

#### FEATURES

- Serial Data Rates up to 1.25 Gb/s
- Parallel Data Rates up to 155 Mb/s
- ECL 100K Compatible Parallel Data I/Os
- Divide-by-8 Clock for Synchronization of Parallel Data to Interfacing Chips
- SONET Frame Recovery Circuitry (VS8012)
- Compatible with STS-3 to STS-24 SONET Applications
- Low Power Dissipation: 2.0 W (Typ. per chip)
- Standard ECL Power Supplies:  
 $V_{EE} = -5.2 \text{ V}$ ,  $V_{TT} = -2.0 \text{ V}$
- Available in Commercial ( $0^\circ$  to  $+70^\circ \text{ C}$ ) or Industrial ( $-40^\circ$  to  $+85^\circ \text{ C}$ ) Temperature Ranges
- Proven E/D Mode GaAs Technology
- 52-pin Leaded Ceramic Chip Carrier

#### FUNCTIONAL DESCRIPTION

##### Introduction

The VS8011 and VS8012 are high speed SONET compatible 8-bit data conversion devices capable of serial data rates up to 1.25 Gb/s. The VS8011 and VS8012 can be used for STS-3 through STS-24 SONET applications.

The VS8011 and VS8012 are fabricated in gallium arsenide using the Vitesse H-GaAs™ E/D MESFET process which achieves high speed and low power dissipation. These products are packaged in a ceramic 52 pin leaded or leadless chip carrier. Refer to Section 5, "Packaging" for a complete description of this package.

##### VS8011 8:1 Multiplexer

The VS8011 8:1 multiplexer accepts 8 parallel ECL data inputs [ $D(1:8)$ ] at rates up to 155 Mb/s and multiplexes them into a single bit stream at speeds up to 1.25 Gb/s. The parallel data inputs are clocked into the input registers with **BYCLK**, an ECL input operating at up to 155 MHz. The high

speed clock input (**CLKI**) is divided by 8 (**CLK8**) and used to synchronize the parallel data to the timing generator. **CLK8** then loads the parallel data into the buffer registers. An on-chip circuit detects internal set up and hold violations caused by improperly related **BYCLK** and **CLK8** falling edges. An external signal (**SYNC**) may be used to correct **CLK8** phase by  $180^\circ$ . **SYNC** is high. If a setup or hold violation has been detected, a **SYNC** input causes **CLK8** to be inverted on the next **BYCLK** falling edge, thereby guaranteeing a safe **CLK8** and **BYCLK** relationship. If no setup and hold violation has been detected **SYNC** has no impact on the circuit.

The high speed differential clock input is brought on-chip at **CLKI**, **CLKIN**. The high speed differential serial data is provided at the **DO**, **DON** outputs. The high speed differential clock signal is transmitted off chip via the high speed outputs **CO**, **CON**.

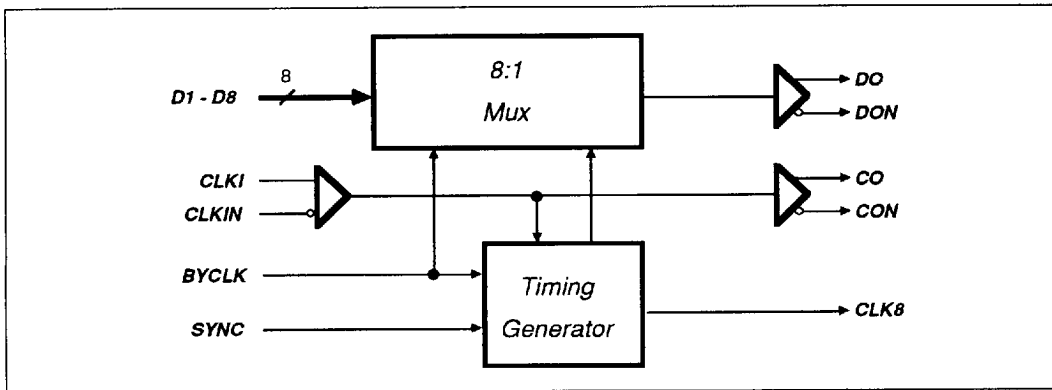
##### VS8012 1:8 Demultiplexer with Frame Recovery

The VS8012 1:8 demultiplexer converts serial data at up to 1.25 Gb/s into an 8-bit parallel data stream at up to 155 Mb/s. The high speed differential serial input is at **DI**, **DIN**. Valid parallel data is clocked out by the divide by 8 clock output **BYCKO**. The demultiplexer also contains SONET frame detection and recovery circuitry.

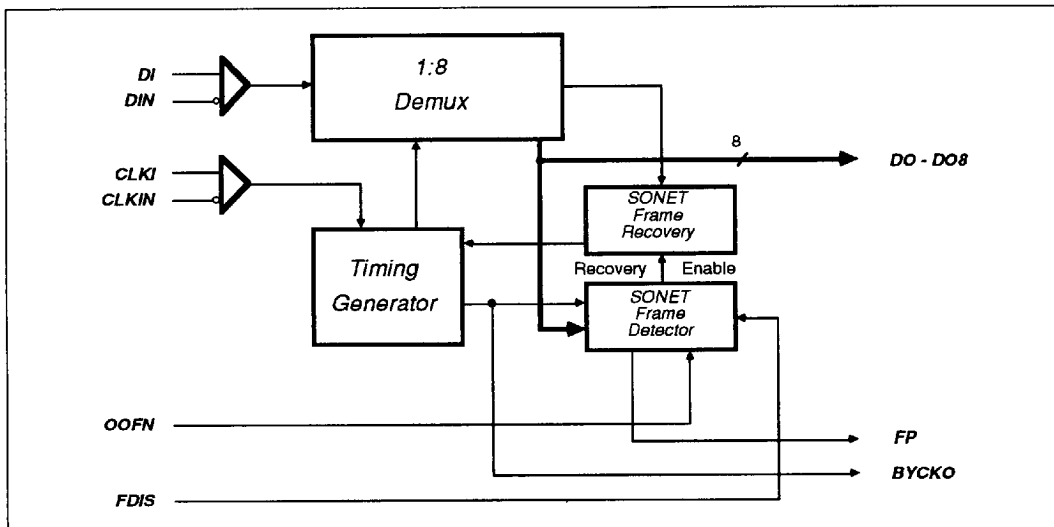
The frame recovery circuits are enabled by a falling edge on the **OOFN** ECL input when the additional **FDIS** ECL input is low. When the **FDIS** input is high the falling edge of **OOFN** disables the frame recovery circuit. The **FDIS** input is included to provide an alternative means of disabling the frame recovery circuit during device evaluation. In normal operation this input is wired to  $V_{TT}$  and the frame recovery circuit is disabled when serial A1's and A2's appear at the high speed differential serial data input (**DI**, **DIN**).

Once the frame is detected, a confirmation signal is sent off-chip through the low power ECL output **FP**. The frame detection confirmation signal also disables the frame recovery circuits.

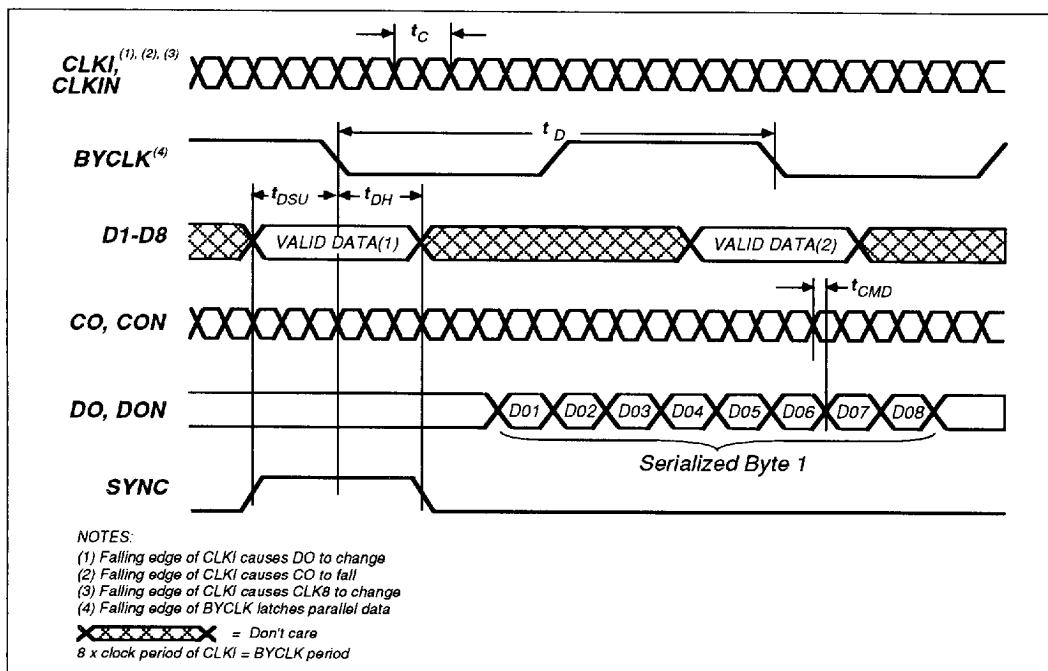
### VS8011 BLOCK DIAGRAM



### VS8012 BLOCK DIAGRAM



## VS8011 MULTIPLEXER WAVEFORMS



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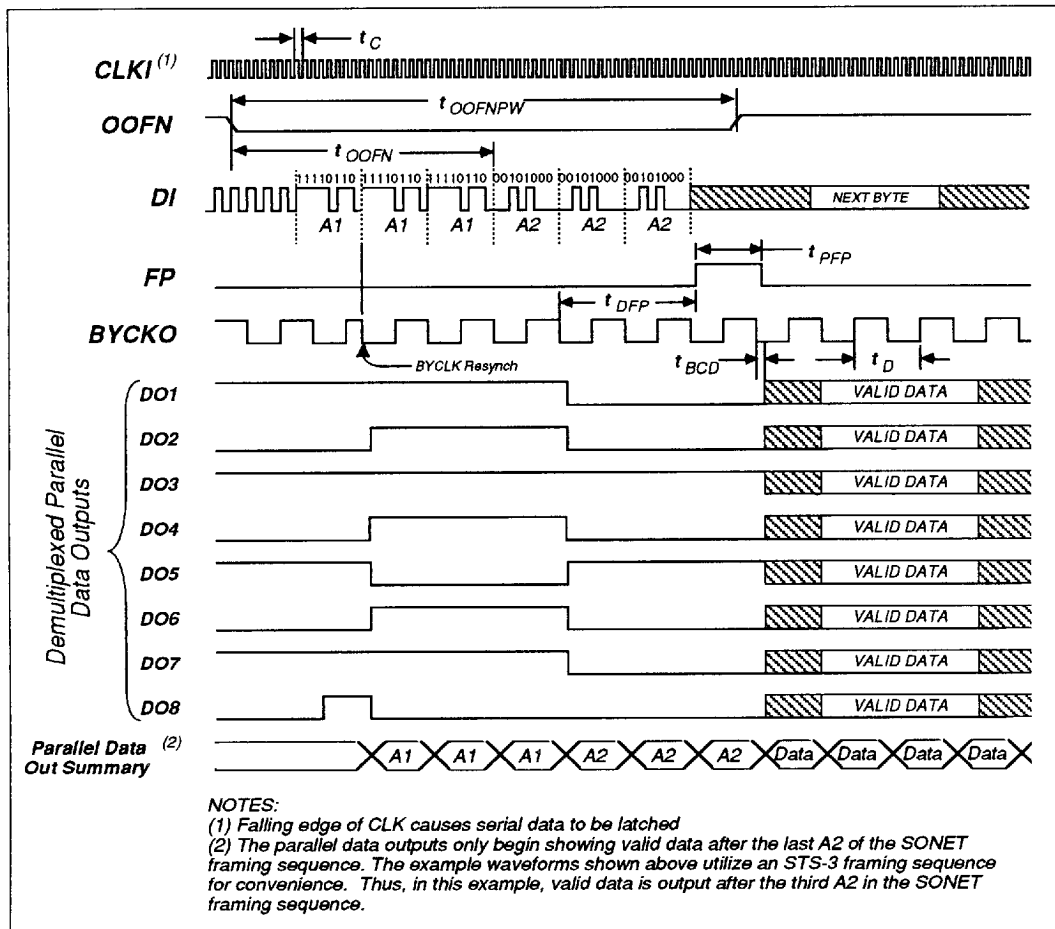
## VS8011 MULTIPLEXER AC CHARACTERISTICS

(Over recommended operating conditions.)

Parameter	Description	Min	Typ	Max	Units
$t_C$	Clock period *	0.8	—	—	ns
$t_D$	BYTE clock period ( $t_D = t_C \times 8$ )	6.4	—	—	ns
$t_{DSU}$	Parallel data set-up time with respect to BYCLK	1.0	—	—	ns
$t_{DH}$	Data hold time with respect to BYCLK	2.0	—	—	ns
$t_{CMD}$	High speed clock output (CO, CON) to muxed data output (DO, DON) timing	—	500	—	ps
jitter(RMS)	CLKI, CLKIN to DO, DON max-min, (HIGH to LOW), same part, same pin at constant conditions	—	<50	—	ps

\* The parts are guaranteed by design to operate from DC to a maximum frequency of 1.25 GHz.

## VS8012 DEMULTIPLEXER WAVEFORMS



**VS8012 DEMULTIPLEXER AC CHARACTERISTICS**

(Over recommended operating conditions.)

Parameter	Description	Min	Typ	Max	Units
$t_C$	Clock period *	0.8	—	—	ns
$t_D$	BYTE clock period ( $t_D = t_C \times 8$ )	6.4	—	—	ns
$t_{DFP}$	FP rising edge from parallel data output change from F1 to F2 ( $t_{DFP} = t_D \times 2$ )	—	12.8	—	ns
$t_{FPF}$	FP pulse width ( $t_{FPF} = t_D$ )	6.4	—	—	ns
$t_{OOFN}$	OOFN falling edge before A1 changes to A2 ( $t_{OOFN} = t_D \times 4$ )	—	25.6	—	ns
$t_{OOFNPW}$	OOFN pulse width ( $t_{OOFNPW} = t_D$ )	6.4	—	—	ns
Phase Margin	Serial data phase timing margin with respect to high speed clock input: $\text{Phase Margin} = \left(1 - \frac{t_{SU} + t_H}{t_C}\right) 360^\circ$ , where $t_C$ is minimum clock cycle.	135	—	—	degrees
$t_{BCD}$	Falling edge of <b>BYCKO</b> to valid parallel data output	$t_C$	$t_C + 0.5$	$t_C + 1.5$	ns

\* If  $t_C$  changes, all the remaining parameters change as indicated by the equations.**VS8012 SONET FRAME RECOVERY AND DETECTION**

The SONET framing sequence is a string of A1 bytes followed by a string of A2 bytes. (A1 = 11110110 and A2 = 00101000) The first serial bit starts at the left of the byte. The table below shows the number of A1 and A2 bytes in each SONET frame for different line rates. The VS8022 contains a frame recovery circuit and a frame detection circuit.

STS LEVEL	LINE RATE (Mb/s)	# OF A1 BYTES	# OF A2 BYTES
STS-3	155.520	3	3
STS-9	466.560	9	9
STS-12	622.080	12	12
STS-18	933.120	18	18
STS-24	1244.16	24	24
STS-48	2488.32	48	48

Example: STS-24 has 24 A1s and 24 A2s:  
A1<sub>1</sub>A1<sub>2</sub>A1<sub>3</sub>.....A1<sub>24</sub>A2<sub>1</sub>A2<sub>2</sub>A2<sub>3</sub>.....A2<sub>24</sub>

**Frame Recovery Circuit**

The VS8012 SONET recovery circuit operates from STS-3 to STS-24. The frame recovery circuit looks for 3 A1s followed by 3 A2s. The byte clock out (**BYCKO**) and parallel byte data out (**DO<sub>1</sub>**-**DO<sub>8</sub>**) become invalid on the falling edge of **OOFN** and become valid when A1 changes to A2. The frame recovery circuit aligns the received serial data on byte boundaries for demultiplexing by controlling the timing generator. The byte boundary alignment is based on specific A1 and A2 byte recognition.

The VS8012 has been designed to recognize 3 A1s followed by 3 A2s, and therefore recognizes frames and aligns on byte boundaries for STS-3 through STS-24 line rates. As shown below, the framing sequence always contains 3 A1s followed by 3 A2s:

STS-24	(24 A1s & 24 A2s)
STS-18	(18 A1s & 18 A2s)
STS-12	(12 A1s & 12 A2s)
STS-9	(9 A1s & 9 A2s)
STS-3	(3 A1s & 3 A2s)

The falling edge of **OOFN** must occur at least 4 byte clock periods before A1 changes to A2. The pulse width of **OOFN** must be at least 1 byte clock period.

### Frame Detection Circuit

The frame detection circuit monitors the demultiplexed data, and senses the boundary between A1 and A2 bytes. If 3 A1 bytes followed by 3 A2 bytes are detected, then a frame confirmation signal is sent off-chip on the ECL output **FP**. The rising edge of the **FP** pulse occurs 2 byte clock periods after A1 changes to A2 on the demultiplexer parallel data outputs. The **FP** pulse width is one byte clock period (refer to demultiplexer waveforms).

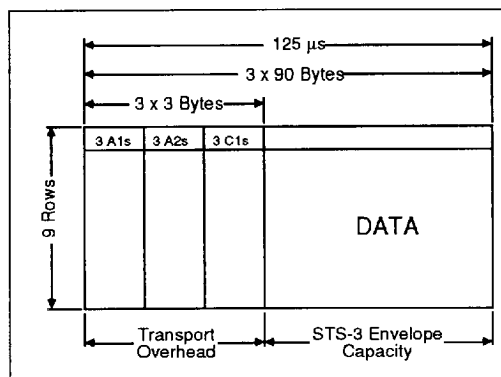
The frame detection circuitry also disables the frame recovery circuits once 3 A1 bytes are followed by 3 A2 bytes. The frame detector sends an **FP** pulse every frame when 3 A1s are followed by 3 A2s independent of the condition of the input **OOFN**.

### Circuit Operation

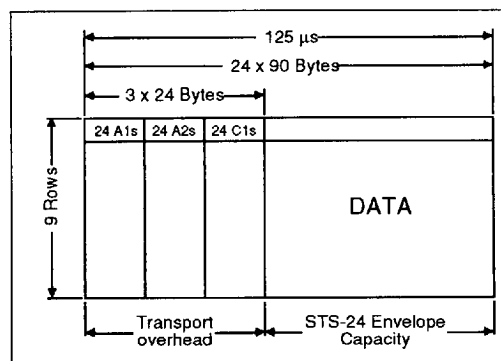
The frame recovery circuits are initialized and enabled on the falling edge of the **OOFN** ECL input with **FDIS** held low. The **OOFN** must be at least one byte clock period wide. It must occur at least 4 byte clock periods before the A1/A2 boundary. The circuit requires at least 3 A1 bytes followed by 3 A2 bytes for successful alignment. The first A1 byte is used by the frame recovery circuit to obtain initial word boundary alignment, while the following A1 and 3 A2 bytes are used to reset the frame recovery circuit and maintain alignment for the subsequent bit stream. Frame recovery and output alignment

will occur only on the first A1 byte following a **OOFN** falling edge input. Frame recognition will occur for each word boundary aligned A1A2A2A2 sequence in the data stream. Frame recognition is signaled by a one byte clock period high pulse on the **FP** ECL output pin. This **FP** pulse will appear one byte period after the second A2 byte appears on the parallel data output pins.

### STS-3 FRAME



### STS-24 FRAME



NOTE: A1s & A2s: SONET framing sequence  
C1s: STS Frame ID

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

Power Supply Voltage ( $V_{TT}$ )	-3.0 V to +0.5 V
Power Supply Voltage ( $V_{EE}$ )	$V_{TT} + 0.7$ V to -6.0 V
ECL Input Voltage Applied <sup>(2)</sup> , ( $V_{ECLIN}$ )	-2.5 V to +0.5 V
High Speed Input Voltage Applied <sup>(2)</sup> , ( $V_{HSIN}$ )	$V_{EE} - 0.7$ V to $V_{CC} + 0.7$ V
Output Current, $I_{OUT}$ , (DC, output HIGH)	-50 mA
Case Temperature Under Bias, ( $T_C$ )	-55° to +125°C
Storage Temperature <sup>(3)</sup> , ( $T_{STG}$ )	-65° to +150°C

**RECOMMENDED OPERATING CONDITIONS**

ECL Power Supply Voltage, ( $V_{TT}$ )	-2.0 V $\pm$ 0.1 V
Power Supply Voltage, ( $V_{EE}$ )	-5.2 V $\pm$ 0.26 V
Operating Temperature Range <sup>(3)</sup> , ( $T$ )	(Commercial) 0° to 70°C, (Industrial) -40° to +85°C

NOTES: (1) CAUTION: Stresses listed under "Absolute Maximum Ratings" may be applied to devices one at a time without causing permanent damage. Functionality at or above the values listed is not implied. Exposure to these values for extended periods may affect device reliability.

(2)  $V_{TT}$  must be applied before any input signal voltage magnitude ( $|V_{ECLIN}|$  and  $|V_{HSIN}|$ ) can be greater than  $|V_{TT} - 0.5V|$ .

(3) Lower limit of specification is ambient temperature and upper limit is case temperature.

**DC CHARACTERISTICS****POWER DISSIPATION**

(Over recommended operating conditions,  $V_{CC} = GND$ , outputs open circuit)

Parameter	Description	VS8010			VS8011			VS8012			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	Power supply current from $V_{EE}$	—	380	720	—	300	600	—	300	600	mA
$I_{TT}$	Power supply current from $V_{TT}$	—	450	900	—	110	220	—	125	250	mA
$P_D$	Power dissipation	—	2.9	5.8	—	1.9	3.7	—	2.0	3.8	W

**ECL Inputs/Outputs**(Over recommended operating range with internal  $V_{REF}$ .  $V_{CC} = GND$ , output load = 50  $\Omega$  to -2.0 V.)

Parameters	Description	Min	Typ	Max	Units	Conditions
$V_{OH}$	Output HIGH voltage	-925	—	-700	mV	$V_{IN} = V_{IH}$ (max) or $V_{IL}$ (min)
$V_{OL}$	Output LOW voltage	$V_{TT}$	—	-1750	mV	
$V_{IH}$	Input HIGH voltage	-1040	—	-600	mV	Guaranteed HIGH signal for all inputs
$V_{IL}$	Input LOW voltage	$V_{TT}$	—	-1600	mV	Guaranteed LOW signal for all inputs
$I_{IH}$	Input HIGH current	—	10	200	$\mu A$	$V_{IN} = V_{IH}$ max
$I_{IL}$	Input LOW current	-50	—	—	$\mu A$	$V_{IN} = V_{IL}$ min
$V_{REF}$	ECL input reference, $V_{BB}^{(2)}$	—	-1.29	—	V	

NOTE: 1) Differential ECL output pins must be terminated identically.

2)  $V_{REF}$  input is used to supply external VBB on chip for ECL 10K ECL compatibility.**High Speed Inputs and Outputs: CLKI, CLKIN, DO, DON**(Over recommended operating conditions.  $V_{CC} = GND$ , output load = 50  $\Omega$  to -2.0 V.)

Parameters	Description	Min	Typ	Max	Units	Conditions
$V_{IH}$	Input HIGH voltage	-3.1	-3.0	-2.9	V	Guaranteed HIGH for high speed inputs
$V_{IL}$	Input LOW voltage	-4.1	-4.0	-3.9	V	Guaranteed LOW for high speed inputs
$\Delta V_{IN}$	Input voltage swing	0.8	1	1.2	V	AC Coupled
$V_{OH}$	Output HIGH voltage	—	-0.9	—	V	Output load, 50 $\Omega$ to -2.0 V
$V_{OL}$	Output LOW voltage	—	-1.8	—	V	Output load, 50 $\Omega$ to -2.0 V
$\Delta V_{OUT}$	Output voltage swing	0.6	0.8	1.2	V	Output load, 50 $\Omega$ to -2.0 V

NOTES: 1) A reference generator is built into each high speed input, and these inputs are designed to be AC coupled.

2) If a high speed input is used single-ended, a 150pF capacitor must be connected between the unused high speed or complement input and  $V_{TT}$ .

3) Differential high speed outputs must be terminated identically.

**HIGH SPEED DIFFERENTIAL CLOCK (C0,C0N) OUTPUTS (VS8010, VS8011)** $V_{EE} = -5.2 \pm 0.26$  V,  $V_{CC} = GND$ ,  $T_c = 0^\circ$  to  $70^\circ$  C, Output load = 50  $\Omega$  to -2.0 V.)

The clock output swing at 1.25 GHz is 400 mVp-p from each output, centered at approximately -1.5 V

The clock output swing at DC is 1.0 Vp-p from each output, centered at approximately -1.5 V



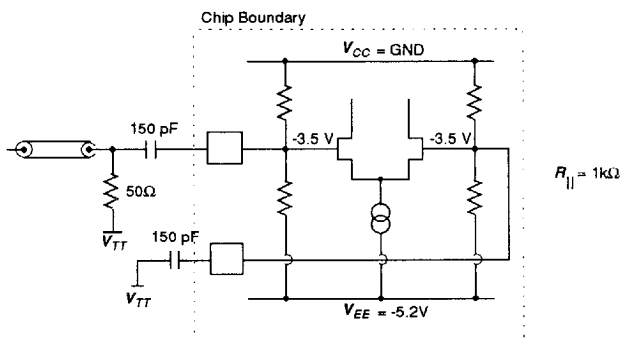
## HIGH SPEED INPUTS

In the past, the high speed inputs, which are typically used for serial data and high speed clock inputs with frequencies greater than 1GHz, were specified with absolute minimum and maximum voltage values. Since these inputs are intended for AC coupled applications, they have been re-specified in terms of a voltage swing ( $\Delta V_{IN}$ ).

High speed clocks are intended for AC coupled operation. In most situations high speed serial data will have high transition density and contain no DC offsets, making them candidates for AC coupling as well. However, it is possible to employ DC coupling when the serial input data contains a DC component.

The structure of the high speed input circuit is shown at right. DC coupled circuits may be used to operate this input provided that the input swing is centered around the reference voltage. Since the internal resistor divider which forms the -3.5V reference presents an

attenuation factor of only 0.6 to the  $V_{EE}$  power supply, it is recommended that, in single-ended DC coupling situations, the user provide an external reference which has better temperature and power supply rejection than the simple on chip resistive attenuator. This external reference should have a nominal value of -3.5 V and can be connected to the complimentary input. This complication can be avoided in DC coupled situations by using differential signals.



## VS8011/VS8012 EXAMPLE APPLICATION: STS-24 SYSTEM

The objective of the system is to multiplex and demultiplex 8 data channels at the STS-24 line rate with SONET frame recovery capability. In this example the system is implemented using two VS8011/VS8012 chip sets as follows:

### 8:1 Multiplexer

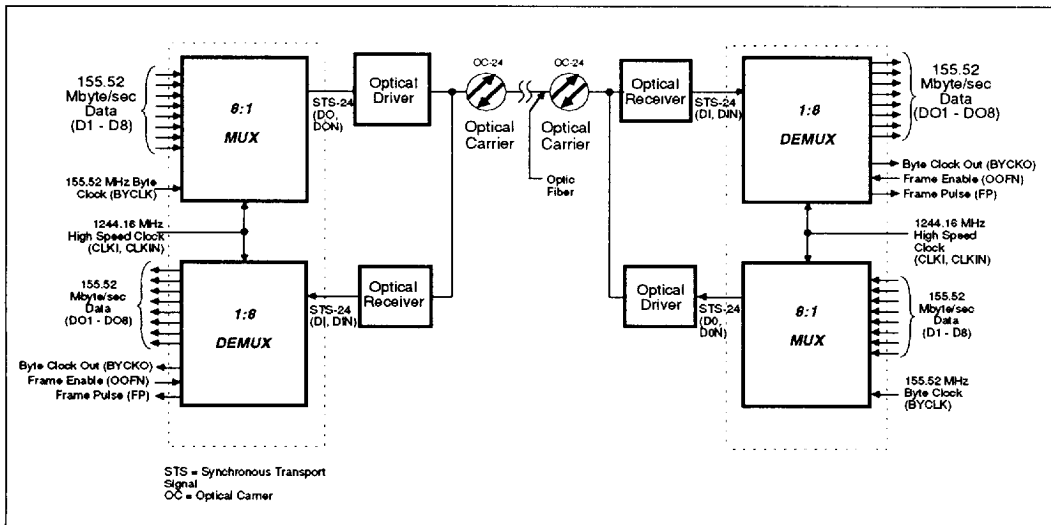
Data at a line rate of 155.52 Mbytes/sec is registered at the inputs using the 155.52 MHz byte clock. The 1244.16 MHz clock is used to generate timing signals for the multiplexing function. The multiplexed output at 1244.16 Mbytes/sec is generated at the serial data output (DO, DON) of the VS8011.

### 1:8 Demultiplexer

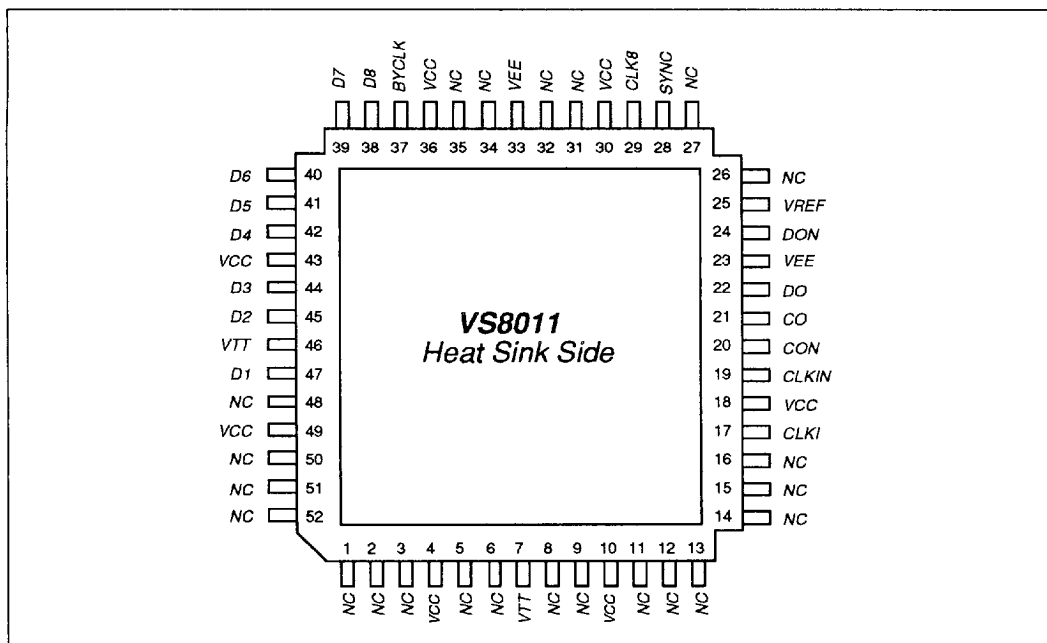
The 1:8 demultiplexer receives serial data at 1244.16 Mbytes/sec and generates parallel data at 155.52 Mbytes/sec along with a byte clock output of 155.52 MHz. The demultiplexer also contains the SONET frame recovery and detection circuitry.

During system start-up the **OOFN** input receives a falling edge from the system control to recover the SONET frame and align on byte boundaries. Once the frame is aligned, the **FP** pulse is generated on every SONET frame. If for any reason the **FP** pulse disappears on frame boundaries then this signals the system that the frame synchronization is lost. The system then asserts the **OOFN** input (HIGH to LOW) to recover the SONET frame and align on byte boundaries, thus bringing the system back to a synchronized condition. The **FP** pulse begins appearing again on every frame.

## SONET STS-24 SECTION LEVEL NODE



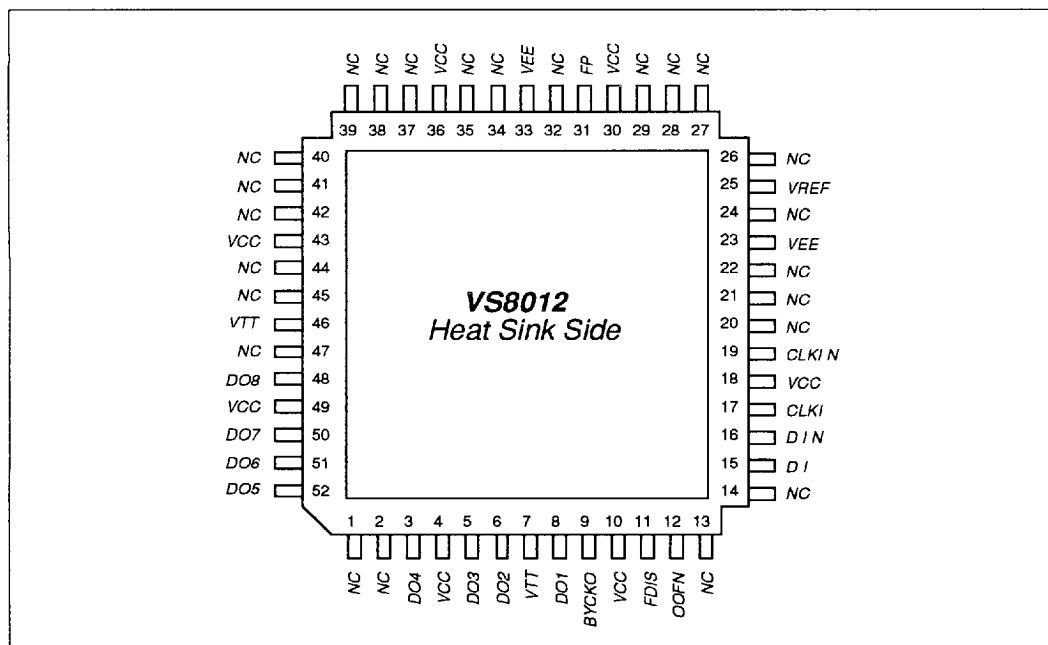
## VS8011 PIN DIAGRAM



## VS8011 PIN DESCRIPTION

Pin #	Name	I/O	Description
47, 45, 44, 42 - 38	<b>D1 - D8</b>	I	Parallel ECL data inputs
17, 19	<b>CLKI, CLKIN</b>	I	High speed differential clock inputs
37	<b>BYCLK</b>	I	Divide by 8 clock ECL input
22, 24	<b>DO, DON</b>	O	High speed serial data output
21, 20	<b>CO, CON</b>	O	High speed differential clock output
29	<b>CLK8</b>	O	Mux divide by 8 clock ECL output
28	<b>SYNC</b>	I	Mux phase alignment enable ECL input
25	<b>V<sub>REF</sub></b>	I	ECL reference level input
4, 10, 18, 30, 36, 43, 49	<b>V<sub>CC</sub></b>		Ground connection
7, 46	<b>V<sub>TT</sub></b>		-2.0 V supply for internal reference generation & low power logic
23, 33	<b>V<sub>EE</sub></b>		-5.2 V supply for high speed logic
1 - 3, 5, 6, 8, 9, 11 - 16, 26, 27, 31, 32, 34, 35, 48, 50 - 52	<b>NC</b>		No connection

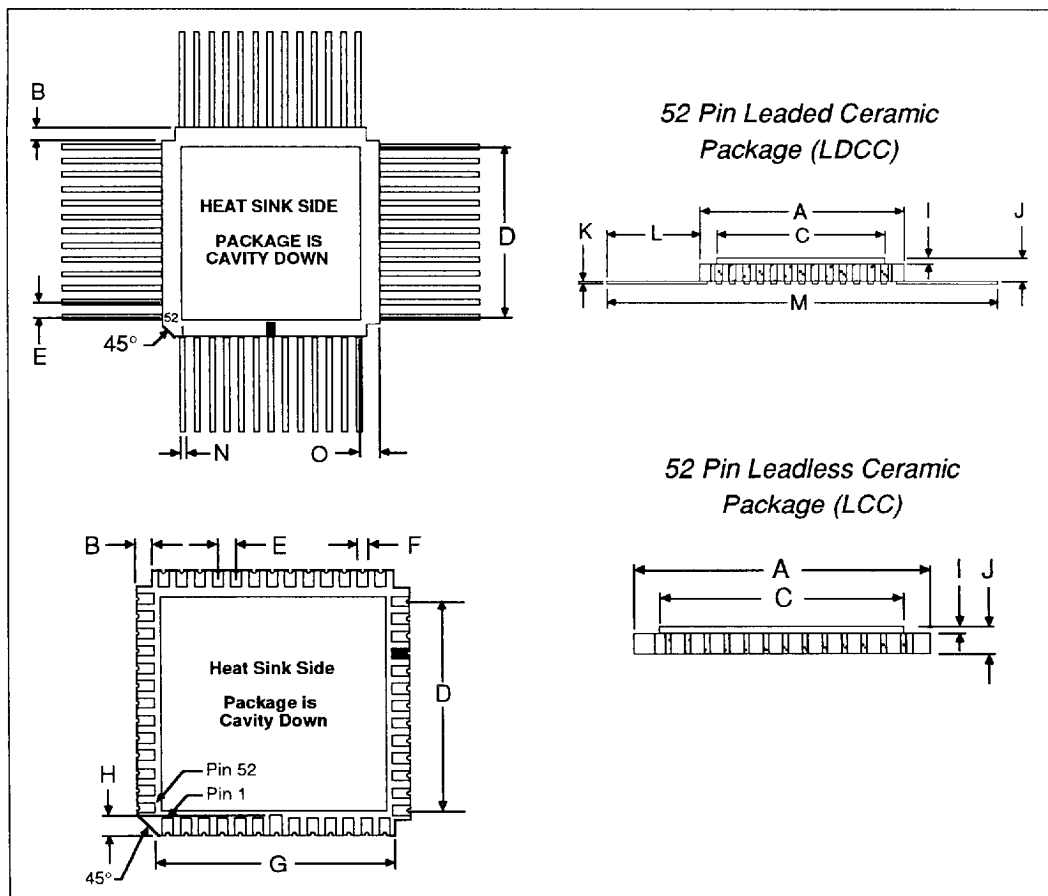
## VS8012 PIN DIAGRAM



## VS8012 PIN DESCRIPTION

Pin #	Name	I/O	Description
8, 6, 5, 3, 52 - 50, 48	<b>DO1 - DO8</b>	O	Parallel ECL data outputs
17, 19	<b>CLKI, CLKIN</b>	I	High speed differential clock inputs
9	<b>BYCKO</b>	O	Divide by 8 clock ECL output
15, 16	<b>DI, DIN</b>	O	High speed differential serial data input
12	<b>OOFN</b>	I	Frame recovery enable ECL input
11	<b>FDIS</b>	I	Frame recovery disable ECL input
31	<b>FP</b>	O	Frame detection confirmation ECL output
25	<b>V<sub>REF</sub></b>	I	ECL reference level input
4, 10, 18, 30, 36, 43, 49	<b>V<sub>CC</sub></b>		Ground connection
7, 46	<b>V<sub>TT</sub></b>		-2.0 V supply for internal reference generation and low power logic
23, 33	<b>V<sub>EE</sub></b>		-5.2 V supply for high speed logic
1, 2, 13, 14, 20 - 22, 24, 26 - 29, 32, 34, 35, 37 - 42, 44, 45, 47	<b>NC</b>		No connection

## 52 PIN CERAMIC LDCC AND LCC PACKAGES



Item	mm (Min/Max)	In (Min/Max)	Item	mm (Min/Max)	In (Min/Max)
A	18.54/19.56	0.730/0.770	I	0.41/0.61	0.016/0.024
B	1.02/1.52	0.040/0.060	J	2.03/2.79	0.080/0.110
C*	15.49/16.51	0.610/0.650	K*	0.09/0.24	0.003/0.009
D*	15.24 TYP	0.600 TYP	L	4.83/5.08	0.190/0.200
E	1.27 TYP	0.050 TYP	M	29.46 TYP	1.160 TYP
F	0.76/1.02	0.030/0.040	N	0.36/0.56	0.014/0.022
G	16.94 TYP	0.667 TYP	O	1.75/1.90	0.069/0.075
H	1.91/2.41	0.075/0.095	—	—	—

\* At package body.

NOTES:  
 1) Drawing not to scale.  
 2) Packages: Ceramic (alumina); Heat sinks: Copper-tungsten; Leads: Alloy 42 with gold plating

**VS8011DUT/VS8012DUT BOARD**

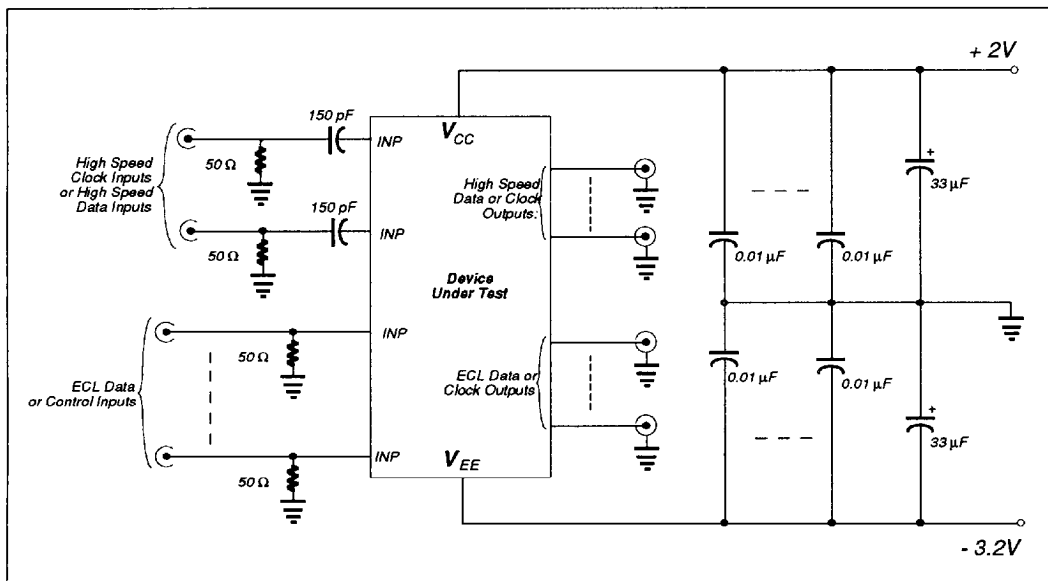
The VS8011 DUT/VS8012 DUT are general purpose circuit boards which provide a test bed suitable for evaluating the performance characteristics of the VS8011/VS8012 in the 52 pin LCC package. The evaluation boards are specific to the VS8011/VS8012 series, and are configured with I/Os which are specific to the VS8011/VS8012.

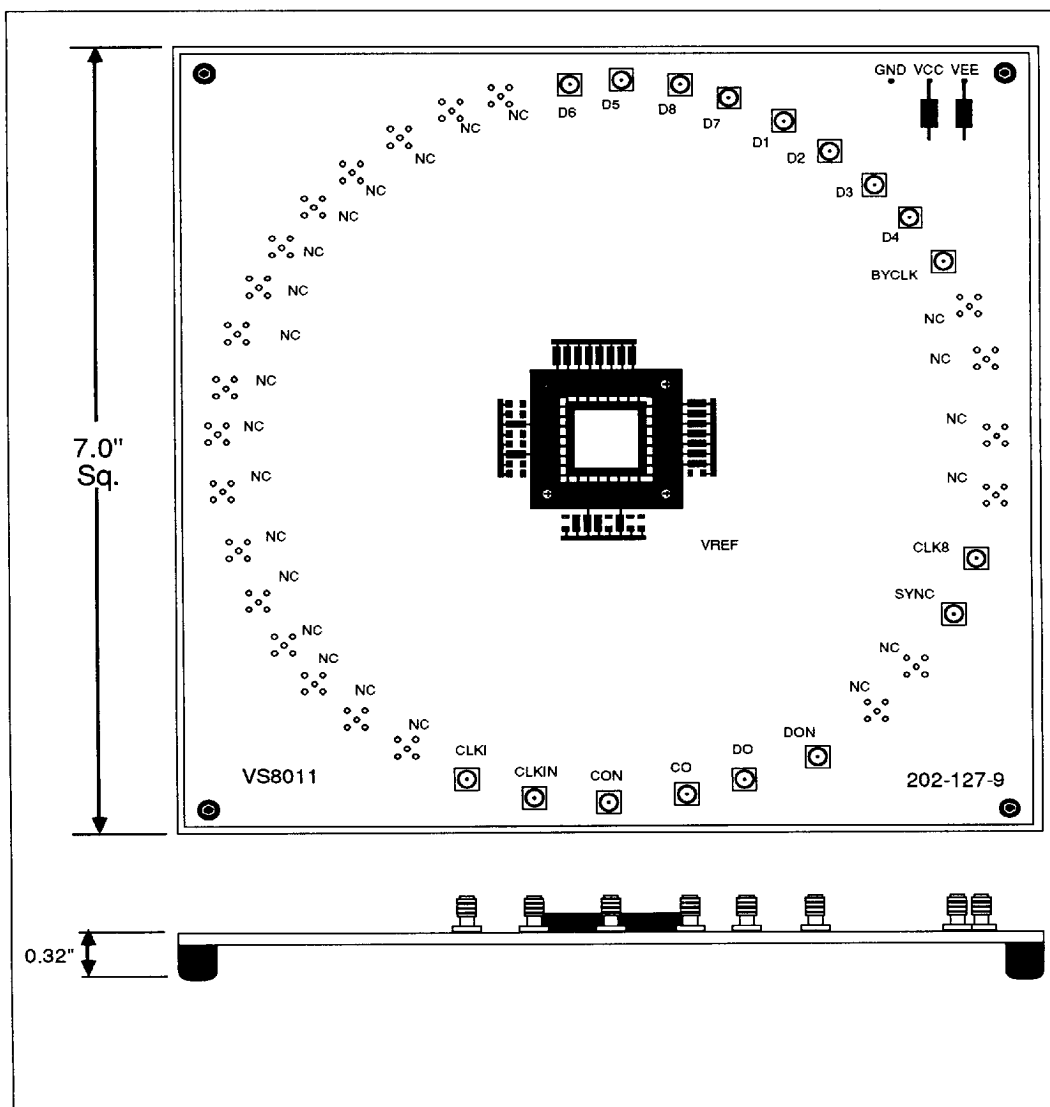
The figure below is a schematic representation of these circuit boards. The boards provide a controlled impedance transmission line for all signals, and suitable decoupling for the power supplies. The signal traces have a characteristic impedance of 50  $\Omega$ . All ECL input lines are terminated with 50  $\Omega$  (chip resistor) as close to the device package pin as possible. The high speed inputs are also provided with 150 pF blocking capacitors as shown. These capacitors are shorted in applications which require DC connection to these inputs. Signals are launched onto the circuit board and removed by means of SMA coaxial

connectors. While the input signals are terminated, the output signals are provided open circuit and are intended to be terminated in the measuring instrument such as an oscilloscope.

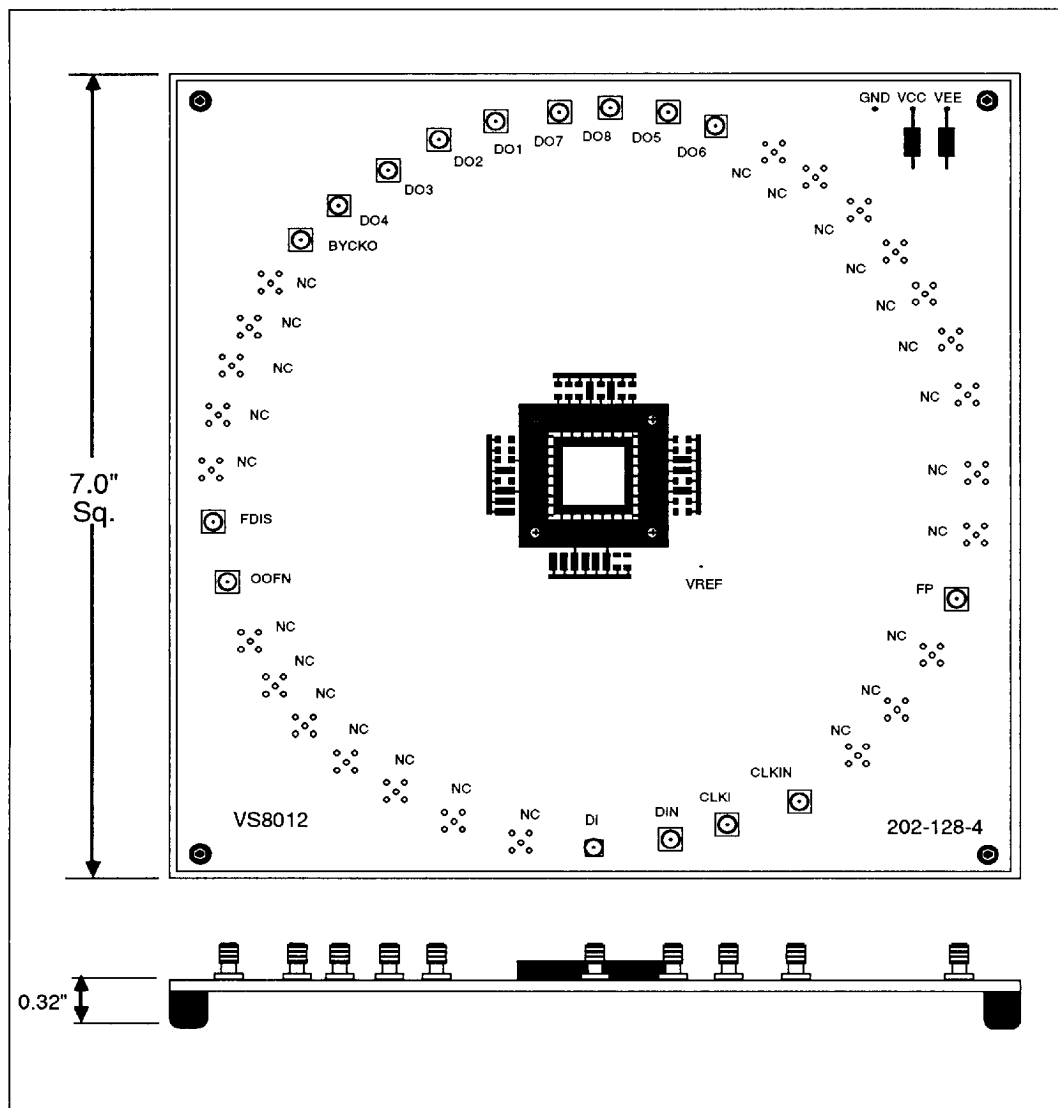
Normally, the VS8011 and VS8012 operate in an ECL environment with standard ECL power buses: 0V, -2V, -5.2V. In order to simplify interface to standard ground referenced test equipment, however, the circuit board power buses are offset so that the shield connectors are at ground voltage. The figure below shows the arrangement of the power supply decoupling capacitors. There is a 33  $\mu$ F electrolytic capacitor, as well as several 0.01  $\mu$ F ceramic capacitors across each power bus.

The device socket is an AMP 55227-1 LCC socket and was chosen for minimum inductance and shortest possible stub length. The figure on this page show the physical dimensions and the SMA connection labels for the VS8011 and VS8012 DUT boards.

**VS8011/VS8012 DUT BOARD SCHEMATIC**

**VS8011DUT DIMENSIONS AND CONNECTION DIAGRAM****2**

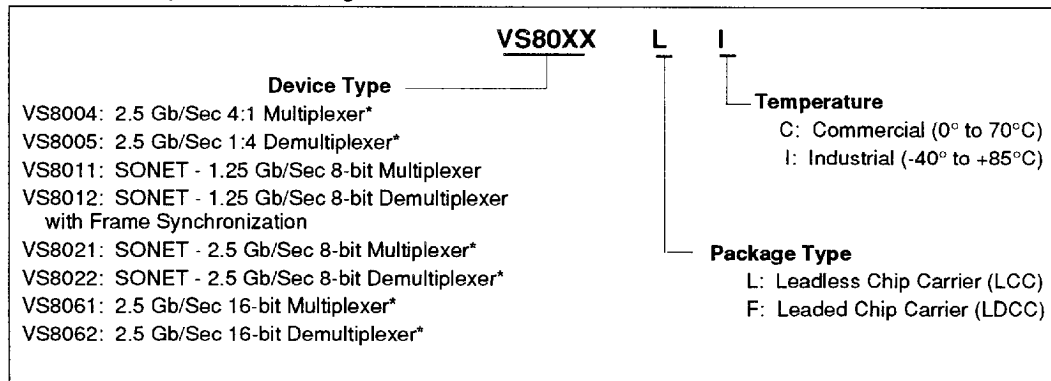
## VS8012DUT DIMENSIONS AND CONNECTION DIAGRAM





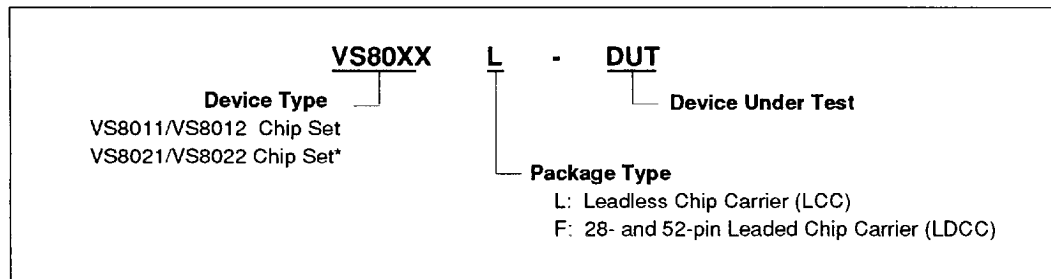
**ORDERING INFORMATION**

Vitesse products are available in a variety of packages and operating ranges. The order number for this product is formed by using a combination of the following: *Device Type*, *Package Type*, and *Operating Temperature Range*.

**VS80XX Family - Standard Logic**

\* Available in (F) package only.

The order number for the VS80XX DUT Board is formed by using a combination of the following: *Device Type*, and *Package Type*.

**Standard Logic Evaluation Boards**

\* Chips are available in (F) package only.