

5 Volt Synchronous x18 First-In/First-Out Queue

Memory Configuration	Device
65,536 x 18	FQ285
32,768 x 18	FQ275
16,384 x 18	FQ265
8,192 x 18	FQ255

Key Features

- Industry leading First-In/First-Out Queues (up to 100MHz)
- Write cycle time of 10ns independent of Read cycle time
- Read cycle time of 10ns independent of Write cycle time
- 5V power supply
- Master Reset clears all previously programmed configurations including Write and Read pointers
- Partial Reset clears Write and Read pointers but maintains all previously programmed configurations
- First Word Fall Through (FWFT) and Standard Timing modes
- Presets for eight different Almost Full and Almost Empty offset values
- Parallel/Serial programming of PRAF and PRAE offset values
- Full, Empty, Almost Full, Almost Empty, and Half Full indicators
- Asynchronous output enable tri-state data output drivers
- Data retransmission
- Available package: 64 - pin Plastic Thin Quad Flat Pack (TQFP), 64 - pin Slim Thin Quad Flat Pack (STQFP)
- (0°C to 70°C) Commercial operating temperature available for cycle time of 10ns and above
- (-40°C to 85°C) Industrial operating temperature available for cycle time of 10ns and above

Product Description

HBA's FlexQ™ II offers industry leading FIFO queuing bandwidth (up to 1.8 Gbps), with a wide range of memory configurations (from 8,192 x 18 to 65,536 x 18). System designer has full flexibility of implementing deeper and wider queues using FWFT mode and width expansion features. Full, Empty, and Half-Full indicators allow easy handshaking between transmitters and receivers. User programmable Almost Full and Almost Empty (Parallel/Serial) indicators allow implementation of virtual queue depths.

Asynchronous Output Enable pin configures the tri-state data output drivers. Independent Write and Read controls provide rate-matching capability.

Master Reset clears all previously programmed configurations by providing a low pulse on $\overline{\text{MRST}}$ pin. In addition, Write and Read pointers to the queue are initialized to zero. Partial Reset will not alter previously programmed configurations but will initialize Write and Read pointers to zero.

In FWFT mode, first data written into the queue appears on output data bus after the specified latency period at the low to high transition of RCLK. Subsequent reads from the queue will require asserting $\overline{\text{REN}}$. This feature is useful when implementing depth expansion functions. In this mode, $\overline{\text{DRDY}}$ and $\overline{\text{QRDY}}$ are used instead of $\overline{\text{FULL}}$ and $\overline{\text{EMPTY}}$ respectively.

In Standard mode, always assert $\overline{\text{REN}}$ for read operation. $\overline{\text{FULL}}$ and $\overline{\text{EMPTY}}$ are used instead of $\overline{\text{DRDY}}$ and $\overline{\text{QRDY}}$ respectively.

$\overline{\text{PRAF}}$, $\overline{\text{PRAE}}$, and $\overline{\text{HALF}}$ are available in either FWFT or Standard mode.

At any time, data previously read from the queue can be retransmitted by asserting $\overline{\text{RET}}$ pin at the low to high transition of RCLK for a retransmit operation. Retransmit initializes the Read pointer to zero. Hence, all re-reads will always start from the physical 0th (Read pointer = zero) location of the queue. Both zero and normal latency timing modes are available for retransmit operation.

Product Description (Continued)

These FlexQ™ II devices have low power consumption, hence minimizing system power requirements. In addition, industry standard 64 - pin Plastic TQFP and 64 - pin STQFP are offered to save system board space.

These queues are ideal for applications such as data communication, telecommunication, graphics, multiprocessing, test equipment, network switching, etc.

Block Diagram of Single Synchronous Queue
65,536 x 18 / 32,768 x 18 / 16,384 x 18 / 8,192 x 18

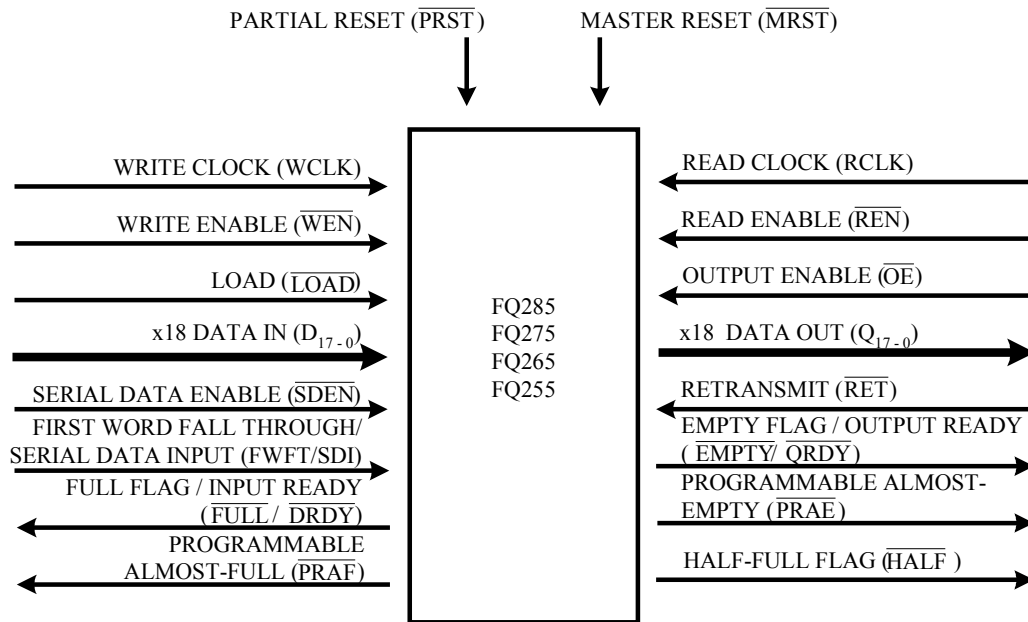


Figure 1. Single Device Configuration Signal Flow Diagram

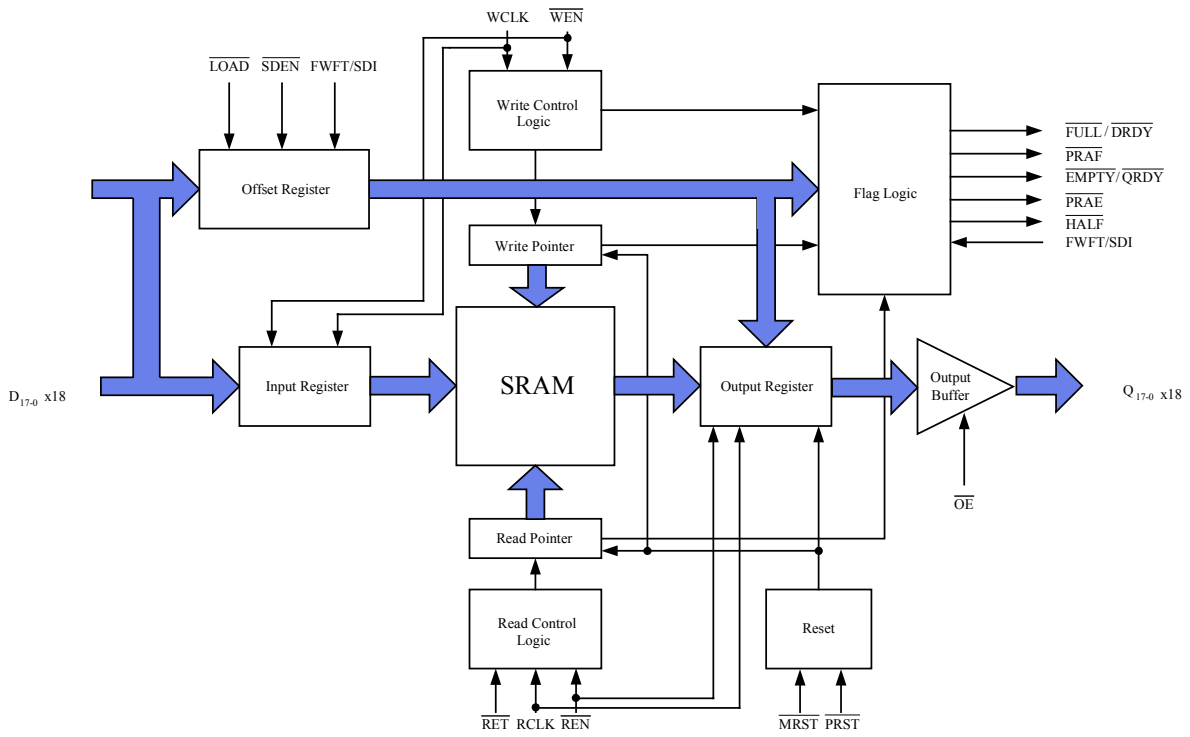


Figure 2. Device Architecture

Pin #	Pin Name	Pin Symbol	Input/Output	Description
62	Master Reset	$\overline{\text{MRST}}$	Input	Master Reset is required to initialize Write and Read pointers to the first position of the queue by setting $\overline{\text{MRST}}$ low. In Standard mode, $\overline{\text{FULL}}$ and $\overline{\text{PRAF}}$ will go high; $\overline{\text{EMPTY}}$ and $\overline{\text{PRAE}}$ will go low. In FWFT mode, $\overline{\text{DRDY}}$ will go low and $\overline{\text{QRDY}}$ will go high. $\overline{\text{PRAF}}$ and $\overline{\text{PRAE}}$ will go to the same state as Standard mode. In both modes, all data outputs will go low. Previous programmed configurations will not be maintained.
63	Partial Reset	$\overline{\text{PRST}}$	Input	Partial Reset is required to initialize Write and Read pointers to the first position of the queue by setting $\overline{\text{PRST}}$ low. In Standard mode, $\overline{\text{FULL}}$ and $\overline{\text{PRAF}}$ will go high; $\overline{\text{EMPTY}}$ and $\overline{\text{PRAE}}$ will go low. In FWFT mode, $\overline{\text{DRDY}}$ will go low and $\overline{\text{QRDY}}$ will go high. $\overline{\text{PRAF}}$ and $\overline{\text{PRAE}}$ will go to the same state as Standard mode. In both modes, all data outputs will go low. Previous programmed configurations will be maintained.
64	Write Clock	WCLK	Input	Writes data into queue during low to high transitions of WCLK if $\overline{\text{WEN}}$ is set to low.
1	Write Enable	$\overline{\text{WEN}}$	Input	Controls write operation into queue or offset registers during low to high transition of WCLK.
61	Load Enable	$\overline{\text{LOAD}}$	Input	During Master Reset, set $\overline{\text{LOAD}}$ low to select parallel programming or one of eight default offset values. Set $\overline{\text{LOAD}}$ high to select serial programming or one of eight default offset values. After Master Reset, $\overline{\text{LOAD}}$ controls write/read, to/from offset registers during low to high transition of WCLK/RCLK respectively. Use in conjunction with $\overline{\text{WEN}}$ / $\overline{\text{REN}}$.
6,7,8,9, 10,11,12,13, 14,15,16,17, 18,19,20,21, 22,23	Data Inputs	D ₁₇₋₀	Input	18 - bit wide input data bus.
52	Read Clock	RCLK	Input	Reads data from queue during low to high transitions of RCLK if $\overline{\text{REN}}$ is set to low.
51	Read Enable	$\overline{\text{REN}}$	Input	Controls read operation from queue or offset registers during low to high transition of RCLK.
49	Output Enable	$\overline{\text{OE}}$	Input	Setting $\overline{\text{OE}}$ low activates the data output drivers. Setting $\overline{\text{OE}}$ high deactivates the data output drivers (High-Z).
48,47,45,44, 42,41,40,38, 37,36,35,34, 32,31,29,28, 26,25	Data Outputs	Q ₁₇₋₀	Output	18 - bit wide output data bus.
60	First Word Fall Through/Serial Data Input	FWFT/SDI	Input	Selects FWFT timing or Standard timing mode during Master Reset. After Master Reset, if serial programming is selected ($\overline{\text{LOAD}}$ = high), FWFT/SDI is used as the serial data input for the offset registers. Serial data is written during the low to high transition of WCLK. Use in conjunction with $\overline{\text{SDEN}}$.

Table 1. Pin Descriptions

Pin #	Pin Name	Pin Symbol	Input/Output	Description
2	Serial Data Input Enable	$\overline{\text{SDEN}}$	Input	If serial programming is selected, setting $\overline{\text{SDEN}}$ low and $\overline{\text{LOAD}}$ low enables serial data input to be written into offset registers during the low to high transition of WCLK.
50	Retransmit	$\overline{\text{RET}}$	Input	Data previously read from the queue can be retransmitted by asserting $\overline{\text{RET}}$ pin at the low to high transition of RCLK for a retransmit operation. Retransmit initializes the Read pointer to zero. Hence, all re-reads will always start from the physical 0 th (Read pointer = zero) location of the queue.
58	Full/Data Input Ready Flag	$\overline{\text{FULL}} / \overline{\text{DRDY}}$	Output	Queue is full when $\overline{\text{FULL}}$ goes low during the low to high transition of WCLK. This prohibits further writes into the queue. In FWFT mode, queue is full when $\overline{\text{DRDY}}$ goes high during low to high transition of WCLK. This prohibits further writes into the queue.
53	Empty/Data Output Ready Flag	$\overline{\text{EMPTY}} / \overline{\text{QRDY}}$	Output	Queue is empty when $\overline{\text{EMPTY}}$ goes low during the low to high transition of RCLK. This prohibits further reads from the queue. In FWFT mode, queue is empty when $\overline{\text{QRDY}}$ goes high during the low to high transition of RCLK. This prohibits further reads from the queue.
57	Almost Full	$\overline{\text{PRAF}}$	Output	Queue is almost full when $\overline{\text{PRAF}}$ goes low during the low to high transition of WCLK. Default (Full-offset) or programmed offset values determine the status of $\overline{\text{PRAF}}$.
54	Almost Empty	$\overline{\text{PRAE}}$	Output	Queue is almost empty when $\overline{\text{PRAE}}$ goes low during the low to high transition of RCLK. Default (Empty +offset) or programmed offset values determine the status of $\overline{\text{PRAE}}$.
56	Half Full	$\overline{\text{HALF}}$	Output	Queue is more than half full when $\overline{\text{HALF}}$ goes low. Triggered by both WCLK and RCLK.
3	Don't Care	DC	N/A	This pin can be tied high or low, cannot be left open.
4, 30, 43, 55	Power	Vcc	N/A	5V power supply.
5, 24, 27, 33, 39, 46, 57	Ground	GND	N/A	0V Ground.

Table 1. Pin Descriptions (Continued)

Symbol	Rating	Com'l & Ind'l	Unit
V _{TERM}	Terminal Voltage with respect to GND	-0.5 to +7	V
T _{STG}	Storage Temperature	-55 to +125	°C
I _{OUT}	DC Output Current	-50 to +50	mA

NOTES:

Absolute Max Ratings are for reference only. Permanent damage to the device may occur if extended period of operation is outside this range. Standard operation should fall within the Recommended Operating Conditions.

Table 2. Absolute Maximum Ratings

		FQ285, FQ275 FQ265, FQ255						Unit
		Commercial Clock = 10ns, 15ns, 20ns			Industrial Clock = 10ns, 15ns, 20ns			
Symbol	Parameter	Min.	Typ.	Max.	Min.	Typ.	Max.	Unit
Recommended Operating Conditions								
V _{CC}	Supply Voltage Com'l / Ind'l	4.5	5.0	5.5	4.5	5.0	5.5	V
GND	Supply Voltage	0	0	0	0	0	0	V
V _{IH}	Input High Voltage Com'l / Ind'l	2.0	-	5.0	2.0	-	5.0	V
V _{IL}	Input Low Voltage Com'l / Ind'l	-	-	0.8	-	-	0.8	V
T _A	Operating Temperature Commercial	0	-	70	0	-	70	°C
T _A	Operating Temperature Industrial	-40	-	85	-40	-	85	°C
DC Electrical Characteristics								
I _{LI} ⁽¹⁾	Input Leakage Current (any input)	-10	-	10	-10	-	10	μA
I _{LO}	Output Leakage Current	-10	-	10	-10	-	10	μA
V _{OH}	Output Logic "1" Voltage, I _{OH} =-2mA	2.4	-	-	2.4	-	-	V
V _{OL}	Output Logic "0" Voltage, I _{OL} =8mA	-	-	0.4	-	-	0.4	V
Power Consumption								
I _{CC1} ^(2,3)	Active Power Supply Current	-	-	60	-	-	60	mA
I _{CC2} ⁽⁴⁾	Standby Current	-	-	20	-	-	20	mA

Table 3. DC Specifications

Capacitance at 100MHz Ambient Temperature (25°C)				
Symbol	Parameter	Conditions	Max.	Unit
C _{IN} ⁽²⁾	Input Capacitance	V _{IN} = 0V	10	pF
C _{OUT} ^(2,4)	Output Capacitance	V _{OUT} = 0V	10	pF

NOTES:

1. Measurement with $0.4 \leq V_{IN} \leq V_{cc}$
2. With output tri-stated (OE = High)
3. I_{cc}(1,2) is measured with WCLK and RCLK at 20 MHz
4. Design simulated, not tested.

Table 3. DC Specifications (Continued)



Symbol	Parameter	Commercial		Commercial & Industrial				Unit
				FQ285-15 FQ275-15 FQ265-15 FQ255-15		FQ285-20 FQ275-20 FQ265-20 FQ255-20		
		Min.	Max.	Min.	Max.	Min.	Max.	
fs	Clock Cycle Frequency	-	100	-	66	-	50	MHz
ta	Data Access Time	2	6.5	2	10	2	12	ns
twCLK	Write Clock Cycle Time	10	-	15	-	20	-	ns
twCLKH	Write Clock High Time	4.5	-	6	-	8	-	ns
twCLKL	Write Clock Low Time	4.5	-	6	-	8	-	ns
trCLK	Read Clock Cycle Time	10	-	15	-	20	-	ns
trCLKH	Read Clock High Time	4.5	-	6	-	8	-	ns
trCLKL	Read Clock Low Time	4.5	-	6	-	8	-	ns
tds	Data Set-up Time	3	-	4	-	5	-	ns
tdh	Data Hold Time	0.5	-	1	-	1	-	ns
tens	Enable Set-up Time	3	-	4	-	5	-	ns
tenh	Enable Hold Time	0.5	-	1	-	1	-	ns
trst	Reset Pulse Width ⁽¹⁾	10	-	15	-	20	-	ns
trsts	Reset Set-up Time	10	-	15	-	20	-	ns
trstr	Reset Recovery Time	10	-	15	-	20	-	ns
trstf	Reset to Flag and Output Time	-	10	-	15	-	20	ns
trsts	Retransmit Setup Time	3	-	4	-	5	-	ns
tolz	Output Enable to Output in Low-Z ⁽¹⁾	0	-	0	-	0	-	ns
toe	Output Enable to Output Valid	2	6	3	8	3	10	ns
tohz	Output Enable to Output in High-Z ⁽¹⁾	2	6	3	8	3	10	ns
tfULL	Write Clock to Full Flag	-	6.5	-	10	-	12	ns
tEMPTY	Read Clock to Empty Flag	-	6.5	-	10	-	12	ns
tpRAFS	Write Clock to Almost-Full Flag	-	6.5	-	10	-	12	ns
tpRAES	Read Clock to Almost-Empty Flag	-	6.5	-	10	-	12	ns
tsKEW1	Skew time between Read Clock & Write Clock for Full Flag / Empty Flag	5	-	6	-	10	-	ns
tsKEW2	Skew time between Read Clock & Write Clock for PRAF & PRAE	12	-	15	-	20	-	ns

Table 4. AC Electrical Characteristics

Symbol	Parameter	Commercial		Commercial & Industrial				Unit
				FQ285-15	FQ285-20			
		FQ285-10	FQ275-10	FQ275-15	FQ275-20			
FQ265-10	FQ265-15	FQ265-20	FQ255-10	FQ255-15	FQ255-20			
		Min.	Max.	Min.	Max.	Min.	Max.	
tLOADS	Load Setup Time	3	-	4	-	5	-	ns
tLOADH	Load Hold Time	0.5	-	1	-	1	-	ns
trTS	Retransmit Setup Time	3	-	4	-	5	-	ns
tHF	Clock to $\overline{\text{HALF}}$	-	16	-	20	-	22	ns

NOTES:

1. Design simulated, not tested.

Table 4. AC Electrical Characteristics (Continued)

Input Pulse Levels	GND to 3.0V
Input Rise/Fall Times	3ns
Input Timing Reference Levels	1.5V
Output Reference Levels	1.5V
Output Load, clock = 10ns	Refer to Figure 4
Output Load*, clock = 10ns, 15ns, 20ns	Refer to Figure 5

* Include jig and scope capacitances

Table 5. AC Test Condition

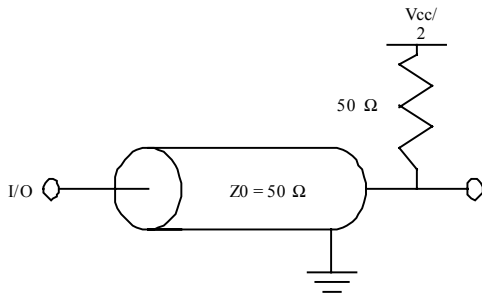


Figure 4. AC Test Load
for clock = 10ns

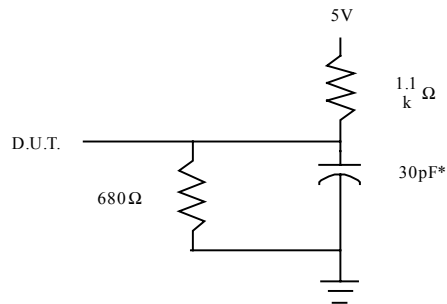


Figure 5. Output Load
for clock = 10ns, 15ns, 20ns
*Includes jig and scope capacitances.

Pin Functions

$\overline{\text{MRST}}$	Master Reset is required to initialize Write and Read pointers to the first position of the queue by setting $\overline{\text{MRST}}$ low. In Standard mode, $\overline{\text{FULL}}$ and $\overline{\text{PRAF}}$ will go high; $\overline{\text{EMPTY}}$ and $\overline{\text{PRAE}}$ will go low. In FWFT mode, $\overline{\text{DRDY}}$ will go low and $\overline{\text{QRDY}}$ will go high. $\overline{\text{PRAF}}$ and $\overline{\text{PRAE}}$ will go to the same state as Standard mode. In both modes, all data outputs will go low. Previous programmed configurations will not be maintained.
$\overline{\text{PRST}}$	Partial Reset is required to initialize Write and Read pointers to the first position of the queue by setting $\overline{\text{PRST}}$ low. In Standard mode, $\overline{\text{FULL}}$ and $\overline{\text{PRAF}}$ will go high; $\overline{\text{EMPTY}}$ and $\overline{\text{PRAE}}$ will go low. In FWFT mode, $\overline{\text{DRDY}}$ will go low and $\overline{\text{QRDY}}$ will go high. $\overline{\text{PRAF}}$ and $\overline{\text{PRAE}}$ will go to the same state as Standard mode. In both modes, all data outputs will go low. Previous programmed configurations will be maintained.
WCLK	Writes data into queue during low to high transitions of WCLK if $\overline{\text{WEN}}$ is activated. Synchronizes $\overline{\text{FULL}} / \overline{\text{DRDY}}$ and $\overline{\text{PRAF}}$ flags. WCLK and RCLK are independent of each other.
$\overline{\text{WEN}}$	Controls write operation into queue or offset registers during low to high transition of WCLK.
$\overline{\text{LOAD}}$	During Master Reset, set $\overline{\text{LOAD}}$ low to select parallel programming or one of eight default offset values. Set $\overline{\text{LOAD}}$ high to select serial programming or one of eight default offset values. After Master Reset, $\overline{\text{LOAD}}$ controls write/read, to/from offset registers during low to high transition of WCLK/RCLK respectively for parallel programming. Use in conjunction with $\overline{\text{WEN}} / \overline{\text{REN}}$. During programming of offset registers, $\overline{\text{PRAF}}$ and $\overline{\text{PRAE}}$ flag status is invalid. For Serial programming, $\overline{\text{LOAD}}$ is used to enable serial loading of offset registers together with $\overline{\text{SDEN}}$. Refer to Figure 6 for details.
D₁₇₋₀	18 - bit wide input data bus.
RCLK	Reads data from queue during low to high transitions of RCLK if $\overline{\text{REN}}$ is set low. Synchronizes the $\overline{\text{EMPTY}} / \overline{\text{QRDY}}$ and $\overline{\text{PRAE}}$ flags. RCLK and WCLK are independent of each other.
$\overline{\text{REN}}$	Reads data from queue during low to high transitions of RCLK if $\overline{\text{REN}}$ is set to low. This also advances the Read pointer of the queue.
$\overline{\text{OE}}$	Setting $\overline{\text{OE}}$ low activates the data output drivers. Setting $\overline{\text{OE}}$ high deactivates the data output drivers (High-Z). $\overline{\text{OE}}$ does not control advancement of Read pointer.
Q₁₇₋₀	18 - bit wide output data bus.
FWFT/SDI	Selects FWFT timing or Standard timing mode during Master Reset. After Master Reset, if serial programming is selected ($\overline{\text{LOAD}} = \text{high}$), FWFT/SDI is used as the serial data input for the offset registers. Serial data is written during the low to high transition of WCLK. Use in conjunction with $\overline{\text{SDEN}}$. In FWFT mode, $\overline{\text{DRDY}}$ and $\overline{\text{QRDY}}$ is used instead of $\overline{\text{FULL}}$ and $\overline{\text{EMPTY}}$. Refer to Table 10 for all flags status. In Standard mode, $\overline{\text{FULL}}$ and $\overline{\text{EMPTY}}$ are used instead of $\overline{\text{DRDY}}$ and $\overline{\text{QRDY}}$. Refer to Table 9 for all flags status.
$\overline{\text{SDEN}}$	If serial programming is selected, setting $\overline{\text{SDEN}}$ and $\overline{\text{LOAD}}$ low enables serial data to be written into offset registers during the low to high transition of WCLK. During serial programming, $\overline{\text{PRAF}}$ and $\overline{\text{PRAE}}$ flags status is invalid. Refer to Figure 6 for details.
$\overline{\text{RET}}$	Data previously read from the queue can be retransmitted by asserting $\overline{\text{RET}}$ pin at the low to high transition of RCLK for a retransmit operation. Retransmit initializes the Read pointer to zero. Hence, all re-reads will always start from the physical 0 th (Read pointer = zero), location of the queue. Refer to Diagram 7 & 8 for details.

Pin Functions (Continued)

$\overline{\text{FULL}} / \overline{\text{DRDY}}$	In Standard mode, queue is full when $\overline{\text{FULL}}$ goes low during the low to high transition of WCLK. This prohibits further writes into the queue and prevents advancement of Write pointer. In FWFT mode, queue is full when $\overline{\text{DRDY}}$ goes high during the low to high transition of WCLK. This prohibits further writes into the queue and prevents advancement of Write pointer. Refer to Table 8 & 9 for behavior of $\overline{\text{FULL}} / \overline{\text{DRDY}}$.
$\overline{\text{EMPTY}} / \overline{\text{QRDY}}$	In Standard mode, queue is empty when $\overline{\text{EMPTY}}$ goes low during the low to high transition of RCLK. This prohibits further reads from the queue and prevents advancement of Read pointer. In FWFT mode, queue is empty when $\overline{\text{QRDY}}$ goes low during the low to high transition of RCLK. This prohibits further reads from the queue and prevents advancement of Read pointer. Refer to Table 8 & 9 for behavior of $\overline{\text{EMPTY}} / \overline{\text{QRDY}}$.
$\overline{\text{PRAF}}$	In Synchronous mode, queue is almost full when $\overline{\text{PRAF}}$ goes low during the low to high transition of WCLK. Default (Full+offset) or programmed offset values determine the status of $\overline{\text{PRAF}}$. In Asynchronous timing mode, $\overline{\text{PRAF}}$ is triggered by both WCLK and RCLK. Refer to Table 8 & 9 for behavior of $\overline{\text{PRAF}}$.
$\overline{\text{PRAE}}$	In Synchronous mode, queue is almost empty when $\overline{\text{PRAE}}$ goes low during the low to high transition of RCLK. Default (Empty+offset) or programmed offset values determine the status of $\overline{\text{PRAE}}$. In Asynchronous timing mode, $\overline{\text{PRAE}}$ is triggered by both WCLK and RCLK. Refer to Table 8 & 9 for behavior of $\overline{\text{PRAE}}$.
$\overline{\text{HALF}}$	Queue is more than half full when $\overline{\text{HALF}}$ goes low during the low to high transition of WCLK. $\overline{\text{HALF}}$ goes high during low to high transition of RCLK when queue is less than half full. Refer to Table 8 & 9 for details.

$\overline{\text{LOAD}}$	$\overline{\text{WEN}}$	$\overline{\text{REN}}$	$\overline{\text{SDEN}}$	WCLK	RCLK	FQ285 FQ275 FQ265 FQ255 Selection / Sequence
0	0	1	1		X	Write to offset registers: Empty Offset Full Offset Parallel write to registers: 1. $\overline{\text{PRAE}}$ 2. $\overline{\text{PRAF}}$
0	1	0	1	X		Read from offset registers: Empty Offset Full Offset Parallel read from registers: 1. $\overline{\text{PRAE}}$ 2. $\overline{\text{PRAF}}$
0	1	1	0		X	Serial shift into registers: 32 bits for the FQ285 30 bits for the FQ275 28 bits for the FQ265 26 bits for the FQ255 1 bit for each rising WCLK edge Starting with Empty Offset (Low Byte) Ending with Full Offset (High Byte)
X	1	1	1	X	X	No Operation
1	0	X	X		X	Write Memory
1	X	0	X	X		Read Memory
1	1	1	X	X	X	No Operation

Figure 6. Programmable Flag Offset Programming Sequence

Device	$\overline{\text{PRAF}}$ Programming (bits)	$\overline{\text{PRAE}}$ Programming (bits)
FQ285	D/Q ₁₅₋₀	D/Q ₁₅₋₀
FQ275	D/Q ₁₄₋₀	D/Q ₁₄₋₀
FQ265	D/Q ₁₃₋₀	D/Q ₁₃₋₀
FQ255	D/Q ₁₂₋₀	D/Q ₁₂₋₀
ALL	DV = 7FH, when $\overline{\text{LOAD}} = 0$ DV = 3FFH, when $\overline{\text{LOAD}} = 1$	DV = 7FH, when $\overline{\text{LOAD}} = 0$ DV = 3FFH, when $\overline{\text{LOAD}} = 1$

Table 6. Parallel Offset Register Data Mapping and Default Values (DV) Table

Device	Standard Mode	FWFT
FQ285	65,536 x 18	65,537 x 18
FQ275	32,768 x 18	32,769 x 18
FQ265	16,384 x 18	16,385 x 18
FQ255	8,192 x 18	8,193 x 18

Table 7. Maximum Depth of Queue for Standard and FWFT Mode

FQV285	FULL	PRAF	HALF	PRAE	EMPTY
0	H	H	H	L	L
1 to $y^{(1)}$	H	H	H	L	H
($y+1$) to 32,768	H	H	H	H	H
32,769 to $[65,536-(x+1)]$	H	H	L	H	H
$(65,536-x^{(2)})$ to 65,535	H	L	L	H	H
65,536	L	L	L	H	H

FQV275	FULL	PRAF	HALF	PRAE	EMPTY
0	H	H	H	L	L
1 to $y^{(1)}$	H	H	H	L	H
($y+1$) to 16,384	H	H	H	H	H
16,385 to $[32,768-(x+1)]$	H	H	L	H	H
$(32,768-x^{(2)})$ to 32,767	H	L	L	H	H
32,768	L	L	L	H	H

FQV265	FULL	PRAF	HALF	PRAE	EMPTY
0	H	H	H	L	L
1 to $y^{(1)}$	H	H	H	L	H
($y+1$) to 8,192	H	H	H	H	H
8,193 to $[16,384-(x+1)]$	H	H	L	H	H
$(16,384-x^{(2)})$ to 16,383	H	L	L	H	H
16,384	L	L	L	H	H

FQV255	FULL	PRAF	HALF	PRAE	EMPTY
0	H	H	H	L	L
1 to $y^{(1)}$	H	H	H	L	H
($y+1$) to 4,096	H	H	H	H	H
4,097 to $[8,192-(x+1)]$	H	H	L	H	H
$(8,192-x^{(2)})$ to 8,191	H	L	L	H	H
8,192	L	L	L	H	H

NOTES:

- $y = \overline{\text{PRAE}}$ offset; Default Values: $y = 127$ when parallel offset loading is selected or $y = 1,023$ when serial offset loading is selected.
- $x = \overline{\text{PRAF}}$ offset; Default Values: $x = 127$ when parallel offset loading is selected or $x = 1,023$ when serial offset loading is selected.

Table 8. Status Flags (Standard Mode)

FQV285	$\overline{\text{DRDY}}$	$\overline{\text{PRAF}}$	$\overline{\text{HALF}}$	$\overline{\text{PRAE}}$	$\overline{\text{QRDY}}$
0	L	L	L	H	H
1 to $y^{(1)+1}$	L	L	L	H	L
(y+2) to 32,769	L	L	L	L	L
32770 to [65,537-(x+1)]	L	L	H	L	L
(65,537- $x^{(2)}$) to 65,536	L	H	H	L	L
65,537	H	H	H	L	L

FQV275	$\overline{\text{DRDY}}$	$\overline{\text{PRAF}}$	$\overline{\text{HALF}}$	$\overline{\text{PRAE}}$	$\overline{\text{QRDY}}$
0	L	L	L	H	H
1 to $y^{(1)+1}$	L	L	L	H	L
(y+2) to 16,385	L	L	L	L	L
16,386 to [32,769-(x+1)]	L	L	H	L	L
(32,769- $x^{(2)}$) to 32,768	L	H	H	L	L
32,769	H	H	H	L	L

FQV265	$\overline{\text{DRDY}}$	$\overline{\text{PRAF}}$	$\overline{\text{HALF}}$	$\overline{\text{PRAE}}$	$\overline{\text{QRDY}}$
0	L	L	L	H	H
1 to $y^{(1)+1}$	L	L	L	H	L
(y+2) to 8,193	L	L	L	L	L
8,194 to [16,385-(x+1)]	L	L	H	L	L
(16,385- $x^{(2)}$) to 16,384	L	H	H	L	L
16,385	H	H	H	L	L

FQV255	$\overline{\text{DRDY}}$	$\overline{\text{PRAF}}$	$\overline{\text{HALF}}$	$\overline{\text{PRAE}}$	$\overline{\text{QRDY}}$
0	L	L	L	H	H
1 to $y^{(1)+1}$	L	L	L	H	L
(y+2) to 4,097	L	L	L	L	L
4,098 to [8,193-(x+1)]	L	L	H	L	L
(8,193- $x^{(2)}$) to 8,192	L	H	H	L	L
8,193	H	H	H	L	L

NOTES:

1. $y = \overline{\text{PRAE}}$ offset; Default Values: $y = 127$ when parallel offset loading is selected or $y = 1,023$ when serial offset loading is selected.
2. $x = \overline{\text{PRAF}}$ offset; Default Values: $x = 127$ when parallel offset loading is selected or $x = 1,023$ when serial offset loading is selected.

Table 9. Status Flags (FWFT Mode)

Timing Diagrams

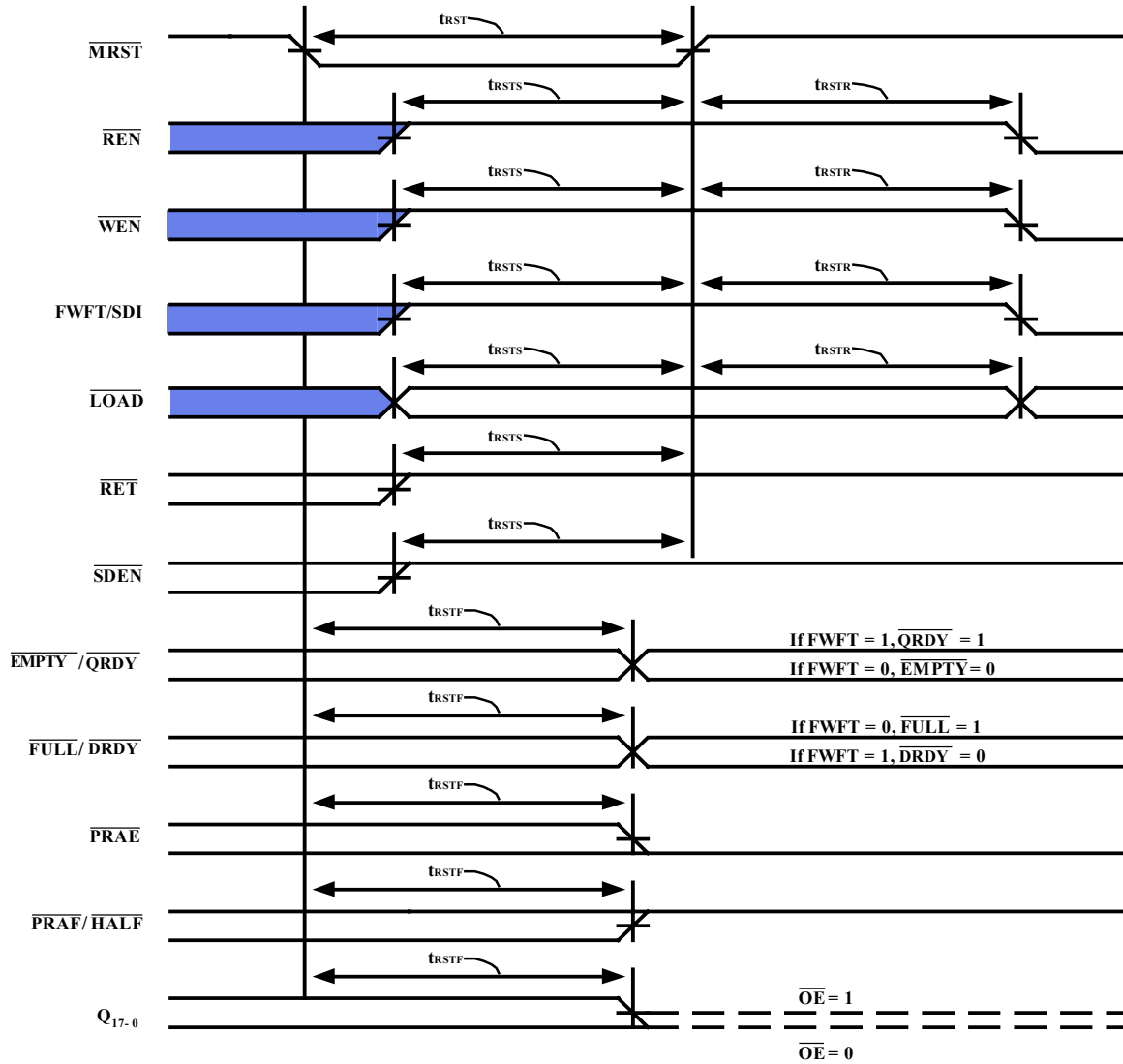


Diagram 1. Master Reset Timing

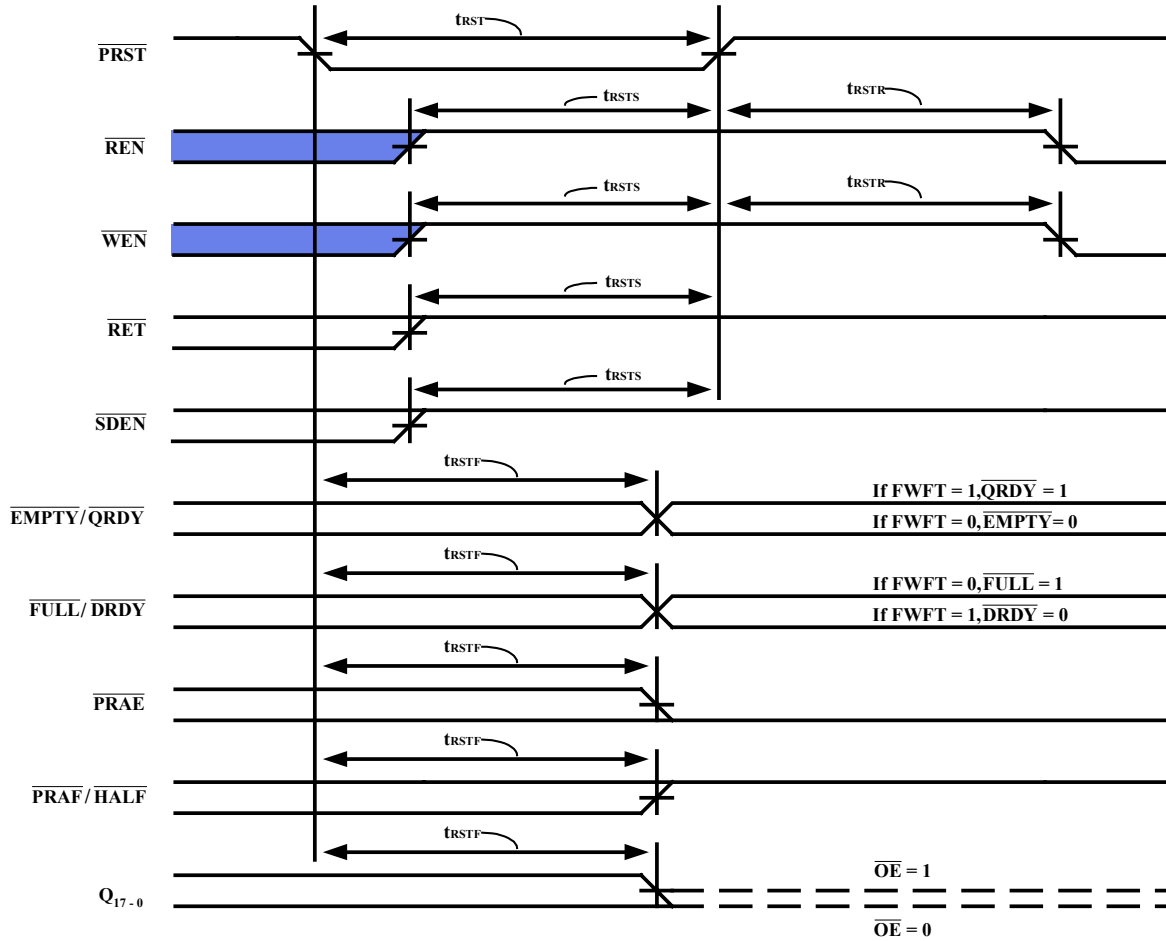
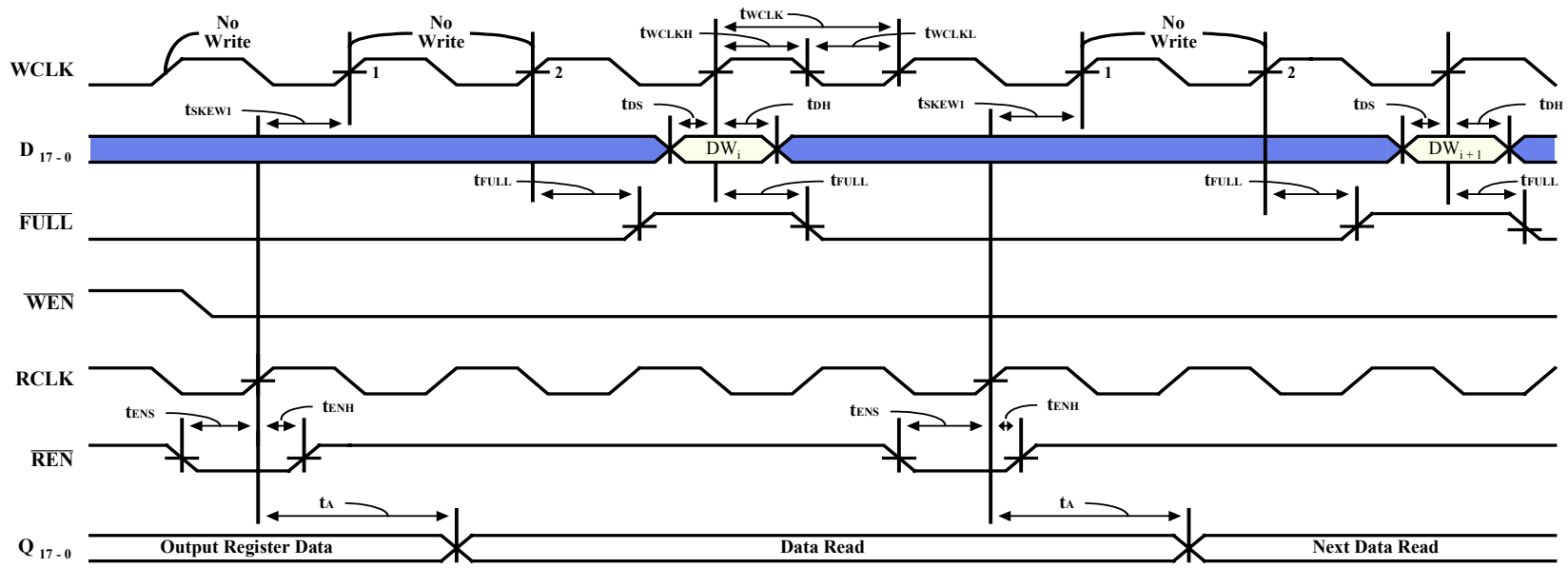


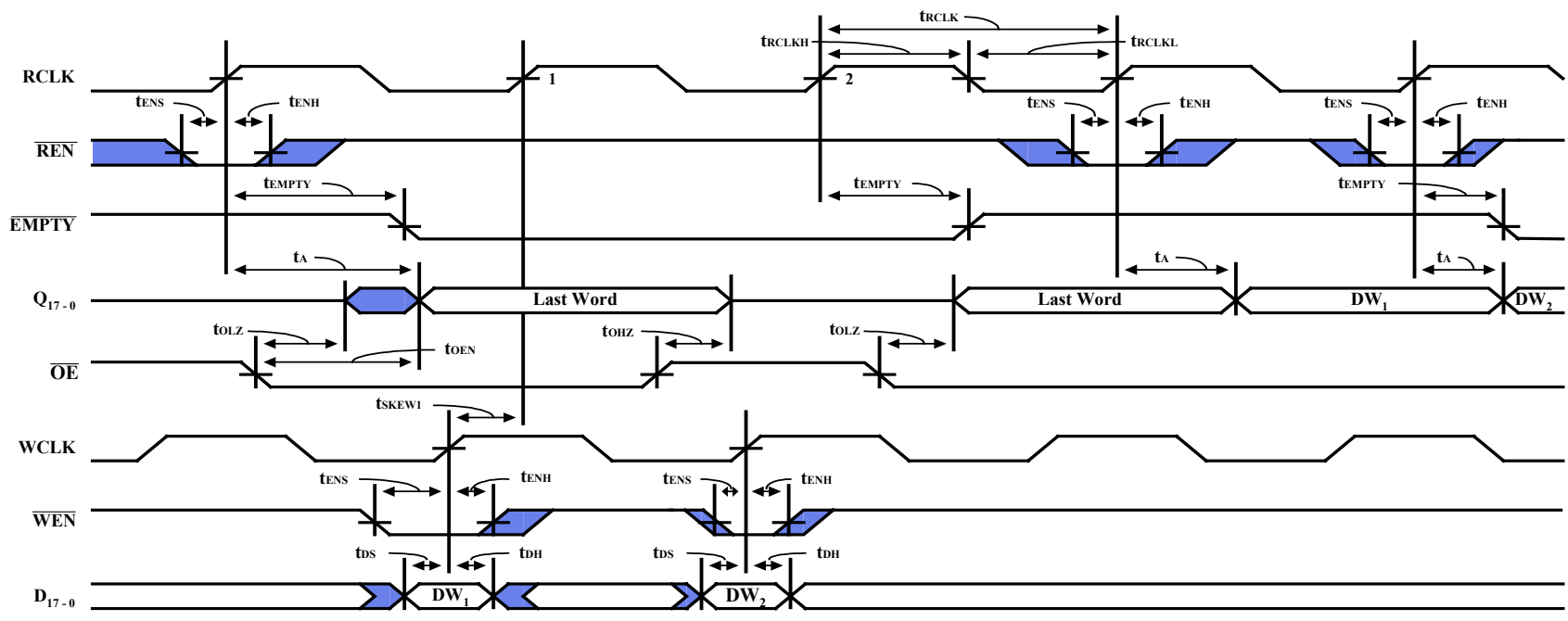
Diagram 2. Partial Reset Timing



NOTES:

1. If the time between a rising edge of RCLK to the rising edge of WCLK is greater than or equal to tsKEW1, FULL will go high (after one WCLK cycle plus tFULL). If tsKEW1 is not met, then FULL will assert 1 or more WCLK cycles.
2. LOAD = High, OE = Low.

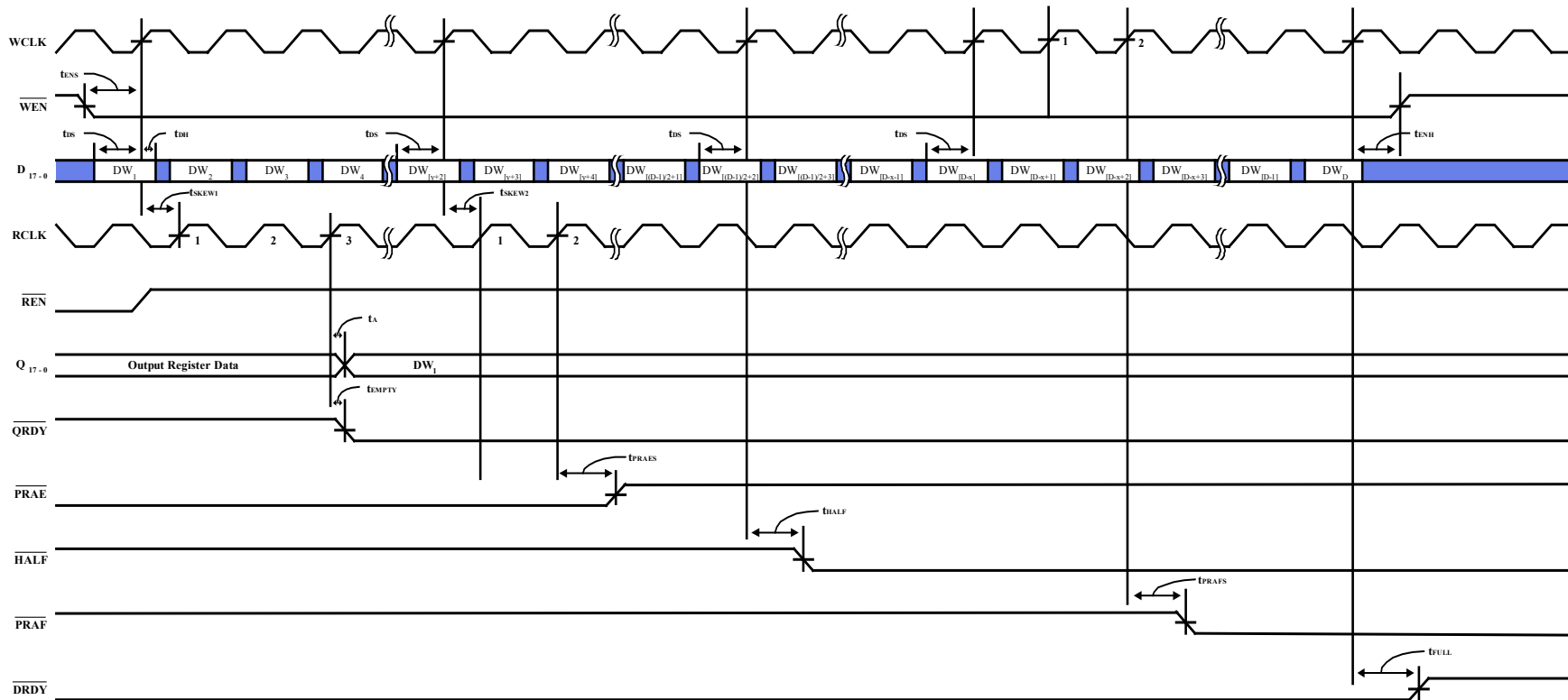
Diagram 3. Write Cycle and Full Flag Timing (Standard Mode)



NOTES:

1. If the time between a rising edge of WCLK to the rising edge of RCLK is greater than or equal to t_{SKEW1} , \overline{EMPTY} will go high (after RCLK cycle plus t_{EMPTY}). If t_{SKEW1} is not met, then \overline{EMPTY} will assert 1 or more RCLK cycles.
2. \overline{LOAD} = High.
3. First word latency: $t_{SKEW1} + t_{EMPTY} + 1 * tr_{CLK}$.

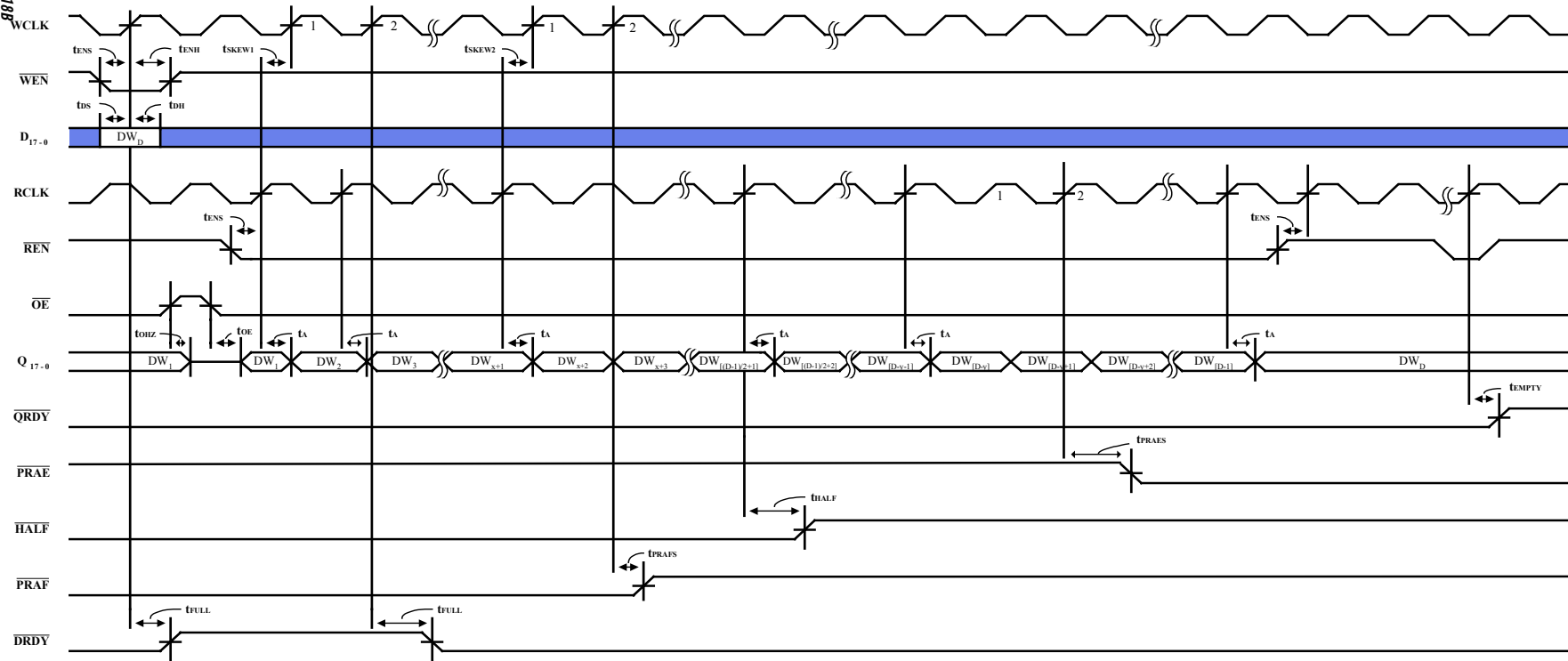
Diagram 4. Read Cycle, Empty Flag and First Data Word Latency Timing (Standard Mode)



NOTES:

1. If the time between a rising edge of WCLK to the rising edge of RCLK is greater than or equal to t_{skew1} , \overline{QRDY} will go low (after two RCLK cycle plus t_{EMPTY}). If t_{skew1} is not met, then \overline{QRDY} will assert 1 or more RCLK cycles.
2. If the time between a rising edge of WCLK to the rising edge of RCLK is greater than or equal to t_{skew2} , \overline{PRAE} will go high (after one RCLK cycle plus t_{PRAES}). If t_{skew2} is not met, then \overline{PRAE} will assert 1 or more RCLK cycles.
3. \overline{LOAD} = High, \overline{OE} = Low.
4. y = \overline{PRAE} offset, x = \overline{PRAF} offset.
5. D = maximum queue depth. Please refer to Table 7 for Depth.
6. First word latency: $t_{skew1} + t_{EMPTY} + 2 * t_{RCLK}$

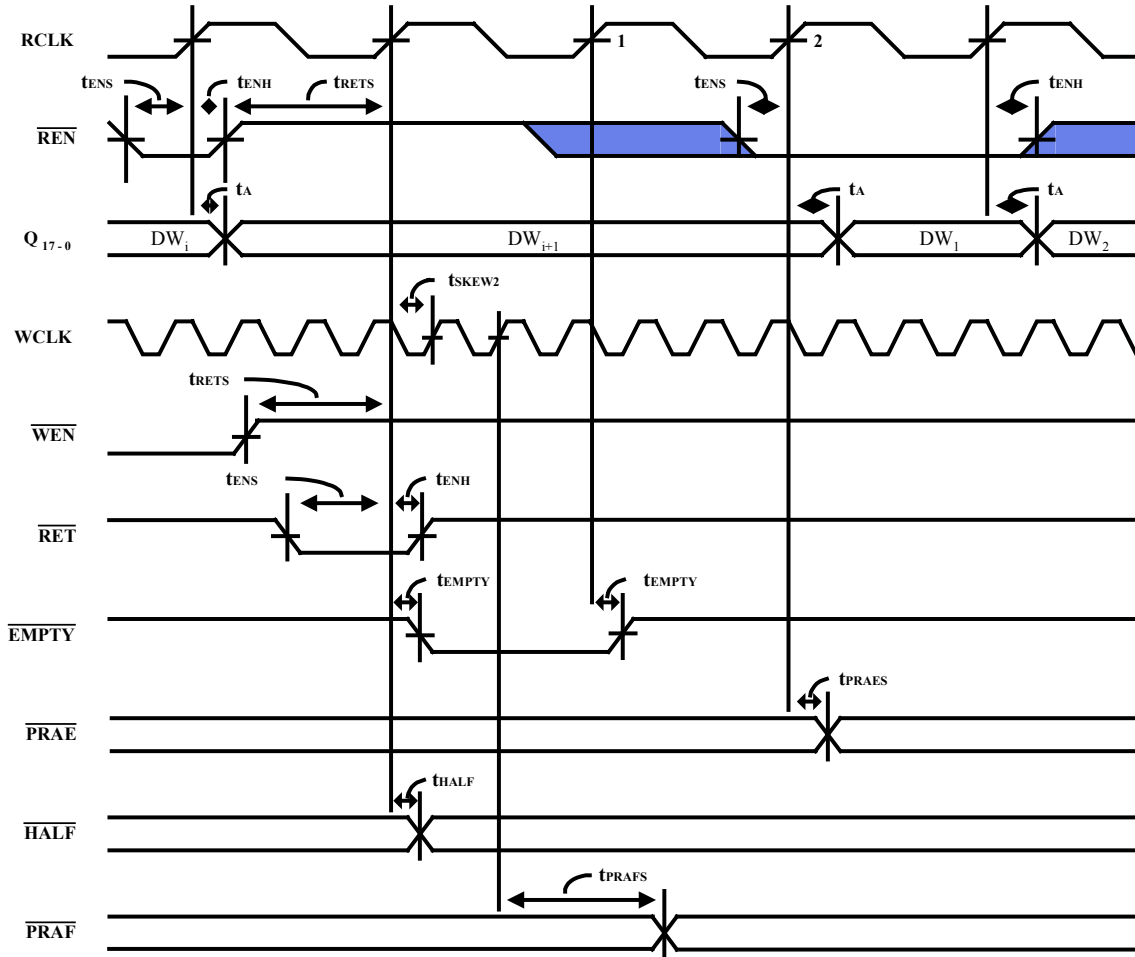
Diagram 5. Write Timing (FWFT Mode)



NOTES:

1. If the time between a rising edge of RCLK to the rising edge of WCLK is greater than or equal to t_{SKEW1}, $\overline{\text{DRDY}}$ will go low (after one WCLK cycle plus t_{FULL}). If t_{SKEW1} is not met, then $\overline{\text{DRDY}}$ will assert 1 or more WCLK cycles.
2. If the time between a rising edge of RCLK to the rising edge of WCLK is greater than or equal to t_{SKEW2}, $\overline{\text{PRAF}}$ will go high (after one WCLK cycle plus t_{PRAFS}). If t_{SKEW2} is not met, then $\overline{\text{PRAF}}$ will assert 1 or more WCLK cycles.
3. $\overline{\text{LOAD}}$ = High
4. y = PRAE Offset, x = $\overline{\text{PRAF}}$ offset.
5. D = maximum queue depth. Please refer to Table 7 for Depth.

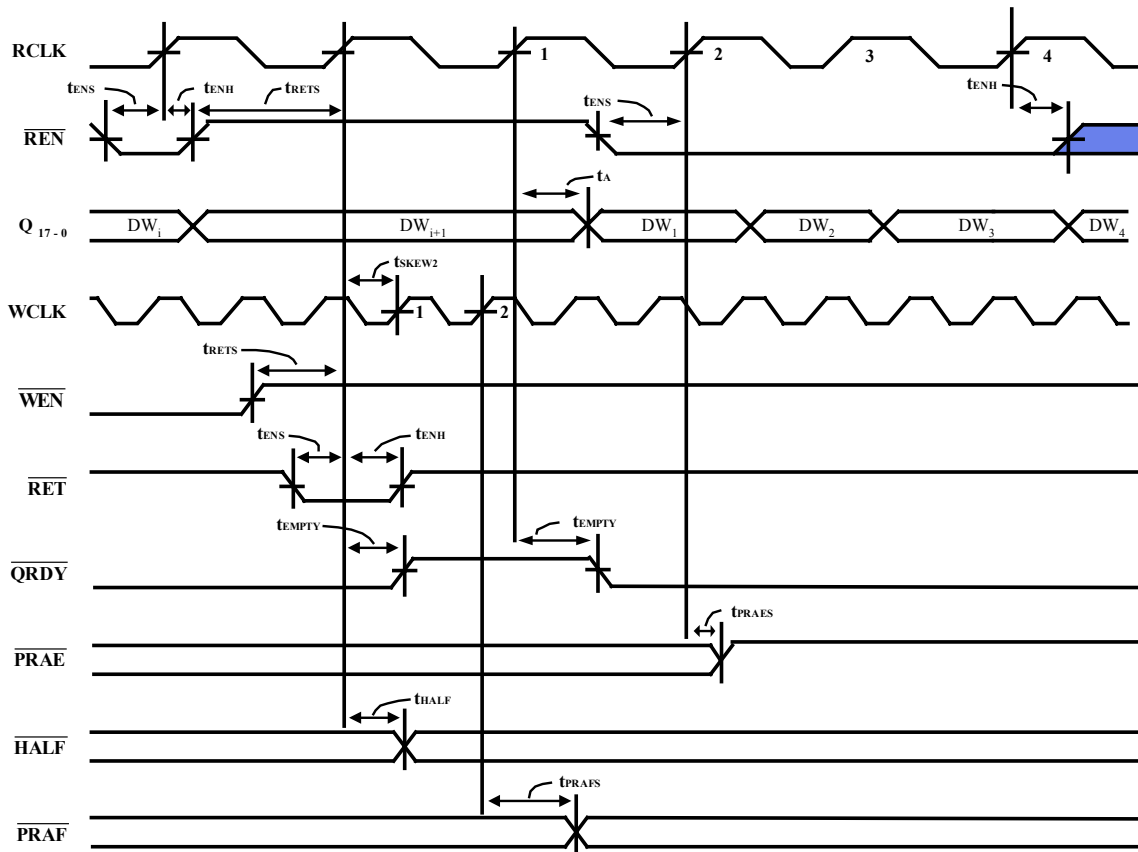
Diagram 6. Read Timing (FWFT Mode)



NOTES:

1. Upon completion of retransmit setup, a read operation can begin only after $\overline{\text{EMPTY}}$ returns high.
2. $\overline{\text{OE}}$ = Low.
3. DW_i = Words written to the queue after $\overline{\text{MRST}}$. Where $i = 1, 2, 3, \dots$ depth.
4. Upon reset completion, there must be more than 2 words written to the queue for a retransmit setup to be valid.

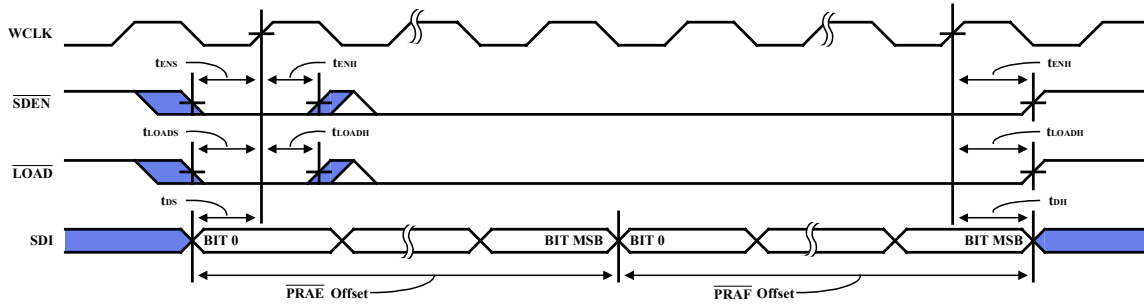
Diagram 7. Retransmit Timing (Standard Mode)



NOTES:

1. Upon completion of retransmit setup, a read operation can begin only after \overline{QRDY} returns low.
2. $\overline{OE} = \text{Low}$.
3. $DW_i = \text{Words written to the queue after } \overline{MRST}$. Where $i = 1, 2, 3 \dots \text{depth}$.
4. Upon reset completion, there must be more than 2 words written to the queue for a retransmit setup to be valid.
5. Please refer to Table 7 for Depth.

Diagram 8. Retransmit Timing (FWFT Mode)



* Refer to Table 10.

Diagram 9. Serial Loading of Programmable Flag Registers (Standard and FWFT Mode)

	FQV285	FQV275	FQV265	FQV255
MSB	15	14	13	12

Table 10. Reference Table for Diagram 9

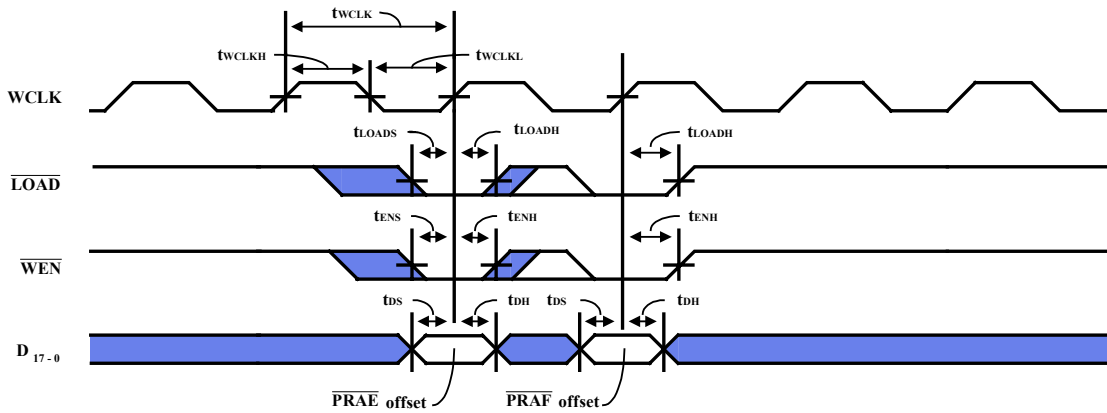


Diagram 10. Parallel Loading of Programmable Flag Registers (Standard and FWFT Mode)

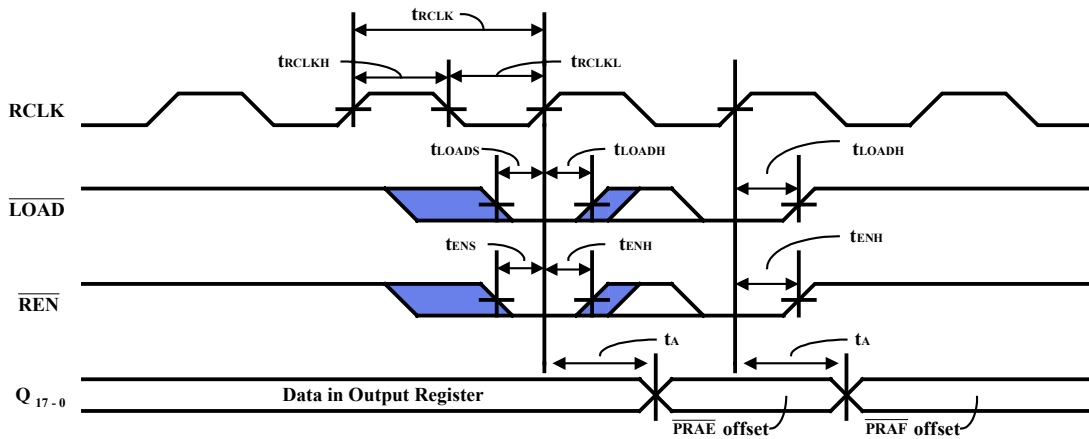
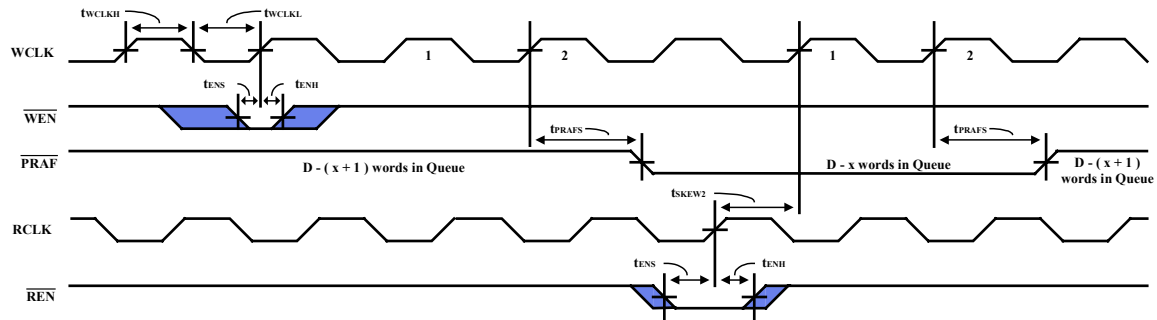


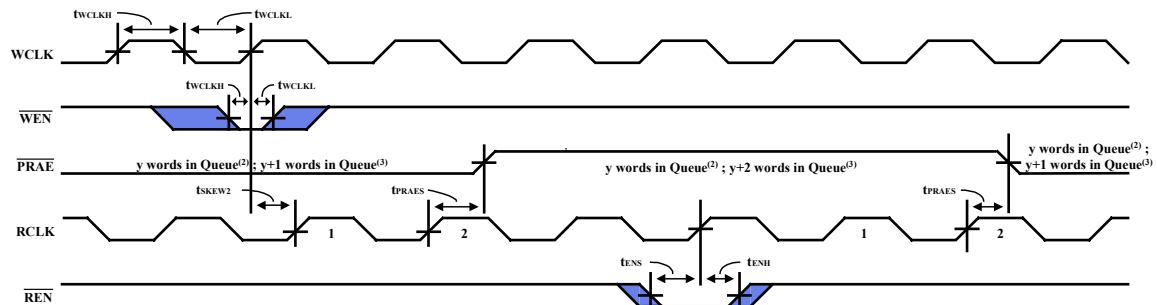
Diagram 11. Parallel Read of Programmable Flag Registers (Standard and FWFT Mode)



NOTES:

1. $x = \overline{PRAF}$ offset.
2. $D =$ maximum queue depth. Please refer to Table 7 for Depth.
3. If the time between a rising edge of RCLK to the rising edge of WCLK is greater than or equal to t_{SKEW2} , \overline{PRAF} will go high (after on WCLK cycle plus t_{PRAFS}). If t_{SKEW2} is not met, then \overline{PRAF} will assert 1 or more WCLK cycles.
4. \overline{PRAF} synchronizes to the rising edge of WCLK only.

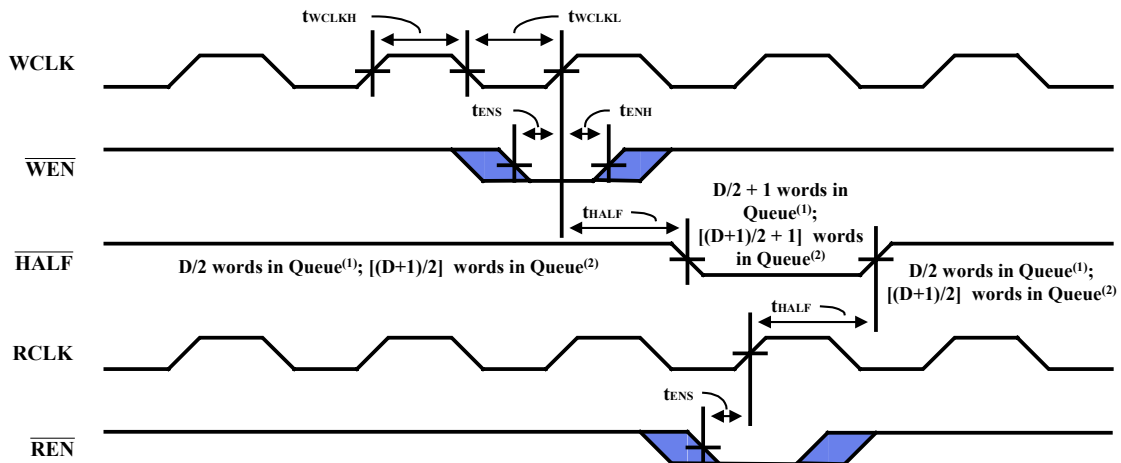
Diagram 12. Programmable Almost-Full Flag Timing (Standard and FWFT Mode)



NOTES:

1. $y = \overline{PRAE}$ offset.
2. For Standard Mode.
3. For FWFT Mode.
4. If the time between a rising edge of WCLK to the rising edge of RCLK is greater than or equal to t_{SKEW2} , \overline{PRAE} will go high (after one RCLK cycle plus t_{PRAES}). If t_{SKEW2} is not met, then \overline{PRAE} will assert 1 or more RCLK cycles.
5. \overline{PRAE} synchronizes to the rising edge of RCLK only.

Diagram 13. Programmable Almost-Empty Flag Timing (Standard and FWFT Mode)



NOTES:

1. For Standard Mode.
2. For FWFT Mode.
3. Please refer to Table 7 for Depth.

Diagram 14. Half-Full Flag Timing (Standard and FWFT Mode)

Order Information:

HBA Device Family	Device Type	Power	Speed (ns)*	Package**	Temperature Range
<u>XX</u>	<u>XXX</u>	<u>X</u>	<u>XX</u>	<u>XX</u>	<u>X</u>
FQ	285 (65,536 x 18)	Low	10 – 100 MHz	PF	Blank – Commercial (0°C to 70°C)
	275 (32,768 x 18)		15 – 66 MHz	TF	I – Industrial (-40° to 85°C)
	265 (16,384 x 18)		20 – 50 MHz		
	255 (8,192 x 18)				

*Speed – Slower speeds available upon request.

**Package – 64 pin Plastic Thin Quad Flat Pack (TQFP), 64 pin Slim Thin Quad Flat Pack (STQFP)

Example:

FQ275L10PF (32k x 18, 10ns, Commercial temp)
 FQ265L20PFI (16k x 18, 20ns, Industrial temp)

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