

## Features

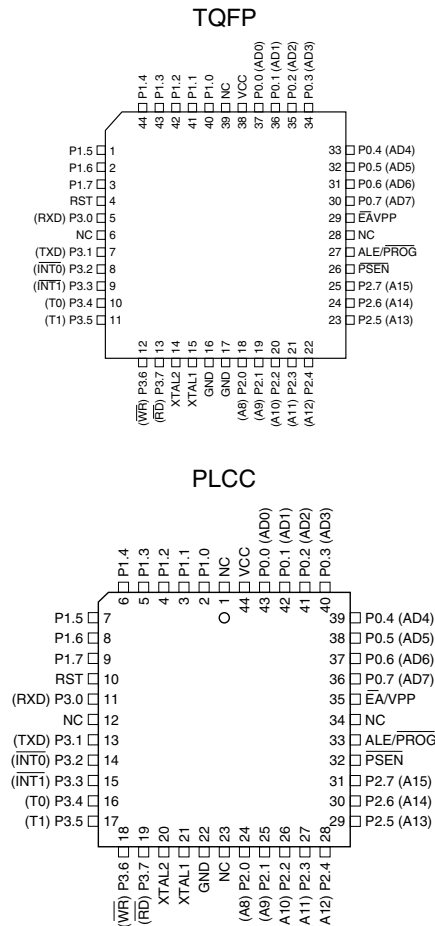
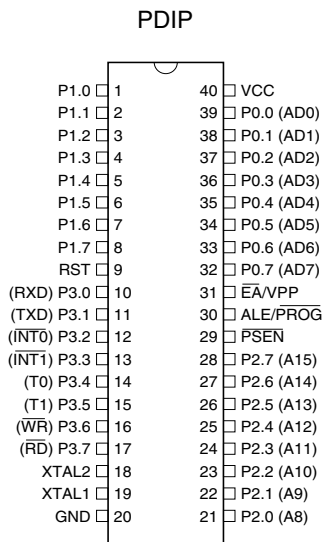
- Compatible with MCS-51™ Products
- 4K Bytes of User Programmable QuickFlash Memory
- 2.7V to 5.5V Operating Range
- Fully Static Operation: 0 Hz to 16 MHz
- Three-level Program Memory Lock
- 128 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Two 16-bit Timer/Counters
- Six Interrupt Sources
- Programmable Serial Channel
- Low-power Idle and Power-down Modes

## Description

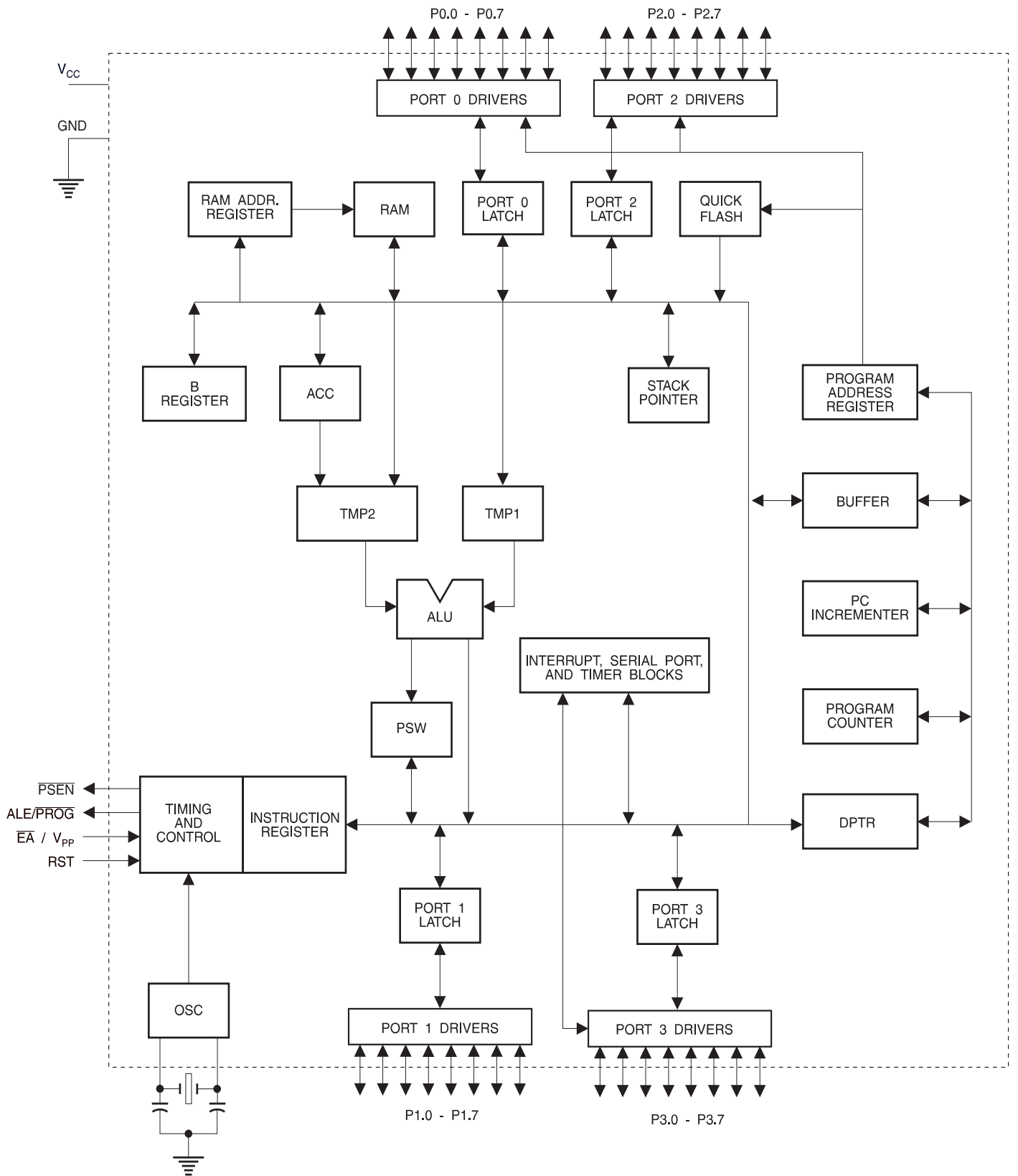
The AT87LV51 is a low-voltage, high-performance CMOS 8-bit microcontroller with 4K bytes of QuickFlash One-Time Programmable (OTP) Read Only memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry standard MCS-51 instruction set and pinout. The on-chip QuickFlash allows the program memory to be user programmed by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with QuickFlash on a monolithic chip, the Atmel AT87LV51 is a powerful microcontroller that provides a highly flexible and cost-effective solution to many embedded control applications.

(continued)

## Pin Configurations



# Block Diagram



The AT87LV51 provides the following standard features: 4K bytes of QuickFlash OTP program memory, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, a five-vector, 2-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT87LV51 is designed with static logic for operation down to zero frequency and supports two software-selectable power-saving modes. The Idle mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

## Pin Description

### VCC

Supply voltage.

### GND

Ground.

### Port 0

Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to Port 0 pins, the pins can be used as high-impedance inputs.

Port 0 may also be configured to be the multiplexed low-order address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull-ups.

Port 0 also receives the code bytes during QuickFlash programming and outputs the code bytes during program verification. External pull-ups are required during program verification.

### Port 1

Port 1 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current ( $I_{IL}$ ) because of the internal pull-ups.

Port 1 also receives the low-order address bytes during QuickFlash programming and verification.

### Port 2

Port 2 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current ( $I_{IL}$ ) because of the internal pull-ups.

Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses (MOVX @ DPTR). In this application, it uses strong internal pull-ups when emitting 1s. During accesses to external data memory that use 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register.

Port 2 also receives the high-order address bits and some control signals during QuickFlash programming and verification.

### Port 3

Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins they 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 ( $I_{IL}$ ) because of the pull-ups.

Port 3 also serves the functions of various special features of the AT87LV51 as listed below:

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	$\overline{INT0}$ (external interrupt 0)
P3.3	$\overline{INT1}$ (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)
P3.6	$\overline{WR}$ (external data memory write strobe)
P3.7	$\overline{RD}$ (external data memory read strobe)

Port 3 also receives some control signals for QuickFlash programming and verification.

### RST

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

### ALE/PROG

Address Latch Enable output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during QuickFlash programming.

In normal operation ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to external data memory.



### $\overline{\text{PSEN}}$

Program Store Enable is the read strobe to external program memory.

When the AT87LV51 is executing code from external program memory,  $\overline{\text{PSEN}}$  is activated twice each machine cycle, except that two  $\overline{\text{PSEN}}$  activations are skipped during each access to external data memory.

### $\overline{\text{EA}}/\text{VPP}$

External Access Enable.  $\overline{\text{EA}}$  must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H, up to FFFFH. Note, however, that if lock bit 1 is programmed,  $\overline{\text{EA}}$  will be internally latched on reset.

$\overline{\text{EA}}$  should be strapped to VCC for internal program executions.

This pin also receives the 12-volt programming enable voltage (VPP) during QuickFlash programming.

### XTAL1

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

### XTAL2

Output from the inverting oscillator amplifier.

## Special Function Registers

A map of the on-chip memory area called the Special Function Register (SFR) space is shown in Table 1.

**Table 1.** AT87LV51 SFR Map and Reset Values

0F8H								0FFH
0F0H	B 00000000							0F7H
0E8H								0EFH
0E0H	ACC 00000000							0E7H
0D8H								0DFH
0D0H	PSW 00000000							0D7H
0C8H								0CFH
0C0H								0C7H
0B8H	IP XX000000							0BFH
0B0H	P3 11111111							0B7H
0A8H	IE 0X000000							0AFH
0A0H	P2 11111111							0A7H
98H	SCON 00000000	SBUF XXXXXXXX						9FH
90H	P1 11111111							97H
88H	TCON 00000000	TMOD 00000000	TL0 00000000	TL1 00000000	TH0 00000000	TH1 00000000		8FH
80H	P0 11111111	SP 00000111	DPL 00000000	DPH 00000000			PCON 0XXX0000	87H

Note that not all of the addresses are occupied, and unoccupied addresses may not be implemented on the chip. Read accesses to these addresses will, in general, return random data and write accesses will have an indeterminate effect.

User software should not write 1s to these unlisted locations, since they may be used in future products to invoke new features. In that case, the reset or inactive values of the new bits will always be 0.

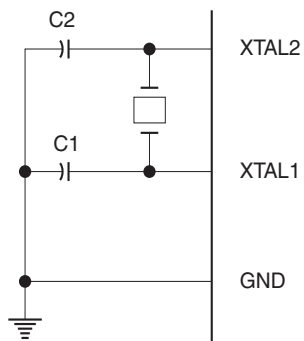
## Timer 0 and 1

Timer 0 and Timer 1 in the AT87LV51 operate the same way as Timer 0 and Timer 1 in the AT89C51.

## Oscillator Characteristics

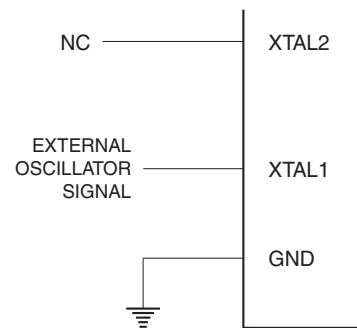
XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier, which can be configured for use as an on-chip oscillator as shown in Figure 1. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is driven as shown in Figure 2. There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide-by-two flip-flop, but minimum and maximum voltage high and low time specifications must be observed.

**Figure 1.** Oscillator Connections



Note: C1, C2 = 30 pF ± 10 pF for Crystals  
 = 40 pF ± 10 pF for Ceramic Resonators

**Figure 2.** External Clock Drive Configuration



## Idle Mode

In Idle Mode, the CPU puts itself to sleep while all the on-chip peripherals remain active. The mode is invoked by software. The content of the on-chip RAM and all the Special Function registers remains unchanged during this mode. The Idle mode can be terminated by any enabled interrupt or by a hardware reset.

It should be noted that when Idle is terminated by a hardware reset, the device normally resumes program execution from where it left off, up to two machine cycles before the internal reset algorithm takes control. On-chip hardware inhibits access to internal RAM in this event, but access to the port pins is not inhibited. To eliminate the possibility of an unexpected write to a port pin when Idle is terminated by reset, the instruction following the one that invokes Idle should not be one that writes to a port pin or to external memory.

## Power-down Mode

In Power-down Mode, the oscillator is stopped and the instruction that invokes power-down is the last instruction executed. The on-chip RAM and Special Function registers retain their values until the Power-down mode is terminated. The only exit from Power-down is a hardware reset. Reset redefines the SFRs but does not change the on-chip RAM. The reset should not be activated before  $V_{CC}$  is restored to its normal operating level and must be held active long enough to allow the oscillator to restart and stabilize.

## Status of External Pins during Idle and Power-down Modes

Mode	Program Memory	ALE	$\overline{\text{PSEN}}$	PORT0	PORT1	PORT2	PORT3
Idle	Internal	1	1	Data	Data	Data	Data
Idle	External	1	1	Float	Data	Address	Data
Power-down	Internal	0	0	Data	Data	Data	Data
Power-down	External	0	0	Float	Data	Data	Data

## Program Memory Lock Bits

The AT87LV51 has three lock bits that can be left unprogrammed (U) or can be programmed (P) to obtain the additional features listed in the table below:

## Lock Bit Protection Modes

Program Lock Bits				Protection Type
	LB1	LB2	LB3	
1	U	U	U	No program lock features.
2	P	U	U	MOV <sub>C</sub> instructions executed from external program memory are disabled from fetching code bytes from internal memory, $\overline{\text{EA}}$ is sampled and latched on reset, and further programming of the QuickFlash is disabled.
3	P	P	U	Same as mode 2, also verify is disabled.
4	P	P	P	Same as mode 3, also external execution is disabled.

When lock bit 1 is programmed, the logic level at the  $\overline{\text{EA}}$  pin is sampled and latched during reset. If the device is powered up without a reset, the latch initializes to a random value, and holds that value until reset is activated. It is necessary that the latched value of  $\overline{\text{EA}}$  be in agreement with the current logic level at that pin in order for the device to function properly.

## Programming the QuickFlash

The AT87LV51 is shipped with the on-chip QuickFlash memory array ready to be programmed. The programming interface needs a high-voltage (12-volt) program enable signal and is compatible with conventional third-party QuickFlash or EPROM programmers.

The AT87LV52 code memory array is programmed byte-by-byte.

**Programming Algorithm:** Before programming the AT87LV51, the address, data and control signals should be set up according to the QuickFlash Programming Modes table and Figure 3 and Figure 4. To program the AT87LV51, the following sequence should be followed:

1. Input the desired memory location on the address lines.
2. Input the appropriate data byte on the data lines.
3. Activate the correct combination of control signals.
4. Raise  $\overline{\text{EA}}/V_{\text{PP}}$  to 12V.
5. Pulse ALE/PROG once to program a byte in the QuickFlash array or the lock bits. The byte-write cycle is self-timed and typically takes no more than 1.5 ms. Repeat steps 1 through 5, changing the address and data for the entire array or until the end of the object file is reached.

**Data Polling:** The AT87LV51 features  $\overline{\text{Data}}$  Polling to indicate the end of a write cycle. During a write cycle, an attempted read of the last byte written will result in the complement of the written data on P0.7. Once the write cycle has been completed, true data is valid on all outputs, and the next cycle may begin.  $\overline{\text{Data}}$  Polling may begin any time after a write cycle has been initiated.

**Ready/Busy:** The progress of byte programming can also be monitored by the RDY/BSY output signal. P3.4 is pulled low after ALE goes high during programming to indicate BUSY. P3.4 is pulled high again when programming is done to indicate READY.

**Program Verify:** If lock bits LB1 and LB2 have not been programmed, the programmed code data can be read back via the address and data lines for verification. The lock bits cannot be verified directly. Verification of the lock bits is achieved by observing that their features are enabled.

**Reading the Signature Bytes:** The signature bytes are read by the same procedure as a normal verification of locations 030H and 031H, except that P3.6 and P3.7 need to be pulled to a logic low. The values returned are:

- (030H) = 1EH indicates manufactured by Atmel
- (031H) = 87H indicates 87F family
- (032H) = 03H indicates 87LV51

## Programming Interface

Every code byte in the QuickFlash array can be programmed by using the appropriate combination of control signals. The write operation cycle is self-timed and once initiated, will automatically time itself to completion.

All major programming vendors offer worldwide support for the Atmel microcontroller series. Please contact your local programming vendor for the appropriate software revision.

## QuickFlash Programming Modes

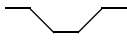
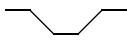
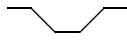
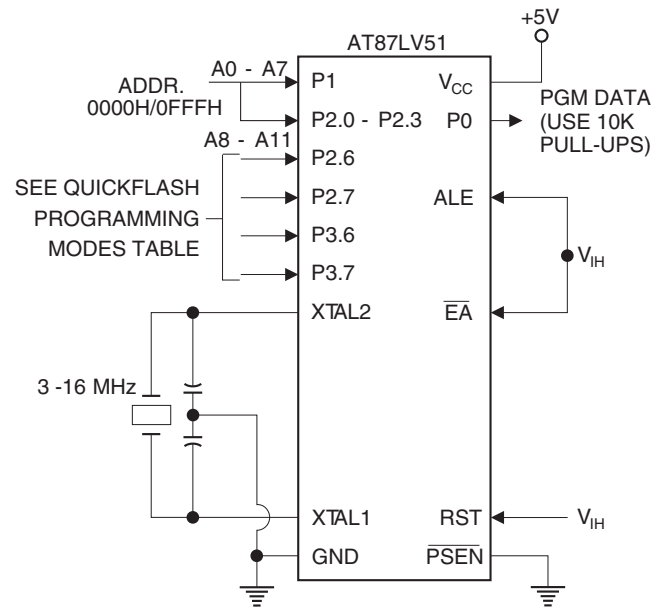
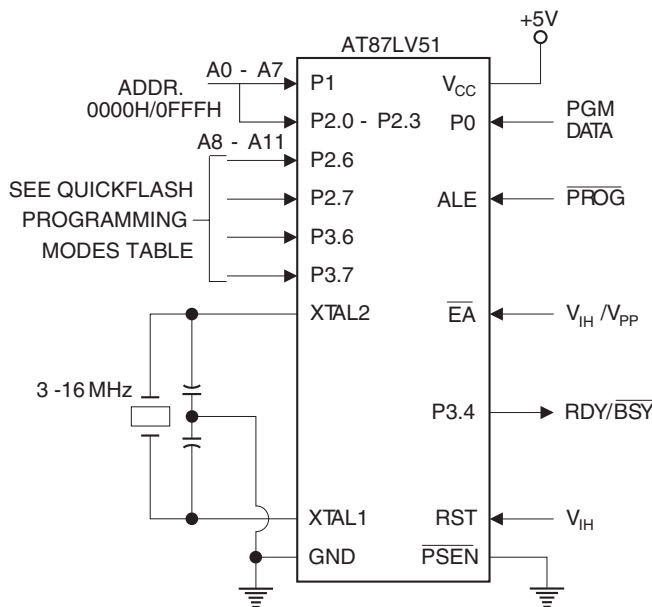
Mode	RST	PSEN	ALE/PROG	EA/V <sub>pp</sub>	P2.6	P2.7	P3.6	P3.7									
Write Code Data	H	L		12V	L	H	H	H									
Read Code Data	H	L	H	H	L	L	H	H									
Write Lock	Bit - 1	H	L		12V	H	H	H									
									Bit - 2	H	L		12V	H	H	L	L
									Bit - 3								
Read Signature Byte	H	L	H	H	L	L	L	L									

Figure 3. Programming the QuickFlash Memory

Figure 4. Verifying the QuickFlash Memory

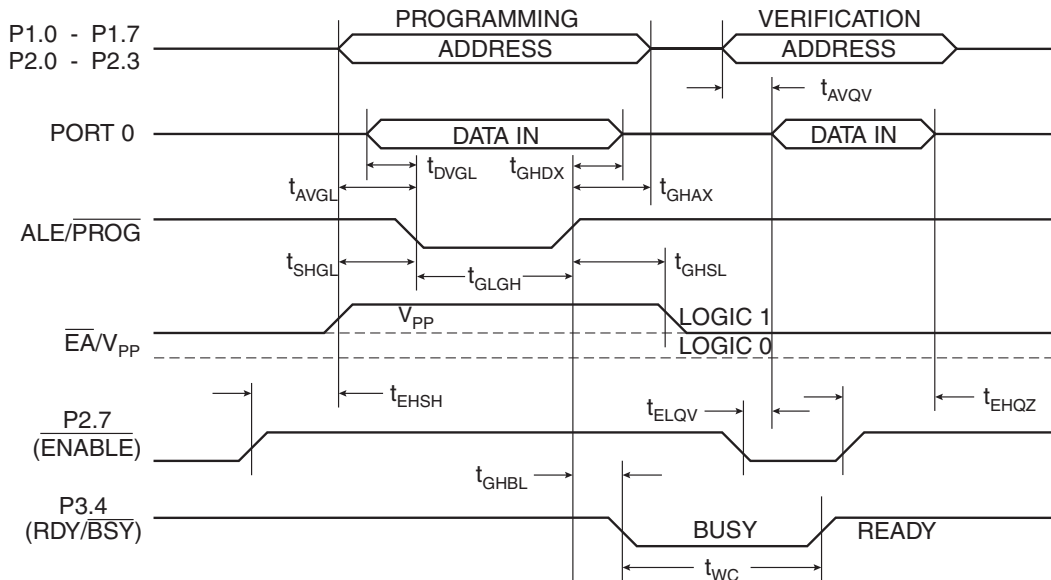


## QuickFlash Programming and Verification Characteristics

$T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ,  $V_{CC} = 5.0\text{V} \pm 10\%$

Symbol	Parameter	Min	Max	Units
$V_{PP}$	Programming Enable Voltage	11.5	12.5	V
$I_{PP}$	Programming Enable Current		1.0	mA
$1/t_{CLCL}$	Oscillator Frequency	3	16	MHz
$t_{AVGL}$	Address Setup to $\overline{\text{PROG}}$ Low	$48t_{CLCL}$		
$t_{GHAX}$	Address Hold After $\overline{\text{PROG}}$	$48t_{CLCL}$		
$t_{DVGL}$	Data Setup to $\overline{\text{PROG}}$ Low	$48t_{CLCL}$		
$t_{GHDX}$	Data Hold After $\overline{\text{PROG}}$	$48t_{CLCL}$		
$t_{EHS}$	P2.7 ( $\overline{\text{ENABLE}}$ ) High to $V_{PP}$	$48t_{CLCL}$		
$t_{SHGL}$	$V_{PP}$ Setup to $\overline{\text{PROG}}$ Low	10		$\mu\text{s}$
$t_{GHSL}$	$V_{PP}$ Hold After $\overline{\text{PROG}}$	10		$\mu\text{s}$
$t_{GLGH}$	$\overline{\text{PROG}}$ Width	1	110	$\mu\text{s}$
$t_{AVQV}$	Address to Data Valid		$48t_{CLCL}$	
$t_{ELQV}$	$\overline{\text{ENABLE}}$ Low to Data Valid		$48t_{CLCL}$	
$t_{EHQZ}$	Data Float After $\overline{\text{ENABLE}}$	0	$48t_{CLCL}$	
$t_{GHBL}$	$\overline{\text{PROG}}$ High to $\overline{\text{BUSY}}$ Low		1.0	$\mu\text{s}$
$t_{WC}$	Byte Write Cycle Time		2.0	ms

## QuickFlash Programming and Verification Waveforms





## Absolute Maximum Ratings\*

Operating Temperature.....	-55°C to +125°C
Storage Temperature.....	-65°C to +150°C
Voltage on Any Pin with Respect to Ground.....	-1.0V to +7.0V
Maximum Operating Voltage.....	6.0V
DC Output Current.....	15.0 mA

\*NOTICE: Stresses beyond 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 beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## DC Characteristics

The values shown in this table are valid for  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  and  $V_{CC} = 2.7\text{V}$  to  $5.5\text{V}$ , unless otherwise noted.

Symbol	Parameter	Condition	Min	Max	Units
$V_{IL}$	Input Low Voltage	(Except $\overline{EA}$ )	-0.5	$0.2 V_{CC} - 0.1$	V
$V_{IL1}$	Input Low Voltage ( $\overline{EA}$ )		-0.5	$0.2 V_{CC} - 0.3$	V
$V_{IH}$	Input High Voltage	(Except XTAL1, RST)	$0.2 V_{CC} + 0.9$	$V_{CC} + 0.5$	V
$V_{IH1}$	Input High Voltage	(XTAL1, RST)	$0.7 V_{CC}$	$V_{CC} + 0.5$	V
$V_{OL}$	Output Low Voltage <sup>(1)</sup> (Ports 1,2,3)	$I_{OL} = 1.6 \text{ mA}$		0.45	V
$V_{OL1}$	Output Low Voltage <sup>(1)</sup> (Port 0, ALE, $\overline{PSEN}$ )	$I_{OL} = 3.2 \text{ mA}$		0.45	V
$V_{OH}$	Output High Voltage (Ports 1,2,3, ALE, $\overline{PSEN}$ )	$I_{OH} = -60 \mu\text{A}$ , $V_{CC} = 5\text{V} \pm 10\%$	2.4		V
		$I_{OH} = -20 \mu\text{A}$	$0.75 V_{CC}$		V
		$I_{OH} = -10 \mu\text{A}$	$0.9 V_{CC}$		V
$V_{OH1}$	Output High Voltage (Port 0 in External Bus Mode)	$I_{OH} = -800 \mu\text{A}$ , $V_{CC} = 5\text{V} \pm 10\%$	2.4		V
		$I_{OH} = -300 \mu\text{A}$	$0.75 V_{CC}$		V
		$I_{OH} = -80 \mu\text{A}$	$0.9 V_{CC}$		V
$I_{IL}$	Logical 0 Input Current (Ports 1,2,3)	$V_{IN} = 0.45\text{V}$		-50	$\mu\text{A}$
$I_{TL}$	Logical 1 to 0 Transition Current (Ports 1,2,3)	$V_{IN} = 2\text{V}$ , $V_{CC} = 5\text{V} \pm 10\%$		-650	$\mu\text{A}$
$I_{LI}$	Input Leakage Current (Port 0, $\overline{EA}$ )	$0.45 < V_{IN} < V_{CC}$		$\pm 10$	$\mu\text{A}$
RRST	Reset Pulldown Resistor		50	300	$\text{K}\Omega$
$C_{IO}$	Pin Capacitance	Test Freq. = 1 MHz, $T_A = 25^\circ\text{C}$		10	pF
$I_{CC}$	Power Supply Current	Active Mode, 12 MHz, $V_{CC} = 6\text{V}/3\text{V}$		20/5.5	mA
		Idle Mode, 12 MHz, $V_{CC} = 6\text{V}/3\text{V}$		5/1	mA
	Power-down Mode <sup>(2)</sup>	$V_{CC} = 6\text{V}$		100	$\mu\text{A}$
		$V_{CC} = 3\text{V}$		20	$\mu\text{A}$

Notes: 1. Under steady state (non-transient) conditions,  $I_{OL}$  must be externally limited as follows:  
 Maximum  $I_{OL}$  per port pin: 10 mA  
 Maximum  $I_{OL}$  per 8-bit port:  
 Port 0: 26 mA  
 Ports 1, 2, 3: 15 mA

Maximum total  $I_{OL}$  for all output pins: 71 mA  
 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.

2. Minimum  $V_{CC}$  for Power-down is 2V.



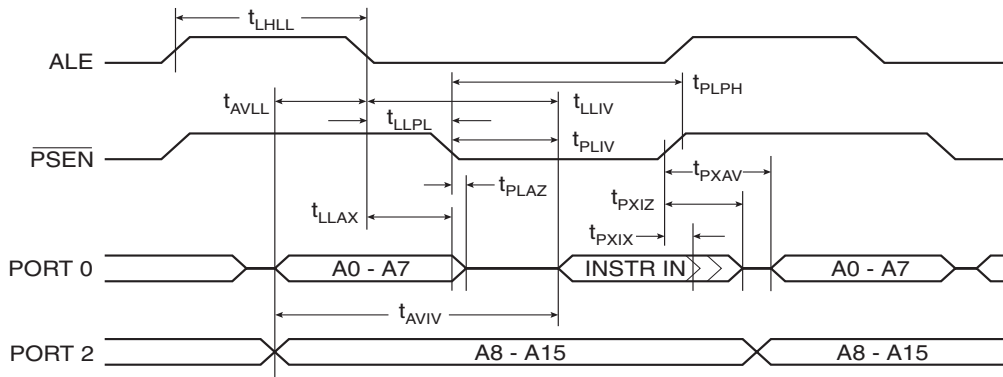
## AC Characteristics

Under operating conditions, load capacitance for Port 0, ALE/ $\overline{\text{PROG}}$ , and  $\overline{\text{PSEN}}$  = 100 pF; load capacitance for all other outputs = 80 pF.

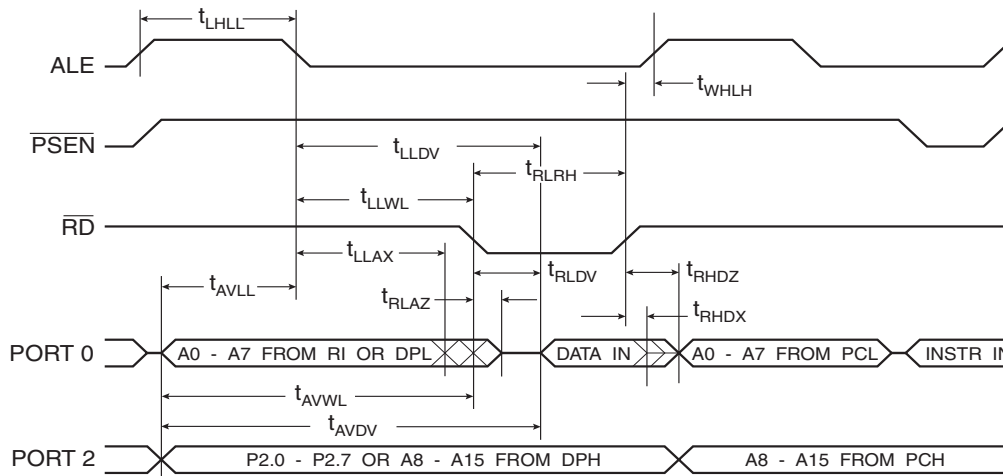
### External Program and Data Memory Characteristics

Symbol	Parameter	16 MHz Oscillator		Variable Oscillator		Units
		Min	Max	Min	Max	
$1/t_{\text{CLCL}}$	Oscillator Frequency			0	16	MHz
$t_{\text{LHLL}}$	ALE Pulse Width	85		$2t_{\text{CLCL}} - 40$		ns
$t_{\text{AVLL}}$	Address Valid to ALE Low	22		$t_{\text{CLCL}} - 40$		ns
$t_{\text{LLAX}}$	Address Hold After ALE Low	32		$t_{\text{CLCL}} - 30$		ns
$t_{\text{LLIV}}$	ALE Low to Valid Instruction In		150		$4t_{\text{CLCL}} - 100$	ns
$t_{\text{LLPL}}$	ALE Low to $\overline{\text{PSEN}}$ Low	32		$t_{\text{CLCL}} - 30$		ns
$t_{\text{PLPH}}$	$\overline{\text{PSEN}}$ Pulse Width	142		$3t_{\text{CLCL}} - 45$		ns
$t_{\text{PLIV}}$	$\overline{\text{PSEN}}$ Low to Valid Instruction In		82		$3t_{\text{CLCL}} - 105$	ns
$t_{\text{PXIX}}$	Input Instruction Hold After $\overline{\text{PSEN}}$	0		0		ns
$t_{\text{PXIZ}}$	Input Instruction Float After $\overline{\text{PSEN}}$		37		$t_{\text{CLCL}} - 25$	ns
$t_{\text{PXAV}}$	$\overline{\text{PSEN}}$ to Address Valid	75		$t_{\text{CLCL}} - 8$		ns
$t_{\text{AVIV}}$	Address to Valid Instruction In		207		$5t_{\text{CLCL}} - 105$	ns
$t_{\text{PLAZ}}$	$\overline{\text{PSEN}}$ Low to Address Float		10		10	ns
$t_{\text{RLRH}}$	$\overline{\text{RD}}$ Pulse Width	275		$6t_{\text{CLCL}} - 100$		ns
$t_{\text{WLWH}}$	$\overline{\text{WR}}$ Pulse Width	275		$6t_{\text{CLCL}} - 100$		ns
$t_{\text{RLDV}}$	$\overline{\text{RD}}$ Low to Valid Data In		147		$5t_{\text{CLCL}} - 165$	ns
$t_{\text{RHDX}}$	Data Hold After $\overline{\text{RD}}$	0		0		ns
$t_{\text{RHDZ}}$	Data Float After $\overline{\text{RD}}$		65		$2t_{\text{CLCL}} - 60$	ns
$t_{\text{LLDV}}$	ALE Low to Valid Data In		350		$8t_{\text{CLCL}} - 150$	ns
$t_{\text{AVDV}}$	Address to Valid Data In		397		$9t_{\text{CLCL}} - 165$	ns
$t_{\text{LLWL}}$	ALE Low to $\overline{\text{RD}}$ or $\overline{\text{WR}}$ Low	137	239	$3t_{\text{CLCL}} - 50$	$3t_{\text{CLCL}} + 50$	ns
$t_{\text{AVWL}}$	Address to $\overline{\text{RD}}$ or $\overline{\text{WR}}$ Low	122		$4t_{\text{CLCL}} - 130$		ns
$t_{\text{QVWX}}$	Data Valid to $\overline{\text{WR}}$ Transition	13		$t_{\text{CLCL}} - 50$		ns
$t_{\text{QVWH}}$	Data Valid to $\overline{\text{WR}}$ High	287		$7t_{\text{CLCL}} - 150$		ns
$t_{\text{WHQX}}$	Data Hold After $\overline{\text{WR}}$	13		$t_{\text{CLCL}} - 50$		ns
$t_{\text{RLAZ}}$	$\overline{\text{RD}}$ Low to Address Float		0		0	ns
$t_{\text{WHLH}}$	$\overline{\text{RD}}$ or $\overline{\text{WR}}$ High to ALE High	23	103	$t_{\text{CLCL}} - 40$	$t_{\text{CLCL}} + 40$	ns

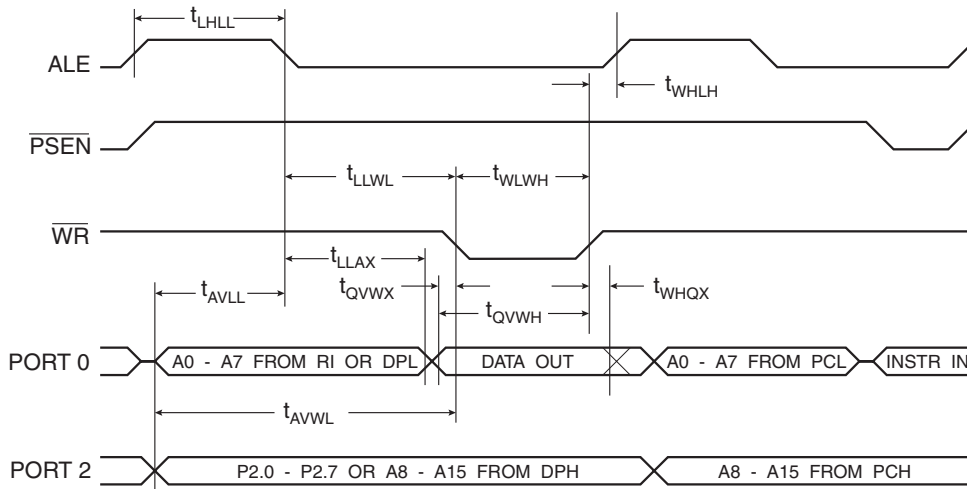
### External Program Memory Read Cycle



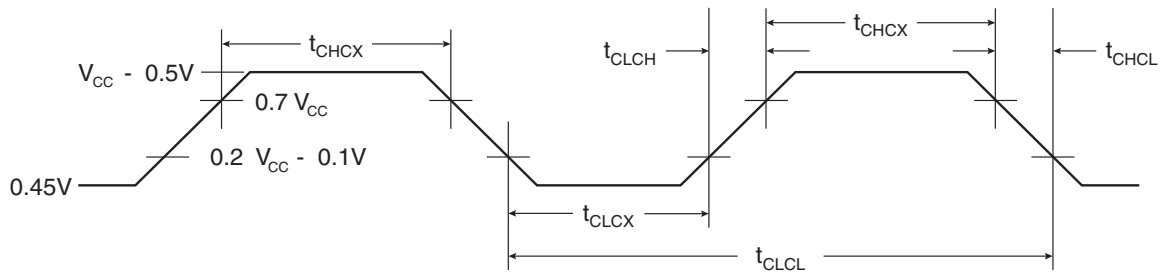
### External Data Memory Read Cycle



## External Data Memory Write Cycle



## External Clock Drive Waveforms



## External Clock Drive

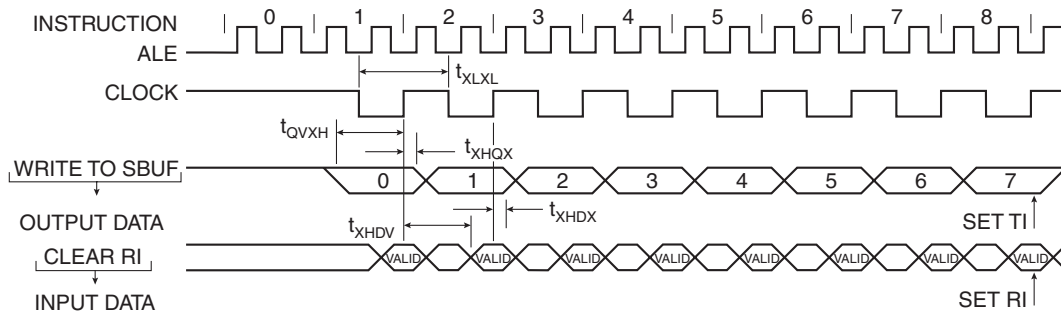
Symbol	Parameter	Min	Max	Units
$1/t_{CLCL}$	Oscillator Frequency	0	16	MHz
$t_{CLCL}$	Clock Period	62.5		ns
$t_{CHCX}$	High Time	20		ns
$t_{CLCX}$	Low Time	20		ns
$t_{CLCH}$	Rise Time		20	ns
$t_{CHCL}$	Fall Time		20	ns

## Serial Port Timing: Shift Register Mode Test Conditions

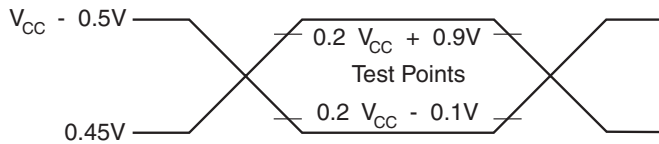
The values in this table are valid for  $V_{CC} = 2.7V$  to  $5.5V$  and Load Capacitance =  $80\text{ pF}$

Symbol	Parameter	12 MHz Oscillator		Variable Oscillator		Units
		Min	Max	Min	Max	
$t_{XLXL}$	Serial Port Clock Cycle Time	1.0		$12t_{CLCL}$		$\mu\text{s}$
$t_{QVXH}$	Output Data Setup to Clock Rising Edge	700		$10t_{CLCL} - 133$		ns
$t_{XHGX}$	Output Data Hold After Clock Rising Edge	50		$2t_{CLCL} - 117$		ns
$t_{XHDX}$	Input Data Hold After Clock Rising Edge	0		0		ns
$t_{XHDV}$	Clock Rising Edge to Input Data Valid		700		$10t_{CLCL} - 133$	ns

## Shift Register Mode Timing Waveforms

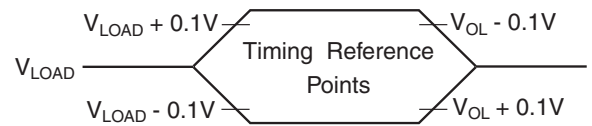


## AC Testing Input/Output Waveforms<sup>(1)</sup>



Note: 1. AC inputs during testing are driven at  $V_{CC} - 0.5V$  for a logic "1" and  $0.45V$  for a logic "0". Timing measurements are made at  $V_{IH}$  min. for a logic "1" and  $V_{IL}$  max. for a logic "0".

## Float Waveforms<sup>(1)</sup>



Note: 1. For timing purposes, a port pin is no longer floating when a  $100\text{ mV}$  change from load voltage occurs. A port pin begins to float when a  $100\text{ mV}$  change from the loaded  $V_{OH}/V_{OL}$  level occurs.



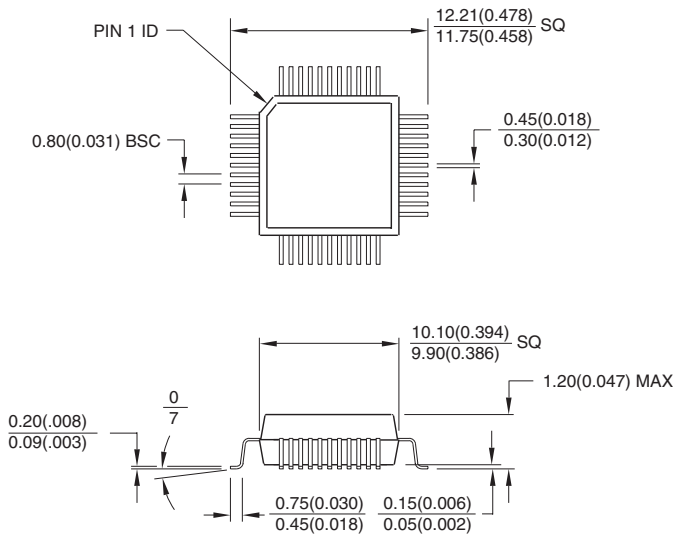
## Ordering Information

Speed (MHz)	Power Supply	Ordering Code	Package	Operation Range
12	2.7V to 5.5V	AT87LV51-12AC	44A	Commercial (0°C to 70°C)
		AT87LV51-12JC	44J	
		AT87LV51-12PC	40P6	
		AT87LV51-12AI	44A	Industrial (-40°C to 85°C)
		AT87LV51-12JI	44J	
		AT87LV51-12PI	40P6	
16	2.7V to 5.5V	AT87LV51-16AC	44A	Commercial (0°C to 70°C)
		AT87LV51-16JC	44J	
		AT87LV51-16PC	40P6	
		AT87LV51-16AI	44A	Industrial (-40°C to 85°C)
		AT87LV51-16JI	44J	
		AT87LV51-16PI	40P6	

Package Type	
<b>44A</b>	44-lead, Thin Plastic Gull Wing Quad Flatpack (TQFP)
<b>44J</b>	44-lead, Plastic J-leaded Chip Carrier (PLCC)
<b>40P6</b>	40-pin, 0.600" Wide, Plastic Dull Inline Package (PDIP)

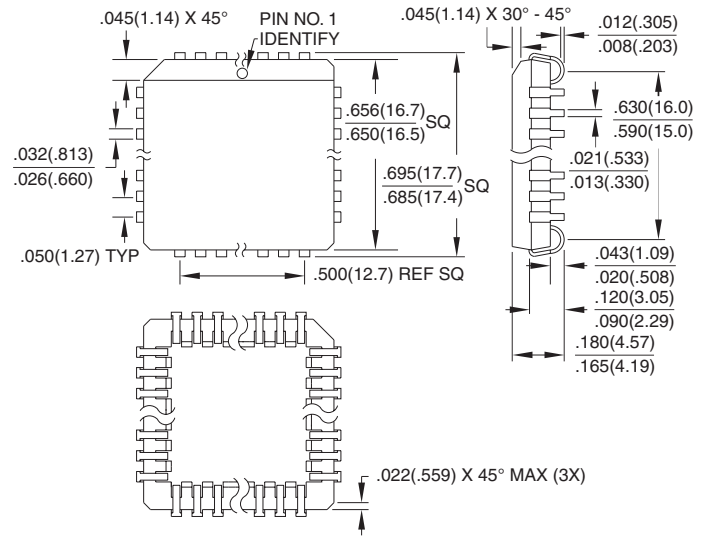
## Packaging Information

**44A**, 44-lead, Thin (1.0 mm) Plastic Gull Wing Quad Flat Package (TQFP)  
 Dimensions in Millimeters and (Inches)\*

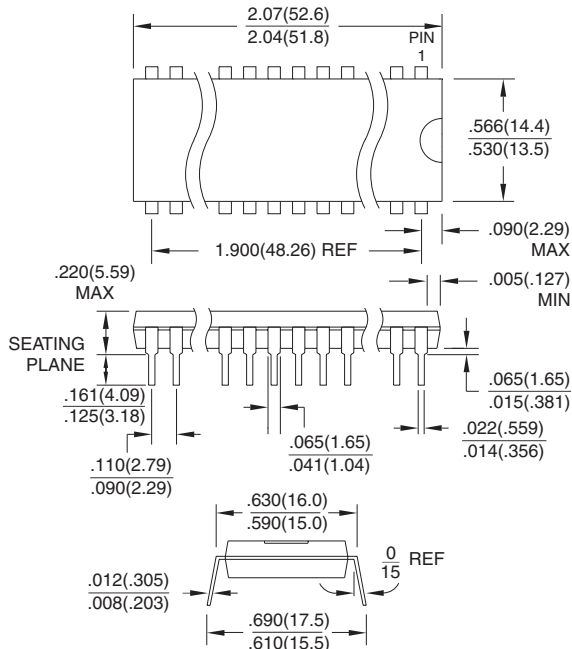


\*Controlling dimension: millimeters

**44J**, 44-lead, Plastic J-leaded Chip Carrier (PLCC)  
 Dimensions in Inches and (Millimeters)



**40P6**, 40-pin, 0.600" Wide,  
 Plastic Dual Inline Package (PDIP)  
 Dimensions in Inches and (Millimeters)  
 JEDEC STANDARD MS-011 AC





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