

# DATA SHEET

**83C750/87C750**

CMOS single-chip 8-bit microcontrollers

Product specification

1998 Jan 19

IC20 Data Handbook

# CMOS single-chip 8-bit microcontrollers

# 83C750/87C750

## DESCRIPTION

The Philips 8XC750 offers the advantages of the 80C51 architecture in a small package and at low cost.

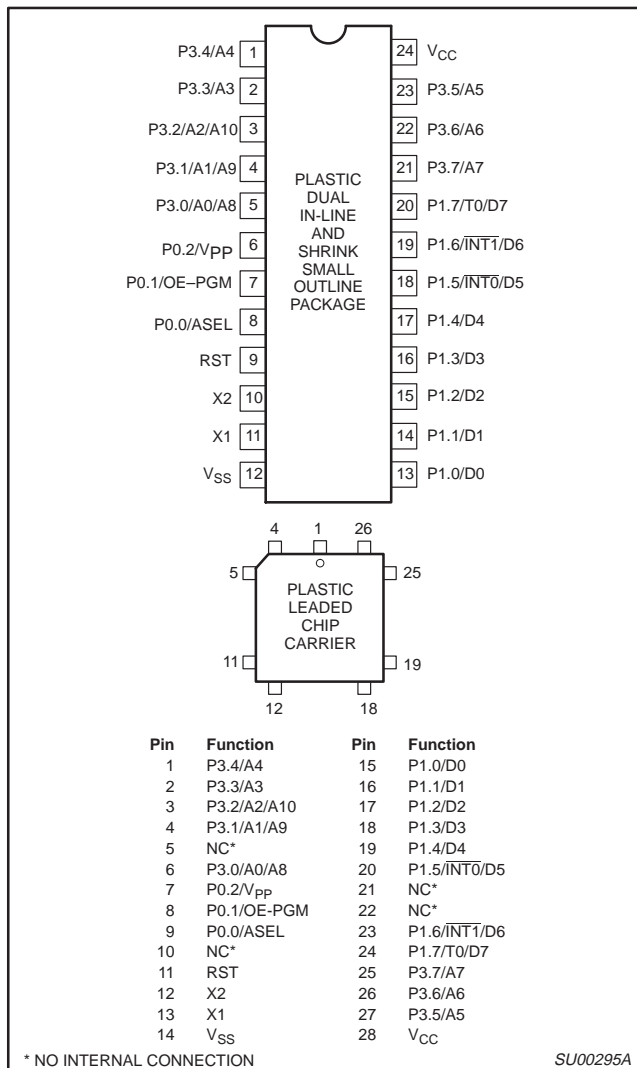
The 8XC750 Microcontroller is fabricated with Philips high-density CMOS technology. Philips epitaxial substrate minimizes CMOS latch-up sensitivity.

The 87C750 contains a 1k × 8 EPROM, a 64 × 8 RAM, 19 I/O lines, a 16-bit auto-reload counter/timer, a five-source, fixed-priority level interrupt structure and an on-chip oscillator.

## FEATURES

- 80C51 based architecture
- Oscillator frequency range—up to 16MHz
- Small package sizes
  - 24-pin DIP (300 mil “skinny DIP”)
  - 24-pin Shrink Small Outline Package
  - 28-pin PLCC
- 87C750 available in one-time programmable plastic packages
- Low power consumption:
  - Normal operation: less than 11mA @ 5V, 12MHz
  - Idle mode
  - Power-down mode
- 1k × 8 EPROM (87C750)
- 64 × 8 RAM
- 16-bit auto reloadable counter/timer
- Boolean processor
- CMOS and TTL compatible
- Well suited for logic replacement, consumer and industrial applications
- LED drive outputs

## PIN CONFIGURATIONS



## ORDERING INFORMATION

| ROM           | EPROM <sup>1</sup> |     | TEMPERATURE RANGE °C AND PACKAGE         | FREQUENCY    | DRAWING NUMBER |
|---------------|--------------------|-----|--|--------------|----------------|
| P83C750EBP N  | P87C750EBP N       | OTP | 0 to +70, Plastic Dual In-line Package   | 3.5 to 16MHz | SOT222-1       |
| P83C750EFP N  | P87C750EFP N       | OTP | -40 to +85, Plastic Dual In-line Package | 3.5 to 16MHz | SOT222-1       |
| P83C750EBA A  | P87C750EBA A       | OTP | 0 to +70, Plastic Lead Chip Carrier      | 3.5 to 16MHz | SOT261-3       |
| P83C750EFA A  | P87C750EFA A       | OTP | -40 to +85, Plastic Lead Chip Carrier    | 3.5 to 16MHz | SOT261-3       |
| P83C750EBD DB | P87C750EBD DB      | OTP | 0 to +70, Shrink Small Outline Package   | 3.5 to 16MHz | SOT340-1       |

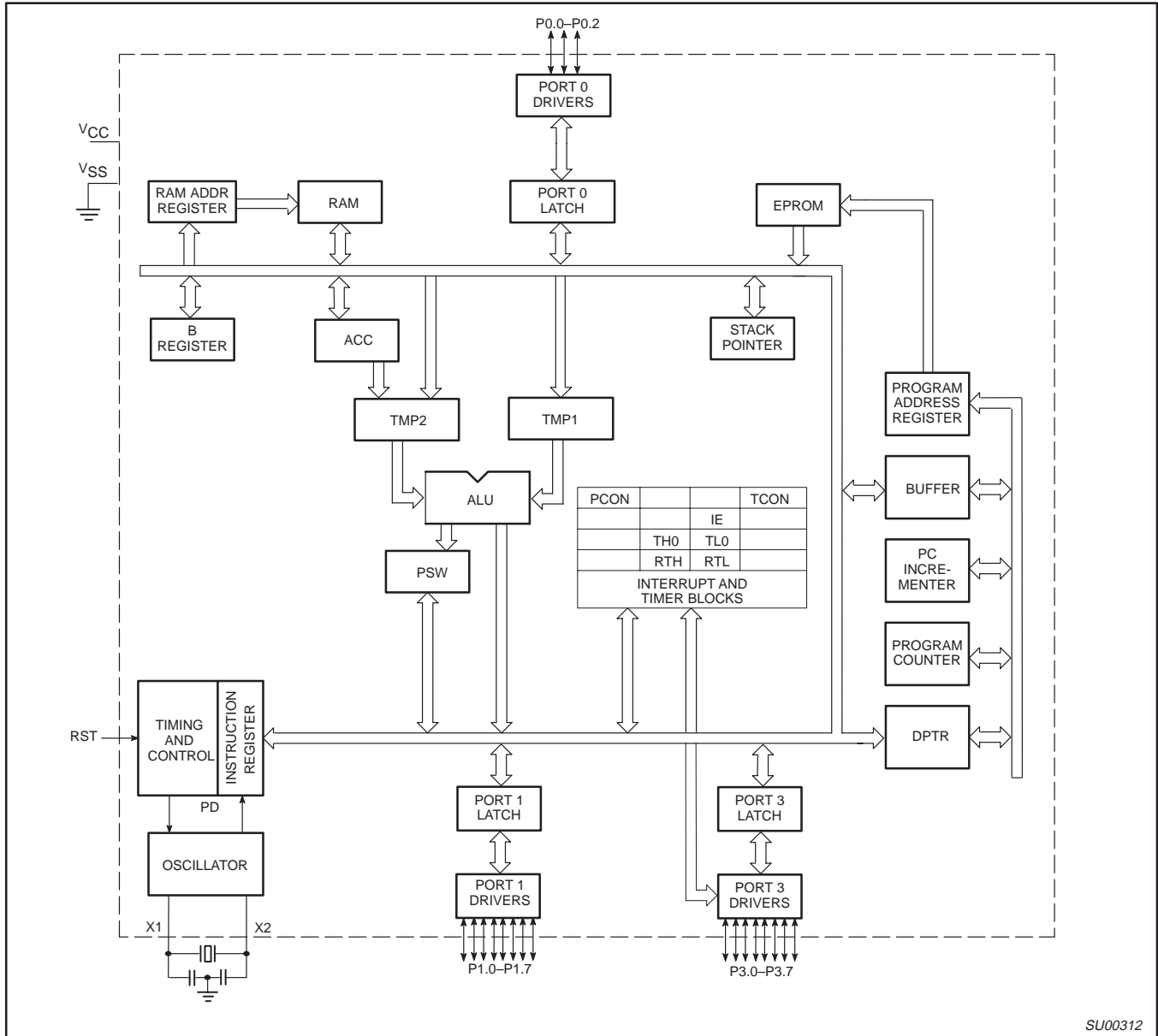
### NOTE:

1. OTP = One Time Programmable EPROM.

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**BLOCK DIAGRAM**



SU00312

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## PIN DESCRIPTIONS

| MNEMONIC        | PIN NO.    |               | TYPE | NAME AND FUNCTION  |
|-----------------|------------|---------------|------|--|
|                 | DIP/SSOP   | LCC           |      |  |
| V <sub>SS</sub> | 12         | 14            | I    | <b>Circuit Ground Potential</b>  |
| V <sub>CC</sub> | 24         | 28            | I    | <b>Supply voltage during normal, idle, and power-down operation.</b>   |
| P0.0-P0.2       | 8-6        | 9-7           | I/O  | <b>Port 0:</b> Port 0 is a 3-bit open-drain, bidirectional port. Port 0 pins that have 1s written to them float, and in that state can be used as high-impedance inputs. These pins are driven low if the port register bit is written with a 0. The state of the pin can always be read from the port register by the program.<br><br>P0.0, P0.1, and P0.2 are open drain bidirectional I/O pins with the electrical characteristics listed in the tables that follow. While these differ from "standard TTL" characteristics, they are close enough for the pins to still be used as general-purpose I/O. Port 0 also provides alternate functions for programming the EPROM memory as follows:<br><br><b>V<sub>PP</sub> (P0.2)</b> – Programming voltage input. (See Note 1.)<br><b>OE/PGM (P0.1)</b> – Input which specifies verify mode (output enable) or the program mode.<br>OE/PGM = 1 output enabled (verify mode).<br>OE/PGM = 0 program mode.<br><b>ASEL (P0.0)</b> – Input which indicates which bits of the EPROM address are applied to port 3.<br>ASEL = 0 low address byte available on port 3.<br>ASEL = 1 high address byte available on port 3 (only the three least significant bits are used). |
| P1.0-P1.7       | 6          | 7             | N/A  |  |
|                 | 7          | 8             | I    |  |
|                 | 8          | 9             | I    |  |
|                 | 13-20      | 15-20, 23, 24 | I/O  | <b>Port 1:</b> Port 1 is an 8-bit bidirectional I/O port with internal pull-ups. Port 1 pins that have 1s written to them are pulled high by the internal pull-ups and can be used as inputs. As inputs, port 1 pins that are externally pulled low will source current because of the internal pull-ups. (See DC Electrical Characteristics: I <sub>IL</sub> ). Port 1 serves to output the addressed EPROM contents in the verify mode and accepts as inputs the value to program into the selected address during the program mode. Port 1 also serves the special function features of the 80C51 family as listed below:<br><br><b>INT0 (P1.5):</b> External interrupt.<br><b>INT1 (P1.6):</b> External interrupt.<br><b>T0 (P1.7):</b> Timer 0 external input.  |
| P3.0-P3.7       | 5-1, 23-21 | 6, 4-1, 27-25 | I/O  | <b>Port 3:</b> Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. Port 3 pins that have 1s written to them are pulled high by the internal pull-ups and can be used as inputs. As inputs, port 3 pins that are externally being pulled low will source current because of the pull-ups. (See DC Electrical Characteristics: I <sub>IL</sub> ). Port 3 also functions as the address input for the EPROM memory location to be programmed (or verified). The 10-bit address is multiplexed into this port as specified by P0.0/ASEL.   |
| RST             | 9          | 11            | I    | <b>Reset:</b> A high on this pin for two machine cycles while the oscillator is running, resets the device. An internal diffused resistor to V <sub>SS</sub> permits a power-on RESET using only an external capacitor to V <sub>CC</sub> . After the device is reset, a 10-bit serial sequence, sent LSB first, applied to RESET, places the device in the programming state allowing programming address, data and V <sub>PP</sub> to be applied for programming or verification purposes. The RESET serial sequence must be synchronized with the X1 input.   |
| X1              | 11         | 13            | I    | <b>Crystal 1:</b> Input to the inverting oscillator amplifier and input to the internal clock generator circuits. X1 also serves as the clock to strobe in a serial bit stream into RESET to place the device in the programming state.  |
| X2              | 10         | 12            | O    | <b>Crystal 2:</b> Output from the inverting oscillator amplifier.  |

## NOTE:

- When P0.2 is at or close to 0 Volt, it may affect the internal ROM operation. We recommend that P0.2 be tied to V<sub>CC</sub> via a small pull-up (e.g., 2kΩ).

## OSCILLATOR CHARACTERISTICS

X1 and X2 are the input and output, respectively, of an inverting amplifier which can be configured for use as an on-chip oscillator.

To drive the device from an external clock source, X1 should be driven while X2 is left unconnected. There are no requirements on the duty cycle of the external clock signal, because the input to the internal clock circuitry is through a divide-by-two flip-flop. However, minimum and maximum high and low times specified in the data sheet must be observed.

## RESET

A reset is accomplished by holding the RST pin high for at least two machine cycles (24 oscillator periods), while the oscillator is running. To insure a good power-up reset, the RST pin must be high long

enough to allow the oscillator time to start up (normally a few milliseconds) plus two machine cycles. At power-up, the voltage on V<sub>CC</sub> and RST must come up at the same time for a proper start-up.

## IDLE MODE

In idle mode, the CPU puts itself to sleep while all of the on-chip peripherals stay active. The instruction to invoke the idle mode is the last instruction executed in the normal operating mode before the idle mode is activated. The CPU contents, the on-chip RAM, and all of the special function registers remain intact during this mode. The idle mode can be terminated either by any enabled interrupt (at which time the process is picked up at the interrupt service routine and continued), or by a hardware reset which starts the processor in the same manner as a power-on reset.

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## POWER-DOWN MODE

In the power-down mode, the oscillator is stopped and the instruction to invoke power-down is the last instruction executed. Only the contents of the on-chip RAM are preserved. A hardware reset is the only way to terminate the power-down mode. The control bits for the reduced power modes are in the special function register PCON.

**Table 1. External Pin Status During Idle and Power-Down Modes**

| MODE       | Port 0 | Port 1 | Port 2 |
|------------|--------|--------|--------|
| Idle       | Data   | Data   | Data   |
| Power-down | Data   | Data   | Data   |

## DIFFERENCES BETWEEN THE 8XC750 AND THE 80C51

### Program Memory

On the 8XC750, program memory is 1024 bytes long and is not externally expandable, so the 80C51 instructions MOVX, LJMP, and LCALL are not implemented. The only fixed locations in program memory are the addresses at which execution is taken up in response to reset and interrupts, which are as follows:

| Event           | Address |
|-----------------|---------|
| Reset           | 000     |
| External INT0   | 003     |
| Counter/timer 0 | 00B     |
| External INT1   | 013     |

### Counter/Timer Subsystem

#### Timer/Counter

The 8XC750 has one timers: a 16-bit timer/counter. The 16-bit timer/counter's operation is similar to mode 2 operation on the 80C51, but is extended to 16 bits. The timer/counter is clocked by either 1/12 the oscillator frequency or by transitions on the T0 pin. The C/T pin in special function register TCON selects between these two modes. When the TCON TR bit is set, the timer/counter is enabled. Register pair TH and TL are incremented by the clock source. When the register pair overflows, the register pair is reloaded with the values in registers RTH and RTL. The value in the reload registers is left unchanged. See the 83C750 counter/timer block diagram in Figure 1. The TF bit in special function register

TCON is set on counter overflow and, if the interrupt is enabled, will generate an interrupt.

### TCON Register

|      | MSB   |     |    |    |     |     | LSB |     |
|------|---|-----|----|----|-----|-----|-----|-----|
|      | GATE  | C/T | TF | TR | IE0 | IT0 | IE1 | IT1 |
| GATE | 1   | 0   | 0  | 0  | 0   | 0   | 0   | 0   |
|      | 1 – Timer/counter is enabled only when INT0 pin is high, and TR is 1. |     |    |    |     |     |     |     |
|      | 0 – Timer/counter is enabled when TR is 1.                            |     |    |    |     |     |     |     |
| C/T  | 1   | 0   | 0  | 0  | 0   | 0   | 0   | 0   |
|      | 1 – Counter/timer operation from T0 pin.                              |     |    |    |     |     |     |     |
|      | 0 – Timer operation from internal clock.                              |     |    |    |     |     |     |     |
| TF   | 1   | 0   | 0  | 0  | 0   | 0   | 0   | 0   |
|      | 1 – Set on overflow of TH.  |     |    |    |     |     |     |     |
|      | 0 – Cleared when processor vectors to interrupt routine and by reset. |     |    |    |     |     |     |     |
| TR   | 1   | 0   | 0  | 0  | 0   | 0   | 0   | 0   |
|      | 1 – Timer/counter enabled.  |     |    |    |     |     |     |     |
|      | 0 – Timer/counter disabled.   |     |    |    |     |     |     |     |
| IE0  | 1   | 0   | 0  | 0  | 0   | 0   | 0   | 0   |
|      | 1 – Edge detected in INT0.  |     |    |    |     |     |     |     |
| IT0  | 1   | 0   | 0  | 0  | 0   | 0   | 0   | 0   |
|      | 1 – INT0 is edge triggered.   |     |    |    |     |     |     |     |
|      | 0 – INT0 is level sensitive.  |     |    |    |     |     |     |     |
| IE1  | 1   | 0   | 0  | 0  | 0   | 0   | 0   | 0   |
|      | 1 – Edge detected on INT1.  |     |    |    |     |     |     |     |
| IT1  | 1   | 0   | 0  | 0  | 0   | 0   | 0   | 0   |
|      | 1 – INT1 is edge triggered.   |     |    |    |     |     |     |     |
|      | 0 – INT1 is level sensitive.  |     |    |    |     |     |     |     |

These flags are functionally identical to the corresponding 80C51 flags, except that there is only one timer on the 83C750 and the flags are therefore combined into one register.

Note that the positions of the IE0/IT0 and IE1/IT1 bits are transposed from the positions used in the standard 80C51 TCON register.

### Interrupt Subsystem – Fixed Priority

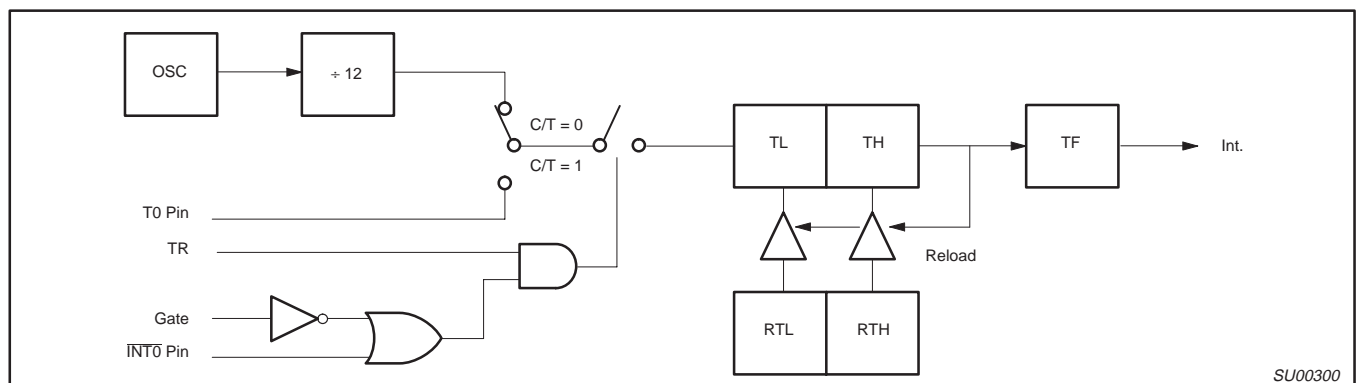
The IP register and the 2-level interrupt system of the 80C51 are eliminated. Simultaneous interrupt conditions are resolved by a single-level, fixed priority as follows:

- Highest priority: Pin INT0
- Counter/timer flag 0
- Pin INT1

### Special Function Register Addresses

Special function registers for the 8XC750 are identical to those of the 80C51, except for the changes listed below:

80C51 special function registers not present in the 8XC750 are TMOD (89), P2 (A0) and IP (B8). The 80C51 registers TH1 and TL1 are replaced with the 87C750 registers RTH and RTL respectively (refer to Table 2).



**Figure 1. 83C750 Counter/Timer Block Diagram**

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**Table 2. 87C750 Special Function Registers**

| SYMBOL | DESCRIPTION            | DIRECT ADDRESS | BIT ADDRESS, SYMBOL, OR ALTERNATIVE PORT FUNCTION |      |      |     |     |     |     |     | RESET VALUE |
|--------|------------------------|----------------|---|------|------|-----|-----|-----|-----|-----|-------------|
|        |                        |                | MSB   |      |      |     | LSB |     |     |     |             |
| ACC*   | Accumulator            | E0H            | E7  | E6   | E5   | E4  | E3  | E2  | E1  | E0  | 00H         |
| B*     | B register             | F0H            | F7  | F6   | F5   | F4  | F3  | F2  | F1  | F0  | 00H         |
| DPTR:  | Data pointer (2 bytes) |                |   |      |      |     |     |     |     |     |             |
| DPH    | High byte              | 83H            |   |      |      |     |     |     |     |     | 00H         |
| DPL    | Low byte               | 82H            | AF  | AE   | AD   | AC  | AB  | AA  | A9  | A8  | 00H         |
| IE*#   | Interrupt enable       | A8H            | EA  | -    | -    | -   | -   | EX1 | ET0 | EX0 | 00H         |
|        |                        |                |   |      |      |     |     | 82  | 81  | 80  |             |
| P0*#   | Port 0                 | 80H            | -   | -    | -    | -   | -   | -   | -   | -   | xxxxx111B   |
|        |                        |                | 97  | 96   | 95   | 94  | 93  | 92  | 91  | 90  |             |
| P1*    | Port 1                 | 90H            | T0  | INT1 | INT0 | -   | -   | -   | -   | -   | FFH         |
| P3*    | Port 3                 | B0H            | B7  | B6   | B5   | B4  | B3  | B2  | B1  | B0  | FFH         |
|        |                        |                |   |      |      |     |     |     |     |     |             |
| PCON#  | Power control          | 87H            | -   | -    | -    | -   | -   | -   | PD  | IDL | xxxxxx00B   |
|        |                        |                | D7  | D6   | D5   | D4  | D3  | D2  | D1  | D0  |             |
| PSW*   | Program status word    | D0H            | CY  | AC   | F0   | RS1 | RS0 | OV  | -   | P   | 00H         |
|        |                        |                |   |      |      |     |     |     |     |     |             |
| SP     | Stack pointer          | 81H            |   |      |      |     |     |     |     |     | 07H         |
|        |                        |                | 8F  | 8E   | 8D   | 8C  | 8B  | 8A  | 89  | 88  |             |
| TCON*# | Timer/counter control  | 88H            | GATE  | C/T  | TF   | TR  | IE0 | IT0 | IE1 | IT1 | 00H         |
|        |                        |                |   |      |      |     |     |     |     |     |             |
| TL#    | Timer low byte         | 8AH            |   |      |      |     |     |     |     |     | 00H         |
| TH#    | Timer high byte        | 8CH            |   |      |      |     |     |     |     |     | 00H         |
| RTL#   | Timer low reload       | 8BH            |   |      |      |     |     |     |     |     | 00H         |
| RTH#   | Timer high reload      | 8DH            |   |      |      |     |     |     |     |     | 00H         |

\* SFRs are bit addressable.

# SFRs are modified from or added to the 80C51 SFRs.

## ABSOLUTE MAXIMUM RATINGS<sup>1, 2</sup>

| PARAMETER   | RATING                        | UNIT |
|---|-------------------------------|------|
| Storage temperature range   | -65 to +150                   | °C   |
| Voltage from V <sub>CC</sub> to V <sub>SS</sub>                   | -0.5 to +6.5                  | V    |
| Voltage from any pin to V <sub>SS</sub> (except V <sub>PP</sub> ) | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| Power dissipation   | 1.0                           | W    |
| Voltage on V <sub>PP</sub> pin to V <sub>SS</sub>                 | 0 to +13.0                    | V    |
| Maximum I <sub>OL</sub> per I/O pin                               | 10                            | mA   |

### NOTES:

- Stresses above 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 conditions other than those described in the AC and DC Electrical Characteristics section of this specification is not implied.
- This product includes circuitry specifically designed for the protection of its internal devices from the damaging effects of excessive static charge. Nonetheless, it is suggested that conventional precautions be taken to avoid applying greater than the rated maxima.

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**DC ELECTRICAL CHARACTERISTICS** $T_{amb} = 0^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$  or  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = 5\text{V} \pm 10\%$ ,  $V_{SS} = 0\text{V}^1$ 

| SYMBOL    | PARAMETER   | TEST CONDITIONS   | LIMITS          |                 | UNIT          |
|-----------|---|---|-----------------|-----------------|---------------|
|           |   |   | MIN             | MAX             |               |
| $V_{IL}$  | Input low voltage   |   | -0.5            | $0.2V_{DD}-0.1$ | V             |
| $V_{IH}$  | Input high voltage, except X1, RST                            |   | $0.2V_{CC}+0.9$ | $V_{CC}+0.5$    | V             |
| $V_{IH1}$ | Input high voltage, X1, RST                                   |   | $0.7V_{CC}$     | $V_{CC}+0.5$    | V             |
| $V_{OL}$  | Output low voltage, ports 1 and 3                             | $I_{OL} = 1.6\text{mA}^2$   |                 | 0.45            | V             |
| $V_{OL1}$ | Output low voltage, port 0                                    | $I_{OL} = 3.2\text{mA}^2$   |                 | 0.45            | V             |
| $V_{OH}$  | Output high voltage, ports 1 and 3                            | $I_{OH} = -60\mu\text{A}$   | 2.4             |                 | V             |
|           |   | $I_{OH} = -25\mu\text{A}$   | $0.75V_{CC}$    |                 | V             |
|           |   | $I_{OH} = -10\mu\text{A}$   | $0.9V_{CC}$     |                 | V             |
| C         | Capacitance   |   |                 | 10              | pF            |
| $I_{IL}$  | Logical 0 input current, ports 1 and 3                        | $V_{IN} = 0.45\text{V}$   |                 | -50             | $\mu\text{A}$ |
| $I_{TL}$  | Logical 1 to 0 transition current, ports 1 and 3 <sup>3</sup> | $V_{IN} = 2\text{V}$ (0 to $+70^{\circ}\text{C}$ )<br>$V_{IN} = 2\text{V}$ ( $-40$ to $+85^{\circ}\text{C}$ )   |                 | -650            | $\mu\text{A}$ |
| $I_{LI}$  | Input leakage current, port 0                                 | $0.45 < V_{IN} < V_{CC}$  |                 | -750            | $\mu\text{A}$ |
|           |   |   |                 | $\pm 10$        | $\mu\text{A}$ |
| $R_{RST}$ | Internal pull-down resistor                                   |   | 25              | 175             | k $\Omega$    |
| $C_{IO}$  | Pin capacitance   | Test freq = 1MHz,<br>$T_{amb} = 25^{\circ}\text{C}$   |                 | 10              | pF            |
| $I_{PD}$  | Power-down current <sup>4</sup>                               | $V_{CC} = 2$ to $V_{CC}$ max  |                 | 50              | $\mu\text{A}$ |
| $V_{PP}$  | $V_{PP}$ program voltage                                      | $V_{SS} = 0\text{V}$<br>$V_{CC} = 5\text{V} \pm 10\%$<br>$T_{amb} = 21^{\circ}\text{C}$ to $27^{\circ}\text{C}$ | 12.5            | 13.0            | V             |
| $I_{PP}$  | Program current   | $V_{PP} = 13.0\text{V}$   |                 | 50              | mA            |
| $I_{CC}$  | Supply current (see Figure 3) <sup>5, 6</sup>                 |   |                 |                 |               |

**NOTES:**

- Parameters are valid over operating temperature range unless otherwise specified. All voltages are with respect to  $V_{SS}$  unless otherwise noted.
- Under steady state (non-transient) conditions,  $I_{OL}$  must be externally limited as follows:  
 Maximum  $I_{OL}$  per port pin: 10mA (NOTE: This is  $85^{\circ}\text{C}$  spec.)  
 Maximum  $I_{OL}$  per 8-bit port: 26mA  
 Maximum total  $I_{OL}$  for all outputs: 67mA  
 If  $I_{OL}$  exceeds the test condition,  $V_{OL}$  may exceed the related specification. Pins are not guaranteed to sink current greater than the listed test conditions.
- Pins of ports 1 and 3 source a transition current when they are being externally driven from 1 to 0. The transition current reaches its maximum value when  $V_{IN}$  is approximately 2V.
- Power-down  $I_{CC}$  is measured with all output pins disconnected; port 0 =  $V_{CC}$ ; X2, X1 n.c.; RST =  $V_{SS}$ .
- Active  $I_{CC}$  is measured with all output pins disconnected; X1 driven with  $t_{CLCH}$ ,  $t_{CHCL} = 5\text{ns}$ ,  $V_{IL} = V_{SS} + 0.5\text{V}$ ,  $V_{IH} = V_{CC} - 0.5\text{V}$ ; X2 n.c.; RST = port 0 =  $V_{CC}$ .  $I_{CC}$  will be slightly higher if a crystal oscillator is used.
- Idle  $I_{CC}$  is measured with all output pins disconnected; X1 driven with  $t_{CLCH}$ ,  $t_{CHCL} = 5\text{ns}$ ,  $V_{IL} = V_{SS} + 0.5\text{V}$ ,  $V_{IH} = V_{CC} - 0.5\text{V}$ ; X2 n.c.; port 0 =  $V_{CC}$ ; RST =  $V_{SS}$ .

**AC ELECTRICAL CHARACTERISTICS** $T_{amb} = 0^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$  or  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = 5\text{V} \pm 10\%$ ,  $V_{SS} = 0\text{V}^1, 2$ 

| SYMBOL                           | PARAMETER             | VARIABLE CLOCK |     |     |     | UNIT |
|----------------------------------|-----------------------|----------------|-----|-----|-----|------|
|                                  |                       | MIN            | MAX | MIN | MAX |      |
| $1/t_{CLCL}$                     | Oscillator frequency: | 3.5            | 16  | 3.5 | 40  | MHz  |
| <b>External Clock (Figure 2)</b> |                       |                |     |     |     |      |
| $t_{CHCX}$                       | High time             | 20             |     | 10  |     | ns   |
| $t_{CLCX}$                       | Low time              | 20             |     | 10  |     | ns   |
| $t_{CLCH}$                       | Rise time             |                | 20  |     | 20  | ns   |
| $t_{CHCL}$                       | Fall time             |                | 20  |     | 20  | ns   |

**NOTES:**

- Parameters are valid over operating temperature range unless otherwise specified. All voltages are with respect to  $V_{SS}$  unless otherwise noted.
- Load capacitance for ports = 80pF.

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## EXPLANATION OF THE AC SYMBOLS

In defining the clock waveform, care must be taken not to exceed the MIN or MAX limits of the AC electrical characteristics table. Each timing symbol has five characters. The first character is always 't' (= time). The other characters, depending on their positions, indicate the name of a signal or the logical status of that signal. The designations are:  
 C – Clock  
 D – Input data

H – Logic level high  
 L – Logic level low  
 Q – Output data  
 T – Time  
 V – Valid  
 X – No longer a valid logic level  
 Z – Float

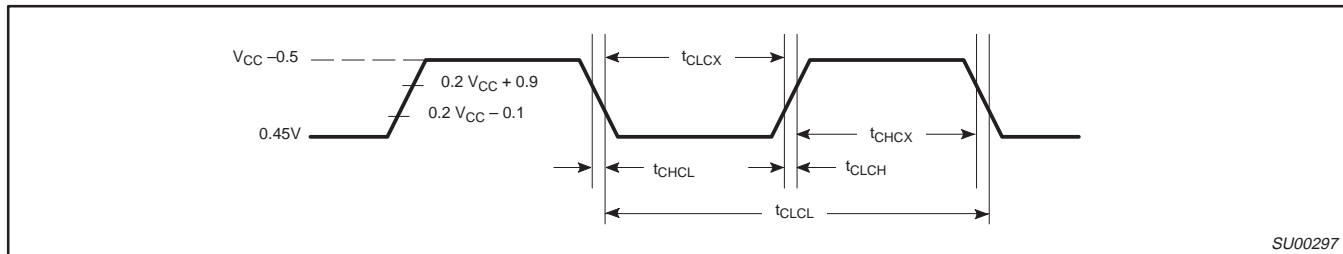


Figure 2. External Clock Drive

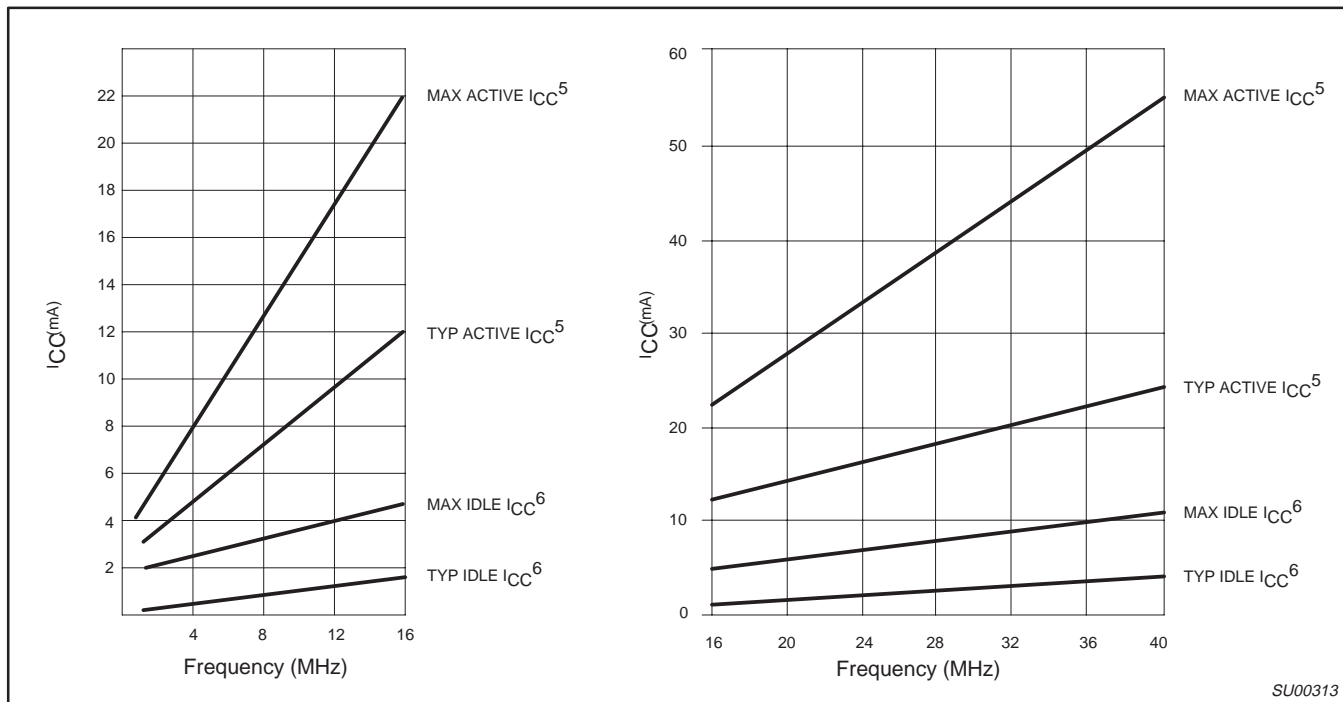


Figure 3.  $I_{CC}$  vs. Frequency

Maximum  $I_{CC}$  values taken at  $V_{CC}$  max and worst case temperature.  
 Typical  $I_{CC}$  values taken at  $V_{CC} = 5.0V$  and  $25^{\circ}C$ .  
 Notes 5 and 6 refer to DC Electrical Characteristics.

## ROM CODE SUBMISSION

When submitting ROM code for the 80C750, the following must be specified:

- 1k byte user ROM data

| ADDRESS        | CONTENT | BIT(S) | COMMENT       |
|----------------|---------|--------|---------------|
| 0000H to 03FFH | DATA    | 7:0    | User ROM Data |



# CMOS single-chip 8-bit microcontrollers

# 83C750/87C750

## 87C750 PROGRAMMING CONSIDERATIONS

### EPROM Characteristics

The 87C750 is programmed by using a modified Quick-Pulse Programming algorithm similar to that used for devices such as the 87C451 and 87C51. It differs from these devices in that a serial data stream is used to place the 87C750 in the programming mode.

Figure 4 shows a block diagram of the programming configuration for the 87C750. Port pin P0.2 is used as the programming voltage supply input ( $V_{PP}$  signal). Port pin P0.1 is used as the program (PGM) signal. This pin is used for the 25 programming pulses.

Port 3 is used as the address input for the byte to be programmed and accepts both the high and low components of the eleven bit address. Multiplexing of these address components is performed using the ASEL input. The user should drive the ASEL input high and then drive port 3 with the high order bits of the address. ASEL should remain high for at least 13 clock cycles. ASEL may then be driven low which latches the high order bits of the address internally. The high address should remain on port 3 for at least two clock cycles after ASEL is driven low. Port 3 may then be driven with the low byte of the address. The low address will be internally stable 13 clock cycles later. The address will remain stable provided that the low byte placed on port 3 is held stable and ASEL is kept low. **Note:** ASEL needs to be pulsed high only to change the high byte of the address.

Port 1 is used as a bidirectional data bus during programming and verify operations. During programming mode, it accepts the byte to be programmed. During verify mode, it provides the contents of the EPROM location specified by the address which has been supplied to Port 3.

The XTAL1 pin is the oscillator input and receives the master system clock. This clock should be between 1.2 and 6MHz.

The RESET pin is used to accept the serial data stream that places the 87C750 into various programming modes. This pattern consists of a 10-bit code with the LSB sent first. Each bit is synchronized to the clock input, X1.

### Programming Operation

Figures 5 and 6 show the timing diagrams for the program/verify cycle. RESET should initially be held high for at least two machine cycles. P0.1 (PGM) and P0.2 ( $V_{PP}$ ) will be at  $V_{OH}$  as a result of the RESET operation. At this point, these pins function as normal quasi-bidirectional I/O ports and the programming equipment may pull these lines low. However, prior to sending the 10-bit code on the RESET pin, the programming equipment should drive these pins high ( $V_{IH}$ ). The RESET pin may now be used as the serial data input for the data stream which places the 87C750 in the programming mode. Data bits are sampled during the clock high time and thus should only change during the time that the clock is low. Following transmission of the last data bit, the RESET pin should be held low.

Next the address information for the location to be programmed is placed on port 3 and ASEL is used to perform the address multiplexing, as previously described. At this time, port 1 functions as an output.

A high voltage  $V_{PP}$  level is then applied to the  $V_{PP}$  input (P0.2). (This sets Port 1 as an input port). The data to be programmed into the EPROM array is then placed on Port 1. This is followed by a series of programming pulses applied to the PGM/ pin (P0.1). These pulses are created by driving P0.1 low and then high. This pulse is

repeated until a total of 25 programming pulses have occurred. At the conclusion of the last pulse, the PGM/ signal should remain high.

The  $V_{PP}$  signal may now be driven to the  $V_{OH}$  level, placing the 87C750 in the verify mode. (Port 1 is now used as an output port). After four machine cycles (48 clock periods), the contents of the addressed location in the EPROM array will appear on Port 1.

The next programming cycle may now be initiated by placing the address information at the inputs of the multiplexed buffers, driving the  $V_{PP}$  pin to the  $V_{PP}$  voltage level, providing the byte to be programmed to Port1 and issuing the 26 programming pulses on the PGM/ pin, bringing  $V_{PP}$  back down to the  $V_C$  level and verifying the byte.

### Programming Modes

The 87C750 has four programming features incorporated within its EPROM array. These include the USER EPROM for storage of the application's code, a 16-byte encryption key array and two security bits. Programming and verification of these four elements are selected by a combination of the serial data stream applied to the RESET pin and the voltage levels applied to port pins P0.1 and P0.2. The various combinations are shown in Table 3.

### Encryption Key Table

The 87C750 includes a 16-byte EPROM array that is programmable by the end user. The contents of this array can then be used to encrypt the program memory contents during a program memory verify operation. When a program memory verify operation is performed, the contents of the program memory location is XNOR'ed with one of the bytes in the 16-byte encryption table. The resulting data pattern is then provided to port 1 as the verify data. The encryption mechanism can be disabled, in essence, by leaving the bytes in the encryption table in their erased state (FFH) since the XNOR product of a bit with a logical one will result in the original bit. The encryption bytes are mapped with the code memory in 16-byte groups. The first byte in code memory will be encrypted with the first byte in the encryption table; the second byte in code memory will be encrypted with the second byte in the encryption table and so forth up to and including the 16th byte. The encryption repeats in 16-byte groups; the 17th byte in the code memory will be encrypted with the first byte in the encryption table, and so forth.

### Security Bits

Two security bits, security bit 1 and security bit 2, are provided to limit access to the USER EPROM and encryption key arrays. Security bit 1 is the program inhibit bit, and once programmed performs the following functions:

1. Additional programming of the USER EPROM is inhibited.
2. Additional programming of the encryption key is inhibited.
3. Verification of the encryption key is inhibited.
4. Verification of the USER EPROM and the security bit levels may still be performed.

(If the encryption key array is being used, this security bit should be programmed by the user to prevent unauthorized parties from reprogramming the encryption key to all logical zero bits. Such programming would provide data during a verify cycle that is the logical complement of the USER EPROM contents).

Security bit 2, the verify inhibit bit, prevents verification of both the USER EPROM array and the encryption key arrays. The security bit levels may still be verified.

## CMOS single-chip 8-bit microcontrollers

## 83C750/87C750

**Programming and Verifying Security Bits**

Security bits are programmed employing the same techniques used to program the USER EPROM and KEY arrays using serial data streams and logic levels on port pins indicated in Table 3. When programming either security bit, it is not necessary to provide address or data information to the 87C750 on ports 1 and 3.

Verification occurs in a similar manner using the RESET serial stream shown in Table 3. Port 3 is not required to be driven and the results of the verify operation will appear on ports 1.6 and 1.7.

Ports 1.7 contains the security bit 1 data and is a logical one if programmed and a logical zero if not programmed. Likewise, P1.6 contains the security bit 2 data and is a logical one if programmed and a logical zero if not programmed.

**Table 3. Implementing Program/Verify Modes**

| OPERATION              | SERIAL CODE | P0.1 (PGM/)     | P0.2 (V <sub>PP</sub> ) |
|------------------------|-------------|-----------------|-------------------------|
| Program user EPROM     | 296H        | –1              | V <sub>PP</sub>         |
| Verify user EPROM      | 296H        | V <sub>IH</sub> | V <sub>IH</sub>         |
| Program key EPROM      | 292H        | –1              | V <sub>PP</sub>         |
| Verify key EPROM       | 292H        | V <sub>IH</sub> | V <sub>IH</sub>         |
| Program security bit 1 | 29AH        | –1              | V <sub>PP</sub>         |
| Program security bit 2 | 298H        | –1              | V <sub>PP</sub>         |
| Verify security bits   | 29AH        | V <sub>IH</sub> | V <sub>IH</sub>         |

**NOTE:**

1. Pulsed from V<sub>IH</sub> to V<sub>IL</sub> and returned to V<sub>IH</sub>.

**EPROM PROGRAMMING AND VERIFICATION**

T<sub>amb</sub> = 21°C to +27°C, V<sub>CC</sub> = 5V ±10%, V<sub>SS</sub> = 0V

| SYMBOL                         | PARAMETER  | MIN                        | MAX                 | UNIT |
|--------------------------------|--|----------------------------|---------------------|------|
| 1/t <sub>CLCL</sub>            | Oscillator/clock frequency                           | 1.2                        | 6                   | MHz  |
| t <sub>AVGL</sub> <sup>1</sup> | Address setup to P0.1 (PROG–) low                    | 10μs + 24t <sub>CLCL</sub> |                     |      |
| t <sub>GHAX</sub>              | Address hold after P0.1 (PROG–) high                 | 48t <sub>CLCL</sub>        |                     |      |
| t <sub>DVGL</sub>              | Data setup to P0.1 (PROG–) low                       | 38t <sub>CLCL</sub>        |                     |      |
| t <sub>DVGL</sub>              | Data setup to P0.1 (PROG–) low                       | 38t <sub>CLCL</sub>        |                     |      |
| t <sub>GHDX</sub>              | Data hold after P0.1 (PROG–) high                    | 36t <sub>CLCL</sub>        |                     |      |
| t <sub>SHGL</sub>              | V <sub>PP</sub> setup to P0.1 (PROG–) low            | 10                         |                     | μs   |
| t <sub>GHSL</sub>              | V <sub>PP</sub> hold after P0.1 (PROG–)              | 10                         |                     | μs   |
| t <sub>GLGH</sub>              | P0.1 (PROG–) width                                   | 90                         | 110                 | μs   |
| t <sub>AVQV</sub> <sup>2</sup> | V <sub>PP</sub> low (V <sub>CC</sub> ) to data valid |                            | 48t <sub>CLCL</sub> |      |
| t <sub>GHGL</sub>              | P0.1 (PROG–) high to P0.1 (PROG–) low                | 10                         |                     | μs   |
| t <sub>SYNL</sub>              | P0.0 (sync pulse) low                                | 4t <sub>CLCL</sub>         |                     |      |
| t <sub>SYNH</sub>              | P0.0 (sync pulse) high                               | 8t <sub>CLCL</sub>         |                     |      |
| t <sub>MASEL</sub>             | ASEL high time                                       | 13t <sub>CLCL</sub>        |                     |      |
| t <sub>MAHLD</sub>             | Address hold time                                    | 2t <sub>CLCL</sub>         |                     |      |
| t <sub>HASET</sub>             | Address setup to ASEL                                | 13t <sub>CLCL</sub>        |                     |      |
| t <sub>ADSTA</sub>             | Low address to valid data                            |                            | 48t <sub>CLCL</sub> |      |

**NOTES:**

1. Address should be valid at least 24t<sub>CLCL</sub> before the rising edge of P0.2 (V<sub>PP</sub>).
2. For a pure verify mode, i.e., no program mode in between, t<sub>AVQV</sub> is 14t<sub>CLCL</sub> maximum.

CMOS single-chip 8-bit microcontrollers

83C750/87C750

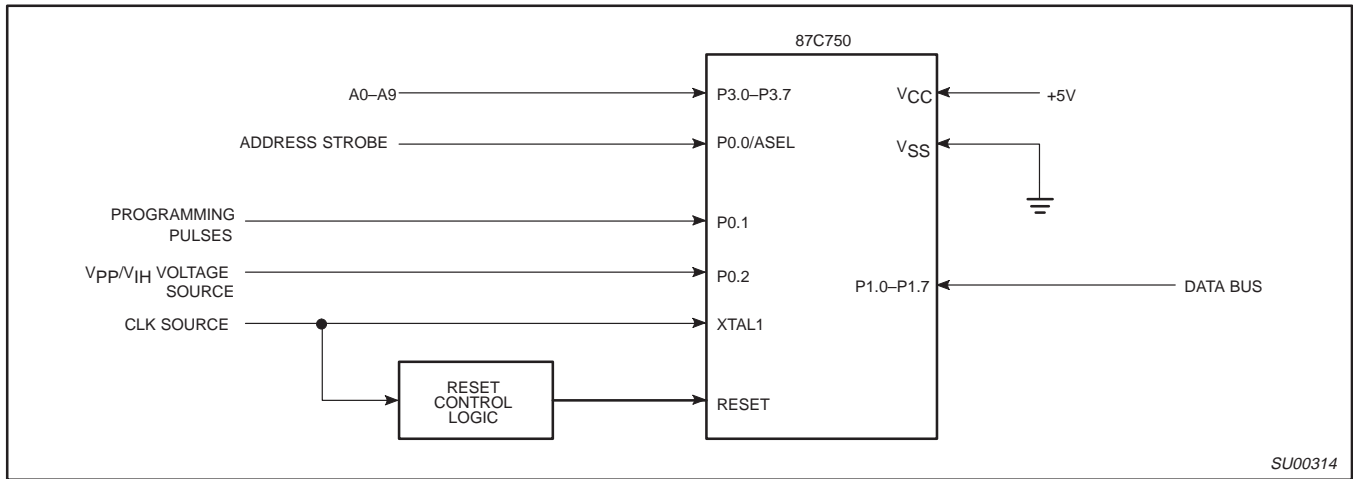


Figure 4. Programming Configuration

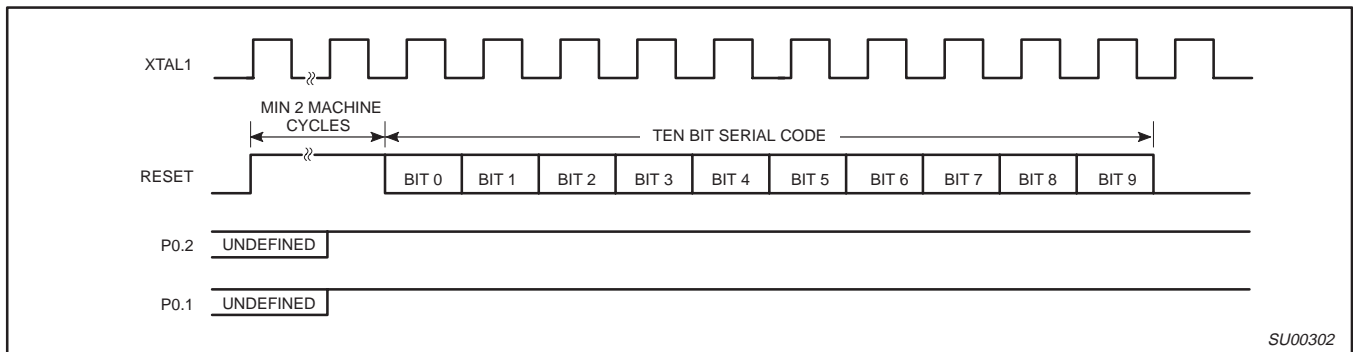


Figure 5. Entry into Program/Verify Modes

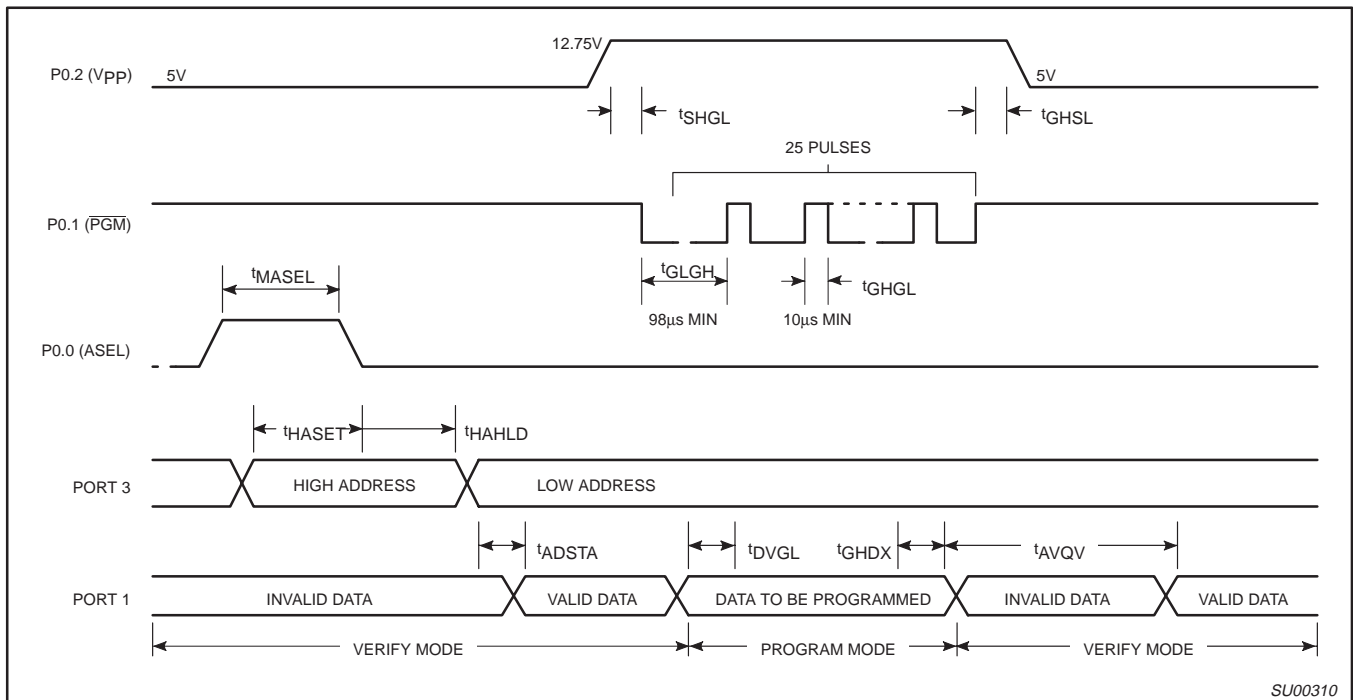


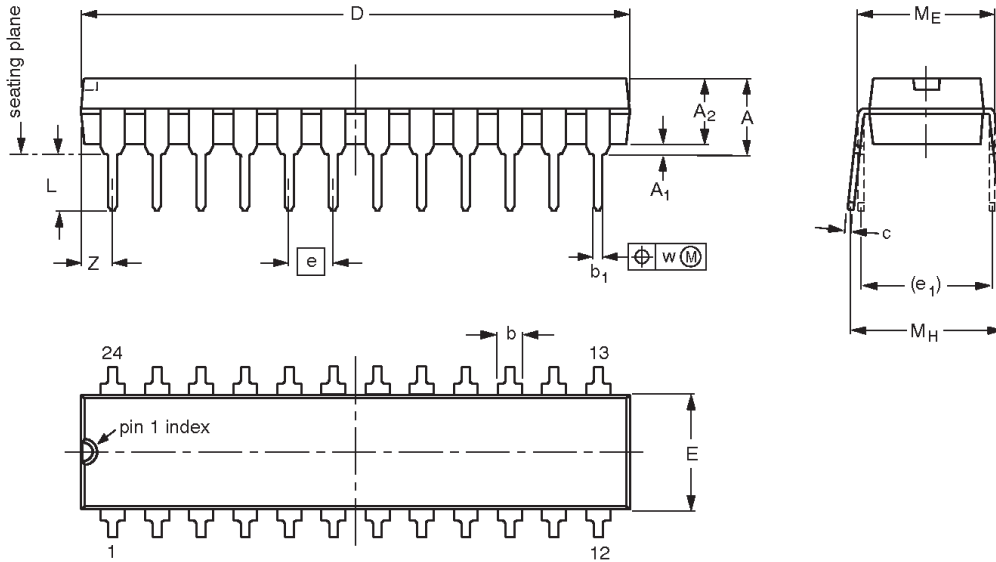
Figure 6. Program/Verify Cycle

CMOS single-chip 8-bit microcontrollers

83C750/87C750

DIP24: plastic dual in-line package; 24 leads (300 mil)

SOT222-1



**DIMENSIONS (millimetre dimensions are derived from the original inch dimensions)**

| UNIT   | A max. | A <sub>1</sub> min. | A <sub>2</sub> max. | b              | b <sub>1</sub> | c              | D <sup>(1)</sup> | E <sup>(1)</sup> | e     | e <sub>1</sub> | L              | M <sub>E</sub> | M <sub>H</sub> | w    | Z <sup>(1)</sup> max. |
|--------|--------|---------------------|---------------------|----------------|----------------|----------------|------------------|------------------|-------|----------------|----------------|----------------|----------------|------|-----------------------|
| mm     | 4.70   | 0.38                | 3.94                | 1.63<br>1.14   | 0.56<br>0.43   | 0.36<br>0.25   | 31.9<br>31.5     | 6.73<br>6.48     | 2.54  | 7.62           | 3.51<br>3.05   | 8.13<br>7.62   | 10.03<br>7.62  | 0.25 | 2.05                  |
| inches | 0.185  | 0.015               | 0.155               | 0.064<br>0.045 | 0.022<br>0.017 | 0.014<br>0.010 | 1.256<br>1.240   | 0.265<br>0.255   | 0.100 | 0.300          | 0.138<br>0.120 | 0.32<br>0.30   | 0.395<br>0.300 | 0.01 | 0.081                 |

**Note**

1. Plastic or metal protrusions of 0.01 inches maximum per side are not included.

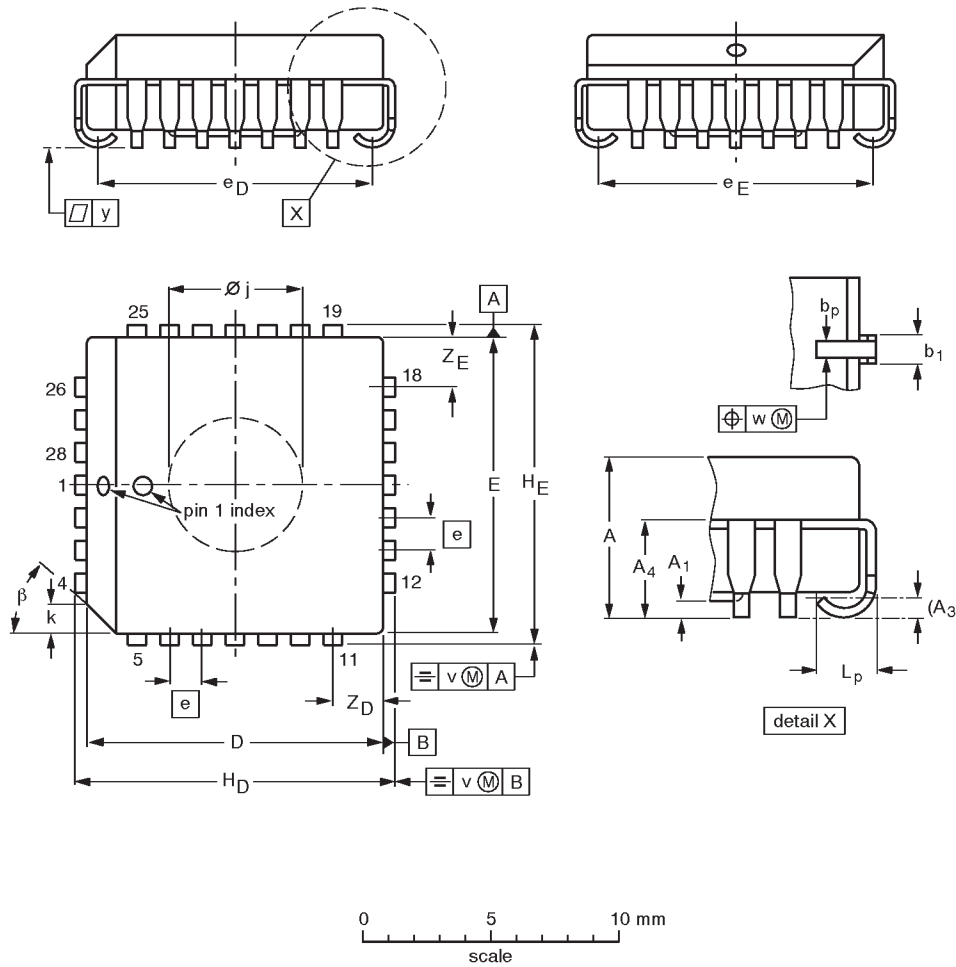
| OUTLINE VERSION | REFERENCES |          |      |  | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|------------|
|                 | IEC        | JEDEC    | EIAJ |  |                     |            |
| SOT222-1        |            | MS-001AF |      |  |                     | 95-03-11   |

CMOS single-chip 8-bit microcontrollers

83C750/87C750

PLCC28: plastic leaded chip carrier; 28 leads; pedestal

SOT261-3



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

| UNIT   | A              | A <sub>1</sub> min. | A <sub>3</sub> | A <sub>4</sub> max. | b <sub>p</sub> | b <sub>1</sub> | D <sup>(1)</sup> | E <sup>(1)</sup> | e    | e <sub>D</sub> | e <sub>E</sub> | H <sub>D</sub> | H <sub>E</sub> | k              | φ <sub>j</sub> | L <sub>p</sub> | v     | w     | y     | Z <sub>D</sub> <sup>(1)</sup> max. | Z <sub>E</sub> <sup>(1)</sup> max. | β   |
|--------|----------------|---------------------|----------------|---------------------|----------------|----------------|------------------|------------------|------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-------|-------|-------|------------------------------------|------------------------------------|-----|
| mm     | 4.57<br>4.19   | 0.13                | 0.25           | 3.05                | 0.53<br>0.33   | 0.81<br>0.66   | 11.58<br>11.43   | 11.58<br>11.43   | 1.27 | 10.92<br>9.91  | 10.92<br>9.91  | 12.57<br>12.32 | 12.57<br>12.32 | 1.22<br>1.07   | 5.69<br>5.54   | 1.44<br>1.02   | 0.18  | 0.18  | 0.10  | 2.06                               | 2.06                               | 45° |
| inches | 0.180<br>0.165 | 0.005               | 0.01           | 0.12                | 0.021<br>0.013 | 0.032<br>0.026 | 0.456<br>0.450   | 0.456<br>0.450   | 0.05 | 0.430<br>0.390 | 0.430<br>0.390 | 0.495<br>0.485 | 0.495<br>0.485 | 0.048<br>0.042 | 0.224<br>0.218 | 0.057<br>0.040 | 0.007 | 0.007 | 0.004 | 0.081                              | 0.081                              |     |

Note

1. Plastic or metal protrusions of 0.01 inches maximum per side are not included.

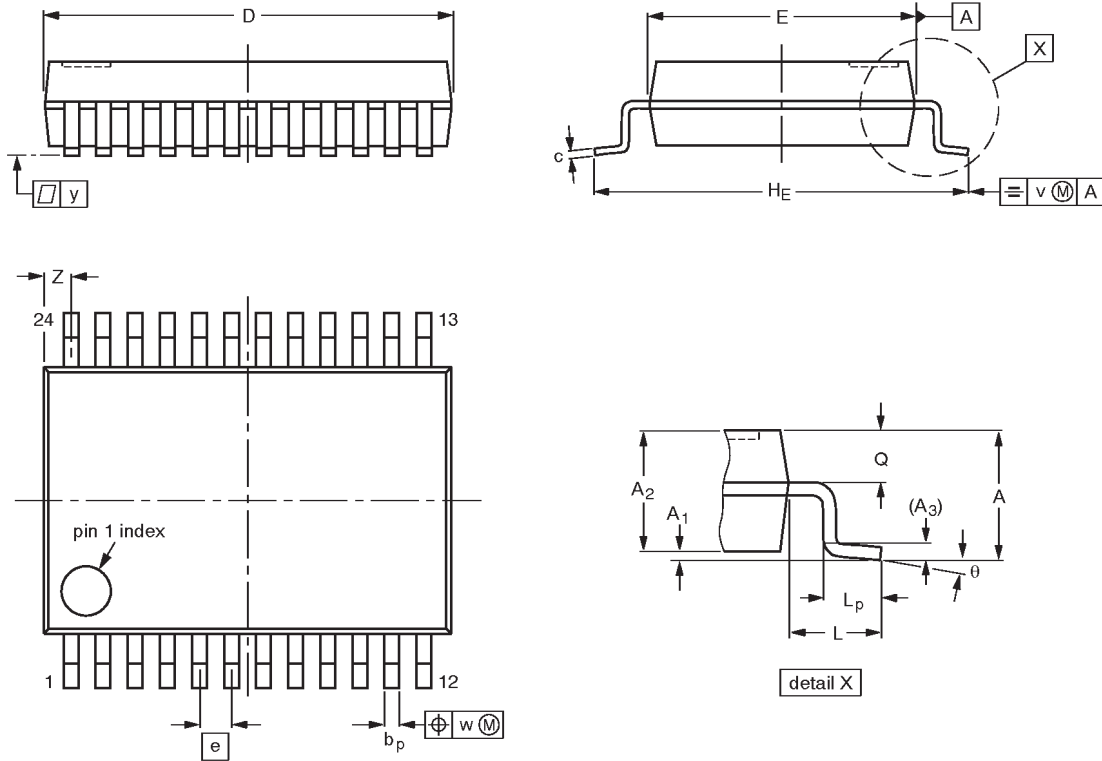
| OUTLINE VERSION | REFERENCES |          |      |  | EUROPEAN PROJECTION | ISSUE DATE           |
|-----------------|------------|----------|------|--|---------------------|----------------------|
|                 | IEC        | JEDEC    | EIAJ |  |                     |                      |
| SOT261-3        |            | MO-047AB |      |  |                     | 92-11-17<br>95-02-25 |

# CMOS single-chip 8-bit microcontrollers

# 83C750/87C750

**SSOP24:** plastic shrink small outline package; 24 leads; body width 5.3 mm

**SOT340-1**



**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | b <sub>p</sub> | c            | D <sup>(1)</sup> | E <sup>(1)</sup> | e    | H <sub>E</sub> | L    | L <sub>p</sub> | Q          | v   | w    | y   | Z <sup>(1)</sup> | θ        |
|------|--------|----------------|----------------|----------------|----------------|--------------|------------------|------------------|------|----------------|------|----------------|------------|-----|------|-----|------------------|----------|
| mm   | 2.0    | 0.21<br>0.05   | 1.80<br>1.65   | 0.25           | 0.38<br>0.25   | 0.20<br>0.09 | 8.4<br>8.0       | 5.4<br>5.2       | 0.65 | 7.9<br>7.6     | 1.25 | 1.03<br>0.63   | 0.9<br>0.7 | 0.2 | 0.13 | 0.1 | 0.8<br>0.4       | 8°<br>0° |

**Note**

1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES |          |      |  | EUROPEAN PROJECTION | ISSUE DATE           |
|-----------------|------------|----------|------|--|---------------------|----------------------|
|                 | IEC        | JEDEC    | EIAJ |  |                     |                      |
| SOT340-1        |            | MO-150AG |      |  |                     | 93-09-08<br>95-02-04 |

## CMOS single-chip 8-bit microcontrollers

83C750/87C750

## DEFINITIONS

| Data Sheet Identification        | Product Status                | Definition   |
|----------------------------------|-------------------------------|--|
| <i>Objective Specification</i>   | <b>Formative or in Design</b> | This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice.   |
| <i>Preliminary Specification</i> | <b>Preproduction Product</b>  | This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |
| <i>Product Specification</i>     | <b>Full Production</b>        | This data sheet contains Final Specifications. Philips Semiconductors reserves the right to make changes at any time without notice, in order to improve design and supply the best possible product.  |

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