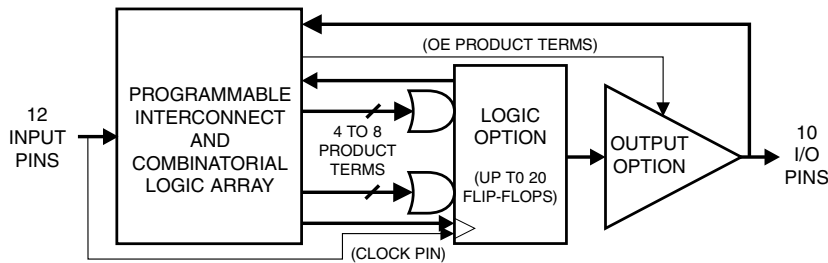


## Features

- **Advanced, High-speed, Electrically-erasable Programmable Logic Device**
  - Superset of 22V10
  - Enhanced Logic Flexibility
  - Backward Compatible with ATV750B/BL and ATV750/L
- **Low-power Edge-sensing “L” Option with 1 mA Standby Current**
- **D- or T-type Flip-flop**
- **Product Term or Direct Input Pin Clocking**
- **7.5 ns Maximum Pin-to-pin Delay with 5V Operation**
- **Highest Density Programmable Logic Available in 24-pin Package**
  - Advanced Electrically-erasable Technology
  - Reprogrammable
  - 100% Tested
- **Increased Logic Flexibility**
  - 42 Array Inputs, 20 Sum Terms and 20 Flip-flops
- **Enhanced Output Logic Flexibility**
  - All 20 Flip-flops Feed Back Internally
  - 10 Flip-flops are also Available as Outputs
- **Programmable Pin-keeper Circuits**
- **Dual-in-line and Surface Mount Package in Standard Pinouts**
- **Commercial and Industrial Temperature Ranges**
- **20-year Data Retention**
- **2000V ESD Protection**
- **1000 Erase/Write Cycles**

## Block Diagram



## Description

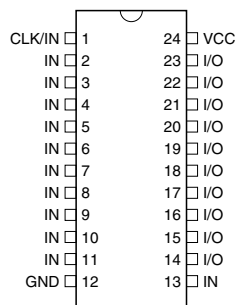
The ATF750C(L)s are twice as powerful as most other 24-pin programmable logic devices. Increased product terms, sum terms, flip-flops and output logic configurations translate into more usable gates. High-speed logic and uniform, predictable delays

*(continued)*

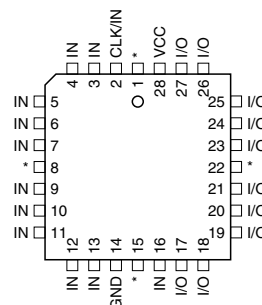
## Pin Configurations

Pin Name	Function
CLK	Clock
IN	Logic Inputs
I/O	Bi-directional Buffers
*	No Internal Connection
VCC	+5V Supply

DIP/SOIC/TSSOP



PLCC



Rev. 0776F-01/00



**High-speed  
Complex  
Programmable  
Logic Device**

**ATF750C  
ATF750CL**



guarantee fast in-system performance. The ATF750C(L) is a high-performance CMOS (electrically-erasable) complex programmable logic device (CPLD) that utilizes Atmel's proven electrically-erasable technology.

Each of the ATF750C(L)'s 22 logic pins can be used as an input. Ten of these can be used as inputs, outputs or bi-directional I/O pins. Each flip-flop is individually configurable as either D- or T-type. Each flip-flop output is fed back into the array independently. This allows burying of all the sum terms and flip-flops.

There are 171 total product terms available. There are two sum terms per output, providing added flexibility. A variable format is used to assign between four to eight product terms per sum term. Much more logic can be replaced by this device than by any other 24-pin PLD. With 20 sum

terms and flip-flops, complex state machines are easily implemented with logic to spare.

Product terms provide individual clocks and asynchronous resets for each flip-flop. Each flip-flop may also be individually configured to have direct input pin controlled clocking. Each output has its own enable product term. One product term provides a common synchronous preset for all flip-flops. Register preload functions are provided to simplify testing. All registers automatically reset upon power-up.

The ATF750C(L) is a low-power device with speeds as fast as 15 ns. The ATF750C(L) provides the optimum low-power CPLD solution. This device significantly reduces total system power, thereby allowing battery-powered operations.

### Absolute Maximum Ratings\*

Temperature Under Bias.....	-55°C to +125°C
Storage Temperature .....	-65°C to +150°C
Voltage on Any Pin with Respect to Ground .....	-2.0V to +7.0V <sup>(1)</sup>
Voltage on Input Pins with Respect to Ground During Programming.....	-2.0V to +14.0V <sup>(1)</sup>
Programming Voltage with Respect to Ground .....	-2.0V to +14.0V <sup>(1)</sup>

\*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.

Note: 1. Minimum voltage is -0.6V DC, which may undershoot to -2.0V for pulses of less than 20 ns. Maximum output pin voltage is  $V_{CC} + 0.75V$  DC, which may overshoot to 7.0V for pulses of less than 20 ns.

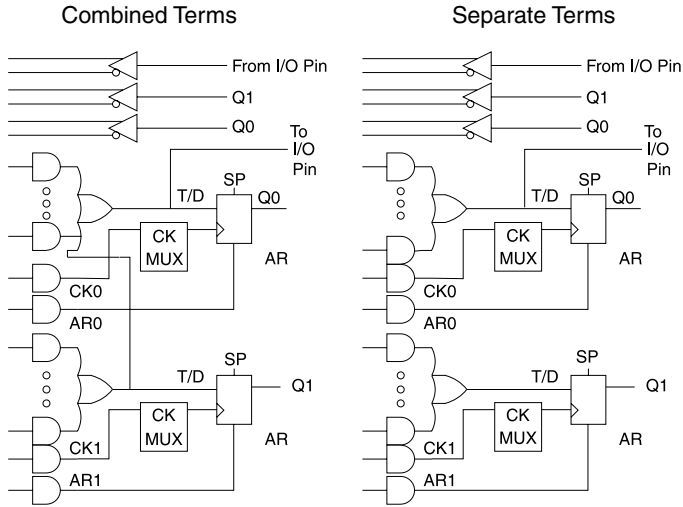
### DC and AC Operating Conditions

All members of the family are specified to operate in either one of two voltage ranges. Parameters are specified as noted to be either 2.7V to 3.6V,  $5V \pm 5\%$  or  $5V \pm 10\%$ .

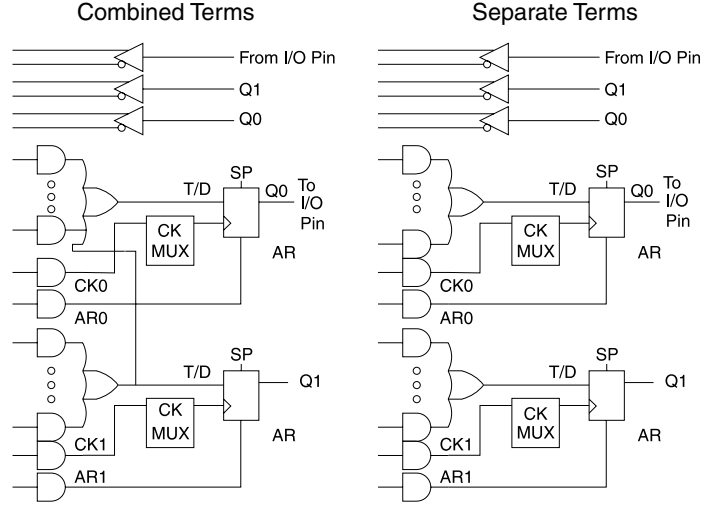
5V Operation	Commercial -7.5, -10, -15	Industrial -10, -15
Operating Temperature (Ambient)	0°C - 70°C	-40°C - +85°C
$V_{CC}$ Power Supply	$5V \pm 5\%$	$5V \pm 10\%$

## Logic Options

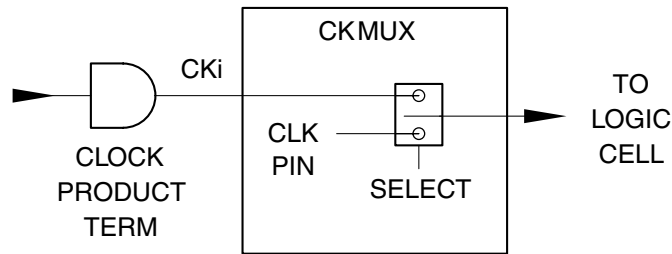
### Combinatorial Output



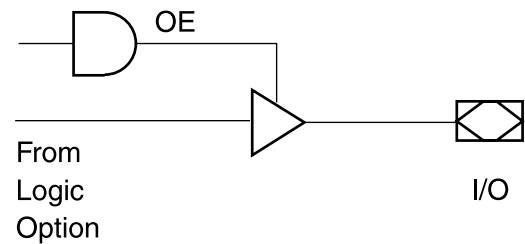
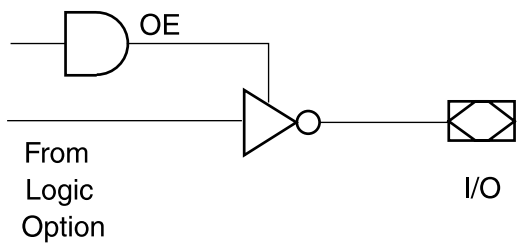
### Registered Output



## Clock Mux



## Output Options



## Bus-friendly Pin-keeper Input and I/Os

All input and I/O pins on the ATF750C(L) have programmable “pin-keeper” circuits. If activated, when any pin is driven high or low and then subsequently left floating, it will stay at that previous high or low level.

This circuitry prevents unused input and I/O lines from floating to intermediate voltage levels, which causes unnecessary power consumption and system noise. The

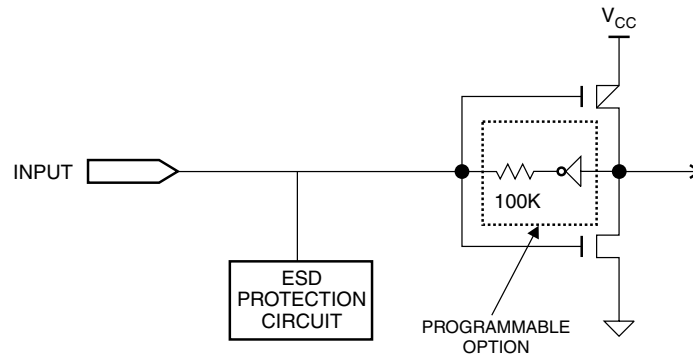
keeper circuits eliminate the need for external pull-up resistors and eliminate their DC power consumption.

Enabling or disabling of the pin-keeper circuits is controlled by the device type chosen in the logic compiler device selection menu. Please refer to the software compiler table for more details. Once the pin-keeper circuits are disabled, normal termination procedures are required for unused inputs and I/Os.

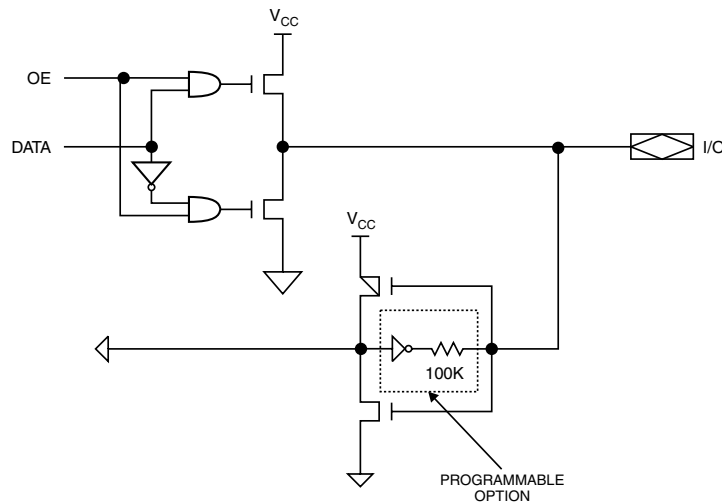
**Table 1.** Software Compiler Mode Selection

Synario	WINCUPL	Pin-keeper Circuit
ATF750C	V750C	Disabled
ATF750C (PPK)	V750CPPK	Enabled

### Input Diagram



### I/O Diagram

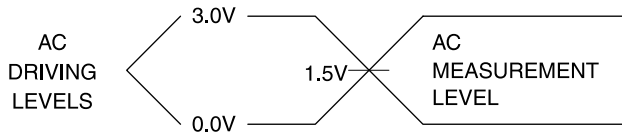


## DC Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Units	
$I_{LI}$	Input Load Current	$V_{IN} = -0.1V$ to $V_{CC} + 1V$			10	$\mu A$	
$I_{LO}$	Output Leakage Current	$V_{OUT} = -0.1V$ to $V_{CC} + 0.1V$			10	$\mu A$	
$I_{CC}$	Power Supply Current, Standby	$V_{CC} = \text{Max,}$ $V_{IN} = \text{Max,}$ Outputs Open	C-7, -10	Com.	125	180	mA
				Ind., Mil.	135	190	mA
			C-15	Com.	125	180	mA
				Ind., Mil.	135	190	mA
			CL-15	Com.	0.12	1	mA
				Ind., Mil.	0.15	2	mA
$I_{OS}^{(1)}$	Output Short Circuit Current	$V_{OUT} = 0.5V$			-120	mA	
$V_{IL}$	Input Low Voltage	$4.5 \leq V_{CC} \leq 5.5V$	-0.6		0.8	V	
$V_{IH}$	Input High Voltage		2.0		$V_{CC} + 0.75$	V	
$V_{OL}$	Output Low Voltage	$V_{IN} = V_{IH}$ or $V_{IL},$ $V_{CC} = \text{Min}$	$I_{OL} = 16 \text{ mA}$	Com., Ind.		0.5	V
			$I_{OL} = 12 \text{ mA}$	Mil.		0.5	V
			$I_{OL} = 24 \text{ mA}$	Com.		0.8	V
$V_{OH}$	Output High Voltage	$V_{IN} = V_{IH}$ or $V_{IL},$ $V_{CC} = \text{Min}$	$I_{OH} = -4.0 \text{ mA}$	2.4		V	

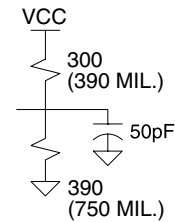
Note: 1. Not more than one output at a time should be shorted. Duration of short circuit test should not exceed 30 sec.

## Input Test Waveforms and Measurement Levels

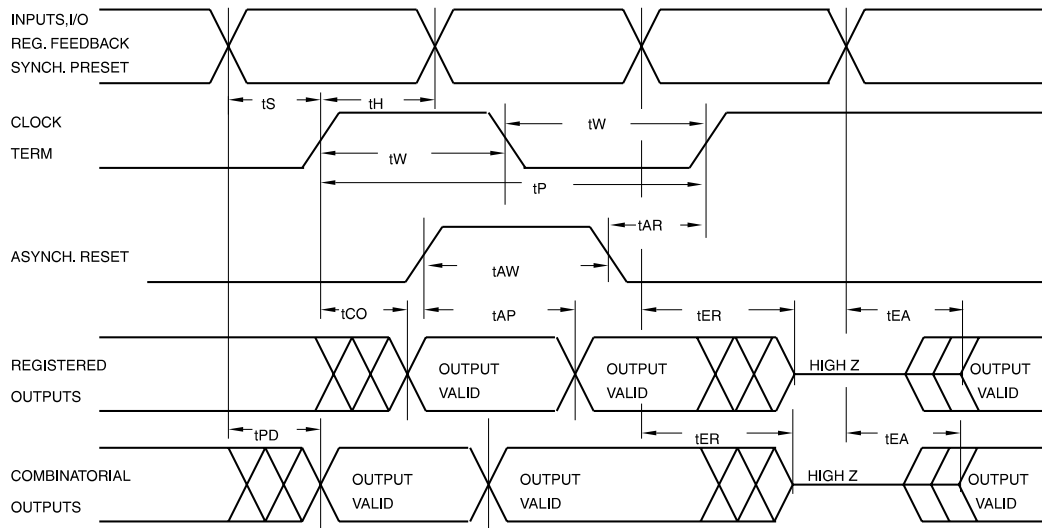


$t_R, t_F < 3 \text{ ns (10\% to 90\%)}$

## Output Test Load



## AC Waveforms, Product Term Clock<sup>(1)</sup>



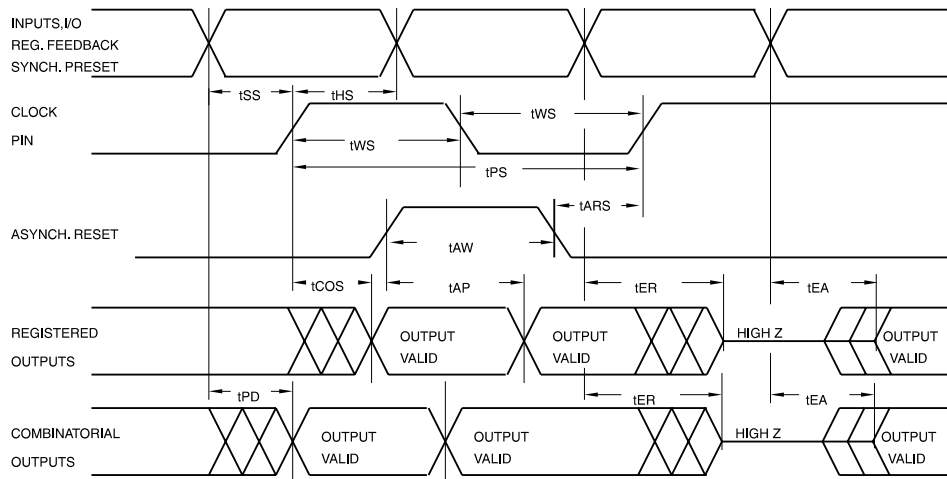
Note: 1. Timing measurement reference is 1.5V. Input AC driving levels are 0.0V and 3.0V, unless otherwise specified.

## AC Characteristics, Product Term Clock<sup>(1)</sup>

Symbol	Parameter	-7		-10		C/CL-15		Units
		Min	Max	Min	Max	Min	Max	
$t_{PD}$	Input or Feedback to Non-registered Output		7.5		10		15	ns
$t_{EA}$	Input to Output Enable		7.5		10		15	ns
$t_{ER}$	Input to Output Disable		7.5		10		15	ns
$t_{CO}$	Clock to Output	3	7.5	4	10	5	12	ns
$t_{CF}$	Clock to Feedback	1	5	4	7.5	5	9	ns
$t_S$	Input Setup Time	3		4		8/12		ns
$t_{SF}$	Feedback Setup Time	3		4		7		ns
$t_H$	Hold Time	1		2		5		ns
$t_P$	Clock Period	7		11		14		ns
$t_W$	Clock Width	3.5		5.5		7		ns
$F_{MAX}$	External Feedback $1/(t_S + t_{CO})$		95		71		50/41	MHz
	Internal Feedback $1/(t_{SF} + t_{CF})$		125		86		62	MHz
	No Feedback $1/(t_P)$		142		90		71	MHz
$t_{AW}$	Asynchronous Reset Width	5		10		15		ns
$t_{AR}$	Asynchronous Reset Recovery Time	3		10		15		ns
$t_{AP}$	Asynchronous Reset to Registered Output Reset		8		12		15	ns
$t_{SP}$	Setup Time, Synchronous Preset	4		7		8		ns

Note: 1. See ordering information for valid part numbers.

## AC Waveforms, Input Pin Clock<sup>(1)</sup>

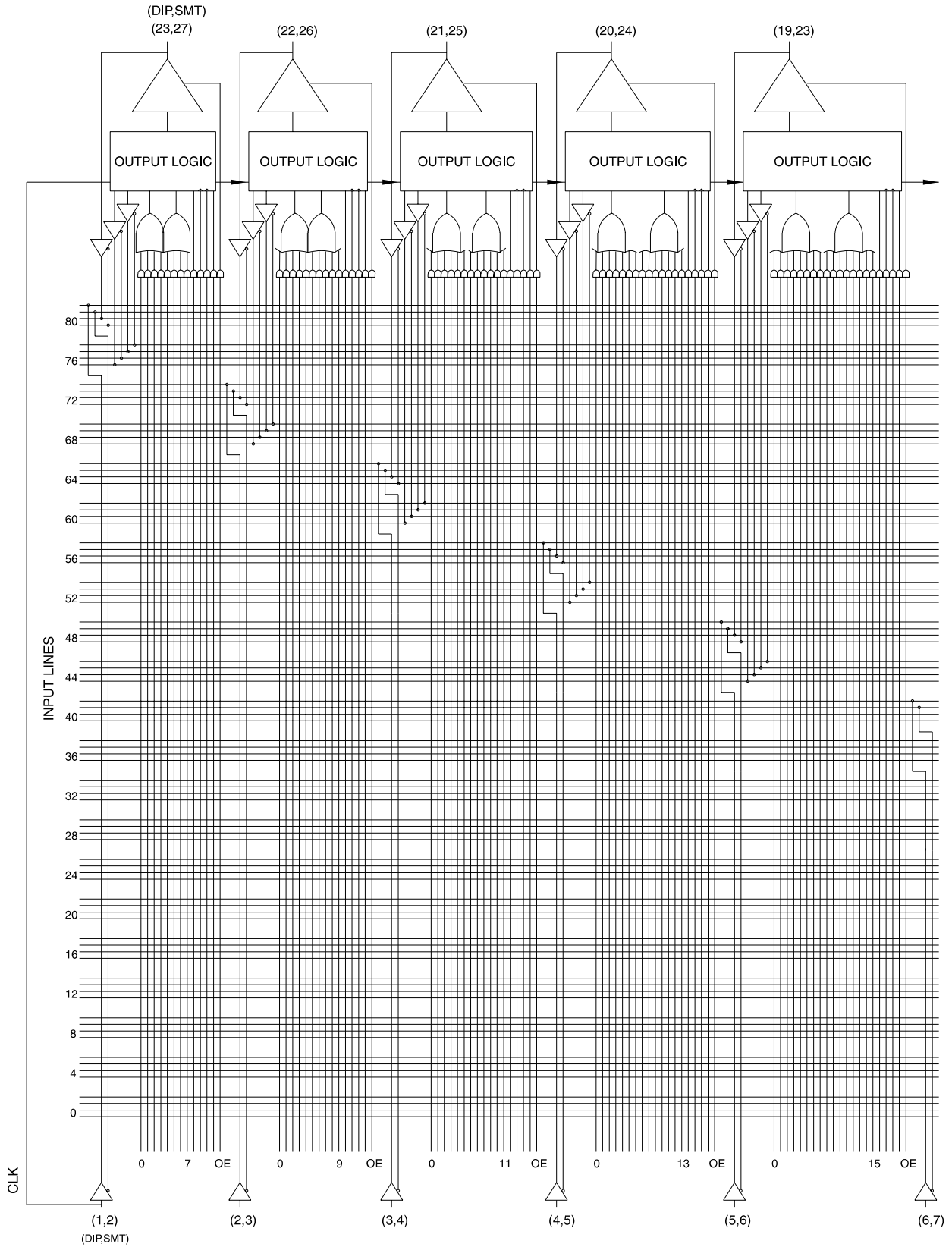


Notes: 1. Timing measurement reference is 1.5V. Input AC driving levels are 0.0V and 3.0V, unless otherwise specified.

## AC Characteristics, Input Pin Clock

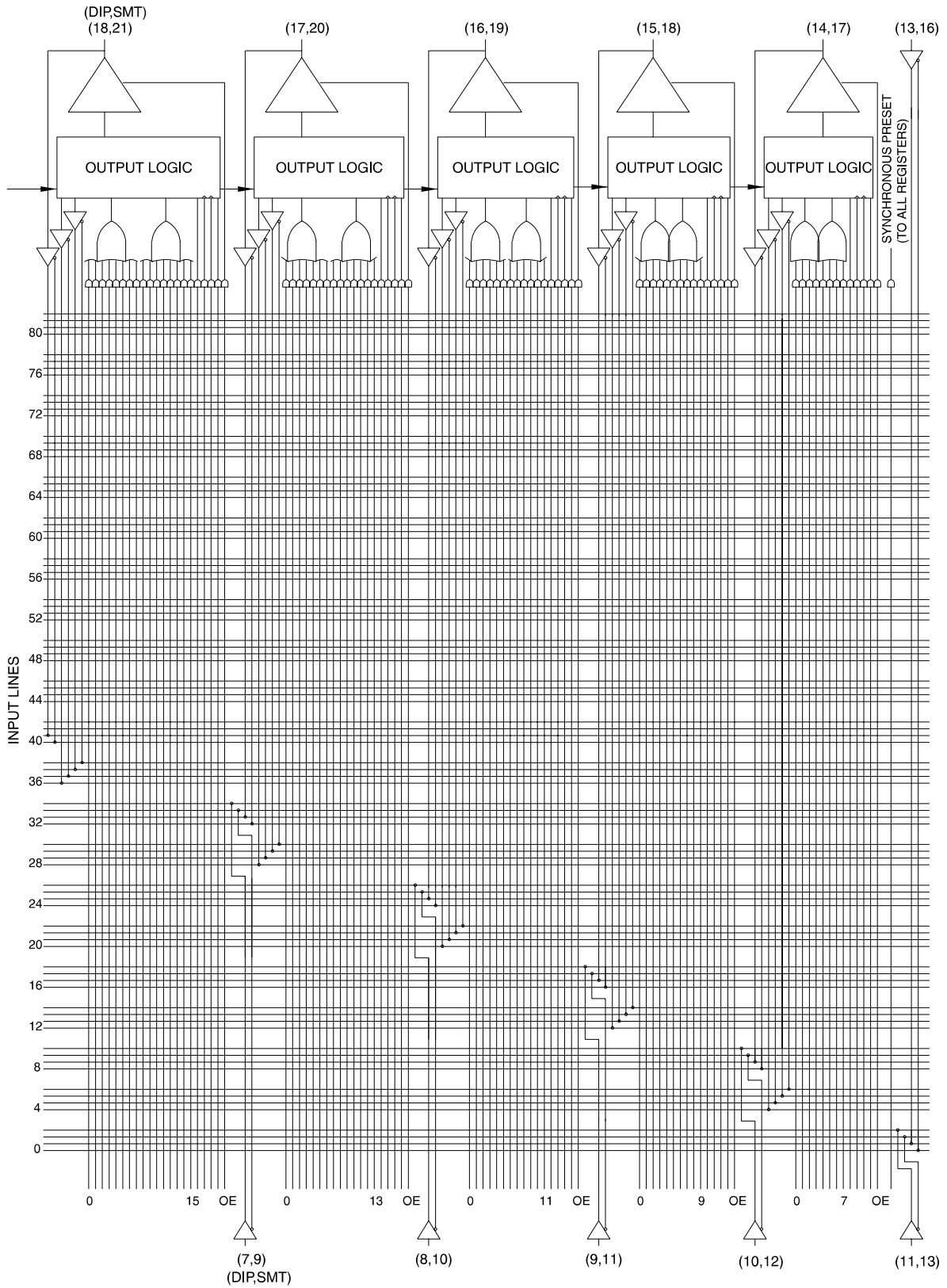
Symbol	Parameter	-7		-10		C/CL-15		Units
		Min	Max	Min	Max	Min	Max	
$t_{PD}$	Input or Feedback to Non-registered Output		7.5		10		15	ns
$t_{EA}$	Input to Output Enable		7.5		10		15	ns
$t_{ER}$	Input to Output Disable		7.5		10		15	ns
$t_{COS}$	Clock to Output	0	6.5	0	7	0	10	ns
$t_{CFS}$	Clock to Feedback	0	3.5	0	5	0	5.5	ns
$t_{SS}$	Input Setup Time	4		5		8/12.5		ns
$t_{SFS}$	Feedback Setup Time	4		5		7		ns
$t_{HS}$	Hold Time	0		0		0		ns
$t_{PS}$	Clock Period	7		10		12		ns
$t_{WS}$	Clock Width	3.5		5		6		ns
$F_{MAXS}$	External Feedback $1/(t_{SS} + t_{COS})$		95		83		55/44	MHz
	Internal Feedback $1/(t_{SFS} + t_{CFS})$		133		100		80	MHz
	No Feedback $1/(t_{PS})$		142		100		83	MHz
$t_{AW}$	Asynchronous Reset Width	5		10		15		ns
$t_{ARS}$	Asynchronous Reset Recovery Time	5		10		15		ns
$t_{AP}$	Asynchronous Reset to Registered Output Reset		8		10		15	ns
$t_{SPS}$	Setup Time, Synchronous Preset	5		5/9		11		ns

# Functional Logic Diagram ATF750C, Upper Half





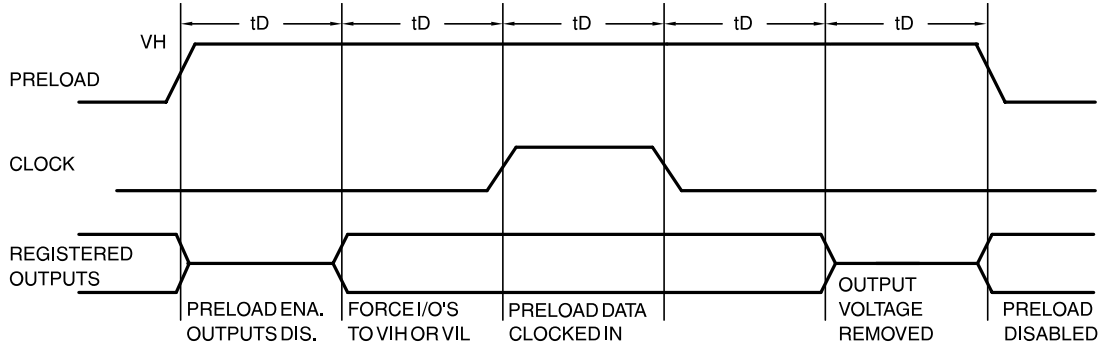
Functional Logic Diagram ATF750C, Lower Half



## Preload of Registered Outputs

The ATF750C(L)'s registers are provided with circuitry to allow loading of each register asynchronously with either a high or a low. This feature will simplify testing since any state can be forced into the registers to control test sequencing. A  $V_{IH}$  level on the I/O pin will force the register

high; a  $V_{IL}$  will force it low, independent of the output polarity. The PRELOAD state is entered by placing a 10.25V to 10.75V signal on pin 8 on DIPs, and lead 10 on SMDs. When the clock term is pulsed high, the data on the I/O pins is placed into the register chosen by the select pin.



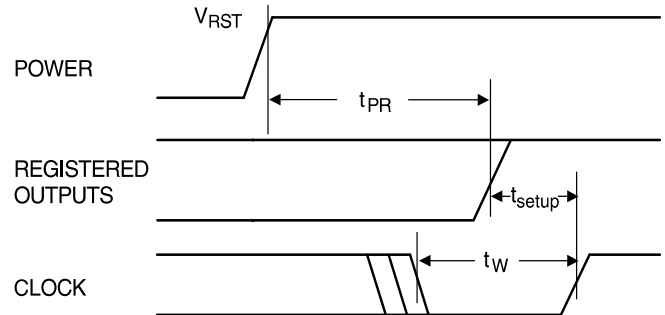
Level Forced on Registered Output Pin during Preload Cycle	Select Pin State	Register #0 State after Cycle	Register #1 State after Cycle
$V_{IH}$	Low	High	X
$V_{IL}$	Low	Low	X
$V_{IH}$	High	X	High
$V_{IL}$	High	X	Low

## Power-up Reset

The registers in the ATF750C(L)s are designed to reset during power-up. At a point delayed slightly from  $V_{CC}$  crossing  $V_{RST}$ , all registers will be reset to the low state. The output state will depend on the polarity of the output buffer.

This feature is critical for state machine initialization. However, due to the asynchronous nature of reset and the uncertainty of how  $V_{CC}$  actually rises in the system, the following conditions are required:

1. The  $V_{CC}$  rise must be monotonic,
2. After reset occurs, all input and feedback setup times must be met before driving the clock terms or pin high, and
3. The clock pin, or signals from which clock terms are derived, must remain stable during  $t_{PR}$ .



Parameter	Description	Typ	Max	Units
$t_{PR}$	Power-up Reset Time	600	1000	ns
$V_{RST}$	Power-up Reset Voltage	3.8	4.5	V

## Pin Capacitance

$f = 1 \text{ MHz}$ ,  $T = 25^\circ\text{C}^{(1)}$

	Typ	Max	Units	Conditions
$C_{IN}$	5	8	pF	$V_{IN} = 0V$
$C_{OUT}$	6	8	pF	$V_{OUT} = 0V$

Note: 1. Typical values for nominal supply voltage. This parameter is only sampled and is not 100% tested.

## Using the ATF750C's Many Advanced Features

The ATF750C(L)'s advanced flexibility packs more usable gates into 24 pins than any other logic device. The ATF750C(L)s start with the popular 22V10 architecture, and add several enhanced features:

- **Selectable D- and T-type Registers**  
Each ATF750C(L) flip-flop can be individually configured as either D- or T-type. Using the T-type configuration, JK and SR flip-flops are also easily created. These options allow more efficient product term usage.
- **Selectable Asynchronous Clocks**  
Each of the ATF750C(L)'s flip-flops may be clocked by its own clock product term or directly from Pin 1 (SMD Lead 2). This removes the constraint that all registers must use the same clock. Buried state machines, counters and registers can all coexist in one device while running on separate clocks. Individual flip-flop clock source selection further allows mixing higher performance pin clocking and flexible product term clocking within one design.
- **A Full Bank of Ten More Registers**  
The ATF750C(L) provides two flip-flops per output logic cell for a total of 20. Each register has its own sum term, its own reset term and its own clock term.
- **Independent I/O Pin and Feedback Paths**  
Each I/O pin on the ATF750C(L) has a dedicated input path. Each of the 20 registers has its own feedback terms into the array as well. This feature, combined with individual product terms for each I/O's output enable, facilitates true bi-directional I/O design.

## Synchronous Preset and Asynchronous Reset

One synchronous preset line is provided for all 20 registers in the ATF750C(L). The appropriate input signals to cause the internal clocks to go to a high state must be received during a synchronous preset. Appropriate setup and hold times must be met, as shown in the switching waveform diagram.

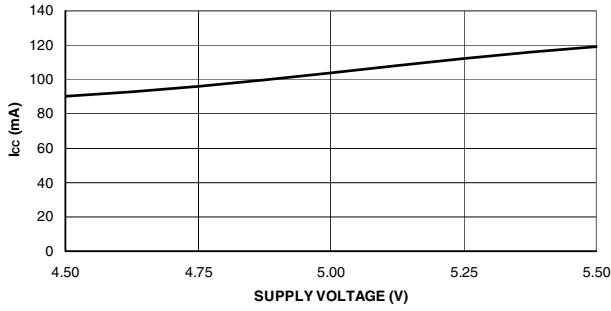
An individual asynchronous reset line is provided for each of the 20 flip-flops. Both master and slave halves of the flip-flops are reset when the input signals received force the internal resets high.

## Security Fuse Usage

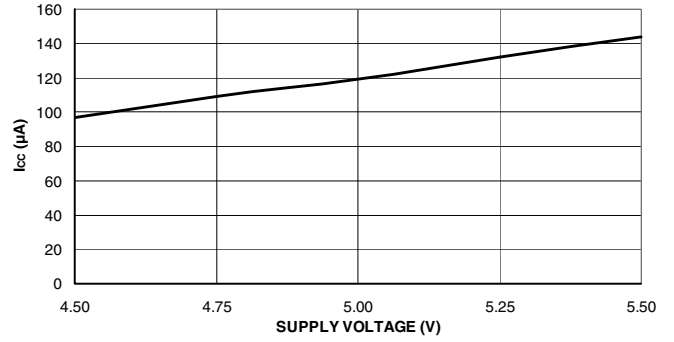
A single fuse is provided to prevent unauthorized copying of the ATF750C(L) fuse patterns. Once the security fuse is programmed, all fuses will appear programmed during verify.

The security fuse should be programmed last, as its effect is immediate.

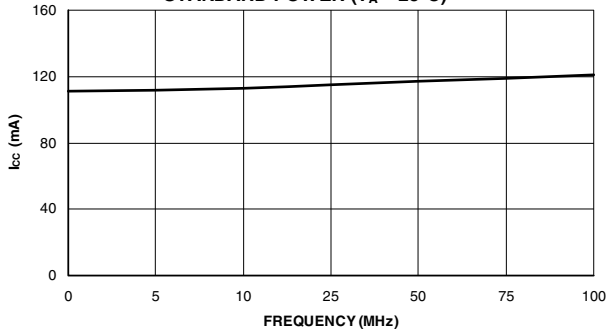
**ATF750C SUPPLY CURRENT VS. SUPPLY VOLTAGE ( $T_A = 25^\circ\text{C}$ )**



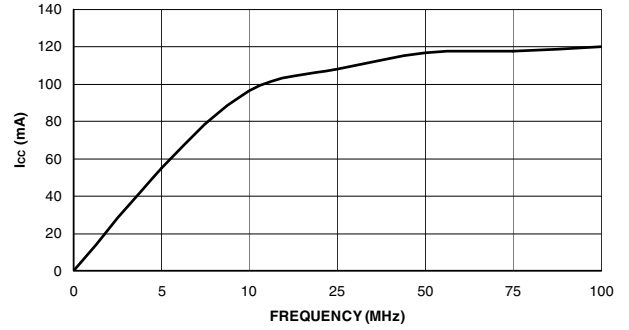
**ATF750CL SUPPLY CURRENT VS. SUPPLY VOLTAGE ( $T_A = 25^\circ\text{C}$ )**



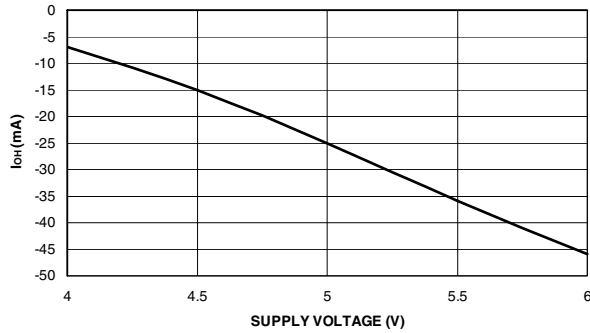
**SUPPLY CURRENT VS. FREQUENCY STANDARD POWER ( $T_A = 25^\circ\text{C}$ )**



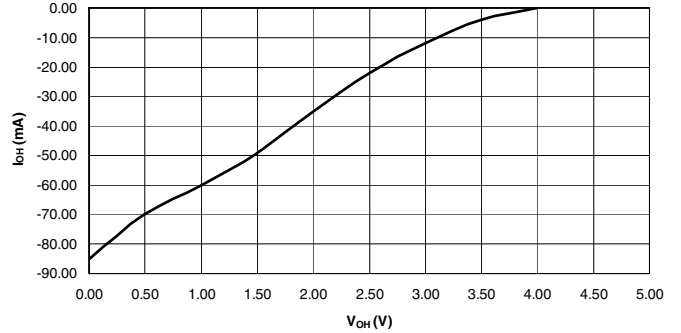
**SUPPLY CURRENT VS. FREQUENCY LOW-POWER ("L") VERSION ( $T_A = 25^\circ\text{C}$ )**



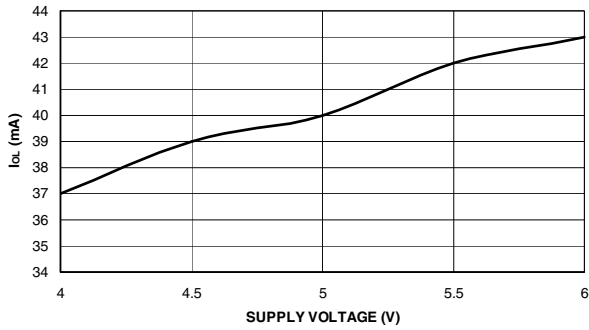
**ATF750C/CL OUTPUT SOURCE CURRENT VS. SUPPLY VOLTAGE ( $V_{OH} = 2.4\text{V}$ )**



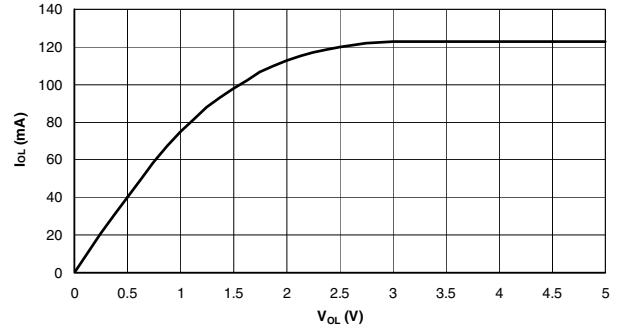
**ATF750C/CL OUTPUT SOURCE CURRENT VS. OUTPUT VOLTAGE ( $V_{CC} = 5\text{V}$ ,  $T_A = 25^\circ\text{C}$ )**



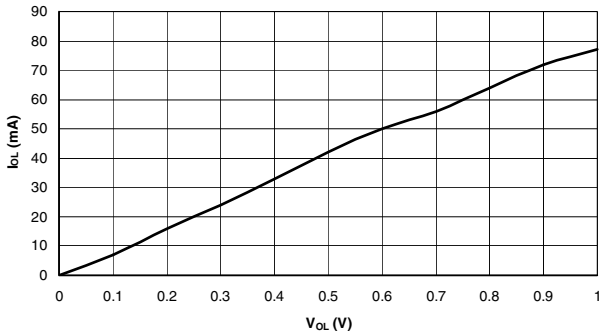
**ATF750C/CL OUTPUT SINK CURRENT  
VS. SUPPLY VOLTAGE ( $V_{OL} = 0.5V$ )**



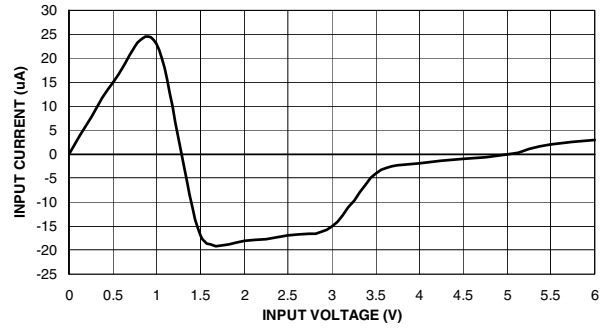
**ATF750C/CL OUTPUT SINK CURRENT  
VS. OUTPUT VOLTAGE ( $V_{CC} = 5V, T_A = 25^\circ C$ )**



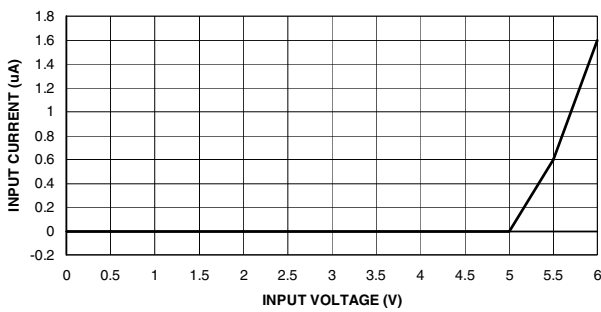
**ATF750C/CL OUTPUT SINK CURRENT  
VS. OUTPUT VOLTAGE ( $V_{CC} = 5V, T_A = 25^\circ C$ )**



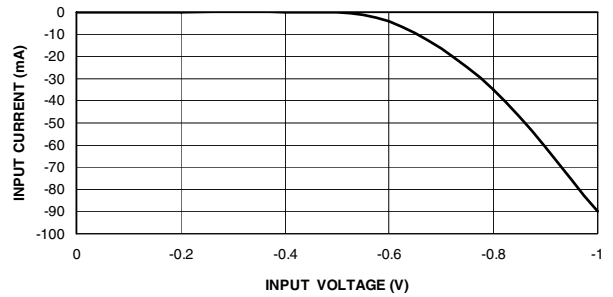
**ATF750C/CL INPUT CURRENT VS. INPUT VOLTAGE  
( $V_{CC} = 5V, T_A = 25^\circ C$ )**



**ATF750C/CL INPUT CURRENT VS. INPUT VOLTAGE  
( $V_{CC} = 5V, T_A = 25^\circ C$ )  
WITHOUT PIN-KEEPER**



**ATF750C/CL INPUT CLAMP CURRENT  
VS. INPUT VOLTAGE ( $V_{CC} = 5V, T_A = 35^\circ C$ )**





## ATF750C(L) Ordering Information

$t_{PD}$ (ns)	$t_{COS}$ (ns)	Ext. $f_{MAXS}$ (MHz)	Ordering Code	Package	Operation Range
7.5	6.5	95	ATF750C-7JC	28J	Commercial (0°C to 70°C)
10	7	83	ATF750C-10JC	28J	Commercial (0°C to 70°C)
			ATF750C-10PC	24P3	
			ATF750C-10SC	24S	
			ATF750C-10XC	24X	
			ATF750C-10JI	28J	Industrial (-40°C to 85°C)
			ATF750C-10PI	24P3	
ATF750C-10SI	24S				
15	10	55	ATF750C-15JC	28J	Commercial (0°C to 70°C)
			ATF750C-15PC	24P3	
			ATF750C-15SC	24S	
			ATF750C-15XC	24X	
			ATF750C-15JI	28J	Industrial (-40°C to 85°C)
			ATF750C-15PI	24P3	
ATF750C-15SI	24S				
15	10	44	ATF750CL-15JC	28J	Commercial (0°C to 70°C)
			ATF750CL-15PC	24P3	
			ATF750CL-15SC	24S	
			ATF750CL-15XC	24X	
			ATF750CL-15JI	28J	Industrial (-40°C to 85°C)
			ATF750CL-15PI	24P3	
ATF750CL-15SI	24S				

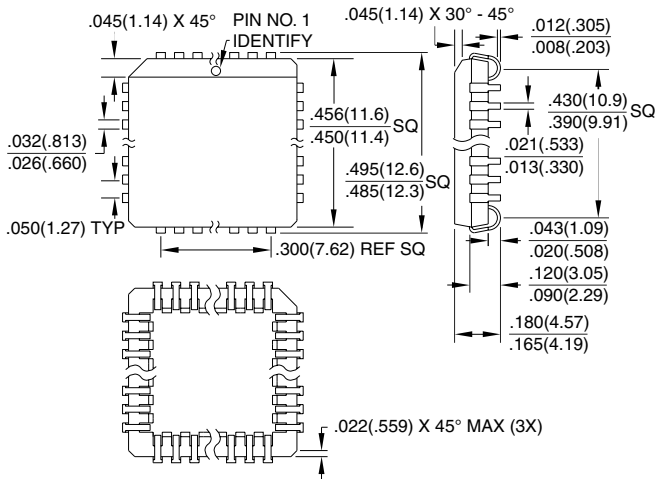
### Using “C” Product for Industrial

To use commercial product for industrial ranges, down-grade one speed grade from the “I” to the “C” device (7 ns “C” = 10 ns “I”) and de-rate power by 30%.

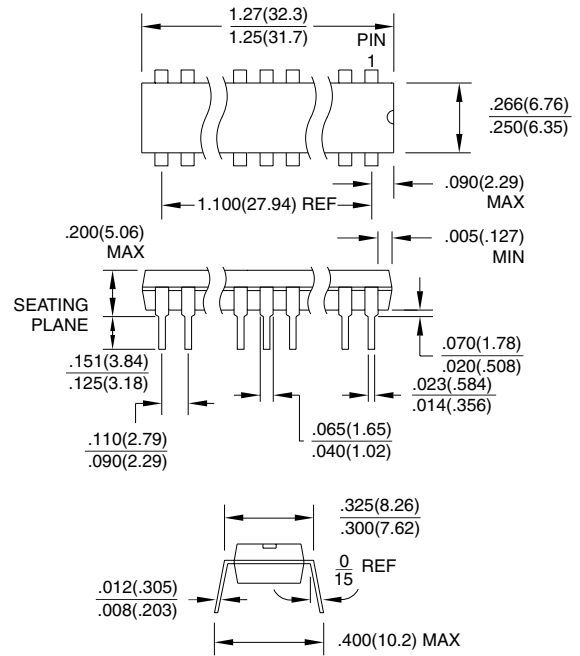
Package Type	
<b>28J</b>	28-lead, Plastic J-leaded Chip Carrier (PLCC)
<b>24P3</b>	24-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
<b>24S</b>	24-lead, 0.300" Wide, Plastic Gull Wing Small Outline (SOIC)
<b>24X</b>	24-lead, 0.173" Wide, Thin Shrink Small Outline (TSSOP)

## Packaging Information

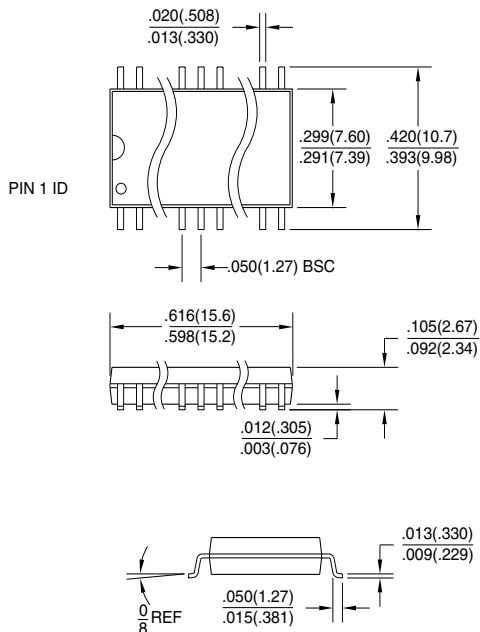
**28J**, 28-lead, Plastic J-leaded Chip Carrier (PLCC)  
 Dimensions in Inches and (Millimeters)  
 JEDEC STANDARD MS-018 AB



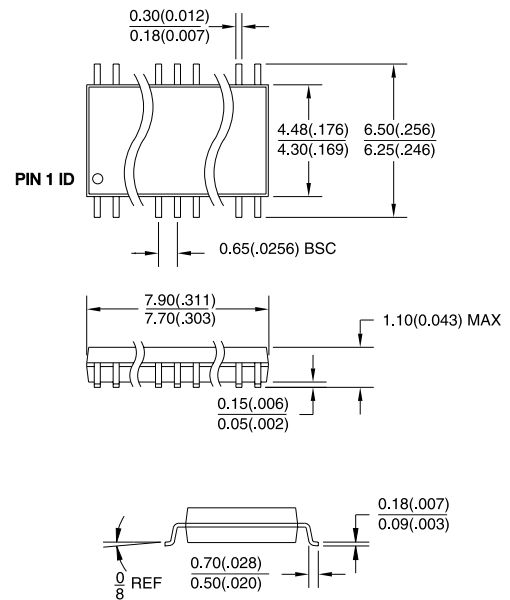
**24P3**, 24-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)  
 Dimensions in Inches and (Millimeters)  
 JEDEC STANDARD MS-001 AF



**24S**, 24-lead, 0.300" Wide, Plastic Gull Wing Small Outline (SOIC)  
 Dimensions in Inches and (Millimeters)



**24X**, 24-lead, 0.173" Wide, Thin Shrink Small Outline (TSSOP)  
 Dimensions in Millimeters and (Inches)\*



\*Controlling dimension: millimeters



## Atmel Headquarters

### *Corporate Headquarters*

2325 Orchard Parkway  
San Jose, CA 95131  
TEL (408) 441-0311  
FAX (408) 487-2600

### *Europe*

Atmel U.K., Ltd.  
Coliseum Business Centre  
Riverside Way  
Camberley, Surrey GU15 3YL  
England  
TEL (44) 1276-686-677  
FAX (44) 1276-686-697

### *Asia*

Atmel Asia, Ltd.  
Room 1219  
Chinachem Golden Plaza  
77 Mody Road Tsimhatsui  
East Kowloon  
Hong Kong  
TEL (852) 2721-9778  
FAX (852) 2722-1369

### *Japan*

Atmel Japan K.K.  
9F, Tonetsu Shinkawa Bldg.  
1-24-8 Shinkawa  
Chuo-ku, Tokyo 104-0033  
Japan  
TEL (81) 3-3523-3551  
FAX (81) 3-3523-7581

## Atmel Operations

### *Atmel Colorado Springs*

1150 E. Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906  
TEL (719) 576-3300  
FAX (719) 540-1759

### *Atmel Rousset*

Zone Industrielle  
13106 Rousset Cedex  
France  
TEL (33) 4-4253-6000  
FAX (33) 4-4253-6001

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### *Fax-on-Demand*

North America:  
1-(800) 292-8635  
International:  
1-(408) 441-0732

### *e-mail*

[literature@atmel.com](mailto:literature@atmel.com)

### *Web Site*

<http://www.atmel.com>

### *BBS*

1-(408) 436-4309

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