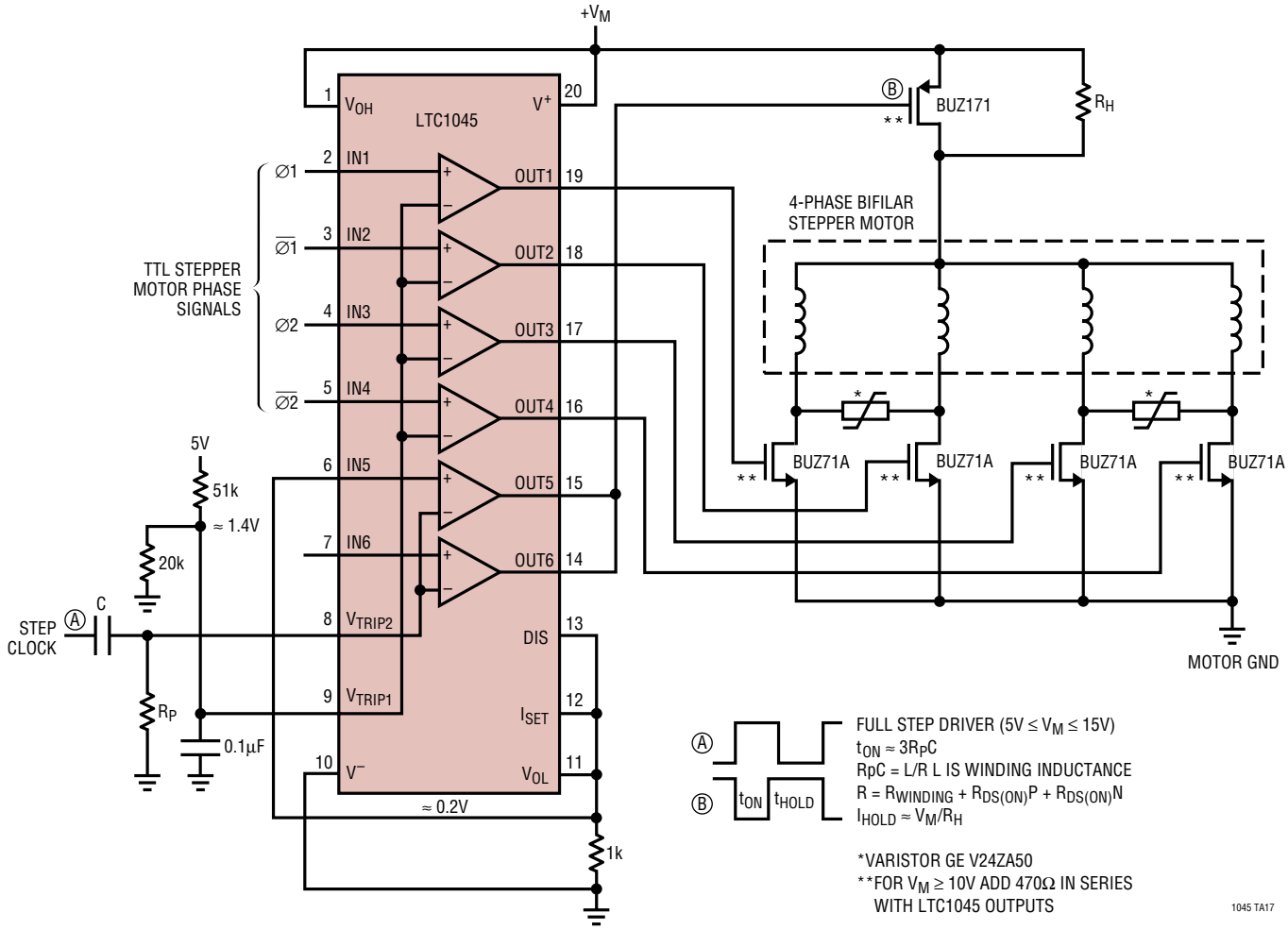
NOTE:
1. PIN 1 IDENT, NOTCH ON TOP AND CAVITIES ON THE BOTTOM OF PACKAGES ARE THE MANUFACTURING OPTIONS. THE PART MAY BE SUPPLIED WITH OR WITHOUT ANY OF THE OPTIONS

*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

TYPICAL APPLICATION

Power MOSFET Driver Low Power Consumption Stepper Motor Driver



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1016	Ultrafast Precision Comparator	10ns Propagation Delay
LT1039	Triple RS232 Driver/Receiver with Shutdown	±12V Supply, No Supply Current in Shutdown
LTC1440/LTC1441/LTC1442	Ultralow Power, Single/Dual Comparator with Reference	2.8µA Supply Current

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