ภาคผนวก ข

เอกสารกำกับอุปกรณ์อิเล็กทรอนิกส์

SIEMENS

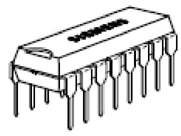
Phase Control IC

TCA 785

Bipolar IC

Features

- Reliable recognition of zero passage
- Large application scope
- May be used as zero point switch
- LSL compatible
- Three-phase operation possible (3 ICs)
- Output current 250 mA
- Large ramp current range
- Wide temperature range

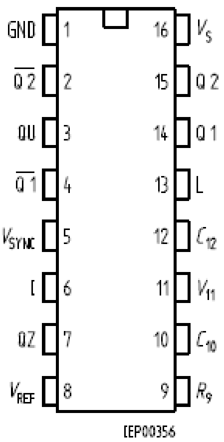


P-DIP-16-1

Type	Ordering Code	Package
TCA 785	Q67000-A2321	P-DIP-16-1

This phase control IC is intended to control thyristors, triacs, and transistors. The trigger pulses can be shifted within a phase angle between 0 ˚ and 180 ˚. Typical applications include converter circuits, AC controllers and three-phase current controllers.

This IC replaces the previous types TCA 780 and TCA 780 D.



Pin Configuration
(top view)

Pin Definitions and Functions

Pin	Symbol	Function
1	GND	Ground
2 3 4	$\overline{Q2}$ Q U $\overline{Q2}$	Output 2 inverted Output U Output 1 inverted
5	V_{SYNC}	Synchronous voltage
6 7	I Q Z	Inhibit Output Z
8	V_{REF}	Stabilized voltage
9 10	R_9 C_{10}	Ramp resistance Ramp capacitance
11	V_{11}	Control voltage
12	C_{12}	Pulse extension
13	L	Long pulse
14 15	Q 1 Q 2	Output 1 Output 2
16	V_S	Supply voltage

Functional Description

The synchronization signal is obtained via a high-ohmic resistance from the line voltage (voltage V_5). A zero voltage detector evaluates the zero passages and transfers them to the synchronization register.

This synchronization register controls a ramp generator, the capacitor C_{10} of which is charged by a constant current (determined by R_9). If the ramp voltage V_{10} exceeds the control voltage V_{11} (triggering angle φ), a signal is processed to the logic. Dependent on the magnitude of the control voltage V_{11}, the triggering angle φ can be shifted within a phase angle of 0° to 180°.

For every half wave, a positive pulse of approx. 30 µs duration appears at the outputs Q 1 and Q 2. The pulse duration can be prolonged up to 180° via a capacitor C_{12}. If pin 12 is connected to ground, pulses with a duration between φ and 180° will result.

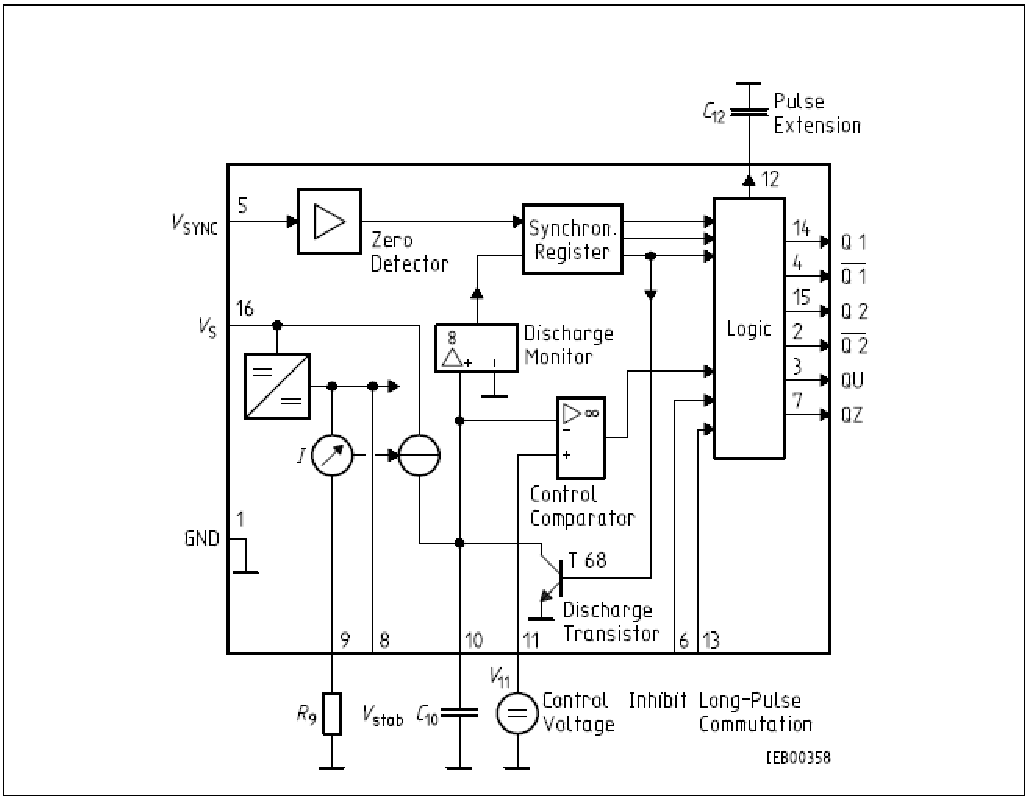
Outputs $\overline{Q1}$ and $\overline{Q2}$ supply the inverse signals of Q 1 and Q 2.

A signal of φ +180° which can be used for controlling an external logic,is available at pin 3.

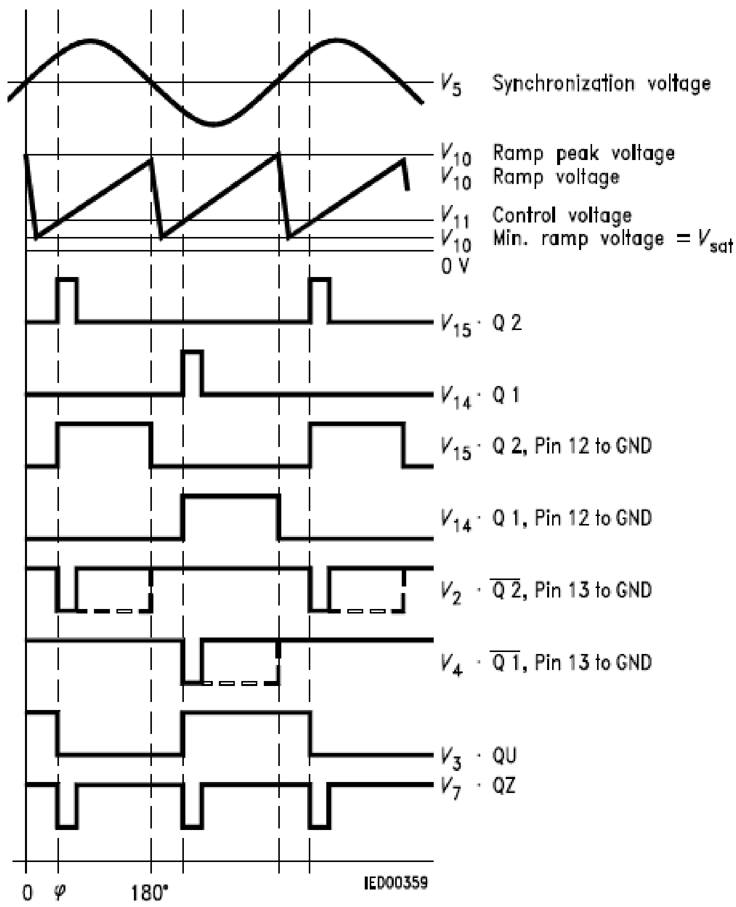
A signal which corresponds to the NOR link of Q 1 and Q 2 is available at output Q Z (pin 7).

The inhibit input can be used to disable outputs Q1, Q2 and $\overline{Q1}$, $\overline{Q2}$.

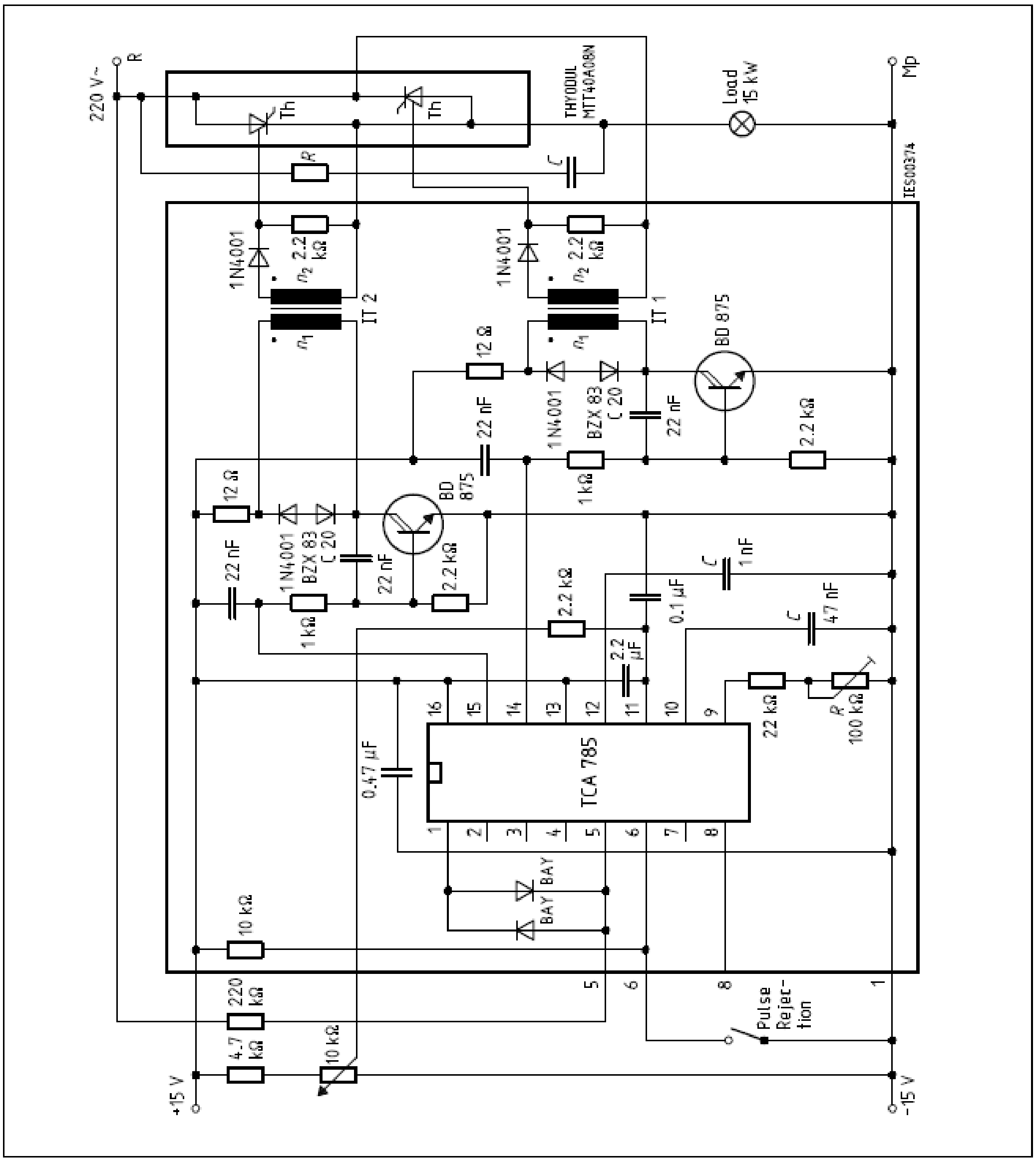
Pin 13 can be used to extend the outputs $\overline{Q1}$ and $\overline{Q2}$ to full pulse length (180° – φ).



Block Diagram



Pulse Diagram



Fully Controlled AC Power Controller
Circuit for Two High-Power Thyristors

Shown is the possibility to trigger two antiparalleled thyristors with one IC TCA 785. The trigger pulse can be shifted continuously within a phase angle between 0˚ and 180˚ by means of a potentiometer. During the negative line half-wave the trigger pulse of pin 14 is fed to the relevant thyristor via a trigger pulse transformer. During the positive line half-wave, the gate of the second thyristor is triggered by a trigger pulse transformer at pin 15.

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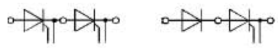
V_{RSM}	V_{RRM} V_{DRM}	$(dv/dt)_{cr}$	I_{TRMS} (maximum value for continuous operation) 50 A; I_{TAV} (sin. 180; T_{case} = 68 °C) 32 A			
V	V	V/µs				
500	400	500	–	–	**SKKH 26/04 D**	–
700	600	500	**SKKT 26/06 D**	–	**SKKH 26/06 D**	**SKKH 27/06 D**
900	800	500	**SKKT 26/08 D**	**SKKT 27/08 D**[1)]	**SKKH 26/08 D**	**SKKH 27/08 D**
1300	1200	1000	**SKKT 26/12 E**	**SKKT 27/12 E**[1)]	**SKKH 26/12 E**	**SKKH 27/12 E**
1500	1400	1000	**SKKT 26/14 E**	**SKKT 27/14 E**[1)]	**SKKH 26/14 E**	**SKKH 27/14 E**
1700	1600	1000	**SKKT 26/16 E**	**SKKT 27/16 E**[1)]	**SKKH 26/16 E**	**SKKH 27/16 E**
1900	1800	1000	**SKKT 26/18 E**	–	–	**SKKH 27/18 E**

Symbol	Conditions	SKKT 26 SKKH 26	SKKT 27 SKKT 27B SKKH 27	Units
I_{TAV}	sin. 180; T_{case} = 68 °C	32		A
	T_{case} = 85 °C	25		A
I_D	B2/B6 T_{amb} = 45 °C; P 3/180	38 / 50		A
	T_{amb} = 35 °C; P 3/180 F	60 / 77		A
I_{RMS}	W1/W3 T_{amb} = 45 °C; P 3/180	52 / 3 x 37		A
I_{TSM}	T_{vj} = 25 °C; 10 ms	550		A
	T_{vj} = 125 °C; 10 ms	480		A
i^2t	T_{vj} = 25 °C; 8,3 ... 10 ms	1 500		A^2s
	T_{vj} = 125 °C; 8,3 ... 10 ms	1 150		A^2s
t_{gd}	T_{vj} = 25 °C; I_G = 1 A			
	di_G/dt = 1 A/µs	1		µs
t_{gr}	$V_D = 0{,}67 \cdot V_{DRM}$	1		µs
$(di/dt)_{cr}$	T_{vj} = 125 °C	150		A/µs
t_q	T_{vj} = 125 °C	typ. 80		µs
I_H	T_{vj} = 25 °C; typ./max.	100 / 200		mA
I_L	T_{vj} = 25 °C; R_G = 33 Ω; typ./max.	250 / 400		mA
V_T	T_{vj} = 25 °C; I_T = 75 A	max. 1,8		V
$V_{T(TO)}$	T_{vj} = 125 °C	0,9		V
r_T	T_{vj} = 125 °C	12		mΩ
I_{DD}; I_{RD}	T_{vj} = 125 °C; $V_{RD} = V_{RRM}$			
	$V_{DD} = V_{DRM}$	max. 10		mA
V_{GT}	T_{vj} = 25 °C; d.c.	3		V
I_{GT}	T_{vj} = 25 °C; d.c.	150		mA
V_{GD}	T_{vj} = 125 °C; d.c.	0,25		V
I_{GD}	T_{vj} = 125 °C; d.c.	5		mA
R_{thjc}	cont. } per thyristor / per module	0,9 / 0,45		°C/W
	sin. 180	0,95 / 0,48		°C/W
	rec. 120	1,0 / 0,5		°C/W
R_{thch}		0,2 / 0,1		°C/W
T_{vj}		– 40 ... + 125		°C
T_{stg}		– 40 ... + 125		°C
V_{isol}	a. c. 50 Hz; r.m.s; 1 s/1 min	3600 / 3000		V~
M_1	to heatsink } SI (US) units	5 (44 lb. in.) ± 15 %[2)]		Nm
M_2	to terminals	3 (26 lb. in.) ± 15 %		Nm
a		5 · 9,81		m/s^2
w	approx.	95		g
Case	→ page B 1 – 95 SKKT 26: A 5; SKKH 26: A 6		SKKT 27: A 46; SKKT 27B: A 48; SKKH 27: A 47	

SEMIPACK® 1
Thyristor / Diode Modules

SKKT 26 SKKH 26
SKKT 27 SKKH 27
SKKT 27B

SKKT 26 **SKKH 26**



SKKT 27 **SKKH 27**
SKKT 27B

Features

- Heat transfer through aluminium oxide ceramic isolated metal baseplate
- Hard soldered joints for high reliability
- UL recognized, file no. E 63 532

Typical Applications

- DC motor control (e.g. for machine tools)
- AC motor soft starters
- Temperature control (e.g. for ovens, chemical processes)
- Professional light dimming (studios, theaters)

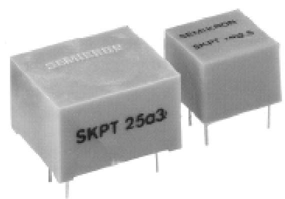
1) Also available in SKKT 27B configuration (case A 48)
2) See the assembly instructions

14.2 Pulse Transformers
Range of preferred types

Pulse Transformers
SKPT 14 to SKPT 27

Absolute Maximum Ratings

Symbol	Conditions	Values
V_{ww}	Crest working voltage	400 ... 650 V
V_{isol}	A.C. rms; 1 minute, see table below [1]	2,5 ... 5 kV
T_{op}	Operating Temperature	– 40 ... + 85 °C
T_{stg}	Storage Temperature	– 50 ... + 90 °C



Characteristics [2]

Types • New Type	N_p/N_s s	$\int Vdt$ µVs	R_p Ω	R_s Ω	L_p mH	L_{ss} µH	C_{ps} pF	I_M mA	t_r µs	R_L Ω	V_{ww} V	V_{Isol} kV	Win-ding conf
SKPT 14b2,5	1:1:1	250	0,86	0,86	1,8	85	10	150	2	80	500	4	B
SKPT 14k2,5	1:1:1	250	0,86	0,86	1,8	85	10	150	2	80	500	4	C
SKPT 14c2,5	2:1	250	1,6	0,86	7,5	400	12	150	2,5	80	500	4	D
SKPT 14a3	1:1	350	1,25	1,25	2,8	135	12	150	2,5	80	500	4	A
SKPT 14i3	1:1	350	1,25	1,25	2,8	135	12	150	2,5	80	500	4	D
SKPT 14g3	2:1:1	330	3,5	1,6	11	148	10	150	5	80	500	4	B
SKPT 14c3,5	2:1	350	3,5	2,4	13,5	82	9	150	2,5	80	500	4	D
SKPT 14i5	1:1	500	2,7	2,7	5,5	75	10	150	2,5	80	500	4	D
SKPT 14k6	1:1:1	600	2,8	2,8	9	290	10	150	2,5	80	500	4	C
SKPT 25j2	1:2:2	200	0,8	1,6	0,9/1,6	30/60	7	250	1,5	47	500	5	H
SKPT 25a3	1:1	300	0,55	0,55	2	45	8	250	1,5	47	500	4	A
SKPT 25b3	1:1:1	300	0,55	0,55	2	48	9	250	1,5	47	500	4	B
SKPT 25e3	3:1:1	300	1,7	0,55	15	300	10	250	1,5	47	500	4	B
SKPT 25h3	1:1:1:1	300	0,55	0,55	2	48	9	250	1,5	47	500	4	C
SKPT 25k3/650	1:1:1	300	0,55	0,55	2	38	9	250	1,5	47	650	4	F
SKPT 25m3	1:1	300	0,55	0,55	1,8	105	7	250	1,5	47	1000	6	G
SKPT 25n3	3:1	300	1,7	0,55	15	870	7	250	1,5	47	1000	6	G
SKPT 25p3/650	3:1:1	300	1,7	0,55	15	300	10	250	1,5	47	650	4	F
SKPT 25a4	1:1	400	0,6	0,6	4	50	10	250	2	47	500	4	A
SKPT 25b4	1:1:1	400	0,6	0,6	4	52	10	250	2	47	500	4	B
SKPT 25g4	2:1:1	400	2,3	1,1	9/15	260/490	7	250	1,5	47	500	5	H
SKPT 25a5	1:1	500	1	1	5,5	85	11	100 250	1,1 3	100 47	500	4	A

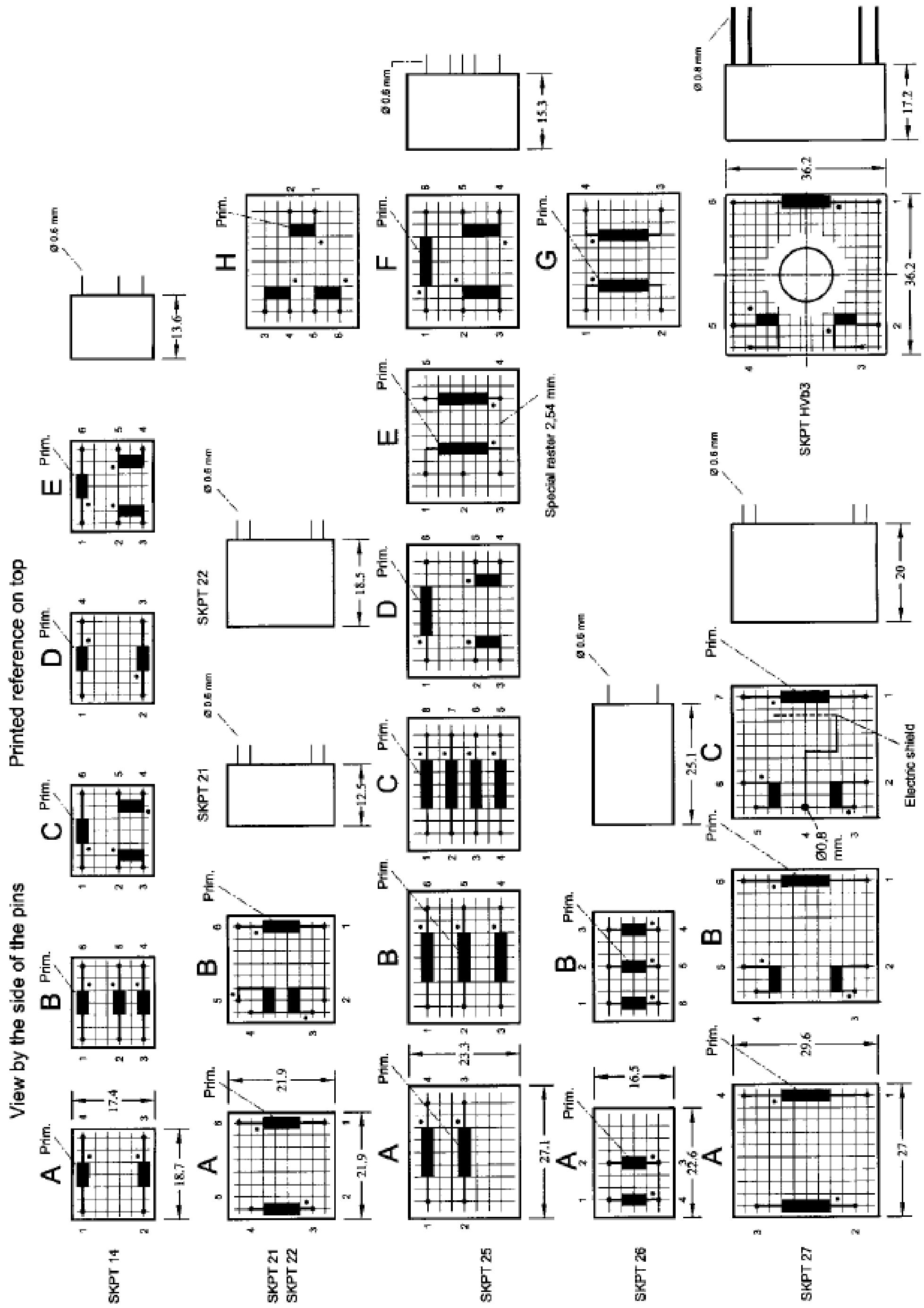
continued on next page

[1] Material used is according to UL94-V0. Isolation test and pin distance according to IEC 60664-1(1992); (VDE 0110-1:1997-4)

[2] Explanations see Chapter A, Section 14.2

SEMIKRON

Winding Configurations and Dimensions in mm
2,5 mm grid

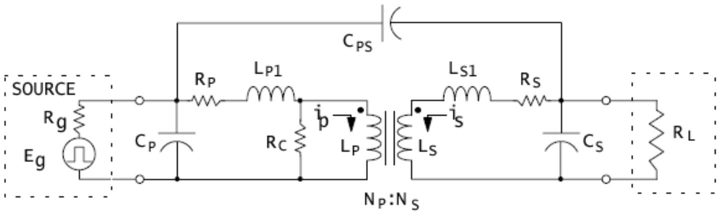


PULSE TRANSFORMERS

TRANSFORMER EQUIVALENT CIRCUIT:

The influences of a transformer's parameters can best be understood by considering the equivalent circuit in below.

This ciruit shows a typical output pulse waveform. Assuming that this output pulse is the result of injecting an ideal rectangular input pulse, one can see that a number of parameters are distorted. Overshoot, droop, back swing, rise time, etc. appear as unwanted signal distortion on the output pulse. Assuming the pulse transformer is properly matched and the source is delivering an ideal rectangular pulse, the transformer should have low values of leakage inductance and distributed capacitance while having a high open circuit inductance. This will limit the deterioration of the pulse shape. Also, the fact that the source will never produce an ideal rectangular pulse adds to the problems of distortion.



Transformer Equivalent Circuit.

Where:
R_g = Internal resistance of the driving source.
E_g = Open circuit source voltage.
R_P = DC Resistance of the primary winding.
R_S = DC Resistance of the secondary winding.
R_L = Load Resistance on the secondary winding.
R_C = Core losses expressed as a shunt resistance in parallel with the primary windings.
C_P = Primary shunt and distributed capacitance.
C_S = Secondary shunt and distributed capacitance.
C_{PS} = Primary-to-Secondary capacitance (inter-winding capacitance).
L_P = Primary inductance that is mutually coupled to the secondary.
L_S = Secondary inductance that is mutually coupled to the primary.
L_{P1} = Primary inductance that does not link the secondary (Primary leakage inductance).
L_{S1} = Secondary inductance that does not link the primary (Secondary leakage inductance).
i_P = Current in the primary turns.
i_S = Current in the secondary turns.
N_P = Number of turns on the primary.
N_S = Number of turns on the secondary.

Rhombus Industries Inc.
15801 Chemical Lane, Huntington Beach, CA 92649-1595
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National Semiconductor

February 2000

LM555
Timer

General Description

The LM555 is a highly stable device for generating accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For astable operation as an oscillator, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output circuit can source or sink up to 200mA or drive TTL circuits.

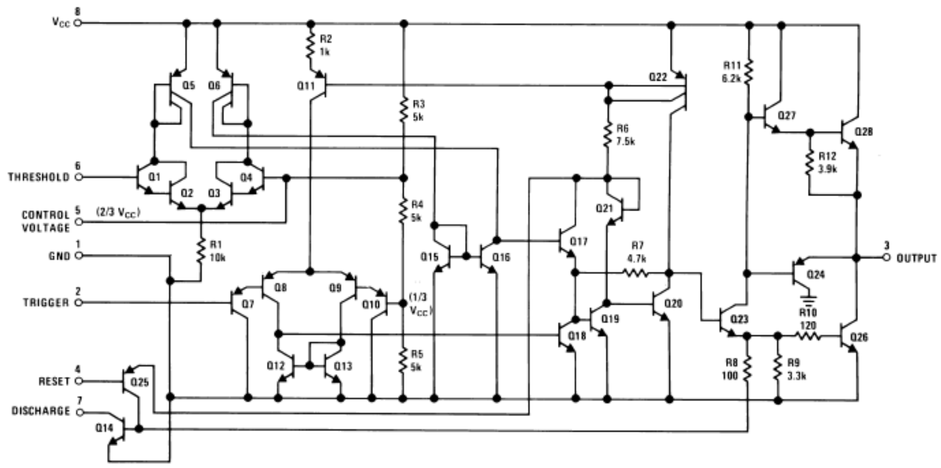
Features

- Direct replacement for SE555/NE555
- Timing from microseconds through hours
- Operates in both astable and monostable modes
- Adjustable duty cycle
- Output can source or sink 200 mA
- Output and supply TTL compatible
- Temperature stability better than 0.005% per °C
- Normally on and normally off output
- Available in 8-pin MSOP package

Applications

- Precision timing
- Pulse generation
- Sequential timing
- Time delay generation
- Pulse width modulation
- Pulse position modulation
- Linear ramp generator

Schematic Diagram

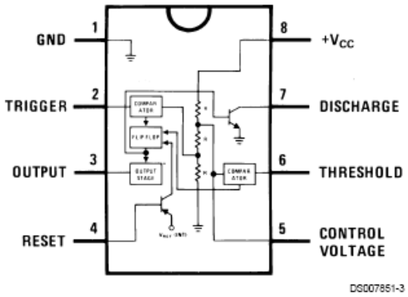


DS007851-1

 DS007851

Connection Diagram

Dual-In-Line, Small Outline and Molded Mini Small Outline Packages



Top View

Ordering Information

Package	Part Number	Package Marking	Media Transport	NSC Drawing
8-Pin SOIC	LM555CM	LM555CM	Rails	M08A
	LM555CMX	LM555CM	2.5k Units Tape and Reel	
8-Pin MSOP	LM555CMM	Z55	1k Units Tape and Reel	MUA08A
	LM555CMMX	Z55	3.5k Units Tape and Reel	
8-Pin MDIP	LM555CN	LM555CN	Rails	N08E

Absolute Maximum Ratings (Note 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Supply Voltage	+18V
Power Dissipation (Note 3)	
LM555CM, LM555CN	1180 mW
LM555CMM	613 mW
Operating Temperature Ranges	
LM555C	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Soldering Information	
Dual-In-Line Package	
Soldering (10 Seconds)	260°C
Small Outline Packages (SOIC and MSOP)	
Vapor Phase (60 Seconds)	215°C
Infrared (15 Seconds)	220°C

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

Electrical Characteristics (Notes 1, 2)

(T_A = 25°C, V_{CC} = +5V to +15V, unless othewise specified)

Parameter	Conditions	Limits			Units
		LM555C			
		Min	Typ	Max	
Supply Voltage		4.5		16	V
Supply Current	V_{CC} = 5V, R_L = ∞ V_{CC} = 15V, R_L = ∞ (Low State) (Note 4)		3 10	6 15	mA
Timing Error, Monostable					
Initial Accuracy			1		%
Drift with Temperature	R_A = 1k to 100kΩ, C = 0.1μF, (Note 5)		50		ppm/°C
Accuracy over Temperature			1.5		%
Drift with Supply			0.1		%/V
Timing Error, Astable					
Initial Accuracy			2.25		%
Drift with Temperature	R_A, R_B = 1k to 100kΩ, C = 0.1μF, (Note 5)		150		ppm/°C
Accuracy over Temperature			3.0		%
Drift with Supply			0.30		%/V
Threshold Voltage			0.667		x V_{CC}
Trigger Voltage	V_{CC} = 15V		5		V
	V_{CC} = 5V		1.67		V
Trigger Current			0.5	0.9	μA
Reset Voltage		0.4	0.5	1	V
Reset Current			0.1	0.4	mA
Threshold Current	(Note 6)		0.1	0.25	μA
Control Voltage Level	V_{CC} = 15V V_{CC} = 5V	9 2.6	10 3.33	11 4	V
Pin 7 Leakage Output High			1	100	nA
Pin 7 Sat (Note 7)					
Output Low	V_{CC} = 15V, I_7 = 15mA		180		mV
Output Low	V_{CC} = 4.5V, I_7 = 4.5mA		80	200	mV

Electrical Characteristics (Notes 1, 2) (Continued)

(T_A = 25°C, V_{CC} = +5V to +15V, unless othewise specified)

Parameter	Conditions	Limits			Units
		LM555C			
		Min	Typ	Max	
Output Voltage Drop (Low)	V_{CC} = 15V				
	I_{SINK} = 10mA		0.1	0.25	V
	I_{SINK} = 50mA		0.4	0.75	V
	I_{SINK} = 100mA		2	2.5	V
	I_{SINK} = 200mA		2.5		V
	V_{CC} = 5V				
	I_{SINK} = 8mA				V
	I_{SINK} = 5mA		0.25	0.35	V
Output Voltage Drop (High)	I_{SOURCE} = 200mA, V_{CC} = 15V		12.5		V
	I_{SOURCE} = 100mA, V_{CC} = 15V	12.75	13.3		V
	V_{CC} = 5V	2.75	3.3		V
Rise Time of Output			100		ns
Fall Time of Output			100		ns

Note 1: All voltages are measured with respect to the ground pin, unless otherwise specified.

Note 2: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

Note 3: For operating at elevated temperatures the device must be derated above 25°C based on a +150°C maximum junction temperature and a thermal resistance of 106°C/W (DIP), 170°C/W (S0-8), and 204°C/W (MSOP) junction to ambient.

Note 4: Supply current when output high typically 1 mA less at V_{CC} = 5V.

Note 5: Tested at V_{CC} = 5V and V_{CC} = 15V.

Note 6: This will determine the maximum value of $R_A + R_B$ for 15V operation. The maximum total ($R_A + R_B$) is 20MΩ.

Note 7: No protection against excessive pin 7 current is necessary providing the package dissipation rating will not be exceeded.

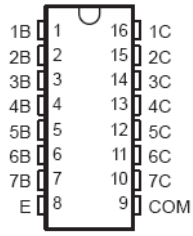
Note 8: Refer to RETS555X drawing of military LM555H and LM555J versions for specifications.

ULN2003AI
HIGH-VOLTAGE, HIGH-CURRENT
DARLINGTON TRANSISTOR ARRAY

SLRS054A – JULY 2003 – REVISED MARCH 2004

- **500-mA-Rated Collector Current (Single Output)**
- **High-Voltage Outputs . . . 50 V**
- **Output Clamp Diodes**
- **Inputs Compatible With Various Types of Logic**
- **Relay-Driver Applications**

D OR N PACKAGE
(TOP VIEW)



description/ordering information

The ULN2003AI is a high-voltage, high-current Darlington transistor array. This device consists of seven npn Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of a single Darlington pair is 500 mA. The Darlington pairs can be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers.

The ULN2003AI has a 2.7-kΩ series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices.

ORDERING INFORMATION

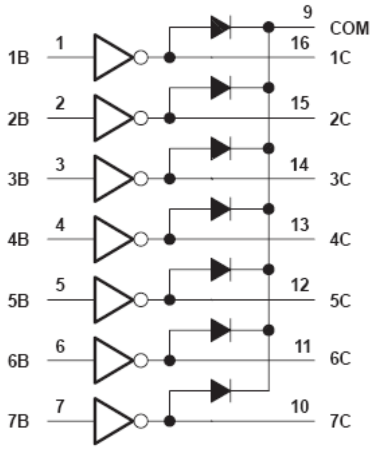
T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
−40°C to 105°C	PDIP (N)	Tube of 425	ULN2003AIN	ULN2003AIN
	SOIC (D)	Tube of 40	ULN2003AID	ULN2003AI
		Reel of 2500	ULN2003AIDR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

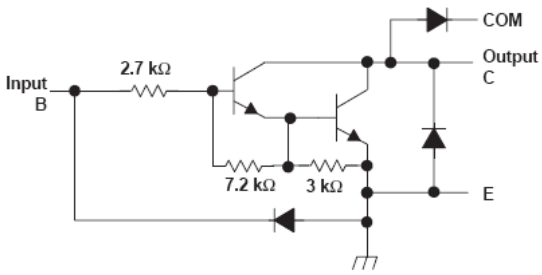
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

logic diagram



schematics (each Darlington pair)



All resistor values shown are nominal.

absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)†

Collector-emitter voltage . . . . . 50 V
Clamp diode reverse voltage (see Note 1) . . . . . 50 V
Input voltage, V_I (see Note 1) . . . . . 30 V
Peak collector current (see Notes 2 and 4) . . . . . 500 mA
Output clamp current, I_{OK} . . . . . 500 mA
Total emitter-terminal current . . . . . −2.5 A
Operating free-air temperature range, T_A . . . . . −40°C to 105°C
Package thermal impedance, θ_{JA} (see Notes 2 and 3): D package . . . . . 73°C/W
N package . . . . . 67°C/W
Operating virtual junction temperature, T_J . . . . . 150°C
Storage temperature range, T_{stg} . . . . . −65°C to 150°C

† 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 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.

NOTES: 1. All voltage values are with respect to the emitter/substrate terminal E, unless otherwise noted.
2. 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.
3. The package thermal impedance is calculated in accordance with JESD 51-7.

electrical characteristics, T_A = 25°C

PARAMETER		TEST FIGURE	TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{I(on)}$	On-state input voltage	5	V_{CE} = 2 V	I_C = 200 mA			2.4	V
				I_C = 250 mA			2.7	
				I_C = 300 mA			3	
$V_{CE(sat)}$	Collector-emitter saturation voltage	4	I_I = 250 µA,	I_C = 100 mA		0.9	1.1	V
			I_I = 350 µA,	I_C = 200 mA		1	1.3	
			I_I = 500 µA,	I_C = 350 mA		1.2	1.6	
I_{CEX}	Collector cutoff current	1	V_{CE} = 50 V,	I_I = 0			50	µA
V_F	Clamp forward voltage	7	I_F = 350 mA			1.7	2	V
$I_{I(off)}$	Off-state input current	2	V_{CE} = 50 V,	I_C = 500 µA,	50	65		µA
I_I	Input current	3	V_I = 3.85 V			0.93	1.35	mA
I_R	Clamp reverse current	6	V_R = 50 V				50	µA
C_i	Input capacitance		V_I = 0,	f = 1 MHz		15	25	pF

electrical characteristics, T_A = −40°C to 105°C

PARAMETER		TEST FIGURE	TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{I(on)}$	On-state input voltage	5	V_{CE} = 2 V	I_C = 200 mA			2.7	V
				I_C = 250 mA			2.9	
				I_C = 300 mA			3	
$V_{CE(sat)}$	Collector-emitter saturation voltage	4	I_I = 250 µA,	I_C = 100 mA		0.9	1.2	V
			I_I = 350 µA,	I_C = 200 mA		1	1.4	
			I_I = 500 µA,	I_C = 350 mA		1.2	1.7	
I_{CEX}	Collector cutoff current	1	V_{CE} = 50 V,	I_I = 0			100	µA
V_F	Clamp forward voltage	7	I_F = 350 mA			1.7	2.2	V
$I_{I(off)}$	Off-state input current	2	V_{CE} = 50 V,	I_C = 500 µA	30	65		µA
I_I	Input current	3	V_I = 3.85 V			0.93	1.35	mA
I_R	Clamp reverse current	6	V_R = 50 V				100	µA
C_i	Input capacitance		V_I = 0,	f = 1 MHz		15	25	pF

switching characteristics, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low- to high-level output	See Figure 8		0.25	1	µs
t_{PHL}	Propagation delay time, high- to low-level output	See Figure 8		0.25	1	µs
V_{OH}	High-level output voltage after switching	V_S = 50 V, $I_O \approx$ 300 mA, See Figure 9	V_S−20			mV

switching characteristics, T_A = −40°C to 105°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low- to high-level output	See Figure 8		1	10	µs
t_{PHL}	Propagation delay time, high- to low-level output	See Figure 8		1	10	µs
V_{OH}	High-level output voltage after switching	V_S = 50 V, $I_O \approx$ 300 mA, See Figure 9	V_S−50			mV

PARAMETER MEASUREMENT INFORMATION

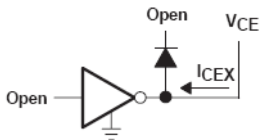


Figure 1. I_{CEX} Test Circuit

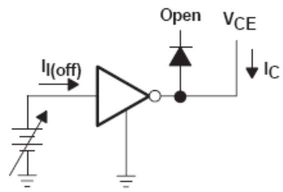


Figure 2. $I_{I(off)}$ Test Circuit

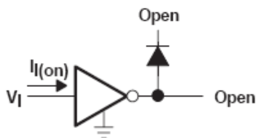
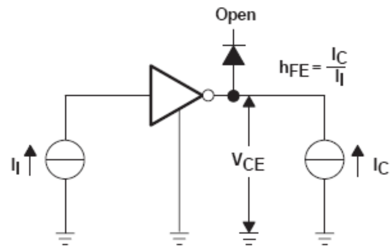


Figure 3. I_I Test Circuit



NOTE: I_I is fixed for measuring $V_{CE(sat)}$, variable for measuring h_{FE}.

Figure 4. h_{FE}, $V_{CE(sat)}$ Test Circuit

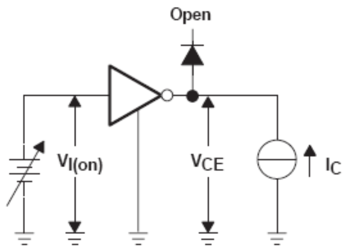


Figure 5. $V_{I(on)}$ Test Circuit

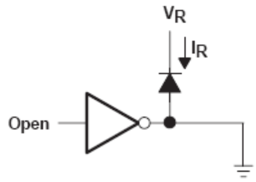


Figure 6. I_R Test Circuit

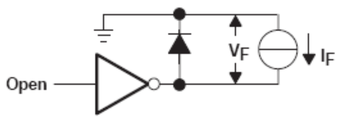
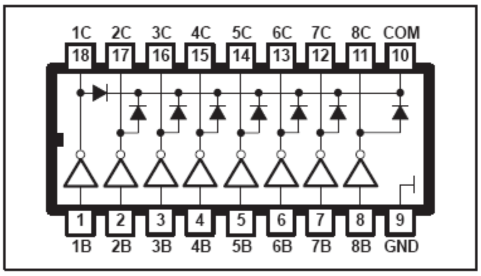


Figure 7. V_F Test Circuit

HIGH-VOLTAGE, HIGH-CURRENT DARLINGTON TRANSISTOR ARRAY

- 500-mA-Rated Collector Current (Single Output)
- High-Voltage Outputs . . . 50 V
- Output Clamp Diodes
- Inputs Compatible With Various Types of Logic
- Relay Driver Applications
- Compatible With ULN2800A-Series

N DUAL-IN-LINE PACKAGE
(TOP VIEW)



description

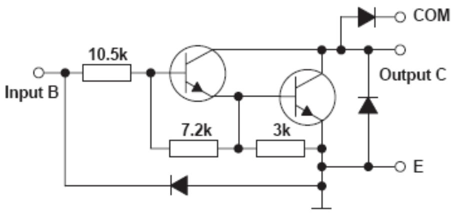
The ULN2804A is a monolithic high-voltage, high-current Darlington transistor array, comprising eight npn Darlington pairs. All units feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of each Darlington pair is 500 mA. Outputs and inputs can each be paralleled for higher current capability.

Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers.

The ULN2804A has an approximate 10.5-kΩ series input resistor to allow its operation directly from CMOS or PMOS, utilizing supply voltages of 6 to 15 volts.

The ULN2804A is characterized for operation from –20°C to 85°C.

schematic (each Darlington pair)



absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)

Collector-emitter voltage	50 V
Input voltage (see Note 1)	30 V
Continuous collector current	500 mA
Output clamp diode current	500 mA
Total substrate-terminal current	–2.5 A
Continuous dissipation (total package) at (or below) 25°C free air temperature (see Note 2)	1150 mW
Operating free-air temperature range	–20°C to 85°C
Storage temperature range	–65°C to 150°C
Lead temperature 1/16 inch from case for 10 seconds	260°C

NOTES: 1. All voltages values, unless otherwise noted, are with respect to the emitter/substrate terminal E.
2. For operation above 25°C free-air temperature, refer to the Dissipation Derating Curves in the Thermal Information section.

electrical characteristics at 25°C free-air temperature (unless otherwise noted)

PARAMETER		TEST FIGURE	TEST CONDITIONS		ULN2804A MIN	ULN2804A TYP	ULN2804A MAX	UNIT
I_{CEX}	Collector cutoff current	1	V_{CE} = 50 V,	I_I = 0			50	µA
		2	T_A = 70°C, V_I = 1 V, V_{CE} = 50 V				500	
$I_{I(off)}$	Off-state input current	3	V_{CE} = 50 V, I_C = 500 µA, T_A = 70°C		50	65		µA
$I_{I(ON)}$	Input current	4	V_I = 3.85 V					mA
			V_I = 5 V			0.35	0.5	
			V_I = 12 V			1.0	1.45	
$V_{I(on)}$	On-state input voltage	6	V_{CE} = 2 V,	I_C = 125 mA			5	V
			V_{CE} = 2 V,	I_C = 200 mA			6	
			V_{CE} = 2 V,	I_C = 250 mA				
			V_{CE} = 2 V,	I_C = 275 mA			7	
			V_{CE} = 2 V,	I_C = 300 mA				
			V_{CE} = 2 V,	I_C = 350 mA			8	
$V_{CE(sat)}$	Collector-emitter saturation voltage	5	I_I = 250 µA,	I_C = 100 mA		0.9	1.1	V
			I_I = 350 µA,	I_C = 200 mA		1.0	1.3	
			I_I = 500 µA,	I_C = 350 mA		1.3	1.6	
I_R	Clamp-diode reverse current	7	V_R = 50 V				50	µA
V_F	Clamp-diode forward voltage	8	I_F = 350 mA			1.7	2	V
C_i	Input capacitance		V_I = 0 V,	f = 1 MHz		15	25	pF

switching characteristics at 25°C free-air temperature

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low- to high-level output	See Figure 9		0.25	1	µs
t_{PHL}	Propagation delay time, high- to low-level output			0.25	1	µs
V_{OH}	High-level output voltage after switching	V_S = 50 V, I_O = 300 mA, See Figure 10	V_S – 20			mV

PARAMETER MEASUREMENT INFORMATION

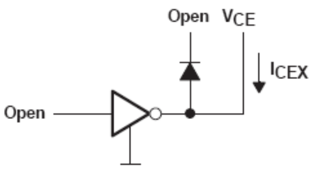


Figure 1. I_{CEX}

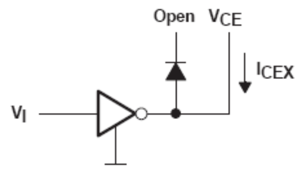


Figure 2. I_{CEX}

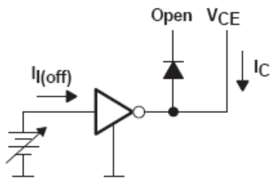


Figure 3. $I_{I(off)}$

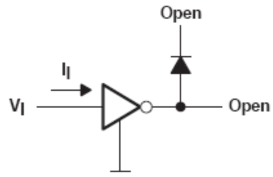


Figure 4. $I_{I(on)}$

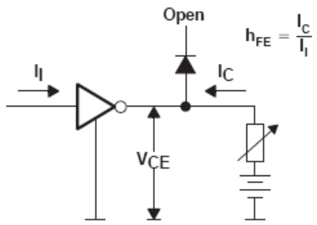


Figure 5. h_{FE}, $V_{CE(sat)}$

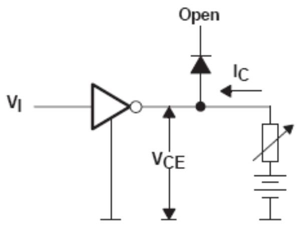


Figure 6. $V_{I(on)}$

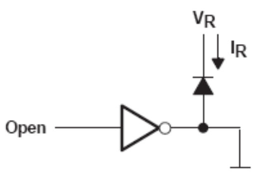


Figure 7. I_R

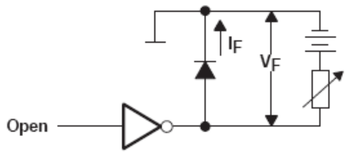


Figure 8. V_F