

# NBSG16BAEVB, NBSG16VSBAEVB

## NBSG16 and NBSG16VS Evaluation Board User's Manual



ON Semiconductor®

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### EVAL BOARD USER'S MANUAL

#### Description

This document describes the NBSG16/16VS evaluation board and the appropriate lab test setups. It should be used in conjunction with the NBSG16/16VS data sheets which contain full technical details on the device specifications and operation. The same PCB is used to evaluate both devices.

The evaluation board is designed to facilitate a quick evaluation of the NBSG16/16VS GigaComm™ Differential Receiver/Driver. The NBSG16 is designed to function as a high speed receiver/driver device with a reduced output swing capability suitable for use in high speed signal amplification and backplane interface applications. The Reduced Swing ECL (RSECL) output ensures minimal noise and fast switching edges. The NBSG16VS has the option to vary the output amplitude swing (additional  $V_{CTRL}$  modulation pin, labeled VS on evaluation board).

The evaluation board is implemented in two layers for higher performance. For standard lab setup and test, a split (dual) power supply is required enabling the 50  $\Omega$  impedance in the scope to be used as termination of the ECL signals ( $V_{TT} = V_{CC} - 2.0$  V, in split power supply setup,  $V_{TT}$  is the system ground).

#### What measurements can you expect to make?

With this evaluation board, the following measurements could be performed in single-ended (Note 1) or differential modes of operation:

- Jitter
- Output Skew
- Gain/Return Loss
- Eye Pattern Generation
- Frequency Performance
- Output Rise and Fall Time
- $V_{IHCMR}$  (Input High Common Mode Range)

1. Single-ended measurements can only be made at  $V_{CC} - V_{EE} = 3.3$  V using this board setup.

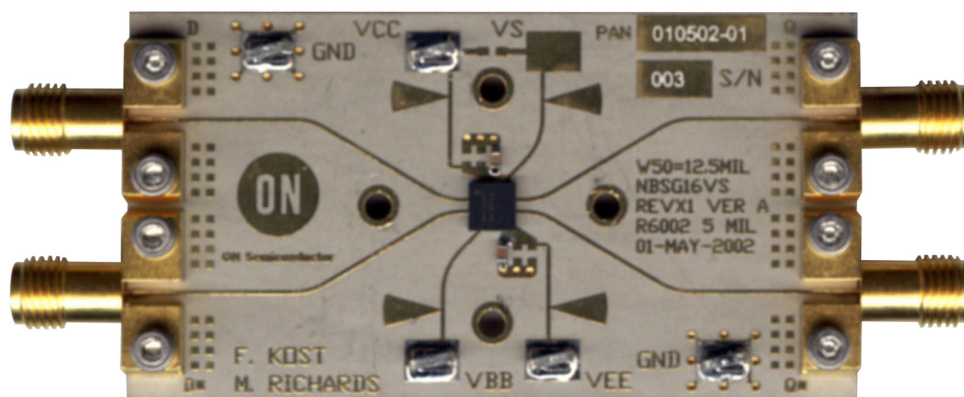


Figure 1. NBSG16/16VS Evaluation Board

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## SETUP FOR TIME DOMAIN MEASUREMENTS

**Table 1. BASIC EQUIPMENT**

| Description                                   | Example Equipment (Note 1)                | Quantity     |
|-----------------------------------------------|-------------------------------------------|--------------|
| Power Supply with 4 Outputs                   | HP6624A                                   | 1            |
| Oscilloscope                                  | TDS8000 with 80E01 Sampling Head (Note 2) | 1            |
| Differential Signal Generator                 | HP 8133A, Advantest D3186                 | 1            |
| Matched High Speed Cables with SMA Connectors | Storm, Semflex                            | 4            |
| Power Supply Cables with Clips                |                                           | 3/4 (Note 3) |

1. Equipment used to generate example measurements within this document.
2. 50 GHz sampling head used (for effective rise, fall and jitter performance measurement)
3. An additional power supply cable with a surface mount clip is necessary to test the NBSG16VS due to the  $V_{CTRL}$  connection.

### Setup

#### Step 1: Connect Power

1a: Three power levels must be provided to the board for  $V_{CC}$ ,  $V_{EE}$ , and GND via the surface mount clips. Using the split power supply mode,  $GND = V_{TT} = V_{CC} - 2.0$  V.

**Table 2. NBSG16/16VS POWER SUPPLY CONNECTIONS**

| 3.3 V Setup                   | 2.5 V Setup                   |
|-------------------------------|-------------------------------|
| $V_{CC} = 2.0$ V (Two Places) | $V_{CC} = 2.0$ V (Two Places) |
| $V_{TT} = GND$ (One Place)    | $V_{TT} = GND$ (One Place)    |
| $V_{EE} = -1.3$ V (One Place) | $V_{EE} = -0.5$ V (One Place) |

**Table 3. NBS/16VS ONLY POWER SUPPLY CONNECTIONS**

| 3.3 V Setup            | 2.5 V Setup            |
|------------------------|------------------------|
| $V_{CTRL}$ (One Place) | $V_{CTRL}$ (One Place) |

NOTE: **For NBSG16VS only:** Adjustable power supply is needed to modulate output amplitude by varying  $V_{CTRL}$  pin as shown in Figures 2 through 6. Connect the  $V_{CTRL}$  (Output Amplitude Swing Control) voltage level for the desired output swing. Refer to NBSG16VS data sheet Figures 4 and 5.

#### Step 2: Connect Inputs

##### For Differential Mode (3.3 V and 2.5 V operation)

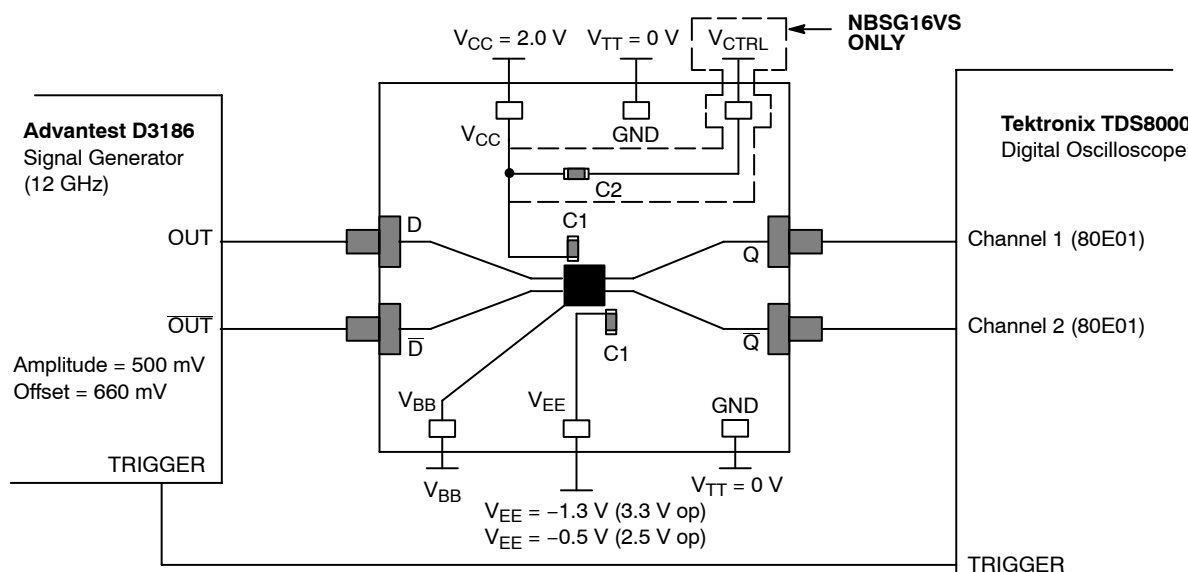
2a: Connect the differential output of the generator to the differential input of the device (D and  $\bar{D}$ ).

##### For Single-ended Mode (3.3 V operation only)

2a: Connect the AC coupled single-ended output generator to input.

NOTE: Device may oscillate when the input is not driven. For best results, unconnected input should be terminated to  $V_{TT}$  through 50  $\Omega$  resistor

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NOTE: All differential cable pairs **must be** matched.

WARNING:  $V_{CTRL}$  **must not** be connected for NBSG16 evaluation board connection or damage may result.

**Figure 2. NBSG16/16VS Board Setup – Time Domain (Differential Mode)**

### Setup (continued)

#### Step 3: Setup Input Signals

3a: Set the signal generator amplitude to 500 mV

NOTE: The signal generator amplitude can vary from 75 mV to 900 mV to produce a 400 mV DUT output.

3b: Set the signal generator offset to 660 mV (the center of a nominal RSECL output).

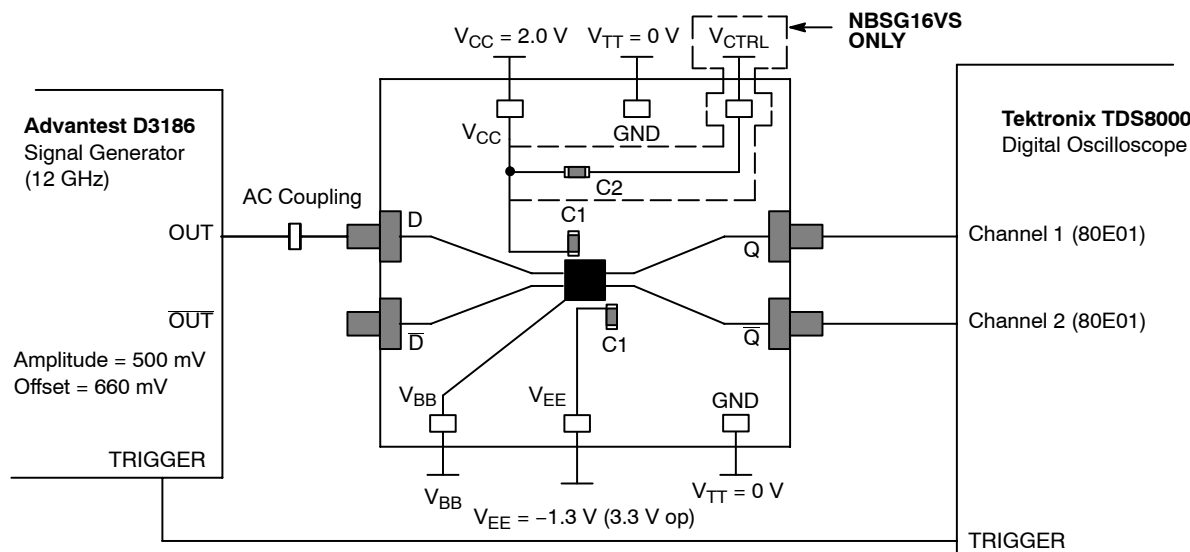
NOTE: The  $V_{IHCMR}$  (Input High Voltage Common Mode Range) allows the signal generator offset to vary as long as  $V_{IH}$  is within the  $V_{IHCMR}$  range. Refer to the device data sheet for further information.

3c: Set the generator output for a PRBS data signal, or for a square wave clock signal with a 50% duty cycle.

#### Step 4: Connect Output Signals

4a: Connect the outputs of the device ( $Q$ ,  $\bar{Q}$ ) to the oscilloscope. The oscilloscope sampling head must have internal 50  $\Omega$  termination to ground.

NOTE: Where a single output is being used, the unconnected output for the pair **must be** terminated to  $V_{TT}$  through a 50  $\Omega$  resistor for best operation. Unused pairs may be left unconnected. Since  $V_{TT} = 0$  V, a standard 50  $\Omega$  SMA termination is recommended.



NOTE: All differential cable pairs **must be** matched.

**Figure 3. NBSG16/16VS Board Setup – Time Domain (Single-ended Mode)**

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## SETUP FOR FREQUENCY DOMAIN MEASUREMENTS

**Table 4. BASIC EQUIPMENT**

| Description                                    | Example Equipment (Note 4) | Quantity     |
|------------------------------------------------|----------------------------|--------------|
| Power Supply with 4 Outputs                    | HP 6624A                   | 1            |
| Vector Network Analyzer (VNA)                  | R&S ZVK (10 MHz to 40 GHz) | 1            |
| 180° Hybrid Coupler                            | Krytar Model #4010180      | 1            |
| Bias Tee with 50 $\Omega$ Resistor Termination | Picosecond Model #5542-219 | 1            |
| Matched High Speed Cables with SMA Connectors  | Storm, Semflex             | 3            |
| Power Supply Cables with Clips                 |                            | 3/4 (Note 5) |

4. Equipment used to generate example measurements within this document.

5. An additional power supply cable with a surface mount clip is necessary to test the NBSG16VS due to the  $V_{CTRL}$  connection.

### Setup

#### Step 1: Connect Power

1a: Three power levels must be provided to the board for  $V_{CC}$ ,  $V_{EE}$ , and GND via the surface mount clips. Using the split power supply mode,  $GND = V_{TT} = V_{CC} - 2.0$  V.

**Table 5. NBSG16/16VS POWER SUPPLY CONNECTIONS**

| 3.3 V Setup                   |
|-------------------------------|
| $V_{CC} = 2.0$ V (Two Places) |
| $V_{TT} = GND$ (One Place)    |
| $V_{EE} = -1.3$ V (One Place) |

**Table 6. NBS/16VS ONLY POWER SUPPLY CONNECTIONS**

| 3.3 V Setup            |
|------------------------|
| $V_{CTRL}$ (One Place) |

NOTE: For frequency domain measurements, 2.5 V power supply is not recommended because additional equipment (bias tee, etc.) is needed for proper operation. The input signal has to be properly offset to meet  $V_{IHCMR}$  range of the device.

### Setup Test Configurations for Differential Operation

#### A) Small Signal Setup

##### Step 2: Input Setup

2a: Calibrate VNA from 1.0 GHz to 12 GHz.

2b: Set input level to  $-35$  dBm at the output of the 180° Hybrid coupler (input of the DUT).

##### Step 3: Output Setup

3a: Set display to measure S21 and record data.

#### B) Large Signal Setup

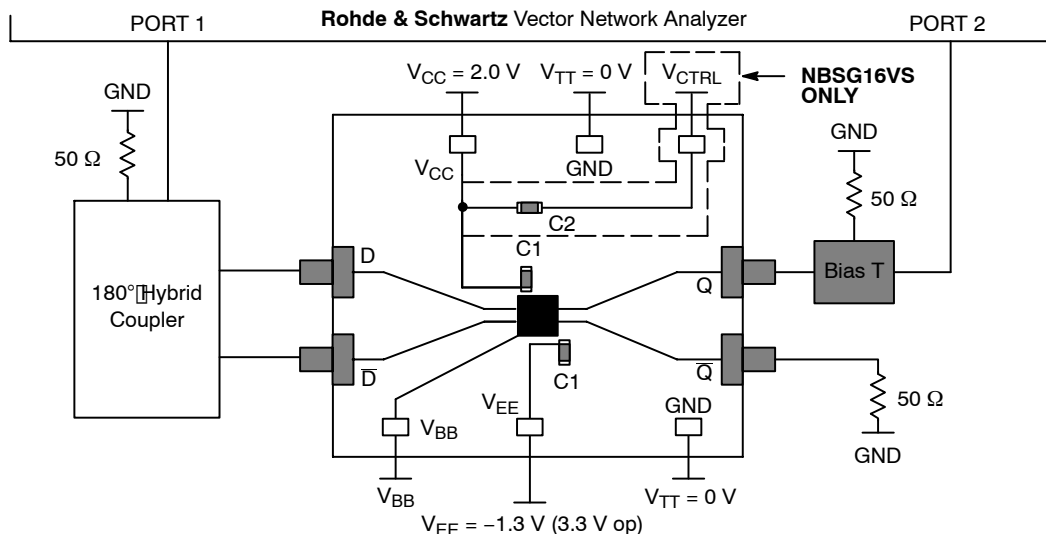
##### Step 2: Input Setup

2a: Calibrate VNA from 1.0 GHz to 12 GHz.

2b: Set input levels to  $-2.0$  dBm (500 mV) at the input of DUT.

##### Step 3: Output Setup

3a: Set display to measure S21 and record data.



**Figure 4. NBSG16/16VS Board Setup – Frequency Domain (Differential Mode)**

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## Setup Test Configurations for Single-ended Operation

### A) Single-ended Mode – Small Signal

#### Step 2: Input Setup

2a: Calibrate VNA from 1.0 GHz to 12 GHz.

2b: Set input level to  $-35$  dBm at the input of DUT.

#### Step 3: Output Setup

3a: Set display to measure  $S_{21}$  and record data.

### B) Single-ended Mode – Large Signal

#### Step 2: Input Setup

2a: Calibrate VNA from 1.0 GHz to 12 GHz.

2b: Set input levels to  $+2$  dBm (500 mV) at the input of DUT.

#### Step 3: Output Setup

3a: Set display to measure  $S_{21}$  and record data.

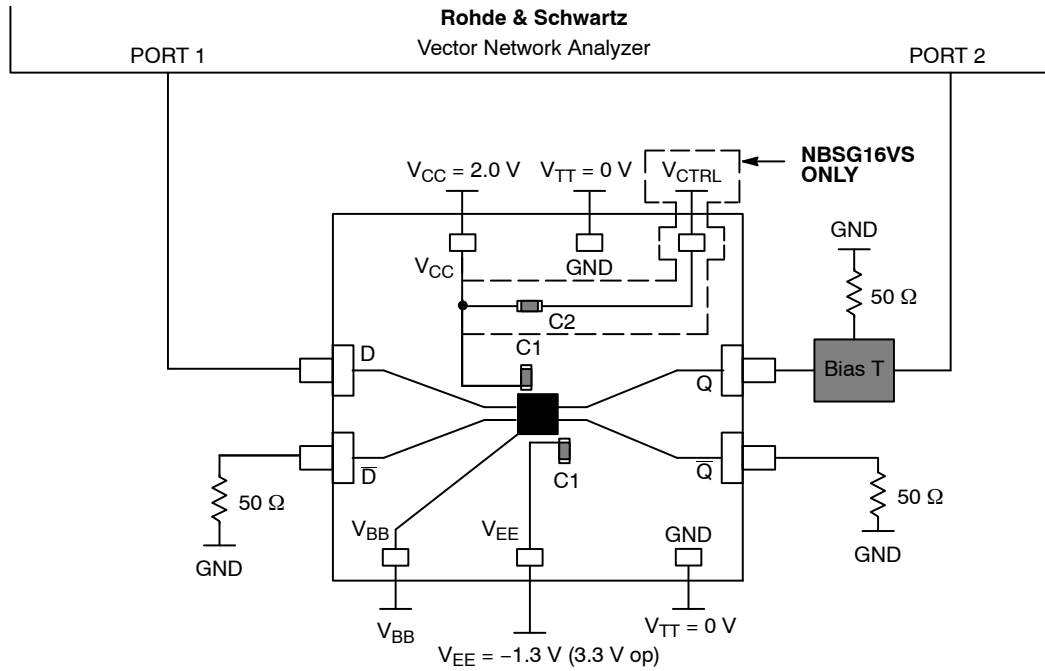


Figure 5. NBSG16/16VS Board Setup – Frequency Domain (Single-ended Mode)

# NBSG16BAEVB, NBSG16VSBAEVB

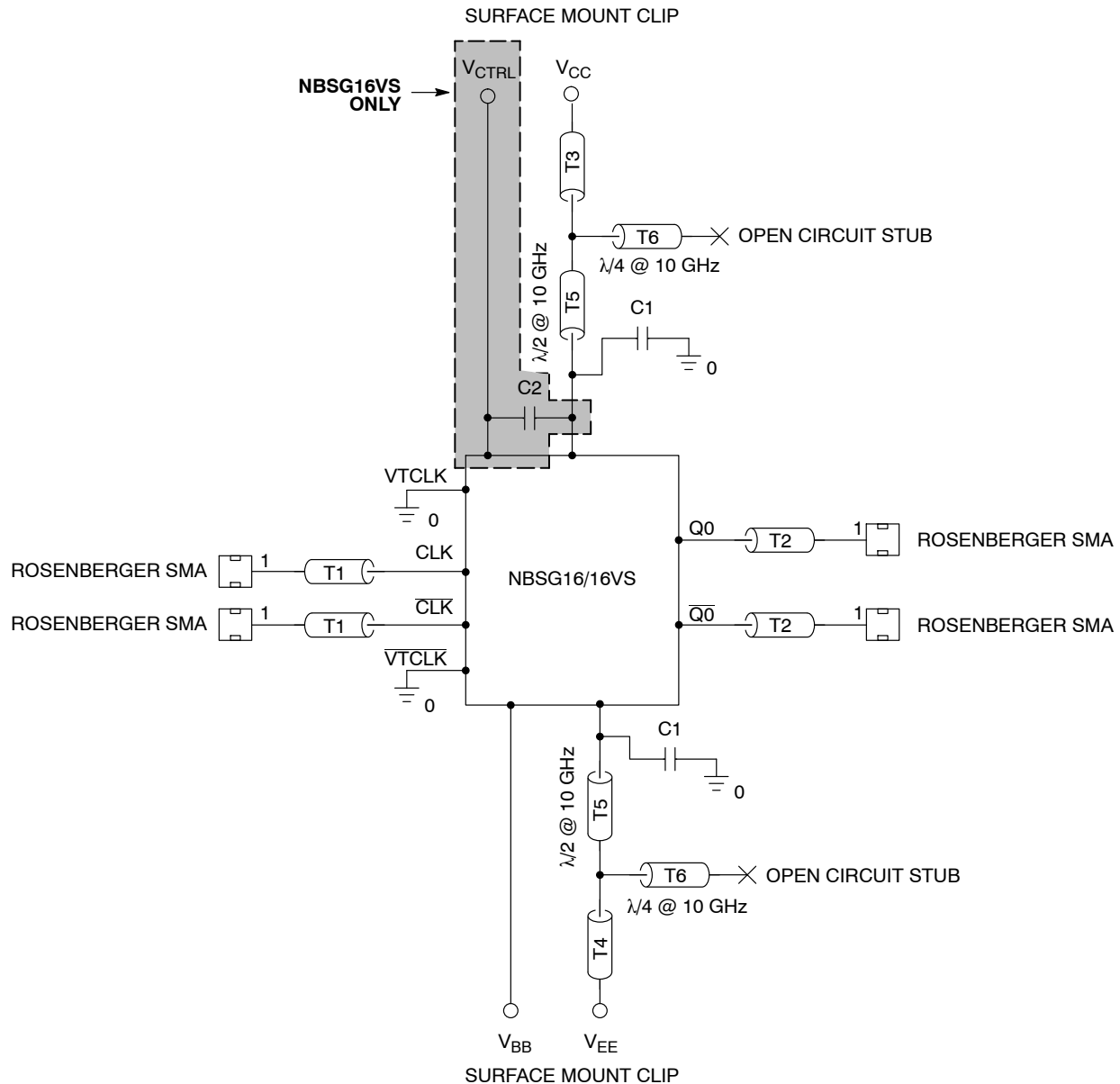
## MORE INFORMATION ABOUT EVALUATION BOARD

### Design Considerations for >10 GHz operation

While the NBSG16/16VS is specified to operate at 12 GHz, this evaluation board is designed to support operating frequencies up to 20 GHz.

The following considerations played a key role to ensure this evaluation board achieves high-end microwave performance:

- Optimal SMA Connector Launch
- Minimal Insertion Loss and Signal Dispersion
- Accurate Transmission Line Matching ( $50\ \Omega$ )
- Distributed Effects while Bypassing and Noise Filtering



NOTE: C1, C2\* = Decoupling cap  
Tx =  $50\ \Omega$  Transmission line  
\*NBSG16VS only

Figure 6. Evaluation Board Schematic

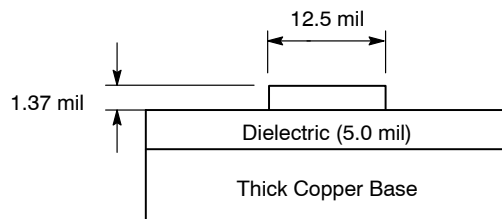
# NBSG16BAEVB, NBSG16VSBAEVB

**Table 7. PARTS LIST**

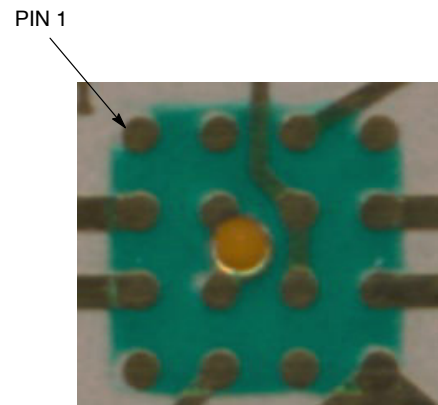
| Part No      | Description                                                              | Manufacturer            | Web Address                                                                 |
|--------------|--------------------------------------------------------------------------|-------------------------|-----------------------------------------------------------------------------|
| NBSG16BA     | 2.5 V/3.3 V SiGe Differential Receiver/Driver with RSECL Outputs         | ON Semiconductor        | <a href="http://www.onsemi.com/NBSG16">http://www.onsemi.com/NBSG16</a>     |
| NBSG16VS     | 2.5 V/3.3 V SiGe Differential Receiver/Driver with Variable Output Swing | ON Semiconductor        | <a href="http://www.onsemi.com/NBSG16VS">http://www.onsemi.com/NBSG16VS</a> |
| 32K243-40ME3 | Gold Plated Connector                                                    | Rosenberger             | <a href="http://www.rosenberger.de">http://www.rosenberger.de</a>           |
| CO6BLBB2X5UX | 2 MHz – 30 GHz Capacitor                                                 | Dielectric Laboratories | <a href="http://www.dilabs.com">http://www.dilabs.com</a>                   |

**Table 8. BOARD MATERIAL**

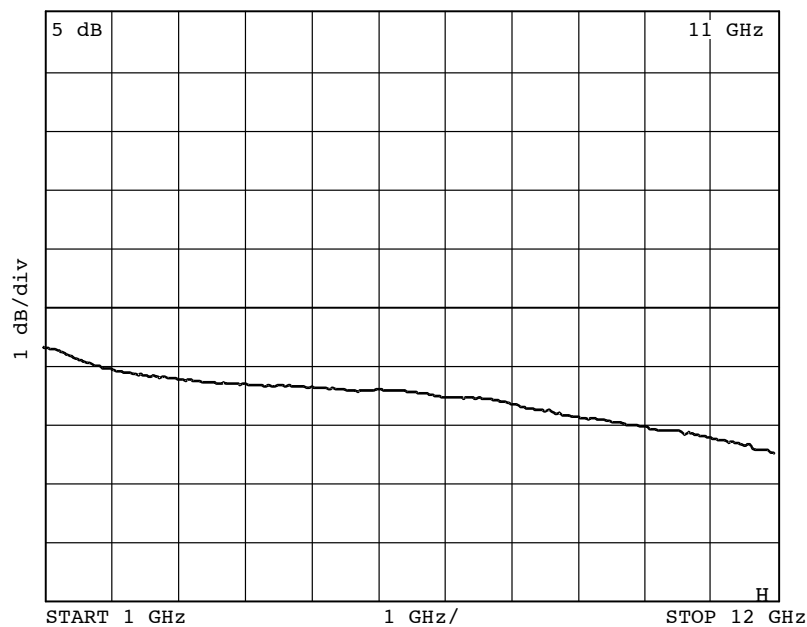
| Material       | Thickness |
|----------------|-----------|
| Rogers 6002    | 5 mil     |
| Copper Plating | 32 mil    |



**Figure 7. Board Stack-up**



**Figure 8. Layout Mask for NBSG16/16VS**



NOTE: The insertion loss curve can be used to calibrate out board loss if testing under small signal conditions.

**Figure 9. Insertion Loss**

# NBSG16BAEVB, NBSG16VSBAEVB

## EXAMPLE MEASUREMENTS IN FREQUENCY DOMAIN ( $V_{CC} - V_{EE} = 3.3\text{ V}$ )

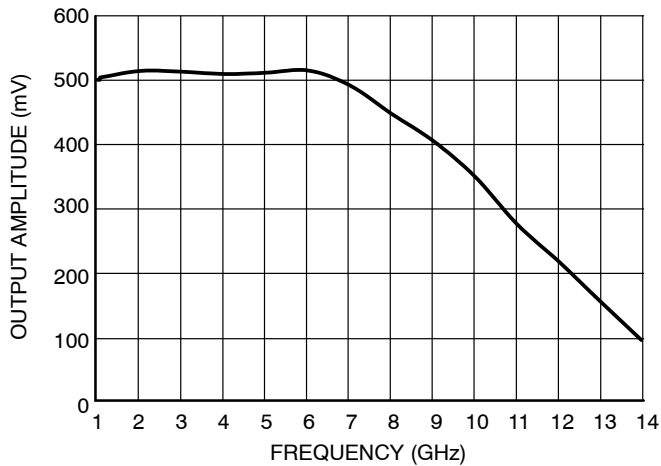


Figure 10. Fmax - Amplitude vs. Frequency  
(NBSG16:  $V_{CC} - V_{EE} = 3.3\text{ V}$  @  $25^{\circ}\text{C}$ )

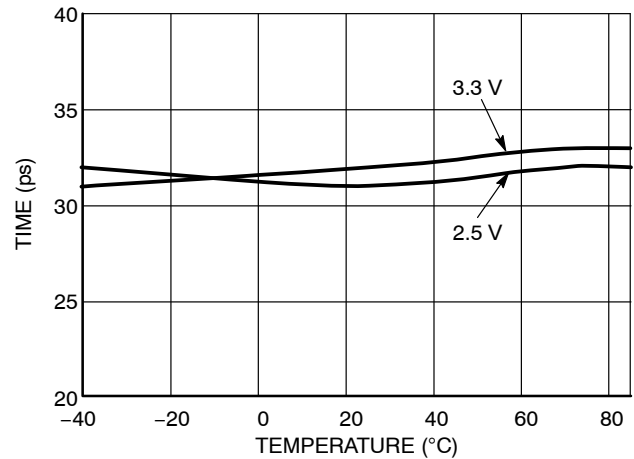


Figure 11. NBSG16  $T_r$  vs. Temperature and Supply Voltage

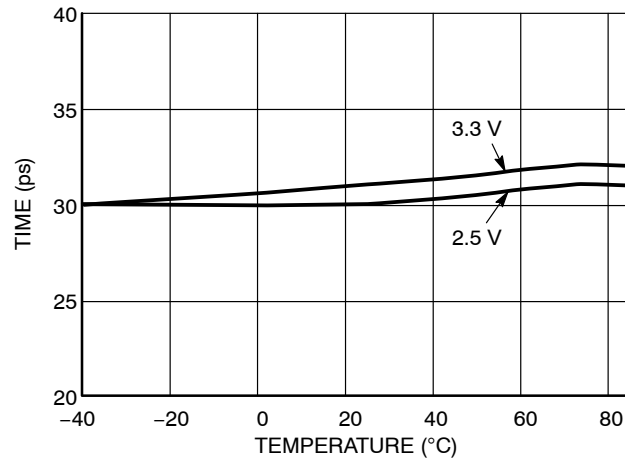


Figure 12. NBSG16  $T_r$  vs. Temperature and Supply Voltage

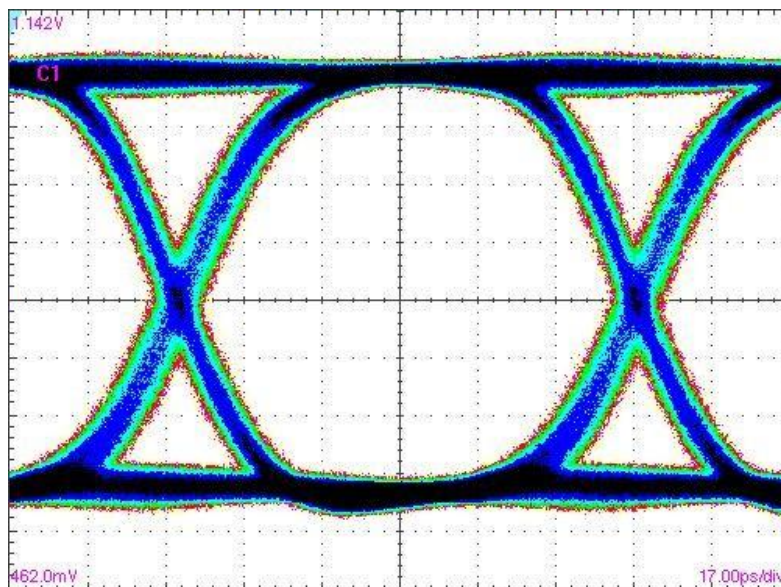
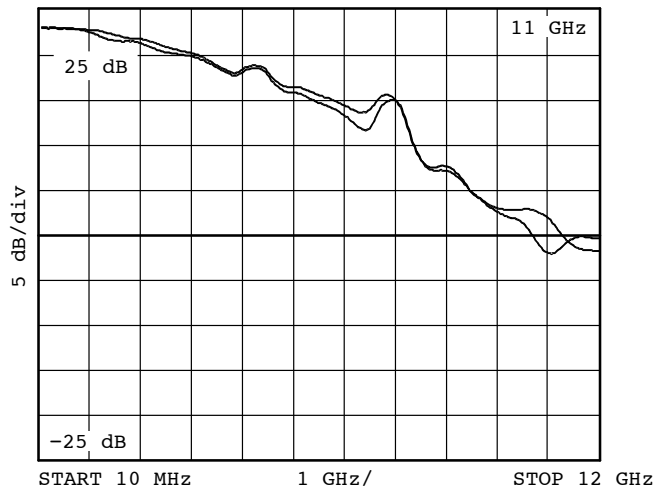


Figure 13. NBSG16: Eye Diagram at 10 Gbps with PRBS  $2^{31}-1$   
(total Pk-Pk system jitter including the signal generator is 15 ps)

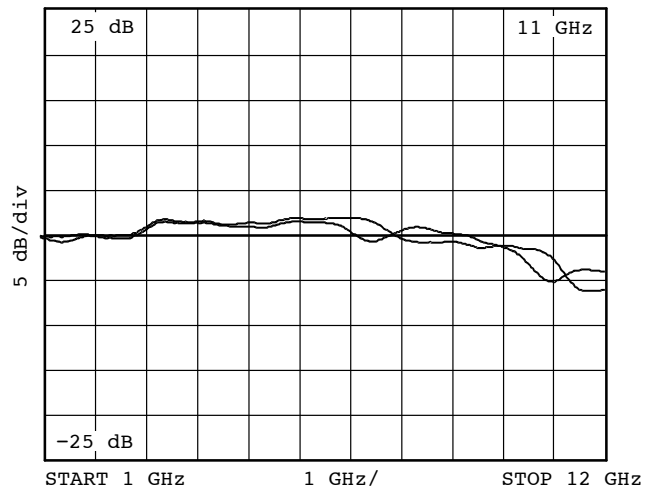


# NBSG16BAEVB, NBSG16VSBAEVB

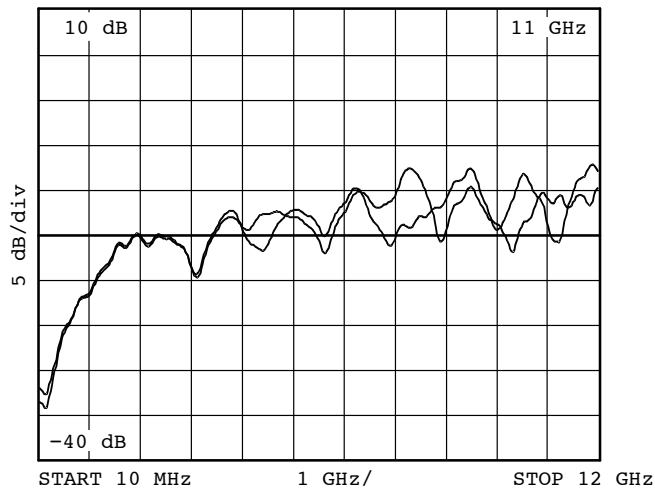
EXAMPLE MEASUREMENTS IN FREQUENCY DOMAIN ( $V_{CC} - V_{EE} = 3.3\text{ V}$ )



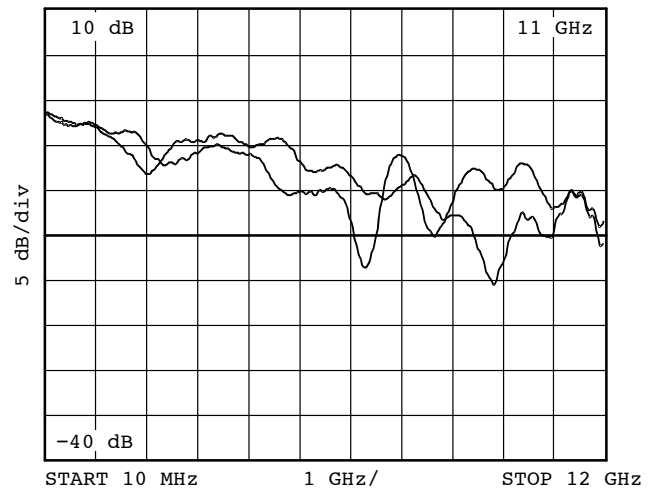
**Figure 14. NBSG16: Small Signal Gain (S21)  
Q0-Q1B**



**Figure 15. NBSG16: Large Signal Gain (S21)  
Q0-Q1B**



**Figure 16. NBSG16: D, DB Return Loss (S11)  
Q-QB**



**Figure 17. NBSG16: Return Loss (S22)  
Q-QB**

# NBSG16BAEVB, NBSG16VSBAEVB

## ADDITIONAL EVALUATION BOARD INFORMATION

### www.onsemi.com

In all cases, the most up-to-date information can be found on our website.

- Sample Orders for Devices and Boards
- New Product Updates
- Literature Download/Order
- IBIS and Spice Models

### References

NBSG16/D, Data Sheet, *NBSG16, 2.5 V/3.3 V SiGe Differential Receiver/Driver with RSECL Outputs*

NBSG16VS/D, Data Sheet, *NBSG16VS, 2.5 V/3.3 V SiGe Differential Receiver/Driver with Variable Output Swing*

AND8077/D, Application Note, *GigaComm™ (SiGe) SPICE Modeling Kit*.

AND8075/D, Application Note, *Board Mounting Considerations for the FCBGA Packages*.

**Table 9. ORDERING INFORMATION**

| Orderable Part No | Description                                                              | Package         | Shipping <sup>†</sup> |
|-------------------|--------------------------------------------------------------------------|-----------------|-----------------------|
| NBSG16BA          | 2.5 V/3.3 V SiGe Differential Receiver/Driver with RSECL Outputs         | 4x4 mm FCBGA/16 | 100 Units/Tray        |
| NBSG16BAR2        | 2.5 V/3.3 V SiGe Differential Receiver/Driver with RSECL Outputs         | 4x4 mm FCBGA/16 | 500 Units/Reel        |
| NBSG16VSBA        | 2.5 V/3.3 V SiGe Differential Receiver/Driver with Variable Output Swing | 4x4 mm FCBGA/16 | 100 Units/Tray        |
| NBSG16VSBAR2      | 2.5 V/3.3 V SiGe Differential Receiver/Driver with Variable Output Swing | 4x4 mm FCBGA/16 | 500 Units/Tray        |
| NBSG16BAEVB       | NBSG16 Evaluation Board                                                  |                 |                       |
| NBSG16VSBAEVB     | NBSG16VS Evaluation Board                                                |                 |                       |

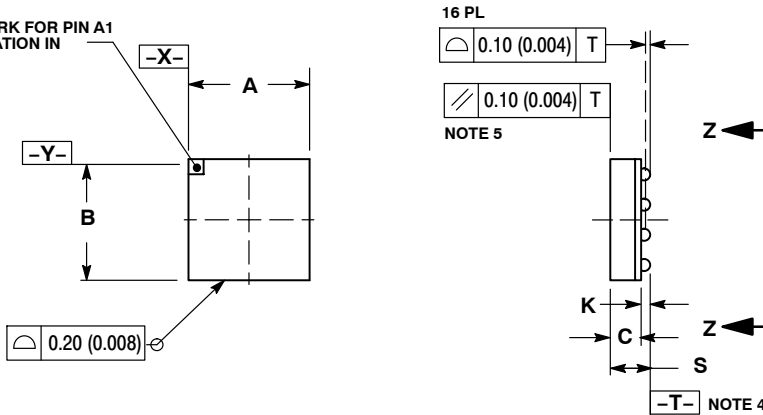
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

# NBSG16BAEVB, NBSG16VSB AEVB

## PACKAGE DIMENSIONS

### 16 PIN FLIP CHIP BGA CASE 489-01 ISSUE O

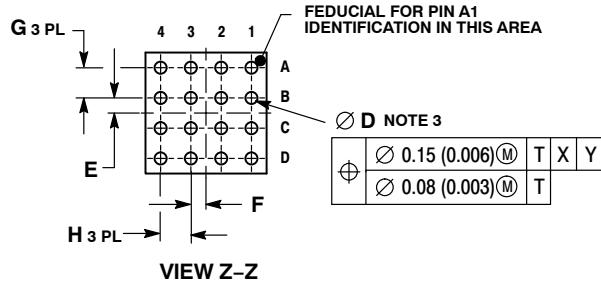
LASER MARK FOR PIN A1  
IDENTIFICATION IN  
THIS AREA



#### NOTES:

1. DIMENSIONIN AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION D IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER, PARALLEL TO DATUM PLANE -T-.
4. DATUM -T- (SEATING PLANE) IS DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
5. PARALLELISM MEASUREMENT SHALL EXCLUDE ANY EFFECT OF MARK ON TOP SURFACE OF PACKAGE.

| DIM | MILLIMETERS |        | INCHES    |         |
|-----|-------------|--------|-----------|---------|
|     | MIN         | MAX    | MIN       | MAX     |
| A   | 4.00 BSC    |        | 0.157 BSC |         |
| B   | 4.00 BSC    |        | 0.157 BSC |         |
| C   | 1.02 REF    |        | 0.040 REF |         |
| D   | Ø 0.30      | Ø 0.50 | Ø 0.012   | Ø 0.020 |
| E   | 0.50 BSC    |        | 0.020 BSC |         |
| F   | 0.50 BSC    |        | 0.020 BSC |         |
| G   | 1.00 BSC    |        | 0.039 BSC |         |
| H   | 1.00 BSC    |        | 0.039 BSC |         |
| K   | 0.25        | 0.35   | 0.010     | 0.014   |
| S   | 1.40 MAX    |        | 0.055 MAX |         |



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