High Performance Flash PLD

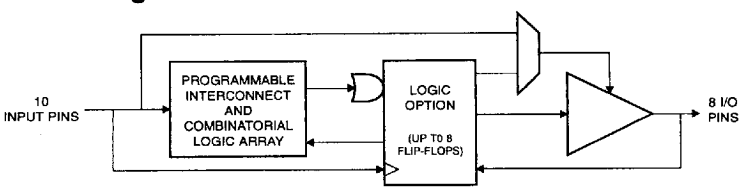
Features

- **Industry Standard Architecture**
  - **Emulates Many 20-Pin PALs®**
  - **Low Cost Easy-to-Use Software Tools**
- **High Speed Electrically Erasable Programmable Logic Devices**
  - **7.5 ns Maximum Pin-to-Pin Delay**
- **Several Power Saving Options**

Device	Icc, Stand-By	Icc, Active
ATF16V8B	50 mA	55 mA
ATF16V8BQ	35 mA	40 mA
ATF16V8BL	5 mA	30 mA
ATF16V8BQL	5 mA	20 mA

- **CMOS and TTL Compatible Inputs and Outputs**
  - **Input and I/O Pull-Up Resistors**
- **Advanced Flash Technology**
  - **Reprogrammable**
  - **100% Tested**
- **High Reliability CMOS Process**
  - **20 Year Data Retention**
  - **100 Erase/Write Cycles**
  - **2,000 V ESD Protection**
  - **200 mA Latchup Immunity**
- **Full Military, Commercial, and Industrial Temperature Ranges**
- **Dual-in-Line and Surface Mount Packages in Standard Pinouts**

Block Diagram



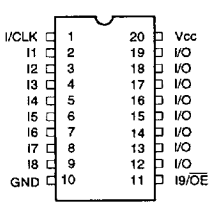
Description

The ATF16V8B is a high performance CMOS (Electrically Erasable) Programmable Logic Device (PLD) which utilizes Atmel's proven electrically erasable Flash memory technology. Speeds down to 7.5 ns and power dissipation as low as 10 mA are offered. All speed ranges are specified over the full 5 V ± 10% range for military and industrial temperature ranges, and 5 V ± 5% for commercial temperature ranges.

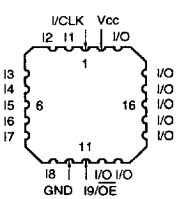
Pin Configurations

Pin Name	Function
CLK	Clock
I	Logic Inputs
I/O	Bidirectional Buffers
$\overline{OE}$	Output Enable
VCC	+5 V Supply

DIP/SOIC



LCC/PLCC



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	-2.0 V to +7.0 V(1)
Voltage on Input Pins with Respect to Ground During Programming	-2.0 V to +14.0 V(1)
Programming Voltage with Respect to Ground	-2.0 V to +14.0 V(1)

*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 -0.6 V dc, which may undershoot to -2.0 V for pulses of less than 20 ns. Maximum output pin voltage is Vcc + 0.75 V dc, which may overshoot to 7.0 V for pulses of less than 20 ns.

D.C. and A.C. Operating Conditions

	Commercial	Industrial	Military
Operating Temperature (Case)	0°C - 70°C	-40°C - 85°C	-55°C - 125°C
Vcc Power Supply	5 V ± 5%	5 V ± 10%	5 V ± 10%

D.C. Characteristics

Symbol	Parameter	Condition			Min	Max	Units
I_{IL}	Input or I/O Low Leakage Current	$0 \le V_{IN} \le V_{IL}$(MAX)				-150	µA
I_{IH}	Input or I/O High Leakage Current	$3.5 \le V_{IN} \le V_{CC}$				10	µA
I_{CC}	Power Supply Current, Standby	V_{CC} = MAX, V_{IN} = MAX, Outputs Open	ATF16V8B	Com.		110	mA
				Ind., Mil.		120	mA
			ATF16V8BL	Com.		10	mA
				Ind., Mil.		15	mA
I_{CC2}	Clocked Power Supply Current	V_{CC} = MAX, Outputs Open	ATF16V8BL	Com.		15	mA/MHz(2)
				Ind., Mil.		20	mA/MHz(2)
I_{CC3}	Clocked Power Supply Current	V_{CC} = MAX, Outputs Open, f=25 MHz		Com.		115	mA
				Ind., Mil.		140	mA
I_{OS} (1)	Output Short Circuit Current	V_{OUT} = 0.5 V				-130	mA
V_{IL}	Input Low Voltage				-0.5	0.8	V
V_{IH}	Input High Voltage				2.0	Vcc+0.75	V
V_{OL}	Output Low Voltage	V_{IN} = V_{IH} or V_{IL}, V_{CC} = MIN	I_{OL} = 24 mA	Com., Ind.		0.5	V
			I_{OL} = 16 mA	Mil.		0.5	V
V_{OH}	Output High Voltage	V_{IN}=V_{IH} or V_{IL}, V_{CC}=MIN	I_{OH} = -4.0 mA		2.4		V

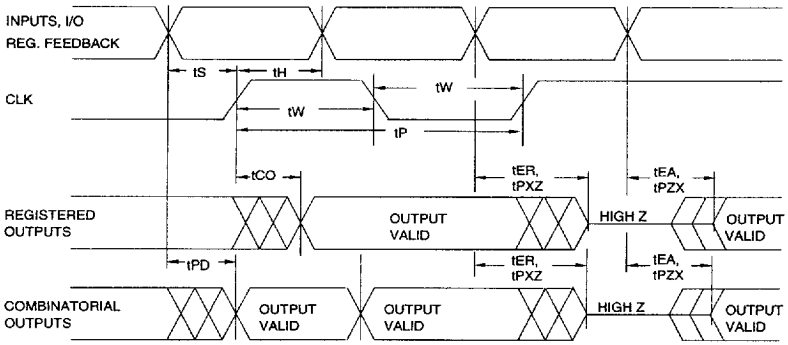
Notes: 1. Not more than one output at a time should be shorted. Duration of short circuit test should not exceed 30 sec.
2. Low frequency only, contact factory for I_{CC} versus frequency characterization curves.

D.C. Characteristics

Symbol	Parameter	Condition			Min	Typ	Max	Units
I_{IL}	Input or I/O Low Leakage Current	$0 \le V_{IN} \le V_{IL}$(MAX)				-35	-100	µA
I_{IH}	Input or I/O High Leakage Current	$3.5 \le V_{IN} \le V_{CC}$					10	µA
I_{CC}	Power Supply Current, Standby	V_{CC} = MAX, V_{IN} = MAX, Outputs Open	B-7, -10	Com.		55	85	mA
				Ind., Mil.		55	95	mA
			B-15, -25	Com.		50	75	mA
				Ind., Mil.		50	80	mA
			BQ-10	Com.		35	55	mA
			BL-15, BQL-15, -25	Com.		5	10	mA
				Ind., Mil.		5	15	mA
I_{CC2}	Clocked Power Supply Current	V_{CC} = MAX, Outputs Open	BL-15, BQL-15, -25	Com.		1		mA/MHz(2)
				Ind., Mil.		1		mA/MHz(2)
I_{CC3}	Clocked Power Supply Current	V_{CC} = MAX, Outputs Open, f=15 MHz	B-7, -10	Com.		60	90	mA
				Ind., Mil.		60	100	mA
			B-15, -25	Com.		55	85	mA
				Ind., Mil.		55	95	mA
			BQ-10	Com.		40	55	mA
			BL-15	Com.		30	40	mA
				Ind., Mil.		30	45	mA
			BQL-15, -25	Com.		20	35	mA
				Ind., Mil.		20	40	mA
I_{OS} (1)	Output Short Circuit Current	V_{OUT} = 0.5 V					-130	mA
V_{IL}	Input Low Voltage				-0.5		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} = MIN	I_{OL} = 24 mA	Com., Ind.			0.5	V
			I_{OL} = 16 mA	Mil.			0.5	V
V_{OH}	Output High Voltage	$V_{IN}=V_{IH}$ or V_{IL}, V_{CC}=MIN	I_{OH} = -4.0 mA		2.4			V

Notes: 1. Not more than one output at a time should be shorted. Duration of short circuit test should not exceed 30 sec.
2. Low frequency only. See Supply Current versus Input Frequency curves.

A.C. Waveforms [1]



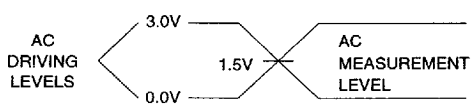
Note: 1. Timing measurement reference is 1.5 V. Input AC driving levels are 0.0 V and 3.0 V, unless otherwise specified.

A.C. Characteristics [1]

Symbol	Parameter		-7 Min	-7 Max	-10 Min	-10 Max	-15 Min	-15 Max	-25 Min	-25 Max	Units
t_{PD}	Input or Feedback to Non-Registered Output	8 outputs switching	3	7.5	3	10	3	15	3	25	ns
		1 output switching		7							ns
t_{CF}	Clock to Feedback			3		6		8		10	ns
t_{CO}	Clock to Output		2	5	2	7	2	10	2	12	ns
t_S	Input or Feedback Setup Time		5		7.5		12		15		ns
t_H	Hold Time		0		0		0		0		ns
t_P	Clock Period		8		12		16		24		ns
t_W	Clock Width		4		6		8		12		ns
F_{MAX}	External Feedback $1/(t_S+t_{CO})$			100		68		45		37	MHz
	Internal Feedback $1/(t_S + t_{CF})$			125		74		50		40	MHz
	No Feedback $1/(t_P)$			125		83		62		41	MHz
t_{EA}	Input to Output Enable — Product Term		3	9	3	10	3	15	3	20	ns
t_{ER}	Input to Output Disable — Product Term		2	9	2	10	2	15	2	20	ns
t_{PZX}	$\overline{OE}$ pin to Output Enable		2	6	2	10	2	15	2	20	ns
t_{PXZ}	$\overline{OE}$ pin to Output Disable		1.5	6	1.5	10	1.5	15	1.5	20	ns

Note: 1. See ordering information for valid part numbers and speed grades.

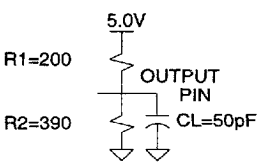
Input Test Waveforms and Measurement Levels:



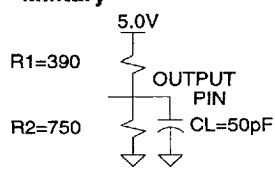
tR, tF < 5ns (10% to 90%)

Output Test Loads:

Commercial



Military



Pin Capacitance (f = 1 MHz, T = 25°C) [1]

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

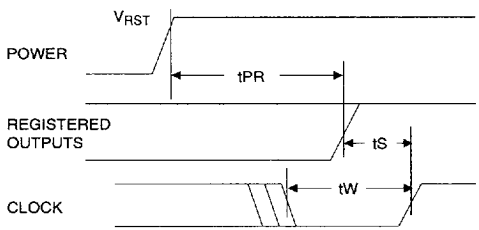
Note: 1. Typical values for nominal supply voltage. This parameter is only sampled and is not 100% tested.

Power Up Reset

The registers in the ATF16V8Bs 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. As a result, the registered output state will always be high on power-up.

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 term high, and
3) The signals from which the clock is derived must remain stable during t_{PR}.



Parameter	Description	Typ	Max	Units
t_{PR}	Power-Up Reset Time	600	1,000	ns
V_{RST}	Power-Up Reset Voltage	3.8	4.5	V

Preload of Registered Outputs

The ATF16V8B's registers are provided with circuitry to allow loading of each register 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 JEDEC file with preload is generated when a source file with vectors is compiled. Once downloaded, the JEDEC file preload sequence will be done automatically by most of the approved programmers after the programming.

Security Fuse Usage

A single fuse is provided to prevent unauthorized copying of the ATF16V8B fuse patterns. Once programmed, fuse verify and preload are inhibited. However, the 64-bit User Signature remains accessible.

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

Electronic Signature Word

There are 64-bits of programmable memory that are always available to the user, even if the device is secured. These bits can be used for user-specific data.

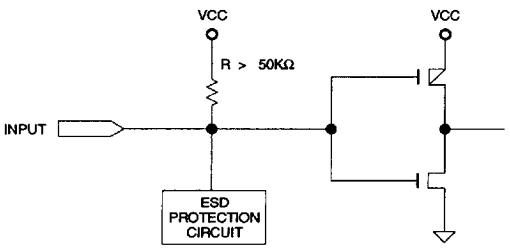
Programming/Erasing

Programming/erasing is performed using standard PLD programmers. See *CMOS PLD Programming Hardware & Software Support* for information on software/programming.

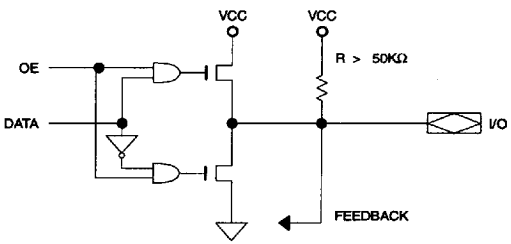
Input and I/O Pull-Ups

The ATF16V8B and ATF16V8BL have internal input and I/O pull-up resistors. Therefore, whenever inputs or I/Os are not being driven externally, they will float to Vcc. This ensures that all logic array inputs are at known states. These are relatively weak active pull-ups that can easily be overdriven by TTL-compatible drivers (see input and I/O diagrams below).

Input Diagram



I/O Diagram



Functional Logic Diagram Description

The Logic Option and Functional Diagrams describe the ATF16V8B architecture. Eight configurable macrocells can be configured as a registered output, combinatorial I/O, combinatorial output, or dedicated input.

The ATF16V8B can be configured in one of three different modes. Each mode makes the ATF16V8B look like a different device. Most PLD compilers can choose the right mode automatically. The user can also force the selection by supplying the compiler with a mode selection. The determining factors would be the usage of register versus combinatorial outputs and dedicated outputs versus outputs with output enable control.

The ATF16V8B universal architecture can be programmed to emulate many 20-pin PAL devices. These architectural subsets can be found in each of the configuration modes described in the following pages. The user can download the listed subset device JEDEC programming file to the PLD programmer, and the ATF16V8B can be configured to act like the chosen device. Check with your programmer manufacturer for this capability.

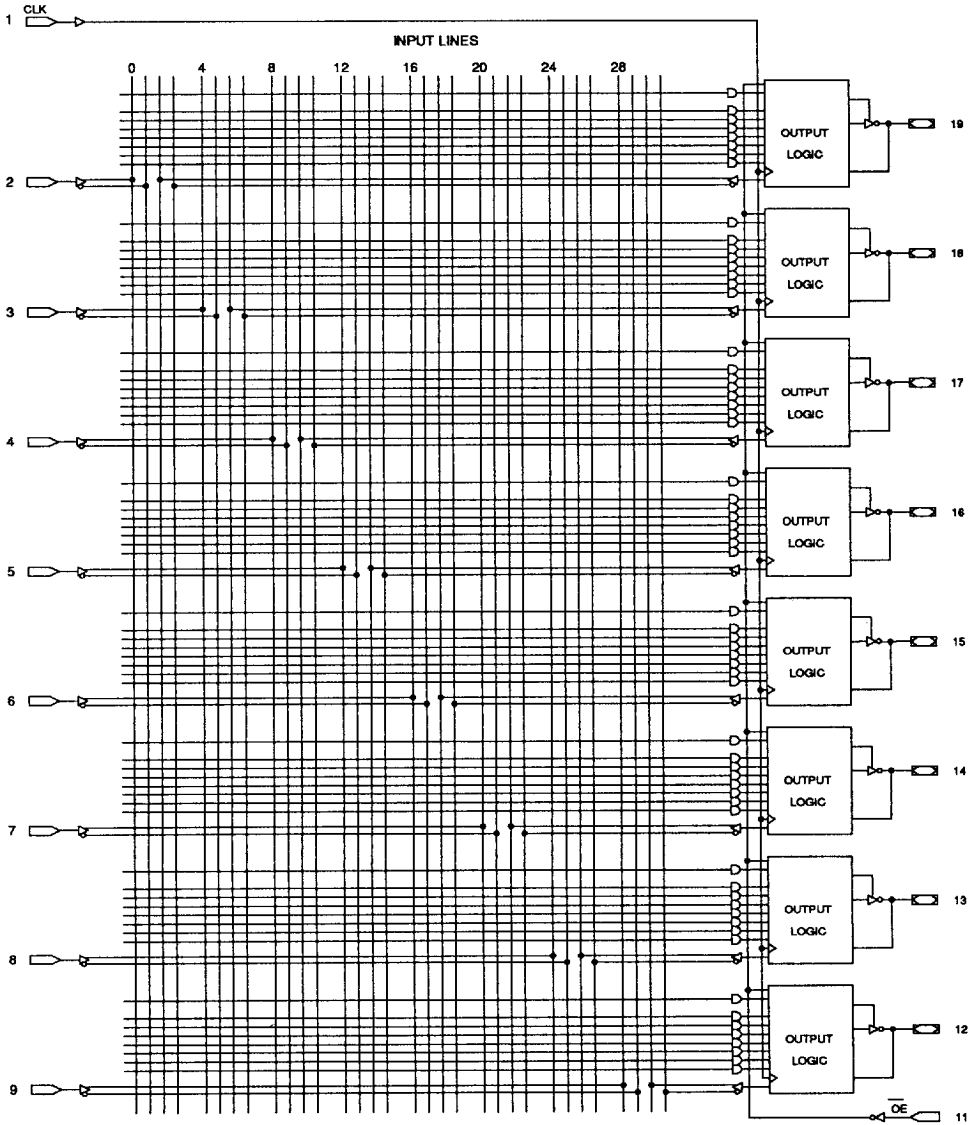
Unused product terms are automatically disabled by the compiler to decrease power consumption. A Security Fuse, when programmed, protects the content of the ATF16V8B. Eight bytes (64 fuses) of User Signature are accessible to the user for purposes such as storing project name, part number, revision, or date. The User Signature is accessible regardless of the state of the Security Fuse.

Compiler Mode Selection

	Registered	Complex	Simple	Auto Select
ABEL, Atmel-ABEL	P16V8R	P16V8C	P16V8AS	P16V8
CUPL	G16V8MS	G16V8MA	G16V8AS	G16V8
LOG/iC	GAL16V8_R [1]	GAL16V8_C7 [1]	GAL16V8_C8 [1]	GAL16V8
OrCAD-PLD	"Registered"	"Complex"	"Simple"	GAL16V8A
PLDesigner	P16V8R	P16V8C	P16V8C	P16V8A
Tango-PLD	G16V8R	G16V8C	G16V8AS	G16V8

Note: 1. Only applicable for version 3.4 or lower.

Registered Mode Logic Diagram



ATF16V8B Complex Mode

PAL Device Emulation/PAL Replacement

In the Complex Mode, combinatorial output and I/O functions are possible. Pins 1 and 11 are regular inputs to the array. Pins 13 through 18 have pin feedback paths back to the AND-array, which makes full I/O capability possible. Pins 12 and 19 (outermost macrocells) are outputs only. They do not have input capability. In this mode, each macrocell has seven product terms going to the sum term and one product term enabling the output.

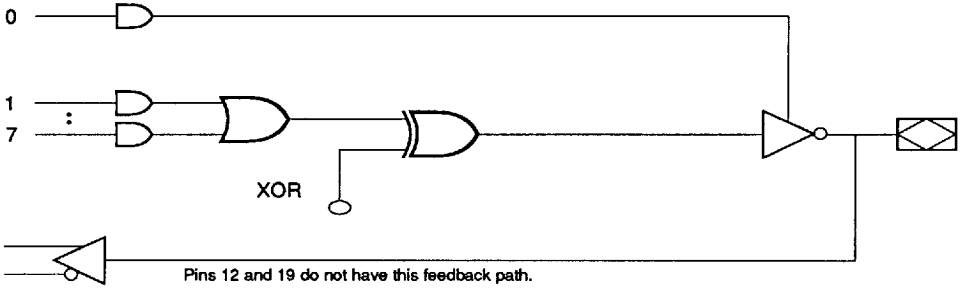
Combinatorial applications with an OE requirement will make the compiler select this mode. The following devices can be emulated using this mode:

16L8

16H8

16P8

Complex Mode Option



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16L8

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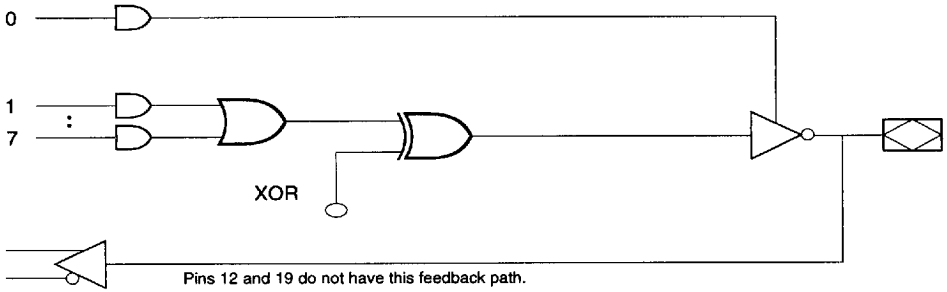
16P8

Complex Mode Option



ATF16V8B Simple Mode

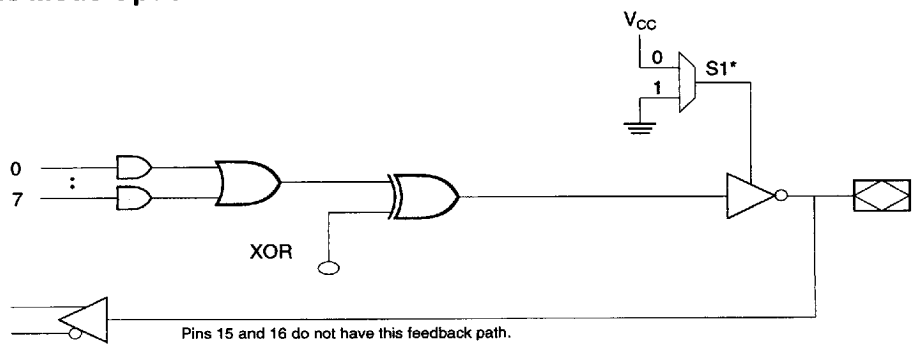
PAL Device Emulation / PAL Replacement

In the Simple Mode, 8 product terms are allocated to the sum term. Pins 15 and 16 (center macrocells) are permanently configured as combinatorial outputs. Other macrocells can be either inputs or combinatorial outputs with pin feedback to the AND-array. Pins 1 and 11 are regular inputs.

The compiler selects this mode when all outputs are combinatorial without OE control. The following simple PALs can be emulated using this mode:

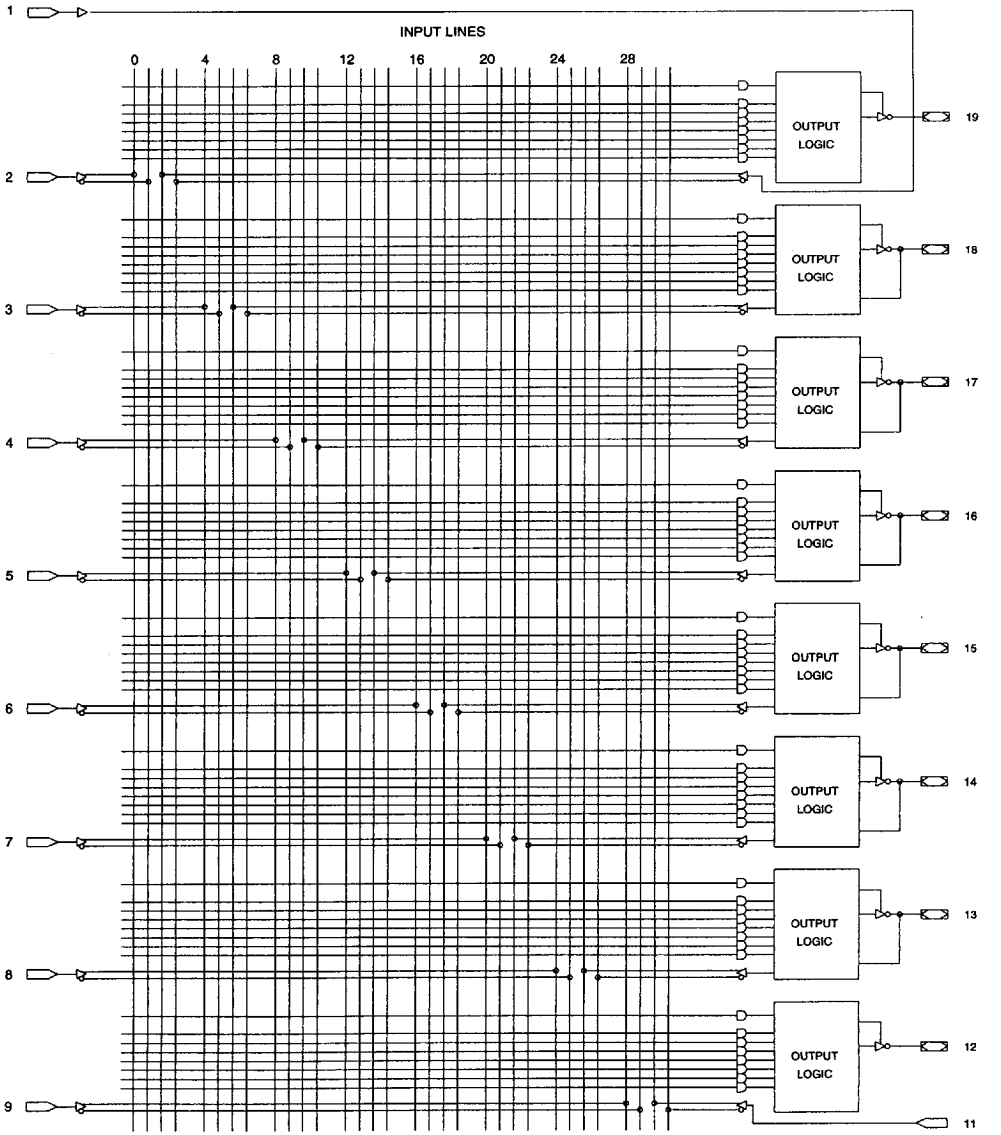
10L8	10H8	10P8
12L6	12H6	12P6
14L4	14H4	14P4
16L2	16H2	16P2

Simple Mode Option

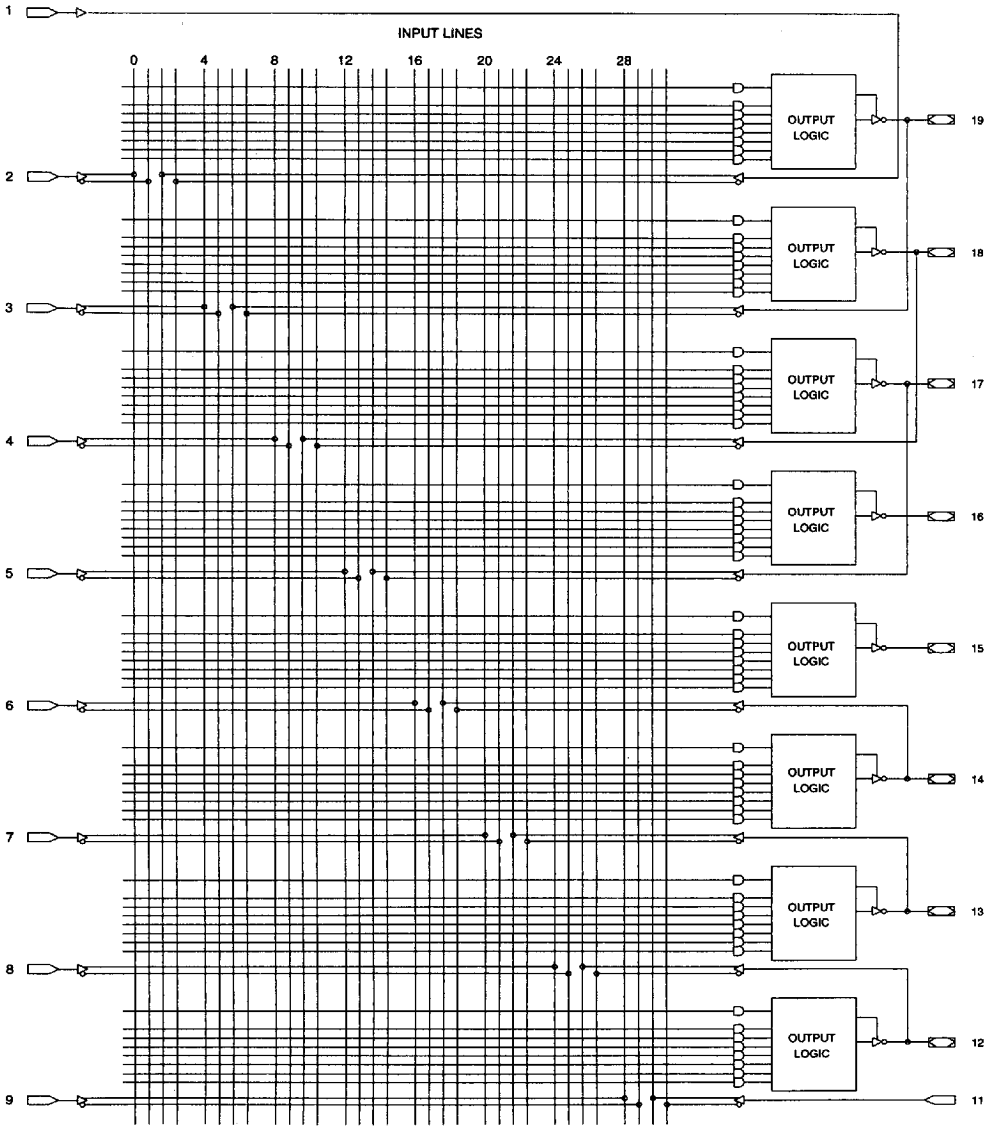


* - Pins 15 and 16 are always enabled.

Complex Mode Logic Diagram

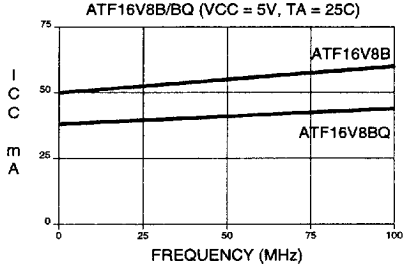


Simple Mode Logic Diagram



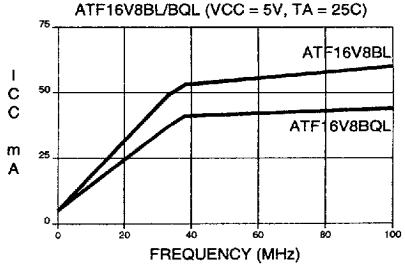
SUPPLY CURRENT vs. INPUT FREQUENCY

ATF16V8B/BQ (VCC = 5V, TA = 25C)



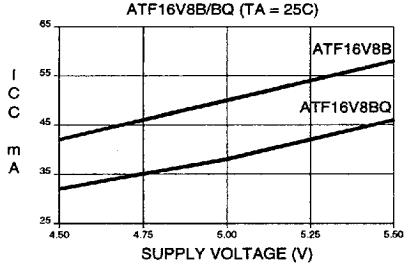
SUPPLY CURRENT vs. INPUT FREQUENCY

ATF16V8BL/BQL (VCC = 5V, TA = 25C)



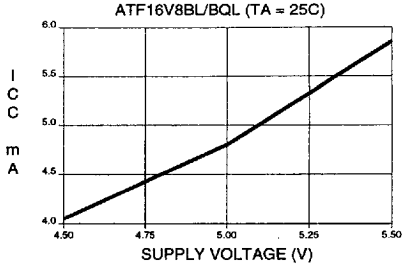
SUPPLY CURRENT vs. SUPPLY VOLTAGE

ATF16V8B/BQ (TA = 25C)



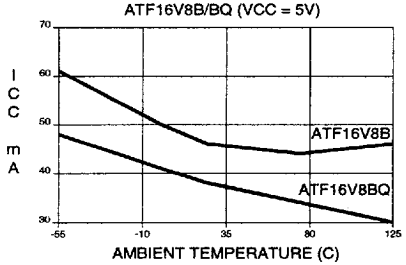
SUPPLY CURRENT vs. SUPPLY VOLTAGE

ATF16V8BL/BQL (TA = 25C)



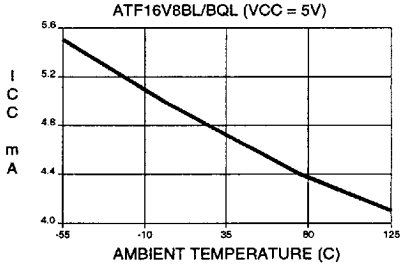
SUPPLY CURRENT vs. AMBIENT TEMPERATURE

ATF16V8B/BQ (VCC = 5V)



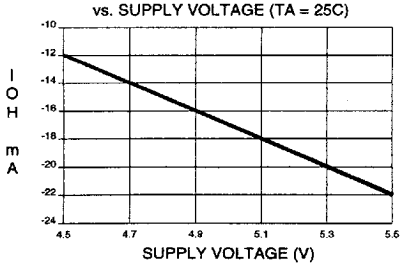
SUPPLY CURRENT vs. AMBIENT TEMPERATURE

ATF16V8BL/BQL (VCC = 5V)



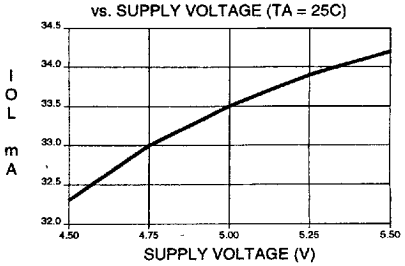
OUTPUT SOURCE CURRENT

vs. SUPPLY VOLTAGE (TA = 25C)

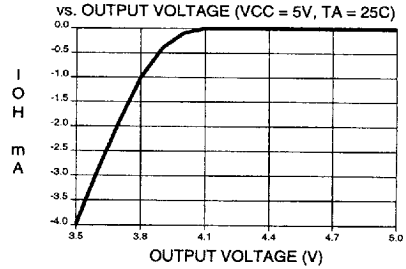


OUTPUT SINK CURRENT

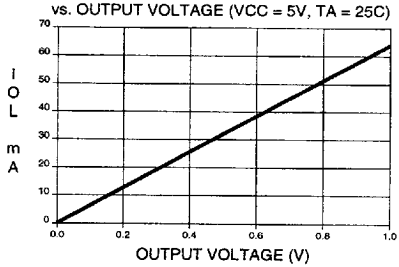
vs. SUPPLY VOLTAGE (TA = 25C)



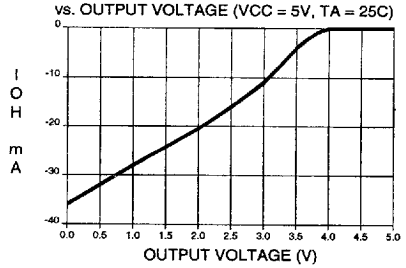
OUTPUT SOURCE CURRENT
vs. OUTPUT VOLTAGE (VCC = 5V, TA = 25C)



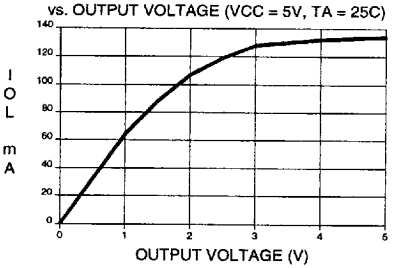
OUTPUT SINK CURRENT
vs. OUTPUT VOLTAGE (VCC = 5V, TA = 25C)



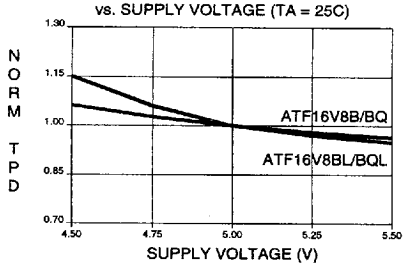
OUTPUT SOURCE CURRENT
vs. OUTPUT VOLTAGE (VCC = 5V, TA = 25C)



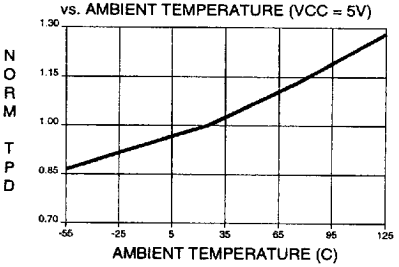
OUTPUT SINK CURRENT
vs. OUTPUT VOLTAGE (VCC = 5V, TA = 25C)



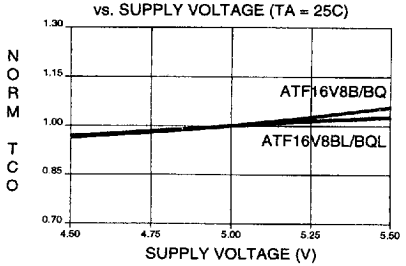
NORMALIZED TPD
vs. SUPPLY VOLTAGE (TA = 25C)



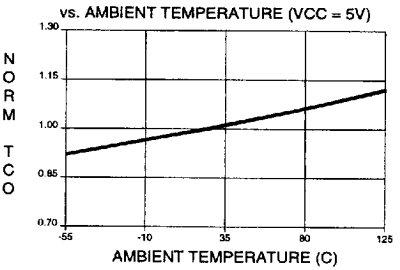
NORMALIZED TPD
vs. AMBIENT TEMPERATURE (VCC = 5V)



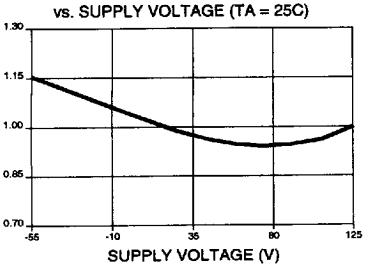
NORMALIZED TCO
vs. SUPPLY VOLTAGE (TA = 25C)



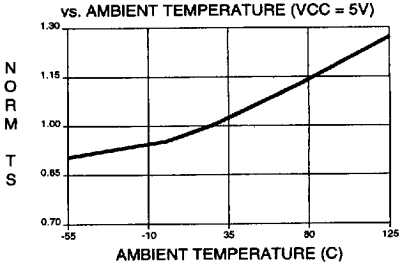
NORMALIZED TCO
vs. AMBIENT TEMPERATURE (VCC = 5V)



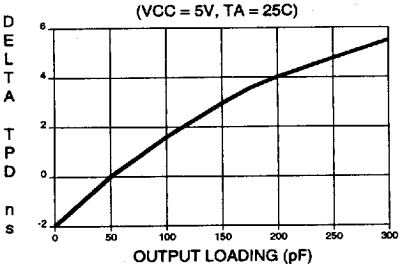
NORMALIZED TS
vs. SUPPLY VOLTAGE (TA = 25C)



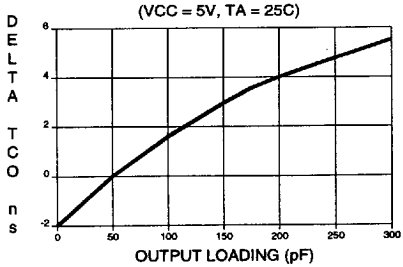
NORMALIZED TS
vs. AMBIENT TEMPERATURE (VCC = 5V)



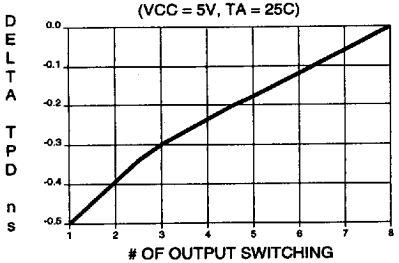
DELTA TPD vs. OUTPUT LOADING
(VCC = 5V, TA = 25C)



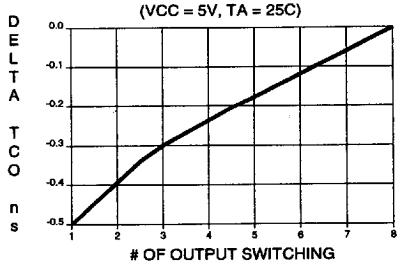
DELTA TCO vs. OUTPUT LOADING
(VCC = 5V, TA = 25C)



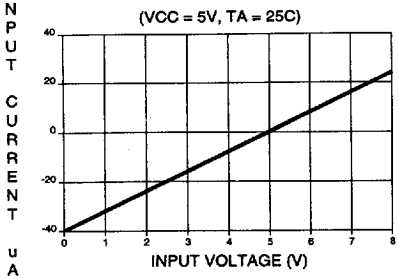
DELTA TPD vs. # OUTPUT SWITCHING
(VCC = 5V, TA = 25C)



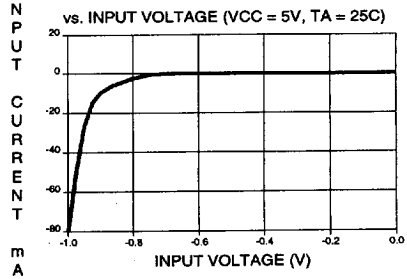
DELTA TCO vs. # OUTPUT SWITCHING
(VCC = 5V, TA = 25C)



INPUT CURRENT vs. INPUT VOLTAGE
(VCC = 5V, TA = 25C)



INPUT CLAMP CURRENT
vs. INPUT VOLTAGE (VCC = 5V, TA = 25C)



Ordering Information

t_{PD} (ns)	t_S (ns)	t_{CO} (ns)	Ordering Code	Package	Operation Range
7.5	5	5	ATF16V8B-7GC ATF16V8B-7JC ATF16V8B-7PC ATF16V8B-7SC	20D3 20J 20P3 20S	Commercial (0°C to 70°C)
10	7.5	7	ATF16V8B-10GC ATF16V8B-10JC ATF16V8B-10PC ATF16V8B-10SC	20D3 20J 20P3 20S	Commercial (0°C to 70°C)
			ATF16V8B-10GI ATF16V8B-10JI ATF16V8B-10PI ATF16V8B-10SI	20D3 20J 20P3 20S	Industrial (-40°C to 85°C)
			ATF16V8B-10GM ATF16V8B-10NM	20D3 20L	Military (-55°C to 125°C)
			ATF16V8B-10GM/883 ATF16V8B-10NM/883	20D3 20L	Military/883C (-55°C to 125°C) Class B, Fully Compliant
15	12	10	ATF16V8B-15GC ATF16V8B-15JC ATF16V8B-15PC ATF16V8B-15SC	20D3 20J 20P3 20S	Commercial (0°C to 70°C)
			ATF16V8B-15GI ATF16V8B-15JI ATF16V8B-15PI ATF16V8B-15SI	20D3 20J 20P3 20S	Industrial (-40°C to 85°C)
			ATF16V8B-15GM ATF16V8B-15NM	20D3 20L	Military (-55°C to 125°C)
			ATF16V8B-15GM/883 ATF16V8B-15NM/883	20D3 20L	Military/883C (-55°C to 125°C) Class B, Fully Compliant
25	15	12	ATF16V8B-25GC ATF16V8B-25JC ATF16V8B-25PC ATF16V8B-25SC	20D3 20J 20P3 20S	Commercial (0°C to 70°C)
			ATF16V8B-25GI ATF16V8B-25JI ATF16V8B-25PI ATF16V8B-25SI	20D3 20J 20P3 20S	Industrial (-40°C to 85°C)

Ordering Information

t_{PD} (ns)	t_S (ns)	t_{CO} (ns)	Ordering Code	Package	Operation Range
15	12	10	ATF16V8BL-15GC ATF16V8BL-15JC ATF16V8BL-15PC ATF16V8BL-15SC	20D3 20J 20P3 20S	Commercial (0°C to 70°C)
			ATF16V8BL-15GI ATF16V8BL-15JI ATF16V8BL-15PI ATF16V8BL-15SI	20D3 20J 20P3 20S	Industrial (-40°C to 85°C)
			ATF16V8BL-15GM ATF16V8BL-15NM	20D3 20L	Military (-55°C to 125°C)
			ATF16V8BL-15GM/883 ATF16V8BL-15NM/883	20D3 20L	Military/883C (-55°C to 125°C) Class B, Fully Compliant
10	7.5	7	ATF16V8BQ-10JC ATF16V8BQ-10PC	20J 20P3	Commercial (0°C to 70°C)
15	12	10	ATF16V8BQL-15JC ATF16V8BQL-15PC ATF16V8BQL-15SC	20J 20P3 20S	Commercial (0°C to 70°C)
25	15	12	ATF16V8BQL-25JC ATF16V8BQL-25PC ATF16V8BQL-25SC	20J 20P3 20S	Commercial (0°C to 70°C)
			ATF16V8BQL-25JI ATF16V8BQL-25PI ATF16V8BQL-25SI	20J 20P3 20S	Industrial (-40°C to 85°C)
			ATF16V8BQL-25GM ATF16V8BQL-25NM	20D3 20L	Military (-55°C to 125°C)
			ATF16V8BQL-25GM/883 ATF16V8BQL-25NM/883	20D3 20L	Military/883C (-55°C to 125°C) Class B, Fully Compliant

Package Type	
20D3	20 Lead, 0.300" Wide, Ceramic Dual Inline Package (Cerdip)
20J	20 Lead, Plastic J-Leaded Chip Carrier (PLCC)
20L	20 Pad, Ceramic Leadless Chip Carrier (LCC)
20P3	20 Lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
20S	20 Lead, 0.300" Wide, Plastic Gull Wing Small Outline (SOIC)