FAIRCHILD SEMICONDUCTOR™

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Description and Family Characteristics

Family Features

- VHC speeds 60% faster than HCMOS
- Guaranteed noise performance
  - V_{OLP} typically less than 1V
  - High Noise Immunity
  - $V_{NIH} = V_{NIL} = 28\%$ for VHC
  - $V_{IH} = 2.0V$, $V_{IL} = 0.8V$ for VHCT
- Output Drive of ±8 mA at 5V V_{CC} and ±4 mA at 3V V_{CC}
- AC performance specifications at 3V and 5V and at 15 pF and 50 pF Loads
- Low static I_{CC} and low I_{OZ}
- Operation from 2.0V–5.5V V_{CC} for VHC
- Operation from 4.5V–5.5V V_{CC} for VHCT
- Human Body Model (HBM) ESD > ±2 kV
- Charged Device Model (CDM) ESD > ±1 kV
- Latch-up protection > ±300 mA
- Inputs allow 0V–7V applied, regardless of supply voltage
- SOIC, TSSOP, and PDIP Packaging
- Industry Standard Functions and Pinouts

AC Performance

The VHC family helps to fill the void between HCMOS and FACT™ AC families as it offers the speed of FACT with the Low Noise of HCMOS. The VHC speed to noise ratio allows designers to achieve propagation delays up to three times faster than HCMOS and is ideal where the full drive of CMOS FACT is not needed. *Figure 1* illustrates the speed to noise ratio for HCMOS, FACT, and VHC. *Figure 2* compares the HC244, AC244 and VHC244 speed versus capacitive load.

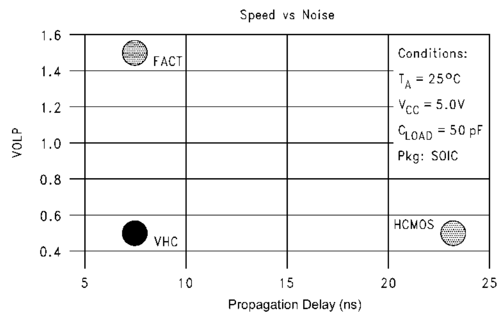

FIGURE 1.

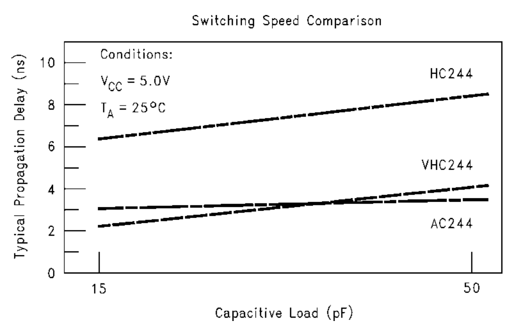

FIGURE 2.

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Noise Characteristics

The VHC noise V_{OLP}/V_{OLV} performance is significantly better in comparison to FACT AC and comparable to HCMOS. *Figure 3* compares the HCMOS, FACT AC and VHC ground bounce waveforms.

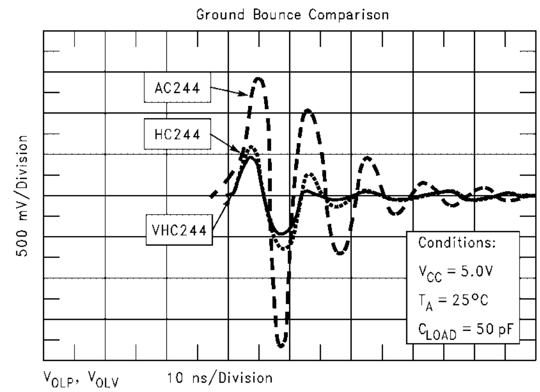


FIGURE 3.

Dynamic Power

The VHC family offers lower dynamic power consumption than the HC and FACT AC families. This feature makes the VHC attractive for low power applications such as battery operated computing. *Figure 4* is a comparison of the HC244, AC244 and VHC244 dynamic power.

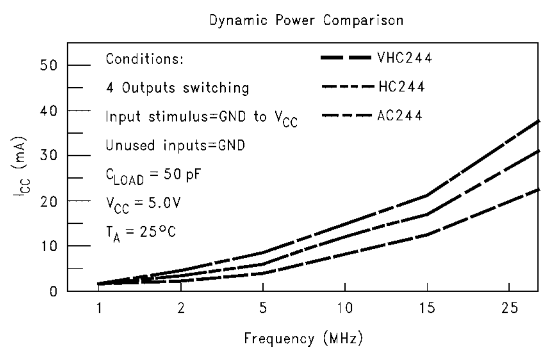


FIGURE 4.

Dynamic Power **(continued)**

The VHC family has higher output drive, faster AC speed, lower power requirements, lower noise and better dynamic thresholds than HC. This improvement of VHC DC and AC specifications over HC is illustrated by the comparison of the VHC04/VHC244 to the HC04/HC244 specifications in Table 1 and Table 2.

TABLE 1. DC Specifications

	VHC04	HC04	VHC244	HC244	Unit	V_{CC}
I_{OH}/I_{OL}	–8/8	–4/4	–8/8	–6/6	mA	4.5V
I_{CC}	20.0	20.0	40.0	80	μA	5.5V
V_{OLP}/V_{OLV}	0.8/–0.8	not spec'd	0.9/–0.9	not spec'd	V	5.0V
V_{ILD}/V_{IHD}	1.5/3.5	not spec'd	1.5/3.5	not spec'd	V	5.0V

TABLE 2. AC Specifications (T_A = – 40°C to +85°C, C_L = 50 pF)

	VHC04	HC04	VHC244	HC244	Unit	V_{CC}
t_{PHL}, t_{PLH} Max	8.5	24	8.5	29	ns	5.0 ± 0.5V
t_{PZH}, t_{PZL}			10.5	38	ns	5.0 ± 0.5V
t_{PHZ}, t_{PLZ}			10.5	38	ns	5.0 ± 0.5V
C_{PD} (T_A = 25°C)	18	20	19	50	pF	

Improved Interface

The VHC/VHCT family allows positive overvoltage on the inputs and positive overvoltage on the 3-stated VHCT outputs. These new input and output specifications enable VHC/VHCT devices to provide logic functions between systems powered by different supply voltages. Thus this family can link systems of different technologies without any translators.

Inputs are constructed without an input protection diode to V_{CC}. This allows 0V to 7V to be applied to the inputs without regard to the V_{CC} supply voltage level. Thereby preventing destruction due to mismatched supply and input voltages. These devices also can be used to interface 5V to 3V systems as well as two supply systems such as a battery backup. As an example, VHC devices can convert 5V logic levels to 3V logic levels (exception is VHC245). Similarly, the VHCT devices can convert 3V logic levels to 5V logic levels (exception is VHCT245A). *Figure 5* shows the VHC/VHCT input protection structure.

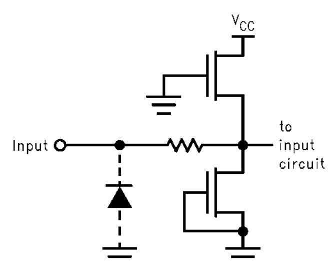


FIGURE 5.

Type Classification

Figure 6 lists the family types included in this Databook.

Type	Internal Stage	Input Threshold	Output Level
VHC	Two stage and above	CMOS Level	CMOS Level
VHCU	Single stage	CMOS Level	CMOS Level
VHCT	Two stage and above	TTL Level	CMOS Level

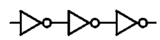
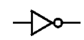
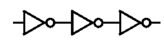
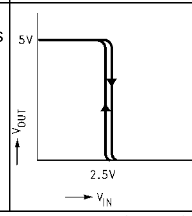
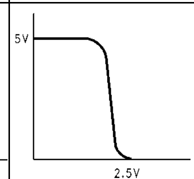
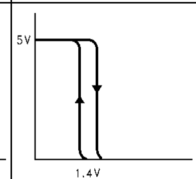
	74VHC04	74VHCU04	74VHCT04A
Logic Diagram			
Input-Output Voltage transfer characteristics			

FIGURE 6.

Input Characteristics

To improve V_{ILD}, V_{IHD} and minimize the affects of slow edge rates on clock inputs, the VHC/VHCT inputs are implemented with a simplified Schmitt Trigger. This provides a typical hysteresis voltage of 0.15V for VHC and 0.3V for VHCT. The devices which do not have this simplified Schmitt Trigger are the VHCU04, which has a single stage input, and the VHC14 and VHC132, which have standard Schmitt Trigger inputs. Refer to *Figure 6*.

VHC/VHCT inputs provide high noise immunity by insuring that input threshold voltages are not compromised during static or dynamic operation. Dynamic Threshold is guaranteed at the DC input threshold levels—1.5V/3.5V for VHC and 0.8V/2.0V for VHCT.

The VHC/VHCT input structures are typical CMOS input designs and as such present a minimal load to the system. The only loading that does occur is due to input capacitance (C_I) and input leakage current (I_{IN}). Typical C_I for the family is 4 pF while I_{IN} is ±1 µA. For I/O parts, C_{IO} is 9 pF and I_{OZ} is ±2.5 µA.

Output Characteristics

VHC and VHCT circuits have conventional CMOS outputs that swing rail-to-rail. Additionally, VHCT devices feature outputs that are over-voltage tolerant, similar to the LCX and VCX Crossvolt families. (VHC inputs are over-voltage tolerant.) This feature prevents the device from drawing excessive current when voltages greater that V_{CC} are applied the inputs or outputs; (outputs in high impedance state). When powered down, the devices will also tolerate input and output voltages up to 5.5 volts with an output current of only 5 micro Amps. These features also support hot insertion. Although VHC family devices have short propagation delays, and fast output edge rates, output noise is controlled using patented wave shaping circuitry. V_{OLP} is typically less than 1 volt.

The VHC V_{OH}/I_{OH} curves at 85°C and 25°C are displayed in *Figure 7* (V_{CC} = 4.5V) and *Figure 8* (V_{CC} = 3V). Similarly, the VHC V_{OL}/I_{OL} curves at 85°C and 25°C are displayed in *Figure 9* (V_{CC} = 4.5V) and *Figure 10* (V_{CC} = 3.0V).

Figure 11 and *Figure 12* display the typical I_{OH} and I_{OL} values at 25°C across V_{CC}.

Note, that the graphs display V_{OH}/I_{OH} and V_{OL}/I_{OL} values outside the V_{OH}/I_{OH} and V_{OL}/I_{OL} specifications to exhibit output drive characteristics, and do not imply the output structures will perform at these levels.

Output Characteristics (continued)

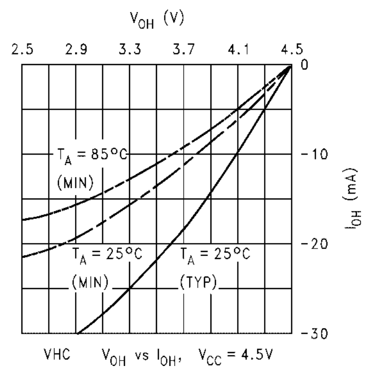


FIGURE 7.

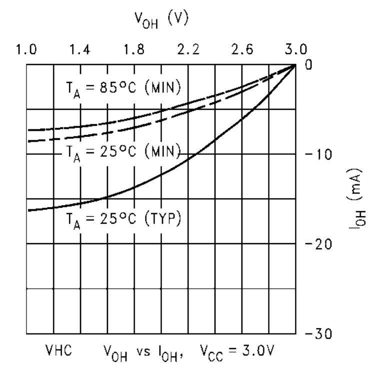


FIGURE 8.

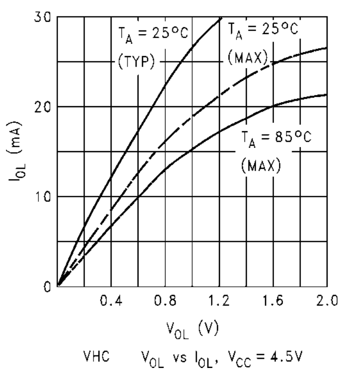


FIGURE 9.

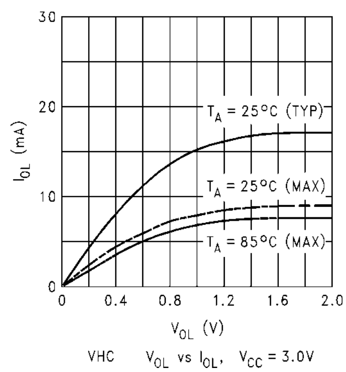


FIGURE 10.

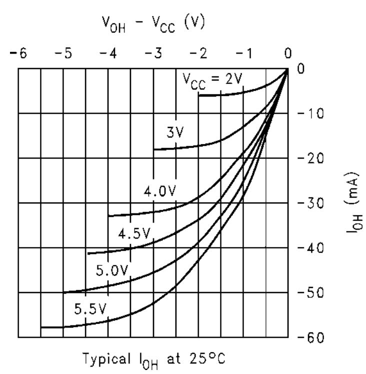


FIGURE 11.

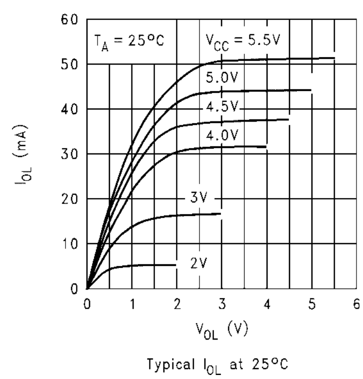


FIGURE 12.

Capacitive Loading Effects on AC and Noise

Capacitive loads greater than 50 pF will increase AC propagation delays, increase output transition times and reduce V_{OLP}/V_{OLV}.

The datasheets specify AC performance under a 15 pF and a 50 pF load. However, to calculate the increased propagation delay use the following formula:

t_{PD} (C_L pF) = (t_{PD}/pF) (C_L pF – 50 pF) + t_{PD} (50 pF)

The t_{PD}/pF (ns/pF) ratio is determined by plotting propagation delay times for C_L values ranging from 50 pF to 150 pF as shown in *Figure 13* (V_{CC} = 4.5V) and *Figure 14* (V_{CC} = 3.0V). The 25°C and 85°C maximum ratios and graphs should be used as guides and are not guaranteed specifications.

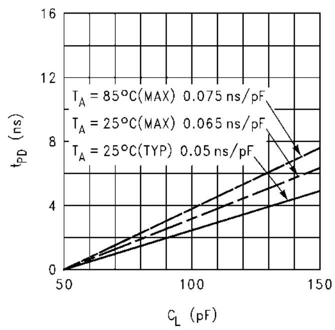


FIGURE 13. t_{PD} vs C_L, V_{CC} = 4.5V

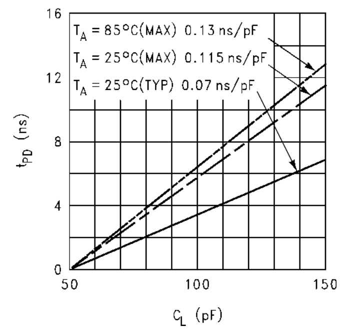


FIGURE 14. t_{PD} vs C_L, V_{CC} = 3.0V

The increase in output transition times is plotted in *Figure 15*.

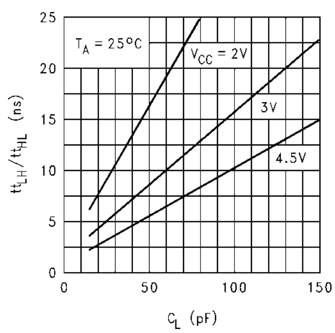


FIGURE 15. tt_{LH}/tt_{HL} (Typ) vs C_L

The reduction in V_{OLP}/V_{OLV} is plotted in *Figure 16*.

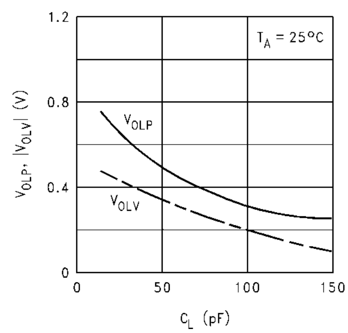


FIGURE 16. V_{OLP}/V_{OLV} vs C_L, V_{CC} = 5.0V (7 Outputs Switching)

Output Skew Characteristics

The output skew for all octal devices is specified to be no greater than 1.0 ns at a V_{CC} = 5.0 ± 0.5V and 1.5 ns at a V_{CC} = 3.3 ± 0.3V. This parameter is guaranteed by design and is not tested.