



**THE DATASHEET OF  
CY74FCT2652ATQCT**

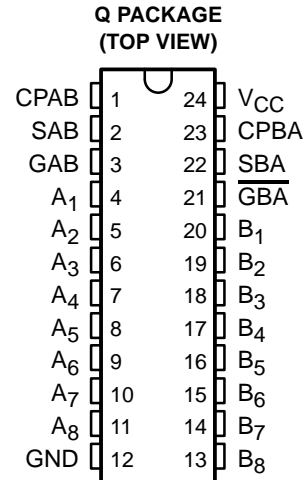


# CY74FCT2652T

## 8-BIT REGISTERED TRANSCEIVER WITH 3-STATE OUTPUTS

SCCS044B – MAY 1994 – REVISED NOVEMBER 2001

- Function and Pinout Compatible With FCT and F Logic
- 25-Ω Output Series Resistors Reduce Transmission-Line Reflection Noise
- Reduced  $V_{OH}$  (Typically = 3.3 V) Versions of Equivalent FCT Functions
- Edge-Rate Control Circuitry for Significantly Improved Noise Characteristics
- $I_{off}$  Supports Partial-Power-Down Mode Operation
- Matched Rise and Fall Times
- Fully Compatible With TTL Input and Output Logic Levels
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)
  - 1000-V Charged-Device Model (C101)
- 12-mA Output Sink Current  
15-mA Output Source Current
- Independent Register for A and B Buses
- Multiplexed Real-Time and Stored Data Transfer
- 3-State Outputs



### description

The CY74FCT2652T consists of bus transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the input bus or from the internal storage registers. Control (GAB and  $\overline{GBA}$ ) inputs control the transceiver functions. Select-control (SAB and SBA) inputs select either real-time or stored data transfer.

The circuitry used for select control eliminates the typical decoding glitch that occurs in a multiplexer during transition between stored and real-time data. A low input level selects real-time data, and a high level selects stored data. Data on the A or B data bus, or both, can be stored in the internal D flip-flops by low-to-high transitions at the appropriate clock (CPAB or CPBA) inputs, regardless of levels at the select- or enable-control inputs. When SAB and SBA are in the real-time transfer mode, it also is possible to store data without using the internal D-type flip-flops by simultaneously enabling GAB and  $\overline{GBA}$ . In this configuration, each output reinforces its input. Thus, when all other data sources to the two sets of bus lines are at high impedance, each set of bus lines remains at its last state.

On-chip termination resistors at the outputs reduce system noise caused by reflections. The CY74FCT2652T can replace the CY74FCT652T to reduce noise in existing designs.

This device is fully specified for partial-power-down applications using  $I_{off}$ . The  $I_{off}$  circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.



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.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

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SCCS044B – MAY 1994 – REVISED NOVEMBER 2001

**ORDERING INFORMATION**

TA	PACKAGE†		SPEED (ns)	ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	QSOP – Q	Tape and reel	5.4	CY74FCT2652CTQCT	FCT2652C
	QSOP – Q	Tape and reel	6.3	CY74FCT2652ATQCT	FCT2652A

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

**FUNCTION TABLE**

INPUTS						DATA I/O		OPERATION OR FUNCTION
GAB	$\overline{\text{GBA}}$	CPAB	CPBA	SAB	SBA	A <sub>1</sub> –A <sub>8</sub>	B <sub>1</sub> –B <sub>8</sub>	
L	H	H or L	H or L	X	X	Input	Input	Isolation
L	H	↑	↑	X	X	Input	Input	Store A and B data
X	H	↑	H or L	X	X	Input	Unspecified§	Store A data, hold B data
H	H	↑	↑	X‡	X	Input	Output	Store A data in both registers
L	X	H or L	↑	X	X	Unspecified§	Input	Hold A data, store B data
L	L	↑	↑	X	X‡	Output	Input	Store B data in both registers
L	L	X	X	X	L	Output	Input	Real-time B data to A bus
L	L	X	H or L	X	H	Output	Input	Stored B data to A bus
H	H	X	X	L	X	Input	Output	Real-time A data to B bus
H	H	H or L	X	H	X	Input	Output	Stored A data to B bus
H	L	H or L	H or L	H	H	Output	Output	Stored A data to B bus and stored B data to A bus

H = High logic level, L = Low logic level, X = Don't care, ↑ = Low-to-high clock transition

‡ Select control = L: clocks can occur simultaneously.

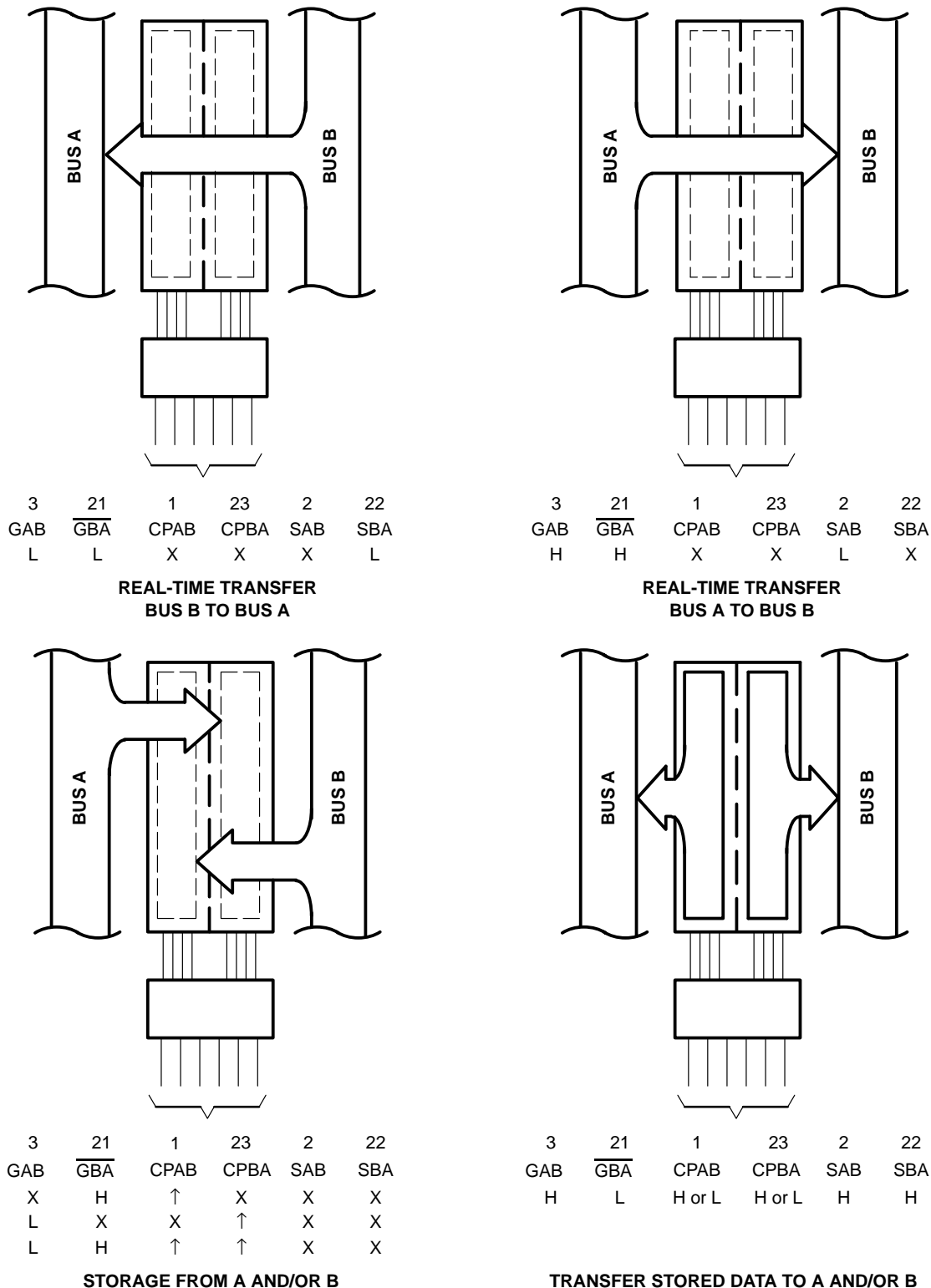
Select control = H: clocks must be staggered in order to load both registers.

§ The data output functions can be enabled or disabled by various signals at GAB or  $\overline{\text{GBA}}$ . Data input functions always are enabled, i.e., data at the bus pins is stored on every low-to-high transition of the clock inputs.



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SCCS044B – MAY 1994 – REVISED NOVEMBER 2001

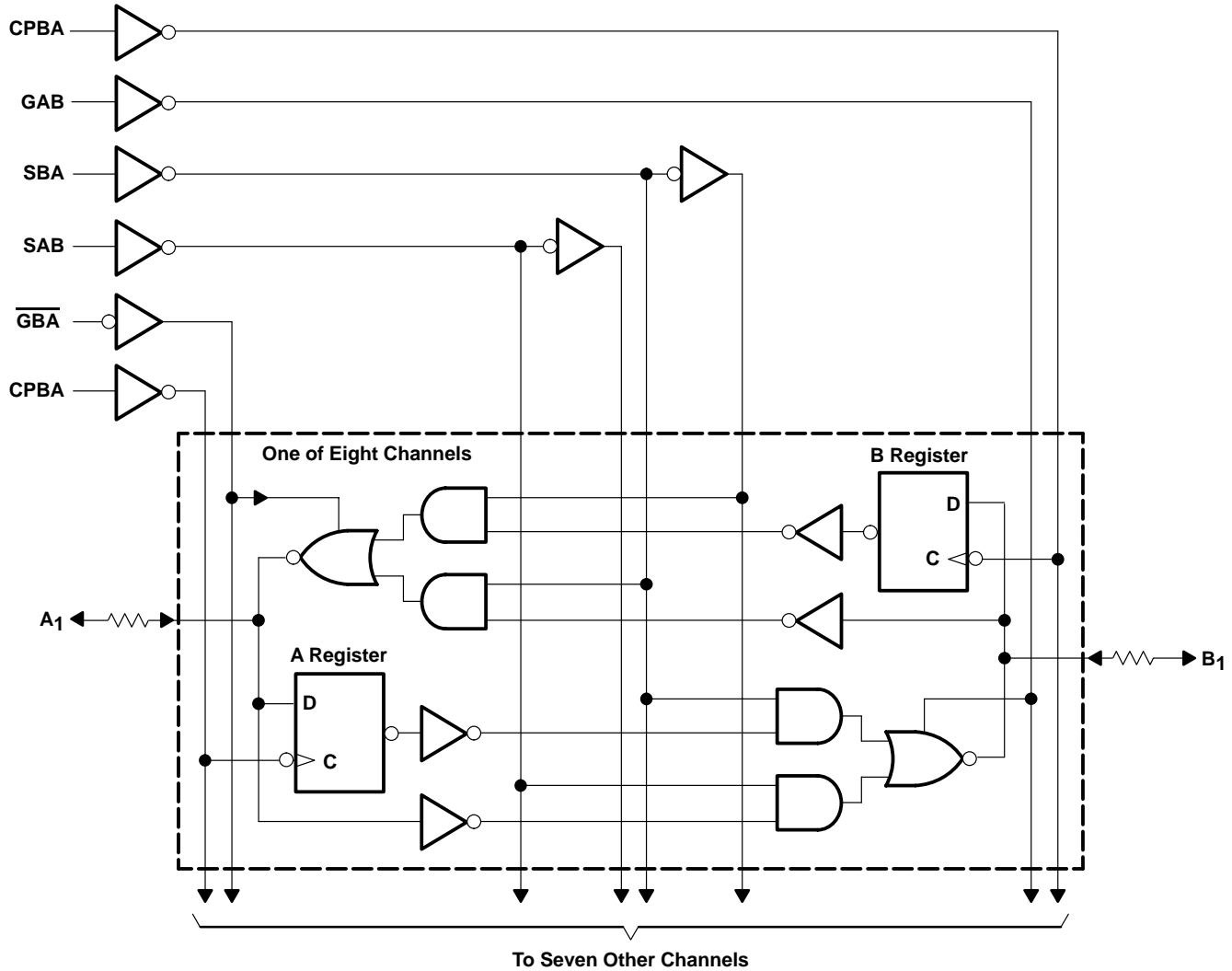


**Figure 1. Bus-Management Functions**

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SCCS044B – MAY 1994 – REVISED NOVEMBER 2001

**logic diagram**



**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†**

Supply voltage range to ground potential .....	-0.5 V to 7 V
DC input voltage range .....	-0.5 V to 7 V
DC output voltage range .....	-0.5 V to 7 V
DC output current (maximum sink current/pin) .....	120 mA
Package thermal impedance, $\theta_{JA}$ (see Note 1) .....	61°C/W
Ambient temperature range with power applied, $T_A$ .....	-65°C to 135°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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51-7.



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SCCS044B – MAY 1994 – REVISED NOVEMBER 2001

**recommended operating conditions (see Note 2)**

	MIN	NOM	MAX	UNIT
V <sub>CC</sub> Supply voltage	4.75	5	5.25	V
V <sub>IH</sub> High-level input voltage	2			V
V <sub>IL</sub> Low-level input voltage			0.8	V
I <sub>OH</sub> High-level output current			-15	mA
I <sub>OL</sub> Low-level output current			12	mA
T <sub>A</sub> Operating free-air temperature	-40		85	°C

NOTE 2: All unused inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation.



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SCCS044B – MAY 1994 – REVISED NOVEMBER 2001

**electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)**

PARAMETER	TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V <sub>IK</sub>	V <sub>CC</sub> = 4.75,	I <sub>IN</sub> = -18 mA		-0.7	-1.2	V
V <sub>OH</sub>	V <sub>CC</sub> = 4.75,	I <sub>OH</sub> = -15 mA	2.4	3.3		V
V <sub>OL</sub>	V <sub>CC</sub> = 4.75,	I <sub>OL</sub> = 12 mA		0.3	0.55	V
R <sub>out</sub>	V <sub>CC</sub> = 4.75,	I <sub>OL</sub> = 12 mA	20	25	40	Ω
V <sub>hys</sub>	All inputs			0.2		V
I <sub>I</sub>	V <sub>CC</sub> = 5.25 V,	V <sub>IN</sub> = V <sub>CC</sub>			5	μA
I <sub>IH</sub>	V <sub>CC</sub> = 5.25 V,	V <sub>IN</sub> = 2.7 V			±1	μA
I <sub>IL</sub>	V <sub>CC</sub> = 5.25 V,	V <sub>IN</sub> = 0.5 V			±1	μA
I <sub>OZH</sub>	V <sub>CC</sub> = 5.25 V,	V <sub>OUT</sub> = 2.7 V			10	μA
I <sub>OZL</sub>	V <sub>CC</sub> = 5.25 V,	V <sub>OUT</sub> = 0.5 V			-10	μA
I <sub>OS</sub> ‡	V <sub>CC</sub> = 5.25 V,	V <sub>OUT</sub> = 0 V	-60	-120	-225	mA
I <sub>off</sub>	V <sub>CC</sub> = 0 V,	V <sub>OUT</sub> = 4.5 V			±1	μA
I <sub>CC</sub>	V <sub>CC</sub> = 5.25 V,	V <sub>IN</sub> ≤ 0.2 V, V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V		0.1	0.2	mA
ΔI <sub>CC</sub>	V <sub>CC</sub> = 5.25 V, V <sub>IN</sub> = 3.4 V§, f <sub>1</sub> = 0, Outputs open			0.5	2	mA
I <sub>CCD</sub> ¶	V <sub>CC</sub> = 5.25 V, One input switching at 50% duty cycle, Outputs open, GAB = GBA = GND, V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V			0.06	0.12	mA/MHz
I <sub>C</sub> #	V <sub>CC</sub> = 5.25 V, Outputs open, GAB = GBA = GND, SAB = CPAB = GND, SBA = V <sub>CC</sub>	One bit switching at f <sub>1</sub> = 5 MHz at 50% duty cycle	V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V	0.7	1.4	mA
			V <sub>IN</sub> = 3.4 V or GND	1.2	3.4	
		Eight bits switching at f <sub>1</sub> = 5 MHz at 50% duty cycle	V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V	2.8	5.6	
			V <sub>IN</sub> = 3.4 V or GND	5.1	14.6	
C <sub>i</sub>				5	10	pF
C <sub>o</sub>				9	12	pF

† Typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

‡ Not more than one output should be shorted at a time. Duration of short should not exceed one second. The use of high-speed test apparatus and/or sample-and-hold techniques are preferable to minimize internal chip heating and more accurately reflect operational values. Otherwise, prolonged shorting of a high output can raise the chip temperature well above normal and cause invalid readings in other parametric tests. In any sequence of parameter tests, I<sub>OS</sub> tests should be performed last.

§ Per TTL-driven input (V<sub>IN</sub> = 3.4 V); all other inputs at V<sub>CC</sub> or GND

¶ This parameter is derived for use in total power-supply calculations.

$$\# I_C = I_{CC} + \Delta I_{CC} \times D_H \times N_T + I_{CCD} (f_0/2 + f_1 \times N_1)$$

Where:

I<sub>C</sub> = Total supply current

I<sub>CC</sub> = Power-supply current with CMOS input levels

ΔI<sub>CC</sub> = Power-supply current for a TTL high input (V<sub>IN</sub> = 3.4 V)

D<sub>H</sub> = Duty cycle for TTL inputs high

N<sub>T</sub> = Number of TTL inputs at D<sub>H</sub>

I<sub>CCD</sub> = Dynamic current caused by an input transition pair (HLH or LHL)

f<sub>0</sub> = Clock frequency for registered devices, otherwise zero

f<sub>1</sub> = Input signal frequency

N<sub>1</sub> = Number of inputs changing at f<sub>1</sub>

All currents are in milliamperes and all frequencies are in megahertz.

|| Values for these conditions are examples of the I<sub>CC</sub> formula.



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SCCS044B – MAY 1994 – REVISED NOVEMBER 2001

**timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2)**

		CY74FCT2652AT		CY74FCT2652CT		UNIT
		MIN	MAX	MIN	MAX	
$t_w^\dagger$	Pulse duration, clock	2		2		ns
$t_{su}$	Setup time, before clock $\uparrow$	A or B		1.5		ns
$t_h$	Hold time, after clock $\uparrow$	A or B		5		ns

$\dagger$  With one data channel switching,  $t_{w(L)} = t_{w(H)} = 4$  ns and  $t_r = t_f = 1$  ns.

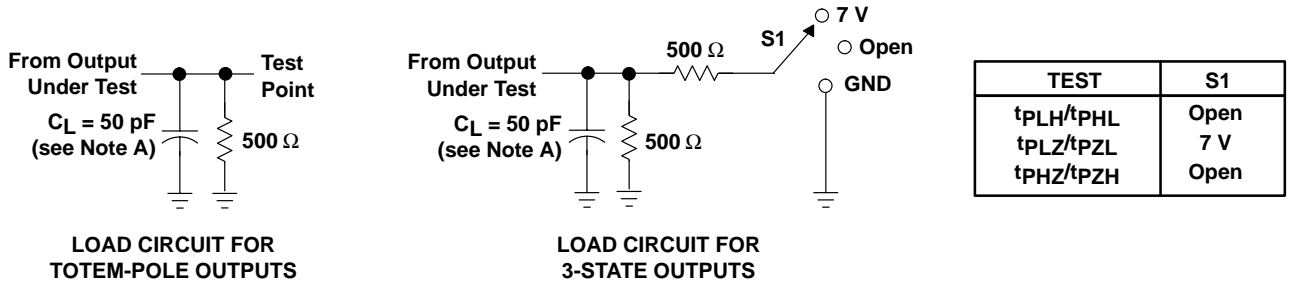
**switching characteristics over operating free-air temperature range (see Figure 2)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	CY74FCT2652AT		CY74FCT2652CT		UNIT
			MIN	MAX	MIN	MAX	
$t_{PLH}$	A or B	B or A	1.5	6.3	1.5	5.4	ns
$t_{PHL}$			1.5	6.3	1.5	5.4	
$t_{PZH}$	GAB or $\overline{GBA}$	B or A	1.5	9.8	1.5	7.8	ns
$t_{PZL}$			1.5	9.8	1.5	7.8	
$t_{PHZ}$	GAB or $\overline{GBA}$	B or A	1.5	6.3	1.5	6.3	ns
$t_{PLZ}$			1.5	6.3	1.5	6.3	
$t_{PLH}$	CPAB or CPBA	B or A	1.5	6.3	1.5	5.7	ns
$t_{PHL}$			1.5	6.3	1.5	5.7	
$t_{PLH}$	SAB or SBA	B or A	1.5	7.7	1.5	6.2	ns
$t_{PHL}$			1.5	7.7	1.5	6.2	

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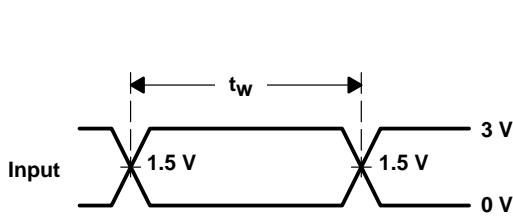
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**PARAMETER MEASUREMENT INFORMATION**

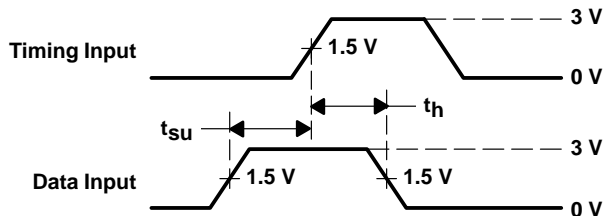


**LOAD CIRCUIT FOR TOTEM-POLE OUTPUTS**

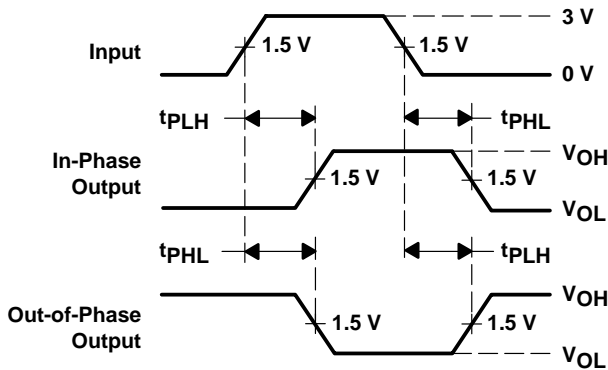
**LOAD CIRCUIT FOR 3-STATE OUTPUTS**



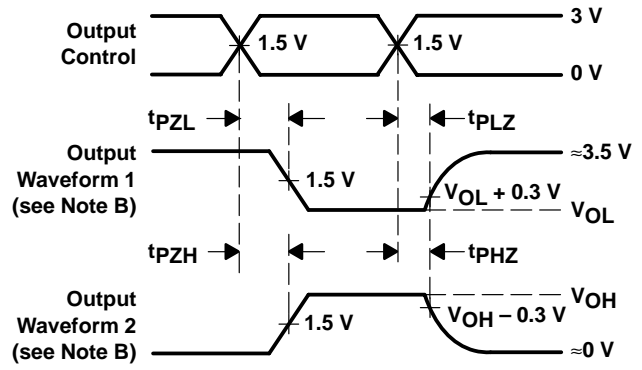
**VOLTAGE WAVEFORMS PULSE DURATION**



**VOLTAGE WAVEFORMS SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS PROPAGATION DELAY TIMES INVERTING AND NONINVERTING OUTPUTS**



**VOLTAGE WAVEFORMS ENABLE AND DISABLE TIMES LOW- AND HIGH-LEVEL ENABLING**

- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.  
 C. The outputs are measured one at a time with one input transition per measurement.

**Figure 2. Load Circuit and Voltage Waveforms**

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CY74FCT2652ATQCT	ACTIVE	SSOP	DBQ	24	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	FCT2652A	Samples

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSELETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

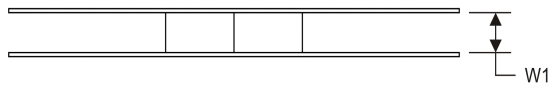
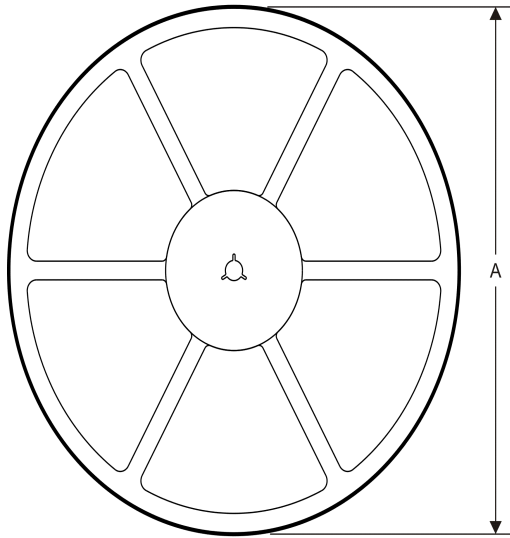
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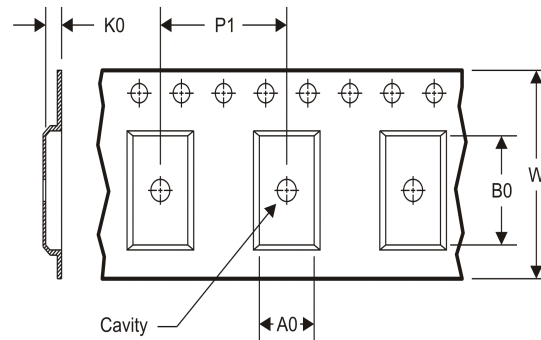


**TAPE AND REEL INFORMATION**

**REEL DIMENSIONS**



**TAPE DIMENSIONS**



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

**TAPE AND REEL INFORMATION**

\*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
CY74FCT2652ATQCT	SSOP	DBQ	24	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



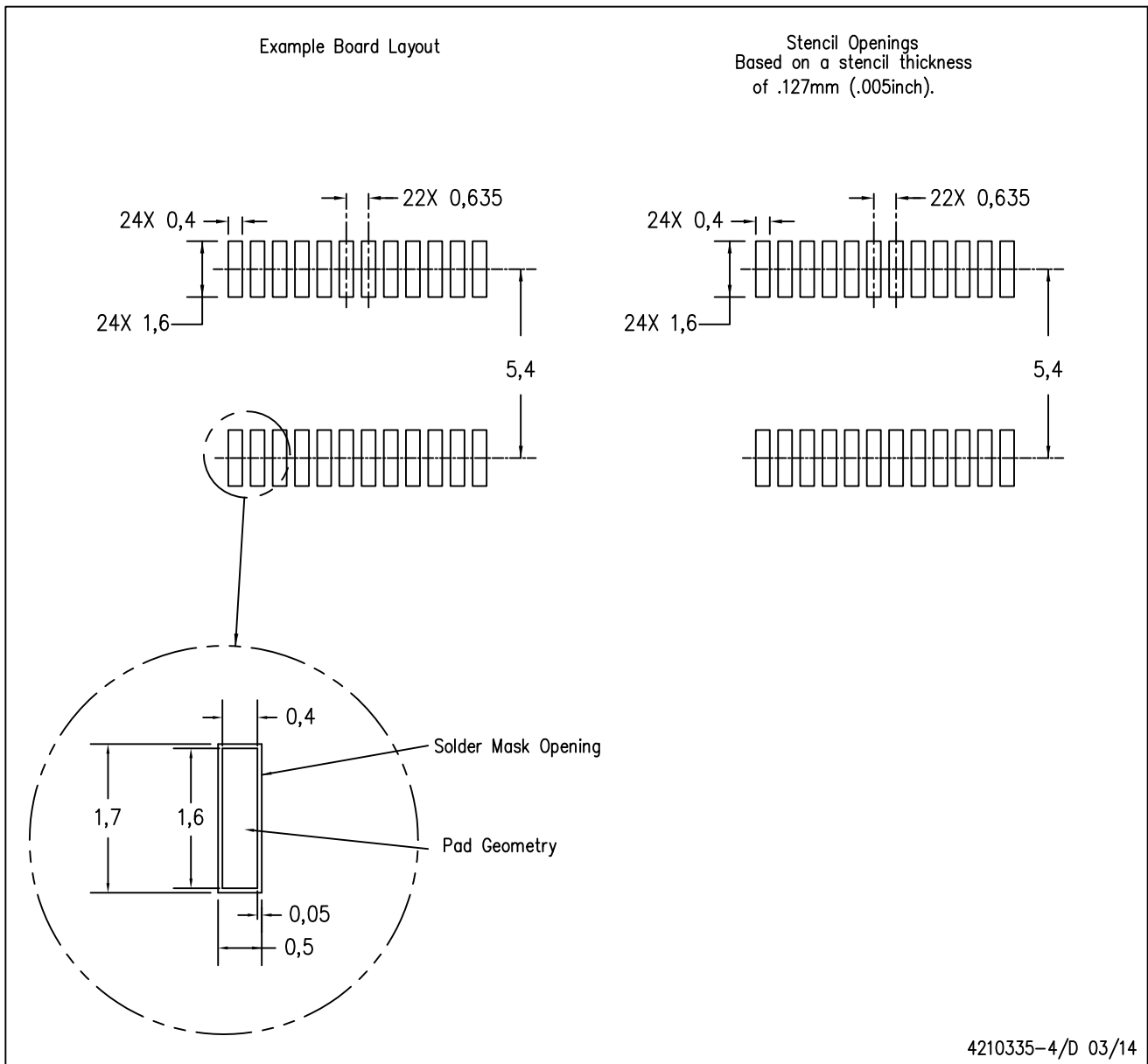
\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CY74FCT2652ATQCT	SSOP	DBQ	24	2500	367.0	367.0	38.0



DBQ (R-PDSO-G24)

PLASTIC SMALL OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

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### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
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