74HC7403-Q100; 74HCT7403-Q100

4-bit x 64-word FIFO register; 3-state

Rev. 1 — 21 September 2012 Product data sheet

1. General description

The 74HC7403-Q100; 74HCT7403-Q100 is an expandable, First-In First-Out (FIFO) memory organized as 64 words by 4 bits. A guaranteed 15 MHz data-rate makes it ideal for high-speed applications. A higher data-rate can be obtained in applications where the status flags are not used (burst-mode). With separate controls for shift-in (SI) and shift-out ($\overline{SO}$), reading and writing operations are completely independent, allowing synchronous and asynchronous data transfers. Additional controls include a master-reset input ($\overline{MR}$), an output enable input ($\overline{OE}$) and flags. The data-in-ready (DIR) and data-out-ready (DOR) flags indicate the status of the device. Inputs include clamp diodes that enable the use of current limiting resistors to interface inputs to voltages in excess of V_{CC}.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - Specified from –40 °C to +85 °C and from –40 °C to +125 °C
- Synchronous or asynchronous operation
- 30 MHz (typical) shift-in and shift-out rates
- Readily expandable in word and bit dimensions
- Pinning arranged for easy board layout: input pins directly opposite output pins
- Input levels:
  - For 74HC7403-Q100: CMOS level
  - For 74HCT7403-Q100: TTL level
- 3-state outputs
- Complies with JEDEC standard JESD7A
- ESD protection:
  - MIL-STD-883, method 3015 exceeds 2000 V
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V (C = 200 pF, R = 0 Ω)
- Multiple package options

3. Applications

- High-speed disc or tape controller
- Communications buffer

4. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC7403D-Q100	−40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT7403D-Q100				

5. Functional diagram

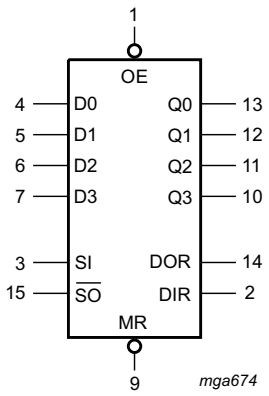


Fig 1. Logic symbol

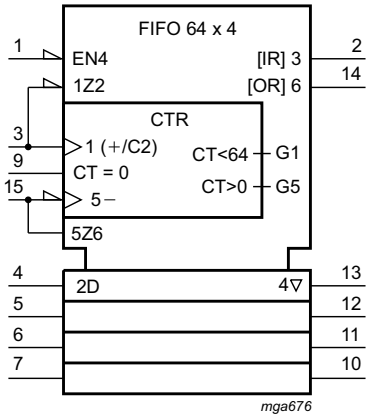


Fig 2. IEC logic symbol

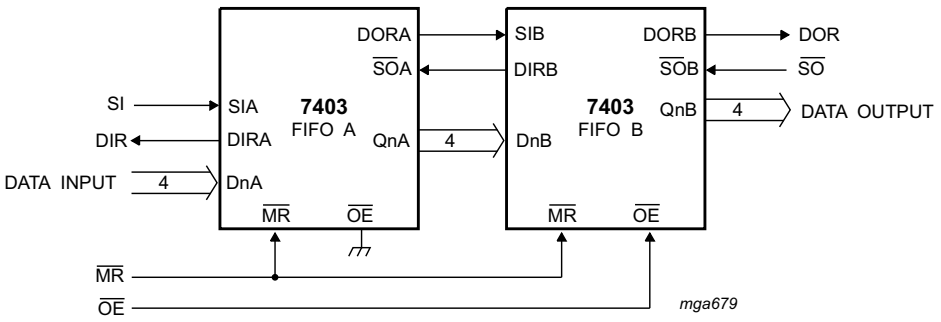
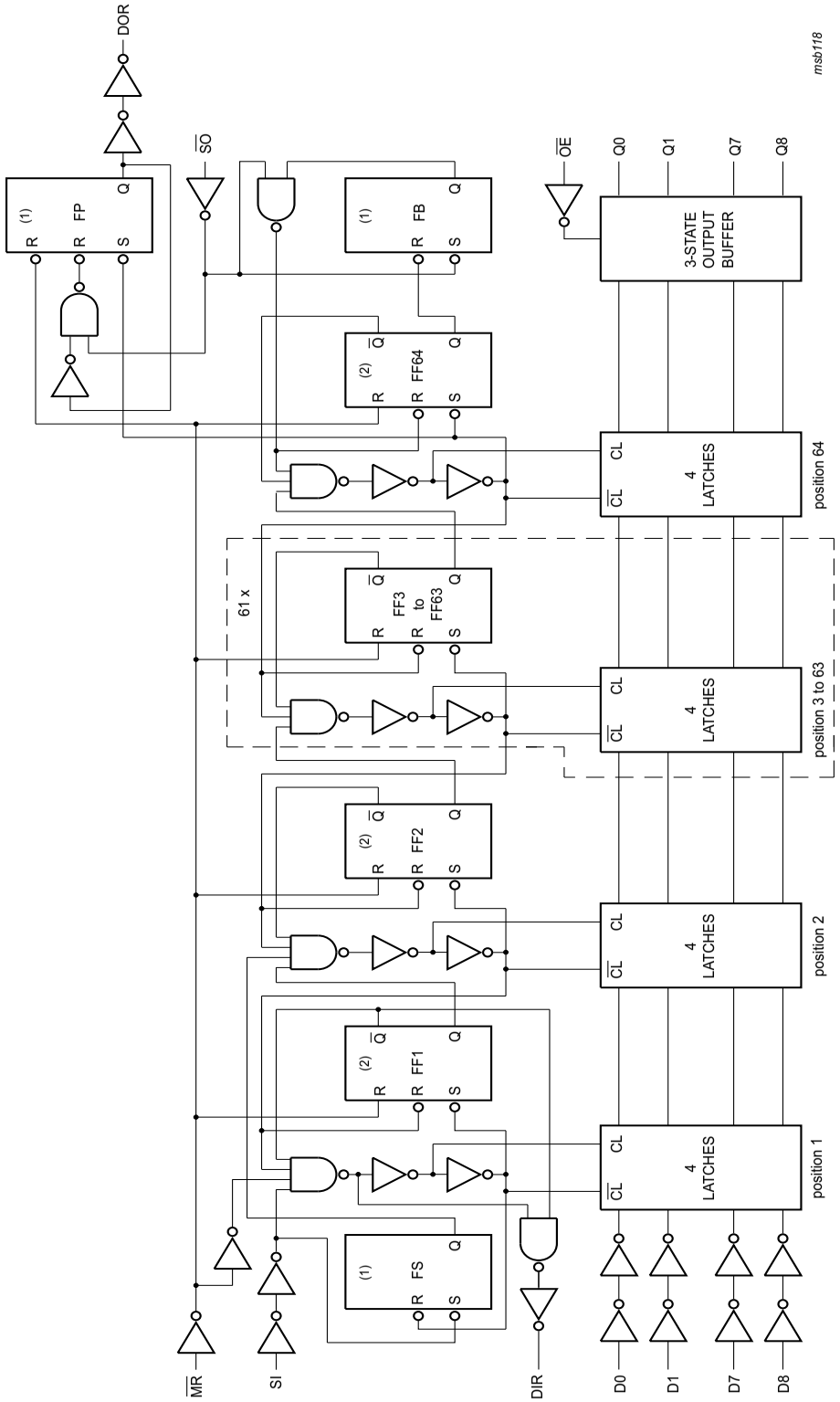


Fig 3. Functional diagram



LOW on $\overline{S}$ input of the flip-flops FS, FB and FP set Q output to HIGH independent of state on $\overline{R}$ input

LOW on $\overline{R}$ input of FF1 to FF64 sets Q output to LOW independent of state on $\overline{S}$ input

Fig 4. Logic diagram

6. Pinning information

6.1 Pinning

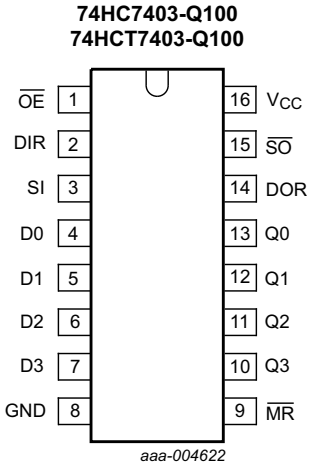


Fig 5. Pin configuration

6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
$\overline{OE}$	1	output enable input (active LOW)
DIR	2	data-in-ready output
SI	3	shift-in input (active HIGH)
D0 to D3	4, 5, 6, 7	parallel data input
GND	8	ground (0 V)
$\overline{MR}$	9	asynchronous master-reset input (active LOW)
Q0 to Q3	13, 12, 11, 10	data output
DOR	14	data-out-ready output
$\overline{SO}$	15	shift-out input (active LOW)
V_{CC}	16	supply voltage

7. Functional description

A DIR flag indicates the input stage status, either empty and ready to receive data (DIR = HIGH) or full and busy (DIR = LOW). When DIR and SI are HIGH, data present at D0 to D3 is shifted into the input stage; once complete DIR goes LOW. When SI is set LOW, data is automatically shifted to the output stage or to the last empty location. DIR set HIGH indicates a FIFO which can receive data.

A DOR flag indicates the output stage status, either data available (DOR = HIGH) or busy (DOR = LOW). When $\overline{SO}$ and DOR are HIGH, data is available at the outputs (Q0 to Q3). When $\overline{SO}$ is set LOW new data may be shifted into the output stage, once complete DOR is set HIGH.

7.1 Expanded format

The DOR and DIR signals are used to allow the 74HC7403-Q100; 74HCT7403-Q100 to be cascaded. Both parallel and serial expansion is possible. (see Figure 18).

Serial expansion is only possible with typical devices.

7.1.1 Parallel expension

Parallel expension is accomplished by logically ANDing the DOR and DIR signals to form a composite signal.

7.1.2 Serial expension

Parallel expension is accomplished by:

- Tying the data outputs of the first device to the data inputs of the second device.
- Connecting the DOR pin of the first device to the SI pin of the second device.
- Connecting the $\overline{SO}$ pin of the first device to the DIR pin of the second device.

8. Limiting values

Table 3. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CC}	supply voltage			−0.5	+7	V
I_{IK}	input clamping current	$V_I < -0.5$ V or $V_I > V_{CC} + 0.5$ V		-	±20	mA
I_{OK}	output clamping current	$V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V		-	±20	mA
I_O	output current	$V_O = -0.5$ V to $(V_{CC} + 0.5$ V)		-	±35	mA
I_{CC}	supply current			-	+70	mA
I_{GND}	ground current			-	−70	mA
T_{stg}	storage temperature			−65	+150	°C
P_{tot}	total power dissipation		[1]	-	500	mW

[1] For SO16 packages: above 70 °C the value of P_{tot} derates linearly with 8 mW/K.

9. Recommended operating conditions

Table 4. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC7403-Q100			74HCT7403-Q100			Unit
			Min	Typ	Max	Min	Typ	Max	
V_{CC}	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
V_I	input voltage		0	-	V_{CC}	0	-	V_{CC}	V
V_O	output voltage		0	-	V_{CC}	0	-	V_{CC}	V
T_{amb}	ambient temperature		−40	+25	+125	−40	+25	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	V_{CC} = 2.0 V	-	-	625	-	-	-	ns/V
		V_{CC} = 4.5 V	-	1.67	139	-	1.67	139	ns/V
		V_{CC} = 6.0 V	-	-	83	-	-	-	ns/V

10. Static characteristics

Table 5. Static characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	25 °C			−40 °C to +85 °C		−40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC7403-Q100										
V_{IH}	HIGH-level input voltage	V_{CC} = 2.0 V	1.5	1.2	-	1.5	-	1.5	-	V
		V_{CC} = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V_{CC} = 6.0 V	4.2	3.2	-	4.2	-	4.2	-	V
V_{IL}	LOW-level input voltage	V_{CC} = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
		V_{CC} = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V_{CC} = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	V
V_{OH}	HIGH-level output voltage	V_I = V_{IH} or V_{IL}								
		I_O = −20 μA; V_{CC} = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I_O = −20 μA; V_{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I_O = −20 μA; V_{CC} = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I_O = −8 mA; V_{CC} = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	V
		I_O = −10 mA; V_{CC} = 6.0 V	5.48	5.81	-	5.34	-	5.2	-	V
V_{OL}	LOW-level output voltage	V_I = V_{IH} or V_{IL}								
		I_O = 20 μA; V_{CC} = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I_O = 20 μA; V_{CC} = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I_O = 20 μA; V_{CC} = 6.0 V	-	0	0.1	-	0.1	-	0.1	V
		I_O = 8 mA; V_{CC} = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V
		I_O = 10 mA; V_{CC} = 6.0 V	-	0.15	0.26	-	0.33	-	0.4	V
I_I	input leakage current	V_I = V_{CC} or GND; V_{CC} = 6.0 V	-	-	±0.1	-	±1.0	-	±1.0	μA
I_{OZ}	OFF-state output current	V_I = V_{IH} or V_{IL}; V_O = V_{CC} or GND; V_{CC} = 6.0 V	-	-	±0.5	-	±5.0	-	±10.0	μA

Table 5. Static characteristics *…continued*

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
I_{CC}	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 6.0$ V	-	-	50	-	500	-	1000	µA
C_I	input capacitance		-	3.5	-					pF
74HCT7403-Q100										
V_{IH}	HIGH-level input voltage	$V_{CC} = 4.5$ V to 5.5 V	2.0	1.6	-	2.0	-	2.0	-	V
V_{IL}	LOW-level input voltage	$V_{CC} = 4.5$ V to 5.5 V	-	1.2	0.8	-	0.8	-	0.8	V
V_{OH}	HIGH-level output voltage	$V_I = V_{IH}$ or V_{IL}; $V_{CC} = 4.5$ V								
		$I_O = -20$ µA	4.4	4.5	-	4.4	-	4.4	-	V
		$I_O = -8$ mA	3.98	4.32	-	3.84	-	3.7	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{IH}$ or V_{IL}; $V_{CC} = 4.5$ V								
		$I_O = 20$ µA	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 8$ mA	-	0.15	0.26	-	0.33	-	0.4	V
I_I	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 5.5$ V	-	-	±0.1	-	±1.0	-	±1.0	µA
I_{OZ}	OFF-state output current	$V_I = V_{IH}$ or V_{IL}; $V_{CC} = 5.5$ V; $V_O = V_{CC}$ or GND per input pin; other inputs at V_{CC} or GND; $I_O = 0$ A	-	-	±0.5	-	±5.0	-	±10	µA
I_{CC}	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 5.5$ V	-	-	50	-	500	-	1000	µA
ΔI_{CC}	additional supply current	$V_I = V_{CC} - 2.1$ V; other inputs at V_{CC} or GND; $V_{CC} = 4.5$ V to 5.5 V; $I_O = 0$ A								
		per input pin; Dn inputs	-	75	270	-	338	-	368	µA
		per input pin; $\overline{OE}$ input	-	100	360	-	450	-	490	µA
		per input pin; SI input	-	150	540	-	675	-	735	µA
		per input pin; $\overline{MR}$ input	-	150	540	-	675	-	735	µA
		per input pin; $\overline{SO}$ input	-	150	540	-	675	-	735	µA
C_I	input capacitance		-	3.5	-					pF

11. Dynamic characteristics

Table 6. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); C_L = 50 pF unless otherwise specified; for test circuit see Figure 17.

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC7403-Q100										
t_{pd}	propagation delay	$\overline{MR}$ to DIR or DOR; see Figure 8 [1]								
		V_{CC} = 2.0 V	-	69	210	-	265	-	315	ns
		V_{CC} = 4.5 V	-	25	42	-	53	-	63	ns
		V_{CC} = 6.0 V	-	20	36	-	45	-	54	ns
		SI to DIR; see Figure 6 [1]								
		V_{CC} = 2.0 V	-	66	205	-	255	-	310	ns
		V_{CC} = 4.5 V	-	24	41	-	51	-	62	ns
		V_{CC} = 5 V; C_L = 15 pF	-	15	-	-	-	-	-	ns
		V_{CC} = 6.0 V	-	19	35	-	43	-	53	ns
		$\overline{SO}$ to DOR; see Figure 9 [1]								
		V_{CC} = 2.0 V	-	94	290	-	365	-	435	ns
		V_{CC} = 4.5 V	-	34	58	-	73	-	87	ns
		V_{CC} = 5 V; C_L = 15 pF	-	15	-	-	-	-	-	ns
		V_{CC} = 6.0 V	-	27	49	-	62	-	74	ns
		DOR to Qn; see Figure 10 [1]								
		V_{CC} = 2.0 V	-	11	35	-	45	-	55	ns
		V_{CC} = 4.5 V	-	4	7	-	9	-	11	ns
		V_{CC} = 6.0 V	-	3	6	-	8	-	9	ns
		$\overline{SO}$ to Qn; see Figure 14 [1]								
		V_{CC} = 2.0 V	-	105	325	-	406	-	488	ns
		V_{CC} = 4.5 V	-	38	65	-	81	-	98	ns
		V_{CC} = 6.0 V	-	30	55	-	69	-	83	ns
t_{PHL}	HIGH to LOW propagation delay	$\overline{MR}$ to Qn; see Figure 8								
		V_{CC} = 2.0 V	-	52	160	-	200	-	240	ns
		V_{CC} = 4.5 V	-	19	32	-	40	-	48	ns
		V_{CC} = 6.0 V	-	15	27	-	34	-	41	ns
t_{PLH}	LOW to HIGH propagation delay	SI to DOR; see Figure 10 [5]								
		V_{CC} = 2.0 V	-	2.2	7	-	8.8	-	10.5	ns
		V_{CC} = 4.5 V	-	0.8	1.4	-	1.8	-	2.1	ns
		V_{CC} = 6.0 V	-	0.6	1.2	-	1.5	-	1.8	ns
		$\overline{SO}$ to DIR; see Figure 7 [6]								
		V_{CC} = 2.0 V	-	2.8	9	-	11.2	-	13.5	ns
		V_{CC} = 4.5 V	-	1.0	1.8	-	2.2	-	2.7	ns
		V_{CC} = 6.0 V	-	0.8	1.5	-	1.9	-	2.3	ns

Table 6. Dynamic characteristics *...continued*

Voltages are referenced to GND (ground = 0 V); C_L = 50 pF unless otherwise specified; for test circuit see Figure 17.

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t_{en}	enable time	$\overline{OE}$ to Qn; see Figure 16 [2]								
		V_{CC} = 2.0 V	-	44	150	-	190	-	225	ns
		V_{CC} = 4.5 V	-	16	30	-	38	-	45	ns
		V_{CC} = 6.0 V	-	13	26	-	32	-	38	ns
t_{dis}	disable time	$\overline{OE}$ to Qn; see Figure 16 [3]								
		V_{CC} = 2.0 V	-	50	150	-	190	-	225	ns
		V_{CC} = 4.5 V	-	18	30	-	38	-	45	ns
		V_{CC} = 6.0 V	-	14	26	-	33	-	38	ns
t_t	transition time	Qn; see Figure 14 [4]								
		V_{CC} = 2.0 V	-	14	60	-	75	-	90	ns
		V_{CC} = 4.5 V	-	5	12	-	15	-	18	ns
		V_{CC} = 6.0 V	-	4	10	-	13	-	15	ns
t_W	pulse width	SI HIGH or LOW; see Figure 6								
		V_{CC} = 2.0 V	35	11	-	45	-	55	-	ns
		V_{CC} = 4.5 V	7	4	-	9	-	11	-	ns
		V_{CC} = 6.0 V	6	3	-	8	-	9	-	ns
		$\overline{SO}$ HIGH or LOW; see Figure 9								
		V_{CC} = 2.0 V	70	22	-	90	-	105	-	ns
		V_{CC} = 4.5 V	14	8	-	18	-	21	-	ns
		V_{CC} = 6.0 V	12	6	-	15	-	18	-	ns
		DIR HIGH; see Figure 7								
		V_{CC} = 2.0 V	10	41	130	8	165	8	195	ns
		V_{CC} = 4.5 V	5	15	26	4	33	4	39	ns
		V_{CC} = 6.0 V	4	12	22	3	28	3	23	ns
		DOR HIGH; see Figure 10								
		V_{CC} = 2.0 V	14	52	160	12	200	12	240	ns
		V_{CC} = 4.5 V	7	19	32	6	40	6	48	ns
		V_{CC} = 6.0 V	6	15	27	5	34	5	41	ns
		$\overline{MR}$ LOW; see Figure 8								
		V_{CC} = 2.0 V	120	39	-	150	-	180	-	ns
		V_{CC} = 4.5 V	24	14	-	30	-	36	-	ns
		V_{CC} = 6.0 V	20	11	-	26	-	31	-	ns
t_{rec}	recovery time	$\overline{MR}$ to SI; see Figure 15								
		V_{CC} = 2.0 V	80	24	-	100	-	120	-	ns
		V_{CC} = 4.5 V	16	8	-	20	-	24	-	ns
		V_{CC} = 6.0 V	14	7	-	17	-	20	-	ns

Table 6. Dynamic characteristics *...continued*

Voltages are referenced to GND (ground = 0 V); C_L = 50 pF unless otherwise specified; for test circuit see Figure 17.

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t_{su}	set-up time	Dn to SI; see Figure 13								
		V_{CC} = 2.0 V	–8	–36	-	–6	-	–6	-	ns
		V_{CC} = 4.5 V	–4	–13	-	–3	-	–3	-	ns
		V_{CC} = 6.0 V	–3	–10	-	–3	-	–3	-	ns
t_h	hold time	Dn to SI; see Figure 13								
		V_{CC} = 2.0 V	135	44	-	170	-	205	-	ns
		V_{CC} = 4.5 V	27	16	-	34	-	12	-	ns
		V_{CC} = 6.0 V	5	13	-	29	-	14	-	ns
f_{max}	maximum frequency	SI, $\overline{SO}$ burst mode; see Figure 11 and Figure 12								
		V_{CC} = 2.0 V	3.6	9.9	-	2.8	-	2.4	-	MHz
		V_{CC} = 4.5 V	18	30	-	14	-	12	-	MHz
		V_{CC} = 5 V; C_L = 15 pF	-	30	-	-	-	-	-	MHz
		V_{CC} = 6.0 V	21	36	-	16	-	14	-	MHz
		SI, $\overline{SO}$ using flags; see Figure 6 and Figure 9								
		V_{CC} = 2.0 V	3.6	9.9	-	2.8	-	2.4	-	MHz
		V_{CC} = 4.5 V	18	30	-	14	-	12	-	MHz
		V_{CC} = 5 V; C_L = 15 pF	-	30	-	-	-	-	-	MHz
		V_{CC} = 6.0 V	21	36	-	16	-	14	-	MHz
		SI, $\overline{SO}$ cascaded; see Figure 6 and Figure 9								
		V_{CC} = 2.0 V	-	7.6	-	-	-	-	-	MHz
		V_{CC} = 4.5 V	-	23	-	-	-	-	-	MHz
		V_{CC} = 6.0 V	-	27	-	-	-	-	-	MHz
C_{PD}	power dissipation capacitance	V_I = GND to V_{CC} [7]	-	475	-	-	-	-	-	pF

Table 6. Dynamic characteristics *...continued*

Voltages are referenced to GND (ground = 0 V); C_L = 50 pF unless otherwise specified; for test circuit see Figure 17.

Symbol	Parameter	Conditions		25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
				Min	Typ	Max	Min	Max	Min	Max	
74HCT7403-Q100											
t_{pd}	propagation delay	$\overline{MR}$ to DIR or DOR; see Figure 8	[1]								
		V_{CC} = 4.5 V		-	30	51	-	53	-	63	ns
		SI to DIR; see Figure 6	[1]								
		V_{CC} = 4.5 V		-	25	43	-	54	-	65	ns
		V_{CC} = 5 V; C_L = 15 pF		-	17	-	-	-	-	-	ns
		$\overline{SO}$ to DOR; see Figure 9	[1]								
		V_{CC} = 4.5 V		-	36	61	-	76	-	92	ns
		V_{CC} = 5 V; C_L = 15 pF		-	17	-	-	-	-	-	ns
		DOR to Qn; see Figure 10	[1]								
		V_{CC} = 4.5 V		-	7	12	-	15	-	18	ns
		$\overline{SO}$ to Qn; see Figure 14	[1]								
		V_{CC} = 4.5 V		-	42	72	-	90	-	108	ns
t_{PHL}	HIGH to LOW propagation delay	$\overline{MR}$ to Qn; see Figure 8									
		V_{CC} = 4.5 V		-	22	38	-	48	-	57	ns
t_{PLH}	LOW to HIGH propagation delay	SI to DOR; see Figure 10	[5]								
		V_{CC} = 4.5 V		-	0.8	1.4	-	1.75	-	2.1	ns
		$\overline{SO}$ to DIR; see Figure 7	[6]								
		V_{CC} = 4.5 V		-	1.0	1.8	-	2.25	-	2.7	ns
t_{en}	enable time	$\overline{OE}$ to Qn; see Figure 16	[2]								
		V_{CC} = 4.5 V		-	16	30	-	38	-	45	ns
t_{dis}	disable time	$\overline{OE}$ to Qn; see Figure 16	[3]								
		V_{CC} = 4.5 V		-	19	30	-	38	-	45	ns
t_t	transition time	Qn; see Figure 14	[4]								
		V_{CC} = 4.5 V		-	5	12	-	15	-	18	ns
t_W	pulse width	SI HIGH or LOW; see Figure 6									
		V_{CC} = 4.5 V		9	5	-	6	-	8	-	ns
		$\overline{SO}$ HIGH or LOW; see Figure 9									
		V_{CC} = 4.5 V		14	8	-	18	-	21	-	ns
		DIR HIGH; see Figure 7									
		V_{CC} = 4.5 V		5	17	29	4	36	4	44	ns
		DOR HIGH; see Figure 10									
		V_{CC} = 4.5 V		7	21	36	6	45	6	54	ns
		$\overline{MR}$ LOW; see Figure 8									
		V_{CC} = 4.5 V		26	15	-	33	-	39	-	ns

Table 6. Dynamic characteristics *...continued*

Voltages are referenced to GND (ground = 0 V); C_L = 50 pF unless otherwise specified; for test circuit see Figure 17.

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t_{rec}	recovery time	$\overline{MR}$ to SI; see Figure 15								
		V_{CC} = 4.5 V	18	10	-	23	-	27	-	ns
t_{su}	set-up time	Dn to SI; see Figure 13								
		V_{CC} = 4.5 V	–5	–16	-	–4	-	–4	-	ns
t_h	hold time	Dn to SI; see Figure 13								
		V_{CC} = 4.5 V	30	18	-	38	-	45	-	ns
f_{max}	maximum frequency	SI, $\overline{SO}$ burst mode; see Figure 11 and Figure 12								
		V_{CC} = 4.5 V	18	30	-	14	-	12	-	MHz
		V_{CC} = 5 V; C_L = 15 pF	-	30	-	-	-	-	-	MHz
		SI, $\overline{SO}$ using flags; see Figure 6 and Figure 9								
		V_{CC} = 4.5 V	18	30	-	14	-	12	-	MHz
		V_{CC} = 5 V; C_L = 15 pF	-	30	-	-	-	-	-	MHz
		SI, $\overline{SO}$ cascaded; see Figure 6 and Figure 9								
		V_{CC} = 4.5 V	-	23	-	-	-	-	-	MHz
C_{PD}	power dissipation capacitance	V_I = GND to V_{CC} – 1.5 V [7]	-	490	-	-	-	-	-	pF

[1] t_{pd} is the same as t_{PLH} and t_{PHL}.

[2] t_{en} is the same as t_{PZH} and t_{PZL}.

[3] t_{dis} is the same as t_{PLZ} and t_{PHZ}.

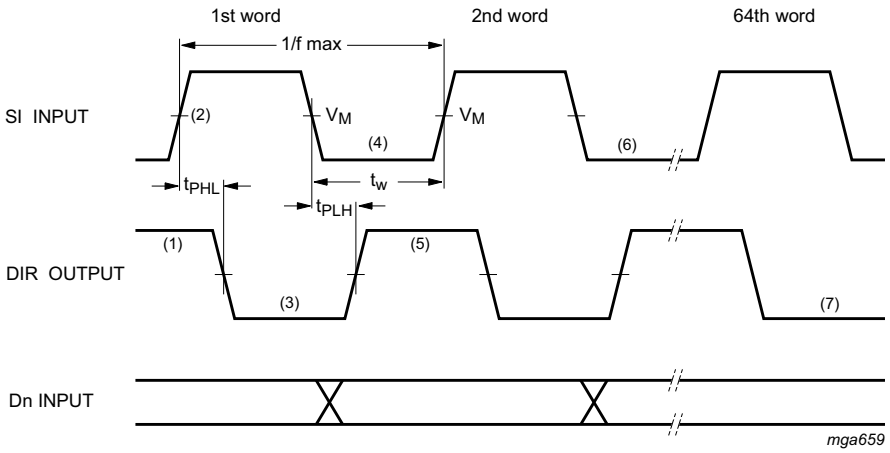
[4] t_t is the same as t_{THL} and t_{TLH}.

[5] This is the ripple through delay.

[6] This is the bubble-up delay.

[7] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).
$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$ where:
f_i = input frequency in MHz;
f_o = output frequency in MHz;
C_L = output load capacitance in pF;
V_{CC} = supply voltage in V;
N = number of inputs switching;
$\Sigma(C_L \times V_{CC}^2 \times f_o)$ = sum of outputs.

12. Waveforms



Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

Shifting in sequence FIFO empty to FIFO full

(1) DIR initially HIGH; FIFO is prepared for valid data

(2) SI set HIGH; data loaded into input stage

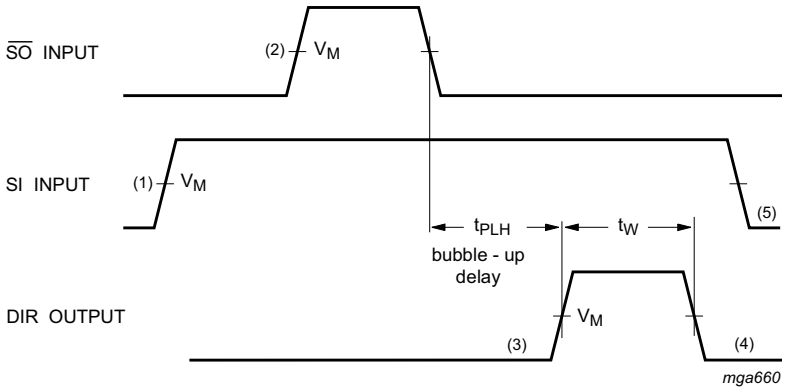
(3) DIR goes LOW; input stage “busy”

(4) SI set LOW; data from first location “ripple through”

(5) DIR goes HIGH; status flag indicates FIFO prepared for additional data

(6) Repeat process to load 2nd word through to 64th word into FIFO; DIR remains LOW; with attempt to shift into full FIFO, no data transfer occurs.

Fig 6. Propagation delay SI input to DIR output, the SI pulse width and the SI maximum frequency



Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

With FIFO full; SI held HIGH in anticipation of empty location

(1) FIFO is initially full, shift-in is held HIGH

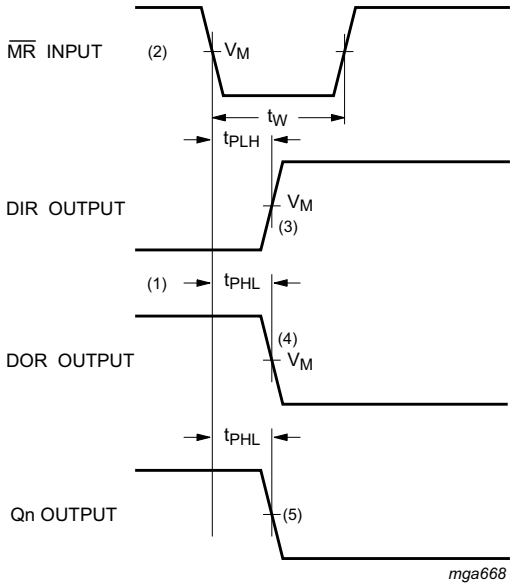
(2) $\overline{SO}$ pulse; data in output stage is unloaded, “bubble-up” process of empty location begins

(3) DIR HIGH; when empty location reaches input stage, flag indicates that FIFO is prepared for data input

(4) DIR returns to LOW; data returns to LOW; data shift-in to empty location is complete, FIFO is full again

(5) SI set LOW; necessary to complete shift-in process, DIR remains LOW, because FIFO is full

Fig 7. Bubble-up delay $\overline{SO}$ input to DIR output and the DIR pulse width.



Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

Master reset applied with FIFO full

(1) DIR LOW; output ready HIGH; assume that FIFO is full

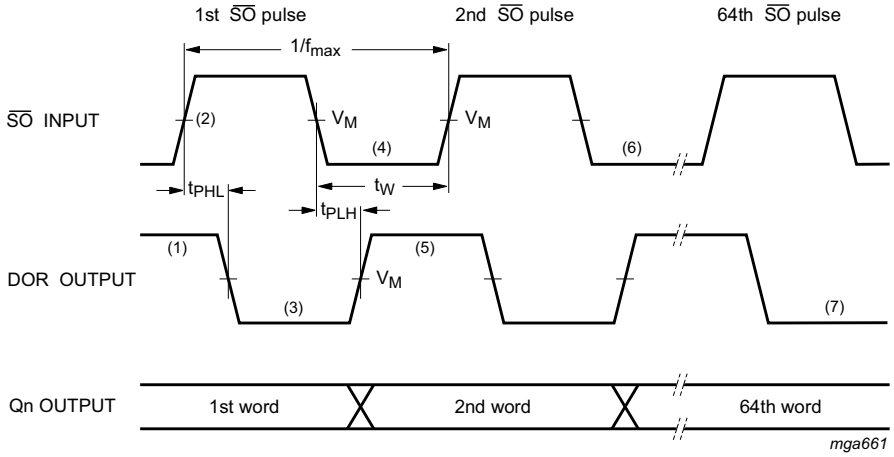
(2) $\overline{MR}$ pulse LOW; clears FIFO

(3) DIR goes HIGH; flag indicates input prepared for valid data

(4) DOR goes LOW; flag indicates FIFO empty

(5) Qn outputs go LOW (only last bit is reset)

Fig 8. Propagation delay $\overline{MR}$ input to DIR output, DOR output and Qn outputs and the $\overline{MR}$ pulse width.



Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

(1) DOR HIGH; no data transfer in progress, valid data is present at the output stage

(2) $\overline{SO}$ set HIGH; result in DOR going LOW

(3) DOR goes LOW; output stage “busy”

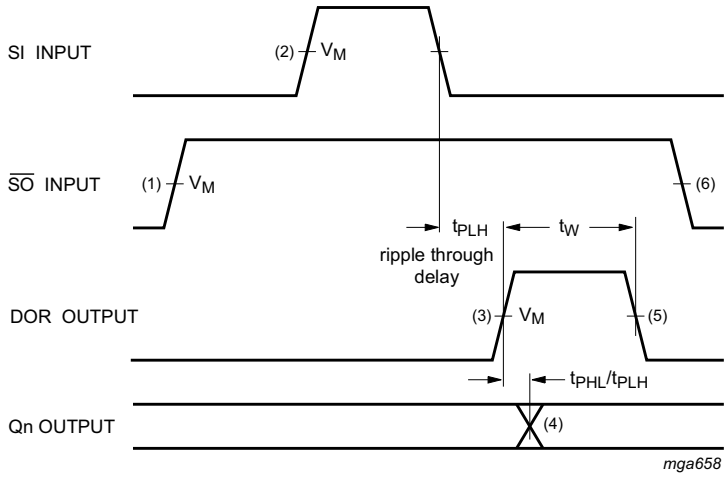
(4) $\overline{SO}$ set LOW; data in the input stage is unloaded, and new data replaces it as empty location “bubbles-up” to input stage

(5) DOR goes HIGH; transfer process completed, valid data present at output after the specified propagation delay

(6) Repeat process to unload the 3rd through the 64th word from FIFO

(7) DOR remains LOW; FIFO is empty

Fig 9. Propagation delay $\overline{SO}$ input to DOR output, the $\overline{SO}$ pulse width and the $\overline{SO}$ maximum frequency.



Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

With FIFO empty; $\overline{SO}$ is held HIGH in anticipation

(1) FIFO is initially empty. $\overline{SO}$ is held HIGH.

(2) SI pulse; loads data into FIFO and initiates ripple through process

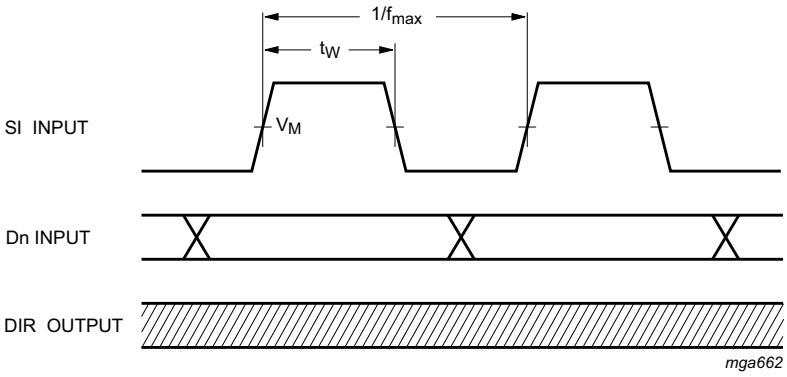
(3) DOR flag signals the arrival of valid data at the output stage

(4) Output transition; data arrives at output stage after the specified propagation delay between the rising and falling edge of the DOR pulse to the Qn output

(5) DOR goes LOW; data shift-out is completed, FIFO is empty again

(6) $\overline{SO}$ set LOW; necessary to complete shift-out process. DOR remains LOW, because FIFO is empty

Fig 10. Ripple through delay SI input to DOR output, propagation delay DOR input to Qn outputs and the DOR pulse width



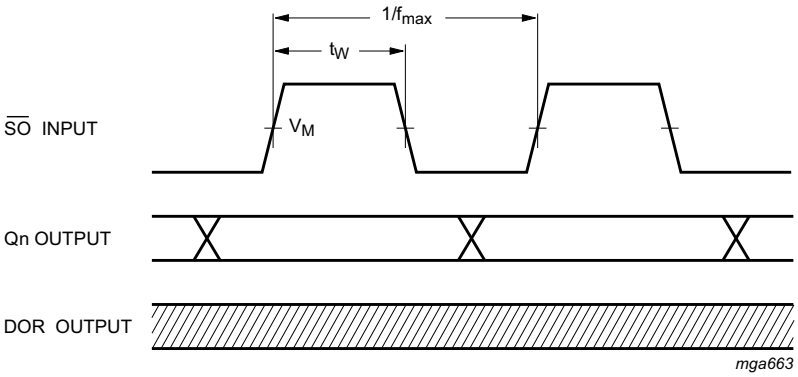
Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

Shift-in operation; high speed burst mode

In the high-speed mode, the burst-in rate is determined by the minimum shift-in HIGH and shift-in LOW specifications. The DIR status flag is a “don’t care” condition, and a shift-in pulse can be applied regardless of the flag. An SI pulse which would overflow the storage capacity of the FIFO is ignored.

Fig 11. Shift-in (SI) pulse width and maximum frequency (SI)



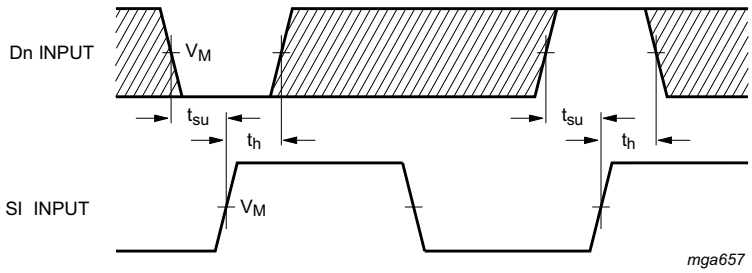
Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

Shift-out operation; high speed burst mode

In the high-speed mode, the burst-out rate is determined by the minimum shift-out HIGH and shift-out LOW specifications. The DOR flag is a “don’t care” condition, and an $\overline{SO}$ pulse can be applied without regard to the flag.

Fig 12. Shift-in ($\overline{SO}$) pulse width and maximum frequency ($\overline{SO}$)

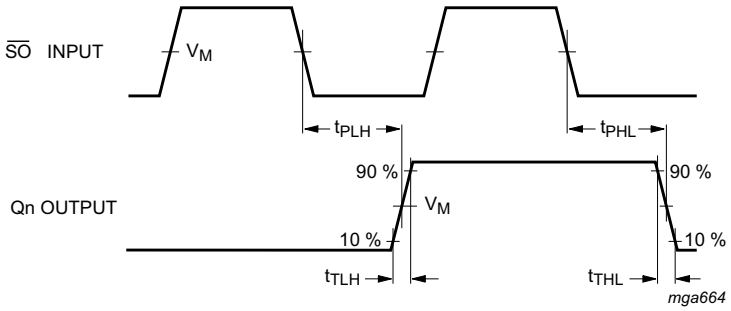


Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

The shaded areas indicate when the output is permitted to change for predictable output performance

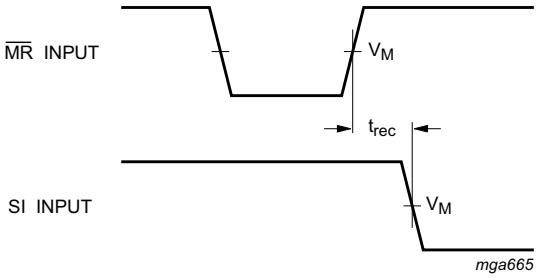
Fig 13. Set-up and hold times



Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

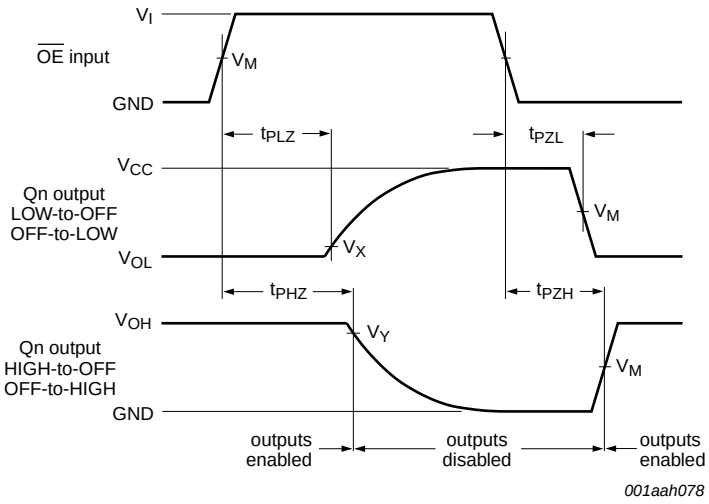
Fig 14. Propagation delay shift-out input ($\overline{SO}$) to data outputs (Qn) and output transition time



Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

Fig 15. Master-reset ($\overline{MR}$) to shift-in (SI) recovery time



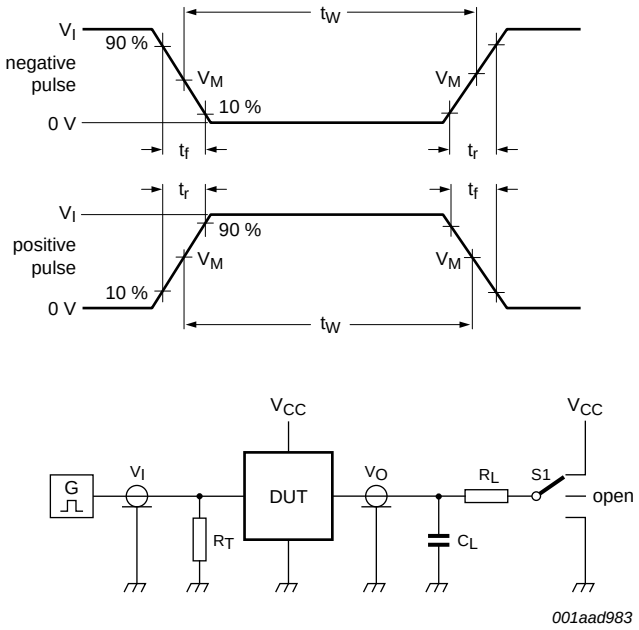
Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

Fig 16. Enable and disable times

Table 7. Measurement points

Type	Input	Output		
	V_M	V_M	V_X	V_Y
74HC7403-Q100	$0.5V_{CC}$	$0.5V_{CC}$	$0.1V_{CC}$	$0.9V_{CC}$
74HCT7403-Q100	1.3 V	1.3 V	$0.1V_{CC}$	$0.9V_{CC}$



Test data is given in Table 8.

Definitions test circuit:

R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator.

C_L = Load capacitance including jig and probe capacitance.

R_L = Load resistance.

S1 = Test selection switch.

Fig 17. Test circuit for measuring switching times

Table 8. Test data

Type	Input		Load		S1 position		
	V_I	t_r, t_f	C_L	R_L	t_{PHL}, t_{PLH}	t_{PZH}, t_{PHZ}	t_{PZL}, t_{PLZ}
74HC7403-Q100	V_{CC}	6 ns	15 pF, 50 pF	1 kΩ	open	GND	V_{CC}
74HCT7403-Q100	3 V	6 ns	15 pF, 50 pF	1 kΩ	open	GND	V_{CC}

13. Application information

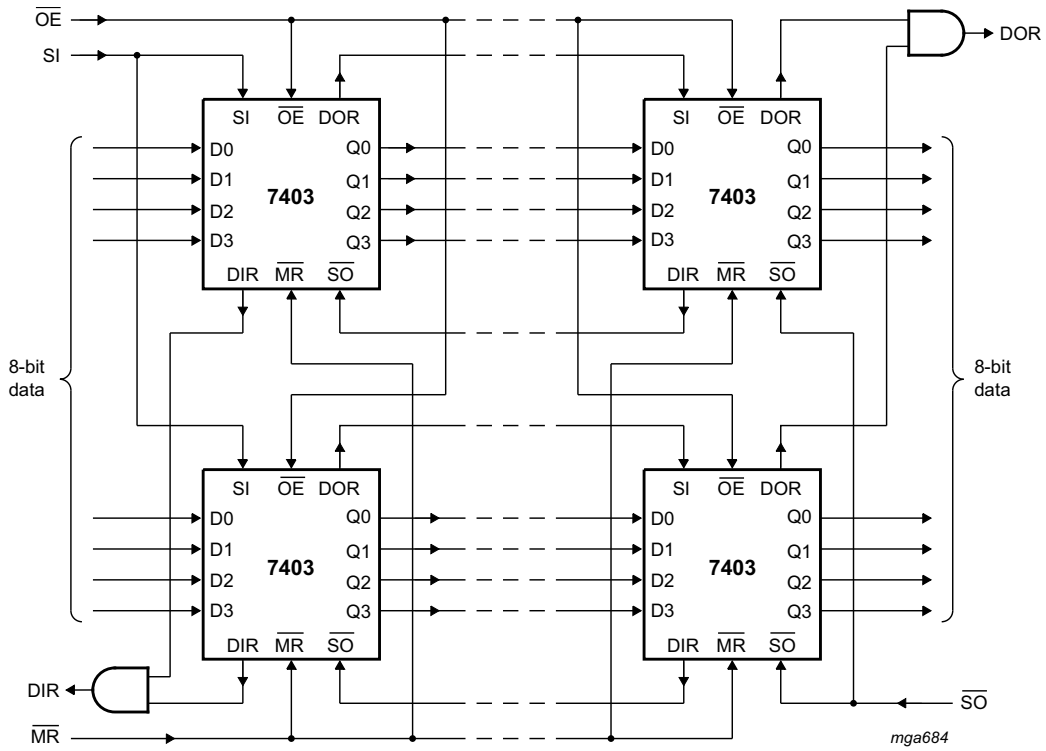
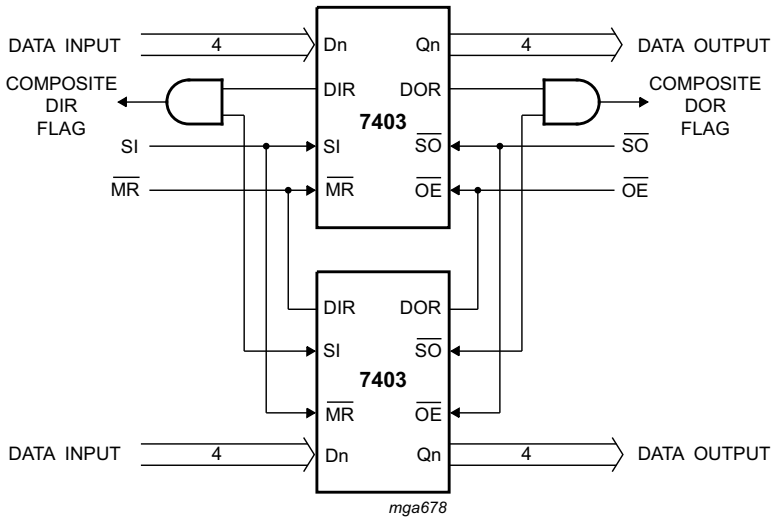
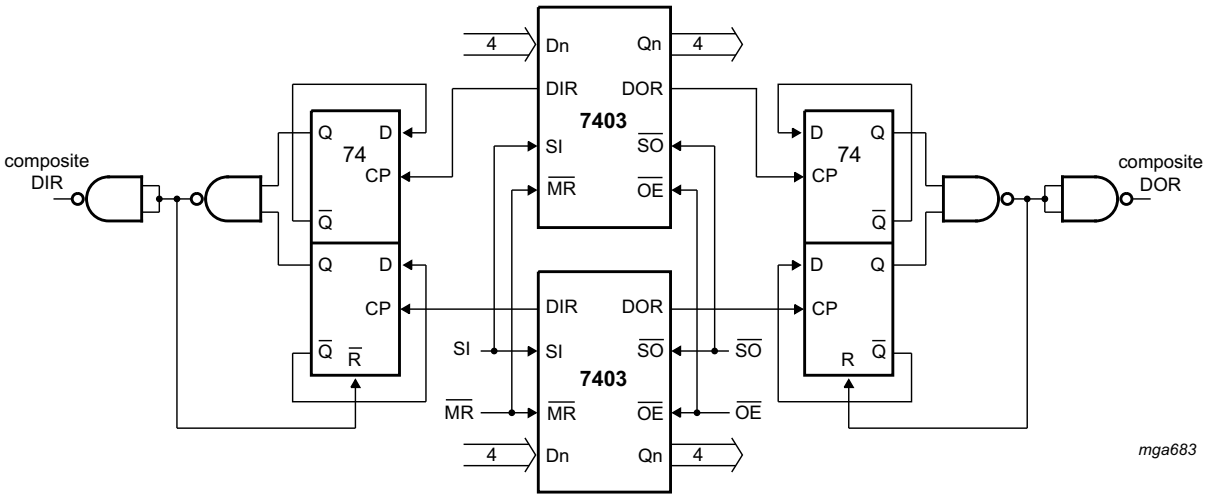


Fig 18. Expanded FIFO (parallel and serial) for increased word length; 8 bits wide x 64 n-bits



The 74HC7403-Q100; 74HCT7403-Q100 is easily expanded to increase word length. Composite DIR and DIR flags are formed with the addition of an AND gate. The basic operation and timing are identical to a single FIFO, with the exception of an added gate delay on the flags.

Fig 19. Expanded FIFO for increased word length; 64 words x 10 bits



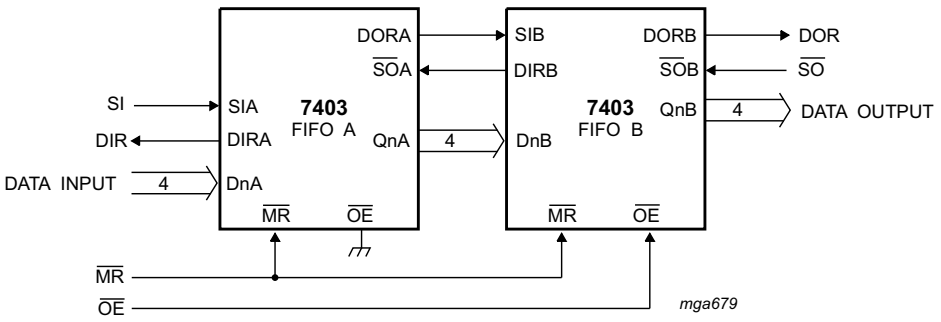
This circuit is only required if the SI input is constantly held HIGH, when the FIFO is empty and the automatic shift-in cycles are started or if the $\overline{SO}$ output is constantly held HIGH, when the FIFO is full and the automatic shift-out cycles are started (see Figure 7 and Figure 10).

Fig 20. Expanded FIFO for increased word length

13.1 Expanded format

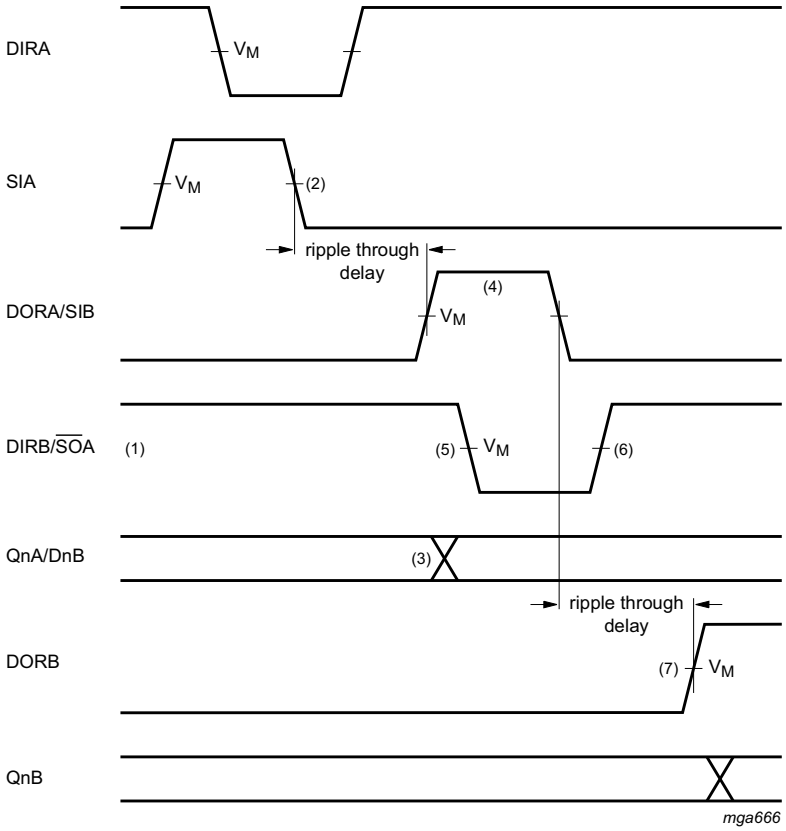
Figure 21 shows two cascaded FIFOs providing a capacity of 128 words x 4 bits. Figure 22 shows the signals on the nodes of both FIFOs after the application of the SI pulse, when both FIFOs are initially empty. After a ripple through delay, data arrives at the output of FIFOA. Due to $\overline{SO}$A being HIGH, a DORA pulse is generated. The requirements od SIB and DnB are satisfied by the DORA pulse width and the timing between the rising edge of DORA and QnA. After a second ripple through delay data arrives at the output of FIFOB.

Figure 23 shows the signals on the nodes of both FIFOs after the application of the $\overline{SO}$B pulse, when both FIFOs are initially full. After a bubble-up delay, a DIRB pulse is generated, which acts as a $\overline{SO}$A pulse for FIFOA. One word is transferred from the output of FIFOA to the input of FIFOB. The requirements of the $\overline{SO}$A pulse for FIFOA is satisfied by the pulse width of DORB. After a second bubble-up delay an empty space arrives at DnA, at which time DIRA goes HIGH. Figure 24 shows the waveforms at all external nodes of both FIFOs during a complete shift-in and shift-out sequence.



The 74HC7403-Q100; 74HCT7403-Q100 is easily cascaded to increase word capacity without external circuitry. In cascaded format, all necessary communications are handled by the FIFOs. Figure 22 and Figure 23 demonstrate the communication timing between FIFOA and FIFOB. Figure 24 provides an overview of pulses and timing of two cascaded FIFOs, when shifted full and shifted empty again.

Fig 21. Cascading for increased word capacity; 128 words x 4 bits



(1) FIFOA and FIFOB are initially empty, $\overline{SO}$A held HIGH in anticipation of data

(2) Load one word into FIFOA; SI pulse; applied. results in DIR pulse

(3) Data-out A/ data-in B transition; valid data arrives at FIFOA output stage after a specified delay of the DOR flag, meeting data input set-up requirements of FIFOB.

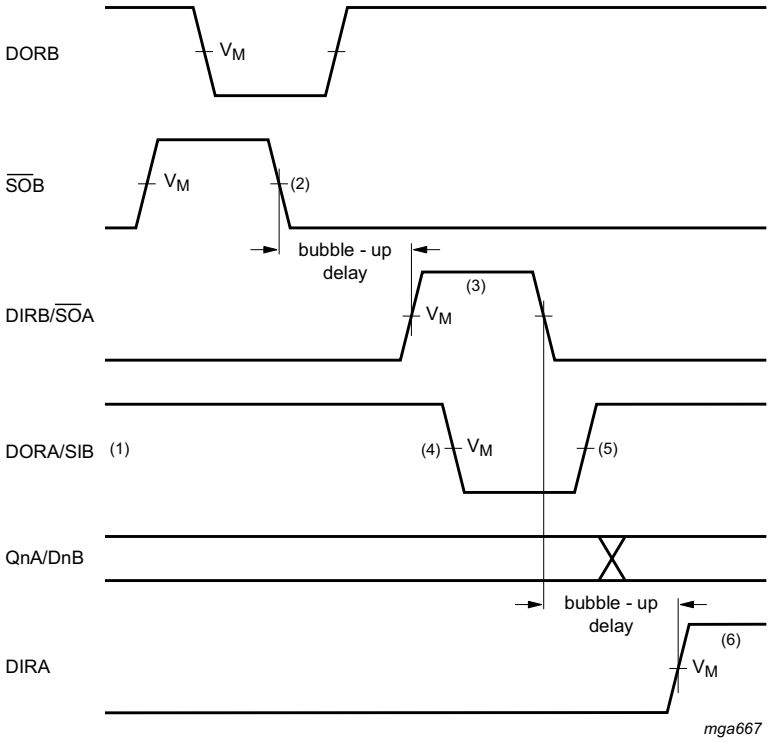
(4) DORA and SIB pulse HIGH; (ripple through delay after SIA LOW) data is unloaded from FIFOA as a result of the data output ready pulse, data is shifted into FIFOB

(5) DIRB and $\overline{SO}$A go LOW; flag indicates that input stage of FIFOB is busy, shift-out of FIFOA is complete

(6) DIRB and $\overline{SO}$A go HIGH automatically; the input stage of FIFOB is again able to receive data, $\overline{SO}$ is held HIGH in anticipation of additional data

(7) DORB goes HIGH; (ripple through delay after SIB LOW) valid data is present one propagation delay later at the FIFOB output stage

Fig 22. FIFO to FIFO communication; input timing under empty condition



(1) FIFOA and FIFOB initially full, SIB held HIGH in anticipation of shifting in new data as an empty location bubbles-up

(2) Unload one word from FIFOB; $\overline{SO}$ pulse applied, results in DOR pulse

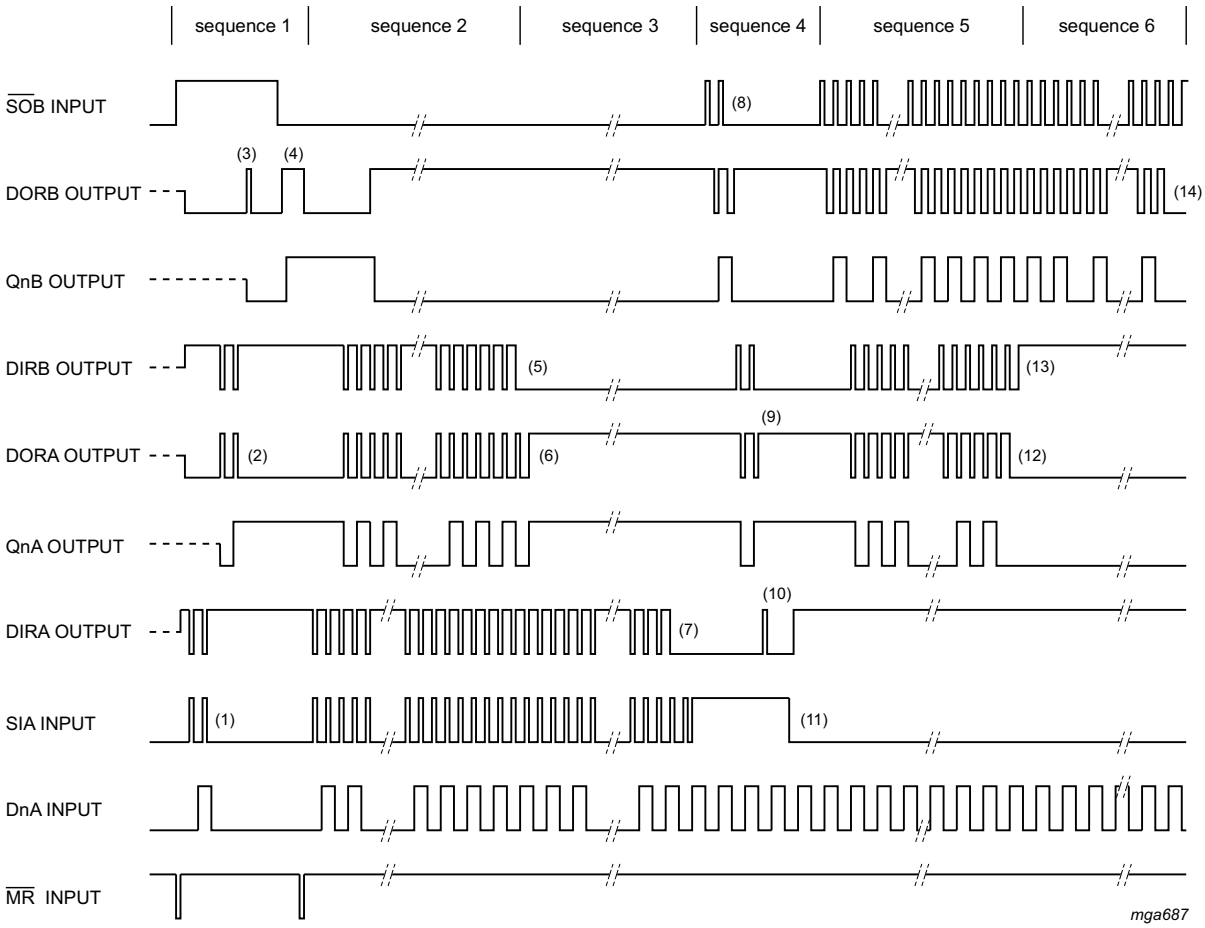
(3) DIRB and $\overline{SOA}$ pulse HIGH; (bubble-up delay after $\overline{SOB}$ LOW) data is loaded into FIFOB as a result of the DIR pulse, data is shifted out of FIFOA

(4) DORA and SIB go LOW; flag indicates that the output stage of FIFOA is busy, shift-in of FIFOB is complete

(5) DORA and SIB go HIGH; flag indicates that valid data is again available at FIFOA output stage, SIB is held HIGH, awaiting bubble-up of empty location.

(6) DIRA goes HIGH; (bubble-up delay after $\overline{SOA}$ LOW) an empty location is present at input stage of FIFOA

Fig 23. FIFO to FIFO communication; output timing under full condition



See also Section 13.1.1

Fig 24. Waveforms showing the functionality and intercommunication between two FIFOs (refer to Figure 19)

13.1.1 Sequence 1 (both FIFOs empty, starting SHIFT-IN process)

After an $\overline{MR}$ pulse has been applied, FIFOA and FIFOB are empty. The DOR flags of FIFOA and FIFOB go LOW due to no valid data being present at the outputs. The DIR flags are set HIGH due to the FIFOs being ready to accept data. $\overline{SOB}$ is held HIGH and two SIA pulses are applied (1). These pulses allow two data words to ripple through the output stage of FIFOA and the input stage of FIFIB (2). When data arrives at the output of FIFOB, a DORB pulse is generated (3). When $\overline{SOB}$ goes LOW, the first bit is shifted out and a second bit ripples through to the output after which DORB goes high (4).

13.1.2 Sequence 2 (FIFOB runs full)

After the $\overline{MR}$ pulse, a series of 64 SI pulses are applied. When 64 words are shifted in, DIRB remains LOW due to FIFOB being full (5). DORA goes LOW due to FIFOA being empty.

13.1.3 Sequence 3 (FIFOA runs full)

When 65 words are shifted in, DORA remains HIGH due to valid data remaining at the output of FIFOA. QnA remains HIGH, being the polarity of the 65th word (6). After the 128th SI pulse, DIR remains LOW and both FIFOs are full (7). Additional pulses have no effect.

13.1.4 Sequence 4 (both FIFOs full, starting SHIFT-OUT)

SIA is held HIGH and two $\overline{SOB}$ pulses are applied (8). These pulses shift out two words and thus allow two empty locations to bubble-up to the input stage of FIFOB, and proceed to FIFOA (9). When the first empty location arrives at the input of FIFOA, a DIRA pulse is generated (10) and a new word is shifted into FIFOA. SIA is made LOW and now the second empty location reaches the input stage of FIFOA, after which DIRA remains HIGH (11).

13.1.5 Sequence 5 (FIFOA runs empty)

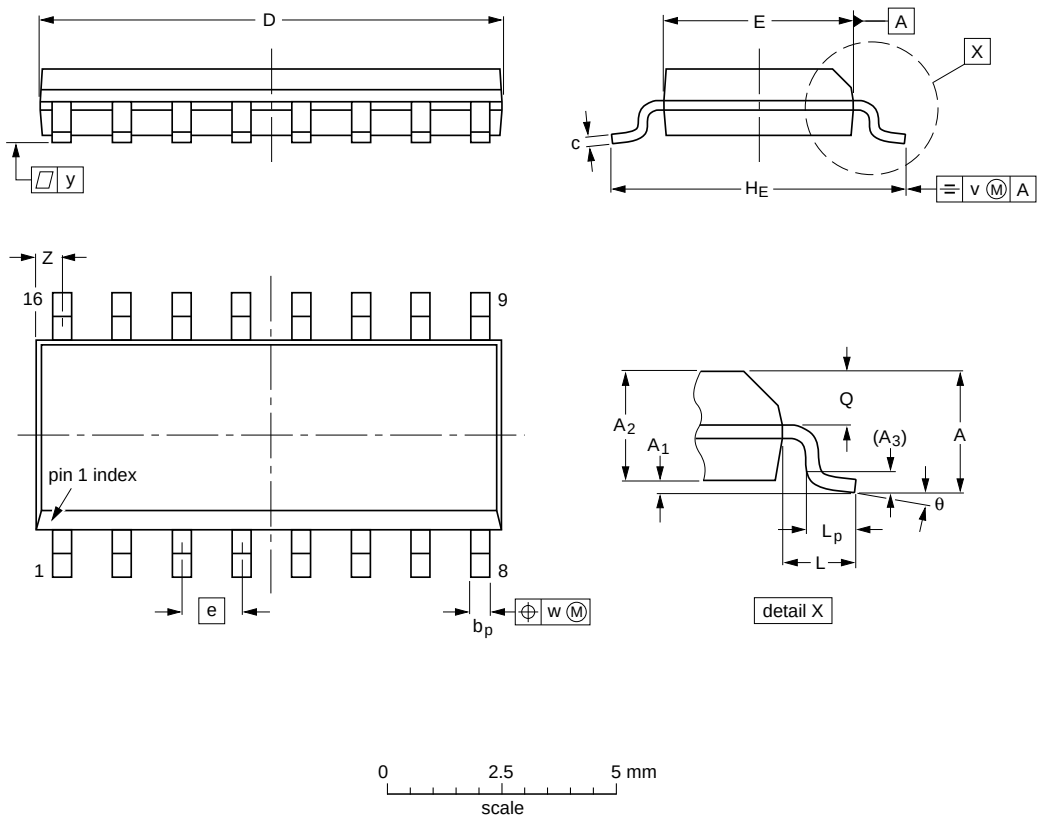
At the start of sequence 5, FIFOA contains 63 valid words due to two words being shifted out and one word being shifted in, in sequence 4. And additional series of $\overline{SOB}$ pulses are applied. After 63 $\overline{SOB}$ pulses, all words from FIFOA are shifted in FIFOB. DORA remains LOW (12).

13.1.6 Sequence 6 (FIFOB runs empty)

After the next $\overline{SOB}$ pulse, DIRB remains HIGH due to the input stage of FIFOB being empty. After another 63 $\overline{SOB}$ pulses, DORB remains LOW due to both FIFOS being empty (14). Additional $\overline{SOB}$ pulses have no effect. The last word remains available at the output Qn.

14. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm **SOT109-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.39 0.38	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT109-1	076E07	MS-012				~~99-12-27~~ 03-02-19

Fig 25. Package outline SOT109-1 (SO16)

15. Abbreviations

Table 9. Abbreviations

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model
TTL	Transistor-Transistor Logic
FIFO	First In First Out
MIL	Military

16. Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT7403_Q100 v.1	20120921	Product data sheet	-	-

17. Legal information

17.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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18. Contact information

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For sales office addresses, please send an email to: **salesaddresses@nxp.com**

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