

Z86319

PS/2 MOUSE CONTROLLER

FEATURES

Device	ROM (KB)	RAM* (Bytes)	I/O Lines	Voltage Range
Z86319	2	125	13	4.5V to 5.5V

Note: *General-Purpose (144K Total RAM)

- 0°C to + 40°C Operating Temperature Range
- Low-Power Consumption: 25 mW (Typical)

- P24-P27 Can Be Configured with a Voltage Divider During Input Mode
- On-Chip Oscillator (Tolerance = $\pm 10\%$)
- Fast Instruction Pointer: 1.5 μ s @ 4 MHz
- ESD Protection Circuitry
- Hardwired Watch-Dog Timer (WDT)
- Excellent System Level EMI/EFT/ESD

GENERAL DESCRIPTION

The Z86319 is a member of the Z8 family of CMOS micro-controllers architecture to be used in mouse applications. These devices offer on-board pull-up and pull-down resistors, a trip-point buffer to accommodate opto-transistor outputs, and high drive ports capable of up to 10 mA current sinking per pin (3 pins maximum).

A permanently enabled Watch-Dog Timer ensures operational reliability across a broad range of mouse application environments. The precision RC oscillator filters out high-frequency noise from the oscillator input pin. When configured as inputs, P24-P27 have built in voltage dividers (25K pull-up / 7.5K pull-down). The input levels are designed for connection to the emitters of the opto-transistors and switch at a voltage level of 0.4 V_{DD} .

For applications requiring powerful I/O capabilities, the Z86319 provides dedicated input and output lines that are grouped into three ports. There are two basic address spaces available to support this configuration: Program Memory, and 125 bytes of general-purpose registers.

The Z86319 device provides two on-chip 8-bit programmable counter/timers with a large number of user-selectable modes. Each counter/timer is driven by its own 6-bit programmable prescaler. The Z86319 counter/timers off-load system real-time tasks such as counting/timing and input/output data communications for increased system efficiency.

GENERAL DESCRIPTION (Continued)

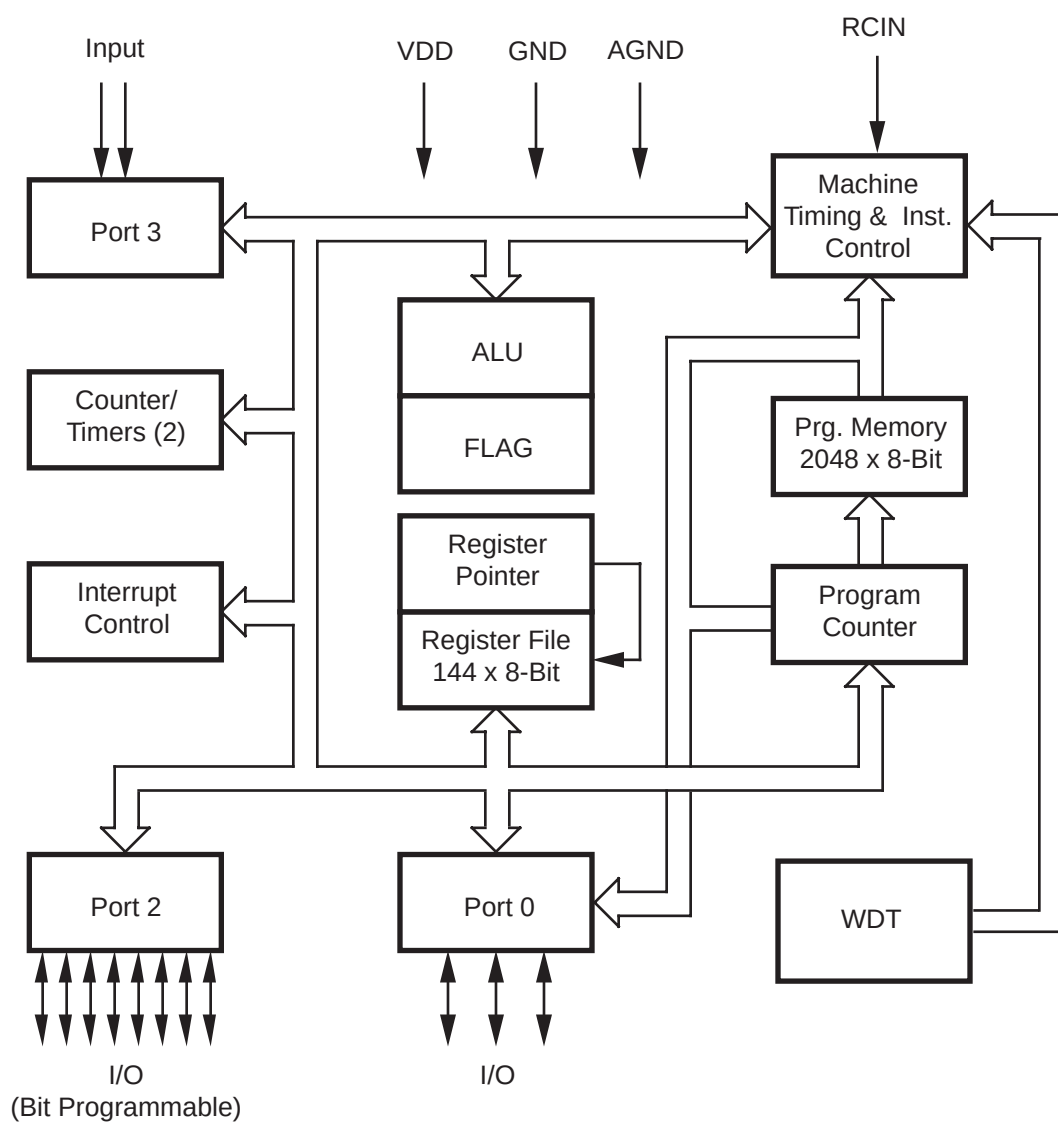


Figure 1. Z86319 Functional Block Diagram

PIN DESCRIPTIONS

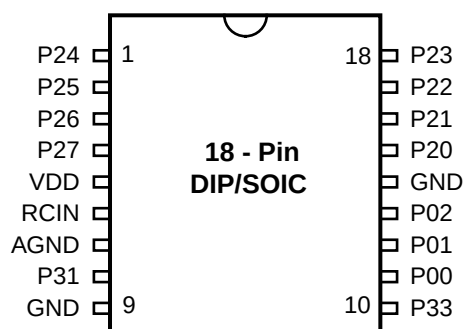


Figure 2. 18-Pin DIP/SOIC Pin Configuration

Table 1. 18-Pin DIP/SOIC Pin Identification

Pin #	Symbol	Function	Direction
1-4	P24-P27	Port 2, Pins 4,5,6,7	In/Output
5	V _{DD}	Power Supply	Power
6	RCIN	RC Oscillator	Input
7	AGND	Analog Ground	Ground
8	P31	Port 3, Pin 1	Input
9	GND	Ground	Input
10	P33	Port 3, Pin 3,	Input
11-13	P00-P02	Port 0, Pins 0,1,2	In/Output
14	GND	Ground	Ground
15-18	P20-P23	Port 2, Pins 0,1,2,3	In/Output

PIN FUNCTIONS

RCIN. A precision 1% resistor is connected to RCIN, generating oscillation with an internal capacitor.

Resistor values and corresponding typical frequencies are shown in Table 2 and graph chart (Figure 3).

Table 2. Resistor Values and Corresponding Typical Frequencies

External Resistor	Average Frequency
14.0K	5.01 MHz
15.0K	4.70 MHz
16.0K	4.43 MHz
17.0K	4.19 MHz
18.0K	3.97 MHz
19.0K	3.78 MHz
20.0K	3.60 MHz
21.0K	3.44 MHz
22.0K	3.30 MHz
23.0K	3.16 MHz

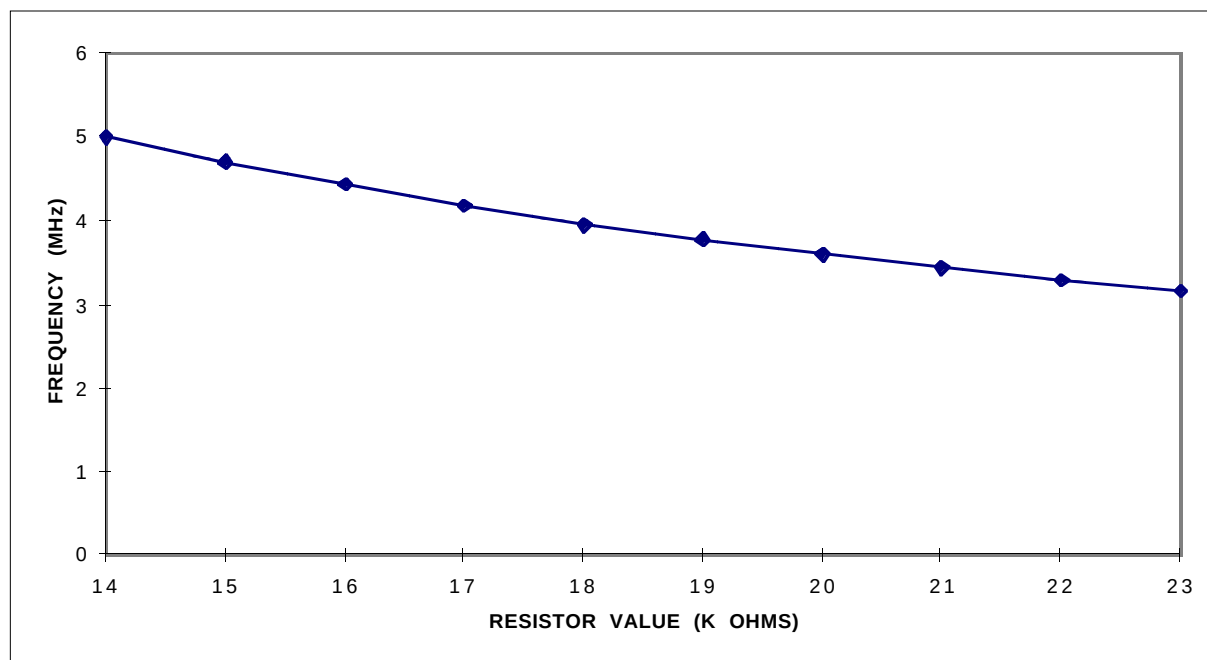


Figure 3. Z86319 RC Frequency in Function of the External Resistance (typical numbers)

STANDARD TEST CONDITIONS

The characteristics listed below apply for standard test conditions as noted. All voltages are referenced to Ground. Positive current flows into the referenced pin (Figure 4).

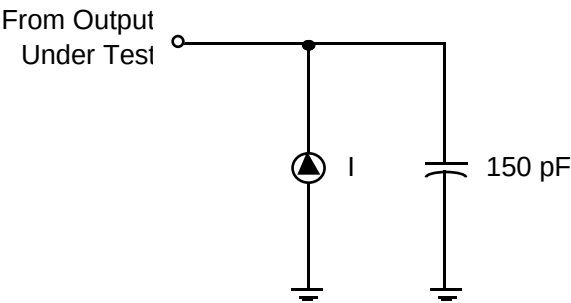


Figure 4. Test Load Diagram

ABSOLUTE MAXIMUM RATINGS

Sym	Parameter	Min	Max	Units
V _{DD}	Supply Voltage*	−0.3	+7	V
T _{STG}	Storage Temp	−65°	+150°	C
T _A	Oper Ambient Temp	0°	40°	C

Notes:
*Voltages on all pins with respect to Ground.

Stresses greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This rating is a stress rating only; operation of the device at any condition above those indicated in the operational sections of these specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

CAPACITANCE

T_A = GND = 0V, f = 1.0 MHz, unmeasured pins returned to Ground.

Parameter	Min	Max
Input Capacitance	0	10 pF
Output Capacitance	0	20 pF
I/O Capacitance	0	25 pF

V_{CC} SPECIFICATION

V_{CC} = 4.5V to 5.5V

Using the precision RC oscillator feature, f = 4.0 MHz ±10% under the following conditions:

- V_{CC} = 5.0V ±10%
- Temp 0 to 40°C
- Application board capacitance:
 - 2.0 pF max.
 - 0.5 pF min.

DC ELECTRICAL CHARACTERISTICS

$$4.5V \geq V_{DD} \leq 5.5V$$

$T_A = 0^{\circ}\text{C to } +40^{\circ}\text{C}$					
Sym	Parameter	Min	Max	Units	Conditions
V_{IH}	Rising Input Schmitt-Triggered	2.3	3.2	V	Note 1
V_{IL}	Falling Input Schmitt-Triggered	1.3	2.2	V	Note 1
V_{IL}	Input Low Voltage CMOS Input			V	
V_{OH}	Output High Voltage	$V_{DD} - 0.4$		V	$I_{OH} = -2.0 \text{ mA};$ $V_{DD}=4.5V$
V_{OL1}	Output Low Voltage		0.4	V	$I_{OL} = +4.0 \text{ mA};$ $V_{DD}=5.5V$
V_{OL2}	Output Low Voltage		0.8	V	$I_{OL} = 10.0 \text{ mA},$ 3 Pin Max; $V_{DD}=5.5V$
V_{LV}	V_{CC} Low Voltage Protection	2.25	2.95	V	@ 4 MHz Max, Note 2
V_{TP}	Trip Point Voltage (P24-P27)	1.9	2.5	V	P24-P27; $V_{DD}=5.5V$
		1.5	2.1	V	$V_{DD}=4.5V$
I_{IL}	Input Leakage	-1.0	1.0	μA	$V_{IN} = 0V$, or V_{CC} Note 4
I_{OL}	Output Leakage	-1.0	1.0	μA	$V_{IN} = 0V$, or V_{CC} Note 4
I_{DD}	Supply Current		4.5	mA	@ 4 MHz, Note 3; $V_{DD}=5.5V$
I_{DD1}	Standby Current		2.2	mA	@ 4 MHz, Note 3; $V_{DD}=5.5V$
I_{PU}	Pull-Up Current (100K)	-20		μA	$V_{IH} @ 1V$
	P00-02, P31, P33		-95	μA	$V_{IH} @ 1V$
I_{PD}	Pull-Down Current (100K)	+20		μA	$V_{IL} @ 3V$
	P00-02, P31, P33		+85	μA	$V_{IL} @ 4V$
I_{PU}	Pull-Up Current (10K)	-370		μA	$V_{IL} = 0V$
	P20, P22		-670	μA	$V_{IL} = 0V$

Notes:

1. The min. and max. values of the Schmitt-Trigger input voltages track each other over temperature, V_{DD} , and process variations.
2. The device is functional from V_{DD} down to V_{LV} voltage. The minimum operational V_{DD} is determined by the value of the V_{LV} voltage at ambient temperature. The V_{LV} voltage increases as the temperature decreases.
3. All input pins are tied to GND and all output pins are floating.

AC ELECTRICAL CHARACTERISTICS

Timing Diagrams

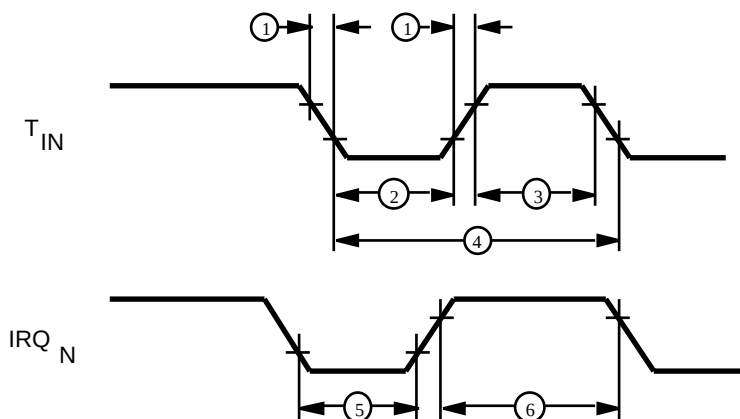


Figure 5. Electrical Timing Diagram

$T_A = 0^{\circ}\text{C to } +40^{\circ}\text{C}$							
No	Symbol	Parameter	V_{DD}	Min	Max	Units	Notes
1	T_{rTin}, T_{tTin}	Timer Input Rise and Fall Time	5.5V		100	ns	1
2	T_{wTinL}	Timer Input Low Width	5.5V	70		ns	1
3	T_{wTinH}	Timer Input High Width	5.5V	$2.5T_{pC}$			1
4	T_{pTin}	Timer Input Period	5.5V	$4T_{pC}$			1
5	T_{wIL}	Int. Request Input Low Time	5.5V	70		ns	1,2
6	T_{wIH}	Int. Request Input High Time	5.5V	$2.5T_{pC}$			1,2
	T_{wdt}	Watch-Dog Timer Time Out	5.5V	10		ms	
	TPOR	Power-On Reset Time	5.5V	2	10	ms	
	T_{pC}	RC Oscillator Clock Period	5.5V	220	5000	ns	

Notes:

1. Timing Reference uses $0.9 V_{DD}$ for a logic 1 and $0.1 V_{DD}$ for a logic 0.
2. Interrupt request through Port 3 (P33-P31)

PIN FUNCTIONS

Port 0 (P02-P00). Port 0 is a 3-bit, I/O programmable, bi-directional, CMOS-compatible I/O port. These three I/O lines can be configured under software control to be input or output (Figure 6). When Port 0 is configured as an input port, all lines have the capability to either sink or source (ROM mask selectable) current emulating a 100K pull-

down or pull-up resistor. Port 00-02 can be accessed through the P0 register (register address 00). The upper 5 bits of this 8-bit register always reads "11111." Writing to the upper 5 bits has no effect (see Figure 34). The lower 3 bits of the P0 register are read/write. Current versus pin voltage graphs are shown in Figures 7 and 8.

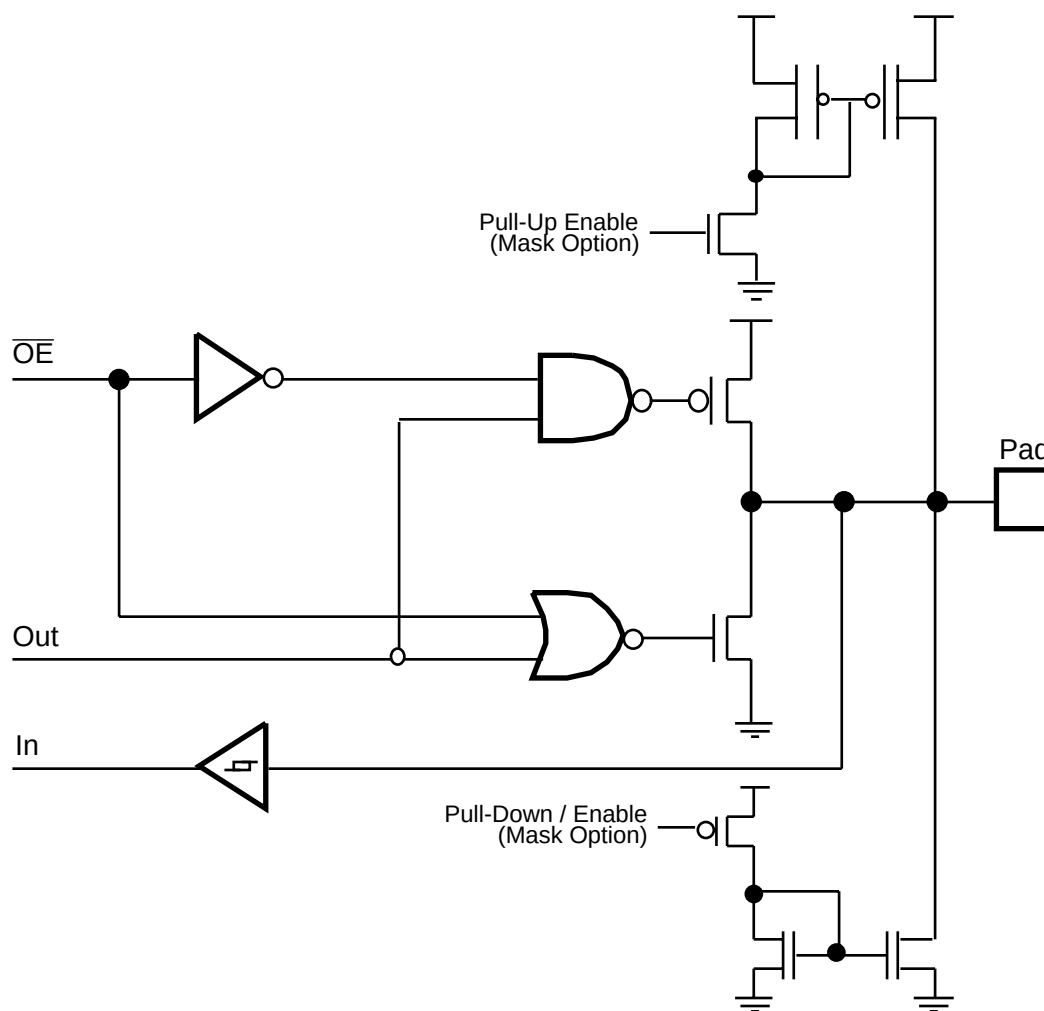


Figure 6. Port 0 Configuration

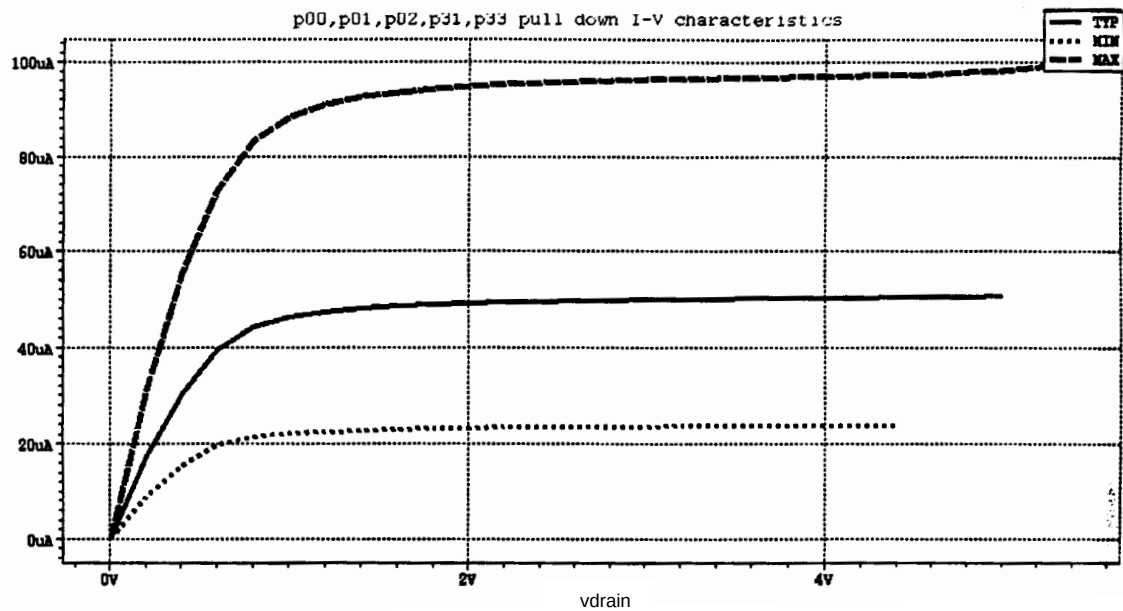


Figure 7. Current vs Pin Voltage Values

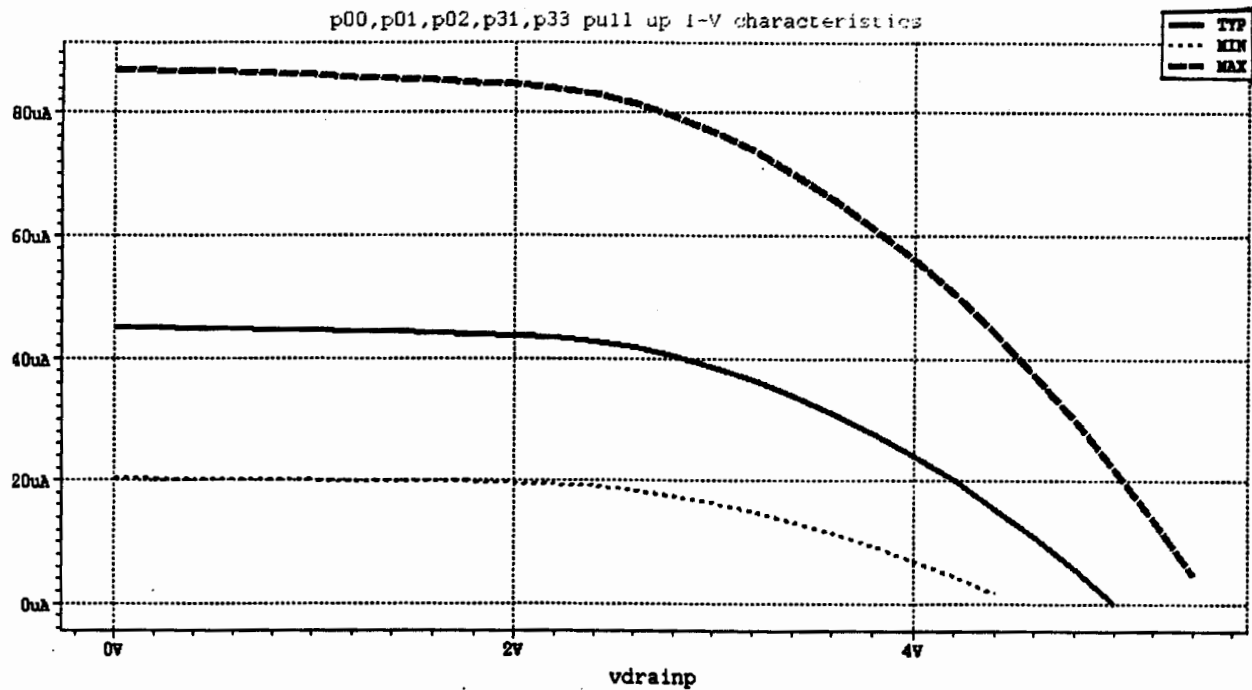


Figure 8. Current vs Pin Voltage Values

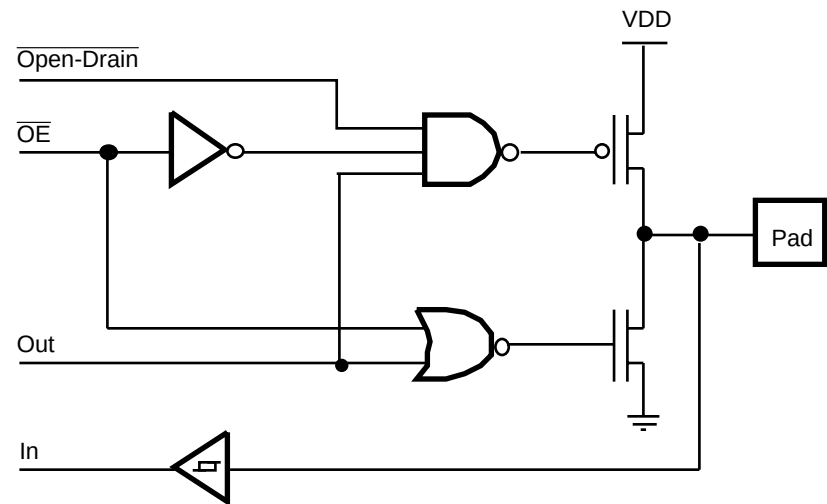


Figure 10. Port 2 P21, P23 Configuration

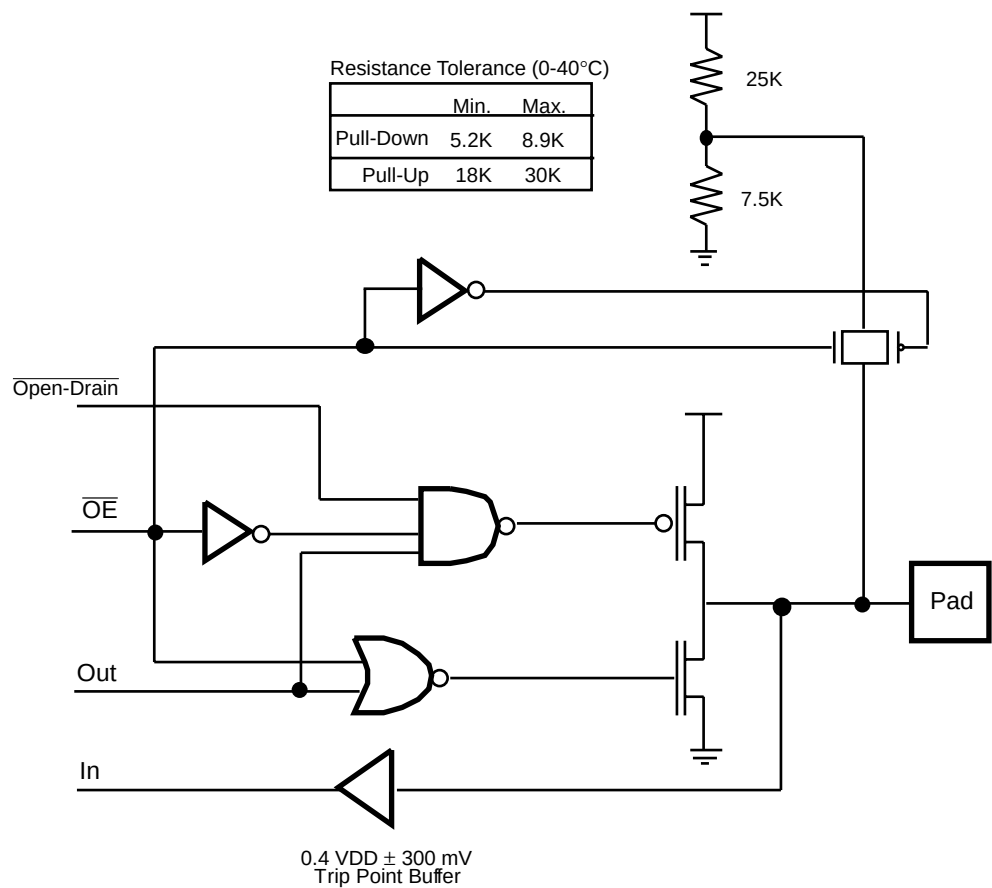


Figure 11. Port 2 P27-P24 Configuration

PIN FUNCTIONS (Continued)

Port 3 (P33, P31). Port 3 is a 2-bit, CMOS-compatible port with two fixed input lines (P33, P31). These two lines can also be used as the interrupt sources IRQ2 and IRQ1. P31 can also be configured as a timer input. Both lines can be configured through ROM mask selection to sink or source current emulating a 100K pull-up or pull-down resistor (Figure 12). Port 33-31 can be accessed through the P3 register. The upper 4 bits of this 8-bit register always reads "1111." Bit D2 reads 0 and Bit D0 reads 1. Bits D3 and D1 represent P33 and P31 respectively (see Figure 36).

Figure 12 shows the internal circuitry for Port 3. It consists of two input lines, P31 and P33, each connected to a pad. Each line has a pull-up enable (mask option) and a pull-down/enable (mask option) circuit. The output of each line is connected to a data latch, which also provides the interrupt signals IRQ2, TIN for P31 and IRQ1 for P33.

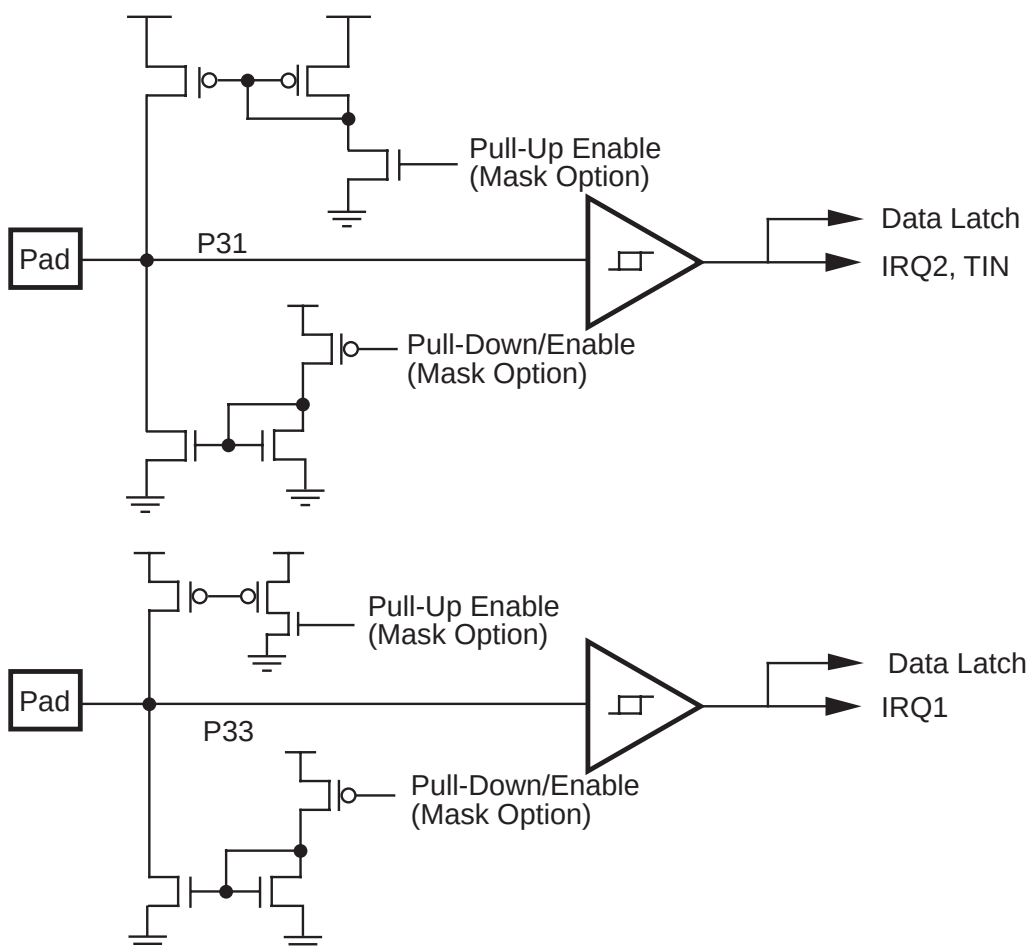


Figure 12. Port 3 P33, P31 Configuration

FUNCTIONAL DESCRIPTION

The Z86319 MCU incorporates the following special features to enhance the Z8 architectural core for use in mice, trackballs, and other consumer applications.

Reset. Upon power-up, the Power-On Reset circuit waits for TPOR, plus 18 clock cycles, then starts program execution at address 000CH (Figure 13). The Z86319 control registers' reset values are shown in Table 4.

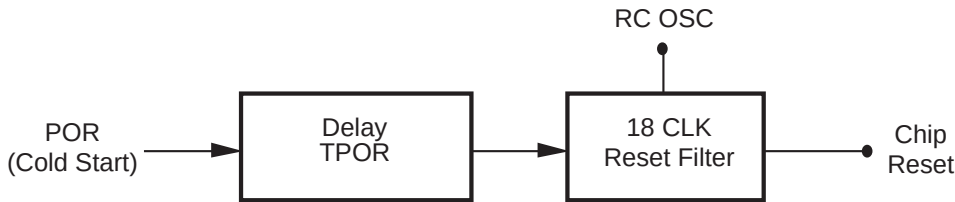


Figure 13. Internal Reset Configuration

Table 4. Z86319 Control Registers

Reset Values										Comments
Addr.	Reg.	D7	D6	D5	D4	D3	D2	D1	D0	
F1	TMR	0	0	0	0	0	0	0	0	
F2	T1	U	U	U	U	U	U	U	U	
F3	PRE1	U	U	U	U	U	U	0	0	
F4	T0	U	U	U	U	U	U	U	U	
F5	PRE0	U	U	U	U	U	U	U	0	
F6	P2M	1	1	1	1	1	1	1	1	Inputs after reset
F7	P3M	U	U	U	U	U	U	1	0	
F8	P01M	U	U	U	0	U	U	0	1	
F9	IPR	U	U	U	U	U	U	U	U	
FA	IRQ	U	U	0	0	0	0	0	0	
FB	IMR	0	U	U	U	U	U	U	U	
FC	FLAGS	U	U	U	U	U	U	U	U	
FD	RP	U	U	U	U	U	U	U	U	
FF	SPL	U	U	U	U	U	U	U	U	

FUNCTIONAL DESCRIPTION (Continued)

Program Memory. The Z86319 can address up to 2 KB of internal program memory (Figure 14). The first 12 bytes of program memory are reserved for the interrupt vectors. These locations contain four 16-bit vectors that correspond to the four available interrupts. Bytes 0-2047 are on-chip mask-programmed ROM.

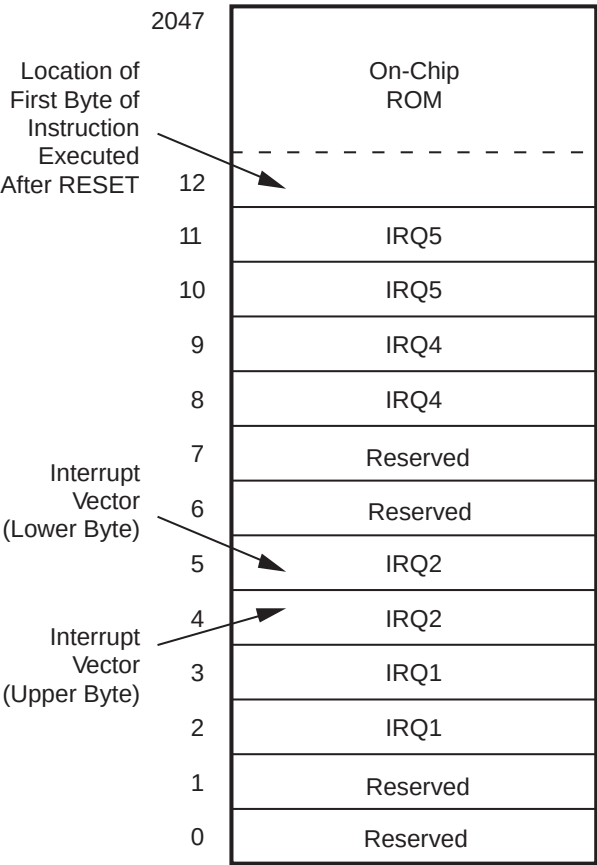


Figure 14. Program Memory Map

Register File. The Register File consists of three I/O port registers, 125 general-purpose registers, and 14 control and status registers, R0-R3, R4-R127 and R241-R255, respectively (Figure 15). The Z86319 instructions can access registers directly or indirectly via an 8-bit address field. This field allows short, 4-bit register addressing using the Register Pointer. In the 4-bit mode, the register file is divided into eight working register groups, each occupying 16 continuous locations. The Register Pointer addresses the starting location of the active working-register group.

LOCATION		IDENTIFIERS
R255	Stack Pointer (Bits 7-0)	SPL
R254	General-Purpose	GPR
R253	Register Pointer	RP
R252	Program Control Flags	FLAGS
R251	Interrupt Mask Register	IMR
R250	Interrupt Request Register	IRQ
R249	Interrupt Priority Register	IPR
R248	Ports 0-1 Mode	P01M
R247	Port 3 Mode	P3M
R246	Port 2 Mode	P2M
R245	T0 Prescaler	PRE0
R244	Timer/Counter0	T0
R243	T1 Prescaler	PRE1
R242	Timer/Counter1	T1
R241	Timer Mode	TMR
R240	Not Implemented	
R128		
R127	General-Purpose Registers	
R4		
R3		
R2		
R1		
R0	Port 0	P0
	Reserved	
	Port 2	P2
	Port 3	P3

Figure 15. Register File

Stack Pointer. The Z86319 features an 8-bit Stack Pointer (R255) used for the internal stack that resides within the general-purpose registers.

Counter/Timer. There are two 8-bit programmable counter/timers (T0 and T1), each driven by its own 6-bit programmable prescaler. The T1 prescaler can be driven by internal or external clock sources, however, the T0 can be driven by the internal clock source only (Figure 16).

The 6-bit prescalers can divide the input frequency of the clock source by any integer number from 1 to 64. Each prescaler drives its counter, which decrements the value (1 to 256) that has been loaded into the counter. When both counter and prescaler reach the end of count, a timer interrupt request IRQ4 (T0) or IRQ5 (T1) is generated.

The counter can be programmed to start, stop, continue, or restart from the initial value. The counters can also be programmed to stop upon reaching zero (single pass mode) or to automatically reload the initial value and continue counting (modulo-n continuous mode).

The counters, but not the prescalers, are read at any time without disturbing their value or count mode. The clock source for T1 is user-definable and can be either the internal microprocessor clock divided by four, or an external signal input via Port 3. The Timer Mode register configures the external timer input (P31) as an external clock, a trigger input that is retriggerable or not retriggerable, or as a gate input for the internal clock.

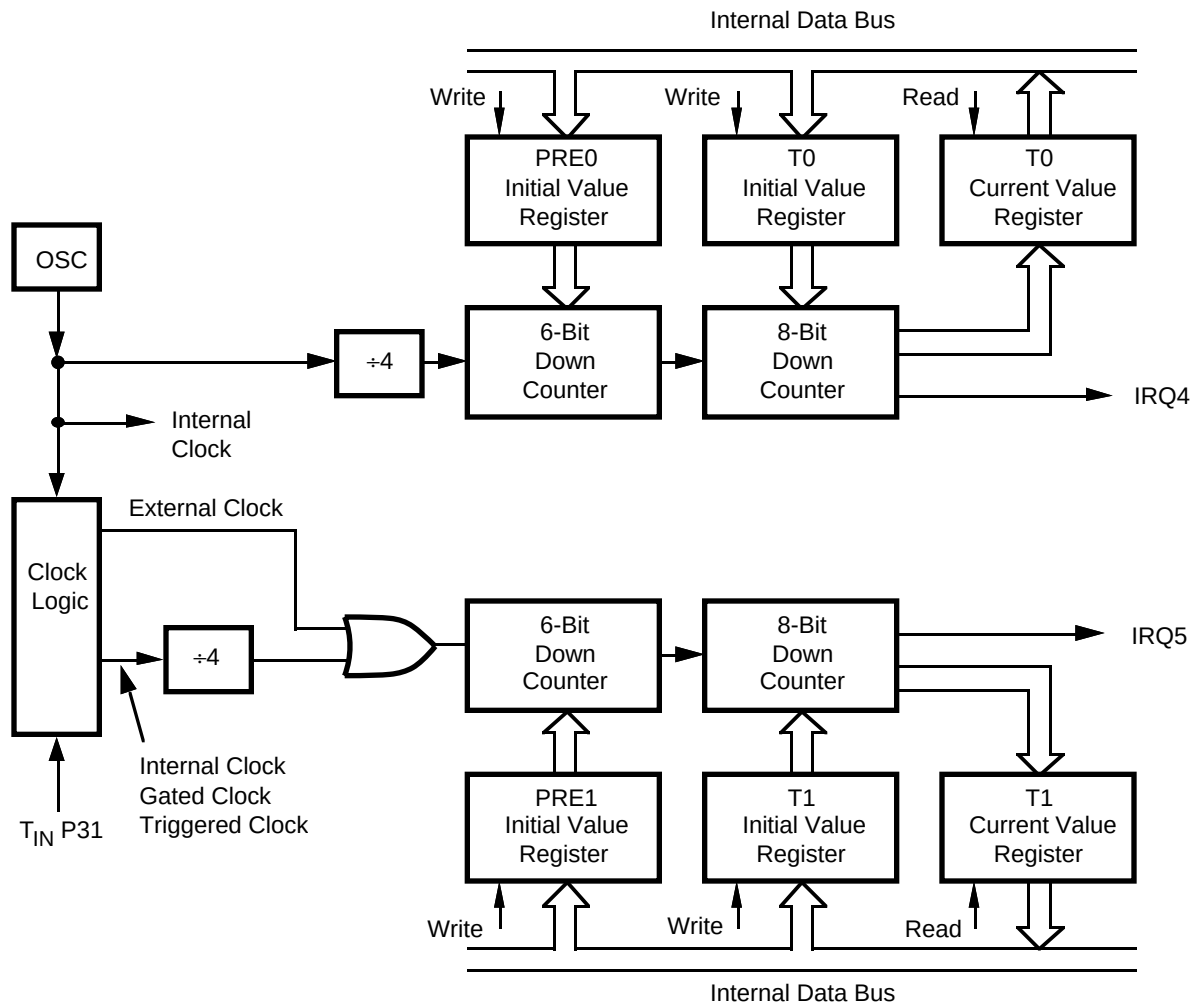


Figure 16. Counter/Timers Block Diagram

FUNCTIONAL DESCRIPTION (Continued)

Interrupts. The Z86319 features four interrupts from four different sources. These interrupts are maskable and prioritized (Figure 17). The four sources are divided as follows: the falling edge of P31, P33, and the two counter/timers. The Interrupt Mask Register globally or individually enables or disables the four interrupt requests (Table 5).

When more than one interrupt is pending, priorities are resolved by a programmable priority encoder that is controlled by the Interrupt Priority register. All Z86319 interrupts are vectored through locations in program memory. When an interrupt machine cycle is activated, an interrupt request is granted, thereby disabling all subsequent interrupts, saving the Program Counter and Status Flags, and branching to the program memory vector location reserved

for that interrupt. This memory location and the next byte contain the 16-bit starting address of the Interrupt Service Routine for that particular interrupt request.

To accommodate polled interrupt systems, interrupt inputs are masked and the Interrupt Request Register is polled to determine which of the interrupt requests requires service.

Table 5. Interrupt Types, Sources, and Vectors

Source	Name	Vector	Location	Comments
P33	IRQ1	2,3	External	Falling Edge
P31	IRQ2	4,5	External	Falling Edge
T0	IRQ4	8,9	Internal	
T1	IRQ5	10,11	Internal	

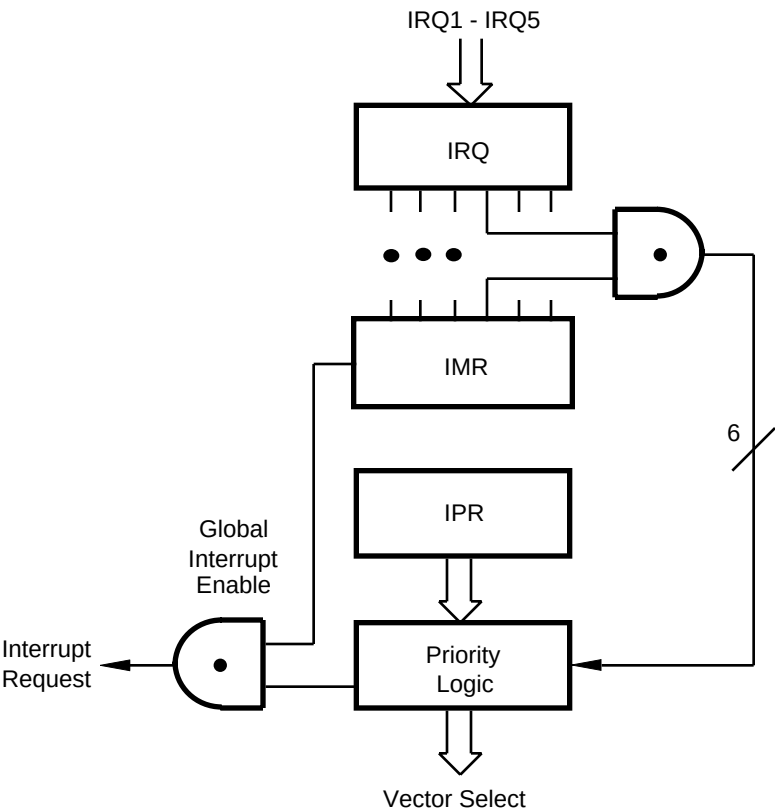


Figure 17. Interrupt Block Diagram

RC Oscillator. The Z86319 features an on-chip RC precision oscillator that requires a 1% precision resistor externally connected between V_{DD} and pin 6 (Figure 18). The tolerance of the RC oscillator is less than $\pm 10\%$ over the voltage range of 4.5V to 5.5V and over a temperature range of 0-40°C. Pin 7 is the Analog Ground for the oscillator.

Increased parasitic board capacitance will slow down the RC oscillator and deteriorate the RC frequency tolerance. The minimum and maximum parasitic board capacitances are 0.5 pF and 2 pF, respectively.

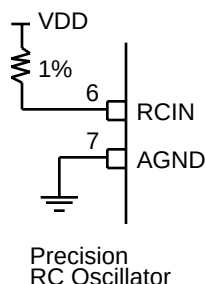


Figure 18. Oscillator Configuration

HALT Mode. This instruction turns off the internal CPU clock but not the precision RC oscillator. The counter/timers, their interrupts, and external interrupts IRQ1 and IRQ2 remain active. The device can be recovered by interrupts, either externally or internally generated. An interrupt must be enabled prior to the HALT Mode, and executed to exit the HALT Mode. After the interrupt service routine, the program continues from the instruction after the HALT.

In order to enter HALT Mode, it is necessary to first flush the instruction pipeline to avoid suspending execution in mid-instruction. To flush the pipeline, the user must execute a NOP (Opcode=FFH) immediately before the HALT instruction. i.e.:

FF	NOP	; clear the pipeline
7F	HALT	; enter the HALT Mode

In HALT Mode, the value of each output line prior to the HALT instruction is retained.

Watch-Dog Timer (WDT). The Watch-Dog Timer is enabled upon power-up of the MCU and is clocked by its own internal RC oscillator. The WDT instruction does not affect the Zero (Z), Sign (S), and Overflow (V) flags.

Opcode WDT (5FH). Execution of WDT clears the WDT counter. The time interval between any 2 consecutive WDT instructions has to be smaller than T_{WDT} min.

Low Voltage Protection (V_{LV}). The device will function normally between 5.5V and 4.5V under all specified conditions. Below 4.5V, the device is still internally functional until the Low Voltage trip point (V_{LV}) is reached, however, it is not guaranteed to meet all AC and DC Characteristics. When the supply voltage drops below V_{LV} , an automatic hardware reset occurs as V_{DD} returns above V_{LV} . Essentially, this action helps in reinitializing the Z86319.

The actual V_{LV} is a function of temperature, operating frequency and process parameters. The typical V_{LV} is a function of the ambient temperature for a frequency of 4 MHz. The device is functional down to V_{LV} voltage. The min. operational V_{DD} is determined by the value of the V_{LV} voltage at ambient temperatures. The V_{LV} voltage increases as the temperature decreases (Figure 19).

FUNCTIONAL DESCRIPTION (Continued)

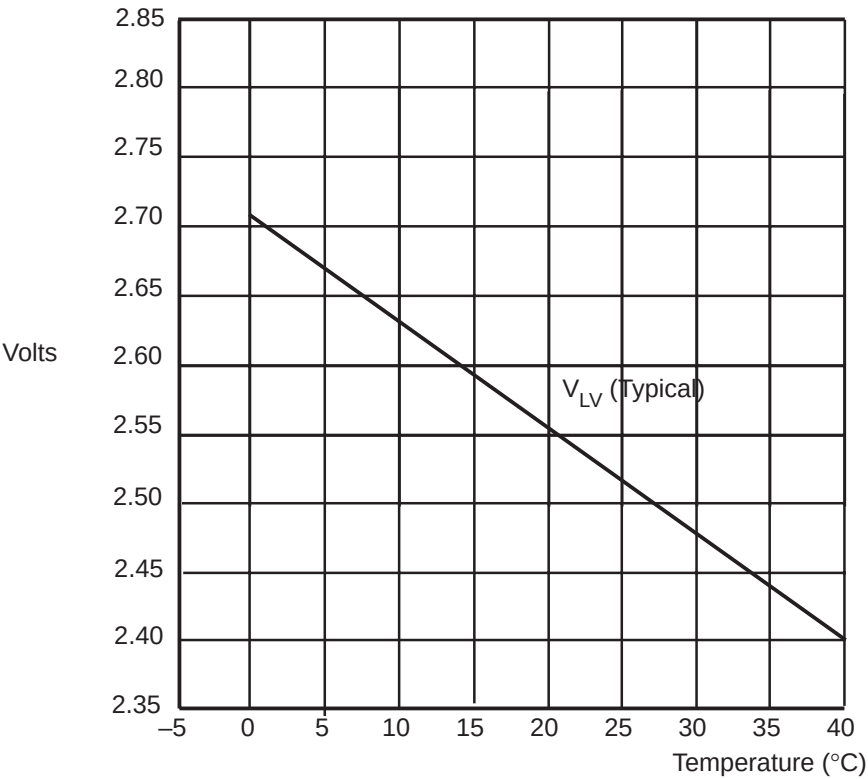
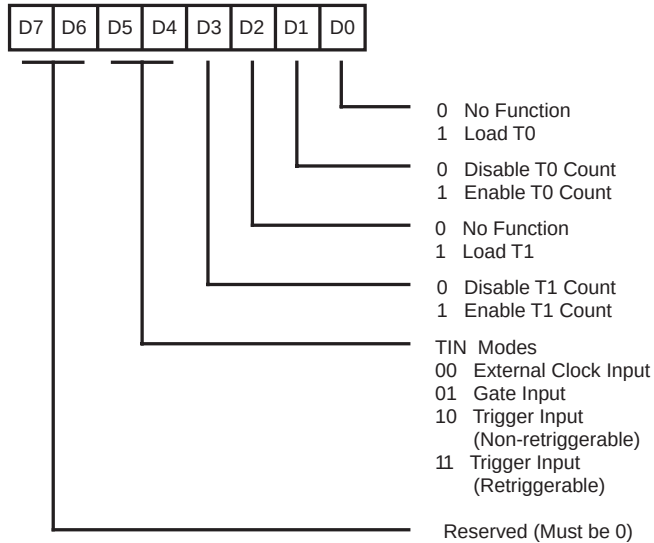


Figure 19. Typical Z86319 VLV vs Temperature

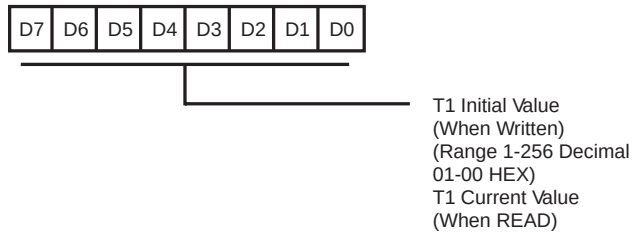
Z8 CONTROL REGISTERS

R241 TMR



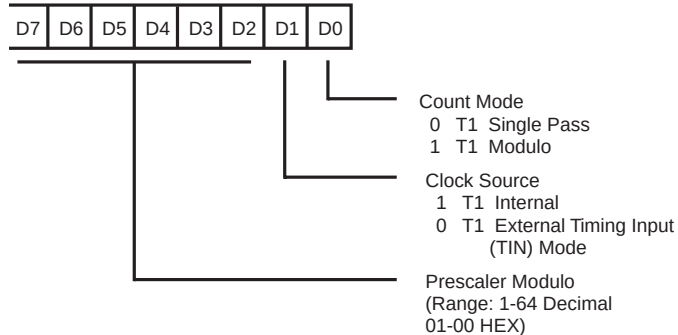
**Figure 20. Timer Mode Register
(F1H: Read/Write)**

R242 T1



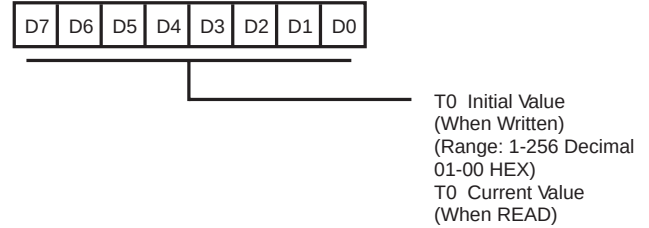
**Figure 21. Counter Timer 1 Register
(F2H: Read/Write)**

R243 PRE1



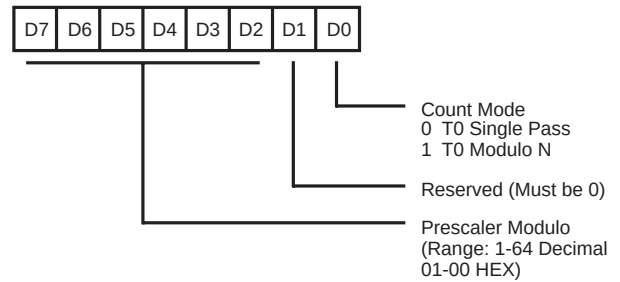
**Figure 22. Prescaler 1 Register
(F3H: Write Only)**

R244 T0



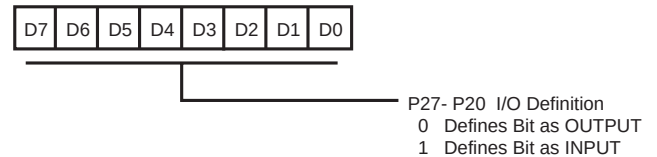
**Figure 23. Counter/Timer 0 Register
(F4H: Read/Write)**

R245 PRE0



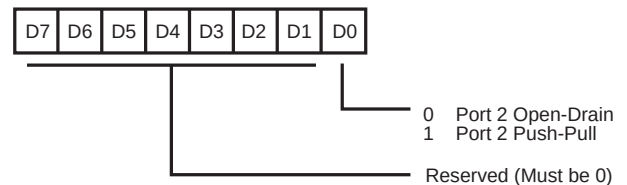
**Figure 24. Prescaler 0 Register
(F5H: Write Only)**

R246 P2M



**Figure 25. Port 2 Mode Register
(F6H: Write Only)**

R247 P3M



**Figure 26. Port 3 Mode Register
(F7H: Write Only)**

Z8 CONTROL REGISTERS (Continued)

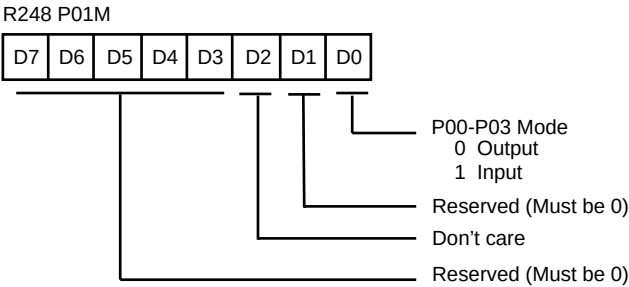


Figure 27. Port 0 and 1 Mode Register (F8H: Write Only)

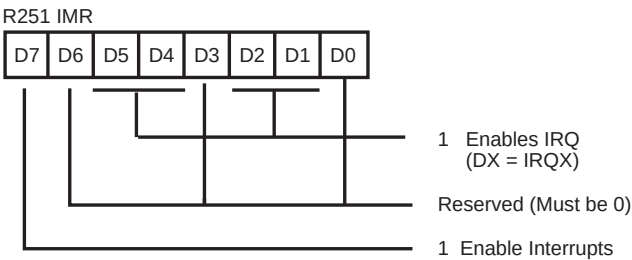


Figure 30. Interrupt Mask Register (FBH: Read/Write)

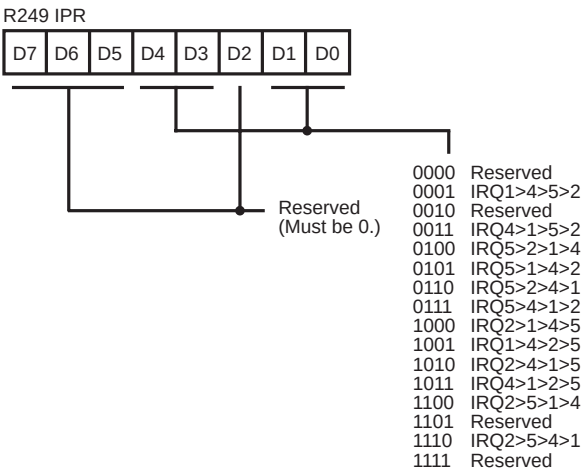


Figure 28. Interrupt Priority Register (F9H: Write Only)

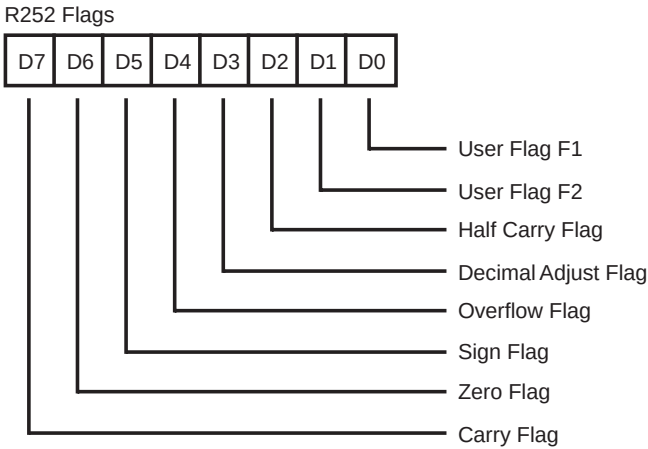


Figure 31. Flag Register (FCH: Read/Write)

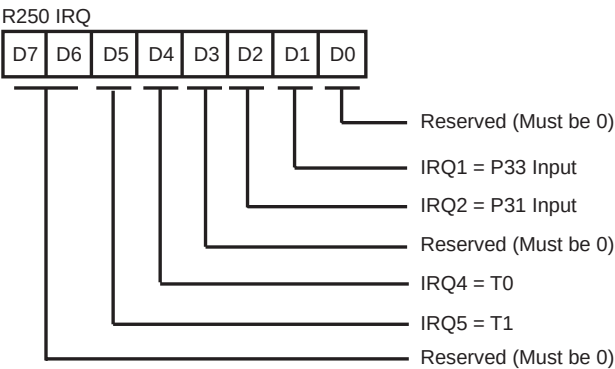


Figure 29. Interrupt Request Register (FAH: Read/Write)

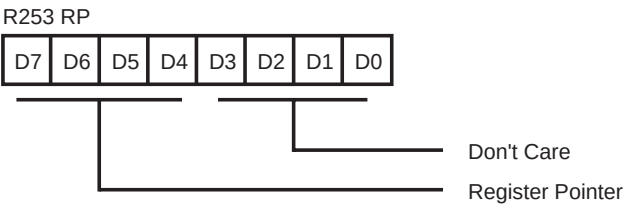


Figure 32. Register Pointer (FDH: Read/Write)

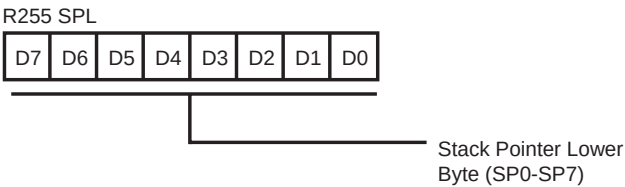


Figure 33. Stack Pointer (FFH: Read/Write)

Z8 PORT REGISTERS

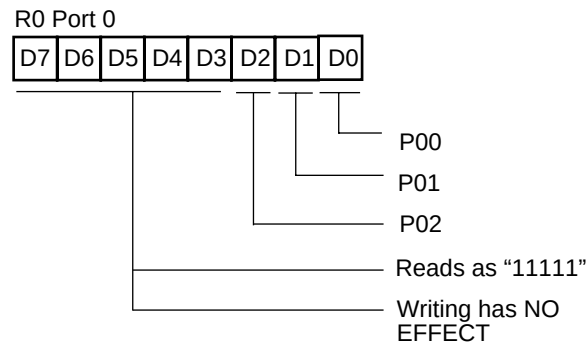


Figure 34. Port 0 Register (Read/Write)

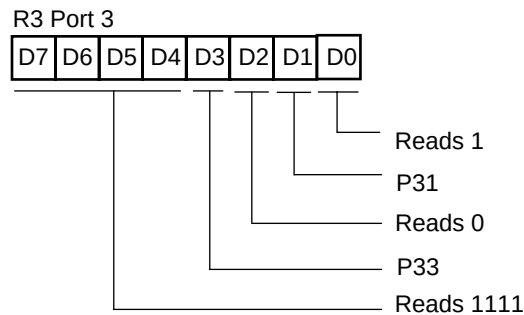


Figure 36. Port 3 Register (Read Only)

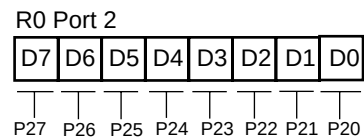


Figure 35. Port 2 Register (Read/Write)

PACKAGING INFORMATION

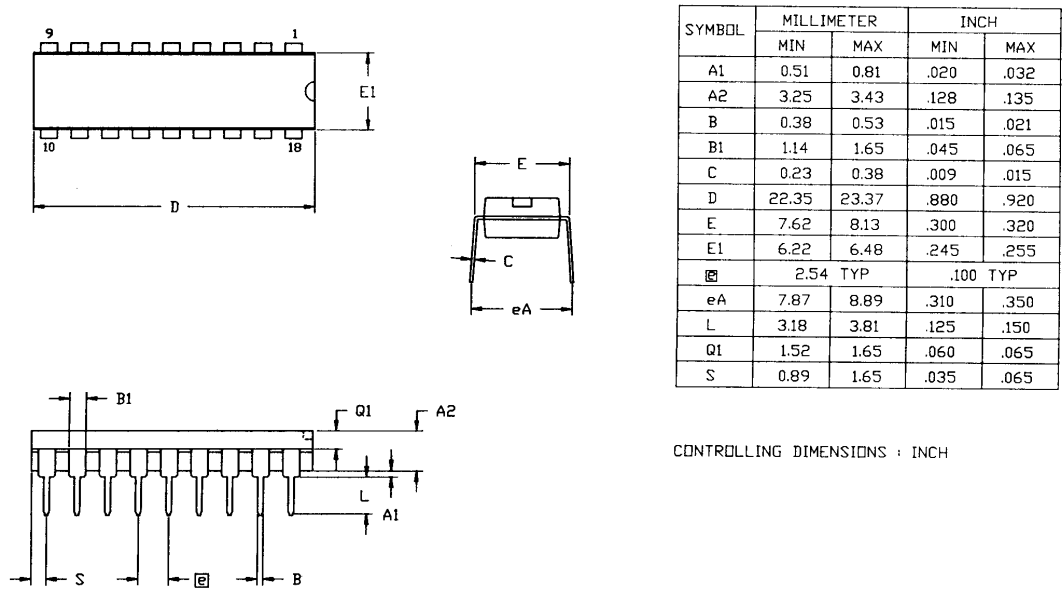


Figure 37. 18-Pin DIP Package Diagram

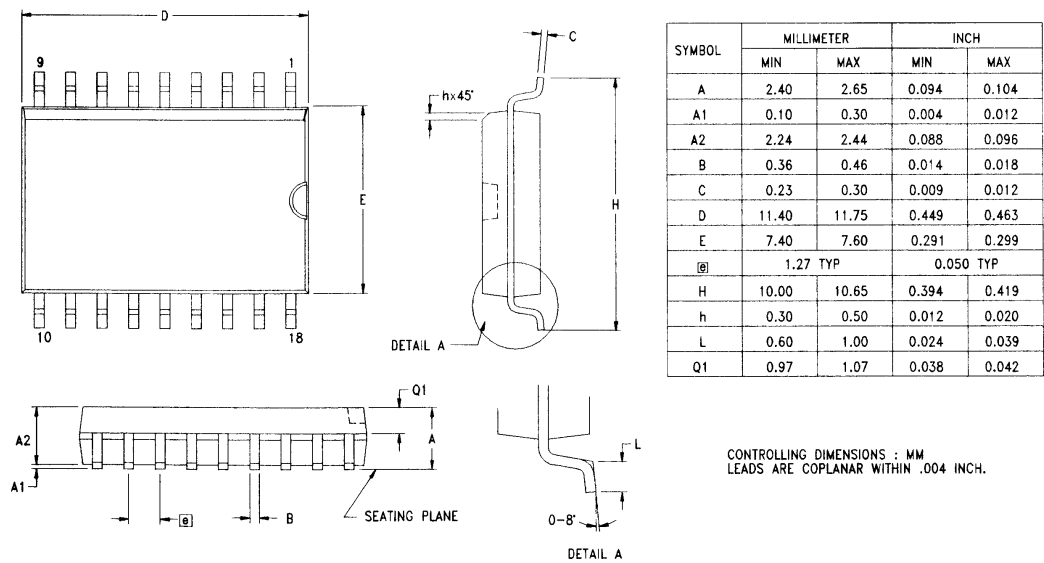


Figure 38. 18-Pin SOIC Package Diagram

ORDERING INFORMATION**Z86319**

Z8631904PSC

Z8631904SSC

For fast results, contact your local Zilog sales offices for assistance in ordering the part required.

CODES**Package**

P = DIP

S = SOIC

Temperature

S = 0°C to +40°C

Speed

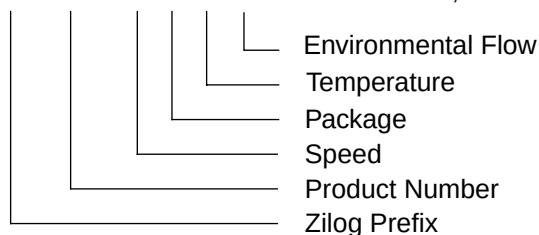
04 = 4 MHz

Environmental

C = Plastic Standard

Example:

Z 86319 0 4 P S C is a Z86319, 4 MHz, DIP, 0° to +40°C, Plastic Standard Flow



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Zilog, Inc. 210 East Hacienda Ave.
Campbell, CA 95008-6600
Telephone (408) 370-8000
FAX 408 370-8056
Internet: <http://www.zilog.com>