- **Member of the Texas Instruments *Widebus*™ Family**
- ***EPIC*™ (Enhanced-Performance Implanted CMOS) Submicron Process**
- ***DOC*™ (Dynamic Output Control) Circuit Dynamically Changes Output Impedance, Resulting in Noise Reduction Without Speed Degradation**
- **Dynamic Drive Capability Is Equivalent to Standard Outputs With I_{OH} and I_{OL} of ±24 mA at 2.5-V V_{CC}**
- **Overvoltage-Tolerant Inputs/Outputs Allow Mixed-Voltage-Mode Data Communications**
- **I_{off} Supports Partial-Power-Down Mode Operation**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class I**
- **Packaged in Thin Shrink Small-Outline Package**

description

A Dynamic Output Control (DOC) circuit is implemented, which, during the transition, initially lowers the output impedance to effectively drive the load and, subsequently, raises the impedance to reduce noise. Figure 1 shows typical V_{OL} vs I_{OL} and V_{OH} vs I_{OH} curves to illustrate the output impedance and drive capability of the circuit. At the beginning of the signal transition, the DOC circuit provides a maximum dynamic drive that is equivalent to a high-drive standard-output device. For more information, refer to the TI application reports, *AVC Logic Family Technology and Applications*, literature number SCEA006, and *Dynamic Output Control (DOC™) Circuitry Technology and Applications*, literature number SCEA009.

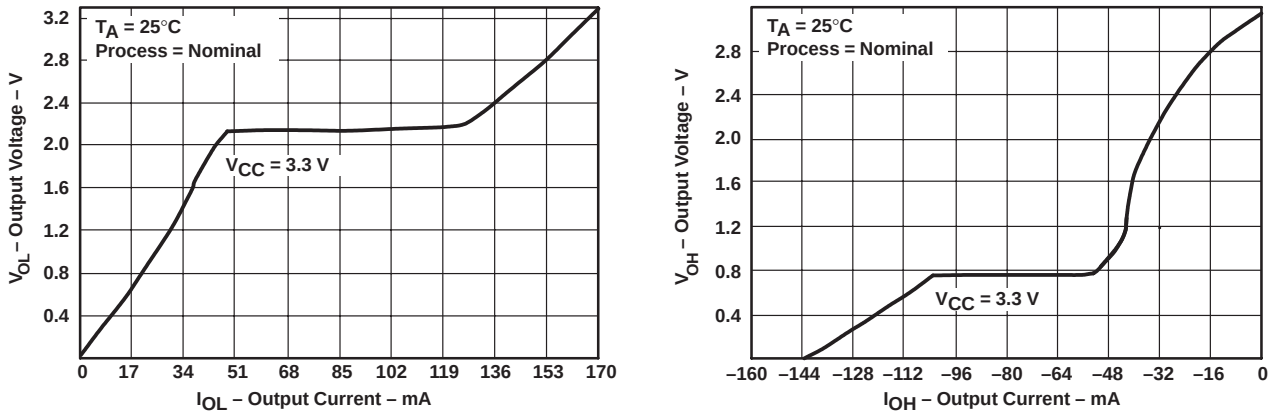


Figure 1. Output Voltage vs Output Current

This 22-bit flip-flop is designed for 3-V to 3.6-V V_{CC} operation.

The 22 flip-flops of the SN74AVCQ16722 are edge-triggered D-type flip-flops with a clock-enable ($\overline{CLKEN}$) input. On the positive transition of the clock (CLK) input, the device stores data into the flip-flops if $\overline{CLKEN}$ is low. If $\overline{CLKEN}$ is high, no data is stored.

A buffered output-enable ($\overline{OE}$) input places the 22 outputs in either a normal logic state (high or low) or the high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. $\overline{OE}$ does not affect the internal operation of the flip-flops. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

description (continued)

To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

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.

The SN74AVCQ16722 is characterized for operation from 0°C to 70°C.

terminal assignments

DGG PACKAGE
(TOP VIEW)

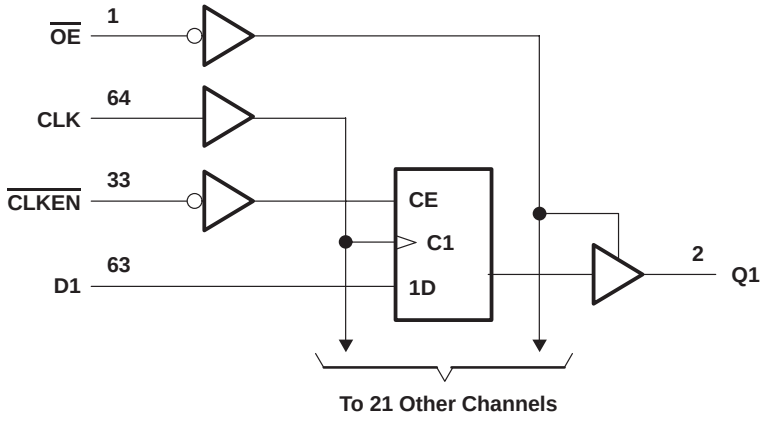
$\overline{OE}$	1	64	CLK
Q1	2	63	D1
Q2	3	62	D2
GND	4	61	GND
Q3	5	60	D3
Q4	6	59	D4
V_{CC}	7	58	V_{CC}
Q5	8	57	D5
Q6	9	56	D6
Q7	10	55	D7
GND	11	54	GND
Q8	12	53	D8
Q9	13	52	D9
Q10	14	51	D10
Q11	15	50	D11
Q12	16	49	D12
Q13	17	48	D13
GND	18	47	GND
Q14	19	46	D14
Q15	20	45	D15
Q16	21	44	D16
V_{CC}	22	43	V_{CC}
Q17	23	42	D17
Q18	24	41	D18
GND	25	40	GND
Q19	26	39	D19
Q20	27	38	D20
V_{CC}	28	37	V_{CC}
Q21	29	36	D21
Q22	30	35	D22
GND	31	34	GND
NC	32	33	$\overline{CLKEN}$

NC – No internal connection

FUNCTION TABLE
(each flip-flop)

INPUTS				OUTPUT
$\overline{OE}$	$\overline{CLKEN}$	CLK	D	Q
L	H	X	X	Q_0
L	L	↑	H	H
L	L	↑	L	L
L	L	L or H	X	Q_0
H	X	X	X	Z

logic diagram (positive logic)



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

Supply voltage range, V_{CC} . . . . . –0.5 V to 4.6 V
Input voltage range, V_I (see Note 1) . . . . . –0.5 V to 4.6 V
Voltage range applied to any output in the high-impedance or power-off state, V_O
(see Note 1) . . . . . –0.5 V to 4.6 V
Voltage range applied to any output in the high or low state, V_O
(see Notes 1 and 2) . . . . . –0.5 V to V_{CC} + 0.5 V
Input clamp current, I_{IK} (V_I < 0) . . . . . –50 mA
Output clamp current, I_{OK} (V_O < 0) . . . . . –50 mA
Continuous output current, I_O . . . . . ±50 mA
Continuous current through each V_{CC} or GND . . . . . ±100 mA
Package thermal impedance, θ_{JA} (see Note 3) . . . . . 55°C/W
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. The input and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
2. The output positive-voltage rating may be exceeded up to 4.6 V maximum if the output current rating is observed.
3. The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions (see Note 4)

			MIN	MAX	UNIT
V_{CC}	Supply voltage		3	3.6	V
V_{IH}	High-level input voltage		2		V
V_{IL}	Low-level input voltage			0.8	V
V_I	Input voltage		0	3.6	V
V_O	Output voltage	Active state	0	V_{CC}	V
		3-state	0	3.6	
I_{OHS}	Static high-level output current†			–12	mA
I_{OLS}	Static low-level output current†			12	mA
$\Delta t/\Delta v$	Input transition rise or fall rate			5	ns/V
T_A	Operating free-air temperature		0	70	°C

† Dynamic drive capability is equivalent to standard outputs with I_{OH} and I_{OL} of ±24 mA at 3.3-V V_{CC}. See Figure 1 for V_{OL} vs I_{OL} and V_{OH} vs I_{OH} characteristics. Refer to the TI application reports, ***AVC Logic Family Technology and Applications***, literature number **SCEA006**, and ***Dynamic Output Control (DOC™) Circuitry Technology and Applications***, literature number **SCEA009**.

NOTES: 4. All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

electrical characteristics over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS		V_{CC}	MIN	TYP‡	MAX	UNIT
V_{OH}		I_{OHS} = –100 µA		3 V to 3.6 V	V_{CC}–0.2			V
		I_{OHS} = –12 mA,	V_{IH} = 2 V	3 V	2.3			
V_{OL}		I_{OLS} = 100 µA		3 V to 3.6 V			0.2	V
		I_{OLS} = 12 mA,	V_{IL} = 0.8 V	3 V			0.7	
I_I	Control inputs	$V_I = V_{CC}$ or GND		3.6 V			±2.5	µA
I_{off}		V_I = 0 or 3.6 V		0			±10	µA
I_{OZ}		$V_O = V_{CC}$ or GND		3.6 V			±10	µA
I_{CC}		$V_I = V_{CC}$ or GND,	I_O = 0	3.6 V			40	µA
C_i	Control inputs	$V_I = V_{CC}$ or GND		3.3 V		3.5		pF
	Data inputs					2		
C_o	Outputs	$V_O = V_{CC}$ or GND		3.3 V		5.5		pF

‡ Typical values are measured at T_A = 25°C.

timing requirements over recommended operating conditions (unless otherwise noted) (see Figure 2)

			MIN	MAX	UNIT
f_{clock}	Clock frequency			200	MHz
t_w	Pulse duration, CLK high or low		2.5		ns
t_{su}	Setup time	Data before CLK↑	2.5		ns
		$\overline{\text{CLKEN}}$ before CLK↑	1.4		
t_h	Hold time	Data after CLK↑	0		ns
		$\overline{\text{CLKEN}}$ after CLK↑	1.2		

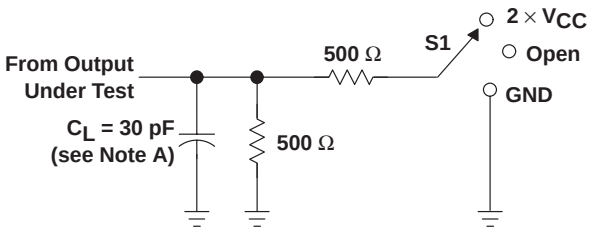
switching characteristics over recommended operating conditions (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	MAX	UNIT
f_{max}			200		MHz
t_{pd}	CLK	Q	1.7	4.3	ns
t_{en}	$\overline{OE}$	Q	1.4	4.3	ns
t_{dis}	$\overline{OE}$	Q	1.2	3.4	ns

operating characteristics, T_A = 25°C

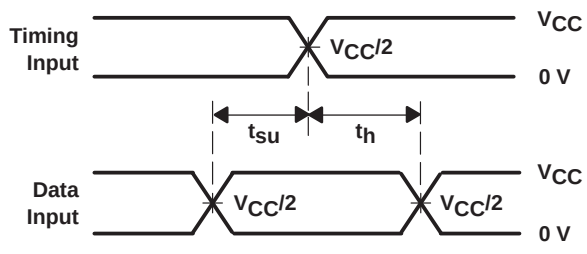
PARAMETER			TEST CONDITIONS	TYP	UNIT
C_{pd} Power dissipation capacitance		Outputs enabled	C_L = 0, f = 10 MHz	115	pF
		Outputs disabled		85	

PARAMETER MEASUREMENT INFORMATION

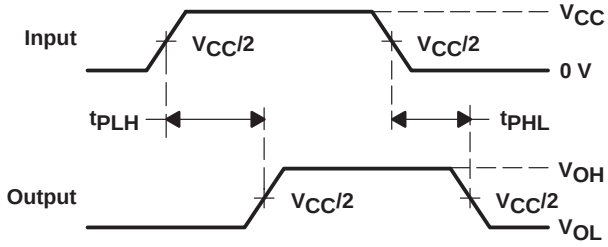


LOAD CIRCUIT

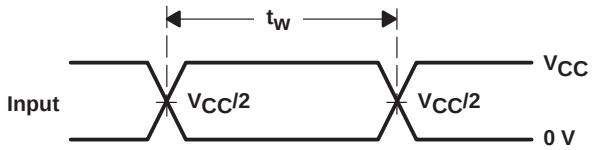
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 × V_{CC}
t_{PHZ}/t_{PZH}	GND



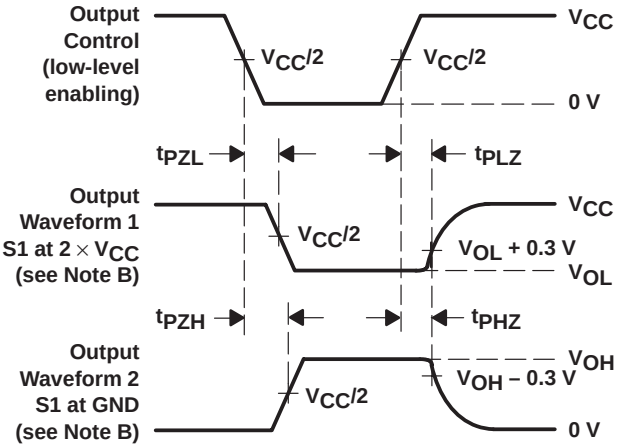
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

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. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2 ns, t_f ≤ 2 ns.
D. The outputs are measured one at a time with one transition per measurement.
E. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
F. t_{PZL} and t_{PZH} are the same as t_{en}.
G. t_{PLH} and t_{PHL} are the same as t_{pd}.

Figure 2. Load Circuit and Voltage Waveforms

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