

W85C178

REAL TIME CLOCK (WITH 114-BYTE SRAM)

GENERAL DESCRIPTION

The W85C178 Real Time Clock with 128-byte RAM is a peripheral device for use with various microprocessors. The W85C178 is designed to be a direct replacement for the MC146818A. The device's functions include a time-of-day clock, an alarm, a one-hundred-year calendar, a square wave generator, programmable interrupts, and 114 bytes of nonvolatile static RAM. The W85C178 uses CMOS technology and interfaces with most microprocessor buses. The device consumes very little power.

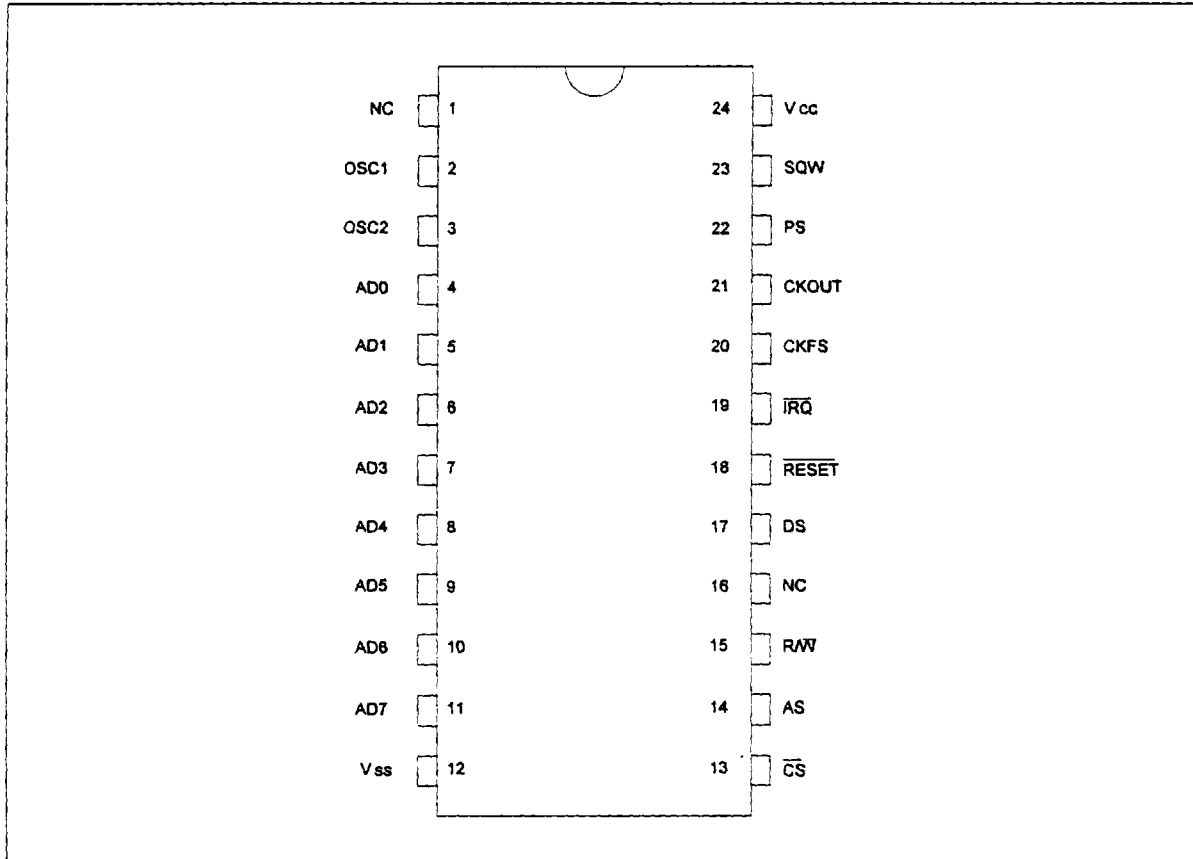
FEATURES

- 14 bytes of clock and control/status registers
- 114 bytes of general nonvolatile storage
- BCD or binary representation of time, calendar, and alarm registers
- Counts seconds, minutes, hours, days of the week, days of the month, months, years
- 12-hour to 24-hour clock with AM and PM in 12-hour mode
- Daylight savings time option
- Automatic leap-year adjustment
- Programmable square wave output signal
- Time base input option: 4.194304 MHz, 1.048576 MHz, 32.768 KHz
- Automatic end of month recognition
- 24-pin DIP package



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PIN CONFIGURATION



PIN DESCRIPTIONS

V_{CC}, V_{SS}

DC power is provided to the device on these pins. The maximum and minimum supply voltages are listed in the electrical characteristics table.

OSC1, OSC2 - Time Base, Input

Oscillator or crystal frequency at 32.768 KHz, 1.048576 MHz, 4.194304 MHz may be connected to these pins. The internal time base clock to be used is chosen in bit[6:4] of register A.

AD[7:0] - Multiplexed Address/Data Bus, Bidirectional Data Bus

AD[7:0] is an 8-bit multiplexed address/data bus and bidirectional data bus. The bus cycle consists of two phases. In the first phase, an address placed on AD[7:0] is latched on the falling edge of the AS signal to the internal address decoder. In the second phase, the AD[7:0] bus acts as a bidirectional data bus. AD[7:0] must be valid during writes. The chip will output data on AD[7:0] during a read operation.

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$\overline{\text{CS}}$ - Chip Select, Input

The chip select signal must be low when the chip is being accessed.

AS - Address Strobe, Input

The rising edge of AS latches the state of the DS. The latch automatically creates functionally identical internal read and write enable signals. The falling edge of AS causes the address to be latched within the W85C178.

$\text{R}/\overline{\text{W}}$ - Read/Write, Input

The $\text{R}/\overline{\text{W}}$ pin has two operating modes. A read function is indicated by a high level on $\text{R}/\overline{\text{W}}$ when DS is high. A write function is indicated by a low on $\text{R}/\overline{\text{W}}$ when DS is high.

$\overline{\text{RESET}}$ - RESET, Input

The $\overline{\text{RESET}}$ pin does not affect the timer, calendar counter, or RAM function. When $\overline{\text{RESET}}$ is active, the following occur:

- $\overline{\text{IRQ}}$ pin enters high impedance state.
- The interrupt flags (IRQF, PF, AF, UF) in register C are cleared.
- The interrupt enable signals (PE, AE, UE) in register B and the SQW pin are cleared.

$\overline{\text{IRQ}}$ - Interrupt Request, Output Tri-State

$\overline{\text{IRQ}}$ is a tri-state output pin which is an active low output to interface. The $\overline{\text{IRQ}}$ output remains low as long as the status bit causing the interrupt is present and the corresponding interrupt enable bit is set. To clear the $\overline{\text{IRQ}}$ pin, the processor program normally reads register C. The $\overline{\text{RESET}}$ pin also clears pending interrupts.

CKFS - Clock Out Frequency Select, Input

When the CKFS pin is tied to Vcc, CKOUT is the same frequency as the OSC1 pin. When CKFS is tied to Vss, CKOUT is the OSC1 input frequency divided by four.

CKOUT - Clock Out, Output

The CKOUT pin is an output equal to the OSC1 frequency divided by 1 or 4.

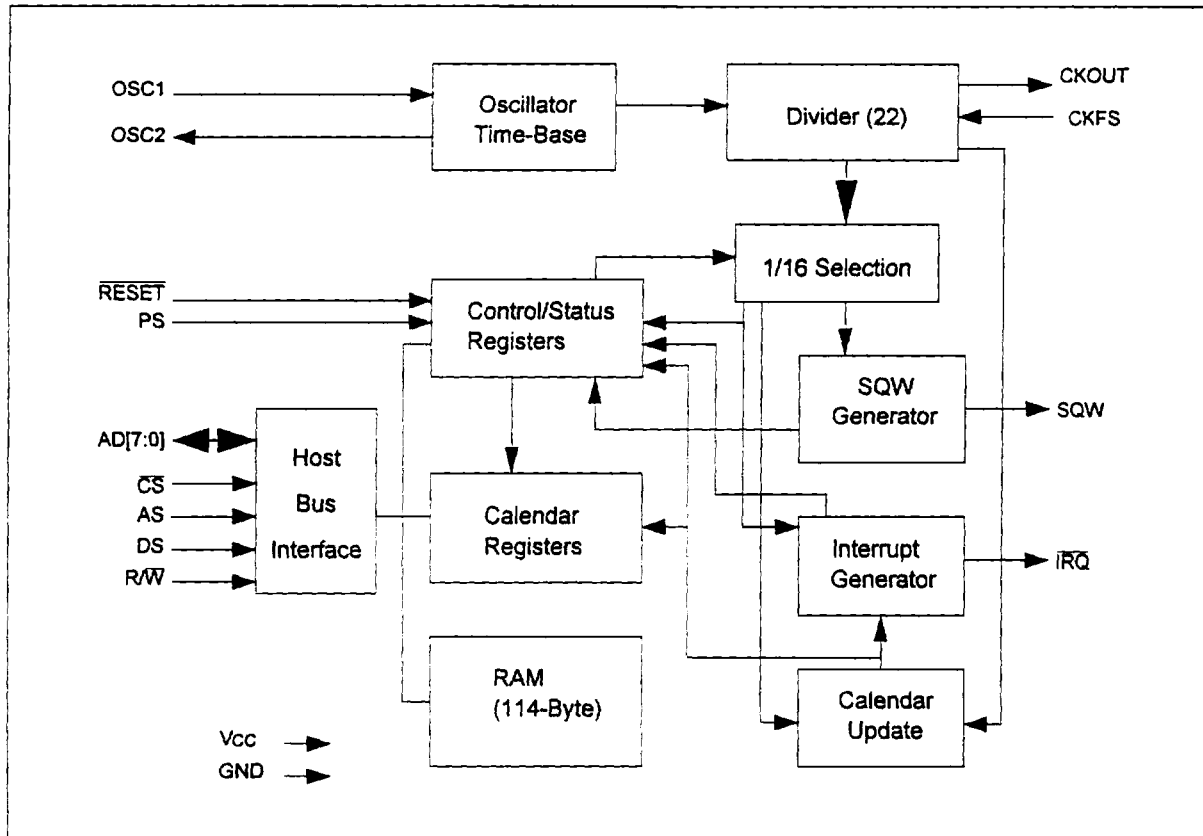
PS - Power Sense, Input

The PS pin is used in the control of the VRT bit in register D. When the PS pin is low, the VRT bit is cleared to low.

SQW - Square Wave, Output

SQW outputs a programmable frequency. Any one of the 15 specific frequencies may be selected through register A. This pin is held low when bit 3 of register B is low.

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

Address Map

The W85C178 consists of 10 bytes of RAM for the time, calendar, and alarm registers and the control and status bytes and another 114 bytes of general nonvolatile RAM. All 128 bytes can be directly read and written by the host program except for the following:

- Registers C and D are read-only.
- Bit 7 of register A is read-only.

Figure 2 depicts the address map for the W85C178.

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Address Map Table

ADDRESS	FUNCTION	BINARY OR BCD CONTENTS
0/00	SECONDS	Yes
1/01	SECONDS ALARM	Yes
2/02	MINUTES	Yes
3/03	MINUTES ALARM	Yes
4/04	HOURS	Yes
5/05	HOURS ALARM	Yes
6/06	DAY OF WEEK	Yes
7/07	DATE OF MONTH	Yes
8/08	MONTH	Yes
9/09	YEAR	Yes
10/0A	REGISTER A	
11/0B	REGISTER B	
12/0C	REGISTER C	
13/0D	REGISTER D	
14/0E	114 BYTES USER RAM	
127/7F		

Time, Calendar, and Alarm Data Modes

REGISTER LOCATION	FUNCTION	RANGE (DATA MODE)		EXAMPLE	
		BINARY	BCD	BINARY	BCD
0	Seconds	00H-3BH	00H-59H	1EH	30H
1	Seconds Alarm	00H-3BH	00H-59H	1EH	30H
2	Minutes	00H-3BH	00H-59H	0FH	15H
3	Minutes Alarm	00H-3BH	00H-59H	0FH	15H
4	Hours (12-Hour Mode) (24-Hour Mode)	01H-0CH (AM) 81H-8CH (PM) 00H-17H	01H-12H (AM) 81H-92H (PM) 00H-23H	08H 08H	08H 08H
5	Hours Alarm (12-Hour Mode) (24-Hour Mode)	01H-0CH (AM) 81H-8CH (PM) 00H-17H	01H-12H (AM) 81H-92H (PM) 00H-23H	08H 08H	08H 08H
6	Day of Week	01H-07H	01H-07H	02H	02H
7	Day of Month	01H-1FH	01H-31H	04H	04H
8	Month	01H-0CH	01H-12H	07H	07H
9	Year	00H-63H	00H-99H	5EH	94H

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Example: 8:15:30AM Monday 4 July 1994

Update Cycle

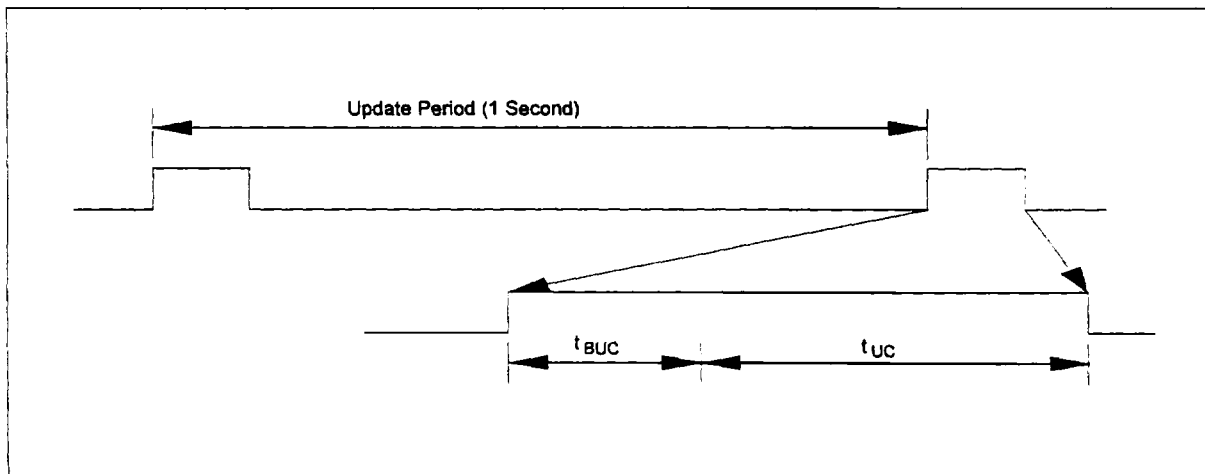
The W85C178 executes an update cycle once per second. During the update cycle, the W85C178 updates the contents of the clock and calendar registers. The update cycle also compares each alarm byte with the corresponding timer byte and generates an alarm flag if a match or a "don't care" condition (0C0Hex) is present in the alarm register.

The update-in-progress bit (UIP) in register A pulses once per second. The update cycle occurs 244 μ S after the UIP bit goes high. This bit is cleared and the update-ended flag (UF) is set at the end of the update cycle.

Update Cycle Times Table

UIP BIT	OSC1 INPUT	UPDATE CYCLE TIME (T_{UC})	BEFORE UPDATE CYCLE TIME (T_{BUCMIN})
1	4.194304 MHz	248 μ S	-
1	1.048576 MHz	248 μ S	-
1	32.768 KHz	1984 μ S	-
0	4.194304 MHz	-	244 μ S
0	1.048576 MHz	-	244 μ S
0	32.768 KHz	-	244 μ S

Update Period and UIP Timing



Registers

The W85C178 has four control/status registers, which are accessible at all times.

Register A

- All bits are unaffected by $\overline{\text{RESET}}$.

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- Register A is a read/write register except for bit 7 (UIP read-only).

Bit	7	6	5	4	3	2	1	0
Name	UIP	DV2	DV1	DV0	RS3	RS2	RS1	RS0

UIP--Read-Only Bit

When UIP equals "1," an update cycle is in progress. The UIP is cleared at the end of each update cycle and also cleared when the SET bit in register B is "1."

DV[2:0]--Divider Control

These three bits are used to select various frequencies for the internal divider. The divider chain may be held reset for precision setting. When the divider changes from reset to operating state, the first update cycle takes place 500 mS later. The divider bits are also used to facilitate testing.

Divider Configuration Table

TIME-BASE FREQUENCY	DV2	DV1	DV0	OPERATION MODE	DIVIDER RESET
4.194304 MHz	0	0	0	Yes	-
1.048576 MHz	0	0	1	Yes	-
32.768 KHz	0	1	0	Yes	-
-	1	0	-	No	*
-	1	1	-	No	Yes

* For test purposes only.

RS[3:0] Periodic Interrupt Rate, Square Wave Output Frequency Selector

Periodic Interrupt Rate, Square Wave Output Frequency Table

RS[3:0]	TIME BASE	
3 2 1 0	4.194304 MHZ OR 1.048576 MHZ	32.768 KHZ
0 0 0 0	None	
0 0 0 1	30.517 μ S/32.768 KHz	3.90625 mS/256 Hz
0 0 1 0	61.035 μ S/16.384 KHz	7.8125 mS/128 Hz
0 0 1 1	122.070 μ S/8.192 KHz	
0 1 0 0	244.141 μ S/4.096 KHz	
0 1 0 1	488.281 μ S/2.048 KHz	
0 1 1 0	976.562 μ S/1.024 KHz	
0 1 1 1	1.953125 mS/512 Hz	
1 0 0 0	3.90625 mS/256 Hz	
1 0 0 1	7.8125 mS/128 Hz	
1 0 1 0	15.625 mS/64 Hz	
1 0 1 1	31.25 mS/32 Hz	
1 1 0 0	62.5 mS/16 Hz	
1 1 0 1	125 mS/8 Hz	
1 1 1 0	250 mS/4 Hz	

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1 1 1 1	500 mS/2 Hz
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Register B (Read/Write)

BIT	7	6	5	4	3	2	1	0
Name	SET	PE	AE	UE	SE	DM	24/12	DSE

SET

When the SET bit is a "1," any update cycle in progress is aborted and registers (0-9) may be modified without an update occurring. When this bit is a "0," the update cycle function occurs once each second. This bit is not affected by any other internal functions or by $\overline{\text{RESET}}$.

PE

A "1" on the periodic interrupt enable bit causes the periodic interrupt flag (PF) bit in register C to drive the $\overline{\text{IRQ}}$ pin low. A "0" on this bit blocks the $\overline{\text{IRQ}}$ output from being driven by a periodic interrupt. This bit is not modified by any internal functions, but it is cleared to "0" by $\overline{\text{RESET}}$.

AE

A "1" on the alarm enable bit permits the alarm flag (AF) bit in register C to assert the $\overline{\text{IRQ}}$ pin low. A "0" on this bit does not initiate an $\overline{\text{IRQ}}$ signal. The $\overline{\text{RESET}}$ pin clears AE to "0." This bit is not modified by any internal functions.

UE

A "1" on the update-ended interrupt enable bit enables the update-end flag (UF) bit in register C to assert $\overline{\text{IRQ}}$. A "0" on this bit does not initiate an $\overline{\text{IRQ}}$ signal. The UE bit is cleared by the SET bit going high or the $\overline{\text{RESET}}$ pin going low.

SE

A "1" on the square-wave enable bit causes a square-wave signal at the frequency specified in RS[3:0] in register A to appear on the SQW pin. A "0" on this bit causes the SQW pin to be held low. This bit is cleared by the $\overline{\text{RESET}}$ pin.

DM

The data mode bit determines whether time and calendar updates are to use binary or binary-coded decimal (BCD) format. A "1" on this bit signifies binary data. A "0" on this bit specifies BCD data. This bit is not modified by $\overline{\text{RESET}}$ pin or by any internal functions.

24/12

A "1" on this bit selects 24-hour mode for the time-of-day function. A "0" on this bit selects 12-hour mode. This bit is not modified by the $\overline{\text{RESET}}$ pin or by any internal function.

DSE

A "1" on this bit allows two special updates:

- On the last Sunday in April the time increments from 1:59:59 AM to 3:00:00 AM.
- On the last Sunday in October when the time first reaches 1:59:59 AM it changes to 1:00:00 AM

A "0" on this bit disables these special updates. DSE is not changed by any internal operations or by $\overline{\text{RESET}}$.

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Register C (Read Only)

Bit	7	6	5	4	3	2	1	0
Name	IRQF	PF	AF	UF	0	0	0	0

IRQF

The interrupt request flag is set to a "1" if one or more of the following are true:

$PF * PE = "1"$

$AF * AE = "1"$

$UF * UE = "1"$

(i.e., $IRQF = PF * PE + AF * AE + UF * UE$)

Any time the IRQF bit is a "1," the $\overline{IRQ}$ pin is driven low. All flag bits are cleared after this register is read by the program or when the $\overline{RESET}$ pin is low.

PF

The periodic interrupt flag is set to "1" when a rising edge is detected on the selected tap of the divider chain (RS[3:0], register A). PF is set to a "1" independent of the state of the PE bit. This bit is cleared after the $\overline{RESET}$ pin goes low or this register is read by the program.

AF

A "1" on this bit indicates that the current time has reached the alarm time setting. A $\overline{RESET}$ or a read of this register clears the alarm flag.

UF

The update-ended interrupt flag bit is set after each update cycle ends. This bit is cleared by a $\overline{RESET}$ or when this register is read.

B3-B0

These bits all read "0." They cannot be written to.

Register D (Read Only)

Bit	7	6-0
Name	VRT	0

VRT

The valid RAM and time bit. A "0" appears on this bit when the PS pin is low, indicating the data integrity of the real time clock and storage registers is not guaranteed. This bit can be set only by reading this register, which is not modified by the $\overline{RESET}$ pin.

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Reading and Writing the W85C178

Read:

```

mov  al,index      ; load address value
mov  dx,RTC        ; load RTC index port
out  dx,al         ; generate AS
...
mov  dx,RTC+1      ; load RTC data port
in   al,dx         ; generate DS, get data
...

```

Write:

```

mov  al,index      ; load address value
mov  dx,RTC        ; load RTC index port
out  dx,al         ; generate AS
...
mov  al,data       ; load write data
mov  dx,RTC+1      ; load RTC data port
out  dx,al         ; generate WR, store data

```

ABSOLUTE MAXIMUM RATINGS (Voltages Referenced to VSS)

RATINGS	SYMBOL	VALUE	UNIT
Supply Voltage	V _{CC}	-0.3 to + 8.0	V
All Input Voltages (Except OSC1)	V _{IN}	V _{SS} - 0.5 to V _{DD} + 0.5	V
Operating Temperature Range	T _A	0 to 70	°C
Storage Temperature Range	T _{STG}	-40 to 70	°C

D.C. CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	MAX.	UNIT
Power Supply Current (with no load)	I _{CC}		15	mA
Output Low Voltage (I _{load} = 2 mA)	V _{OL}	-	0.4	V
Output High voltage (I _{load} = -1 mA)	V _{OH}	2.4	-	V
Input Low Voltage	V _{IL}	-0.3	0.8	V
Input High Voltage	V _{IH}	2.2	V _{CC} + 0.3	V
Input Current (DS, AS, R/W)	I _I	-1	1	mA
Input Leakage Current	I _{LI}	-1	1	uA
I/O Leakage Current (SQW,/IRQ, AD[7:0])	I _{LIO}	-1	1	uA

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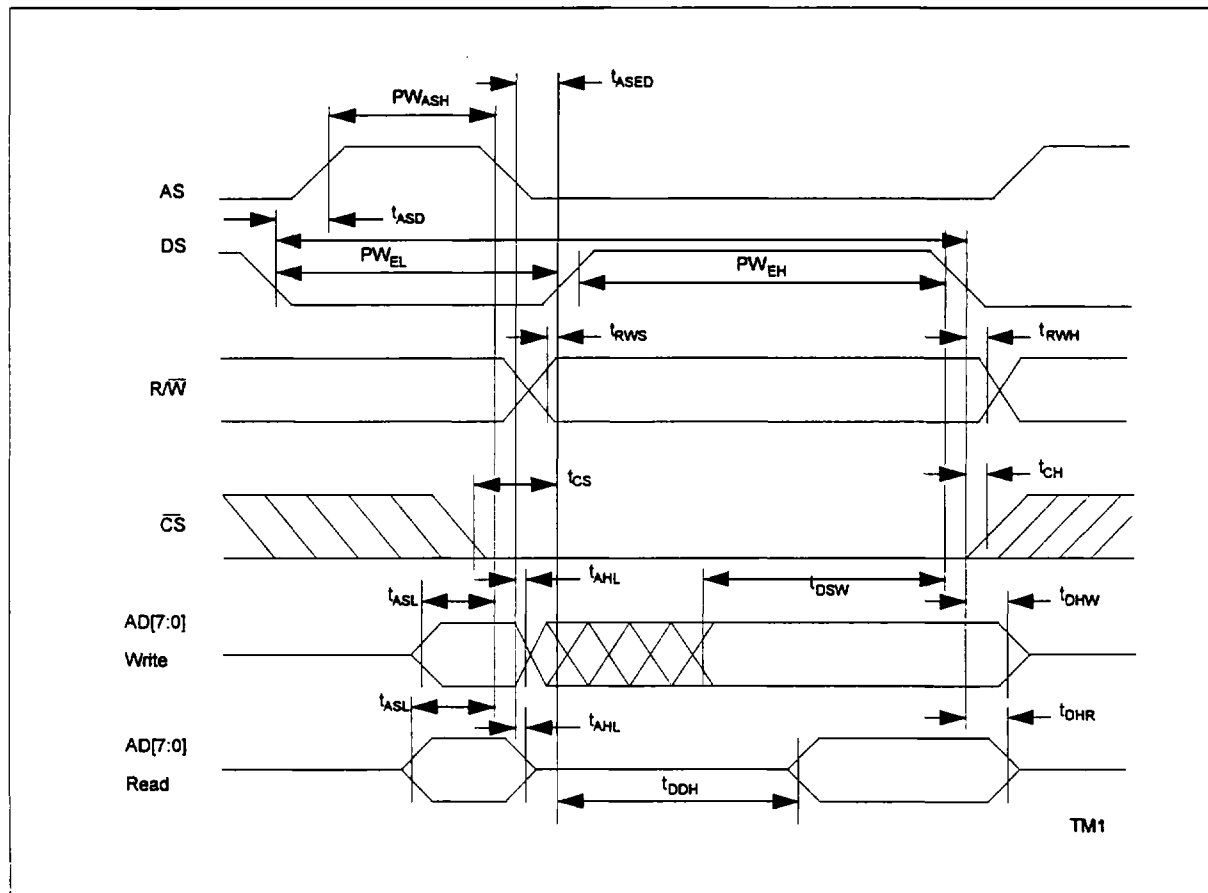
A.C. CHARACTERISTICS

CHARACTERISTICS	SYMBOLS	MIN.	MAX.	UNIT
Cycle Time	t_{CYC}	200	DC	nS
Pulse Width (DS Low or $\overline{RD}$ High)	PW_{EL}	150	-	nS
Pulse Width (DS High or $\overline{WR}$ Low)	PW_{EH}	100	-	nS
Input Rise, Fall Time	$t_{R, F}$	-	30	nS
$R/\overline{W}$ Hold Time	t_{RWH}	10	-	nS
$R/\overline{W}$ Setup Time Before DS	t_{RWS}	10	-	nS
$\overline{CS}$ Active Setup Time Before AS Fall	t_{CS}	0	30	nS
$\overline{CS}$ Active Hold Time	t_{CH}	0	-	nS
Read Data Hold Time	t_{DHR}	10	1000	nS
Write Data Hold Time	t_{DHW}	0	-	nS
Muxed Address Valid Time to AS Fall	t_{ASL}	25	-	nS
Muxed Address Hold Time	t_{AHL}	10	-	nS
Dealy Time DS to AS Rise	t_{ASD}	50	-	nS
Pulse Width, AS High	PW_{ASH}	50	-	nS
Delay Time, AS to DS Rise	t_{ASED}	50	-	nS
Output Data Delay Time from Read	t_{DDR}	15	30	nS
Data Setup Time	t_{DSW}	50	-	nS

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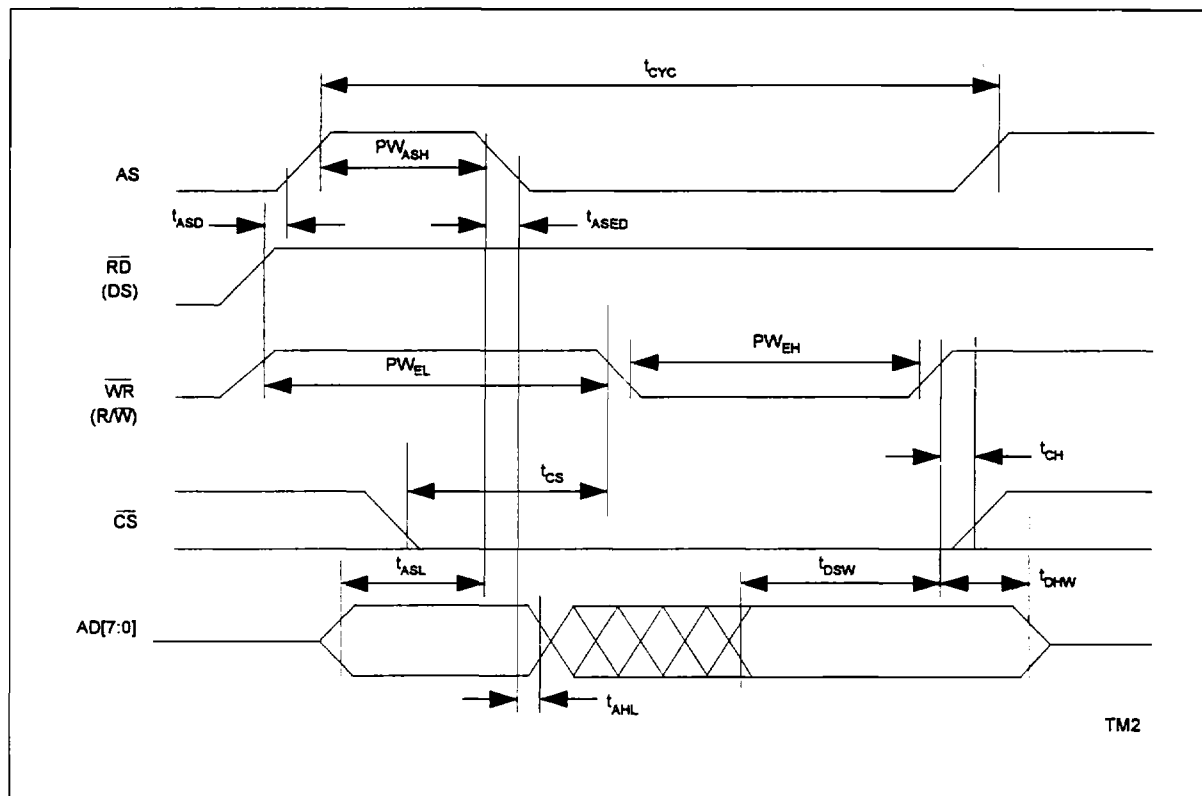
TIMING WAVEFORMS

BUS TIMING FOR MOTOROLA INTERFACE



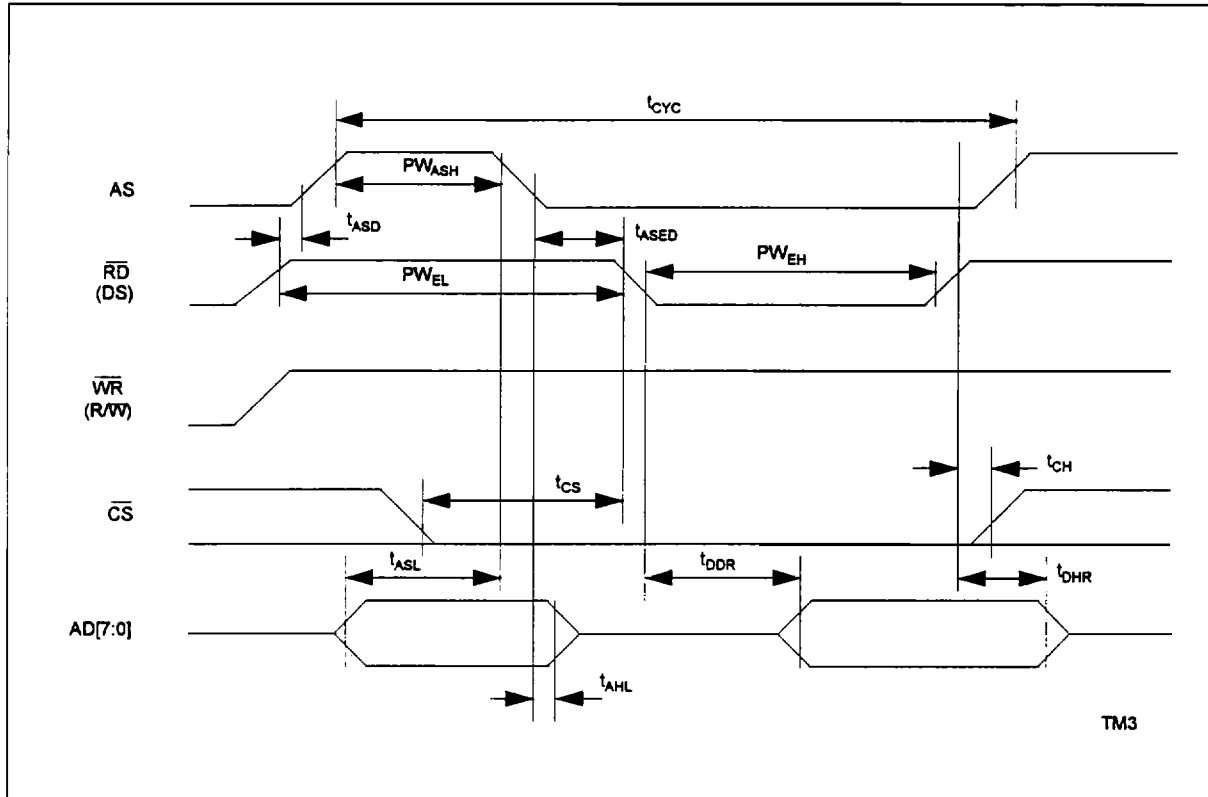
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WRITE BUS TIMING FOR INTEL INTERFACE

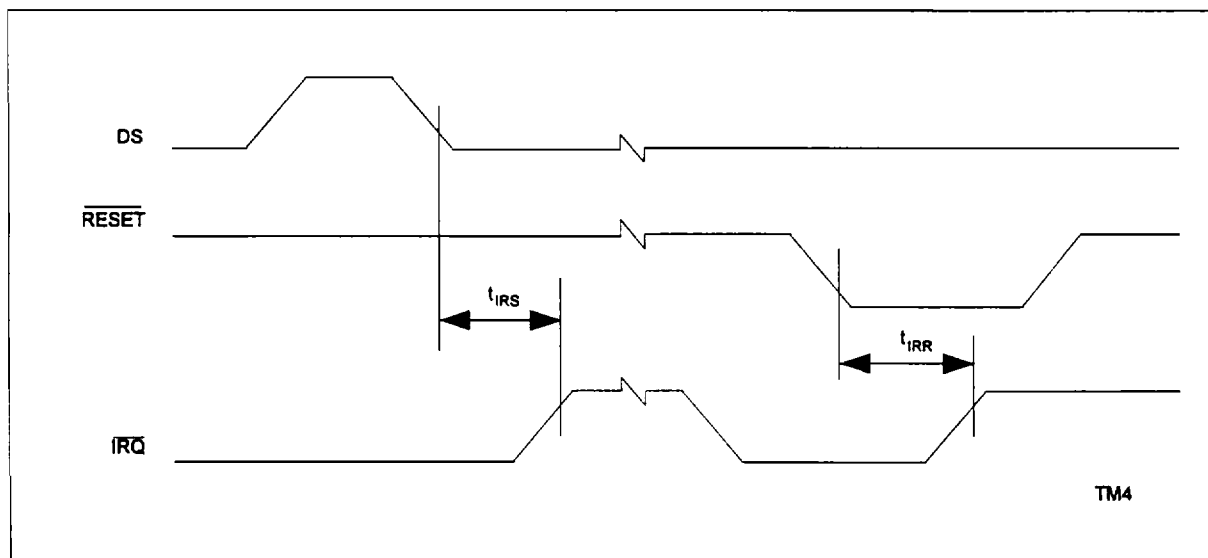


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READ BUS TIMING FOR INTEL INTERFACE

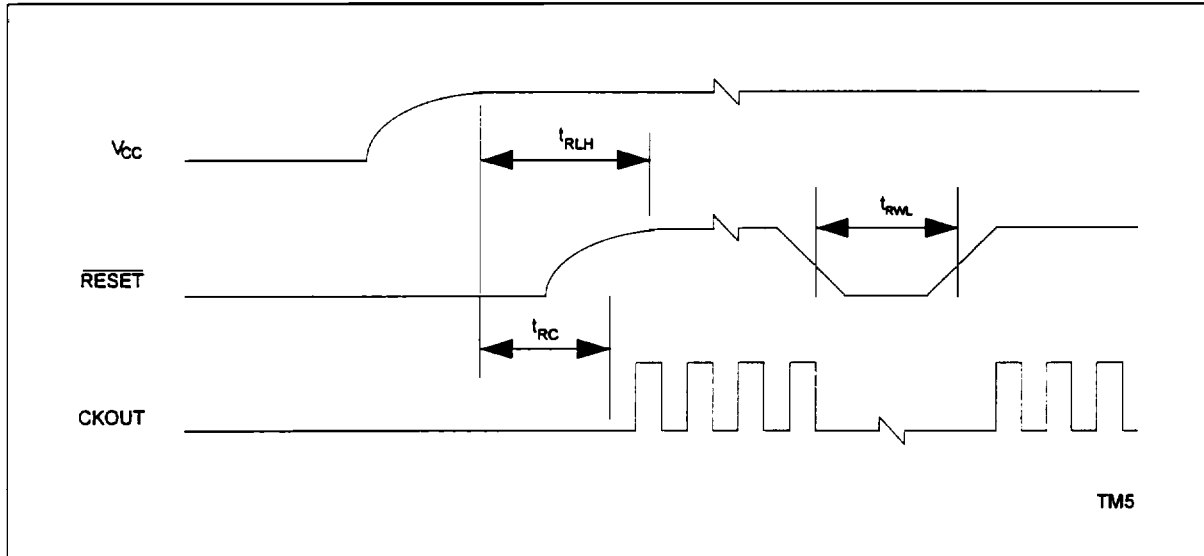


$\overline{IRQ}$ RELEASE DELAY

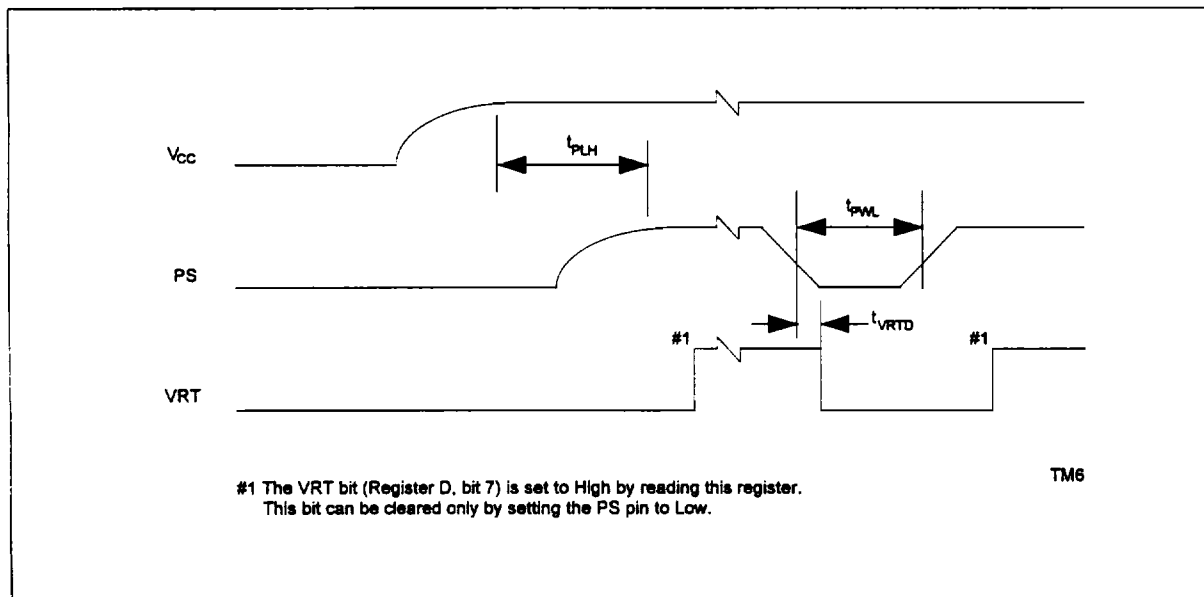


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POWER UP



VRT BIT CONDITION



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OUTPUT LOAD

