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SN74ALVC7813-20DL

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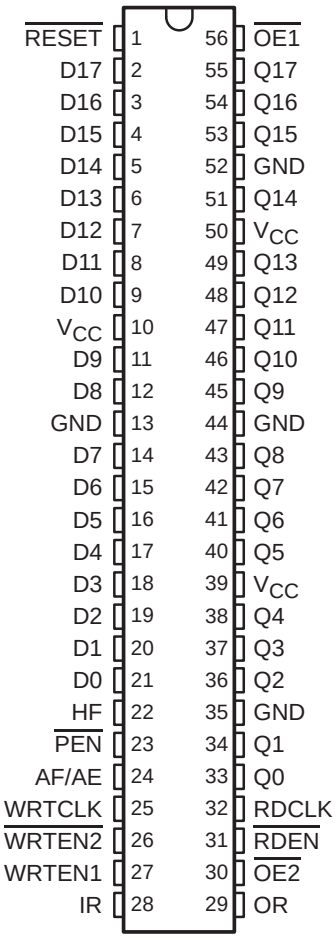
SN74ALVC7813
64 × 18
LOW-POWER CLOCKED FIRST-IN, FIRST-OUT MEMORY

SCAS594A – OCTOBER 1997 – REVISED APRIL 1998

- **Member of the Texas Instruments Widebus™ Family**
- **Low-Power Advanced CMOS Technology**
- **Operates From 3-V to 3.6-V V_{CC}**
- **Free-Running Read and Write Clocks Can Be Asynchronous or Coincident**
- **Read and Write Operations Synchronized to Independent System Clocks**
- **Half-Full Flag and Programmable Almost-Full/Almost-Empty Flag**
- **Bidirectional Configuration and Width Expansion Without Additional Logic**
- **Input-Ready Flag Synchronized to Write Clock**
- **Output-Ready Flag Synchronized to Read Clock**
- **Fast Access Times of 13 ns With a 50-pF Load and All Data Outputs Switching Simultaneously**
- **Data Rates up to 50 MHz**
- **Pin-to-Pin Compatible With SN74ACT7803, SN74ACT7805, and SN74ACT7813**
- **Packaged in Shrink Small-Outline 300-mil Package Using 25-mil Center-to-Center Lead Spacing**

DL PACKAGE
(TOP VIEW)



description

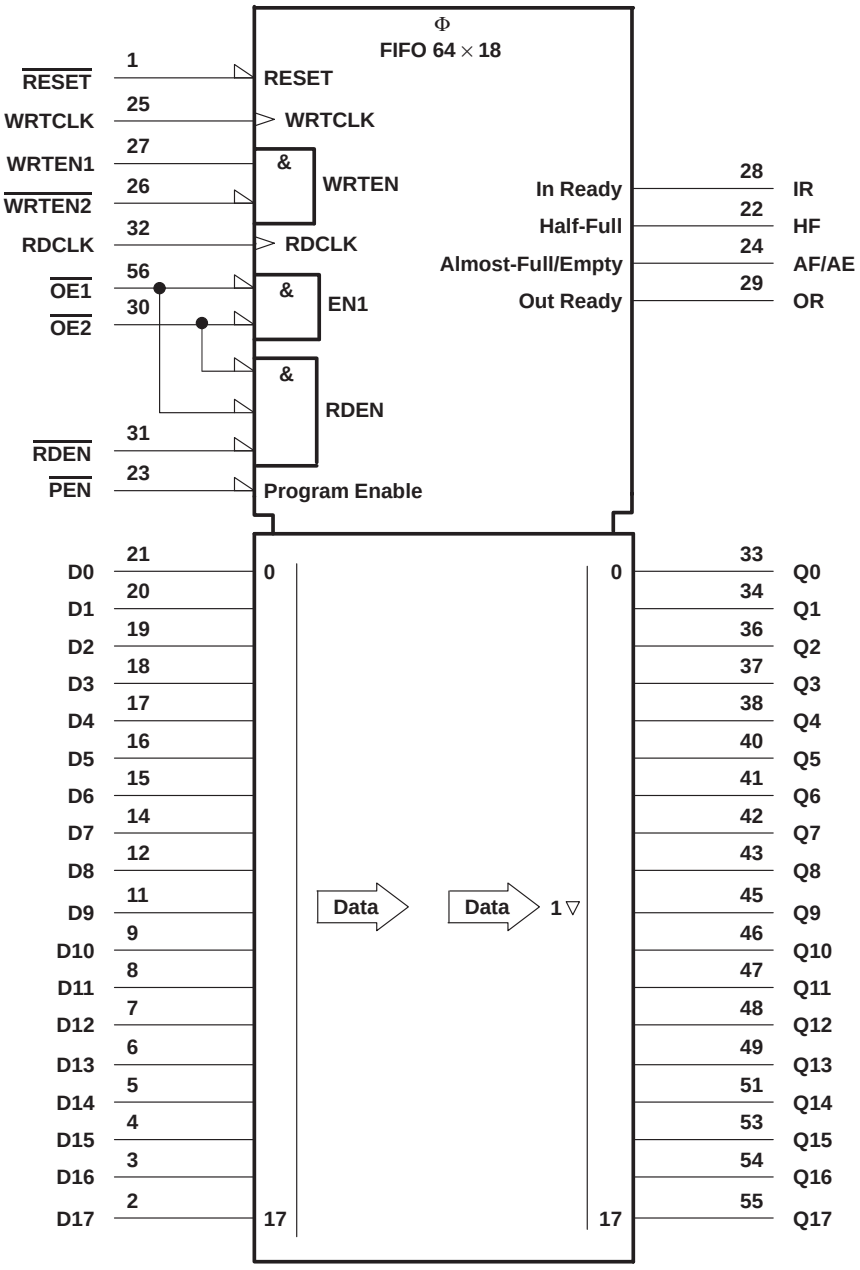
The SN74ALVC7813 is suited for buffering asynchronous data paths up to 50-MHz clock rates and 13-ns access times. This device is designed for 3-V to 3.6-V V_{CC} operation. Two devices can be configured for bidirectional data buffering without additional logic.

The write clock (WRTCLK) and read clock (RDCLK) are free running and can be asynchronous or coincident. Data is written to memory on the rising edge of WRTCLK when WRTEN1 is high, $\overline{\text{WRTEN2}}$ is low, and input ready (IR) is high. Data is read from memory on the rising edge of RDCLK when $\overline{\text{RDEN}}$, $\overline{\text{OE1}}$, and $\overline{\text{OE2}}$ are low and output ready (OR) is high. The first word written to memory is clocked through to the output buffer, regardless of the $\overline{\text{RDEN}}$, $\overline{\text{OE1}}$, and $\overline{\text{OE2}}$ levels. The OR flag indicates that valid data is present on the output buffer.

The FIFO can be reset asynchronously to WRTCLK and RDCLK. Reset ($\overline{\text{RESET}}$) must be asserted while at least four WRTCLK and four RDCLK rising edges occur to clear the synchronizing registers. Resetting the FIFO initializes the IR, OR, and half-full (HF) flags low and the almost-full/almost-empty (AF/AE) flag high. The FIFO must be reset upon power up.

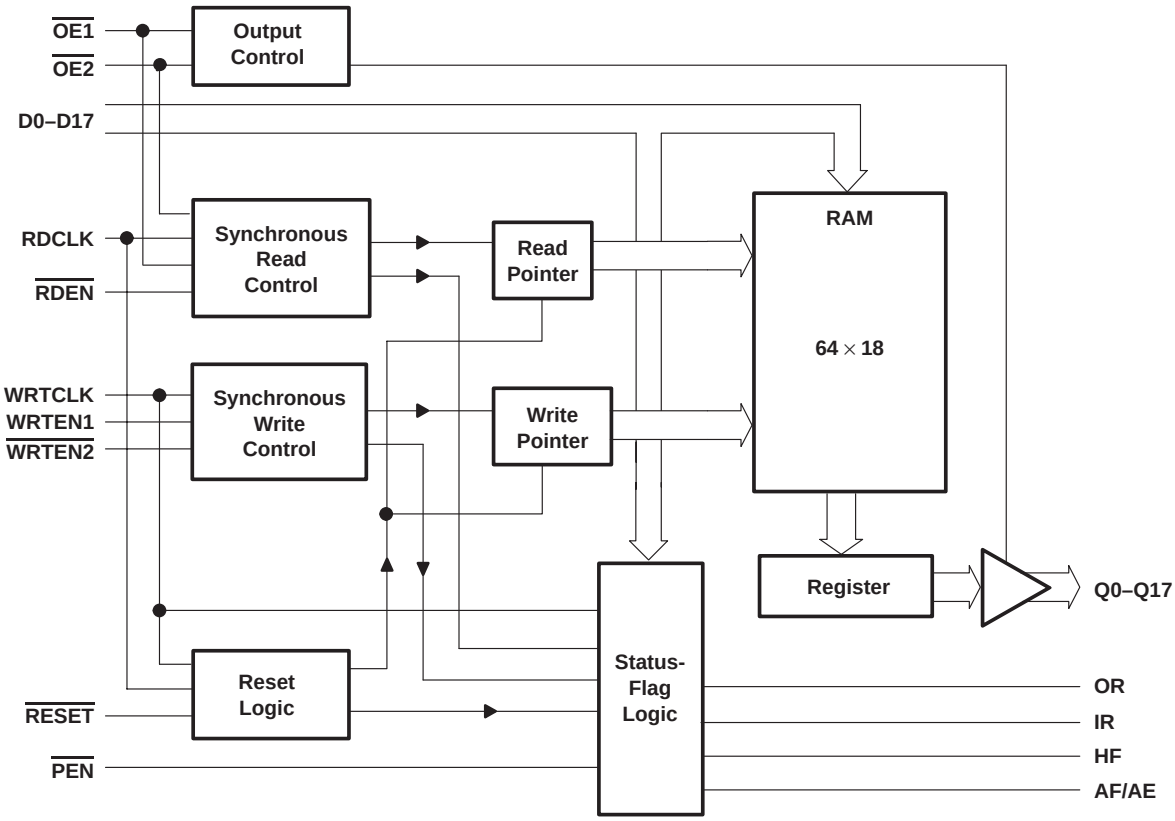
The SN74ALVC7813 is characterized for operation from 0°C to 70°C.

logic symbol†



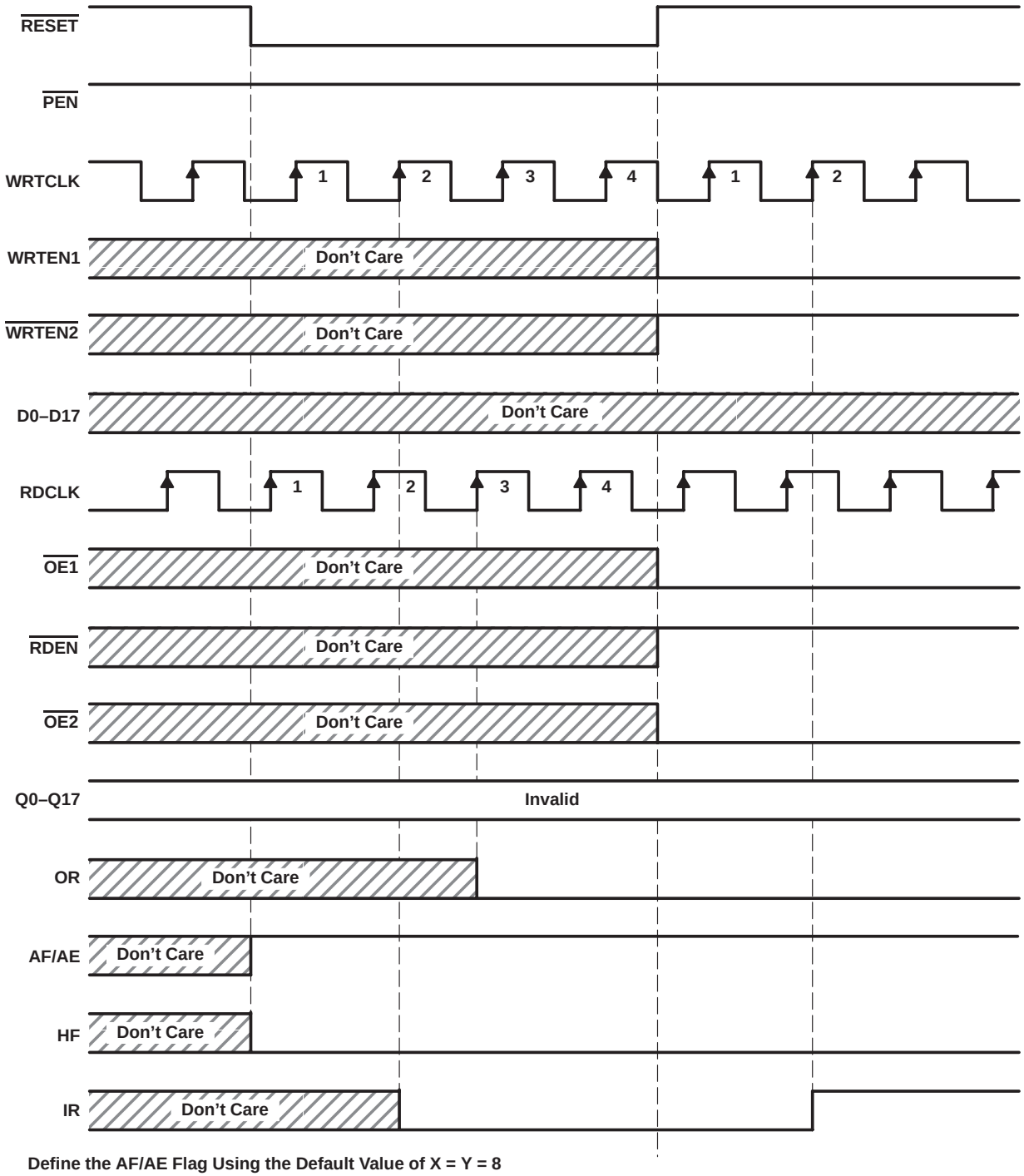
† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

functional block diagram



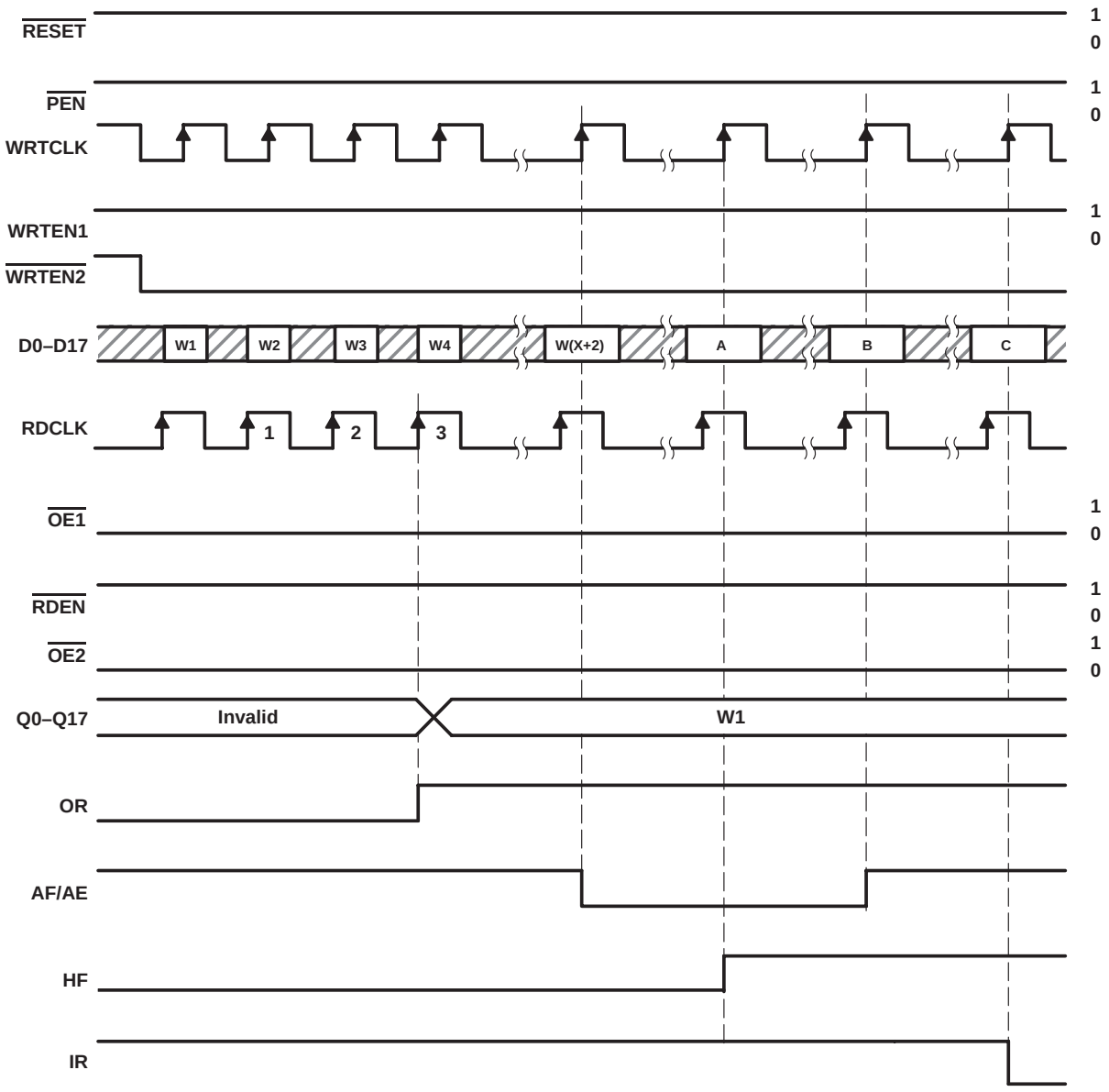
Terminal Functions

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
AF/AE	24	O	Almost-full/almost-empty flag. Depth-offset values can be programmed for this flag, or the default value of 8 can be used for both the almost-empty offset (X) and the almost-full offset (Y). AF/AE is high when memory contains X or fewer words or (64 – Y) or more words. AF/AE is high after reset.
D0–D17	2–9, 11–12, 14–21	I	18-bit data input port
HF	22	O	Half-full flag. HF is high when the FIFO memory contains 32 or more words. HF is low after reset.
IR	28	O	Input-ready flag. IR is synchronized to the low-to-high transition of WRTCLK. When IR is low, the FIFO is full and writes are disabled. IR is low during reset and goes high on the second low-to-high transition of WRTCLK after reset.
$\overline{OE1}$ $\overline{OE2}$	56 30	I	Output enables. When $\overline{OE1}$, $\overline{OE2}$, and $\overline{RDEN}$ are low and OR is high, data is read from the FIFO on a low-to-high transition of RDCLK. When either $\overline{OE1}$ or $\overline{OE2}$ is high, reads are disabled and the data outputs are in the high-impedance state.
OR	29	O	Output-ready flag. OR is synchronized to the low-to-high transition of RDCLK. When OR is low, the FIFO is empty and reads are disabled. Ready data is present on Q0–Q17 when OR is high. OR is low during reset and goes high on the third low-to-high transition of RDCLK after the first word is loaded to empty memory.
$\overline{PEN}$	23	I	Program enable. After reset and before the first word is written to the FIFO, the binary value on D0–D7 is latched as an AF/AE offset value when $\overline{PEN}$ is low and WRTCLK is high.
Q0–Q17	33–34, 36–38, 40–43, 45–49, 51, 53–55	O	18-bit data output port. After the first valid write to empty memory, the first word is output on Q0–Q17 on the third rising edge of RDCLK. OR also is asserted high at this time to indicate ready data. When OR is low, the last word read from the FIFO is present on Q0–Q17.
RDCLK	32	I	Read clock. RDCLK is a continuous clock and can be asynchronous or coincident to WRTCLK. A low-to-high transition of RDCLK reads data from memory when $\overline{OE1}$, $\overline{OE2}$, and $\overline{RDEN}$ are low and OR is high. OR is synchronous to the low-to-high transition or RDCLK.
$\overline{RDEN}$	31	I	Read enable. When $\overline{RDEN}$, $\overline{OE1}$, and $\overline{OE2}$ are low and OR is high, data is read from the FIFO on the low-to-high transition of RDCLK.
$\overline{RESET}$	1	I	Reset. To reset the FIFO, four low-to-high transitions of RDCLK and four low-to-high transitions of WRTCLK must occur while $\overline{RESET}$ is low. This sets HF, IR, and OR low and AF/AE high.
WRTCLK	25	I	Write clock. WRTCLK is a continuous clock and can be asynchronous or coincident to RDCLK. A low-to-high transition of WRTCLK writes data to memory when $\overline{WRTEN2}$ is low, WRTEN1 is high, and IR is high. IR is synchronous to the low-to-high transition of WRTCLK.
WRTEN1 $\overline{WRTEN2}$	27 26	I	Write enables. When WRTEN1 is high, $\overline{WRTEN2}$ is low, and IR is high, data is written to the FIFO on a low-to-high transition of WRTCLK.



Define the AF/AE Flag Using the Default Value of X = Y = 8

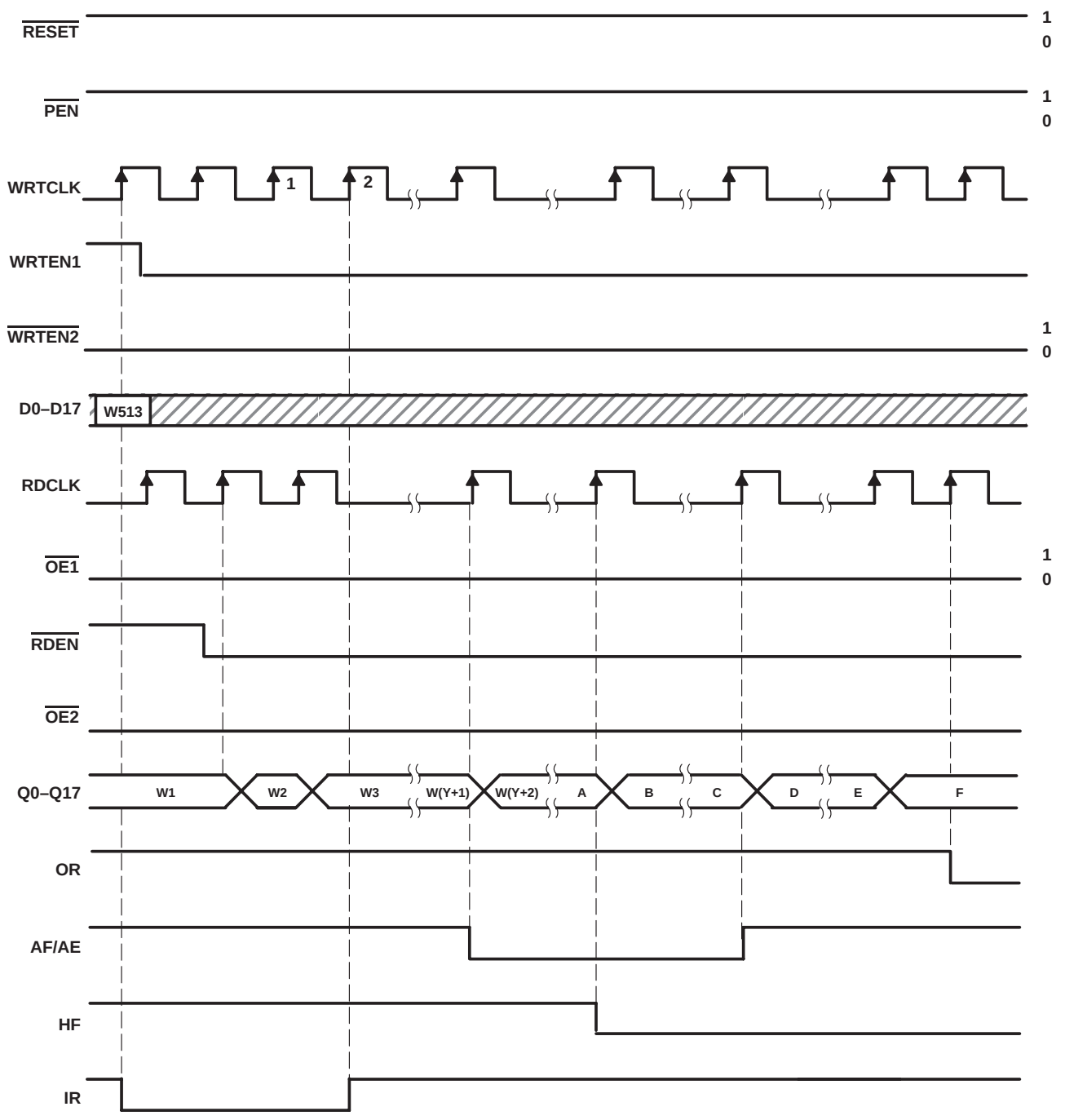
Figure 1. Reset Cycle



DATA-WORD NUMBER FOR FLAG TRANSITIONS

DEVICE	TRANSITION WORD		
	A	B	C
SN74ALVC7813	W33	W(65 – Y)	W65

Figure 2. FIFO Write



DATA-WORD NUMBERS FOR FLAG TRANSITIONS

DEVICE	TRANSITION WORD					
	A	B	C	D	E	F
SN74ALVC7813	W33	W34	W(64 – X)	W(65 – X)	64	65

Figure 3. FIFO Read

offset values for AF/AE

The AF/AE flag has two programmable limits: the almost-empty offset value (X) and the almost-full offset value (Y). They can be programmed after the FIFO is reset and before the first word is written to memory. If the offsets are not programmed, the default values of X = Y = 8 are used. The AF/AE flag is high when the FIFO contains X or fewer words or (64 – Y) or more words.

Program enable ($\overline{PEN}$) should be held high throughout the reset cycle. $\overline{PEN}$ can be brought low only when IR is high. On the following low-to-high transition of WRTCLK, the binary value on D0–D7 is stored as the almost-empty offset value (X) and the almost-full offset value (Y). Holding $\overline{PEN}$ low for another low-to-high transition of WRTCLK reprograms Y to the binary value on D0–D7 at the time of the second WRTCLK low-to-high transition. When the offsets are being programmed, writes to the FIFO memory are disabled, regardless of the state of the write enables (WRTEN1, $\overline{WRTEN2}$). A maximum value of 63 can be programmed for either X or Y (see Figure 4). To use the default values of X = Y = 8, $\overline{PEN}$ must be held high.

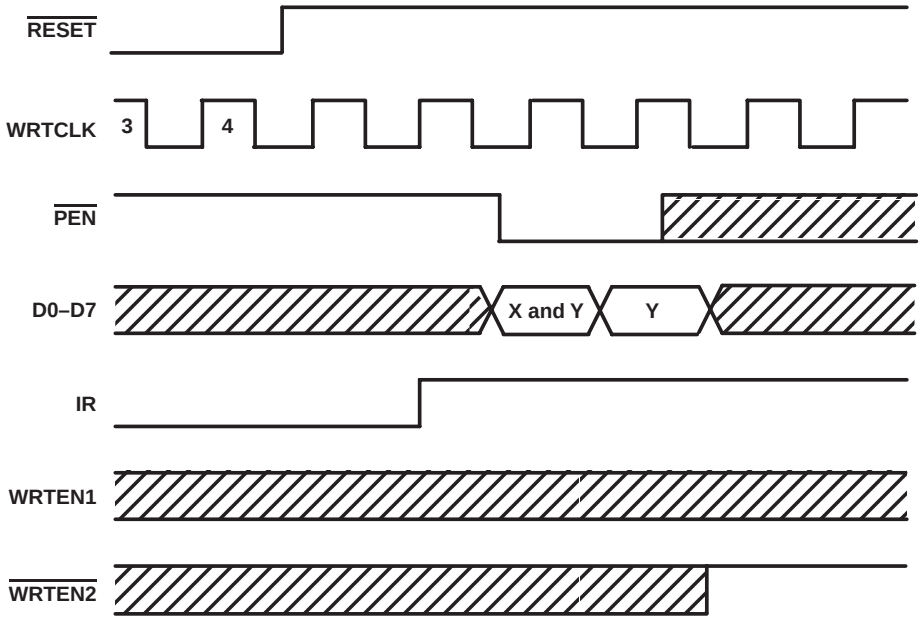


Figure 4. Programming X and Y Separately

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
Output voltage range, V_O (see Notes 1 and 2) . . . . . –0.5 V to V_{CC} + 0.5 V
Voltage range applied to a disabled 3-state output . . . . . –0.5 V to 3.6 V
Input clamp current, I_{IK} ($V_I < 0$) . . . . . –50 mA
Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$) . . . . . ±50 mA
Continuous output current, I_O ($V_O = 0$ to V_{CC}) . . . . . ±50 mA
Continuous current through V_{CC} or GND . . . . . ±100 mA
Package thermal impedance, θ_{JA} (see Note 3) . . . . . 74°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 voltage ratings can be exceeded if the input and output clamp current ratings are observed.
2. This value is limited to 4.6 V maximum.
3. The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions

			’ALVC7813-20		’ALVC7813-25		’ALVC7813-40		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage		3	3.6	3	3.6	3	3.6	V
V_{IH}	High-level input voltage		2		2		2		V
V_{IL}	Low-level input voltage			0.8		0.8		0.8	V
I_{OH}	High-level output current, Q outputs, flags	V_{CC} = 3 V		–8		–8		–8	mA
I_{OL}	Low-level output current, Q outputs, flags	V_{CC} = 3 V		16		16		16	mA
T_A	Operating free-air temperature		0	70	0	70	0	70	°C

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

PARAMETER		TEST CONDITIONS		MIN	TYP‡	MAX	UNIT
V_{IK}		V_{CC} = 3 V,	I_{IK} = –18 mA			–1.2	V
V_{OH}	Flags, Q outputs	V_{CC} = 3 V to 3.6 V,	I_{OH} = –100 µA	V_{CC}–0.2			V
		V_{CC} = 3 V,	I_{OH} = –8 mA	2.4			
V_{OL}	Flags, Q outputs	V_{CC} = 3 V to 3.6 V,	I_{OL} = 100 µA			0.2	V
	Flags	V_{CC} = 3 V,	I_{OL} = 8 mA			0.4	
	Q outputs	V_{CC} = 3 V,	I_{OL} = 16 mA			0.55	
I_I		V_{CC} = 3.6 V,	$V_I = V_{CC}$ or GND			±5	µA
I_{OZ}		V_{CC} = 3.6 V,	$V_O = V_{CC}$ or GND			±10	µA
I_{CC}		$V_I = V_{CC}$ or 0				40	µA
ΔI_{CC}§		V_{CC} = 3.6 V, One input at V_{CC} – 0.6 V, Other inputs at V_{CC} or GND				500	µA
C_i		V_{CC} = 3.3 V,	$V_I = V_{CC}$ or GND		2.5		pF
C_o		V_{CC} = 3.3 V,	$V_O = V_{CC}$ or GND		5.5		pF

‡ All typical values are at V_{CC} = 3.3 V, T_A = 25°C.
§ This is the supply current for each input that is at one of the specified TTL voltage levels rather than 0 V or V_{CC}.

timing requirements over recommended operating conditions (see Figures 1 through 5)

			’ALVC7813-20		’ALVC7813-25		’ALVC7813-40		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency			50		40		25	MHz
t_w	Pulse duration	D0–D17 high or low	9		10		14		ns
		WRTCLK high or low	7		8		12		
		RDCLK high or low	7		8		12		
		$\overline{PEN}$ low	9		9		12		
		WRTEN1 high, $\overline{WRTEN2}$ low	8		8		12		
		$\overline{OE1}$, $\overline{OE2}$ low	9		9		12		
		$\overline{RDEN}$ low	8		8		12		
t_{su}	Setup time	D0–D17 before WRTCLK↑	5		5		5		ns
		WRTEN1, $\overline{WRTEN2}$ before WRTCLK↑	5		5		5		
		$\overline{OE1}$, $\overline{OE2}$ before RDCLK↑	5		6		6		
		$\overline{RDEN}$ before RDCLK↑	5		5		7		
		Reset: $\overline{RESET}$ low before first WRTCLK↑ and RDCLK↑†	6		6		6		
		$\overline{PEN}$ before WRTCLK↑	6		6		6		
t_h	Hold time	D0–D17 after WRTCLK↑	0		0		0		ns
		WRTEN1, $\overline{WRTEN2}$ after WRTCLK↑	0		0		0		
		$\overline{OE1}$, $\overline{OE2}$, $\overline{RDEN}$ after RDCLK↑	0		0		0		
		Reset: $\overline{RESET}$ low after fourth WRTCLK↑ and RDCLK↑†	2		2		2		
		$\overline{PEN}$ low after WRTCLK↑	2		2		2		

† To permit the clock pulse to be utilized for reset purposes

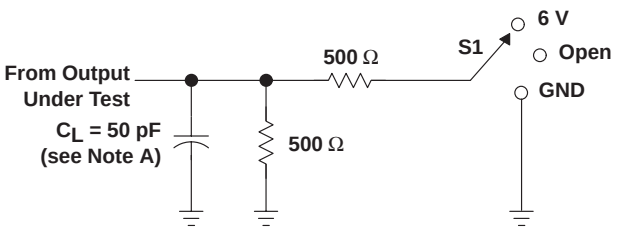
switching characteristics over recommended ranges of supply voltage and operating free-air temperature, C_L = 50 pF (unless otherwise noted) (see Figure 5)

PARAMETER	FROM (OUTPUT)	TO (INPUT)	’ALVC7813-20		’ALVC7813-25		’ALVC7813-40		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
f_{max}	WRTCLK or RDCLK		50		40		25		MHz
t_{pd}	RDCLK↑	Any Q	4	13	4	15	4	20	ns
	WRTCLK↑	IR	3	11	3	13	3	15	
	RDCLK↑	OR	3	11	3	13	3	15	
	WRTCLK↑	AF/AE	7	19	7	21	7	23	
	RDCLK↑		7	19	7	21	7	23	
t_{PLH}	WRTCLK↑	HF	7	17	7	19	7	21	ns
t_{PHL}	RDCLK↑	HF	7	18	7	20	7	22	ns
t_{PLH}	$\overline{RESET}$ low	AF/AE	2	11	2	13	2	15	ns
t_{PHL}	$\overline{RESET}$ low	HF	2	12	2	14	2	16	ns
t_{en}	$\overline{OE1}$, $\overline{OE2}$	Any Q	2	11	2	11	2	14	ns
t_{dis}	$\overline{OE1}$, $\overline{OE2}$	Any Q	2	11	2	14	2	14	ns

operating characteristics, V_{CC} = 3.3 V, T_A = 25°C

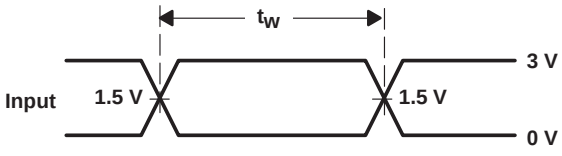
PARAMETER			TEST CONDITIONS		TYP	UNIT
C_{pd}	Power dissipation capacitance	Outputs enabled	C_L = 50 pF,	f = 5 MHz	53	pF

PARAMETER MEASUREMENT INFORMATION

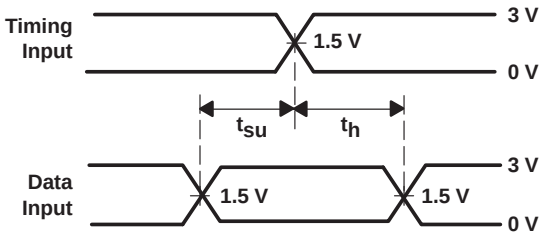


PARAMETER		S1
t_{en}	t_{PZH}	GND
	t_{PZL}	6 V
t_{dis}	t_{PHZ}	GND
	t_{PLZ}	6 V
t_{pd}	t_{PHL}/t_{PLH}	Open

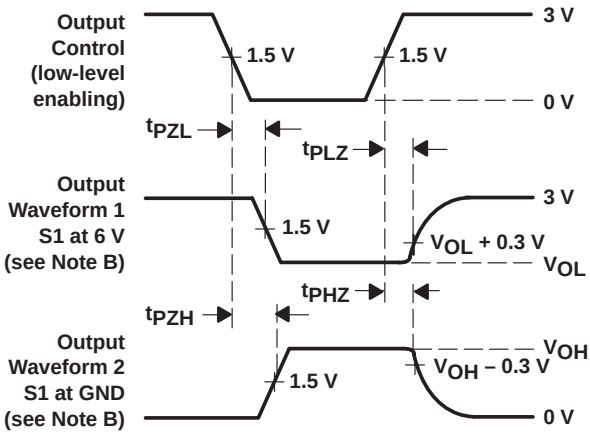
LOAD CIRCUIT FOR OUTPUTS



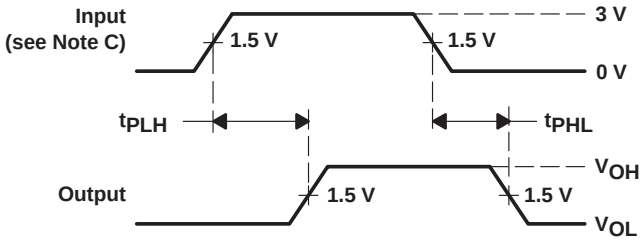
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY 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 ≤ 2.5 ns, t_f ≤ 2.5 ns.

Figure 5. Standard CMOS Outputs (FULL, EMPTY, HF, AF/AE)

TYPICAL CHARACTERISTICS

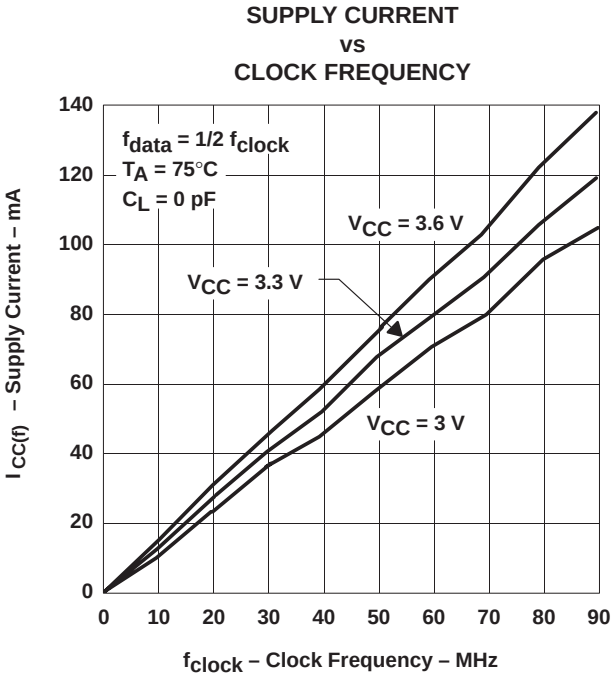


Figure 6

APPLICATION INFORMATION

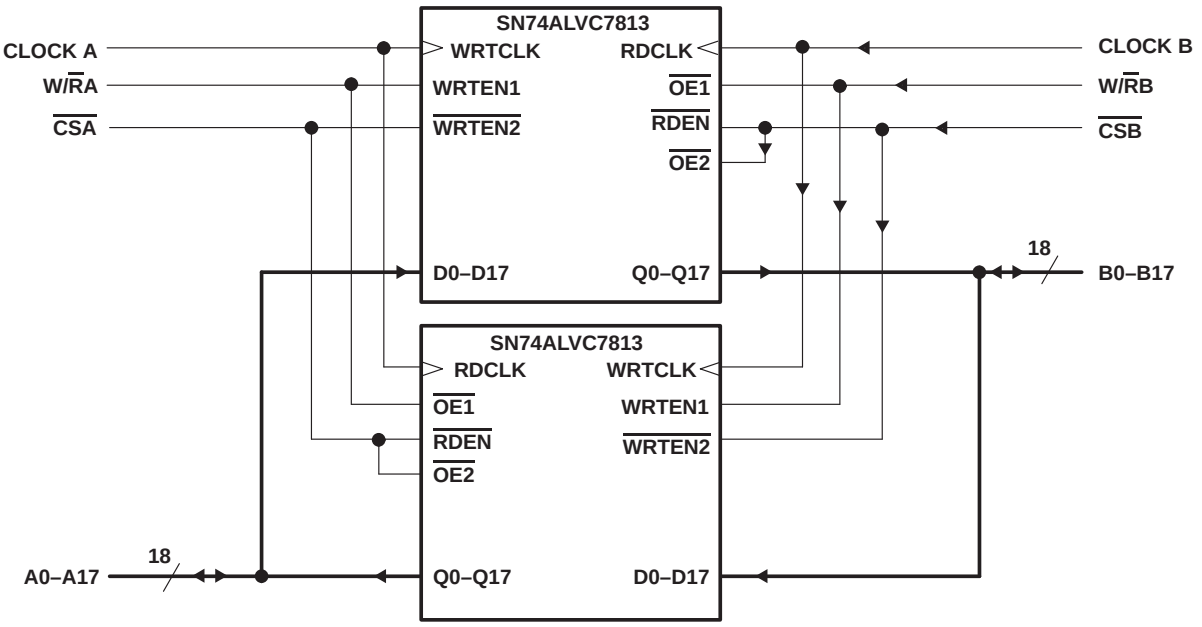


Figure 7. Bidirectional Configuration

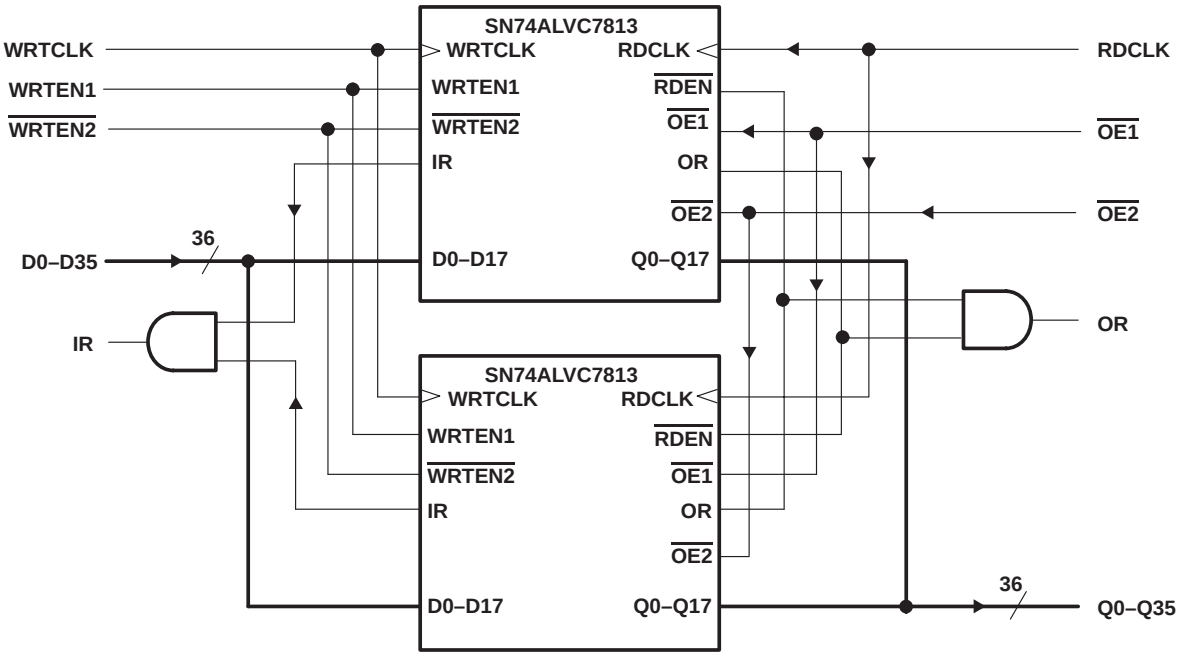


Figure 8. Word-Width Expansion: 64 × 36 Bits

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