# HIGH-SPEED 2.5V 256/128/64K x 36 SYNCHRONOUS DUAL-PORT STATIC RAM WITH 3.3V OR 2.5V INTERFACE

IDT70T3519/99/89S

Features:

- True Dual-Port memory cells which allow simultaneous access of the same memory location
- High-speed data access
  - *Commercial: 3.4 (200MHz)/3.6ns (166MHz)/ 4.2ns (133MHz)(max.)*
  - *Industrial: 3.6ns (166MHz)/4.2ns (133MHz) (max.)*
- Selectable Pipelined or Flow-Through output mode
- Counter enable and repeat features
- Dual chip enables allow for depth expansion without additional logic
- Full synchronous operation on both ports
  - *5ns cycle time, 200MHz operation (14Gbps bandwidth)*
  - *Fast 3.4ns clock to data out*
  - *1.5ns setup to clock and 0.5ns hold on all control, data, and address inputs @ 200MHz*
  - *Data input, address, byte enable and control registers*
  - *Self-timed write allows fast cycle time*

- Interrupt and Collision Detection Flags
- Separate byte controls for multiplexed bus and bus matching compatibility
- Dual Cycle Deselect (DCD) for Pipelined Output Mode
- 2.5V (±100mV) power supply for core
- LVTTL compatible, selectable 3.3V (±150mV) or 2.5V (±100mV) power supply for I/Os and control signals on each port
- Industrial temperature range (-40°C to +85°C) is available at 166MHz and 133MHz
- Available in a 256-pin Ball Grid Array (BGA), a 208-pin Plastic Quad Flatpack (PQFP) and 208-pin fine pitch Ball Grid Array (fpBGA)
- Supports JTAG features compliant with IEEE 1149.1
- Due to limited pin count JTAG is not supported on the 208-pin PQFP package
- Green parts available, see ordering information

Functional Block Diagram

5666 drw 01
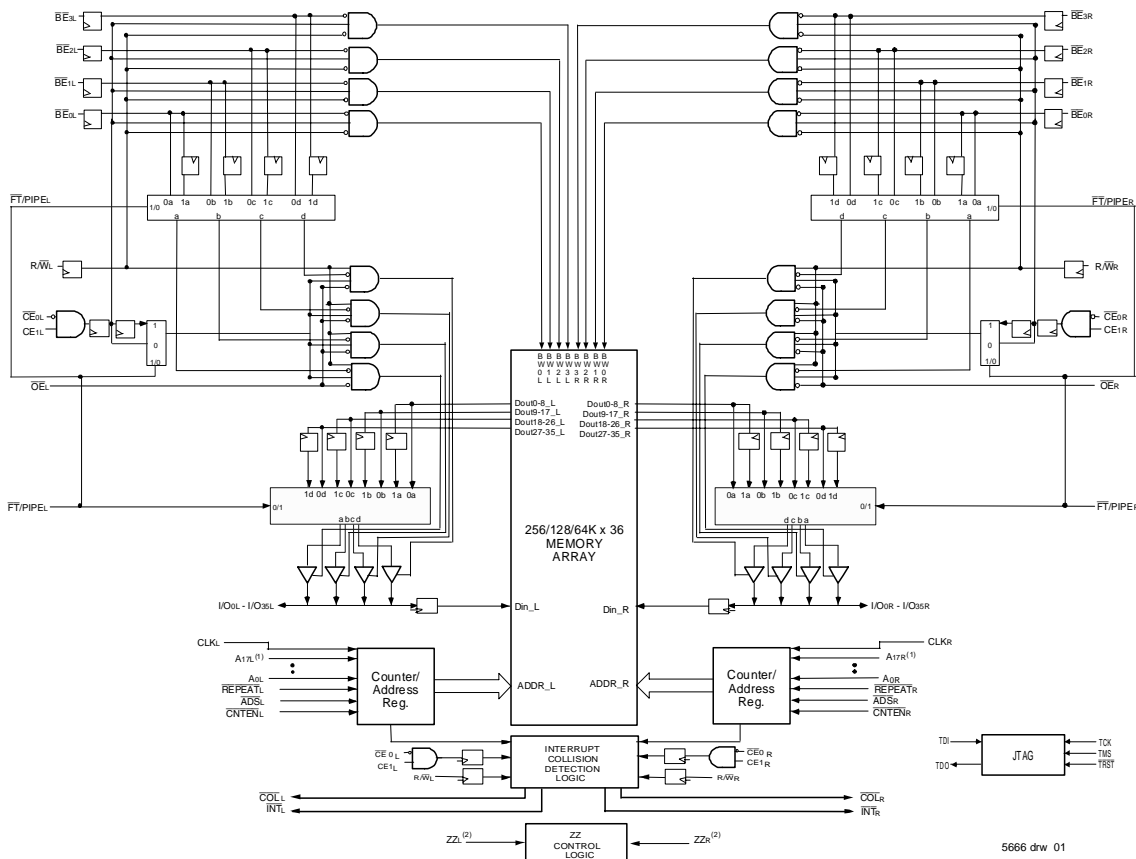
NOTES:
1. Address A_{17} is a NC for the IDT70T3599. Also, Addresses A_{17} and A_{16} are NC's for the IDT70T3589.
2. The sleep mode pin shuts off all dynamic inputs, except JTAG inputs, when asserted. All static inputs, i.e., PL/$\overline{FT}$x and OPTx and the sleep mode pins themselves (ZZx) are not affected during sleep mode.

JANUARY 2009

DSC 5666/10

Description:

The IDT70T3519/99/89 is a high-speed 256/128/64K x 36 bit synchronous Dual-Port RAM. The memory array utilizes Dual-Port memory cells to allow simultaneous access of any address from both ports. Registers on control, data, and address inputs provide minimal setup and hold times. The timing latitude provided by this approach allows systems to be designed with very short cycle times. With an input data register, the IDT70T3519/99/89 has been optimized for applications having unidirec-

tional or bidirectional data flow in bursts. An automatic power down feature, controlled by $\overline{CE}_0$ and CE_1, permits the on-chip circuitry of each port to enter a very low standby power mode.

The 70T3519/99/89 can support an operating voltage of either 3.3V or 2.5V on one or both ports, controllable by the OPT pins. The power supply for the core of the device (V_{DD}) is at 2.5V.

Pin Configuration [3,4,5,6,9]

70T3519/99/89BC
BC-256[7]

256-Pin BGA
Top View[8]

06/19/02

|	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A	NC	TDI	NC	A_{17L}[1]	A_{14L}	A_{11L}	A_{8L}	$\overline{BE}_{2L}$	$\overline{CE}_{1L}$	$\overline{OE}_L$	$\overline{CNTEN}_L$	A_{5L}	A_{2L}	A_{0L}	NC	NC
B	I/O$_{18L}$	NC	TDO	NC	A_{15L}	A_{12L}	A_{9L}	$\overline{BE}_{3L}$	$\overline{CE}_{0L}$	R/$\overline{W}_L$	$\overline{REPEAT}_L$	A_{4L}	A_{1L}	V$_{DD}$	I/O$_{17L}$	NC
C	I/O$_{18R}$	I/O$_{19L}$	V$_{SS}$	A_{16L}[2]	A_{13L}	A_{10L}	A_{7L}	$\overline{BE}_{1L}$	$\overline{BE}_{0L}$	CLK$_L$	$\overline{ADS}_L$	A_{6L}	A_{3L}	OPT$_L$	I/O$_{17R}$	I/O$_{16L}$
D	I/O$_{20R}$	I/O$_{19R}$	I/O$_{20L}$	PIPE/$\overline{FT}_L$	V$_{DDQL}$	V$_{DDQL}$	V$_{DDQR}$	V$_{DDQR}$	V$_{DDQL}$	V$_{DDQL}$	V$_{DDQR}$	V$_{DDQR}$	V$_{DD}$	I/O$_{15R}$	I/O$_{15L}$	I/O$_{16R}$
E	I/O$_{21R}$	I/O$_{21L}$	I/O$_{22L}$	V$_{DDQL}$	V$_{DD}$	V$_{DD}$	$\overline{INT}_L$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{DD}$	V$_{DD}$	V$_{DDQR}$	I/O$_{13L}$	I/O$_{14L}$	I/O$_{14R}$
F	I/O$_{23L}$	I/O$_{22R}$	I/O$_{23R}$	V$_{DDQL}$	V$_{DD}$	NC	$\overline{COL}_L$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{DD}$	V$_{DDQR}$	I/O$_{12R}$	I/O$_{13R}$	I/O$_{12L}$
G	I/O$_{24R}$	I/O$_{24L}$	I/O$_{25L}$	V$_{DDQR}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{DDQL}$	I/O$_{10L}$	I/O$_{11L}$	I/O$_{11R}$
H	I/O$_{26L}$	I/O$_{25R}$	I/O$_{26R}$	V$_{DDQR}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{DDQL}$	I/O$_{9R}$	IO$_{9L}$	I/O$_{10R}$
J	I/O$_{27L}$	I/O$_{28L}$	I/O$_{27R}$	V$_{DDQL}$	ZZ$_R$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	ZZ$_L$	V$_{DDQR}$	I/O$_{8R}$	I/O$_{7R}$	I/O$_{8L}$
K	I/O$_{29R}$	I/O$_{29L}$	I/O$_{28L}$	V$_{DDQL}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{DDQR}$	I/O$_{6R}$	I/O$_{6L}$	I/O$_{7L}$
L	I/O$_{30L}$	I/O$_{31R}$	I/O$_{30R}$	V$_{DDQR}$	V$_{DD}$	NC	$\overline{COL}_R$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{DD}$	V$_{DDQL}$	I/O$_{5L}$	I/O$_{4R}$	I/O$_{5R}$
M	I/O$_{32R}$	I/O$_{32L}$	I/O$_{31L}$	V$_{DDQR}$	V$_{DD}$	V$_{DD}$	$\overline{INT}_R$	V$_{SS}$	V$_{SS}$	V$_{SS}$	V$_{DD}$	V$_{DD}$	V$_{DDQL}$	I/O$_{3R}$	I/O$_{3L}$	I/O$_{4L}$
N	I/O$_{33L}$	I/O$_{34R}$	I/O$_{33R}$	PIPE/$\overline{FT}_R$	V$_{DDQR}$	V$_{DDQR}$	V$_{DDQL}$	V$_{DDQL}$	V$_{DDQR}$	V$_{DDQR}$	V$_{DDQL}$	V$_{DDQL}$	V$_{DD}$	I/O$_{2L}$	I/O$_{1R}$	I/O$_{2R}$
P	I/O$_{35R}$	I/O$_{34L}$	TMS	A_{16R}[2]	A_{13R}	A_{10R}	A_{7R}	$\overline{BE}_{1R}$	$\overline{BE}_{0R}$	CLK$_R$	$\overline{ADS}_R$	A_{6R}	A_{3R}	I/O$_{0L}$	I/O$_{0R}$	I/O$_{1L}$
R	I/O$_{35L}$	NC	$\overline{TRST}$	NC	A_{15R}	A_{12R}	A_{9R}	$\overline{BE}_{3R}$	$\overline{CE}_{0R}$	R/$\overline{W}_R$	$\overline{REPEAT}_R$	A_{4R}	A_{1R}	OPT$_R$	NC	NC
T	NC	TCK	NC	A_{17R}[1]	A_{14R}	A_{11R}	A_{8R}	$\overline{BE}_{2R}$	CE_{1R}	$\overline{OE}_R$	$\overline{CNTEN}_R$	A_{5R}	A_{2R}	A_{0R}	NC	NC

5666 drw 02d

NOTES:
1. Pin is a NC for IDT70T3599 and IDT70T3589.
2. Pin is a NC for IDT70T3589.
3. All V$_{DD}$ pins must be connected to 2.5V power supply.
4. All V$_{DDQ}$ pins must be connected to appropriate power supply: 3.3V if OPT pin for that port is set to V$_{DD}$ (2.5V), and 2.5V if OPT pin for that port is set to V$_{SS}$ (0V).
5. All V$_{SS}$ pins must be connected to ground supply.
6. Package body is approximately 17mm x 17mm x 1.4mm, with 1.0mm ball-pitch.
7. This package code is used to reference the package diagram.
8. This text does not indicate orientation of the actual part-marking.
9. Pins A15 and T15 will be V$_{REFL}$ and V$_{REFR}$ respectively for future HSTL device.

Pin Configuration [3,4,5,6,9,10] (con't.)

06/19/02
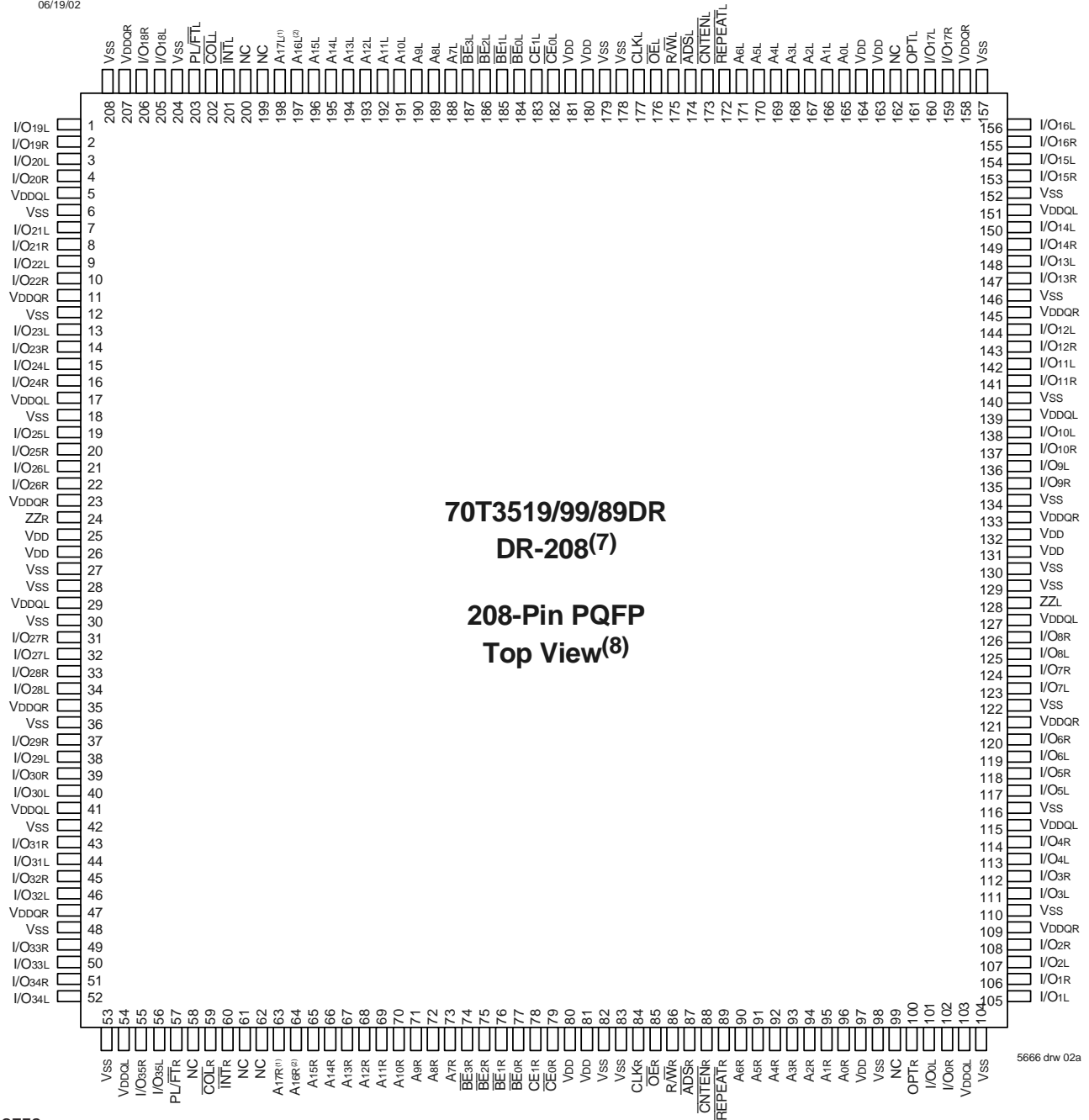
70T3519/99/89DR

DR-208[7]

208-Pin PQFP
Top View[8]

5666 drw 02a

NOTES:

1. Pin is a NC for IDT70T3599 and IDT70T3589.

2. Pin is a NC for IDT70T3589.

3. All V_{DD} pins must be connected to 2.5V power supply.

4. All V_{DDQ} pins must be connected to appropriate power supply: 3.3V if OPT pin for that port is set to V_{DD} (2.5V), and 2.5V if OPT pin for that port is set to V_{SS} (0V).

5. All V_{SS} pins must be connected to ground supply.

6. Package body is approximately 28mm x 28mm x 3.5mm.

7. This package code is used to reference the package diagram.

8. This text does not indicate orientation of the actual part-marking.

9. Due to limited pin count, JTAG is not supported in the DR-208 package.

10. Pins 162 and 99 will be V_{REFL} and V_{REFR} respectively for future HSTL device.

Pin Configuration [3,4,5,6,9] (con't.)

01/23/03

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A1 I/O_{19L}	**A2** I/O_{18L}	**A3** V_{SS}	**A4** TDO	**A5** $\overline{COL}_L$	**A6** $A16_L$[2]	**A7** $A12_L$	**A8** $A8_L$	**A9** $\overline{BE1}_L$	**A10** V_{DD}	**A11** CLK_L	**A12** $\overline{CNTEN}_L$	**A13** $A4_L$	**A14** $A0_L$	**A15** OPT_L	**A16** I/O_{17L}	**A17** V_{SS}
B1 I/O_{20R}	**B2** V_{SS}	**B3** I/O_{18R}	**B4** TDI	**B5** $A17_L$[1]	**B6** $A13_L$	**B7** $A9_L$	**B8** $\overline{BE2}_L$	**B9** $\overline{CE0}_L$	**B10** V_{SS}	**B11** $\overline{ADS}_L$	**B12** $A5_L$	**B13** $A1_L$	**B14** NC	**B15** V_{DDQR}	**B16** I/O_{16L}	**B17** I/O_{15R}
C1 V_{DDQL}	**C2** I/O_{19R}	**C3** V_{DDQR}	**C4** $PL/\overline{FT}_L$	**C5** $\overline{INT}_L$	**C6** $A14_L$	**C7** $A10_L$	**C8** $\overline{BE3}_L$	**C9** $CE1_L$	**C10** V_{SS}	**C11** $R/\overline{W}_L$	**C12** $A6_L$	**C13** $A2_L$	**C14** V_{DD}	**C15** I/O_{16R}	**C16** I/O_{15L}	**C17** V_{SS}
D1 I/O_{22L}	**D2** V_{SS}	**D3** I/O_{21L}	**D4** I/O_{20L}	**D5** $A15_L$	**D6** $A11_L$	**D7** $A7_L$	**D8** $\overline{BE0}_L$	**D9** V_{DD}	**D10** $\overline{OE}_L$	**D11** $\overline{REPEAT}_L$	**D12** $A3_L$	**D13** V_{DD}	**D14** I/O_{17R}	**D15** V_{DDQL}	**D16** I/O_{14L}	**D17** I/O_{14R}
E1 I/O_{23L}	**E2** I/O_{22R}	**E3** V_{DDQR}	**E4** I/O_{21R}										**E14** I/O_{12L}	**E15** I/O_{13R}	**E16** V_{SS}	**E17** I/O_{13L}
F1 V_{DDQL}	**F2** I/O_{23R}	**F3** I/O_{24L}	**F4** V_{SS}										**F14** V_{SS}	**F15** I/O_{12R}	**F16** I/O_{11L}	**F17** V_{DDQR}
G1 I/O_{26L}	**G2** V_{SS}	**G3** I/O_{25L}	**G4** I/O_{24R}										**G14** I/O_{9L}	**G15** V_{DDQL}	**G16** I/O_{10L}	**G17** I/O_{11R}
H1 V_{DD}	**H2** I/O_{26R}	**H3** V_{DDQR}	**H4** I/O_{25R}				70T3519/99/89BF						**H14** V_{DD}	**H15** I/O_{9R}	**H16** V_{SS}	**H17** I/O_{10R}
J1 V_{DDQL}	**J2** V_{DD}	**J3** V_{SS}	**J4** ZZ_R				BF-208[7]						**J14** ZZ_L	**J15** V_{DD}	**J16** V_{SS}	**J17** V_{DDQR}
K1 I/O_{28R}	**K2** V_{SS}	**K3** I/O_{27R}	**K4** V_{SS}				208-Pin fpBGA						**K14** I/O_{7R}	**K15** V_{DDQL}	**K16** I/O_{8R}	**K17** V_{SS}
L1 I/O_{29R}	**L2** I/O_{28L}	**L3** V_{DDQR}	**L4** I/O_{27L}				Top View[8]						**L14** I/O_{6R}	**L15** I/O_{7L}	**L16** V_{SS}	**L17** I/O_{8L}
M1 V_{DDQL}	**M2** I/O_{29L}	**M3** I/O_{30R}	**M4** V_{SS}										**M14** V_{SS}	**M15** I/O_{6L}	**M16** I/O_{5R}	**M17** V_{DDQR}
N1 I/O_{31L}	**N2** V_{SS}	**N3** I/O_{31R}	**N4** I/O_{30L}										**N14** I/O_{3R}	**N15** V_{DDQL}	**N16** I/O_{4R}	**N17** I/O_{5L}
P1 I/O_{32R}	**P2** I/O_{32L}	**P3** V_{DDQR}	**P4** I/O_{35R}	**P5** $\overline{TRST}$	**P6** $A16_R$[2]	**P7** $A12_R$	**P8** $A8_R$	**P9** $\overline{BE1}_R$	**P10** V_{DD}	**P11** CLK_R	**P12** $\overline{CNTEN}_R$	**P13** $A4_R$	**P14** I/O_{2L}	**P15** I/O_{3L}	**P16** V_{SS}	**P17** I/O_{4L}
R1 V_{SS}	**R2** I/O_{33L}	**R3** I/O_{34R}	**R4** TCK	**R5** $A17_R$[1]	**R6** $A13_R$	**R7** $A9_R$	**R8** $\overline{BE2}_R$	**R9** $\overline{CE0}_R$	**R10** V_{SS}	**R11** $\overline{ADS}_R$	**R12** $A5_R$	**R13** $A1_R$	**R14** NC	**R15** V_{DDQL}	**R16** I/O_{1R}	**R17** V_{DDQR}
T1 I/O_{33R}	**T2** I/O_{34L}	**T3** V_{DDQL}	**T4** TMS	**T5** $\overline{INT}_R$	**T6** $A14_R$	**T7** $A10_R$	**T8** $\overline{BE3}_R$	**T9** $CE1_R$	**T10** V_{SS}	**T11** $R/\overline{W}_R$	**T12** $A6_R$	**T13** $A2_R$	**T14** V_{SS}	**T15** I/O_{0R}	**T16** V_{SS}	**T17** I/O_{2R}
U1 V_{SS}	**U2** I/O_{35L}	**U3** $PL/\overline{FT}_R$	**U4** $\overline{COL}_R$	**U5** $A15_R$	**U6** $A11_R$	**U7** $A7_R$	**U8** $\overline{BE0}_R$	**U9** V_{DD}	**U10** $\overline{OE}_R$	**U11** $\overline{REPEAT}_R$	**U12** $A3_R$	**U13** $A0_R$	**U14** V_{DD}	**U15** OPT_R	**U16** I/O_{0L}	**U17** I/O_{1L}

5666 drw 02c

NOTES:
1. Pin is a NC for IDT70T3599 and IDT70T3589.
2. Pin is a NC for IDT70T3589.
3. All V_{DD} pins must be connected to 2.5V power supply.
4. All V_{DDQ} pins must be connected to appropriate power supply: 3.3V if OPT pin for that port is set to V_{DD} (2.5V), and 2.5V if OPT pin for that port is set to V_{SS} (0V).
5. All V_{SS} pins must be connected to ground supply.
6. Package body is approximately 15mm x 15mm x 1.4mm with 0.8mm ball pitch.
7. This package code is used to reference the package diagram.
8. This text does not indicate orientation of the actual part-marking.
9. Pins B14 and R14 will be V_{REFL} and V_{REFR} respectively for future HSTL device.

Pin Names

Left Port	Right Port	Names
$\overline{CE}_{0L}$, CE_{1L}	$\overline{CE}_{0R}$, CE_{1R}	Chip Enables (Input)[7]
$R/\overline{W}_L$	$R/\overline{W}_R$	Read/Write Enable (Input)
$\overline{OE}_L$	$\overline{OE}_R$	Output Enable (Input)
A_{0L} - A_{17L}[6]	A_{0R} - A_{17R}[6]	Address (Input)
I/O_{0L} - I/O_{35L}	I/O_{0R} - I/O_{35R}	Data Input/Output
CLK_L	CLK_R	Clock (Input)
$PL/\overline{FT}_L$	$PL/\overline{FT}_R$	Pipeline/Flow-Through (Input)
$\overline{ADS}_L$	$\overline{ADS}_R$	Address Strobe Enable (Input)
$\overline{CNTEN}_L$	$\overline{CNTEN}_R$	Counter Enable (Input)
$\overline{REPEAT}_L$	$\overline{REPEAT}_R$	Counter Repeat[3]
$\overline{BE}_{0L}$ - $\overline{BE}_{3L}$	$\overline{BE}_{0R}$ - $\overline{BE}_{3R}$	Byte Enables (9-bit bytes) (Input)[7]
V_{DDQL}	V_{DDQR}	Power (I/O Bus) (3.3V or 2.5V)[1] (Input)
OPT_L	OPT_R	Option for selecting V_{DDQX}[1,2] (Input)
ZZ_L	ZZ_R	Sleep Mode pin[4] (Input)
V_{DD}		Power (2.5V)[1] (Input)
V_{SS}		Ground (0V) (Input)
TDI[5]		Test Data Input
TDO[5]		Test Data Output
TCK[5]		Test Logic Clock (10MHz) (Input)
TMS[5]		Test Mode Select (Input)
$\overline{TRST}$[5]		Reset (Initialize TAP Controller) (Input)
$\overline{INT}_L$	$\overline{INT}_R$	Interrupt Flag (Output)
$\overline{COL}_L$	$\overline{COL}_R$	Collision Alert (Output)

5666 tbl 01

NOTES:
1. V_{DD}, OPT_X, and V_{DDQX} must be set to appropriate operating levels prior to applying inputs on the I/Os and controls for that port.
2. OPT_X selects the operating voltage levels for the I/Os and controls on that port. If OPT_X is set to V_{DD} (2.5V), then that port's I/Os and controls will operate at 3.3V levels and V_{DDQX} must be supplied at 3.3V. If OPT_X is set to V_{SS} (0V), then that port's I/Os and address controls will operate at 2.5V levels and V_{DDQX} must be supplied at 2.5V. The OPT pins are independent of one another—both ports can operate at 3.3V, both can operate at 2.5V levels, or either can operate at 3.3V with the other at 2.5V.
3. When $\overline{REPEAT}_X$ is asserted, the counter will reset to the last valid address loaded via $\overline{ADS}_X$.
4. The sleep mode pin shuts off all dynamic inputs, except JTAG inputs, when asserted. All static inputs, i.e., $PL/\overline{FT}_X$ and OPT_X and the sleep mode pins themselves (ZZ_X) are not affected during sleep mode. It is recommended that boundry scan not be operated during sleep mode.
5. Due to limited pin count, JTAG is not supported in the DR-208 package.
6. Address A_{17X} is a NC for the IDT70T3599. Also, Addresses A_{17X} and A_{16X} are NC's for the IDT 70T3589.
7. Chip Enables and Byte Enables are double buffered when $PL/\overline{FT}$ = V_{IH}, i.e., the signals take two cycles to deselect.

Truth Table I—Read/Write and Enable Control [1,2,3,4]

$\overline{OE}$	CLK	$\overline{CE}_0$	CE_1	$\overline{BE}_3$	$\overline{BE}_2$	$\overline{BE}_1$	$\overline{BE}_0$	R/$\overline{W}$	ZZ	Byte 3 I/O$_{27-35}$	Byte 2 I/O$_{18-26}$	Byte 1 I/O$_{9-17}$	Byte 0 I/O$_{0-8}$	MODE
X	↑	H	X	X	X	X	X	X	L	High-Z	High-Z	High-Z	High-Z	Deselected–Power Down
X	↑	X	L	X	X	X	X	X	L	High-Z	High-Z	High-Z	High-Z	Deselected–Power Down
X	↑	L	H	H	H	H	H	X	L	High-Z	High-Z	High-Z	High-Z	All Bytes Deselected
X	↑	L	H	H	H	H	L	L	L	High-Z	High-Z	High-Z	D$_{IN}$	Write to Byte 0 Only
X	↑	L	H	H	H	L	H	L	L	High-Z	High-Z	D$_{IN}$	High-Z	Write to Byte 1 Only
X	↑	L	H	H	L	H	H	L	L	High-Z	D$_{IN}$	High-Z	High-Z	Write to Byte 2 Only
X	↑	L	H	L	H	H	H	L	L	D$_{IN}$	High-Z	High-Z	High-Z	Write to Byte 3 Only
X	↑	L	H	H	H	L	L	L	L	High-Z	High-Z	D$_{IN}$	D$_{IN}$	Write to Lower 2 Bytes Only
X	↑	L	H	L	L	H	H	L	L	D$_{IN}$	D$_{IN}$	High-Z	High-Z	Write to Upper 2 bytes Only
X	↑	L	H	L	L	L	L	L	L	D$_{IN}$	D$_{IN}$	D$_{IN}$	D$_{IN}$	Write to All Bytes
L	↑	L	H	H	H	H	L	H	L	High-Z	High-Z	High-Z	D$_{OUT}$	Read Byte 0 Only
L	↑	L	H	H	H	L	H	H	L	High-Z	High-Z	D$_{OUT}$	High-Z	Read Byte 1 Only
L	↑	L	H	H	L	H	H	H	L	High-Z	D$_{OUT}$	High-Z	High-Z	Read Byte 2 Only
L	↑	L	H	L	H	H	H	H	L	D$_{OUT}$	High-Z	High-Z	High-Z	Read Byte 3 Only
L	↑	L	H	H	H	L	L	H	L	High-Z	High-Z	D$_{OUT}$	D$_{OUT}$	Read Lower 2 Bytes Only
L	↑	L	H	L	L	H	H	H	L	D$_{OUT}$	D$_{OUT}$	High-Z	High-Z	Read Upper 2 Bytes Only
L	↑	L	H	L	L	L	L	H	L	D$_{OUT}$	D$_{OUT}$	D$_{OUT}$	D$_{OUT}$	Read All Bytes
H	↑	X	X	X	X	X	X	X	L	High-Z	High-Z	High-Z	High-Z	Outputs Disabled
X	X	X	X	X	X	X	X	X	H	High-Z	High-Z	High-Z	High-Z	Sleep Mode

5666 tbl 02

NOTES:
1. "H" = V$_{IH}$, "L" = V$_{IL}$, "X" = Don't Care.
2. $\overline{ADS}$, $\overline{CNTEN}$, $\overline{REPEAT}$ = X.
3. $\overline{OE}$ and ZZ are asynchronous input signals.
4. It is possible to read or write any combination of bytes during a given access. A few representative samples have been illustrated here.

Truth Table II—Address Counter Control [1,2]

Address	Previous Internal Address	Internal Address Used	CLK	$\overline{ADS}$	$\overline{CNTEN}$	$\overline{REPEAT}$[6]	I/O[3]	MODE
An	X	An	↑	L[4]	X	H	D$_{I/O}$ (n)	External Address Used
X	An	An + 1	↑	H	L[5]	H	D$_{I/O}$(n+1)	Counter Enabled—Internal Address generation
X	An + 1	An + 1	↑	H	H	H	D$_{I/O}$(n+1)	External Address Blocked—Counter disabled (An + 1 reused)
X	X	An	↑	X	X	L[4]	D$_{I/O}$(n)	Counter Set to last valid $\overline{ADS}$ load

5666 tbl 03

NOTES:
1. "H" = V$_{IH}$, "L" = V$_{IL}$, "X" = Don't Care.
2. Read and write operations are controlled by the appropriate setting of R/$\overline{W}$, $\overline{CE}_0$, CE_1, $\overline{BE}n$ and $\overline{OE}$.
3. Outputs configured in flow-through output mode: if outputs are in pipelined mode the data out will be delayed by one cycle.
4. $\overline{ADS}$ and $\overline{REPEAT}$ are independent of all other memory control signals including $\overline{CE}_0$, CE_1 and $\overline{BE}n$
5. The address counter advances if $\overline{CNTEN}$ = V$_{IL}$ on the rising edge of CLK, regardless of all other memory control signals including $\overline{CE}_0$, CE_1, $\overline{BE}n$.
6. When $\overline{REPEAT}$ is asserted, the counter will reset to the last valid address loaded via $\overline{ADS}$. This value is not set at power-up: a known location should be loaded via $\overline{ADS}$ during initialization if desired. Any subsequent $\overline{ADS}$ access during operations will update the $\overline{REPEAT}$ address location.

Recommended Operating Temperature and Supply Voltage [1]

Grade	Ambient Temperature	GND	V_{DD}
Commercial	0°C to +70°C	0V	2.5V ± 100mV
Industrial	-40°C to +85°C	0V	2.5V ± 100mV

5666 tbl 04

NOTES:
1. This is the parameter TA. This is the "instant on" case temperature.

Recommended DC Operating Conditions with V_{DDQ} at 2.5V

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{DD}	Core Supply Voltage	2.4	2.5	2.6	V
V_{DDQ}	I/O Supply Voltage[3]	2.4	2.5	2.6	V
V_{SS}	Ground	0	0	0	V
V_{IH}	Input High Volltage (Address, Control & Data I/O Inputs)[3]	1.7	—	V_{DDQ} + 100mV[2]	V
V_{IH}	Input High Voltage – JTAG	1.7	—	V_{DD} + 100mV[2]	V
V_{IH}	Input High Voltage - ZZ, OPT, PIPE/$\overline{FT}$	V_{DD} - 0.2V	—	V_{DD} + 100mV[2]	V
V_{IL}	Input Low Voltage	-0.3[1]	—	0.7	V
V_{IL}	Input Low Voltage - ZZ, OPT, PIPE/$\overline{FT}$	-0.3[1]	—	0.2	V

5666 tbl 05a

NOTES:
1. V_{IL} (min.) = -1.0V for pulse width less than $t_{CYC}/2$ or 5ns, whichever is less.
2. V_{IH} (max.) = V_{DDQ} + 1.0V for pulse width less than $t_{CYC}/2$ or 5ns, whichever is less.
3. To select operation at 2.5V levels on the I/Os and controls of a given port, the OPT pin for that port must be set to V_{SS}(0V), and V_{DDQX} for that port must be supplied as indicated above.

Recommended DC Operating Conditions with V_{DDQ} at 3.3V

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{DD}	Core Supply Voltage	2.4	2.5	2.6	V
V_{DDQ}	I/O Supply Voltage[3]	3.15	3.3	3.45	V
V_{SS}	Ground	0	0	0	V
V_{IH}	Input High Voltage (Address, Control &Data I/O Inputs)[3]	2.0	—	V_{DDQ} + 150mV[2]	V
V_{IH}	Input High Voltage – JTAG	1.7	—	V_{DD} + 100mV[2]	V
V_{IH}	Input High Voltage - ZZ, OPT, PIPE/$\overline{FT}$	V_{DD} - 0.2V	—	V_{DD} + 100mV[2]	V
V_{IL}	Input Low Voltage	-0.3[1]	—	0.8	V
V_{IL}	Input Low Voltage - ZZ, OPT, PIPE/$\overline{FT}$	-0.3[1]	—	0.2	V

5666 tbl 05b

NOTES:
1. V_{IL} (min.) = -1.0V for pulse width less than $t_{CYC}/2$, or 5ns, whichever is less.
2. V_{IH} (max.) = V_{DDQ} + 1.0V for pulse width less than $t_{CYC}/2$ or 5ns, whichever is less.
3. To select operation at 3.3V levels on the I/Os and controls of a given port, the OPT pin for that port must be set to V_{DD} (2.5V), and V_{DDQX} for that port must be supplied as indicated above.

Absolute Maximum Ratings [1]

Symbol	Rating	Commercial & Industrial	Unit
V_{TERM} (V_{DD})	V_{DD} Terminal Voltage with Respect to GND	-0.5 to 3.6	V
V_{TERM}[2] (V_{DDQ})	V_{DDQ} Terminal Voltage with Respect to GND	-0.3 to V_{DDQ} + 0.3	V
V_{TERM}[2] (INPUTS and I/O's)	Input and I/O Terminal Voltage with Respect to GND	-0.3 to V_{DDQ} + 0.3	V
T_{BIAS}[3]	Temperature Under Bias	-55 to +125	ºC
T_{STG}	Storage Temperature	-65 to +150	ºC
T_{JN}	Junction Temperature	+150	ºC
I_{OUT}(For V_{DDQ} = 3.3V)	DC Output Current	50	mA
I_{OUT}(For V_{DDQ} = 2.5V)	DC Output Current	40	mA

5666 tbl 06

NOTES:
1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
2. This is a steady-state DC parameter that applies after the power supply has reached its nominal operating value. Power sequencing is not necessary; however, the voltage on any Input or I/O pin cannot exceed V_{DDQ} during power supply ramp up.
3. Ambient Temperature under DC Bias. No AC Conditions. Chip Deselected.

Capacitance [1]
(T_A = +25°C, F = 1.0MHz) PQFP ONLY

Symbol	Parameter	Conditions[2]	Max.	Unit
C_{IN}	Input Capacitance	V_{IN} = 3dV	8	pF
C_{OUT}[3]	Output Capacitance	V_{OUT} = 3dV	10.5	pF

5666 tbl 07

NOTES:
1. These parameters are determined by device characterization, but are not production tested.
2. 3dV references the interpolated capacitance when the input and output switch from 0V to 3V or from 3V to 0V.
3. C_{OUT} also references $C_{I/O}$.

DC Electrical Characteristics Over the Operating Temperature and Supply Voltage Range (V_{DD} = 2.5V ± 100mV)

Symbol	Parameter	Test Conditions	70T3519/99/89S Min.	Max.	Unit
$|I_{LI}|$	Input Leakage Current[1]	V_{DDQ} = Max., V_{IN} = 0V to V_{DDQ}	—	10	µA
$|I_{LI}|$	JTAG & ZZ Input Leakage Current[1,2]	V_{DD} = Max., V_{IN} = 0V to V_{DD}	—	± 30	µA
$|I_{LO}|$	Output Leakage Current[1,3]	$\overline{CE}_0$ = V_{IH} or CE_1 = V_{IL}, V_{OUT} = 0V to V_{DDQ}	—	10	µA
V_{OL} (3.3V)	Output Low Voltage[1]	I_{OL} = +4mA, V_{DDQ} = Min.	—	0.4	V
V_{OH} (3.3V)	Output High Voltage[1]	I_{OH} = -4mA, V_{DDQ} = Min.	2.4	—	V
V_{OL} (2.5V)	Output Low Voltage[1]	I_{OL} = +2mA, V_{DDQ} = Min.	—	0.4	V
V_{OH} (2.5V)	Output High Voltage[1]	I_{OH} = -2mA, V_{DDQ} = Min.	2.0	—	V

5666 tbl 08

NOTES:
1. V_{DDQ} is selectable (3.3V/2.5V) via OPT pins. Refer to p.5 for details.
2. Applicable only for TMS, TDI and $\overline{TRST}$ inputs.
3. Outputs tested in tri-state mode.

DC Electrical Characteristics Over the Operating Temperature and Supply Voltage Range [3] (V_{DD} = 2.5V ± 100mV)

Symbol	Parameter	Test Condition	Version		70T3519/99/89 S200 Com'l Only[8]		70T3519/99/89 S166 Com'l & Ind[7]		70T3519/99/89 S133 Com'l & Ind		Unit
					Typ.[4]	Max.	Typ.[4]	Max.	Typ.[4]	Max.	
I_{DD}	Dynamic Operating Current (Both Ports Active)	$\overline{CE}_L$ and $\overline{CE}_R$= V_{IL}, Outputs Disabled, f = f_{MAX}[1]	COM'L	S	375	525	320	450	260	370	mA
			IND	S	—	—	320	510	260	450	
I_{SB1}[6]	Standby Current (Both Ports - TTL Level Inputs)	$\overline{CE}_L$ = $\overline{CE}_R$ = V_{IH} f = f_{MAX}[1]	COM'L	S	205	270	175	230	140	190	mA
			IND	S	—	—	175	275	140	235	
I_{SB2}[6]	Standby Current (One Port - TTL Level Inputs)	$\overline{CE}$"A" = V_{IL} and $\overline{CE}$"B" = V_{IH}[5] Active Port Outputs Disabled, f=f_{MAX}[1]	COM'L	S	300	375	250	325	200	250	mA
			IND	S	—	—	250	365	200	310	
I_{SB3}	Full Standby Current (Both Ports - CMOS Level Inputs)	Both Ports $\overline{CE}_L$ and $\overline{CE}_R \geq V_{DDQ}$ - 0.2V, $V_{IN} \geq V_{DDQ}$ - 0.2V or $V_{IN} \leq$ 0.2V, f = 0[2]	COM'L	S	5	15	5	15	5	15	mA
			IND	S	—	—	5	20	5	20	
I_{SB4}[6]	Full Standby Current (One Port - CMOS Level Inputs)	$\overline{CE}$"A" $\leq$ 0.2V and $\overline{CE}$"B" $\geq V_{DDQ}$ - 0.2V[5] $V_{IN} \geq V_{DDQ}$ - 0.2V or $V_{IN} \leq$ 0.2V Active Port, Outputs Disabled, f = f_{MAX}[1]	COM'L	S	300	375	250	325	200	250	mA
			IND	S	—	—	250	365	200	310	
I_{ZZ}	Sleep Mode Current (Both Ports - TTL Level Inputs)	ZZ_L = ZZ_R = V_{IH} f=f_{MAX}[1]	COM'L	S	5	15	5	15	5	15	mA
			IND	S	—	—	5	20	5	20	

5666 tbl 09

NOTES:

1. At f = f_{MAX}, address and control lines (except Output Enable) are cycling at the maximum frequency clock cycle of 1/t_{CYC}, using "AC TEST CONDITIONS".
2. f = 0 means no address, clock, or control lines change. Applies only to input at CMOS level standby.
3. Port "A" may be either left or right port. Port "B" is the opposite from port "A".
4. V_{DD} = 2.5V, T_A = 25°C for Typ, and are not production tested. I_{DD} DC(f=0) = 15mA (Typ).
5. $\overline{CE}_X$ = V_{IL} means $\overline{CE}_{0X}$ = V_{IL} and CE_{1X} = V_{IH}
   $\overline{CE}_X$ = V_{IH} means $\overline{CE}_{0X}$ = V_{IH} or CE_{1X} = V_{IL}
   $\overline{CE}_X \leq$ 0.2V means $\overline{CE}_{0X} \leq$ 0.2V and $CE_{1X} \geq V_{DDQ}$ - 0.2V
   $\overline{CE}_X \geq V_{DDQ}$ - 0.2V means $\overline{CE}_{0X} \geq V_{DDQ}$ - 0.2V or CE_{1X} - 0.2V
   "X" represents "L" for left port or "R" for right port.
6. I_{SB1}, I_{SB2} and I_{SB4} will all reach full standby levels (I_{SB3}) on the appropriate port(s) if ZZ_L and/or ZZ_R = V_{IH}.
7. 166MHz I-Temp is not available in the BF-208 package.
8. 200Mhz is not available in the BF-208 and DR-208 packages.

AC Test Conditions (V$_{DDQ}$ - 3.3V/2.5V)

Input Pulse Levels (Address & Controls)	GND to 3.0V/GND to 2.4V
Input Pulse Levels (I/Os)	GND to 3.0V/GND to 2.4V
Input Rise/Fall Times	2ns
Input Timing Reference Levels	1.5V/1.25V
Output Reference Levels	1.5V/1.25V
Output Load	Figure 1

5666 tbl 10
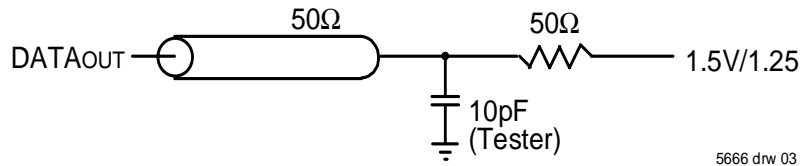
5666 drw 03

Figure 1. AC Output Test load.

Δ tCD
(Typical, ns)
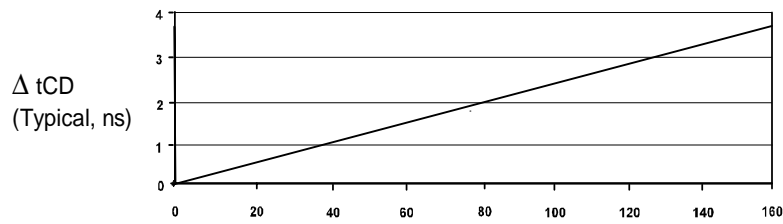
Δ Capacitance (pF) from AC Test Load   5666 drw 04

AC Electrical Characteristics Over the Operating Temperature Range (Read and Write Cycle Timing) [2,3] (V_{DD} = 2.5V ± 100mV, T_A = 0°C to +70°C)

Symbol	Parameter	70T3519/99/89 S200 Com'l Only[5] Min.	Max.	70T3519/99/89 S166 Com'l & Ind[4] Min.	Max.	70T3519/99/89 S133 Com'l & Ind Min.	Max.	Unit
t_{CYC1}	Clock Cycle Time (Flow-Through)[1]	15	—	20	—	25	—	ns
t_{CYC2}	Clock Cycle Time (Pipelined)[1]	5	—	6	—	7.5	—	ns
t_{CH1}	Clock High Time (Flow-Through)[1]	6	—	8	—	10	—	ns
t_{CL1}	Clock Low Time (Flow-Through)[1]	6	—	8	—	10	—	ns
t_{CH2}	Clock High Time (Pipelined)[2]	2	—	2.4	—	3	—	ns
t_{CL2}	Clock Low Time (Pipelined)[1]	2	—	2.4	—	3	—	ns
t_{SA}	Address Setup Time	1.5	—	1.7	—	1.8	—	ns
t_{HA}	Address Hold Time	0.5	—	0.5	—	0.5	—	ns
t_{SC}	Chip Enable Setup Time	1.5	—	1.7	—	1.8	—	ns
t_{HC}	Chip Enable Hold Time	0.5	—	0.5	—	0.5	—	ns
t_{SB}	Byte Enable Setup Time	1.5	—	1.7	—	1.8	—	ns
t_{HB}	Byte Enable Hold Time	0.5	—	0.5	—	0.5	—	ns
t_{SW}	R/W Setup Time	1.5	—	1.7	—	1.8	—	ns
t_{HW}	R/W Hold Time	0.5	—	0.5	—	0.5	—	ns
t_{SD}	Input Data Setup Time	1.5	—	1.7	—	1.8	—	ns
t_{HD}	Input Data Hold Time	0.5	—	0.5	—	0.5	—	ns
t_{SAD}	$\overline{ADS}$ Setup Time	1.5	—	1.7	—	1.8	—	ns
t_{HAD}	$\overline{ADS}$ Hold Time	0.5	—	0.5	—	0.5	—	ns
t_{SCN}	$\overline{CNTEN}$ Setup Time	1.5	—	1.7	—	1.8	—	ns
t_{HCN}	$\overline{CNTEN}$ Hold Time	0.5	—	0.5	—	0.5	—	ns
t_{SRPT}	$\overline{REPEAT}$ Setup Time	1.5	—	1.7	—	1.8	—	ns
t_{HRPT}	$\overline{REPEAT}$ Hold Time	0.5	—	0.5	—	0.5	—	ns
t_{OE}	Output Enable to Data Valid	—	4.4	—	4.4	—	4.6	ns
t_{OLZ}[6]	Output Enable to Output Low-Z	1	—	1	—	1	—	ns
t_{OHZ}[6]	Output Enable to Output High-Z	1	3.4	1	3.6	1	4.2	ns
t_{CD1}	Clock to Data Valid (Flow-Through)[1]	—	10	—	12	—	15	ns
t_{CD2}	Clock to Data Valid (Pipelined)[1]	—	3.4	—	3.6	—	4.2	ns
t_{DC}	Data Output Hold After Clock High	1	—	1	—	1	—	ns
t_{CKHZ}[6]	Clock High to Output High-Z	1	3.4	1	3.6	1	4.2	ns
t_{CKLZ}[6]	Clock High to Output Low-Z	1	—	1	—	1	—	ns
t_{INS}	Interrupt Flag Set Time	—	7	—	7	—	7	ns
t_{INR}	Interrupt Flag Reset Time	—	7	—	7	—	7	ns
t_{COLS}	Collision Flag Set Time	—	3.4	—	3.6	—	4.2	ns
t_{COLR}	Collision Flag Reset Time	—	3.4	—	3.6	—	4.2	ns
t_{ZZSC}	Sleep Mode Set Cycles	2	—	2	—	2	—	cycles
t_{ZZRC}	Sleep Mode Recovery Cycles	3	—	3	—	3	—	cycles
Port-to-Port Delay								
t_{CO}	Clock-to-Clock Offset	4	—	5	—	6	—	ns
t_{OFS}	Clock-to-Clock Offset for Collision Detection	Please refer to Collision Detection Timing Table on Page 21						

5666 tbl 11

NOTES:
1. The Pipelined output parameters (t_{CYC2}, t_{CD2}) apply to either or both left and right ports when PL/$\overline{FT}$x = V_{DD} (2.5V). Flow-through parameters (t_{CYC1}, t_{CD1}) apply when PL/$\overline{FT}$ = V_{SS} (0V) for that port.
2. All input signals are synchronous with respect to the clock except for the asynchronous Output Enable ($\overline{OE}$), PL/$\overline{FT}$ and OPT. PL/$\overline{FT}$ and OPT should be treated as DC signals, i.e. steady state during operation.
3. These values are valid for either level of V_{DDQ} (3.3V/2.5V). See page 6 for details on selecting the desired operating voltage levels for each port.
4. 166MHz I-Temp is not available in the BF-208 package.
5. 200Mhz is not available in the BF-208 and DR-208 packages.
6. Guaranteed by design (not production tested).

Timing Waveform of Read Cycle for Pipelined Operation ($\overline{\text{FT}}$/PIPE'x' = V_{IH})[1,2]
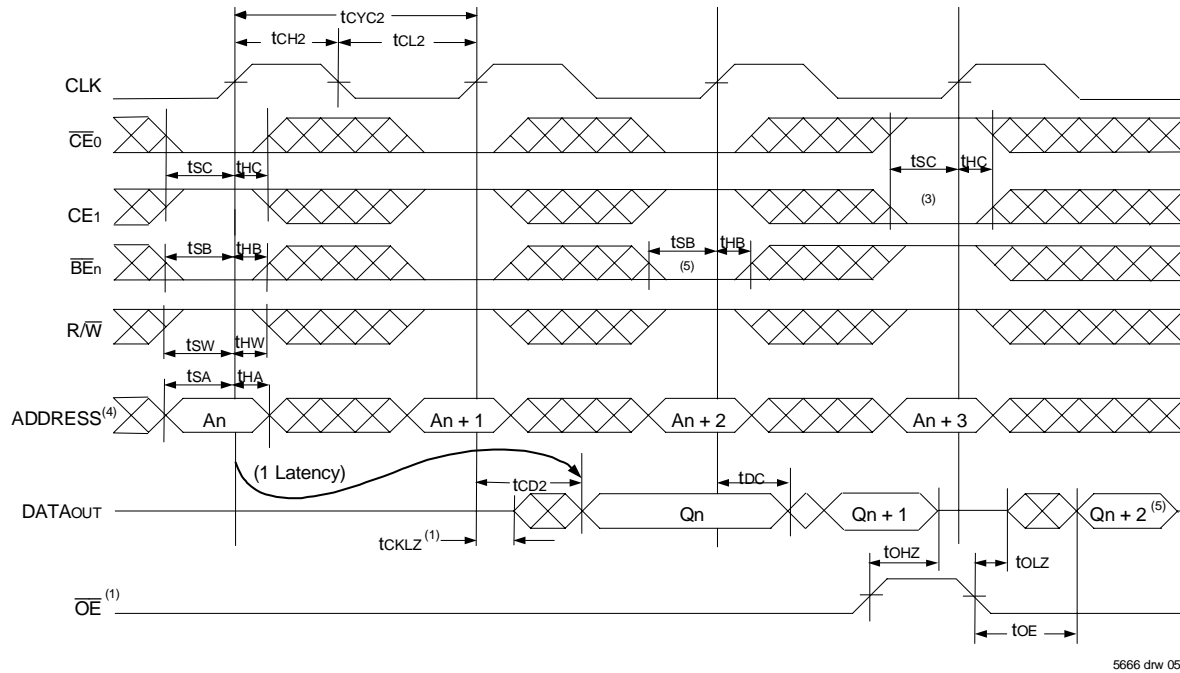
5666 drw 05

Timing Waveform of Read Cycle for Flow-through Output ($\overline{\text{FT}}$/PIPE"x" = V_{IL})[1,2,6]
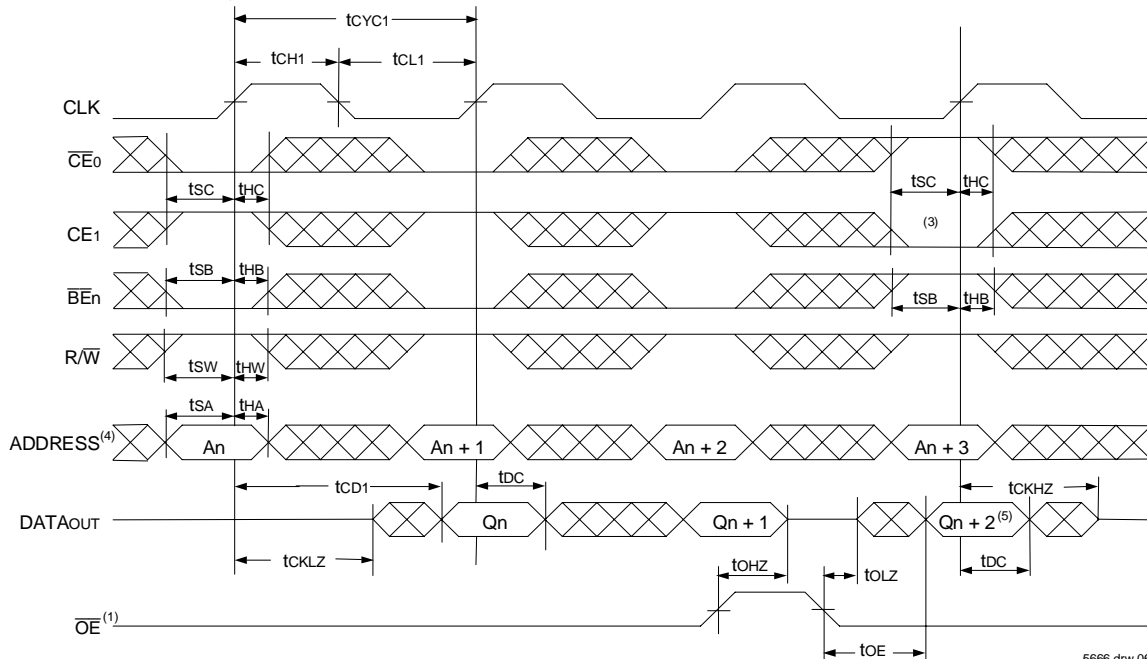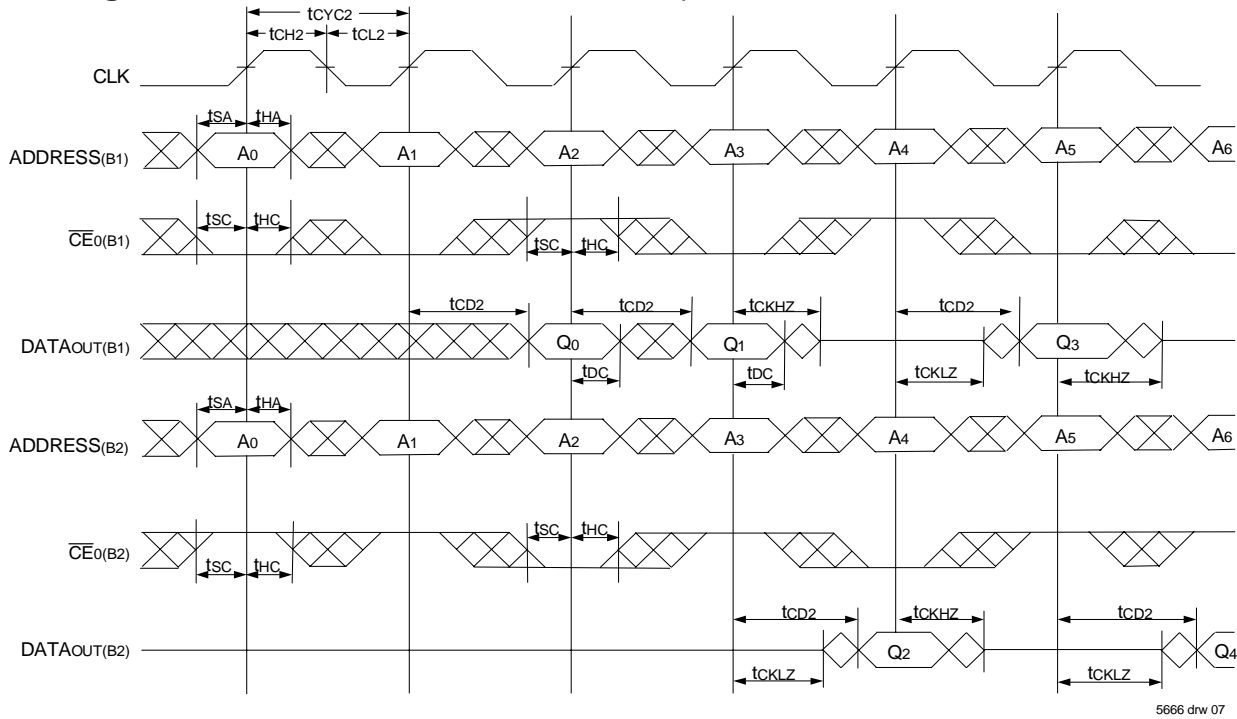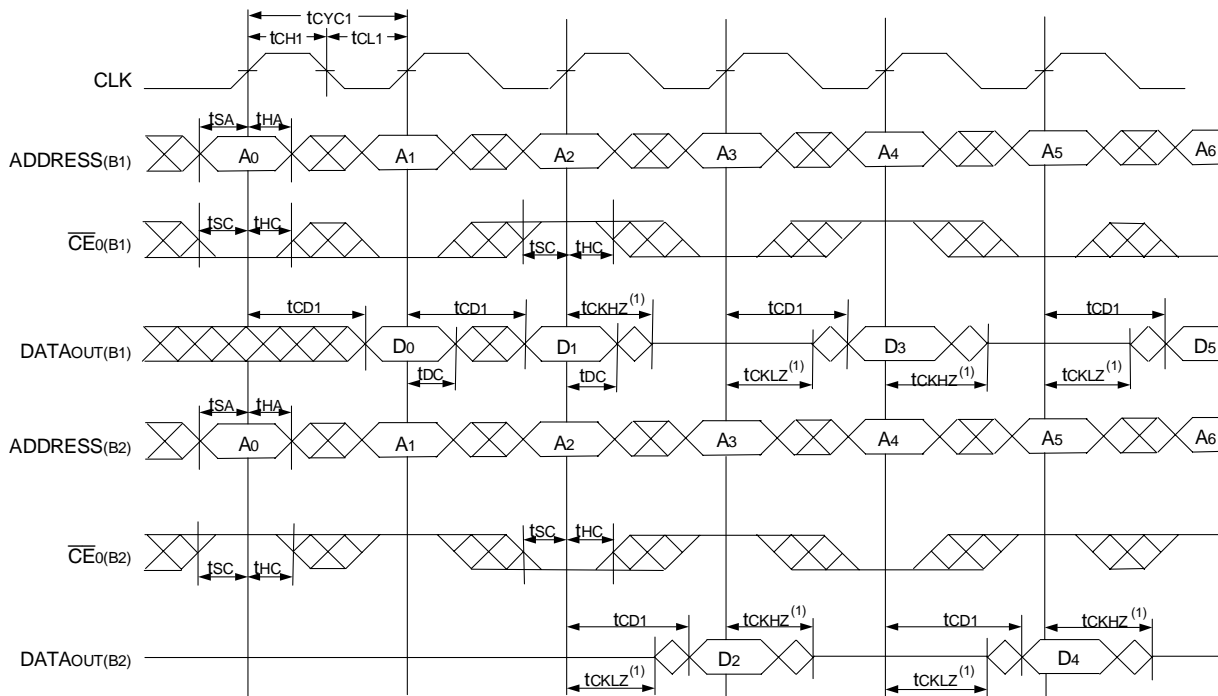

5666 drw 06

NOTES:
1. $\overline{\text{OE}}$ is asynchronously controlled; all other inputs depicted in the above waveforms are synchronous to the rising clock edge.
2. $\overline{\text{ADS}}$ = V_{IL}, $\overline{\text{CNTEN}}$ and $\overline{\text{REPEAT}}$ = V_{IH}.
3. The output is disabled (High-Impedance state) by $\overline{\text{CE}}_0$ = V_{IH}, CE_1 = V_{IL}, $\overline{\text{BE}}_n$ = V_{IH} following the next rising edge of the clock. Refer to Truth Table 1.
4. Addresses do not have to be accessed sequentially since $\overline{\text{ADS}}$ = V_{IL} constantly loads the address on the rising edge of the CLK; numbers are for reference use only.
5. If $\overline{\text{BE}}_n$ was HIGH, then the appropriate Byte of DATA$_{OUT}$ for Qn + 2 would be disabled (High-Impedance state).
6. "x" denotes Left or Right port. The diagram is with respect to that port.

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Timing Waveform of a Multi-Device Pipelined Read [1,2]

5666 drw 07

Timing Waveform of a Multi-Device Flow-Through Read [1,2]

5666 drw 08

NOTES:
1. B1 Represents Device #1; B2 Represents Device #2. Each Device consists of one IDT70T3519/99/89 for this waveform, and are setup for depth expansion in this example. ADDRESS(B1) = ADDRESS(B2) in this situation.
2. $\overline{BE}_n$, $\overline{OE}$, and $\overline{ADS}$ = V_{IL}; CE1(B1), CE1(B2), R/$\overline{W}$, $\overline{CNTEN}$, and $\overline{REPEAT}$ = V_{IH}.

Timing Waveform of Left Port Write to Pipelined Right Port Read [1,2,4]

5666 drw 09
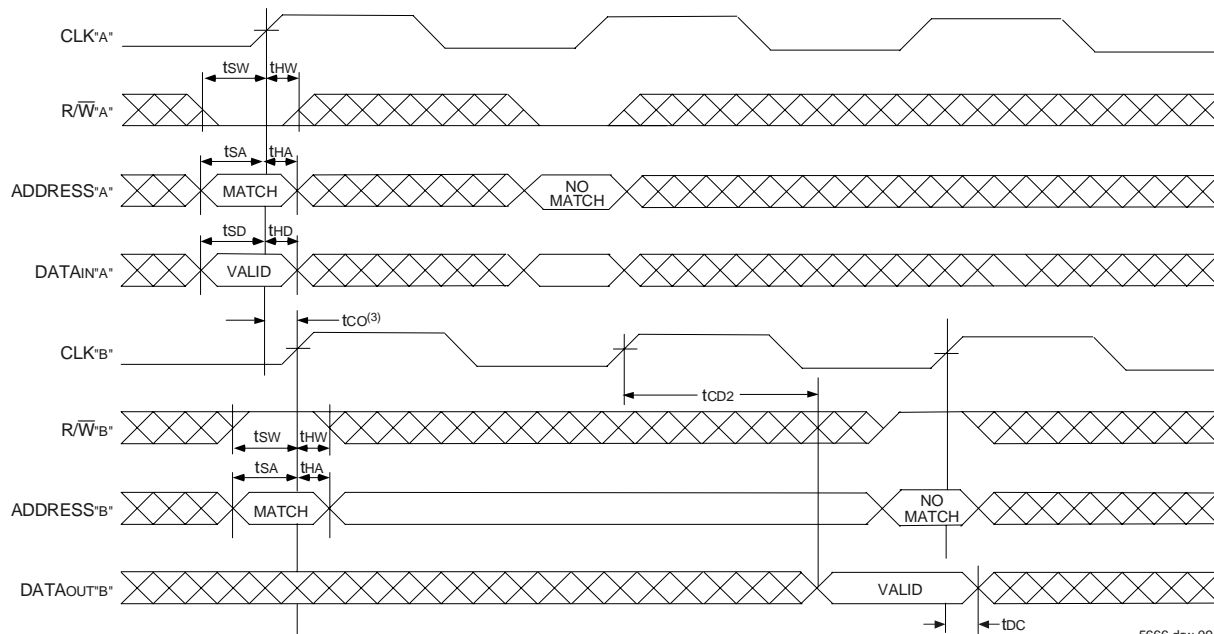
NOTES:
1. $\overline{CE}_0$, $\overline{BE}_n$, and $\overline{ADS}$ = V_{IL}; CE_1, $\overline{CNTEN}$, and $\overline{REPEAT}$ = V_{IH}.
2. $\overline{OE}$ = V_{IL} for Port "B", which is being read from. $\overline{OE}$ = V_{IH} for Port "A", which is being written to.
3. If $t_{CO} \leq$ minimum specified, then data from Port "B" read is not valid until following Port "B" clock cycle (ie, time from write to valid read on opposite port will be t_{CO} + 2 t_{CYC2} + t_{CD2}). If $t_{CO} >$ minimum, then data from Port "B" read is available on first Port "B" clock cycle (ie, time from write to valid read on opposite port will be t_{CO} + t_{CYC2} + t_{CD2}).
4. All timing is the same for Left and Right ports. Port "A" may be either Left or Right port. Port "B" is the opposite of Port "A"

Timing Waveform with Port-to-Port Flow-Through Read [1,2,4]

5666 drw 10
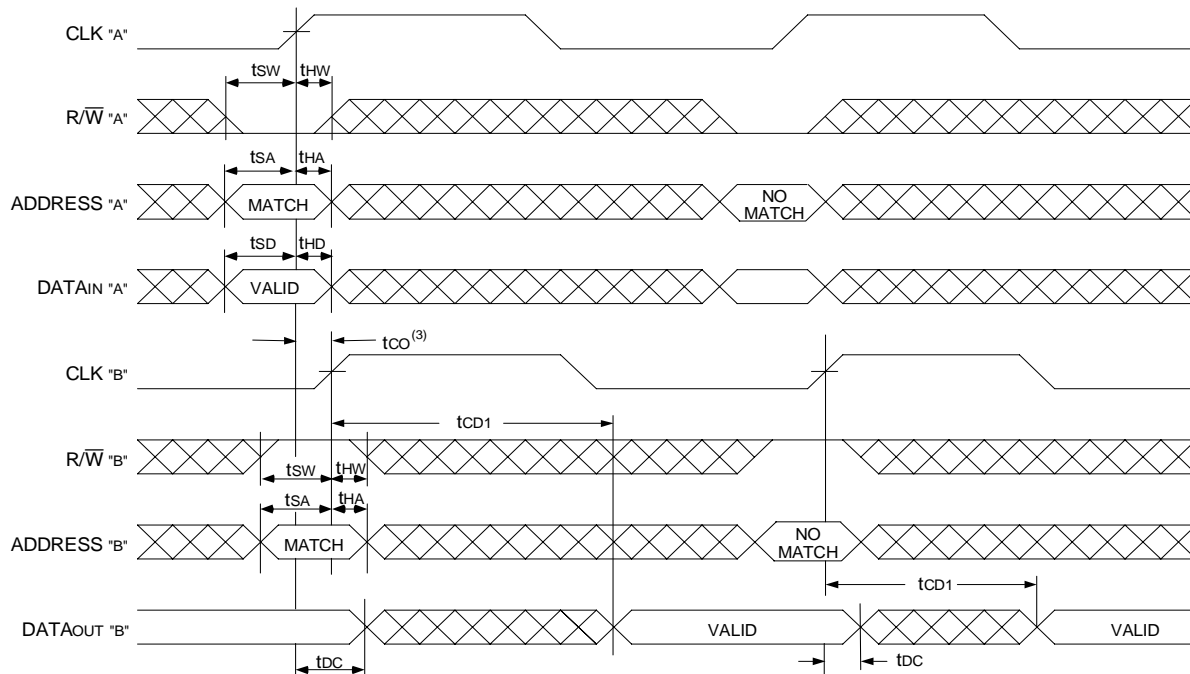
NOTES:
1. $\overline{CE}_0$, $\overline{BE}_n$, and $\overline{ADS}$ = V_{IL}; CE_1, $\overline{CNTEN}$, and $\overline{REPEAT}$ = V_{IH}.
2. $\overline{OE}$ = V_{IL} for the Right Port, which is being read from. $\overline{OE}$ = V_{IH} for the Left Port, which is being written to.
3. If $t_{CO} \leq$ minimum specified, then data from Port "B" read is not valid until following Port "B" clock cycle (i.e., time from write to valid read on opposite port will be t_{CO} + t_{CYC} + t_{CD1}). If $t_{CO} >$ minimum, then data from Port "B" read is available on first Port "B" clock cycle (i.e., time from write to valid read on opposite port will be t_{CO} + t_{CD1}).
4. All timing is the same for both left and right ports. Port "A" may be either left or right port. Port "B" is the opposite of Port "A".

Timing Waveform of Pipelined Read-to-Write-to-Read ($\overline{\text{OE}}$ = V_{IL})[2]
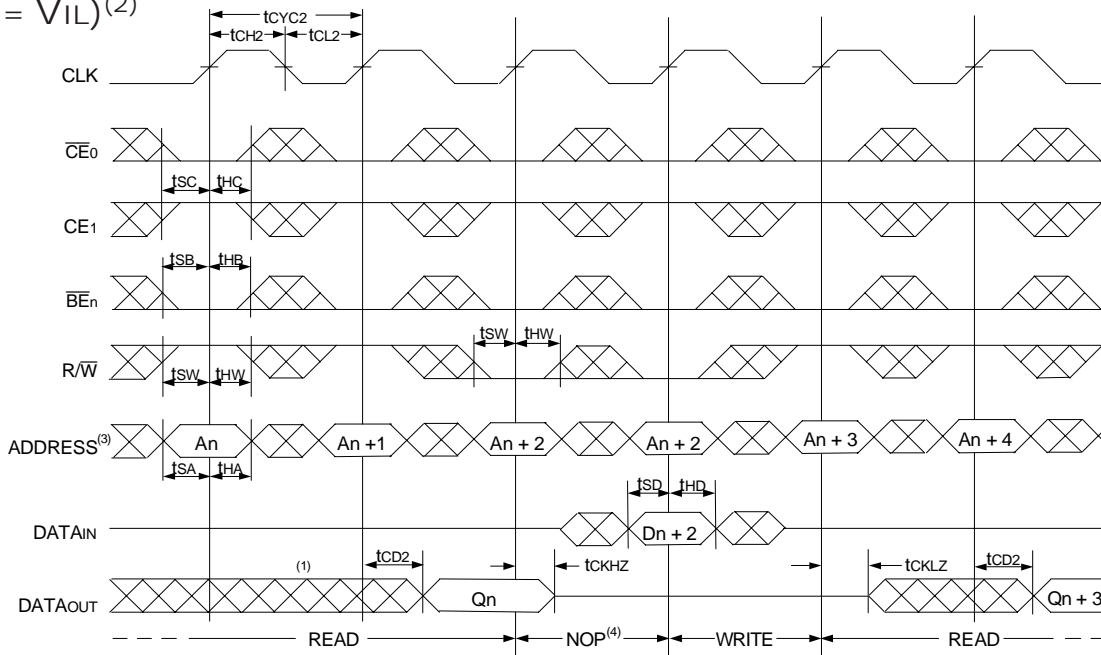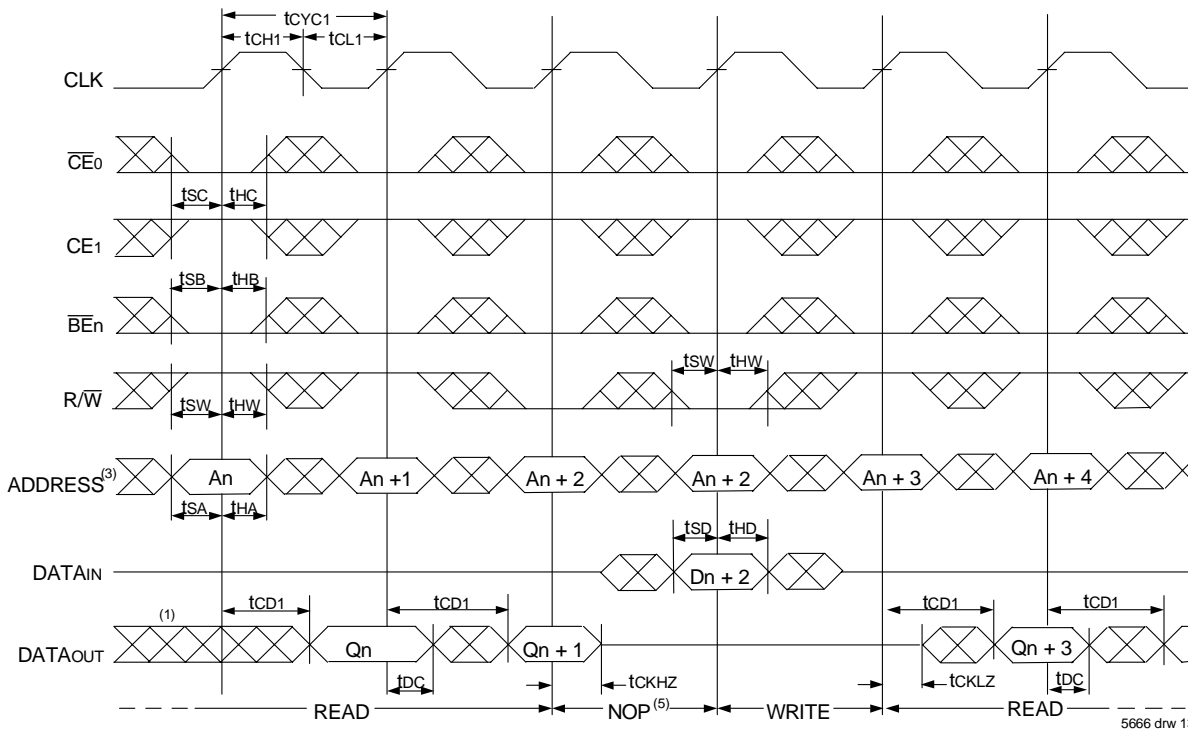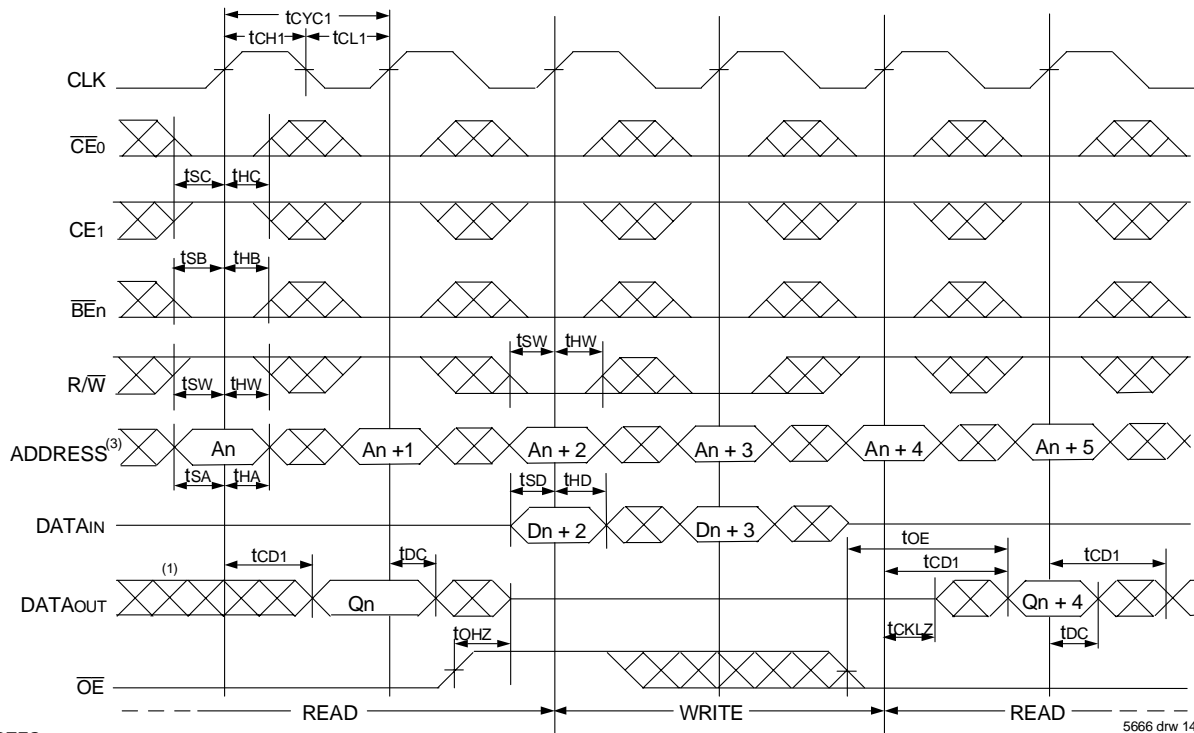

5666 drw 11

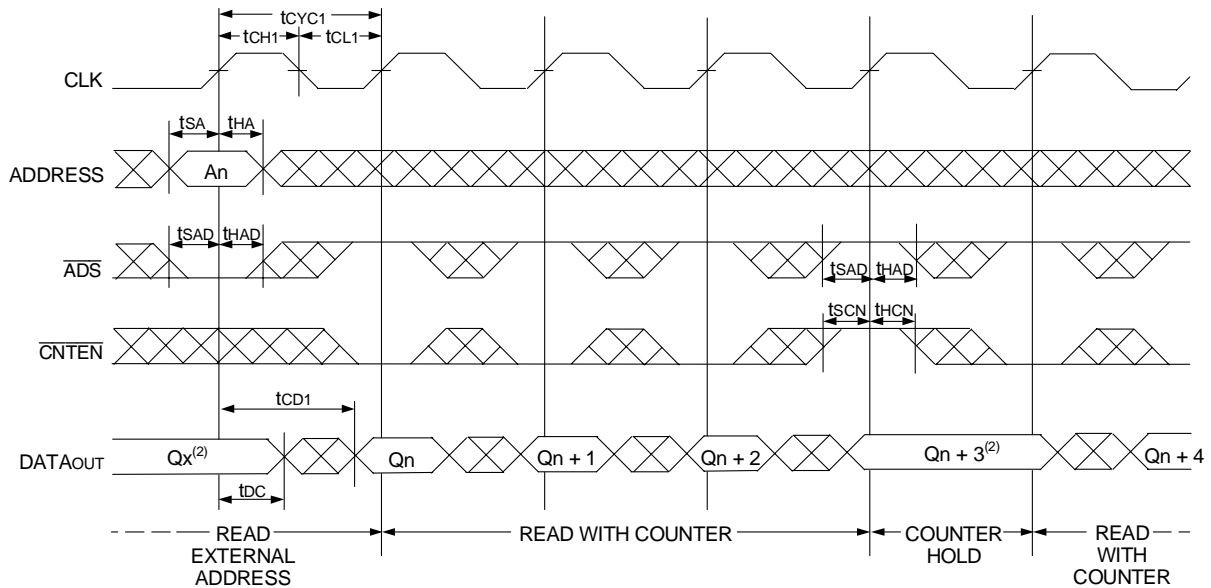**NOTES:**
1. Output state (High, Low, or High-impedance) is determined by the previous cycle control signals.
2. $\overline{CE}_0$, $\overline{BE}_n$, and $\overline{ADS}$ = V_{IL}; CE_1, $\overline{CNTEN}$, and $\overline{REPEAT}$ = V_{IH}. "NOP" is "No Operation".
3. Addresses do not have to be accessed sequentially since $\overline{ADS}$ = V_{IL} constantly loads the address on the rising edge of the CLK; numbers are for reference use only.
4. "NOP" is "No Operation." Data in memory at the selected address may be corrupted and should be re-written to guarantee data integrity.

Timing Waveform of Pipelined Read-to-Write-to-Read ($\overline{\text{OE}}$ Controlled) [2]
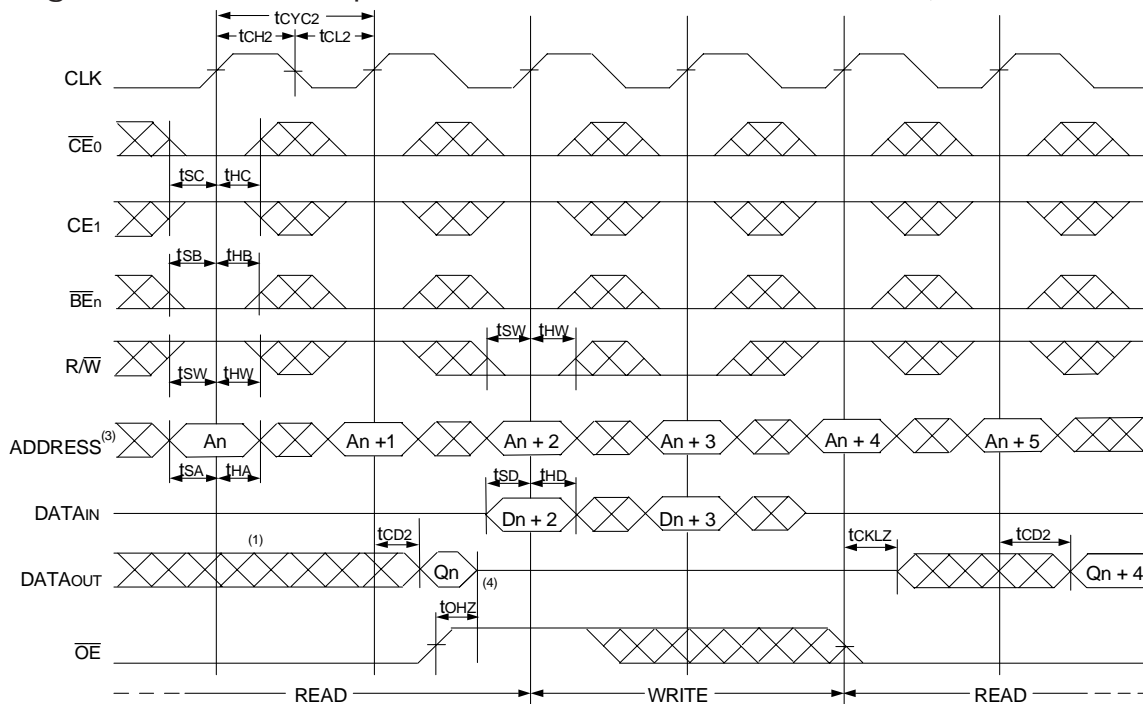

5666 drw 12

NOTES:
1. Output state (High, Low, or High-impedance) is determined by the previous cycle control signals.
2. $\overline{CE}_0$, $\overline{BE}_n$, and $\overline{ADS}$ = V_{IL}; CE_1, $\overline{CNTEN}$, and $\overline{REPEAT}$ = V_{IH}.
3. Addresses do not have to be accessed sequentially since $\overline{ADS}$ = V_{IL} constantly loads the address on the rising edge of the CLK; numbers are for reference use only.
4. This timing does not meet requirements for fastest speed grade. This waveform indicates how logically it could be done if timing so allows.

Timing Waveform of Flow-Through Read-to-Write-to-Read ($\overline{OE}$ = V$_{IL}$)[2]

5666 drw 13

Timing Waveform of Flow-Through Read-to-Write-to-Read ($\overline{OE}$ Controlled)[2]

5666 drw 14

NOTES:

1. Output state (High, Low, or High-impedance) is determined by the previous cycle control signals.
2. $\overline{CE}_0$, $\overline{BE}_n$, and $\overline{ADS}$ = V$_{IL}$; CE$_1$, $\overline{CNTEN}$, and $\overline{REPEAT}$ = V$_{IH}$.
3. Addresses do not have to be accessed sequentially since $\overline{ADS}$ = V$_{IL}$ constantly loads the address on the rising edge of the CLK; numbers are for reference use only.
4. "NOP" is "No Operation." Data in memory at the selected address may be corrupted and should be re-written to guarantee data integrity.

Timing Waveform of Pipelined Read with Address Counter Advance [1]

5666 drw 15
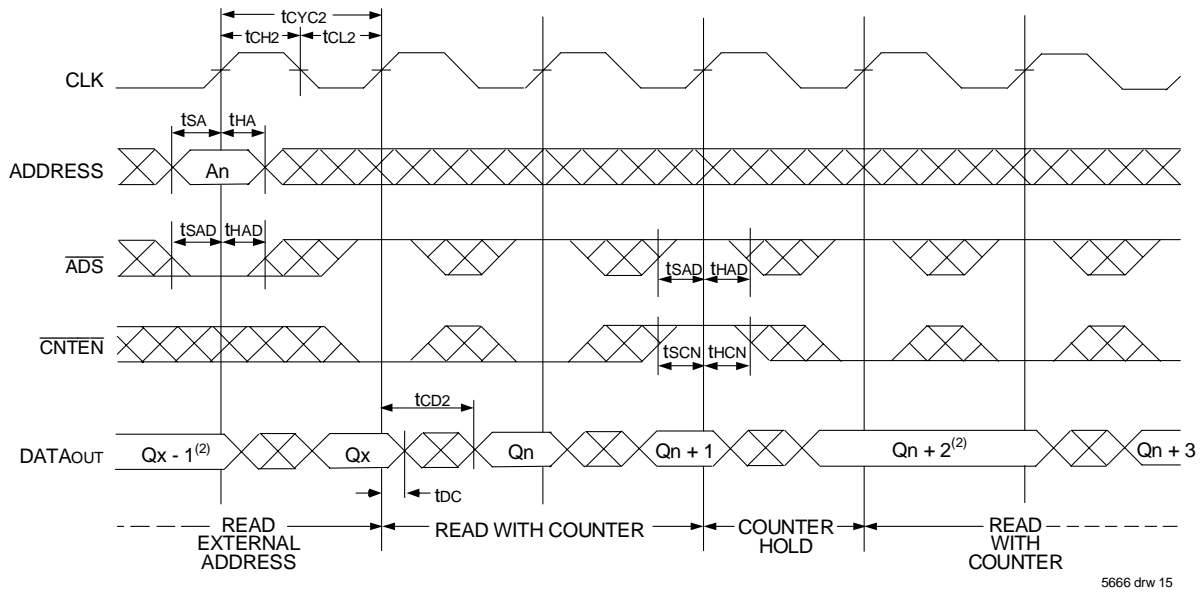
Timing Waveform of Flow-Through Read with Address Counter Advance [1]

5666 drw 16

NOTES:
1. $\overline{CE}_0$, $\overline{OE}$, $\overline{BE}n$ = V_{IL}; CE1, R/$\overline{W}$, and $\overline{REPEAT}$ = V_{IH}.
2. If there is no address change via $\overline{ADS}$ = V_{IL} (loading a new address) or $\overline{CNTEN}$ = V_{IL} (advancing the address), i.e. $\overline{ADS}$ = V_{IH} and $\overline{CNTEN}$ = V_{IH}, then the data output remains constant for subsequent clocks.

Timing Waveform of Write with Address Counter Advance (Flow-through or Pipelined Inputs) [1]

5666 drw 17
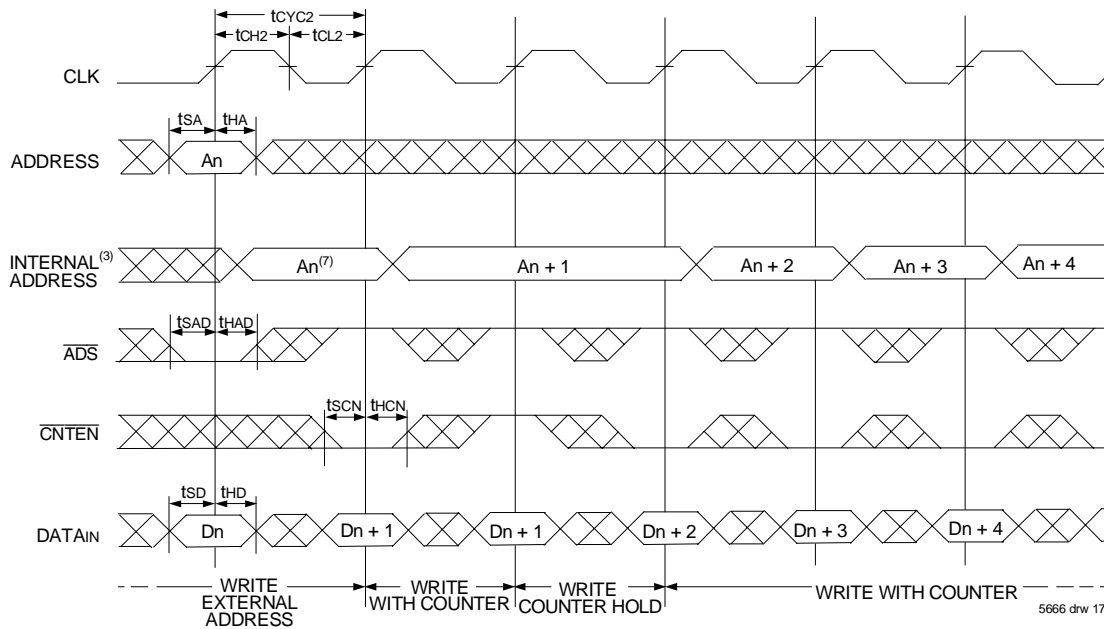
Timing Waveform of Counter Repeat [2,6]

5666 drw 18
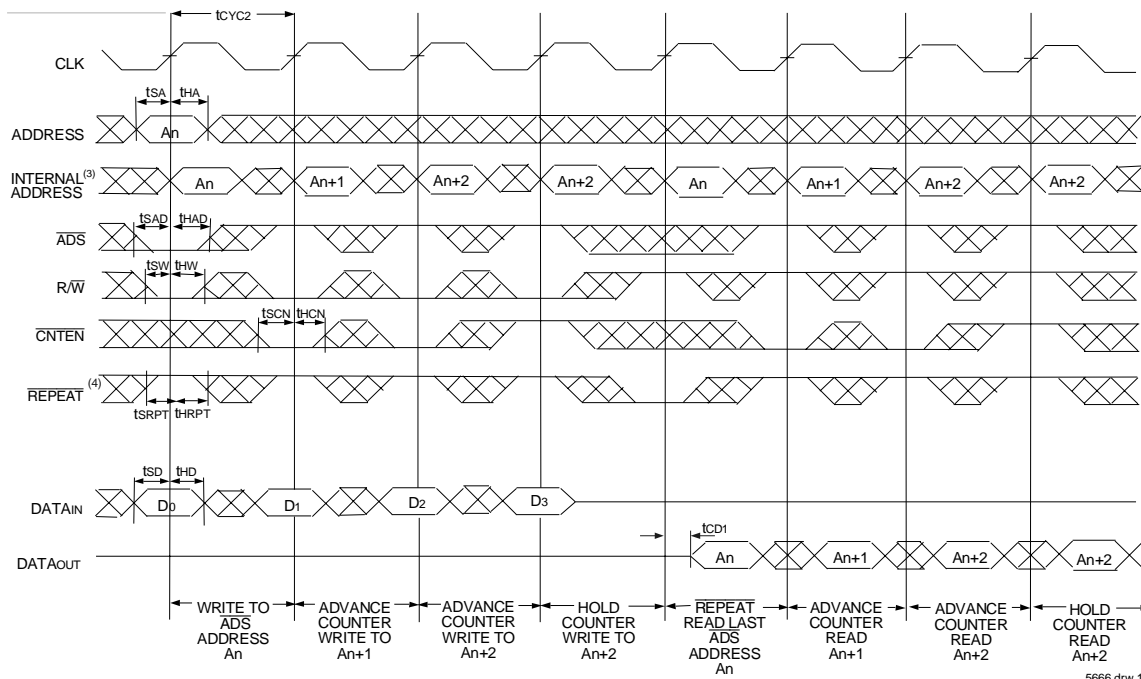
NOTES:
1. $\overline{CE_0}$, $\overline{BE_n}$, and R/$\overline{W}$ = V_{IL}; CE_1 and $\overline{REPEAT}$ = V_{IH}.
2. $\overline{CE_0}$, $\overline{BE_n}$ = V_{IL}; CE_1 = V_{IH}.
3. The "Internal Address" is equal to the "External Address" when $\overline{ADS}$ = V_{IL} and equals the counter output when $\overline{ADS}$ = V_{IH}.
4. No dead cycle exists during $\overline{REPEAT}$ operation. A READ or WRITE cycle may be coincidental with the counter $\overline{REPEAT}$ cycle: Address loaded by last valid $\overline{ADS}$ load will be accessed. For more information on $\overline{REPEAT}$ function refer to Truth Table II.
5. $\overline{CNTEN}$ = V_{IL} advances Internal Address from 'An' to 'An +1'. The transition shown indicates the time required for the counter to advance. The 'An +1'Address is written to during this cycle.
6. For Pipelined Mode user should add 1 cycle latency for outputs as per timing waveform of read cycle for pipelined operations.

Waveform of Interrupt Timing [2]
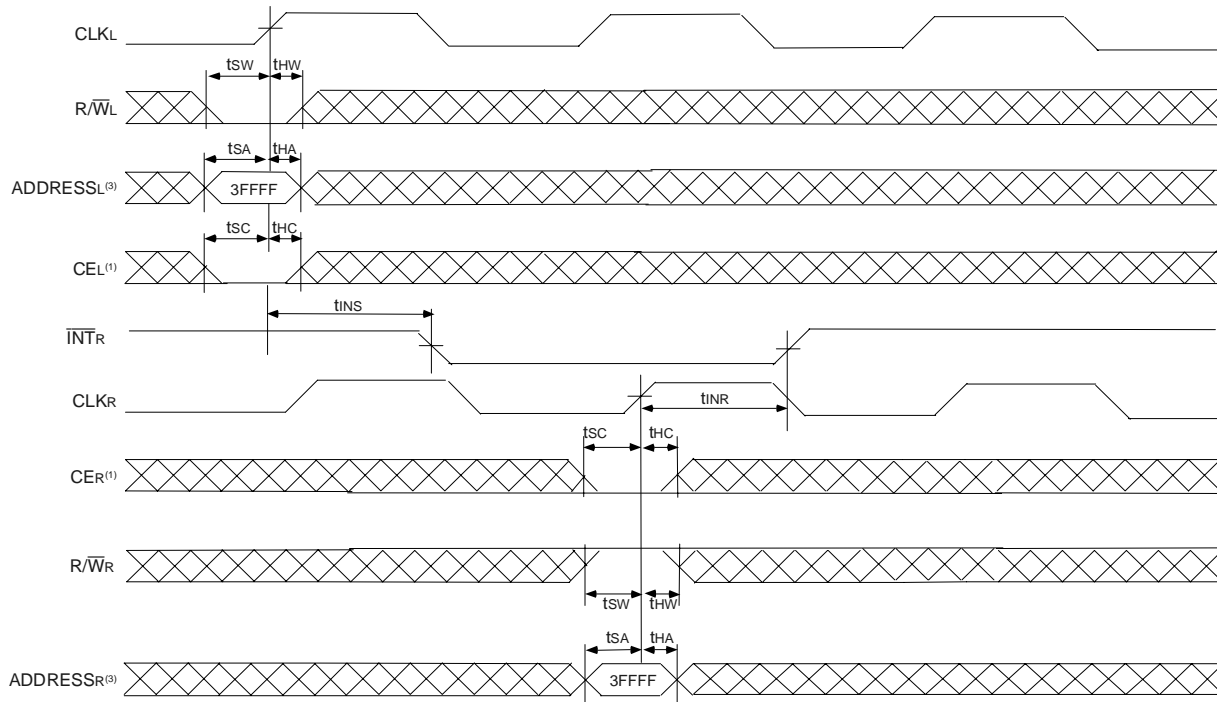
5666 drw 19

NOTES:
1. $\overline{CE}_0 = V_{IL}$ and $CE_1 = V_{IH}$.
2. All timing is the same for Left and Right ports.
3. Address is for internal register, not the external bus, i.e., address needs to be qualified by one of the Address counter control signals.

Truth Table III — Interrupt Flag [1]

Left Port					Right Port					
CLK$_L$	**R/$\overline{W}_L$[2]**	**CE$_L$[2]**	**A$_{17L}$-A$_{0L}$[3,4,5]**	**$\overline{INT}_L$**	**CLK$_R$**	**R/$\overline{W}_R$[2]**	**CE$_R$[2]**	**A$_{17R}$-A$_{0R}$[3,4,5]**	**$\overline{INT}_R$**	**Function**
↑	L	L	3FFFF	X	↑	X	X	X	L	Set Right $\overline{INT}_R$ Flag
↑	X	X	X	X	↑	H	L	3FFFF	H	Reset Right $\overline{INT}_R$ Flag
↑	X	X	X	L	↑	L	L	3FFFE	X	Set Left $\overline{INT}_L$ Flag
↑	H	L	3FFFE	H	↑	X	X	X	X	Reset Left $\overline{INT}_L$ Flag

5666 tbl 12

NOTES:
1. $\overline{INT}_L$ and $\overline{INT}_R$ must be initialized at power-up by Resetting the flags.
2. $\overline{CE}_0 = V_{IL}$ and $CE_1 = V_{IH}$. R/$\overline{W}$ and CE are synchronous with respect to the clock and need valid set-up and hold times.
3. A17$_X$ is a NC for IDT70T3599, therefore Interrupt Addresses are 1FFFF and 1FFFE.
4. A17$_X$ and A16$_X$ are NC's for IDT70T3589, therefore Interrupt Addresses are FFFF and FFFE.
5. Address is for internal register, not the external bus, i.e., address needs to be qualified by one of the Address counter control signals.

Waveform of Collision Timing[1,2]
Both Ports Writing with Left Port Clock Leading
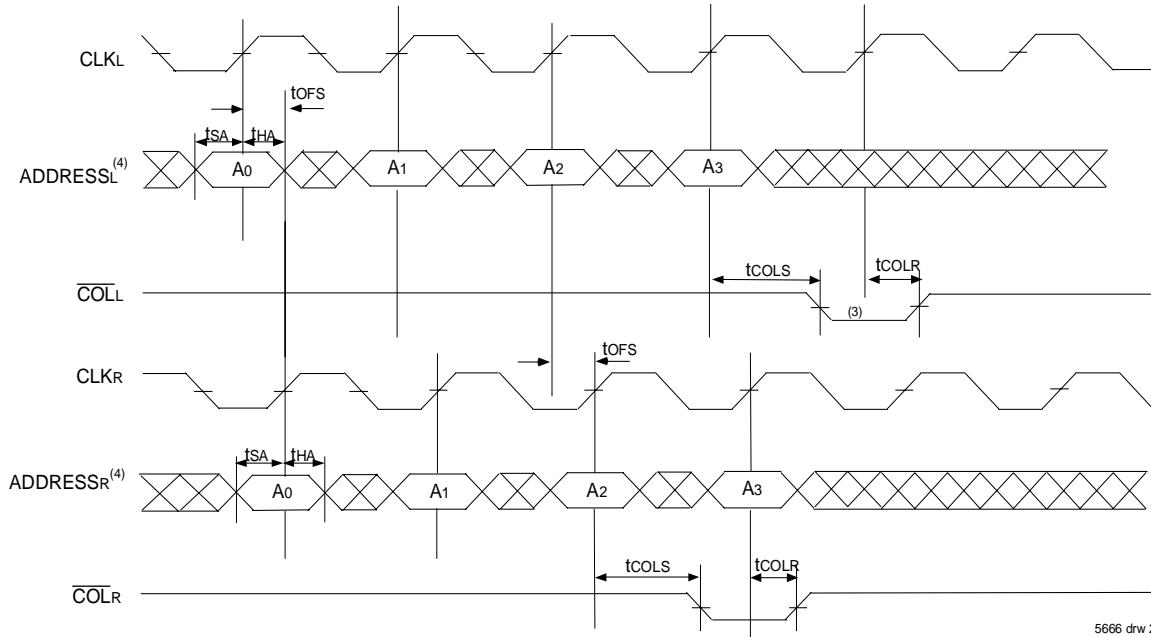
5666 drw 20

NOTES:
1. $\overline{CE}_0 = V_{IL}$, $CE_1 = V_{IH}$.
2. For reading port, $\overline{OE}$ is a Don't care on the Collision Detection Logic. Please refer to Truth Table IV for specific cases.
3. Leading Port Output flag might output $3t_{CYC2} + t_{COLS}$ after Address match.
4. Address is for internal register, not the external bus, i.e., address needs to be qualified by one of the Address counter control signals.

Collision Detection Timing[3,4]

Cycle Time	t_{OFS} (ns)	
	Region 1 (ns) [1]	Region 2 (ns) [2]
5ns	0 - 2.8	2.81 - 4.6
6ns	0 - 3.8	3.81 - 5.6
7.5ns	0 - 5.3	5.31 - 7.1

5666 tbl 13

NOTES:
1. Region 1
   Both ports show collision after 2nd cycle for Addresses 0, 2, 4 etc.
2. Region 2
   Leading port shows collision after 3rd cycle for addresses 0, 3, 6, etc.
   while trailing port shows collision after 2nd cycle for addresses 0, 2, 4 etc.
3. All the production units are tested to midpoint of each region.
4. These ranges are based on characterization of a typical device.

Truth Table IV — Collision Detection Flag

Left Port					Right Port					
CLK_L	$R/\overline{W}_L$[1]	CE_L[1]	$A_{17L}-A_{0L}$[2]	$\overline{COL}_L$	CLK_R	$R/\overline{W}_R$[1]	CE_R[1]	$A_{17R}-A_{0R}$[2]	$\overline{COL}_R$	Function
↑	H	L	MATCH	H	↑	H	L	MATCH	H	Both ports reading. Not a valid collision. No flag output on either port.
↑	H	L	MATCH	L	↑	L	L	MATCH	H	Left port reading, Right port writing. Valid collision, flag output on Left port.
↑	L	L	MATCH	H	↑	H	L	MATCH	L	Right port reading, Left port writing. Valid collision, flag output on Right port.
↑	L	L	MATCH	L	↑	L	L	MATCH	L	Both ports writing. Valid collision. Flag output on both ports.

5666 tbl 14

NOTES:
1. $\overline{CE}_0 = V_{IL}$ and $CE_1 = V_{IH}$. $R/\overline{W}$ and CE are synchronous with respect to the clock and need valid set-up and hold times.
2. Address is for internal register, not the external bus, i.e., address needs to be qualified by one of the Address counter control signals.
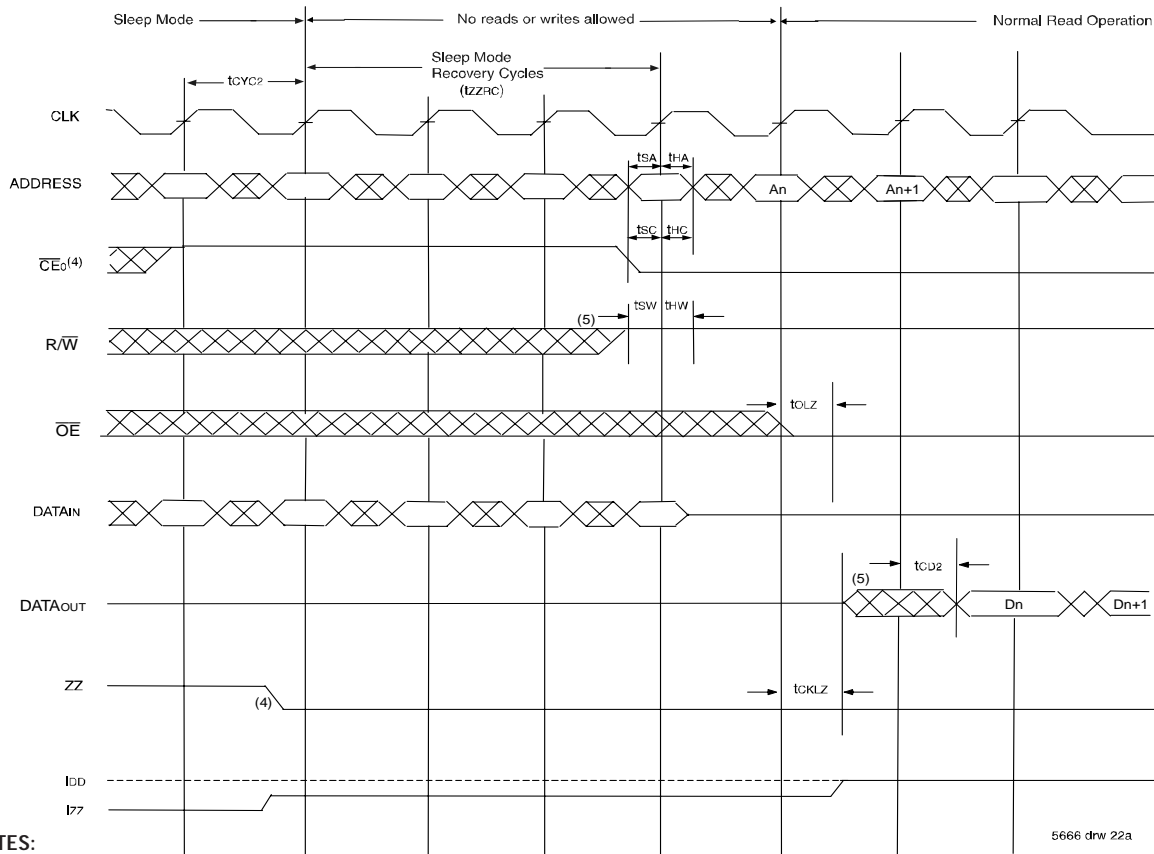
Timing Waveform - Entering Sleep Mode [1,2]
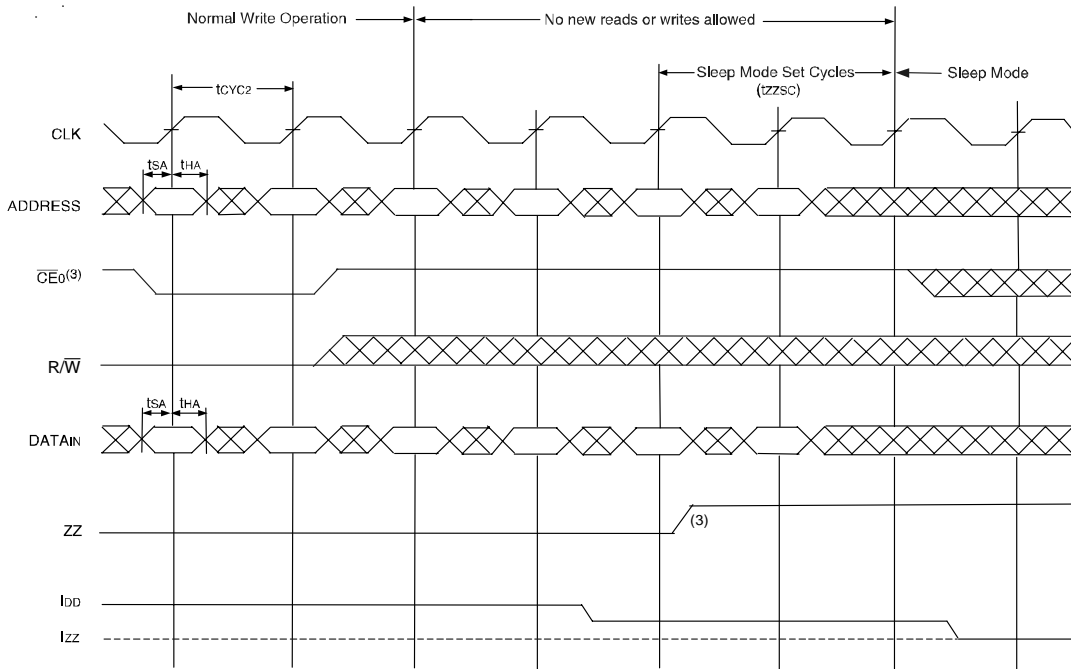
5666 drw 22

Timing Waveform - Exiting Sleep Mode [1,2]

5666 drw 22a

NOTES:
1. $CE_1 = V_{IH}$.
2. All timing is same for Left and Right ports.
3. $\overline{CE}_0$ has to be deactivated ($\overline{CE}_0 = V_{IH}$) three cycles prior to asserting ZZ (ZZx = V_{IH}) and held for two cycles after asserting ZZ (ZZx = V_{IH}).
4. $\overline{CE}_0$ has to be deactivated ($\overline{CE}_0 = V_{IH}$) one cycle prior to de-asserting ZZ (ZZx = V_{IL}) and held for three cycles after de-asserting ZZ (ZZx = V_{IL}).
5. The device must be in Read Mode (R/$\overline{W}$ High) when exiting sleep mode. Outputs are active but data is not valid until the following cycle.

Functional Description

The IDT70T3519/99/89 provides a true synchronous Dual-Port Static RAM interface. Registered inputs provide minimal set-up and hold times on address, data, and all critical control inputs. All internal registers are clocked on the rising edge of the clock signal, however, the self-timed internal write pulse width is independent of the cycle time.

An asynchronous output enable is provided to ease asynchronous bus interfacing. Counter enable inputs are also provided to stall the operation of the address counters for fast interleaved memory applications.

A HIGH on $\overline{CE}_0$ or a LOW on CE_1 for one clock cycle will power down the internal circuitry to reduce static power consumption. Multiple chip enables allow easier banking of multiple IDT70T3519/99/89s for depth expansion configurations. Two cycles are required with $\overline{CE}_0$ LOW and CE_1 HIGH to re-activate the outputs.

Interrupts

If the user chooses the interrupt function, a memory location (mail box or message center) is assigned to each port. The left port interrupt flag ($\overline{INT}_L$) is asserted when the right port writes to memory location 3FFFE (HEX), where a write is defined as $\overline{CE}_R = R/\overline{W}_R = V_{IL}$ per the Truth Table. The left port clears the interrupt through access of address location 3FFFE when $\overline{CE}_L = V_{IL}$ and $R/\overline{W}_L = V_{IH}$. Likewise, the right port interrupt flag ($\overline{INT}_R$) is asserted when the left port writes to memory location 3FFFF (HEX) and to clear the interrupt flag ($\overline{INT}_R$), the right port must read the memory location 3FFFF (1FFFF or 1FFFE for IDT70T3599 and FFFF or FFFE for IDT70T3589). The message (36 bits) at 3FFFE or 3FFFF (1FFFF or 1FFFE for IDT70T3599 and FFFF or FFFE for IDT70T3589) is user-defined since it is an addressable SRAM location. If the interrupt function is not used, address locations 3FFFE and 3FFFF (1FFFF or 1FFFE for IDT70T3599 and FFFF or FFFE for IDT70T3589) are not used as mail boxes, but as part of the random access memory. Refer to Truth Table III for the interrupt operation.

Collision Detection

Collision is defined as an overlap in access between the two ports resulting in the potential for either reading or writing incorrect data to a specific address. For the specific cases: (a) Both ports reading - no data is corrupted, lost, or incorrectly output, so no collision flag is output on either port. (b) One port writing, the other port reading - the end result of the write will still be valid. However, the reading port might capture data that is in a state of transition and hence the reading port's collision flag is output. (c) Both ports writing - there is a risk that the two ports will interfere with each other, and the data stored in memory will not be a valid write from either port (it may essentially be a random combination of the two). Therefore, the collision flag is output on both ports. Please refer to Truth Table IV for all of the above cases.

The alert flag ($\overline{COL}_X$) is asserted on the 2nd or 3rd rising clock edge of the affected port following the collision, and remains low for one cycle. Please refer to Collision Detection Timing table on Page 21. During that next cycle, the internal arbitration is engaged in resetting the alert flag (this avoids a specific requirement on the part of the user to reset the alert flag). If two collisions occur on subsequent clock cycles, the second collision may not generate the appropriate alert

flag. A third collision will generate the alert flag as appropriate. In the event that a user initiates a burst access on both ports with the same starting address on both ports and one or both ports writing during each access (i.e., imposes a long string of collisions on contiguous clock cycles), the alert flag will be asserted and cleared every other cycle. Please refer to the Collision Detection timing waveform on Page 21Collision detection on the IDT70T3519/99/89 represents a significant advance in functionality over current sync multi-ports, which have no such capability. In addition to this functionality the IDT70T3519/99/89 sustains the key features of bandwidth and flexibility. The collision detection function is very useful in the case of bursting data, or a string of accesses made to sequential addresses, in that it indicates a problem within the burst, giving the user the option of either repeating the burst or continuing to watch the alert flag to see whether the number of collisions increases above an acceptable threshold value. Offering this function on chip also allows users to reduce their need for arbitration circuits, typically done in CPLD's or FPGA's. This reduces board space and design complexity, and gives the user more flexibility in developing a solution.

Sleep Mode

The IDT70T3519/99/89 is equipped with an optional sleep or low power mode on both ports. The sleep mode pin on both ports is asynchronous and active high. During normal operation, the ZZ pin is pulled low. When ZZ is pulled high, the port will enter sleep mode where it will meet lowest possible power conditions. The sleep mode timing diagram shows the modes of operation: Normal Operation, No Read/Write Allowed and Sleep Mode.

For normal operation all inputs must meet setup and hold times prior to sleep and after recovering from sleep. Clocks must also meet cycle high and low times during these periods. Three cycles prior to asserting ZZ ($ZZ_X = V_{IH}$) and three cycles after de-asserting ZZ ($ZZ_X = V_{IL}$), the device must be disabled via the chip enable pins. If a write or read operation occurs during these periods, the memory array may be corrupted. Validity of data out from the RAM cannot be guaranteed immediately after ZZ is asserted (prior to being in sleep). When exiting sleep mode, the device must be in Read mode ($R/\overline{W}_X = V_{IH}$) when chip enable is asserted, and the chip enable must be valid for one full cycle before a read will result in the output of valid data.

During sleep mode the RAM automatically deselects itself. The RAM disconnects its internal clock buffer. The external clock may continue to run without impacting the RAMs sleep current (I_{ZZ}). All outputs will remain in high-Z state while in sleep mode. All inputs are allowed to toggle. The RAM will not be selected and will not perform any reads or writes.

Depth and Width Expansion

The IDT70T3519/99/89 features dual chip enables (refer to Truth Table I) in order to facilitate rapid and simple depth expansion with no requirements for external logic. Figure 4 illustrates how to control the various chip enables in order to expand two devices in depth.

The IDT70T3519/99/89 can also be used in applications requiring expanded width, as indicated in Figure 4. Through combining the control signals, the devices can be grouped as necessary to accommodate applications needing 72-bits or wider.

Figure 4. Depth and Width Expansion with IDT70T3519/99/89
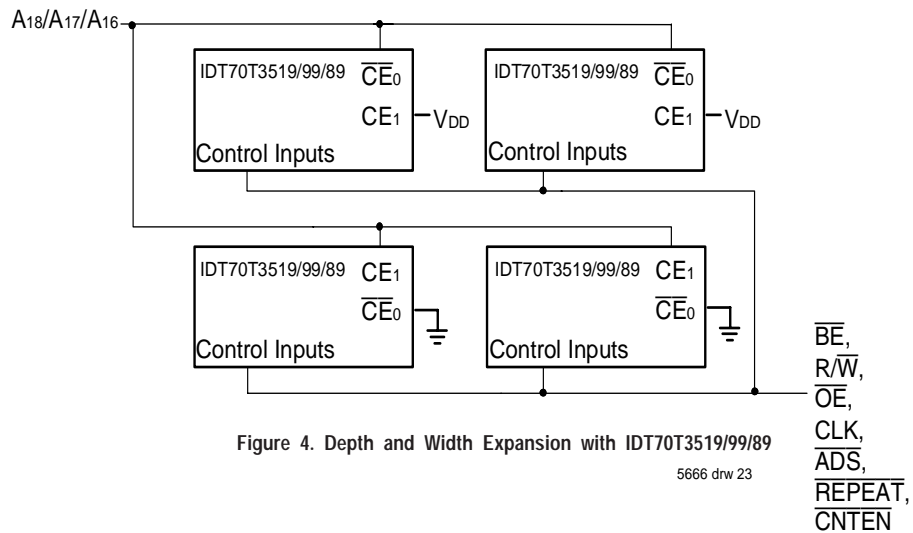
5666 drw 23

NOTE:
1. A_{18} is for IDT70T3519, A_{17} is for IDT70T3599, A_{16} is for IDT70T3589.
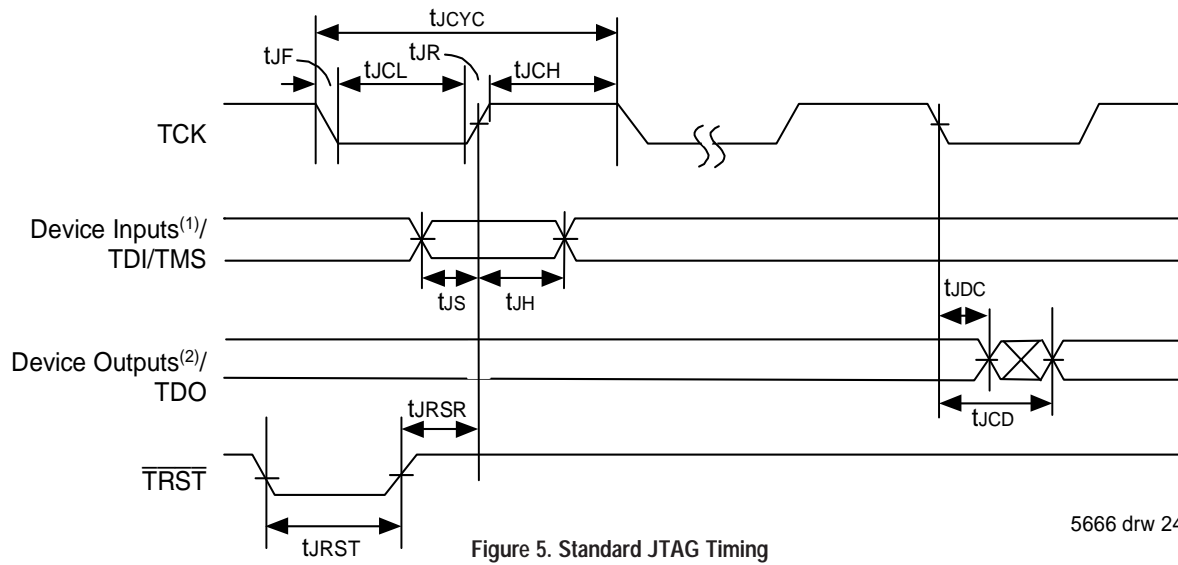
JTAG Timing Specifications

Figure 5. Standard JTAG Timing

5666 drw 24

NOTES:
1. Device inputs = All device inputs except TDI, TMS, and TRST.
2. Device outputs = All device outputs except TDO.

JTAG AC Electrical Characteristics [1,2,3,4]

Symbol	Parameter	70T3519/99/89		
		Min.	Max.	Units
t_{JCYC}	JTAG Clock Input Period	100	—	ns
t_{JCH}	JTAG Clock HIGH	40	—	ns
t_{JCL}	JTAG Clock Low	40	—	ns
t_{JR}	JTAG Clock Rise Time	—	3[1]	ns
t_{JF}	JTAG Clock Fall Time	—	3[1]	ns
t_{JRST}	JTAG Reset	50	—	ns
t_{JRSR}	JTAG Reset Recovery	50	—	ns
t_{JCD}	JTAG Data Output	—	25	ns
t_{JDC}	JTAG Data Output Hold	0	—	ns
t_{JS}	JTAG Setup	15	—	ns
t_{JH}	JTAG Hold	15	—	ns

5666 tbl 15

NOTES:
1. Guaranteed by design.
2. 30pF loading on external output signals.
3. Refer to AC Electrical Test Conditions stated earlier in this document.
4. JTAG operations occur at one speed (10MHz). The base device may run at any speed specified in this datasheet.

Identification Register Definitions

Instruction Field	Value	Description
Revision Number (31:28)	0x0	Reserved for version number
IDT Device ID (27:12)	0x330[1]	Defines IDT part number
IDT JEDEC ID (11:1)	0x33	Allows unique identification of device vendor as IDT
ID Register Indicator Bit (Bit 0)	1	Indicates the presence of an ID register

5666 tbl 16

NOTE:
1. Device ID for IDT70T3599 is 0x331. Device ID for IDT70T3589 is 0x332.

Scan Register Sizes

Register Name	Bit Size
Instruction (IR)	4
Bypass (BYR)	1
Identification (IDR)	32
Boundary Scan (BSR)	Note (3)

5666 tbl 17
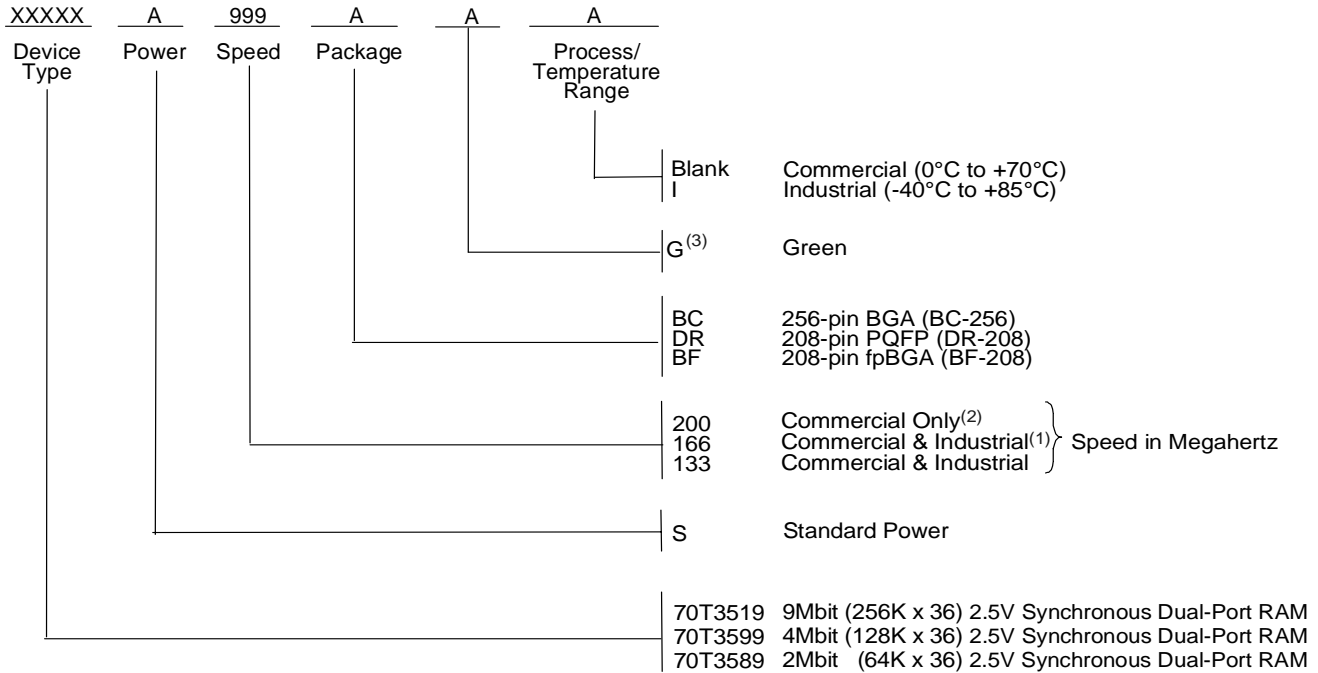
System Interface Parameters

Instruction	Code	Description
EXTEST	0000	Forces contents of the boundary scan cells onto the device outputs[1]. Places the boundary scan register (BSR) between TDI and TDO.
BYPASS	1111	Places the bypass register (BYR) between TDI and TDO.
IDCODE	0010	Loads the ID register (IDR) with the vendor ID code and places the register between TDI and TDO.
HIGHZ	0100	Places the bypass register (BYR) between TDI and TDO. Forces all device output drivers to a High-Z state except $\overline{COL}$x & $\overline{INT}$x outputs.
CLAMP	0011	Uses BYR. Forces contents of the boundary scan cells onto the device outputs. Places the bypass register (BYR) between TDI and TDO.
SAMPLE/PRELOAD	0001	Places the boundary scan register (BSR) between TDI and TDO. SAMPLE allows data from device inputs[2] to be captured in the boundary scan cells and shifted serially through TDO. PRELOAD allows data to be input serially into the boundary scan cells via the TDI.
RESERVED	0101, 0111, 1000, 1001, 1010, 1011, 1100	Several combinations are reserved. Do not use codes other than those identified above.
PRIVATE	0110,1110,1101	For internal use only.

5666 tbl 18

NOTES:
1. Device outputs = All device outputs except TDO.
2. Device inputs = All device inputs except TDI, TMS, and $\overline{TRST}$.
3. The Boundary Scan Descriptive Language (BSDL) file for this device is available on the IDT website (www.idt.com), or by contacting your local IDT sales representative.

Ordering Information

```
XXXXX        A        999        A        A        A
Device     Power    Speed    Package              Process/
Type                                              Temperature
                                                  Range
```

	Blank	Commercial (0°C to +70°C)
	I	Industrial (-40°C to +85°C)
	G[3]	Green
	BC	256-pin BGA (BC-256)
	DR	208-pin PQFP (DR-208)
	BF	208-pin fpBGA (BF-208)
	200	Commercial Only[2] ⎫
	166	Commercial & Industrial[1] ⎬ Speed in Megahertz
	133	Commercial & Industrial ⎭
	S	Standard Power
	70T3519	9Mbit (256K x 36) 2.5V Synchronous Dual-Port RAM
	70T3599	4Mbit (128K x 36) 2.5V Synchronous Dual-Port RAM
	70T3589	2Mbit (64K x 36) 2.5V Synchronous Dual-Port RAM

5666 drw 25

NOTES:
1. 166MHz I-Temp is only available in the BC-256 package.
2. 200Mhz is only available in the BC-256 package.
3. Green parts available. For specific speeds, packages and powers contact your local sales office.

IDT Clock Solution for IDT70T3519/99/89 Dual-Port

IDT Dual-Port Part Number	Dual-Port I/O Specifications		Clock Specifications				IDT PLL Clock Device	IDT Non-PLL Clock Device
	Voltage	I/O	Input Capacitance	Input Duty Cycle Requirement	Maximum Frequency	Jitter Tolerance		
70T3519/99/89	2.5	LVTTL	8pF	40%	200	75ps	5T2010	5T9010 5T905, 5T9050 5T907, 5T9070

5666 tbl 19

Datasheet Document History:

01/23/03:		Initial Datasheet
01/30/03:	Page 1	Corrected 208-pin package from TQFP to PQFP
04/25/03:	Page 11	Added Capacitance Derating drawing
	Page 12	Changed t_{INS} and t_{INR} specs in AC Electrical Characteristics table
11/11/03:	Page 10	Updated power numbers in DC Electrical Characteristics table
	Page 12	Added t_{OFS} symbol and parameter to AC Electrical Characteristics table
	Page 21	Updated Collision Timing waveform
	Page 22	Added Collision Detection Timing table and footnotes
	Page 26	Updated HIGHZ function in System Interface Parameters table
	Page 27	Added IDT Clock Solution table
03/30/04:	Page 22 & 23	Clarified Sleep Mode Text and Waveforms
	Page 1 & 27	Removed Preliminary status
04/22/04:	Page 6	Added another sentence to footnote 4 to recommend that boundary scan not be operated during sleep mode
04/12/05:	Page 27	Clarified footnotes 1 & 2 for the ordering information
	Page 1 & 28	Replaced old IDT ™ with new IDT ™ logo
	Page 1	Added green availability to features
	Page 27	Added green indicator to ordering information
02/07/06:	Page 7	Changed footnote 2 for Truth Table I from $\overline{ADS}$, $\overline{CNTEN}$, $\overline{REPEAT}$ = V_{IH} to $\overline{ADS}$, $\overline{CNTEN}$, $\overline{REPEAT}$ = X
04/10/06:	Page 1,3 & 12	Changed $\overline{FT}x/PLx$ to $PLx/\overline{FT}x$ on diagrams and Notes.
07/28/08:	Page 10	Corrected a typo in the footnotes of DC Chars table
01/19/09:	Page 27	Removed "IDT" from orderable part number