



## GAL<sup>®</sup>26V12 Device Datasheet

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September 2010

# All Devices Discontinued!

Product Change Notifications (PCNs) have been issued to discontinue all devices in this data sheet.

The original datasheet pages have not been modified and do not reflect those changes. Please refer to the table below for reference PCN and current product status.

Product Line	Ordering Part Number	Product Status	Reference PCN
GAL26V12	GAL26V12C-10LP	Discontinued	<a href="#">PCN#06-07</a>
	GAL26V12C-15LP		
	GAL26V12C-20LP		
	GAL26V12C-10LPI		
	GAL26V12C-15LPI		
	GAL26V12C-20LPI		
	GAL26V12C-7LJ		<a href="#">PCN#13-10</a>
	GAL26V12C-10LJ		
	GAL26V12C-15LJ		
	GAL26V12C-20LJ		
	GAL26V12C-10LJI		
	GAL26V12C-15LJI		
	GAL26V12C-20LJI		

**FEATURES**

- **HIGH PERFORMANCE E<sup>2</sup>CMOS<sup>®</sup> TECHNOLOGY**
  - 7.5 ns Maximum Propagation Delay
  - F<sub>max</sub> = 142.8 MHz
  - 4.5 ns Maximum from Clock Input to Data Output
  - TTL Compatible 16 mA Outputs
  - UltraMOS<sup>®</sup> Advanced CMOS Technology
- **LOW POWER CMOS**
  - 90 mA Typical I<sub>cc</sub>
- **E<sup>2</sup> CELL TECHNOLOGY**
  - Reconfigurable Logic
  - Reprogrammable Cells
  - 100% Tested/Guaranteed 100% Yields
  - High Speed Electrical Erasure (<100ms)
  - 20 Year Data Retention
- **TWELVE OUTPUT LOGIC MACROCELLS**
  - Maximum Flexibility for Complex Logic Designs
- **PRELOAD AND POWER-ON RESET OF REGISTERS**
  - 100% Functional Testability
- **APPLICATIONS INCLUDE:**
  - DMA Control
  - State Machine Control
  - High Speed Graphics Processing
  - Standard Logic Speed Upgrade
- **ELECTRONIC SIGNATURE FOR IDENTIFICATION**

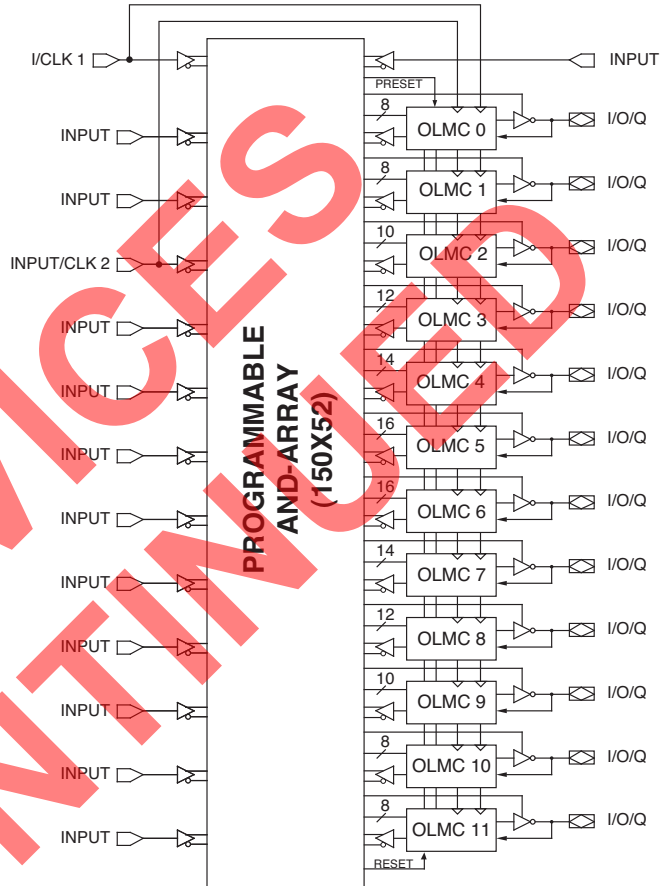
**DESCRIPTION**

The GAL26V12, at 7.5ns maximum propagation delay time, combines a high performance CMOS process with Electrically Erasable (E<sup>2</sup>) floating gate technology to provide the highest performance available of any 26V12 device on the market. E<sup>2</sup> technology offers high speed (<100ms) erase times, providing the ability to reprogram or reconfigure the device quickly and efficiently.

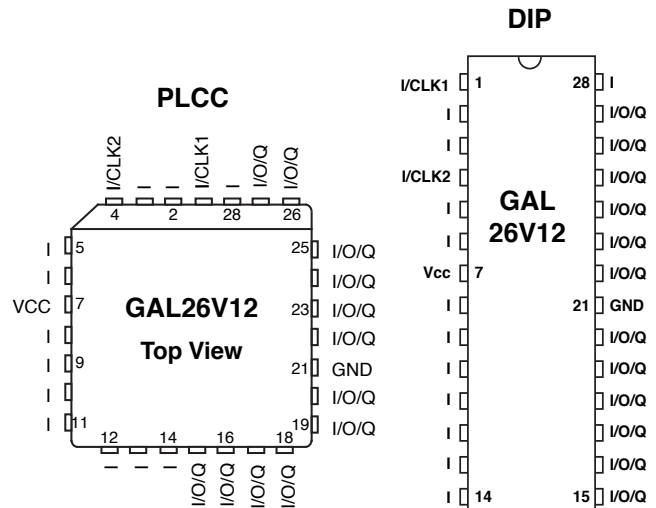
The generic architecture provides maximum design flexibility by allowing the Output Logic Macrocell (OLMC) to be configured by the user. The GAL26V12 is fully function/fuse map/parametric compatible with other 26V12 devices.

Unique test circuitry and reprogrammable cells allow complete AC, DC, and functional testing during manufacture. As a result, LATTICE is able to guarantee 100% field programmability and functionality of all GAL<sup>®</sup> products. LATTICE also guarantees 100 erase/rewrite cycles.

**FUNCTIONAL BLOCK DIAGRAM**



**PACKAGE DIAGRAMS**



Select devices have been discontinued. See Ordering Information section for product status.

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**GAL26V12 ORDERING INFORMATION**

**Commercial Grade Specifications**

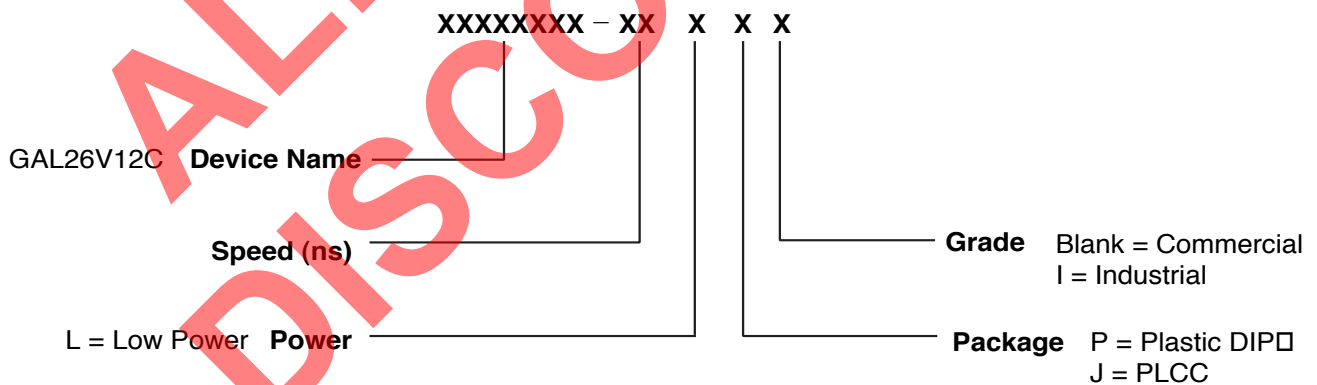
Tpd (ns)	Tsu (ns)	Tco (ns)	Icc (mA)	Ordering #	Package
7.5	6	4.5	130	GAL26V12C-7LJ	28-Lead PLCC
10	7	7	130	GAL26V12C-10LP <sup>1</sup>	28-Pin Plastic DIP
			130	GAL26V12C-10LJ	28-Lead PLCC
15	10	8	105	GAL26V12C-15LP <sup>1</sup>	28-Pin Plastic DIP
			105	GAL26V12C-15LJ	28-Lead PLCC
20	12	12	105	GAL26V12C-20LP <sup>1</sup>	28-Pin Plastic DIP
			105	GAL26V12C-20LJ	28-Lead PLCC

**Industrial Grade Specifications**

Tpd (ns)	Tsu (ns)	Tco (ns)	Icc (mA)	Ordering #	Package
10	7	7	150	GAL26V12C-10LPI <sup>1</sup>	28-Pin Plastic DIP
			150	GAL26V12C-10LJI	28-Lead PLCC
15	10	8	150	GAL26V12C-15LPI <sup>1</sup>	28-Pin Plastic DIP
			150	GAL26V12C-15LJI	28-Lead PLCC
20	12	12	150	GAL26V12C-20LPI <sup>1</sup>	28-Pin Plastic DIP
			150	GAL26V12C-20LJI	28-Lead PLCC

1. Discontinued per PCN #06-07. Contact Rochester Electronics for available inventory.

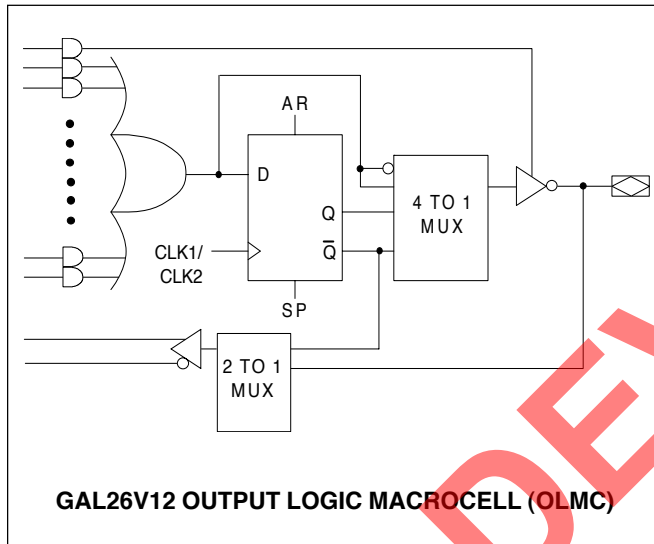
**PART NUMBER DESCRIPTION**



Select devices have been discontinued. See Ordering Information section for product status.

## OUTPUT LOGIC MACROCELL (OLMC)

The GAL26V12 has a variable number of product terms per OLMC. Of the ten available OLMCs, four OLMCs have access to eight product terms (pins 15, 16, 26 and 27), two have ten product terms (pins 17 and 25), two have twelve product terms (pins 18 and 24), two have fourteen product terms (pins 19 and 23), and two OLMCs have sixteen product terms (pins 20 and 22). In addition to the product terms available for logic, each OLMC has an additional product-term dedicated to output enable control.



The output polarity of each OLMC can be individually programmed to be true or inverting, in either combinatorial or registered mode. This allows each output to be individually configured as either active high or active low.

In the registered mode configuration the clock source for the register can be selected. The two clock options, CLK1 and CLK2, originate from input pin1 and pin4 respectively.

The GAL26V12 has a product term for Asynchronous Reset (AR) and a product term for Synchronous Preset (SP). These two product terms are common to all registered OLMCs. The Asynchronous Reset sets all registers to zero any time this dedicated product term is asserted. The Synchronous Preset sets all registers to a logic one on the rising edge of the next clock pulse after this product term is asserted.

**NOTE:** The AR and SP product terms will force the Q output of the flip-flop into the same state regardless of the polarity of the output. Therefore, a reset operation, which sets the register output to a zero, may result in either a high or low at the output pin, depending on the pin polarity chosen.

## OUTPUT LOGIC MACROCELL CONFIGURATIONS

Each of the Macrocells of the GAL26V12 has two primary functional modes: registered, and combinatorial I/O. The modes and the output polarity are set by four architecture bits (S0, S1, S2 and S3), which are normally controlled by the logic compiler. Each of these two primary modes, and the bit settings required to enable them, are described below and on the following page.

### REGISTERED MODE

In registered mode the output pin associated with an individual OLMC is driven by the Q output of that OLMC's D-type flip-flop. Logic polarity of the output signal at the pin may be selected by specifying that the output buffer drive either true (active high) or inverted (active low). Output tri-state control is available as an individual product-term for each OLMC, and can therefore be defined by a logic equation.

There are two options for the feedback of the registered mode - internal /Q feedback and I/O pin feedback. The D flip-flop's /Q output is fed back into the AND array, with both the true and complement of the feedback available as inputs to the AND array. Similarly the I/O pin feedback with both true and complement input to the AND array. The resulting polarity depends on the input polarity selection as well as the registered I/O output polarity configuration.

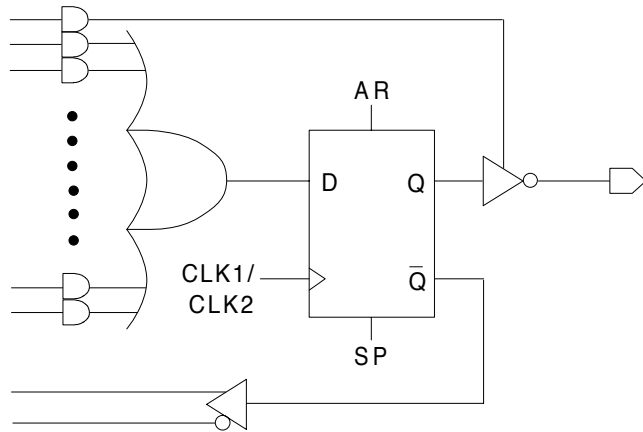
### COMBINATORIAL MODE

In combinatorial mode the pin associated with an individual OLMC is driven by the output of the sum term gate. Logic polarity of the output signal at the pin may be selected by specifying that the output buffer drive either true (active high) or inverted (active low). Output tri-state control is available as an individual product-term for each output, and may be individually set by the compiler as either "on" (dedicated output), "off" (dedicated input), or "product-term driven" (dynamic I/O).

In combinatorial mode there are also two options for the feedback. The first feedback option into the AND array is from the I/O pin side of the output buffer. Both polarities (true and inverted) of the pin are fed back into the AND array. The second option is to drive the feedback from /Q of the buried register. This option provides the combinatorial output with the ability to register the feedback of the same combinatorial output.

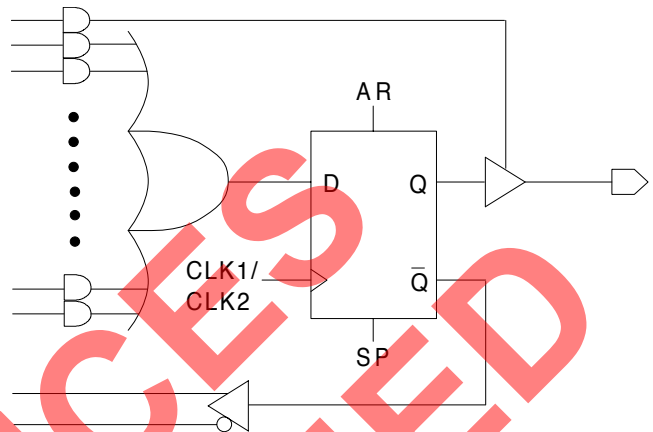
Select devices have been discontinued. See Ordering Information section for product status.

**REGISTERED MODE**



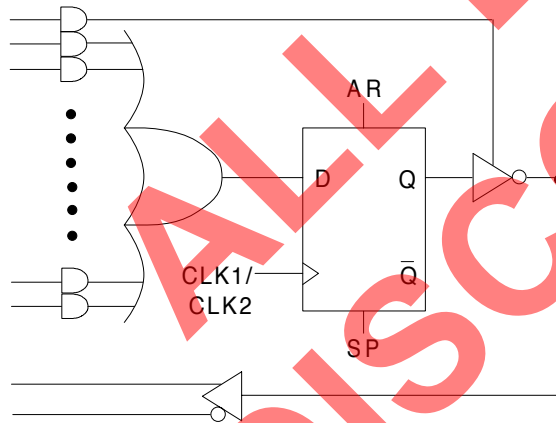
**ACTIVE LOW REGISTERED OUTPUT  
WITH BURIED FEEDBACK**

S0 = 0      S2 = 1 Selects CLK1  
S1 = 0      S2 = 0 Selects CLK2  
S3 = 1



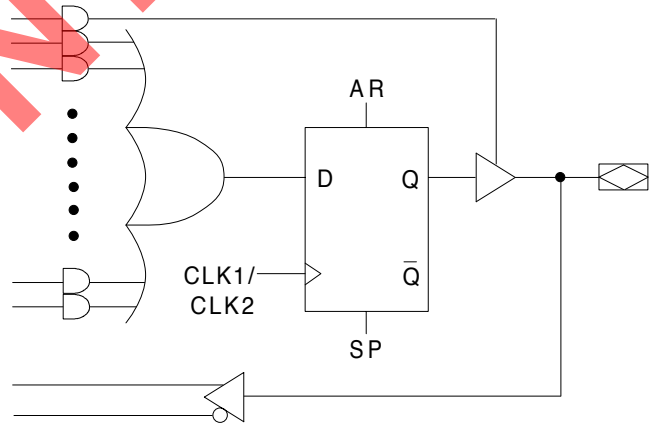
**ACTIVE HIGH REGISTERED OUTPUT  
WITH BURIED FEEDBACK**

S0 = 1      S2 = 1 Selects CLK1  
S1 = 0      S2 = 0 Selects CLK2  
S3 = 1



**ACTIVE LOW REGISTERED OUTPUT  
WITH I/O FEEDBACK**

S0 = 0      S2 = 1 Selects CLK1  
S1 = 0      S2 = 0 Selects CLK2  
S3 = 0

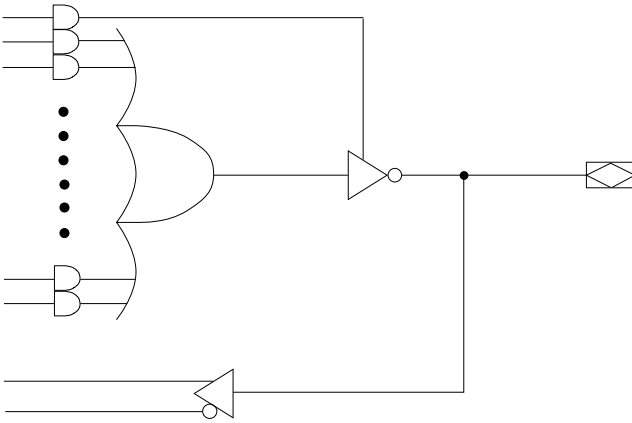


**ACTIVE HIGH REGISTERED OUTPUT  
WITH I/O FEEDBACK**

S0 = 1      S2 = 1 Selects CLK1  
S1 = 0      S2 = 0 Selects CLK2  
S3 = 0

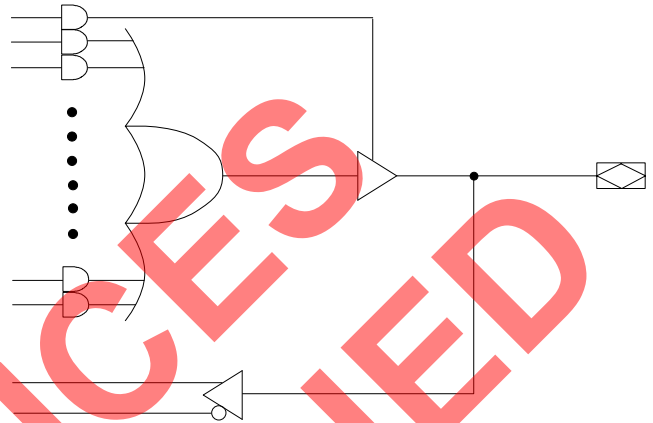
Select devices have been discontinued.  
See Ordering Information section for product status.

**COMBINATORIAL MODE**



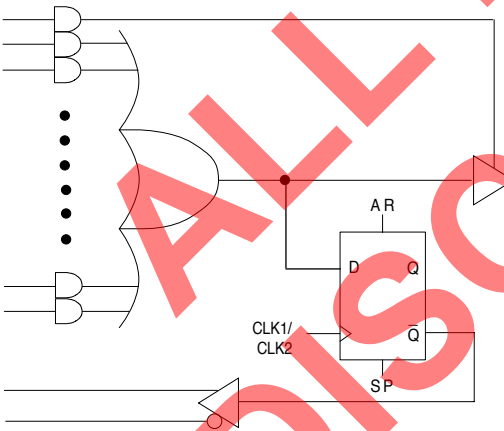
**ACTIVE LOW COMBINATORIAL OUTPUT  
WITH I/O FEEDBACK**

S0 = 0      S2 = 1 Selects CLK1  
S1 = 1      S2 = 0 Selects CLK2  
S3 = 1



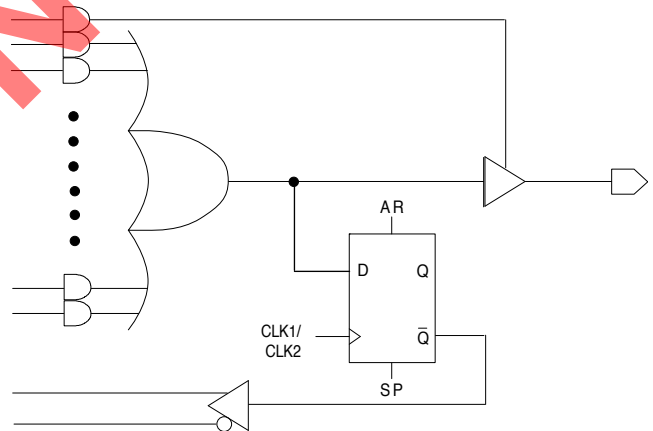
**ACTIVE HIGH COMBINATORIAL OUTPUT  
WITH I/O FEEDBACK**

S0 = 1      S2 = 1 Selects CLK1  
S1 = 1      S2 = 0 Selects CLK2  
S3 = 1



**ACTIVE LOW COMBINATORIAL OUTPUT  
WITH BURIED REGISTER FEEDBACK**

S0 = 0      S2 = 1 Selects CLK1  
S1 = 1      S2 = 0 Selects CLK2  
S3 = 0



**ACTIVE HIGH COMBINATORIAL OUTPUT  
WITH BURIED REGISTER FEEDBACK**

S0 = 1      S2 = 1 Selects CLK1  
S1 = 1      S2 = 0 Selects CLK2  
S3 = 0

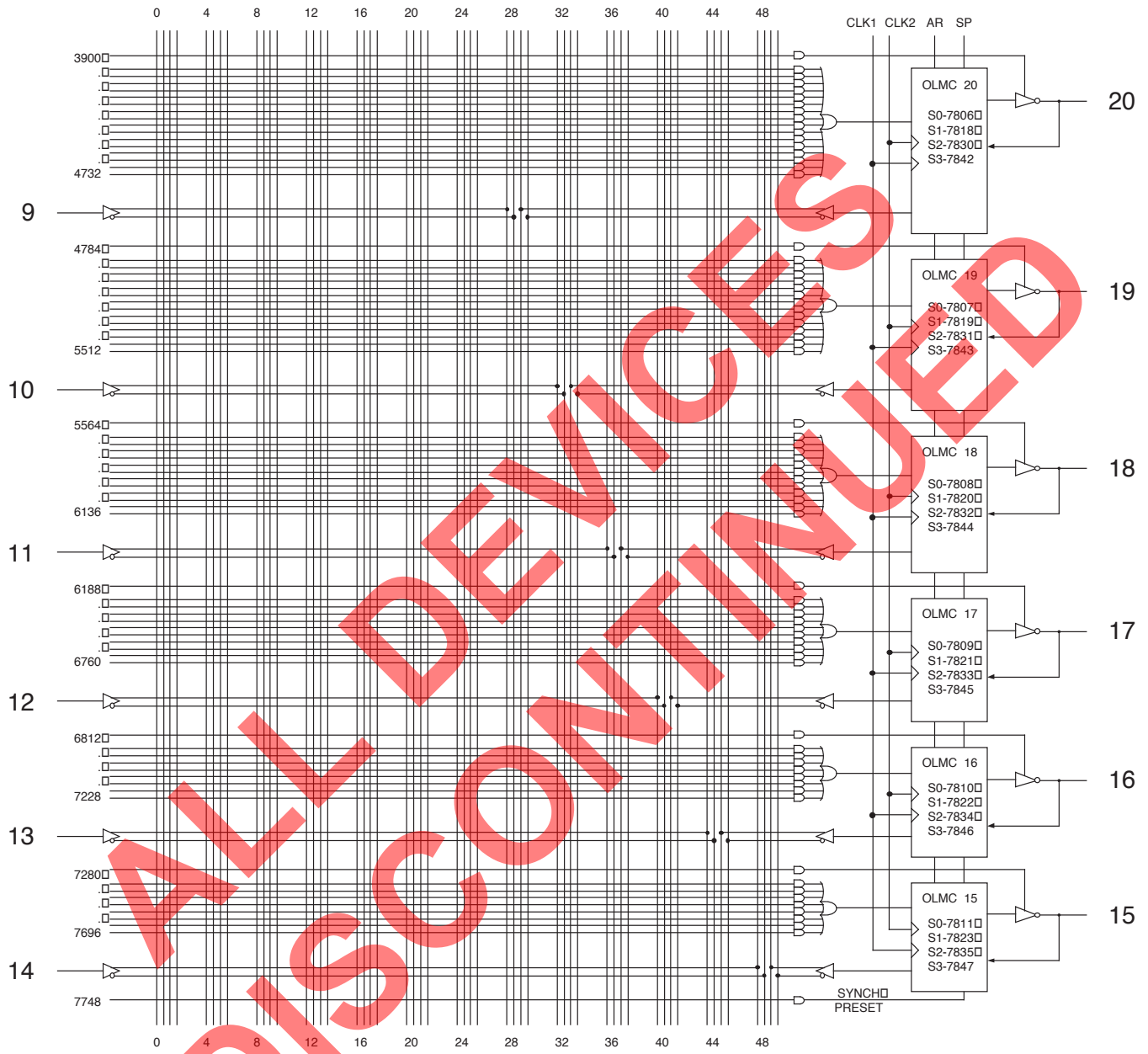
Select devices have been discontinued.  
See Ordering Information section for product status.

**GAL26V12 LOGIC DIAGRAM / JEDEC FUSEMAP**



Select devices have been discontinued.  
See Ordering Information section for product status.

**GAL26V12 LOGIC DIAGRAM / JEDEC FUSEMAP (CONT.)**



Select devices have been discontinued.  
See Ordering Information section for product status.

ALL DEVICES DISCONTINUED

B0	B1	LD	MD	B3	B4	B5	B6	B7
7848	7849...	SD	SP	Electronic Signature				...7910 7911



**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

Supply voltage  $V_{CC}$  ..... -0.5 to +7V  
 Input voltage applied ..... -2.5 to  $V_{CC} + 1.0V$   
 Off-state output voltage applied ..... -2.5 to  $V_{CC} + 1.0V$   
 Storage Temperature ..... -65 to 150°C  
 Ambient Temperature with  
 Power Applied ..... -55 to 125°C

1. Stresses above those listed under the "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress only ratings and functional operation of the device at these or at any other conditions above those indicated in the operational sections of this specification is not implied (while programming, follow the programming specifications).

**RECOMMENDED OPERATING COND.**

**Commercial Devices:**

Ambient Temperature ( $T_A$ ) ..... 0 to +75°C  
 Supply voltage ( $V_{CC}$ )  
 with Respect to Ground ..... +4.75 to +5.25V

**Industrial Devices:**

Ambient Temperature ( $T_A$ ) ..... -40 to 85°C  
 Supply voltage ( $V_{CC}$ )  
 with Respect to Ground ..... +4.5 to +5.5V

Select devices have been discontinued. See Ordering Information section for product status.

**DC ELECTRICAL CHARACTERISTICS**

Over Recommended Operating Conditions (Unless Otherwise Specified)

SYMBOL	PARAMETER	CONDITION	MIN.	TYP. <sup>4</sup>	MAX.	UNITS
<b>V<sub>IL</sub></b>	Input Low Voltage		$V_{SS} - 0.5$	—	0.8	V
<b>V<sub>IH</sub></b>	Input High Voltage		2.0	—	$V_{CC} + 1$	V
<b>I<sub>IL</sub><sup>1</sup></b>	Input or I/O Low Leakage Current	$0V \leq V_{IN} \leq V_{IL} (MAX.)$	—	—	-10	μA
<b>I<sub>IH</sub></b>	Input or I/O High Leakage Current	$3.5V \leq V_{IN} \leq V_{CC}$	—	—	10	μA
<b>V<sub>OL</sub></b>	Output Low Voltage	$I_{OL} = MAX., V_{in} = V_{IL} \text{ or } V_{IH}$	—	—	0.5	V
<b>V<sub>OH</sub></b>	Output High Voltage	$I_{OH} = MAX., V_{in} = V_{IL} \text{ or } V_{IH}$	2.4	—	—	V
<b>I<sub>OL</sub></b>	Low Level Output Current		—	—	16	mA
<b>I<sub>OH</sub></b>	High Level Output Current		—	—	-3.2	mA
<b>I<sub>OS</sub><sup>2</sup></b>	Output Short Circuit Current	$V_{CC} = 5V, V_{OUT} = 0.5V, T_A = 25^\circ C$	-30	—	-130	mA

**COMMERCIAL**

<b>I<sub>CC</sub><sup>3</sup></b>	Operating Power	$V_{IL} = 0.5V, V_{IH} = 3.0V, f_{toggle} = 15MHz$	-7/-10	—	90	130	mA
	Supply Current	Outputs Open	-15/-20	—	75	105	mA

**INDUSTRIAL**

<b>I<sub>CC</sub><sup>3</sup></b>	Operating Power	$V_{IL} = 0.5V, V_{IH} = 3.0V, f_{toggle} = 15MHz$	-10/-15/-20	—	110	150	mA
	Supply Current	Outputs Open					

- 1) The leakage current is due to the internal pull-up on all pins. See **Input Buffer** section for more information.
- 2) One output at a time for a maximum duration of one second.  $V_{out} = 0.5V$  was selected to avoid test problems caused by tester ground degradation. Guaranteed but not 100% tested.
- 3)  $I_{CC}$  specified for a ten-bit binary counter pattern.
- 4) Typical values are at  $V_{CC} = 5V$  and  $T_A = 25^\circ C$

**AC SWITCHING CHARACTERISTICS**

Over Recommended Operating Conditions

PARAM.	TEST COND. <sup>1</sup>	DESCRIPTION	-7		-10		-15		-20		UNITS
			MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
<b>t<sub>pd</sub></b>	A	Input or I/O to Combinatorial Output	—	7.5	—	10	—	15	—	20	ns
<b>t<sub>co</sub></b>	A	Clock to Output Delay	—	4.5	—	7	—	8	—	12	ns
<b>t<sub>cf</sub><sup>2</sup></b>	—	Clock to Feedback Delay	—	2	—	2.5	—	2.5	—	10	ns
<b>t<sub>su1</sub></b>	—	Setup Time, Input or Fdbk before Clk↑	6	—	7	—	10	—	12	—	ns
<b>t<sub>su2</sub></b>	—	Synch. Preset before Clk↑	5.5	—	6.5	—	10	—	12	—	ns
<b>t<sub>h</sub></b>	—	Hold Time, Input or Feedback after Clock↑	0	—	0	—	0	—	0	—	ns
<b>f<sub>max</sub><sup>3</sup></b>	A	Maximum Clock Frequency with External Feedback, 1/(t <sub>su</sub> + t <sub>co</sub> )	95.2	—	71.4	—	55.5	—	41.6	—	MHz
	A	Maximum Clock Frequency with Internal Feedback, 1/(t <sub>su</sub> + t <sub>cf</sub> )	125.0	—	105.2	—	80.0	—	45.4	—	MHz
	A	Maximum Clock Frequency with No Feedback	142.8	—	125	—	83.3	—	62.5	—	MHz
<b>t<sub>wh</sub></b>	—	Clock Pulse Duration, High	3.5	—	4	—	6	—	8	—	ns
<b>t<sub>wl</sub></b>	—	Clock Pulse Duration, Low	3.5	—	4	—	6	—	8	—	ns
<b>t<sub>en</sub></b>	B	Input or I/O to Output Enabled	—	7.5	—	10	—	15	—	20	ns
<b>t<sub>dis</sub></b>	C	Input or I/O to Output Disabled	—	7.5	—	10	—	15	—	20	ns
<b>t<sub>ar</sub></b>	A	Input or I/O to Asynch. Reset of Register	—	9	—	13	—	20	—	20	ns
<b>t<sub>arw</sub></b>	—	Asynchronous Reset Pulse Duration	6	—	8	—	10	—	15	—	ns
<b>t<sub>arr</sub></b>	—	Asynch. Reset to Clock Recovery Time	5	—	8	—	10	—	15	—	ns
<b>t<sub>spr</sub></b>	—	Synch. Preset to Clock Recovery Time	5	—	8	—	10	—	12	—	ns

- 1) Refer to **Switching Test Conditions** section.
- 2) Calculated from f<sub>max</sub> with internal feedback. Refer to **f<sub>max</sub> Description** section.
- 3) Refer to **f<sub>max</sub> Description** section.

**CAPACITANCE (T<sub>A</sub> = 25°C, f = 1.0 MHz)**

SYMBOL	PARAMETER	MAXIMUM*	UNITS	TEST CONDITIONS
C <sub>I</sub>	Input Capacitance	8	pF	V <sub>CC</sub> = 5.0V, V <sub>I</sub> = 2.0V
C <sub>I/O</sub>	I/O Capacitance	8	pF	V <sub>CC</sub> = 5.0V, V <sub>I/O</sub> = 2.0V

\*Guaranteed but not 100% tested.

Select devices have been discontinued. See Ordering Information section for product status.

**AC SWITCHING CHARACTERISTICS**

Over Recommended Operating Conditions

PARAM.	TEST COND. <sup>1</sup>	DESCRIPTION	-10		-15		-20		UNITS
			MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
<b>t<sub>pd</sub></b>	A	Input or I/O to Combinatorial Output	—	10	—	15	—	20	ns
<b>t<sub>co</sub></b>	A	Clock to Output Delay	—	7	—	8	—	12	ns
<b>t<sub>cf</sub><sup>2</sup></b>	—	Clock to Feedback Delay	—	2.5	—	2.5	—	10	ns
<b>t<sub>su1</sub></b>	—	Setup Time, Input or Fdbk before Clk↑	7	—	10	—	12	—	ns
<b>t<sub>su2</sub></b>	—	Synch. Preset before Clk↑	6.5	—	10	—	12	—	ns
<b>t<sub>h</sub></b>	—	Hold Time, Input or Feedback after Clock↑	0	—	0	—	0	—	ns
<b>f<sub>max</sub><sup>3</sup></b>	A	Maximum Clock Frequency with External Feedback, 1/(t <sub>su</sub> + t <sub>co</sub> )	71.4	—	55.5	—	41.6	—	MHz
	A	Maximum Clock Frequency with Internal Feedback, 1/(t <sub>su</sub> + t <sub>cf</sub> )	105.2	—	80.0	—	45.4	—	MHz
	A	Maximum Clock Frequency with No Feedback	125.0	—	83.3	—	62.5	—	MHz
<b>t<sub>wh</sub></b>	—	Clock Pulse Duration, High	4	—	6	—	8	—	ns
<b>t<sub>wl</sub></b>	—	Clock Pulse Duration, Low	4	—	6	—	8	—	ns
<b>t<sub>en</sub></b>	B	Input or I/O to Output Enabled	—	10	—	15	—	20	ns
<b>t<sub>dis</sub></b>	C	Input or I/O to Output Disabled	—	10	—	15	—	20	ns
<b>t<sub>ar</sub></b>	A	Input or I/O to Asynch. Reset of Register	—	13	—	20	—	20	ns
<b>t<sub>arw</sub></b>	—	Asynchronous Reset Pulse Duration	8	—	10	—	15	—	ns
<b>t<sub>arr</sub></b>	—	Asynch. Reset to Clock Recovery Time	8	—	10	—	15	—	ns
<b>t<sub>spr</sub></b>	—	Synch. Preset to Clock Recovery Time	8	—	10	—	12	—	ns

- 1) Refer to **Switching Test Conditions** section.
- 2) Calculated from f<sub>max</sub> with internal feedback. Refer to **f<sub>max</sub> Description** section.
- 3) Refer to **f<sub>max</sub> Description** section.

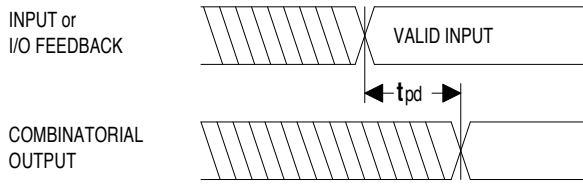
**CAPACITANCE (T<sub>A</sub> = 25°C, f = 1.0 MHz)**

SYMBOL	PARAMETER	MAXIMUM*	UNITS	TEST CONDITIONS
C <sub>I</sub>	Input Capacitance	8	pF	V <sub>CC</sub> = 5.0V, V <sub>I</sub> = 2.0V
C <sub>I/O</sub>	I/O Capacitance	8	pF	V <sub>CC</sub> = 5.0V, V <sub>I/O</sub> = 2.0V

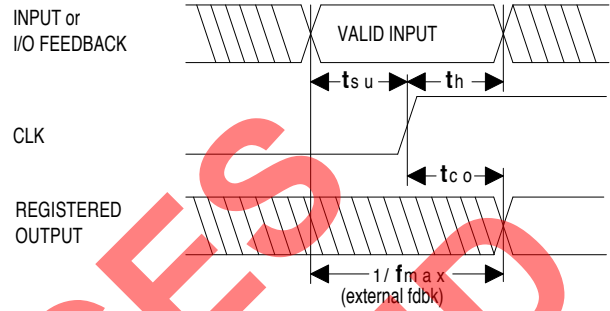
\*Guaranteed but not 100% tested.

Select devices have been discontinued. See Ordering Information section for product status.

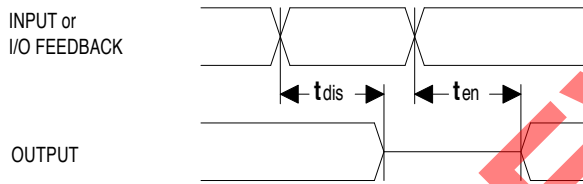
**SWITCHING WAVEFORMS**



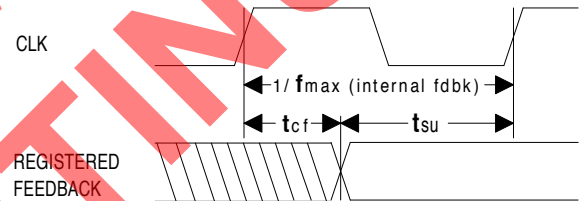
**Combinatorial Output**



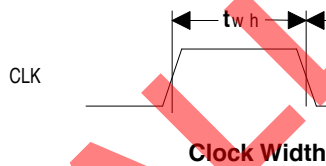
**Registered Output**



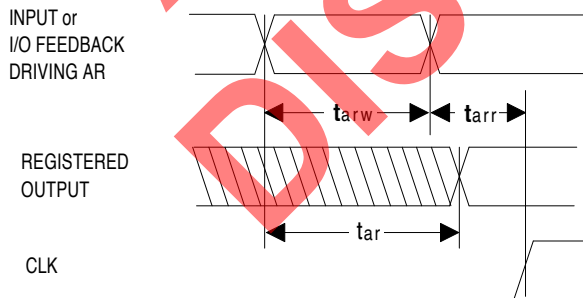
**Input or I/O to Output Enable/Disable**



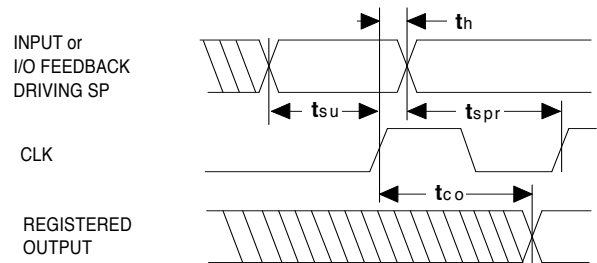
**fmax with Feedback**



**Clock Width**



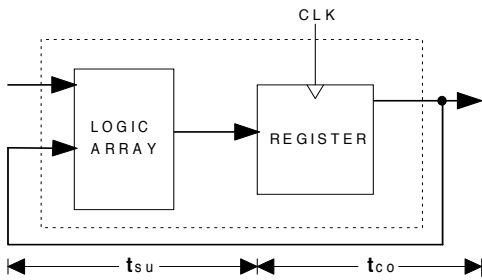
**Asynchronous Reset**



**Synchronous Preset**

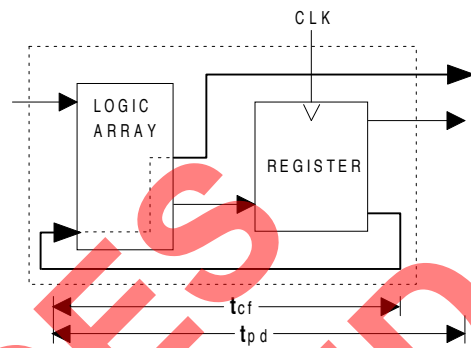
Select devices have been discontinued. See Ordering Information section for product status.

**f<sub>max</sub> DESCRIPTIONS**



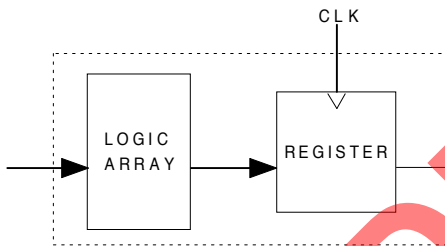
**f<sub>max</sub> with External Feedback 1/(t<sub>su</sub>+t<sub>co</sub>)**

**Note:** f<sub>max</sub> with external feedback is calculated from measured t<sub>su</sub> and t<sub>co</sub>.



**f<sub>max</sub> with Internal Feedback 1/(t<sub>su</sub>+t<sub>cf</sub>)**

**Note:** t<sub>cf</sub> is a calculated value, derived by subtracting t<sub>su</sub> from the period of f<sub>max</sub> w/internal feedback (t<sub>cf</sub> = 1/f<sub>max</sub> - t<sub>su</sub>). The value of t<sub>cf</sub> is used primarily when calculating the delay from clocking a register to a combinatorial output (through registered feedback), as shown above. For example, the timing from clock to a combinatorial output is equal to t<sub>cf</sub> + t<sub>pd</sub>.



**f<sub>max</sub> With No Feedback**

**Note:** f<sub>max</sub> with no feedback may be less than 1/t<sub>wh</sub> + t<sub>wl</sub>. This is to allow for a clock duty cycle of other than 50%.

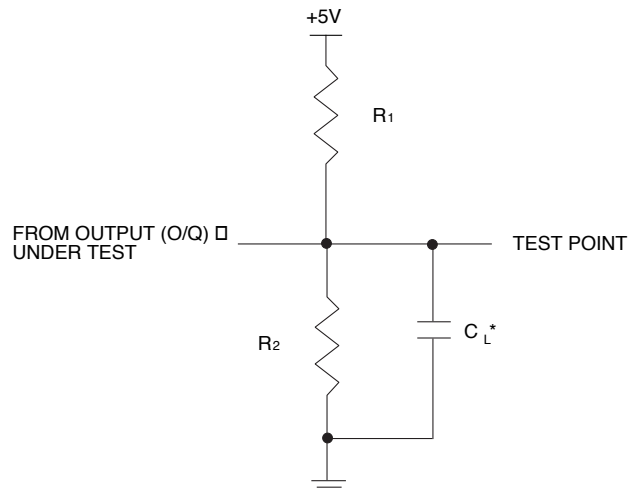
**SWITCHING TEST CONDITIONS**

Input Pulse Levels	GND to 3.0V
Input Rise and Fall Times	2ns 10% – 90%
Input Timing Reference Levels	1.5V
Output Timing Reference Levels	1.5V
Output Load	See Figure

3-state levels are measured 0.5V from steady-state active level.

**Output Load Conditions (see figure)**

Test Condition	R <sub>1</sub>	R <sub>2</sub>	C <sub>L</sub>
A	300Ω	390Ω	50pF
B	Active High	∞	390Ω
	Active Low	300Ω	390Ω
C	Active High	∞	5pF
	Active Low	300Ω	390Ω



\*C<sub>L</sub> INCLUDES TEST FIXTURE AND PROBE CAPACITANCE

Select devices have been discontinued. See Ordering Information section for product status.

## ELECTRONIC SIGNATURE

An electronic signature is provided in every GAL26V12 device. It contains 64 bits of reprogrammable memory that can contain user-defined data. Some uses include user ID codes, revision numbers, or inventory control. The signature data is always available to the user independent of the state of the security cell.

## SECURITY CELL

A security cell is provided in every GAL26V12 device to prevent unauthorized copying of the array patterns. Once programmed, this cell prevents further read access to the functional bits in the device. This cell can only be erased by re-programming the device, so the original configuration can never be examined once this cell is programmed. The Electronic Signature is always available to the user, regardless of the state of this control cell.

## LATCH-UP PROTECTION

GAL26V12 devices are designed with an on-board charge pump to negatively bias the substrate. The negative bias minimizes the potential for latch-up caused by negative input undershoots. Additionally, outputs are designed with n-channel pull-ups instead of the traditional p-channel pull-ups in order to eliminate latch-up due to output overshoots.

## DEVICE PROGRAMMING

GAL devices are programmed using a Lattice-approved Logic Programmer, available from a number of manufacturers (see the GAL Development Tools section). Complete programming of the device takes only a few seconds. Erasing of the device is transparent to the user, and is done automatically as part of the programming cycle.

## OUTPUT REGISTER PRELOAD

When testing state machine designs, all possible states and state transitions must be verified in the design, not just those required in the normal machine operations. This is because certain events may occur during system operation that throw the logic into an illegal state (power-up, line voltage glitches, brown-outs, etc.). To test a design for proper treatment of these conditions, a way must be provided to break the feedback paths, and force any desired (i.e., illegal) state into the registers. Then the machine can be sequenced and the outputs tested for correct next state conditions.

The GAL26V12 device includes circuitry that allows each registered output to be synchronously set either high or low. Thus, any present state condition can be forced for test sequencing. If necessary, approved GAL programmers capable of executing test vectors perform output register preload automatically.

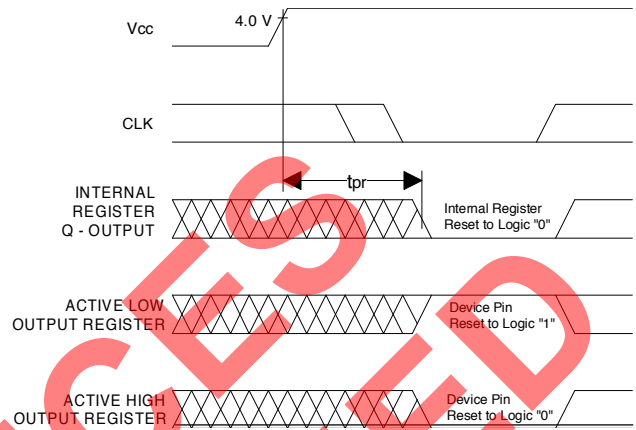
## INPUT BUFFERS

GAL26V12 devices are designed with TTL level compatible input buffers. These buffers have a characteristically high impedance, and present a much lighter load to the driving logic than bipolar TTL devices.

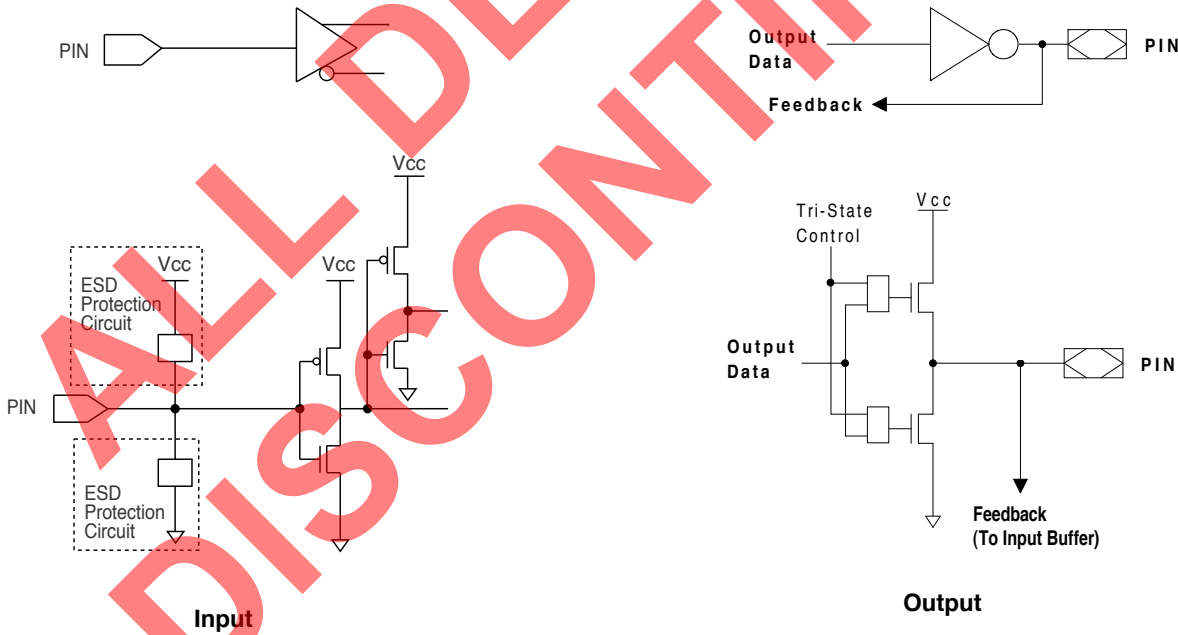
**Select devices have been discontinued.  
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**POWER-UP RESET**

Circuitry within the GAL26V12 provides a reset signal to all registers during power-up. All internal registers will have their Q outputs set low after a specified time ( $t_{pr}$ , 1 $\mu$ s MAX). As a result, the state on the registered output pins (if they are enabled) will be either high or low on power-up, depending on the programmed polarity of the output pins. This feature can greatly simplify state machine design by providing a known state on power-up. The timing diagram for power-up is shown below. Because of the asynchronous nature of system power-up, some conditions must be met to guarantee a valid power-up reset of the GAL26V12. First, the VCC rise must be monotonic. Second, the clock input must be at static TTL level as shown in the diagram during power up. The registers will reset within a maximum of  $t_{pr}$  time. As in normal system operation, avoid clocking the device until all input and feedback path setup times have been met. The clock must also meet the minimum pulse width requirements.



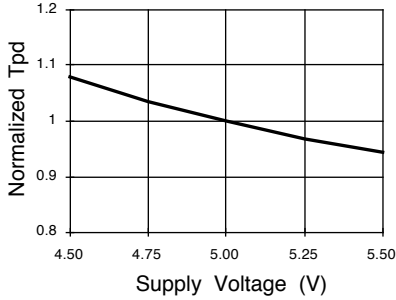
**INPUT/OUTPUT EQUIVALENT SCHEMATICS**



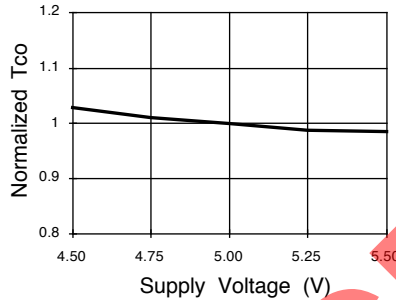
Select devices have been discontinued. See Ordering Information section for product status.

**TYPICAL AC AND DC CHARACTERISTIC DIAGRAMS**

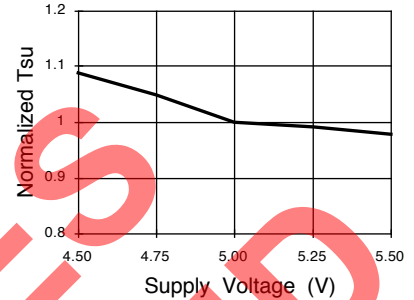
Normalized Tpd vs Vcc



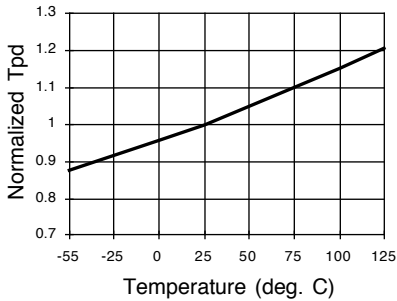
Normalized Tco vs Vcc



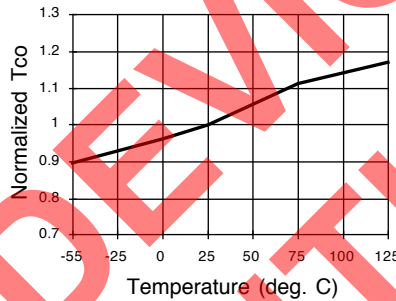
Normalized Tsu vs Vcc



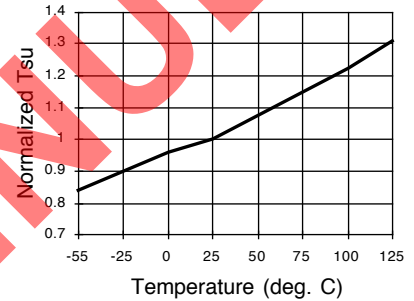
Normalized Tpd vs Temp



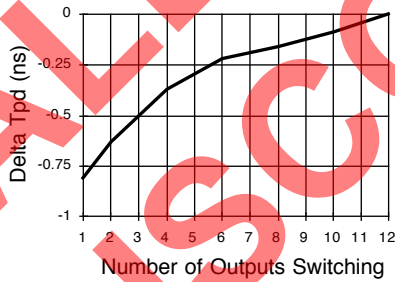
Normalized Tco vs Temp



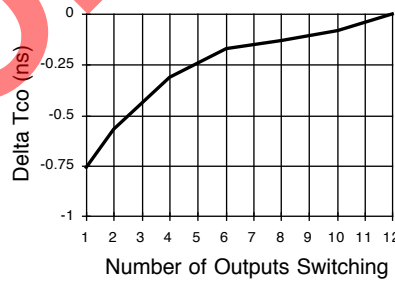
Normalized Tsu vs Temp



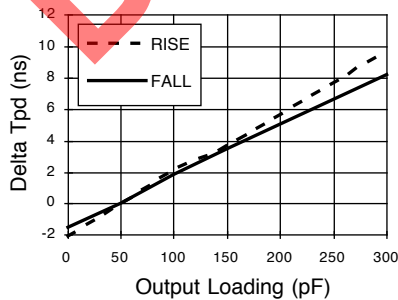
Delta Tpd vs # of Outputs Switching



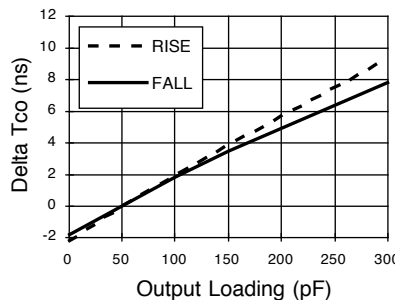
Delta Tco vs # of Outputs Switching



Delta Tpd vs Output Loading



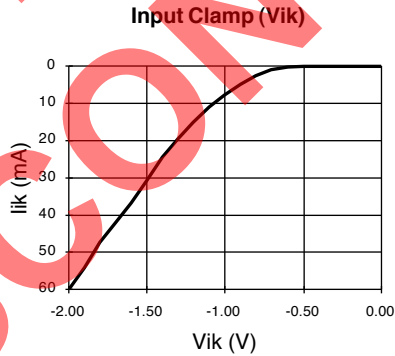
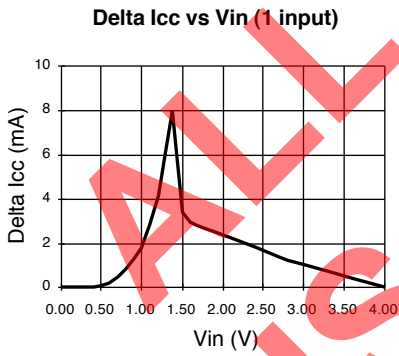
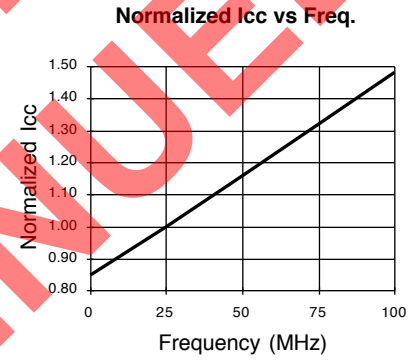
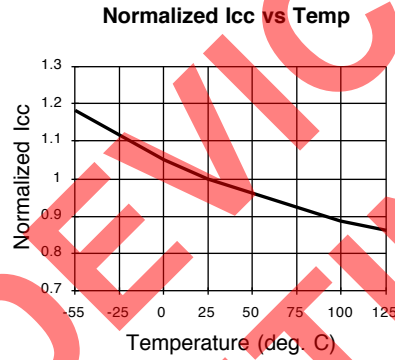
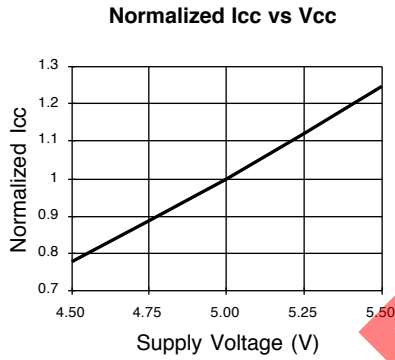
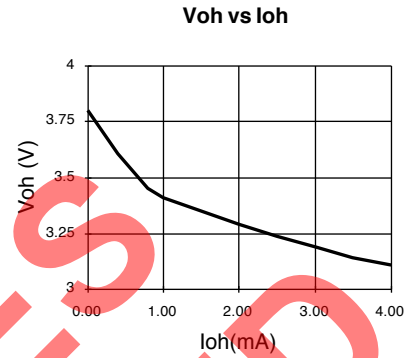
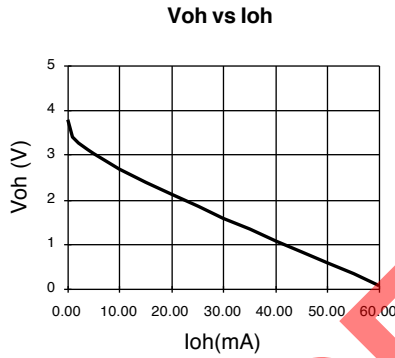
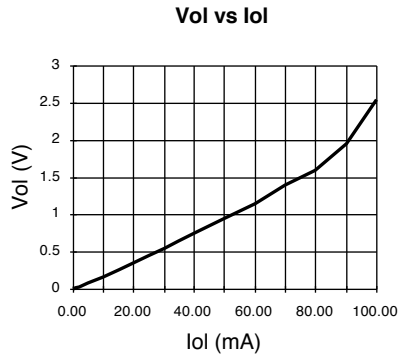
Delta Tco vs Output Loading



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**TYPICAL AC AND DC CHARACTERISTIC DIAGRAMS**



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