Microsemi.

Le79124-SW

LineCare™ Software Package
Next Generation Carrier Chipset (NGCC)

CONFIDENTIAL

SOFTWARE PACKAGES

- **Call Control Package**
  - Call Control Functions
- **Basic Test Package**
  - Call Control Functions
  - GR909 Equivalent Line Testing
- **Advanced Test Package**
  - Call Control Functions
  - GR844 Equivalent Line Testing
- **Advanced Test Plus Package**
  - Call Control Functions
  - GR844 Equivalent Line Testing
  - Increased Accuracies, Additional Tests
- **TestHead Package**
  - Call Control Functions
  - GR844 Equivalent Line Testing
  - Next-Generation Diagnostic Tests

BENEFITS

- **Most cost-effective, highly-integrated, highly-featured line interface solution** for plug and play analog line cards in self contained architectures and worldwide applications.

- **Detailed 72 Channel RoHS compliant** reference schematics available.

- **Complete, all encompassing line testing solution** for applications requiring comprehensive, multi-line analog line card functionality, featuring a package with sophisticated test head diagnostics.

- **Field-Upgradable Firmware** for expanding line card test, control and signal processing capabilities.

- **The NGVCP reduces the processing duties of the Host Processor**. Tasks such as the line testing and cadencing are performed by the NGVCP, leaving the host more processor cycles for more complex applications or allowing the host to be a lower performance processor.

- **Simplified programming interface** as well as a sample quick start application to reduce development cycle and speed time to market.

- **Self-diagnostics** simplify production & system testing for lower cost of ownership.

- **Fully validated** test routines with published accuracies.

ORDERING INFORMATION

Software Package	Description
Le79124SLNT	Call Control
Le79124SLBT	Basic Test
Le79124SLAT	Advanced Test
Le79124SLATP	Advanced Test Plus
Le79124SLTHP	TestHead POTS

DESCRIPTION

Microsemi's LineCare™ software package for the Next Generation VoiceEdge™ Control Processor (NGVCP) is a complete software solution that aggregates control of Microsemi's Voice Termination Devices (VTDs) to provide a simplified programming interface.

The software package provides a set of functions additional to the feature set of the underlying VTDs. It significantly reduces the product development cycle and time-to-market. This document describes the software package for the NGVCP and the Next Generation Carrier Chipset (NGCC) devices. In combination, this set of devices provides a cost-effective, highly integrated and fully programmable line testing solution for applications requiring complete line card functionality.

Five different software packages are available:

(1) Call Control (NT) package, implements all supported call control features.

(2) Basic Test (BT) package, includes all the features of the NT package plus GR909 equivalent line test capabilities.

(3) Advanced Test (AT) package, includes all the features of the BT package plus GR844 equivalent line test capabilities.

(4) Advanced Test Plus (ATP) package, includes all the features of the AT package plus additional diagnostic tests and a line calibration feature for increased accuracies.

(5) TestHead (THP) package, includes all the features of the ATP package plus a suite of Next-Generation diagnostic tests.

Each software package has an associated hardware configuration. Detailed reference designs are available.

RELATED LITERATURE

- **129907 VoicePath™ API-II Reference Guide VCP/VCP2-BT/AT/ATP/TH**
- **129908 VoicePath™ API-II Reference Guide VCP/VCP2-NT**
- **130145 VoicePath™ API-II Test Library User's Guide**
- **081567 Le79124 NGVCP Data Sheet**
- **081193 Le79238 NGSLAC Data Sheet**
- **136868 ZL79258 External Ringing NGSLAC Data Sheet**
- **126583 NGCC Hardware Design Guide**

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MICROSEMI'S LINECARE™ SOFTWARE PACKAGE

Key Features

Microsemi's LineCare™ software package implements common features and functions to reduce complexity.

Key features of the LineCare™ package include:

- Provides an abstract, uniform software interface for any combination of Microsemi voice products.
- Provides various design tools to help in the creation and organization of parameters specific to the design and market.
- Supports any combination of FXS lines configured for either loop-start signaling or ground-start signaling.
- Exposes device functionality for pulse-digit and flash decoding, ringing cadencing and tone cadencing.
- Proven on embedded operating systems such as Linux and VxWorks, and also compatible with non-OS environments; fits into common driver and static/dynamic library models.
- Can be used with single or multi-threaded applications.
- Supports various interrupt modes and both big-endian and little-endian host processors.
- Implemented in C code that is efficient, portable, and ANSI C compliant.
- Provides Self Test and Advanced line testing capabilities, including support for GR-844 and GR-909 equivalent line testing.
- Provides optional calibration for enhanced accuracy utilizing external calibration circuit in combination with NGVCP Advanced line measurement functions.
- Available in five different packages (Call Control, Basic Test, Advanced Test, Advanced Test Plus, and TestHead) to fit the customer needs.
- Sample Quick Start Guide and Quick Start Application software provided with source code to facilitate startup and troubleshooting.
- NGVCP-Host (HBI/SPI) Hardware Verification Application source code and MPI Verification Application NGVCP loadable binary image provided to verify the interfaces between the NGVCP and the SLAC.
- Includes comprehensive documentation, an excellent starting point to help the developer quickly become familiar with the architecture.

The software package includes the following items.

VoicePath™ API-II

Microsemi's VoicePath™ Application Programmer Interface (VP API-II) is a C source code module that provides a standard software interface for implementing call control and line testing functions for a set of subscriber lines using Microsemi VTDs. The VP API-II abstracts and simplifies the details of controlling the Microsemi VTDs and allows software developers to focus on the application instead of the underlying hardware.

The API-II functions can be summarized into the following five groups:

- **Initialization functions:** These functions initialize various aspects of the NGVCP or perform the configuration required before a particular NGVCP feature may be used. Example of initialization features include:
  - Boot-load the firmware image into the NGVCP and start the DSP core inside the NGVCP.
  - Configure all lines with specified design parameters.
  - Calibrate all analog circuits of termination devices.
- **Query Functions:** The query functions provide several methods for servicing the NGVCP device's interrupts and checking the status of the lines. These functions allow the user to read option settings or line conditions, and to retrieve event contents or test results. Examples of query functions include:
  - On/Off hook, read loop conditions for a specific line.
  - Global device status for up to 72 lines.
  - Read various VoicePath™ API-II device options and test results.
- **Control Functions:** These functions control the current line state and options that may change during run-time. Examples of control functions include:
  - Set a line to a desired state.
  - Place a cadenced DTMF call progress tone on the line.
  - Start metering on a particular line.
  - Set various VoicePath™ API-II device specific options.
- **Test Functions:** The test functions provide a toolbox of line tests and diagnostic utilities. Example of test functions include:
  - Perform Self Test on a particular line or the entire system.
  - Test primitives to support GR844 or GR909 line tests on any given channel.

- **Helper Functions:** The helper functions provide an interface for sending raw commands to a SLAC device controlled by the NGVCP over the MPI.

VoicePath™ Test Library

The VoicePath™ Test Library (VP-TL) is a collection of functions and data types that further utilize the line testing capabilities of Microsemi's VP API-II. These algorithms are executed on the host processor interfaced to Microsemi's NGVCP device combined with the NGCC devices through the VoicePath™ API-II.

The VP-TL offers the following key features:

- Performs a complete high-level test by running several VP API-II test primitives in sequence.
- Provides optimal default values for test input parameters that do not typically change at runtime, such as integration times, settling times, etc.
- Converts fixed-point results returned by the VP API-II test primitives into standard units that the application can readily use.
- Includes line Self-Testing to check for possible problems before putting a line into service.
- Includes line calibration for improving the testing accuracy by identifying correction factors that will be applied against measurement results.
- Allows line topology to be specified on a per line basis.
- Includes four versions of the Test Library, with increasing feature sets depending on the test package selected.

NGVCP Firmware

NGVCP firmware implements specific functions such as the line test primitives, advanced tone processing and cadencing. The software package controls the NGVCP device. The NGVCP device's registers and commands are abstracted by the VP API-II which is the communication layer between the NGVCP device and the customer's host processor. The NGVCP firmware is currently available in three variations NT, BT, and AT. The AT firmware is included in both the AT and ATP release packages. The software packages are:

- NT - Includes all supported call control features.
- BT - Includes all supported call control features plus the GR909 equivalent line testing.
- AT - Includes all the features of the BT package plus the GR844 equivalent line testing.
- ATP - Includes all the features of the AT package, additional line diagnostic tests, and a line calibration routine for increased accuracies.
- THP - Includes all the features of the ATP package plus additional next-generation TestHead line diagnostic tests.

Design Toolset

Microsemi products can be configured to meet standards worldwide, including custom requirements. To address such varying system-level specifications, Microsemi provides tools like WinSLAC™ and Profile Wizard to help engineers generate design data. The design data provided by these tools is organized into profiles to meet specific system requirements. The data for each profile is created with the Profile Wizard application. Profiles can be generated for the following design parameters:

- **System Profile** - The System Profile is a data array that contains set-and-forget parameters for the event mask, clocks, etc., and for other global configuration options.
- **AC Profile** - The AC Profile is a transmission characteristic profile. The AC profile holds the SLAC device's gain block and filter block commands and data. Each AC Profile is designed to address the specific AC transmission requirements for a given design. In general, AC Profiles are used to address the varying requirements of different market segments.
- **DC Profile** - The DC Profile holds the SLAC device's DC feed and Loop Supervision command and data. Each DC profile is designed to address the specific DC feed and Loop Supervision requirements of a given design. Examples of different DC feed profiles include a Constant Current Profile and a Resistive Feed Profile.
- **Ringing Profile** - The Ringing Profile contains the necessary commands and data to set up the ringing generator of a SLAC device. Different Profiles can be used to vary the ringing characteristics of a line. Options available in the Ringing Profile include: ringing waveform, frequency, amplitude, DC offset, ring trip detector mode and a selection of internal or external ringing.
- **Metering Profile** - The Metering Configuration Profile contains the necessary commands and data to set up the Pulse Meter Signal Generator of the SLAC device. The parameters configured include voltage limits.
- **Tone Profile** - The Tone Profile defines the various call progress tones that might be used in a system. The tones include dial tone, busy, ring-back, and reorder. The Tone Profiles are used to address worldwide market variations.
- **Tone Cadence Profile** - The Tone Cadence Profile defines the various cadences that might be used in a system for call progress tones. The Tone Cadence Profiles are used to address market variations.
- **Ring Cadence Profile** - The Ring Cadence Profile defines the various cadences that might be used in a system for ringing. The Ring Cadence Profiles are used to address market variations.

- **Caller ID** - Defines the various Caller Line Identity (CLI) types that might be used in a system. The Caller ID Profiles are used to address the market variations that exist around the world.

The NGVCP contains internal tables for each of the profile types. This allows a fixed number (as defined in the Profile Table section of the *VoicePath™ API-II Reference Guide*) of each profile type to be stored in the NGVCP. When the host application requires the services of a particular profile for a function, it can simply refer to the profile by its index in the NGVCP device's profile table. Alternatively, the host application can maintain some (or all) of the needed profiles in the host, and pass them to the NGVCP for any function call that requires them.

Once the profiles have been created, they can be compiled into the user's application and passed into the VoicePath™ API-II. Then, the application can either load the profiles into the NGVCP, keep the profiles on the host and download them on demand, or perform a combination of the two methods.

Profile Wizard and WinSLAC are Microsoft® Windows® based applications that are part of the NGCC Design Kit and are used to create the various profiles needed to fulfill the specific market requirements.

SYSTEM ARCHITECTURE

Figure 1 illustrates a typical system block diagram incorporating the software block diagram and a detailed block diagram of the underlying hardware combining the NGVCP and the NGCC line termination architecture. The LineCare™ software requires the System Services Layer and Hardware Abstraction Layer to operate correctly. The following sections describe each of the blocks.

Figure 1.   NGCC System Architecture with NGVCP
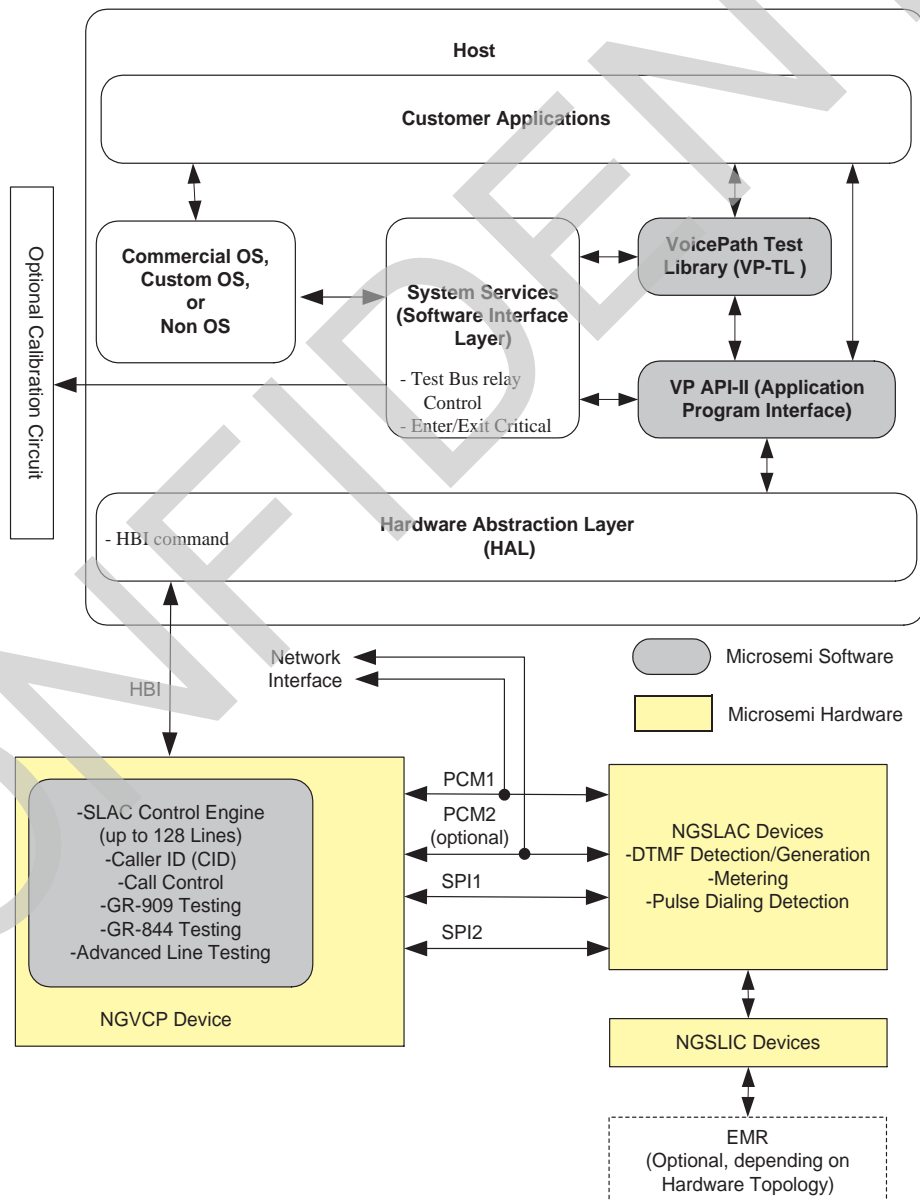
Software Architecture

Customer Application

This block represents the user's *line management* module that performs tasks such as initializing the system, configuring lines, changing line states in response to line events and other inputs, switching digitized voice traffic, line testing etc. These functions may be distributed across a complex system. Microsemi provides example applications as part of the NGVCP software package.

Operating System

This block represents whatever operating system (if any) the user is running on the host processor. The VP API-II does not directly utilize any operating system resources (e.g. queues, semaphores, etc.). The application developer may use operating system features such as tasks or shared memory with the VP API-II. Chapter 3 in the *API Reference Guide* covers using the VP API-II in a multitasking environment in detail.

System Services Layer

The System Services Layer abstracts platform-specific functions such as test relay control and other customer specific functions. This layer derives the functions required by the VP API-II from the facilities provided by the underlying hardware or operating system. This module is also platform-dependent and must be implemented by the VP API-II user. Microsemi provides example System Services Layer source code.

The System Service Layer should contain different procedures to control the various states of the calibration circuit when such circuit is present. These procedures will be called by the Test Library whenever a specific calibration load is required.

VoicePath™ Test Library

The VoicePath™ Test Library (VP-TL) algorithms are executed on the host processor using the VoicePath™ API-II.

VoicePath™ API-II

The VP API-II is the core component of the software package. This software module runs on the host processor that controls Microsemi VTDs. This code is supplied by Microsemi and should not be modified by the application developer.

Hardware Abstraction Layer

The Hardware Abstraction Layer (HAL) provides access to Microsemi devices through the Host Bus Interface (HBI). The HAL software is platform-dependent and must be implemented by the VP API-II user. Microsemi provides example HAL source code with the NGVCP Software Package.

Host Bus Interface

The Host Bus Interface (HBI) provides a means for the host to communicate with the NGVCP. The HBI includes the Application, Transport, and Physical Layers of the NGVCP device's host interface.

The physical layer defines the electrical characteristics of the interface (pins, timings, etc.) between the host and the NGVCP. The NGVCP supports two different physical layers: a General Purpose Parallel Interface (GPI) and a Serial Peripheral Interface (SPI).

This layered architecture allows the host programmer to control the NGVCP independently of the chosen physical layer (8-bit vs. 16-bit, byte-framing vs. command-framing).

Hardware Architecture

The hardware consists of the Le79124 NGVCP, the Le79238 NGSLAC and the Le79271 NGSLIC Voice Termination Devices.

The NGVCP is a digital signal processor platform that performs all of the management required for controlling multiple SLAC devices, as well as all the sequencing necessary for advanced line test functionality. To the host processor, the NGVCP looks like a single 72-line voice controller. The host communicates directly with the NGVCP device(s) through the HBI and does not communicate directly with any of the individual SLAC devices controlled by the NGVCP. The host can choose to poll the NGVCP or service it by waiting for an interrupt to indicate that servicing is needed. Multiple NGVCP devices can be connected to the same host.

The NGVCP communicates with the SLAC device(s) through one or two SPI ports. The Le79124 NGVCP has 32 General Purpose I/O pins of which 8 are used as chip selects and 8 are used as interrupts. From the NGVCP/API perspective, an addressing space of up to 128 lines can be supported. The Le79124 NGVCP supports up to 72 channels, for a higher line count, use the Le79128 NGVCP.

The API line mapping to the SPI bus is fixed as shown in Table 1. There are 72 channels, these are numbered from 0 to 71 (boardLineID). To alleviate signal integrity problems both SPI ports are utilized. SPI1 controls the first 4 SLAC devices and SPI2 controls the second 5 SLAC devices. For the 5 SLAC devices controlled by SPI2, these lines map to APIChannelID 64 to 103. There are no chip selects on SLAC_ID 4 through 7 of SPI1. The API-II will assume that boardLineID's 32 through 63 are on SPI1 unless instructed otherwise by the host at initialization. At system initialization, a software line object needs to be created for each individual line and contains all parameters associated with that line (VpMakeLineObject). A line context pointer to this line object

is also created. After the system initialization is completed, all VP API-II functions use the line context pointer as a channel identifier such that the host application code needs not be concerned with the NGVCP channel ID.

Table 1.   NGVCP GPIO Chip Select and Interrupt Assignments

APIchannelID	boardLineID (LineCtx)	SPI Port #	SLAC_ID	Chip Select			Interrupt		
					GPIO	GPIO Pin #		GPIO	GPIO Pin #
0 to 7	0 to 7		0	CS0	16	36	INT0	0	76
8 to 15	8 to 15		1	CS1	17	7	INT1	1	77
16 to 23	16 to 23		2	CS2	18	8	INT2	2	78
24 to 31	24 to 31	1	3	CS3	19	12	INT3	3	79
32 to 39			4	CS4	20	13	INT4	4	82
40 to 47			5	CS5	21	15	INT5	5	83
48 to 55			6	CS6	22	19	INT6	6	85
56 to 63			7	CS7	23	20	INT7	7	92
64 to 71	32 to 39		0	CS8	24	2	INT8	8	98
72 to 79	40 to 47		1	CS9	25	1	INT9	9	99
80 to 87	48 to 55		2	CS10	26	128	INT10	10	100
88 to 95	56 to 63		3	CS11	27	127	INT11	11	101
96 to 103	64 to 71	2	4	CS12	28	126	INT12	12	102
104 to 111			5	CS13	29	125	INT13	13	103
112 to 119			6	CS14	30	124	INT14	14	106
120 to 127			7	CS15	31	123	INT15	15	107

Hardware Topologies

Microsemi specifies standard topologies that defines the hardware test architecture. This architecture defines the termination type for the VoicePath™ Test Library software. The software for NGCC currently supports three general hardware topologies. Table 2 lists the hardware topologies and the supported termination types.

Table 2.   VoicePath™ Test Library Supported Termination Types

Hardware Topologies	Software Termination Types	Device	Description
Configuration C	VP_TERM_FXS_GENERIC	NGVCP	Generic FXS termination
Configuration D	VP_TERM_FXS_TI	NGVCP	FXS termination with Test-In relay
Configuration E	VP_TERM_FXS_RR	NGVCP	FXS termination with Ringing Relay

Configuration C Topology (VP_TERM_FXS_GENERIC)

Configuration C topology has the following features:

- POTS service.
- Foreign voltages in excess of the SLIC power rail voltages can be measured when the PTCs are activated or if the fault current doesn't exceed the SLIC current drive capability.
- The test load resistor is used for self-testing.
- No disconnect relay. There is no means to disconnect the line from the loop during inward looking test, therefore Self Test can only be performed in the factory. The published Self Test accuracies are given for production testing only, when no loop is connected to the equipment port. If Self Tests are performed in the field, the host application needs to take into account any loop impedance present.

Figure 2.   Configuration C Topology
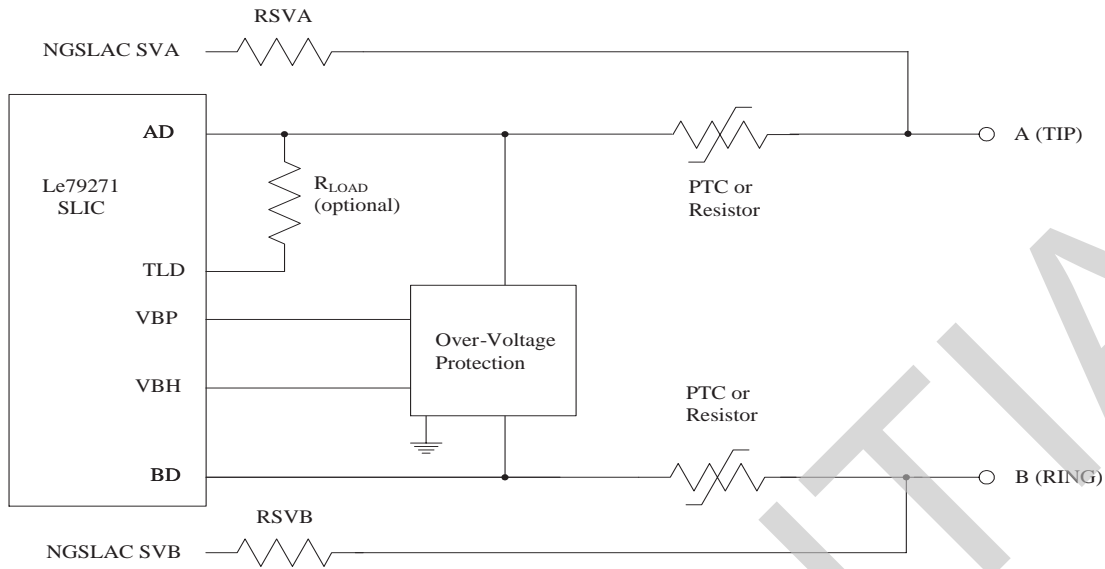
Configuration C supports the relay states listed in Table 3. See the *VoicePath™ API-II Reference Guide* for details of the VpSetRelayState() function. Connectivity for the various relay states is depicted in Table 4.

Table 3.   Software States for Configuration C

Software State (VpRelayState)	Description
VP_RELAY_NORMAL	Test load switch off
VP_RELAY_TALK	Test load switch off
VP_RELAY_BRIDGED_TEST	Test load switch on

Table 4.   Configuration C Bus Connections

Software State	AD/BD	SVA/SVB	Rload	TIP/RING
VP_RELAY_NORMAL	●———————	●		——————●
VP_RELAY_TALK	●———————	●		——————●
VP_RELAY_BRIDGED_TEST	●———————	●	●	——————●

Configuration D Topology (VP_TERM_FXS_TI)

Configuration D topology has the following features:

- POTS service with a relay to connect to a calibration circuit for In-Service Calibration and Self Testing.
- Foreign voltages in excess of the SLIC power rail voltages can be measured when the PTCs are activated or if the fault current doesn't exceed the SLIC current drive capability.
- The relay is used to disconnect the loop during self-testing.
- Calibration can be performed using a shared circuit connected to the Calibration Bus.
- Self-test is performed using the calibration circuit or a per-channel test load resistor.

Figure 3.   Configuration D Topology
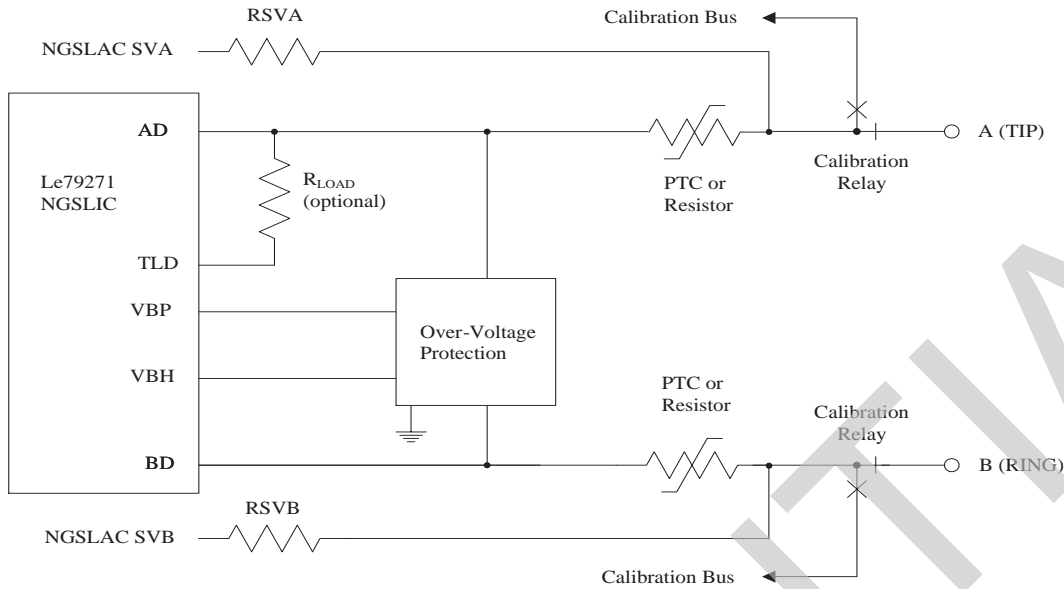
Configuration D supports the relay states listed in Table 5. See the *VoicePath™ API-II Reference Guide* for details of the VpSetRelayState() function. Connectivity for the various relay states is depicted in Table 6.

Table 5.   Software States for Configuration D

Software State (VpRelayState)	Description
VP_RELAY_NORMAL	Test load switch off
VP_RELAY_TALK	Test load switch off
VP_RELAY_TEST	Test load switch off, Calibration relay activated
VP_RELAY_DISCONNECT	Test load switch off, Calibration relay activated
VP_RELAY_BRIDGED_TEST	Test load switch on
VP_RELAY_SPLIT_TEST	Test load switch on, Calibration relay activated

Table 6.   Configuration D Bus Connections

Software State	AD/BD	SVA/SVB	Rload	Calibration Bus	TIP/RING
VP_RELAY_NORMAL	●	●			●
VP_RELAY_TALK	●	●			●
VP_RELAY_TEST	●	●		●	
VP_RELAY_DISCONNECT	●	●		●	
VP_RELAY_BRIDGED_TEST	●	●	●		●
VP_RELAY_SPLIT_TEST	●	●	●	●	

Configuration E Topology (VP_TERM_FXS_RR)

Configuration E topology has the following features:

- POTS service with external ringing.
- Foreign voltages in excess of the SLIC power rail voltages can be measured when the PTCs are activated, if the fault current doesn't exceed the SLIC current drive capability, or by operating the ringing relay to disconnect the SLIC drivers from the external port. The last option is only available if the ringing bus can be made high impedance during the foreign voltage test.
- The test load resistor is used for self-testing.
- This configuration does not use a VBP supply, therefore some test restrictions apply.
- No disconnect relay. There is no means to disconnect the line from the loop during inward looking test, therefore Self Test can only be performed in the factory. The published Self Test accuracies are given for production testing only, when no loop is connected to the equipment port. If Self Tests are performed in the field, the host application needs to take into account

any loop impedance present.

Figure 4.   Configuration E Topology
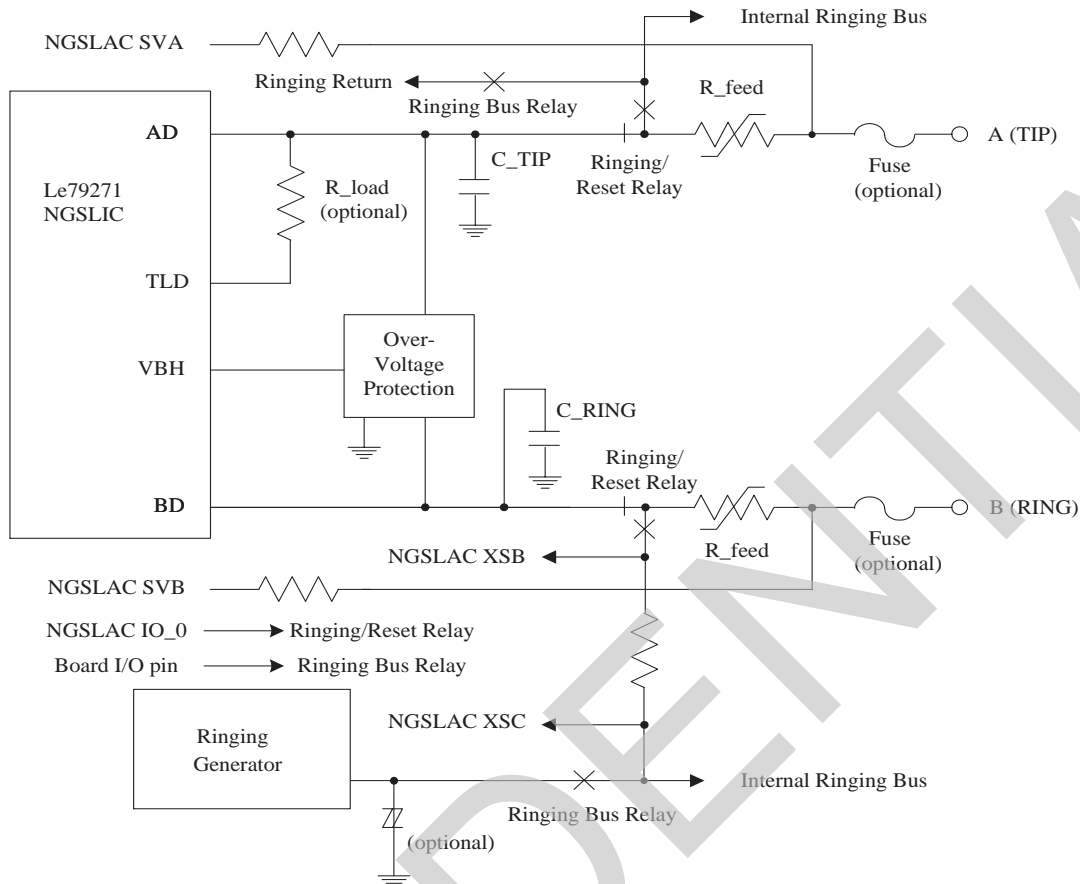
Configuration E supports the relay states listed in Table 7. See the *VoicePath™ API-II Reference Guide* for details of the VpSetRelayState() function.

Connectivity for the various relay states is depicted in Table 8.

Table 7.   Software States for Configuration E

Software State (VpRelayState)	Description
VP_RELAY_NORMAL	Ringing relay on or off based on line state, test load released
VP_RELAY_TALK	Ringing/Reset relay released, test load released
VP_RELAY_RINGING	Ringing relay active, test load released
VP_RELAY_BRIDGED_TEST	Ringing/Reset relay released, test load active
VP_RELAY_RESET[1]	Ringing relay active, test load released, ringing bus relay active
1. Note: The application developer must implement the VptlSysCaptureRingingBus() and the VptlSysReleaseRingingBus() functions in order to use the VP_RELAY_RESET state. The ringing bus relay is controlled by those two functions, not by the VpSetRelayState() function. Refer to the VoicePath™ API-II Test Library User's Guide for more details.	

Table 8.   Configuration E Bus Connections

Software State	AD/BD	SVA/SVB	R_{load}	Ringing	TIP/RING
VP_RELAY_NORMAL[1]	●	●			●
VP_RELAY_NORMAL[2]		●		●	●
VP_RELAY_TALK	●	●			●
VP_RELAY_RINGING		●		●	●
VP_RELAY_BRIDGED_TEST	●	●	●		●
VP_RELAY_RESET		●			●
1. Non-ringing line state. 2. Ringing line state.					

Calibration

The VoicePath™ Test Library delivered with the NGVCP ATP and THP packages include a calibration function that can be used to improve the testing accuracy. Performing the line testing on an external calibration circuit (see Figure 5) identifies the correction factors that will be applied against subsequent results. Calibration is performed on a per-line basis. Calibration factors for each line are to be stored individually, and applied individually.

Two classes of calibration can be performed, Factory Calibration and In-Service Calibration.

Factory Calibration would be performed at the time the line card is manufactured, prior to the line card being shipped. Correction factors would be stored on the respective line card board. Using Factory Calibration requires the user to store the calibration factors in non-volatile memory and re-apply these factors as needed.

In-Service Calibration can be performed after the line card is deployed. To achieve this, a test-in relay is required.

Configuration C and E do not include a test-in relay and can only be calibrated at the factory by applying the calibration circuit directly to the line's A and B leads.

Configuration D has a relay that can provide Calibration Bus access to perform In-Service Calibration. Of course the Factory Calibration can also be performed with Configuration D.

LINE TESTING

Time Slot Requirements

Line test works in linear mode so a minimum of two adjacent time slots per channel are required. The 15-kHz noise test requires 8 adjacent time slots. For line test the NGVCP keeps an image of the time slot assignments, so there is no need to do a reassignment after the test completes. The NGVCP does not however keep track of adjacent time slot usage, so the host must ensure that the adjacent time slot is not assigned. As an example, if there is a voice channel assigned to time slot 5, when you request a test to that same channel, the NGVCP will know the channel is on time slot 5, but the NGVCP will not check to see if time slot 6 is available - the NGVCP assumes this time slot is available.

Another way to manage time slot control is to put the voice time slots adjacent to each other and reserve a block of 20 time slots for testing. The block of 20 time slots will accommodate the following valid combinations:

- Four regular transmission tests: 8 time slots.
- One 15-kHz test plus three regular transmission tests: 14 time slots.
- Two 15-kHz test plus two regular transmission tests: 20 time slots.

Common time slot management options:

- Put all channels contiguous, one after each other, and allocate 20 time slots for line testing. Always reallocate the channel time slot before executing any test requiring PCM access. Or,
- Skip every second channel, leaving an empty time slot between each time slot in use, and allocate 16 time slots to line testing. Only reallocate the channel time slot before executing a 15-kHz noise test. Regular transmission tests do not require a time slot re-allocation.

Of course the host must keep a record of the testing time slots already in use and grab an empty one when starting a new test.

All transmission tests use the PCM bus to transfer signal samples from the SLAC to the NGVCP. Some impedance or voltage measurements also use the PCM bus for the same purpose. Moreover, this may change over time if new tests are developed, or if existing tests are improved. Therefore, it is recommended to always assume the PCM bus will be used and to ensure the channel under test uses a non-conflicting time slot before executing any test.

The number of channels controlled by the NGVCP (up to 72), the PCM clock frequency (maximum 8.192 MHz), usage assumptions, and the choice of line test time slot management will dictate the number of PCM highways that are required. The NGVCP supports one or two PCM highways.

Device Level Test Restrictions

Line test restrictions at the device level are:

- Up to 4 lines in line testing simultaneously running per NGVCP.
- Of the 4 lines in line testing simultaneously running per NGVCP, there is a limit of two simultaneous 15-kHz noise tests per NGVCP.
- Up to 2 lines in line testing simultaneously running per SLAC.
- Of the 2 lines in line testing simultaneously running per SLAC, only one of these tests may be the 15-kHz noise test.

Line Test Packages

Table 9 provides a complete list of the supported line test algorithms and their library names. The table also shows which configuration topology the algorithms can be used with and in which software package they're available.

Many of these tests will be used for GR-844 testing. A subset of these will be used for GR-909 testing. These tests are detailed in Table 10.

Table 9.   NGVCP-NGCC Supported Line Test Packages

Algorithm Names	Description	VP-Test Library Names	Config.			NGVCP Packages				
			C	D	E	NT	BT	AT	ATP	THP
Calibration	To measure correction factors that can be used to improve measurement and DC feed accuracy. **Factory Calibration.**	VPTL_TID_CALIBRATE	●		●				●	●
	To measure correction factors that can be used to improve measurement and DC feed accuracy. **Factory or In-Service Calibration.**			●					●	●
Apply Calibration	To transfer the calibration factors into the SLAC in order to improve the testing and DC feed accuracy.	VPTL_TID_APPLY_CALIBRATION	●	●	●				●	●
Foreign DC Voltage Test	To measure the DC foreign voltage present in the loop while the line card is in a high impedance state. A low-pass filter is used to filter out any AC voltage present on the line.	VPTL_TID_OPEN_DC_VOLTAGE	●	●	●[2]		●	●	●	●
Foreign AC Voltage Test	To measure the AC foreign voltage present in the loop. A high pass filter is used to filter out any DC voltage present on the line.	VPTL_TID_OPEN_AC_VOLTAGE	●	●	●[3]		●	●	●	●
DC Loop Resistance Test	To measure low loop impedance values generally less than 4K Ohms using either Forward/Reverse Battery or Offset Compensation algorithms.	VPTL_TID_DC_LOOP_RES	●	●	●		●	●	●	●
Generic Insulation Resistance	Similar to Three-Element Insulation Resistance Test except user can control voltage and measurement times.	VPTL_TID_GEN_RES	●	●	●[6]		●	●	●	●
Three-Element Insulation Resistance Test	To measure the resistances connected between Tip and ground, Ring and ground, and Tip to Ring. The test can also measure the foreign DC voltage and current. The test can measure foreign voltage sources in excess of the SLIC power supply rails.	VPTL_TID_3ELE_RES	●	●	●[4]		●	●	●	●
Four-Element Insulation Resistance Test	To measure the resistances connected between Tip and ground, Ring and ground, Tip to Ring, and Ring to Tip using dual polarities for the metallic test signal.	VPTL_TID_4ELE_RES	●	●	●[4]			●	●	●
Five-Element Insulation Resistance Test	To measure the resistances connected between Tip and ground, Ring and ground, and Tip to Ring as well as resistances between Tip and Battery and Ring and battery.	VPTL_TID_5ELE_RES	●	●	●[4]				●	●
Six-Element Insulation Resistance Test	Similar to Five-Element Resistance with the addition of Tip to Ring and Ring to Tip resistance differentiation in order to detect a non-linear element such as a diode.	VPTL_TID_6ELE_RES	●	●	●[4]				●	●

Table 9.   NGVCP-NGCC Supported Line Test Packages (Continued)

Algorithm Names	Description	VP-Test Library Names	Config.			NGVCP Packages				
			C	D	E	NT	BT	AT	ATP	THP
Master Socket Test	To detect the presence of an M-Socket used in Hong Kong and a passive test termination (PPA - Passiver Prüfabschluss) used in the German telephony network. An M-Socket termination diagram is presented in Figure 6. A PPA termination diagram is presented in Figure 7.	VPTL_TID_MSOCKET	•	•	•				•	•
CO Splitter Signature Detection	To measure the signature network of a POTS splitter filter located at the CO end of the loop. Two zener options are provided, VPTL_ZENER_24V and VPTL_ZENER_36V. CO splitter signature types are presented in Figure 10.	VPTL_TID_CO_SPLITTER	•	•	•[5]				•	•
CPE Splitter and IAD Signature Detection	To detect CPE splitter and Integrated Access Device signature types. Zener and mode input parameters allow for discrimination of the various networks. Signature network diagrams are presented in Figure 8 and Figure 9.	VPTL_TID_CPE_SPLITTER_IAD	•	•	•				•	•
ISDN Terminal Detection Test	To detect if an ISDN terminal is connected at the customer end of the loop. Targeted at detecting a German NTBA (Network Termination Basisanschluss).	VPTL_TID_ISDN_TERMINAL	•	•	•				•	•
Three-Element Capacitance Test	To measure the capacitances connected between Tip and ground, Ring and ground, and Tip to Ring. This test also measures foreign AC voltage. The test can measure foreign voltage sources in excess of the SLIC power supply rails.	VPTL_TID_3ELE_CAP	•	•	•		•		•	•
Generic Three-Element Capacitance Test	Similar to Three-Element Capacitance Test except user can control voltage, frequency and measurement times. This test can be used to implement a low capacitance phone detection algorithm.	VPTL_TID_GEN_3ELE_CAP	•	•	•		•		•	•
Receiver Off-Hook Test	To distinguish between a receiver taken off hook and a line short.	VPTL_TID_ROH	•	•	•		•	•	•	•
Distance to Open Test	To diagnose a line to locate a cable cut. Returns the distance in meters between the central office and the cable cut.	VPTL_TID_DISTANCE_TO_OPEN	•	•	•			•	•	•
Foreign AC Currents Test	To measure the AC current flowing in each lead when the line is set to a specific common mode voltage.	VPTL_TID_FOREIGN_AC_CURRENT	•	•	•			•	•	•
Ringer Equivalency Number Test	To measure REN characteristics of regular or electronic phones.	VPTL_TID_REN	•	•	•[6]		•	•	•	•
Ringer Equivalency Number with Phase	To measure the REN magnitude and phase of a phone attached to the line taking into account the loop characteristics.	VPTL_TID_REN_PHASE	•	•	•[6]		•	•	•	•

Table 9.   NGVCP-NGCC Supported Line Test Packages (Continued)

Algorithm Names	Description	VP-Test Library Names	Config.			NGVCP Packages				
			C	D	E	NT	BT	AT	ATP	THP
DTMF and Pulse Digit Measurement Test	To detect and measure a DTMF digit, pulse digit, or hook-switch flash.	VPTL_TID_DTMF_PULSE_MSRMNT	•	•	•		•	•	•	•
Noise Measurement Test	To measure the sum of the line circuit noise and the subscriber loop noise using one of the many weighting filters – Flat, 3-kHz, 15-kHz, 3.4-kHz, CMSG, D-Filter, Psophometric.	VPTL_TID_NOISE	•	•	•		•	•	•	•
Signal to Noise Ratio Test	To measure the signal to noise ratio due to circuit noise and quantization distortion while applying a 1010 Hz test tone to the loop.	VPTL_TID_SNR_QNTZ_DIST	•	•	•				•	•
Arbitrary Single Tone Measurement Test	To measure the frequency and level of an arbitrary single tone that may be present on the loop.	VPTL_TID_ARB_TONE	•	•	•				•	•
Tone Generation Test	To generate specific tones to a specific line. (Generate up to 4 tones)	VPTL_TID_TONE_GEN	•	•	•		•	•	•	•
Unbalanced Tone Generation	To generate a tracing tone on a single wire.	VPTL_TID_UNBAL_TONE	•	•	•[6]	•	•	•	•	•
Trans-Hybrid Loss Test	To measure the Trans Hybrid Loss of the line circuit under test.	VPTL_TID_TRANS_HYBRID_LOSS	•	•	•		•	•	•	•
Draw and Break Dial Tone Test	Apply an off-hook load and detect the presence of dial tone on the loop. Return the characteristics of the tones (amplitudes and frequencies). Then, dial a simulated digit to verify proper removal of the dial tone signal.	VPTL_TID_DRAW_BREAK_DIALTONE	•[1]	•	•[1]		•	•	•	•
Inward Current Test	When used as a test head, to verify the AC/DC current generated by another line.	VPTL_TID_INWRD_CUR		•					•	•
DC Feed Self-Test	To verify the capability of the SLIC to drive currents into a load and to measure the voltage developed across it.	VPTL_TID_DC_FEED_SELF_TEST	•[1]	•	•[1]		•	•	•	•
On/Off Hook Self-Test	To verify the capability of the line card circuitry to detect on-hook and off-hook conditions.	VPTL_TID_ON_OFF_HOOK_SELF_TEST	•[1]	•	•[1]		•	•	•	•
Ringing Self-Test	To verify the capability of the line card circuitry to generate a ringing voltage at the desired amplitude and to perform ring trip upon application of an off-hook.	VPTL_TID_RINGING_SELF_TEST	•[1]	•			•	•	•	•
Ringing Monitor Test	To measure the ringing voltage while applying normal ringing on a terminating call.	VPTL_TID_RINGING_MONITOR_TEST	•	•	•		•	•	•	•
Metering Self-Test	To verify the capability of the line card circuitry to generate a metering pulse.	VPTL_TID_METERING_SELF_TEST	•[1]	•	•[1]			•	•	•
Transmission Self-Test	To verify the capability of the line card circuitry to pass Voice Frequency signals in the D/A and in the A/D directions.	VPTL_TID_TRANSMISSION_SELF_TEST	•[1]	•	•[1]		•	•	•	•

Table 9.   NGVCP-NGCC Supported Line Test Packages (Continued)

Algorithm Names	Description	VP-Test Library Names	Config.			NGVCP Packages				
			C	D	E	NT	BT	AT	ATP	THP
Dialing Self-Test	To verify the capability of the line card circuitry to detect pulse dialing and DTMF dialing.	VPTL_TID_DIALING_SELF_TEST	●[1]	●	●[1]			●	●	●
Line Circuit Currents and Voltages	Measure AC or DC current or voltage while providing service.	VPTL_TID_MONITOR_IV	●	●	●		●	●	●	●
AC Transmission Test	To verify the channel transmission characteristics.	VPTL_TID_AC_TRANS	●[1]	●	●[1]				●	●
Howler Test	British, Australian and North American Howler Tone generation.	VPTL_TID_HOWLER_TEST	●	●	●			●	●	●
Fuse Test	To verify the integrity of the fuses on the Tip and Ring leads.	VPTL_TID_FUSE_TEST	●	●	●				●	●
Read Loop and Battery Conditions	Read the loop conditions and, high, low and positive battery voltages.	VPTL_TID_LOOP_BAT_COND_TEST	●	●	●[7]		●	●	●	●
GR909-All Test	To execute the complete list of GR-909 tests in less than 2 seconds.	VPTL_TID_GR909_ALL	●	●	●		●	●	●	●
Combined Multi-Test	To execute a series of voltage, resistance, and capacitance tests.	VPTL_TID_MULTI_TEST	●	●	●[2,3,4]			●	●	●
Susceptance Test	Measures the complex admittance of the Tip to ground, Ring to ground, and Tip to Ring branches using a sinewave with phase control and reports the conductance and susceptance of each branch.	VPTL_TID_SUSCEPTANCE_TEST	●	●	●[4]				●	●
Foreign AC Voltage with Frequency Measurement Test	To measure the AC foreign voltage present in the loop and the frequency of those foreign signals. A high pass filter is used to filter out any DC voltage present on the line.	VPTL_TID_OPEN_AC_VOLTAGE_FREQ	●	●	●[3]				●	●
Four-Element Insulation Resistance with a Controlled Metallic Voltage Test	To measure the resistances connected between Tip and ground, Ring and ground, Tip to Ring, and Ring to Tip with the user's choice of metallic voltage.	VPTL_TID_4ELE_RES_CTL	●	●	●[4]					●
Three-Element Capacitance with Frequency Control Test	To measure the capacitances and impedances connected between Tip and ground, Ring and ground, and Tip to Ring with the user's choice of frequency, peak voltage, and algorithm. This test also measures foreign AC voltage. The test can measure foreign voltage sources in excess of the SLIC power supply rails.	VPTL_TID_3ELE_CAP_CTL	●	●	●					●

Table 9.   NGVCP-NGCC Supported Line Test Packages (Continued)

Algorithm Names	Description	VP-Test Library Names	Config.			NGVCP Packages				
			C	D	E	NT	BT	AT	ATP	THP
Extended Master Socket Test	To detect the presence of an M-Socket used in Hong Kong and a passive test termination (PPA - Passiver Prüfabschluss) used in the German telephony network. An M-Socket termination diagram is presented in Figure 6. A PPA termination diagram is presented in Figure 7. This test uses results from the Four-Element Insulation Resistance Test to improve execution time.	VPTL_TID_EXT_MSOCKET	●	●	●				●	●
Measure DC Voltages and Currents Test	Using the line as a test head, the user can measure foreign voltages and currents while manipulating DC test bias and lead measurement parameters.	VPTL_TID_MEASURE_DC	●	●	●6					●
Electronic Ringer Detection	Generates a voltage ramp with an amplitude higher than the zener voltage of an electronic ringer network, then measures the various elements of this non-linear metallic impedance.	VPTL_TID_ELE_RINGER_DET	●	●	●8				●	●
Measure AC Voltages and Currents Test	Using the line as a test head, the user can measure foreign voltages and currents while manipulating AC test bias and lead measurement parameters.	VPTL_TID_MEASURE_AC	●	●	●6					●
Electronic Ringer Test	Using the line as a test head, measures charging current into the ringer load capacitance using one of several measurement algorithms.	VPTL_TID_ERD_TEST	●	●	●					●
Get Reference Voltage Test	To obtain open circuit ring lead voltage.	VPTL_TID_REF_VOLTAGE	●	●	●					●
Get Line Voltages Test	To measure voltages generated by the line circuit.	VPTL_TID_LINE_VOLTAGES	●	●	●					●
Group Test	To execute Get Reference Voltage, Get Line Voltages, Foreign DC Voltage, Foreign AC Voltage, Six-Element Insulation Resistance, and Susceptance Tests within a single call.	VPTL_TID_GROUP_TEST	●	●	●4					●
Extended Group Test	To execute Foreign DC Voltage, Foreign AC Voltage, Four-Element Insulation Resistance, Three-Element Capacitance, and Susceptance Tests within a single call.	VPTL_TID_EXT_GROUP_TEST	●	●	●2,3,4				●	●
Fast Group Test	To execute Foreign DC Voltage, Foreign AC Voltage, Four-Element Insulation Resistance, Three-Element Capacitance, and Susceptance Tests within a single call.	VPTL_TID_FAST_GROUP_TEST	●	●	●2,3,4, 8				●	●
Loop Resistance with High Metallic Voltage Test	To measure the resistance of an ETSI DC signature located at the CPE end of the loop. A signature network diagram is presented in Figure 11.	VPTL_TID_LOOP_RES_HIGH	●	●	●9					●
Continuous Tone Generation Test	To generate a continuous tracing tone at desired frequency and amplitude across a 600 ohm load.	VPTL_TID_TONE	●	●	●				●	●

Table 9.   NGVCP-NGCC Supported Line Test Packages (Continued)

1. Configuration C and E have no disconnect relay. If there is no other means to disconnect the line from the loop during inward looking test, Self Tests can only be performed in the factory. The published Self Test accuracies are given for production testing only when no loop is connected to the equipment port. If the Self Tests are performed in the field, the host application needs to interpret the data accordingly, taking into account any loop impedance present.

2. Minor functional difference on how test is performed and reduced range with Configuration E for Foreign DC Voltage Tests. Refer to VoicePath™ API-II Test Library User's Guide for details.

3. Reduced range with Configuration E for Foreign AC Voltage Tests. Refer to VoicePath™ API-II Test Library User's Guide for details.

4. Range reduction in low resistance measurements with Configuration E for Resistance Tests. Refer to VoicePath™ API-II Test Library User's Guide for details.

5. With Configuration E, the VPTL_ZENER_36V option of this test is only supported if the VBH potential is adequate to support a 45 V metallic drive. Refer to VoicePath™ API-II Test Library User's Guide for details.

6. Some restrictions on the input parameter selection range apply with Configuration E due to the absence of a VBP supply. Refer to VoicePath™ API-II Test Library User's Guide for details.

7. Can not measure IMT and ILG currents when in the ringing mode.

8. Range reduction with Configuration E for Electronic Ringer Detection. Refer to VoicePath™ API-II Test Library User's Guide for details.

9. Test is limited to lower zener voltages with Configuration E. Refer to VoicePath™ API-II Test Library User's Guide for details.

Table 10.   GR-909 Tests and their corresponding Test Library Names

GR-909 test names	Description	Test Library Names
Outward loop testing		
Hazardous potential test AC	To measure the foreign AC Voltage present in the loop. A high pass filter is used to filter out any DC voltage present on the line.	VPTL_TID_OPEN_AC_VOLTAGE
Foreign voltage test AC		
Hazardous potential test DC	To measure the foreign DC Voltage present in the loop while the card is in a high impedance state	VPTL_TID_OPEN_DC_VOLTAGE
Foreign voltage test DC		
Resistive fault test	To measure any resistive fault present between Tip and ground, Ring and ground, Tip and Ring.	VPTL_TID_3ELE_RES
Receiver off-hook test	To verify the difference between a receiver taken off-hook and a line short.	VPTL_TID_ROH
Ringer test	To measure the ringer equivalence number of a phone	VPTL_TID_REN
GR-909 tests	Performs all outward loop tests	VPTL_TID_GR909_ALL
Inward equipment testing		
DC feed test[1]	See DC Feed and On-OFF Hook Self Test definitions in Table 9	VPTL_TID_DC_FEED_SELF_TEST and VPTL_TID_ON_OFF_HOOK_SELF_TEST
Ringing test[1]	To verify the capability of the line card circuitry to generate internal ringing voltage at the desired amplitude and to perform ring trip upon an off-hook event	VPTL_TID_RINGING_SELF_TEST
Two-wire channel loss[1,2]	To measure the Trans Hybrid Loss of the line circuit under test	VPTL_TID_TRANSMISSION_SELF_TEST or VPTL_TID_TRANS_HYBRID_LOSS
Echo return loss[1]		
Idle channel noise	To measure the sum of the line circuit noise and the subscriber loop noise using a C-Message filter	VPTL_TID_NOISE

Notes:

1. *Requires the test load resistor as the termination.*

2. *Using open-circuit as the reflect termination.*

Measurement Range and Accuracy

Table 11 presents measurement ranges and accuracies for the Configuration C topology. Table 12 presents measurement ranges and accuracies for the Configuration D topology. Table 13 presents measurement ranges and accuracies for the Configuration E topology. Accuracies are listed for each calibration option and are specified for the recommended sense resistor tolerance. Accuracies apply to the recommended application circuits and parts lists that are defined in the *NGCC Hardware Design Guide, Document ID 126583*. Refer to the notes following the tables for additional information.

Table 11.   Configuration C Measurement Range and Accuracy

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION C No Calibration RSVA/RSVB 0.5%, 100 ppm				CONFIGURATION C Factory Calibration RSVA/RSVB 0.5%, 100 ppm			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_OPEN_DC_VOLTAGE	Tip or ring voltage	Notes 1, 3, 8, 10, 12, 13	-1000	-400	V	±2.2% & ±3.0 V	-1000	-400	V	±1.95% & ±1.5 V
			-400	400		±1.9% & ±1.0 V	-400	400		±1.75% & ±0.5 V
			400	1000		±2.2% & ±3.0 V	400	1000		±1.95% & ±1.5 V
		AC induction rejection	0	280	Vrms	> 40 dB	0	280	Vrms	> 40 dB
VPTL_TID_OPEN_AC_VOLTAGE	Tip or ring voltage	Notes 1, 3, 8, 10, 12, 14	0	280	Vrms	±1.9% & ±0.05 V	0	280	Vrms	±1.75% & ±0.05 V
			280	700		±2.2% & ±0.2 V	280	700		±1.95% & ±0.2 V
		Frequency Range	50	200	Hz		50	200	Hz	
		Foreign DC rejection	-400	400	V	> 40 dB	-400	400	V	> 40 dB
	Differential voltage	Notes 1, 3, 8, 10, 12, 14	0	280	Vrms	±2.65% & ±0.05 V	0	280	Vrms	±1.8% & ±0.05 V
			280	700		±3.1% & ±0.2 V	280	700		±2.5% & ±0.2 V
		Frequency Range	50	200	Hz		50	200	Hz	
		Common-mode Rejection	0	280	Vrms	< 2%	0	280	Vrms	< 2%
		Foreign DC rejection	-400	400	V	> 40 dB	-400	400	V	> 40 dB
VPTL_TID_MONITOR_IV	ILG current	Notes 3, 8, 13, 14, 15	0	80	mA	±3.2% & ±1.0 mA	0	80	mA	±3.2% & ±1.0 mA
	IMT current		0	80	mA	±4.0% & ±1.0 mA	0	80	mA	±2.5% & ±0.75 mA
VPTL_TID_DC_LOOP_RES	Test with offset compensation	Notes 2, 3, 8	0	4	kΩ	±6% & ±10 Ω	0	4	kΩ	±4.5% & ±10 Ω
		Note 4	5	70	mA	±4.0% & ±2.0 mA	5	70	mA	±2.5% & ±0.75 mA
VPTL_TID_REN	Mechanical ringer test	Notes 3, 8	1	10	kΩ	±5% & ±20 Ω	1	10	kΩ	±4.5% & ±20 Ω
			10	100	kΩ	±6%	10	100	kΩ	±5%
		Signal Frequency Range	10	80	Hz		10	80	Hz	
	Electronic ringer test	With 500 Ω to 7500 Ω Series Resistor and > 100 kΩ Parallel Resistor	0	4	µF	±6% & ±50 nF	0	4	µF	±5% & ±50 nF

Table 11.   Configuration C Measurement Range and Accuracy (Continued)

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION C No Calibration RSVA/RSVB 0.5%, 100 ppm				CONFIGURATION C Factory Calibration RSVA/RSVB 0.5%, 100 ppm			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_3ELE_RES, VPTL_TID_4ELE_RES	Resistance to GND	Notes 3, 5, 8	1	1000	Ω	±4% & ±10 Ω	1	1000	Ω	±2.5% & ±10 Ω
			1	10	kΩ	±4% & ±10 Ω	1	10	kΩ	±2.25% & ±10 Ω
			10	30		±4.25%	10	30		±2.5%
			30	100		-4.75%, +5.4%	30	100		±2.5%
			100	150		-5.75%, +6.8%	100	150		±2.5%
			150	360		-10%, +14%	150	360		±3.35%
			360	1000		-23%, +36%	360	1000		±7.5%
			1	2	MΩ	-65%, +100%	1	5	MΩ	-21%, +34%
							5	10		-34%, +100%
							10	20		-50%, infinity
	Resistance A to B	Notes 3, 5, 8	1	1000	Ω	±4% & ±20 Ω	1	1000	Ω	±2.5% & ±20 Ω
			1	10	kΩ	±4% & ±20 Ω	1	10	kΩ	±2.25% & ±20 Ω
			10	30		±4.1%	10	30		±2.5%
			30	100		±4.0%	30	100		±2.5%
			100	150		±4.1%	100	150		±2.5%
			150	360		±4.3%	150	360		±3.0%
			360	1000		±6%	360	1000		±4.5%
			1	5	MΩ	-20%, +40%	1	5	MΩ	-15%, +20%
			5	10		-40%, +50%	5	10		-25%, +40%
							10	20		-40%, +120%
VPTL_TID_3ELE_RES	Foreign DC currents	IAE + IBE (Notes 3, 8, 9)	0	80	mA	±5% & ±1.2 mA	0	80	mA	±4% & ±0.6 mA
		AC current rejection	0	40	mArms	> 40 dB	0	40	mArms	> 40 dB

Table 11.   Configuration C Measurement Range and Accuracy (Continued)

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION C No Calibration RSVA/RSVB 0.5%, 100 ppm				CONFIGURATION C Factory Calibration RSVA/RSVB 0.5%, 100 ppm			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_3ELE_CAP	Capacitance to GND	Notes 3, 5, 8	0	100	nF	±4.1% & ±0.55 nF	0	100	nF	±2.25% & ±0.3 nF
			100	1000	nF	±4.1% & ±1.0 nF	100	1000	nF	±2.25% & ±0.8 nF
			1	20	μF	±4.45%	1	20	μF	±2.5%
			20	50	μF	±5.2%	20	50	μF	±3.15%
	Capacitance A to B	Notes 3, 5, 8	0	100	nF	±4.1% & ±0.55 nF	0	100	nF	±2.25% & ±0.25 nF
			100	1000	nF	±4.15% & ±0.75 nF	100	1000	nF	±2.25% & ±0.65 nF
			1	20	μF	±4.0%	1	20	μF	±2.4%
			20	50	μF	±4.3%	20	50	μF	±2.6%
		Signal Frequency Range	10	200	Hz		10	200	Hz	
VPTL_TID_FOREIGN_ AC_CURRENT		IAE + IBE (Notes 3, 8, 9, 15)	0.1	50	mArms	±5% & ±0.01 mArms	0.1	50	mArms	±4% & ±0.01 mArms
		Frequency Range	50	200	Hz		50	200	Hz	
		DC current rejection	-60	60	mA	> 40 dB	-60	60	mA	> 40 dB
VPTL_TID_DTMF_PULSE_ MSRMNT	Dial pulse test	Dial Speed	8	12	pps	±1.0%	8	12	pps	±1.0%
		Break Interval	40	80	%	±1.0%	40	80	%	±1.0%
		Dial Speed	18	22	pps	±2.0%	18	22	pps	±2.0%
		Break Interval	40	80	%	±2.0%	40	80	%	±2.0%
	DTMF test	DTMF Level (Notes 6, 8)	-20	0	dBm	±1.0 dB	-20	0	dBm	±1.0 dB
		DTMF Level (Notes 6, 8)	-25	-20	dBm	±1.5 dB	-25	-20	dBm	±1.5 dB
		DTMF Frequency (Notes 6, 8)	600	2000	Hz	±2 Hz	600	2000	Hz	±2 Hz

Table 11.   Configuration C Measurement Range and Accuracy (Continued)

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION C No Calibration RSVA/RSVB 0.5%, 100 ppm				CONFIGURATION C Factory Calibration RSVA/RSVB 0.5%, 100 ppm			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_NOISE		Notes 7, 8, 18	-40	0	dBm	±1 dB	-40	0	dBm	±1 dB
			-50	-40	dBm	±2 dB	-50	-40	dBm	±2 dB
			-60	-50	dBm	±3 dB	-60	-50	dBm	±3 dB
VPTL_TID_SNR_QNTZ_DIST		Notes 7, 8, 19	-40	0	dBm	±1 dB	-40	0	dBm	±1 dB
			-50	-40	dBm	±2 dB	-50	-40	dBm	±2 dB
			-60	-50	dBm	±3 dB	-60	-50	dBm	±3 dB
VPTL_TID_ARB_TONE		Notes 6, 8, 20	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB
			300	3400	Hz	±2 Hz	300	3400	Hz	±2 Hz
VPTL_TID_AC_TRANS		Notes 6, 8, 19	-40	0	dBm	±1.0 dB	-40	0	dBm	±1.0 dB
			300	3400	Hz	±2 Hz	300	3400	Hz	±2 Hz
VPTL_TID_TONE_GEN		Note 21	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB
			300	3400	Hz	±0.25%	300	3400	Hz	±0.25%
VPTL_TID_UNBAL_TONE	Notes 17, 22	AC peak output	0	150	V	±2.4% & Note 16	0	150	V	±1.4% & Note 16
		Frequency output	10	1200	Hz	±2 Hz	10	1200	Hz	±2 Hz
		DC level output	-150	150	V	±2.4% & ±0.7 V	-150	150	V	±1.4% & ±0.45 V
VPTL_TID_DRAW_BREAK_ DIALTONE	Self Test	Notes 6, 8, 20	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB
			300	800	Hz	±2 Hz	300	800	Hz	±2 Hz
	Inward test	Notes 6, 8	-20	0	dBm	±1.0 dB	-20	0	dBm	±1.0 dB
			300	800	Hz	±2 Hz	300	800	Hz	±2 Hz
VPTL_TID_TRANS_HYBRID_ LOSS		Notes 7, 8, 19	-40	0	dBm	±1.0 dB	-40	0	dBm	±1.0 dB
			300	3400	Hz	±0.25%	300	3400	Hz	±0.25%

Table 12. Configuration D Measurement Range and Accuracy

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION D No Calibration RSVA/RSVB 0.5%, 100 ppm No Calibration Bus				CONFIGURATION D Factory Calibration RSVA/RSVB 0.5%, 100 ppm No Calibration Bus				CONFIGURATION D In-Service Calibration RSVA/RSVB 0.5%, 100 ppm Calibration Bus			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_OPEN_ DC_VOLTAGE	Tip or ring voltage	Notes 1, 3, 8, 10, 12, 13	-1000	-400	V	±2.2% & ±3.0 V	-1000	-400	V	±1.95% & ±1.5 V	-1000	-400	V	±1.55% & ±0.7 V
			-400	400		±1.9% & ±0.05 V	-400	400		±1.75% & ±0.05 V	-400	400		±1.1% & ±0.05 V
			400	1000		±2.2% & ±3.0 V	400	1000		±1.95% & ±1.5 V	400	1000		±1.55% & ±0.7 V
		AC induction rejection	0	280	Vrms	> 40 dB	0	280	Vrms	> 40 dB	0	280	Vrms	> 40 dB
VPTL_TID_OPEN_ AC_VOLTAGE	Tip or ring voltage	Notes 1, 3, 8, 10, 12, 14	0	280	Vrms	±1.9% & ±0.05 V	0	280	Vrms	±1.75% & ±0.05 V	0	280	Vrms	±1.1% & ±0.05 V
			280	700		±2.2% & ±0.2 V	280	700		±1.95% & ±0.2 V	280	700		±1.55% & ±0.2 V
		Frequency Range	50	200	Hz		50	200	Hz		50	200	Hz	
		Foreign DC rejection	-400	400	V	> 40 dB	-400	400	V	> 40 dB	-400	400	V	> 40 dB
	Differential voltage	Notes 1, 3, 8, 10, 12, 14	0	280	Vrms	±2.65% & ±0.05 V	0	280	Vrms	±1.8% & ±0.05 V	0	280	Vrms	±1.55% & ±0.05 V
			280	700		±3.1% & ±0.2 V	280	700		±2.5% & ±0.2 V	280	700		±2.2% & ±0.2 V
		Frequency Range	50	200	Hz		50	200	Hz		50	200	Hz	
		Common-mode Rejection	0	280	Vrms	< 2%	0	280	Vrms	< 2%	0	280	Vrms	< 2%
		Foreign DC rejection	-400	400	V	> 40 dB	-400	400	V	> 40 dB	-400	400	V	> 40 dB
VPTL_TID_ MONITOR_IV	ILG current	Notes 2, 3, 8, 13, 14, 15	0	80	mA	±3.2% & ±0.02 mA	0	80	mA	±3.2% & ±0.02 mA	0	80	mA	±3.2% & ±0.02 mA
	IMT current		0	80	mA	±4.0% & ±0.02 mA	0	80	mA	±2.5% & ±0.02 mA	0	80	mA	±2.0% & ±0.02 mA
VPTL_TID_DC_ LOOP_RES	Test with offset compensa-tion	Notes 2, 3, 8	0	4	kΩ	±6% & ±10 Ω	0	4	kΩ	±4.5% & ±10 Ω	0	4	kΩ	±3.5% & ±10 Ω
		Note 4	5	70	mA	±4.0% & ±2.0 mA	5	70	mA	±2.5% & ±0.75 mA	5	70	mA	±2.0% & ±0.5 mA

Table 12.   Configuration D Measurement Range and Accuracy (Continued)

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION D No Calibration RSVA/RSVB 0.5%, 100 ppm No Calibration Bus				CONFIGURATION D Factory Calibration RSVA/RSVB 0.5%, 100 ppm No Calibration Bus				CONFIGURATION D In-Service Calibration RSVA/RSVB 0.5%, 100 ppm Calibration Bus			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_REN	Mechanical ringer test	Notes 3, 8	1	10	kΩ	±5% & ±20 Ω	1	10	kΩ	±4.5% & ±20 Ω	1	10	kΩ	±3.5% & ±20 Ω
			10	100	kΩ	±6%	10	100	kΩ	±5%	10	100	kΩ	±4%
		Signal Frequency Range	10	80	Hz		10	80	Hz		10	80	Hz	
	Electronic ringer test	With 500 Ω to 7500 Ω series resistor and > 100 kΩ parallel resistor	0	4	µF	±6% & ±50 nF	0	4	µF	±5% & ±50 nF	0	4	µF	±4% & ±50 nF
VPTL_TID_ 3ELE_RES, VPTL_TID_ 4ELE_RES	Resistance to GND	Notes 3, 5, 8	1	1000	Ω	±4% & ±10 Ω	1	1000	Ω	±2.5% & ±10 Ω	1	1000	Ω	±2.3% & ±7 Ω
			1	10	kΩ	±4% & ±10 Ω	1	10	kΩ	±2.25% & ±10 Ω	1	10	kΩ	±1.85% & ±7 Ω
			10	30		±4.25%	10	30		±2.5%	10	30		±2.25%
			30	100		±4.0%	30	100		±2.5%	30	100		±2.25%
			100	150		±4.0%	100	150		±2.25%	100	150		±1.95%
			150	360		±4.15%	150	360		±2.5%	150	360		±2.2%
			360	1000		±5.1%	360	1000		±4.0%	360	1000		±3.65%
			1	5	MΩ	-12%, +15%	1	5	MΩ	-12%, +15%	1	5	MΩ	-12%, +15%
			5	10		-20%, +35%	5	10		-20%, +35%	5	10		-20%, +35%
			10	20		-33%, +100%	10	20		-33%, +100%	10	20		-33%, +100%
	Resistance A to B	Notes 3, 5, 8	1	1000	Ω	±4% & ±20 Ω	1	1000	Ω	±2.5% & ±20 Ω	1	1000	Ω	±2.3% & ±15 Ω
			1	10	kΩ	±4% & ±20 Ω	1	10	kΩ	±2.25% & ±20 Ω	1	10	kΩ	±1.85% & ±15 Ω
			10	30		±4.35%	10	30		±2.5%	10	30		±2.25%
			30	100		±4.0%	30	100		±2.5%	30	100		±2.25%
			100	150		±4.0%	100	150		±2.25%	100	150		±1.95%
			150	360		±4.15%	150	360		±2.5%	150	360		±2.2%
			360	1000		±5.1%	360	1000		±4%	360	1000		±3.65%
			1	5	MΩ	-12%, +15%	1	5	MΩ	-12%, +15%	1	5	MΩ	-12%, +15%
			5	10		-20%, +35%	5	10		-20%, +35%	5	10		-20%, +35%
			10	20		-33%, +100%	10	20		-33%, +100%	10	20		-33%, +100%

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Table 12.   Configuration D Measurement Range and Accuracy (Continued)

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION D No Calibration RSVA/RSVB 0.5%, 100 ppm No Calibration Bus				CONFIGURATION D Factory Calibration RSVA/RSVB 0.5%, 100 ppm No Calibration Bus				CONFIGURATION D In-Service Calibration RSVA/RSVB 0.5%, 100 ppm Calibration Bus			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_ 3ELE_RES	Foreign DC currents	IAE + IBE (Notes 2, 3, 8, 9)	0	80	mA	±5% & ±0.02 mA	0	80	mA	±4% & ±0.02 mA	0	80	mA	±3% & ±0.02 mA
		AC current rejection	0	40	mA rms	> 40 dB	0	40	mA rms	> 40 dB	0	40	mA rms	> 40 dB
VPTL_TID_ 3ELE_CAP	Capacitance to GND	Notes 3, 5, 8	0	100	nF	±4.1% & ±0.2 nF	0	100	nF	±2.25% & ±0.2 nF	0	100	nF	±1.9% & ±0.2 nF
			100	1000	nF	±4.1% & ±0.9 nF	100	1000	nF	±2.25% & ±0.9 nF	100	1000	nF	±1.9% & ±0.9 nF
			1	20	µF	±4.45%	1	20	µF	±2.4%	1	20	µF	±2.15%
			20	50	µF	±5.2%	20	50	µF	±3.15%	20	50	µF	±2.85%
	Capacitance A to B	Notes 3, 5, 8	0	100	nF	±4.1% & ±0.25 nF	0	100	nF	±2.25% & ±0.2 nF	0	100	nF	±1.9% & ±0.2 nF
			100	1000	nF	±4.15% & ±1.1 nF	100	1000	nF	±2.25% & ±1.1 nF	100	1000	nF	±1.9% & ±1.1 nF
			1	20	µF	±4.0%	1	20	µF	±2.25%	1	20	µF	±1.9%
			20	50	µF	±4.3%	20	50	µF	±2.6%	20	50	µF	±2.3%
		Signal Freq. Range	10	200	Hz		10	200	Hz		10	200	Hz	
VPTL_TID_ FOREIGN_ AC_CURRENT		IAE + IBE (Notes 8, 9,15)	0.1	50	mA rms	±5% & ±0.01 mArms	0.1	50	mA rms	±4% & ±0.01 mArms	0.1	50	mA rms	±3% & ±0.01 mArms
		Freq. Range	50	200	Hz		50	200	Hz		50	200	Hz	
		DC current rejection	-60	60	mA	> 40 dB	-60	60	mA	> 40 dB	-60	60	mA	> 40 dB
VPTL_TID_ DTMF_PULSE_ MSRMNT	Dial pulse test	Dial Speed	8	12	pps	±1.0%	8	12	pps	±1.0%	8	12	pps	±1.0%
		Break Interval	40	80	%	±1.0%	40	80	%	±1.0%	40	80	%	±1.0%
		Dial Speed	18	22	pps	±2.0%	18	22	pps	±2.0%	18	22	pps	±2.0%
		Break Interval	40	80	%	±2.0%	40	80	%	±2.0%	40	80	%	±2.0%
	DTMF test	DTMF Level (Notes 6, 8)	-20	0	dBm	±1.0 dB	-20	0	dBm	±1.0 dB	-20	0	dBm	±1.0 dB
			-25	-20	dBm	±1.5 dB	-25	-20	dBm	±1.5 dB	-25	-20	dBm	±1.5 dB
		DTMF Frequency (Notes 6, 8)	600	2000	Hz	±2 Hz	600	2000	Hz	±2 Hz	600	2000	Hz	±2 Hz

Table 12.   Configuration D Measurement Range and Accuracy (Continued)

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION D No Calibration RSVA/RSVB 0.5%, 100 ppm No Calibration Bus				CONFIGURATION D Factory Calibration RSVA/RSVB 0.5%, 100 ppm No Calibration Bus				CONFIGURATION D In-Service Calibration RSVA/RSVB 0.5%, 100 ppm Calibration Bus			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_NOISE		Notes 7, 8, 18	-40	0	dBm	±1 dB	-40	0	dBm	±1 dB	-40	0	dBm	±1 dB
			-50	-40	dBm	±2 dB	-50	-40	dBm	±2 dB	-50	-40	dBm	±2 dB
			-60	-50	dBm	±3 dB	-60	-50	dBm	±3 dB	-60	-50	dBm	±3 dB
VPTL_TID_SNR_QNTZ_DIST		Notes 7, 8, 19	-40	0	dBm	±1 dB	-40	0	dBm	±1 dB	-40	0	dBm	±1 dB
			-50	-40	dBm	±2 dB	-50	-40	dBm	±2 dB	-50	-40	dBm	±2 dB
			-60	-50	dBm	±3 dB	-60	-50	dBm	±3 dB	-60	-50	dBm	±3 dB
VPTL_TID_ARB_TONE		Notes 6, 8, 20	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB
			300	3400	Hz	±2 Hz	300	3400	Hz	±2 Hz	300	3400	Hz	±2 Hz
VPTL_TID_AC_TRANS		Notes 6, 8, 19	-40	0	dBm	±1.0 dB	-40	0	dBm	±1.0 dB	-40	0	dBm	±1.0 dB
			300	3400	Hz	±2 Hz	300	3400	Hz	±2 Hz	300	3400	Hz	±2 Hz
VPTL_TID_TONE_GEN		Note 21	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB
			300	3400	Hz	±0.25%	300	3400	Hz	±0.25%	300	3400	Hz	±0.25%
VPTL_TID_UNBAL_TONE	Notes 17, 22	AC peak output	0	150	V	±2.4% & Note 16	0	150	V	±1.4% & Note 16	0	150	V	±1.3% & Note 16
		Frequency output	10	1200	Hz	±2 Hz	10	1200	Hz	±2 Hz	10	1200	Hz	±2 Hz
		DC level output	-150	150	V	±2.4% & ±0.7 V	-150	150	V	±1.4% & ±0.45 V	-150	150	V	±1.3% & ±0.3 V
VPTL_TID_DRAW_BREAK_DIALTONE	Self Test	Notes 6, 8, 20	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB
			300	800	Hz	±2 Hz	300	800	Hz	±2 Hz	300	800	Hz	±2 Hz
	Inward test	Notes 6, 8	-20	0	dBm	±1.0 dB	-20	0	dBm	±1.0 dB	-20	0	dBm	±1.0 dB
			300	800	Hz	±2 Hz	300	800	Hz	±2 Hz	300	800	Hz	±2 Hz
VPTL_TID_TRANS_HYBRID_LOSS		Notes 7, 8, 19	-40	0	dBm	±1.0 dB	-40	0	dBm	±1.0 dB	-40	0	dBm	±1.0 dB
			300	3400	Hz	±0.25%	300	3400	Hz	±0.25%	300	3400	Hz	±0.25%

Table 13. Configuration E Measurement Range and Accuracy

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION E No Calibration RSVA/RSVB 0.5%, 100 ppm				CONFIGURATION E Factory Calibration RSVA/RSVB 0.5%, 100 ppm			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_OPEN_DC_VOLTAGE	Tip or ring voltage	Notes 1, 3, 8, 10, 12, 13	-1000	-400	V	±2.2% & ±3.0 V	-1000	-400	V	±1.95% & ±1.5 V
			-400	400		±1.9% & ±1.0 V	-400	400		±1.75% & ±0.5 V
			400	1000		±2.2% & ±3.0 V	400	1000		±1.95% & ±1.5 V
		AC induction rejection	0	280	Vrms	> 40 dB	0	280	Vrms	> 40 dB
VPTL_TID_OPEN_AC_VOLTAGE	Tip or ring voltage	Notes 1, 3, 8, 10, 12, 14	0	280	Vrms	±1.9% & ±0.05 V	0	280	Vrms	±1.75% & ±0.05 V
			280	700		±2.2% & ±0.2 V	280	700		±1.95% & ±0.2 V
		Frequency Range	50	200	Hz		50	200	Hz	
		Foreign DC rejection	-400	400	V	> 40 dB	-400	400	V	> 40 dB
	Differential voltage	Notes 1, 3, 8, 10, 12, 14	0	280	Vrms	±2.65% & ±0.05 V	0	280	Vrms	±1.8% & ±0.05 V
			280	700		±3.1% & ±0.2 V	280	700		±2.5% & ±0.2 V
		Frequency Range	50	200	Hz		50	200	Hz	
		Common-mode Rejection	0	280	Vrms	< 2%	0	280	Vrms	< 2%
		Foreign DC rejection	-400	400	V	> 40 dB	-400	400	V	> 40 dB
VPTL_TID_MONITOR_IV	ILG current	Notes 3, 8, 13, 14, 15	0	80	mA	±3.2% & ±1.0 mA	0	80	mA	±3.2% & ±1.0 mA
	IMT current		0	80	mA	±4.0% & ±1.0 mA	0	80	mA	±2.5% & ±0.75 mA
VPTL_TID_DC_LOOP_RES	Test with offset compensation	Notes 2, 3, 8	0	4	kΩ	±6% & ±10 Ω	0	4	kΩ	±4.5% & ±10 Ω
		Note 4	5	70	mA	±4.0% & ±2.0 mA	5	70	mA	±2.5% & ±0.75 mA
VPTL_TID_REN	Mechanical ringer test	Notes 3, 8	1	10	kΩ	±5% & ±20 Ω	1	10	kΩ	±4.5% & ±20 Ω
			10	100	kΩ	±6%	10	100	kΩ	±5%
		Signal Frequency Range	10	80	Hz		10	80	Hz	
	Electronic ringer test	With 500 Ω to 7500 Ω Series Resistor and > 100 kΩ Parallel Resistor	0	4	µF	±6% & ±50 nF	0	4	µF	±5% & ±50 nF

Table 13. Configuration E Measurement Range and Accuracy

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION E No Calibration RSVA/RSVB 0.5%, 100 ppm				CONFIGURATION E Factory Calibration RSVA/RSVB 0.5%, 100 ppm			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_3ELE_RES, VPTL_TID_4ELE_RES	Resistance to GND	Notes 3, 5, 8	1	10	kΩ	±4% & ±10 Ω	1	10	kΩ	±2.25% & ±10 Ω
			10	30		±4.25%	10	30		±2.5%
			30	100		-4.75%, +5.4%	30	100		±2.5%
			100	150		-5.75%, +6.8%	100	150		±2.5%
			150	360		-10%, +14%	150	360		±3.35%
			360	1000		-23%, +36%	360	1000		±7.5%
			1	2	MΩ	-65%, +100%	1	5	MΩ	-21%, +34%
							5	10		-34%, +100%
							10	20		-50%, infinity
	Resistance A to B	Notes 3, 5, 8	1	10	kΩ	±4% & ±20 Ω	1	10	kΩ	±2.25% & ±20 Ω
			10	30		±4.1%	10	30		±2.5%
			30	100		±4.0%	30	100		±2.5%
			100	150		±4.1%	100	150		±2.5%
			150	360		±4.3%	150	360		±3.0%
			360	1000		±6%	360	1000		±4.5%
			1	5	MΩ	-20%, +40%	1	5	MΩ	-15%, +20%
			5	10		-40%, +50%	5	10		-25%, +40%
							10	20		-40%, +120%
VPTL_TID_3ELE_RES	Foreign DC currents	IAE + IBE (Notes 3, 8, 9)	0	80	mA	±5% & ±1.2 mA	0	80	mA	±4% & ±0.6 mA
		AC current rejection	0	40	mArms	> 40 dB	0	40	mArms	> 40 dB

Table 13. Configuration E Measurement Range and Accuracy

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION E No Calibration RSVA/RSVB 0.5%, 100 ppm				CONFIGURATION E Factory Calibration RSVA/RSVB 0.5%, 100 ppm			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_3ELE_CAP	Capacitance to GND	Notes 3, 5, 8	0	100	nF	±4.1% & ±0.55 nF	0	100	nF	±2.25% & ±0.3 nF
			100	1000	nF	±4.1% & ±1.0 nF	100	1000	nF	±2.25% & ±0.8 nF
			1	20	µF	±4.45%	1	20	µF	±2.5%
			20	50	µF	±5.2%	20	50	µF	±3.15%
	Capacitance A to B	Notes 3, 5, 8	0	100	nF	±4.1% & ±0.55 nF	0	100	nF	±2.25% & ±0.25 nF
			100	1000	nF	±4.15% & ±0.75 nF	100	1000	nF	±2.25% & ±0.65 nF
			1	20	µF	±4.0%	1	20	µF	±2.4%
			20	50	µF	±4.3%	20	50	µF	±2.6%
		Signal Frequency Range	10	200	Hz		10	200	Hz	
VPTL_TID_FOREIGN_AC_CURRENT		IAE + IBE (Notes 3, 8, 9, 15)	0.1	50	mArms	±5% & ±0.01 mArms	0.1	50	mArms	±4% & ±0.01 mArms
		Frequency Range	50	200	Hz		50	200	Hz	
		DC current rejection	-60	60	mA	> 40 dB	-60	60	mA	> 40 dB
VPTL_TID_DTMF_PULSE_MSRMNT	Dial pulse test	Dial Speed	8	12	pps	±1.0%	8	12	pps	±1.0%
		Break Interval	40	80	%	±1.0%	40	80	%	±1.0%
		Dial Speed	18	22	pps	±2.0%	18	22	pps	±2.0%
		Break Interval	40	80	%	±2.0%	40	80	%	±2.0%
	DTMF test	DTMF Level (Notes 6, 8)	-20	0	dBm	±1.0 dB	-20	0	dBm	±1.0 dB
		DTMF Level (Notes 6, 8)	-25	-20	dBm	±1.5 dB	-25	-20	dBm	±1.5 dB
		DTMF Frequency (Notes 6, 8)	600	2000	Hz	±2 Hz	600	2000	Hz	±2 Hz

Table 13. Configuration E Measurement Range and Accuracy

Test Library Function	Specific Test	Notes / Parameter	CONFIGURATION E No Calibration RSVA/RSVB 0.5%, 100 ppm				CONFIGURATION E Factory Calibration RSVA/RSVB 0.5%, 100 ppm			
			From	To	Unit	Accuracy / Specification	From	To	Unit	Accuracy / Specification
VPTL_TID_NOISE		Notes 7, 8, 18	-40	0	dBm	±1 dB	-40	0	dBm	±1 dB
			-50	-40	dBm	±2 dB	-50	-40	dBm	±2 dB
			-60	-50	dBm	±3 dB	-60	-50	dBm	±3 dB
VPTL_TID_SNR_QNTZ_DIST		Notes 7, 8, 19	-40	0	dBm	±1 dB	-40	0	dBm	±1 dB
			-50	-40	dBm	±2 dB	-50	-40	dBm	±2 dB
			-60	-50	dBm	±3 dB	-60	-50	dBm	±3 dB
VPTL_TID_ARB_TONE		Notes 6, 8, 20	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB
			300	3400	Hz	±2 Hz	300	3400	Hz	±2 Hz
VPTL_TID_AC_TRANS		Notes 6, 8, 19	-40	0	dBm	±1.0 dB	-40	0	dBm	±1.0 dB
			300	3400	Hz	±2 Hz	300	3400	Hz	±2 Hz
VPTL_TID_TONE_GEN		Note 21	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB
			300	3400	Hz	±0.25%	300	3400	Hz	±0.25%
VPTL_TID_UNBAL_TONE	Notes 17, 22	AC peak output	0	150	V	±2.4% & Note 16	0	150	V	±1.4% & Note 16
		Frequency output	10	1200	Hz	±2 Hz	10	1200	Hz	±2 Hz
		DC level output	-150	150	V	±2.4% & ±0.7 V	-150	150	V	±1.4% & ±0.45 V
VPTL_TID_DRAW_BREAK_ DIALTONE	Self Test	Notes 6, 8, 20	-40	0	dBm	±0.5 dB	-40	0	dBm	±0.5 dB
			300	800	Hz	±2 Hz	300	800	Hz	±2 Hz
	Inward test	Notes 6, 8	-20	0	dBm	±1.0 dB	-20	0	dBm	±1.0 dB
			300	800	Hz	±2 Hz	300	800	Hz	±2 Hz
VPTL_TID_TRANS_HYBRID_ LOSS		Notes 7, 8, 19	-40	0	dBm	±1.0 dB	-40	0	dBm	±1.0 dB
			300	3400	Hz	±0.25%	300	3400	Hz	±0.25%

Notes:

1. The total voltage range is ±1000 V for the sum of AC and DC signals and may be further limited by the protection devices.

2. Using the two-step method with offset cancellation

3. Absolute and relative tolerances are additive.

4. The achievable current will be limited by the driver output voltage as a function of the load under test.

5. Accuracies only apply to a real resistor or to a real capacitor of the exact value of the test load. Resistance and Capacitance measurement accuracies are given for a single element present. The presence of an impedance in any of the other two branches may cause >50 times this impedance to appear in the branch under test and will degrade the observed accuracy. This is also true for the branches that are open. When performing the 3 element measurement the test will measure all 3 branches, whether the branches are open or not.

6. Accuracies are given for FFT sizes of 1024 or more.

7. Accuracies are given for filter integration time of 100 ms or more.

8. Accuracies are given for testing in the absence of interference from a foreign AC or DC voltage.

9. The total current range is ±80 mA for the sum of the AC and DC signals.

10. The specified tolerance for RSVA and RSVB is ±0.5% with a temperature coefficient of resistance of 100 ppm/°C. Stated performance is only validated and guaranteed for the 0.5%, 100 ppm/°C resistor. If a looser tolerance resistor is used, DC voltage and AC voltage measurement accuracies need to be relaxed. For instance, if a resistor with a ±1% tolerance and a 200 ppm/°C temperature coefficient of resistance is used, then widen the accuracies as follows. For No Calibration tests, widen the listed VPTL_TID_OPEN_DC_VOLTAGE and VPTL_TID_OPEN_AC_VOLTAGE accuracies by 0.2%. For Factory Calibration and In-Service Calibration tests, widen the listed VPTL_TID_OPEN_DC_VOLTAGE and VPTL_TID_OPEN_AC_VOLTAGE accuracies by 0.25%. If non-standard configurations are used, customer must do due diligence with regards to validation.

11. Additional notes with regards to stated accuracies: Accuracies are set at 99% of the estimated distribution including all BOM component tolerances as documented in the NGCC Hardware Design Guide, Doc ID 126583. Tolerance for any overcurrent protection PTC component is ±10%. Calibration circuit has tolerances and temperature coefficients as specified in the Calibration Circuit Parts List. Temperature at Factory Calibration time is 20°C ±10°C. The temperature changes by no more than 20°C between executing the SLAC internal calibration function, executing In-Service Calibration (if applicable), applying the Factory or In-Service calibration factors (if applicable), and running the test.

12. Accuracy of VPTL_TID_INWRD_CUR is set by this test.

13. Accuracy of DC voltage level when using VPTL_TID_MONITOR_IV is set by VPTL_TID_OPEN_DC_VOLTAGE.

14. Accuracy of AC voltage level when using VPTL_TID_MONITOR_IV is set by VPTL_TID_OPEN_AC_VOLTAGE.

15. Accuracy of AC current level when using VPTL_TID_MONITOR_IV is set by VPTL_TID_FOREIGN_AC_CURRENT.

16. AC amplitude accuracy:

$$\text{Maximum percentage increase} = 100\% * \left(\sqrt{ \frac{1 + \left(\frac{\text{freq}}{3617} \right)^2}{1 + \left(\frac{\text{freq}}{5741} \right)^2} } - 1 \right)$$

$$\text{Maximum percentage decrease} = 100\% * \left(\sqrt{ \frac{1 + \left(\frac{\text{freq}}{3617} \right)^2}{1 + \left(\frac{\text{freq}}{2529} \right)^2} } - 1 \right)$$

17. Level is limited by the selection of power supply rails.

18. Accuracy figures are given for a measurement of wideband noise applied to the Tip and Ring port and measured with any of the optional noise filters. The accuracy figure relates the rms noise result produced by the line test with the rms noise result produced by a reference instrument using the same filter selection and the same input impedance.

19. The accuracy figures provide the tolerances to be applied to the sum of the nominal transmit path and receive path frequency response computed by WinSLAC for the AC profile and the load impedance used during the test.

20. The accuracy figures provide the tolerances to be applied to the nominal transmit path frequency response computed by WinSLAC for the AC profile and the signal source impedance used during the test.

21. The accuracy figures provide the tolerances to be applied to the nominal receive path frequency response computed by WinSLAC for the AC profile and the load impedance used during the test.

22. The maximum peak-to-peak signal amplitude is reduced as the frequency increases because the maximum rate of change must be limited to 250 V/ms on the Tip and Ring port when using 220 nF C_{DCA} and C_{DCB} capacitors. This is equivalent to a 11.7 Vpeak sinewave at 3400 Hz.

Calibration Circuit

The calibration circuit used for In-Service Calibration is shown in Figure 5. The circuit provides a precision reference voltage and precision reference loads. The Test-In Bus leads are wired to the Calibration Bus leads of Configuration D shown in Figure 3. The relays are controlled by the host controller.

The bill of materials for the calibration circuit is listed in Table 14.

Figure 5.   Calibration Circuit

CALIBRATION CIRCUIT

TEST BUS RELAYS
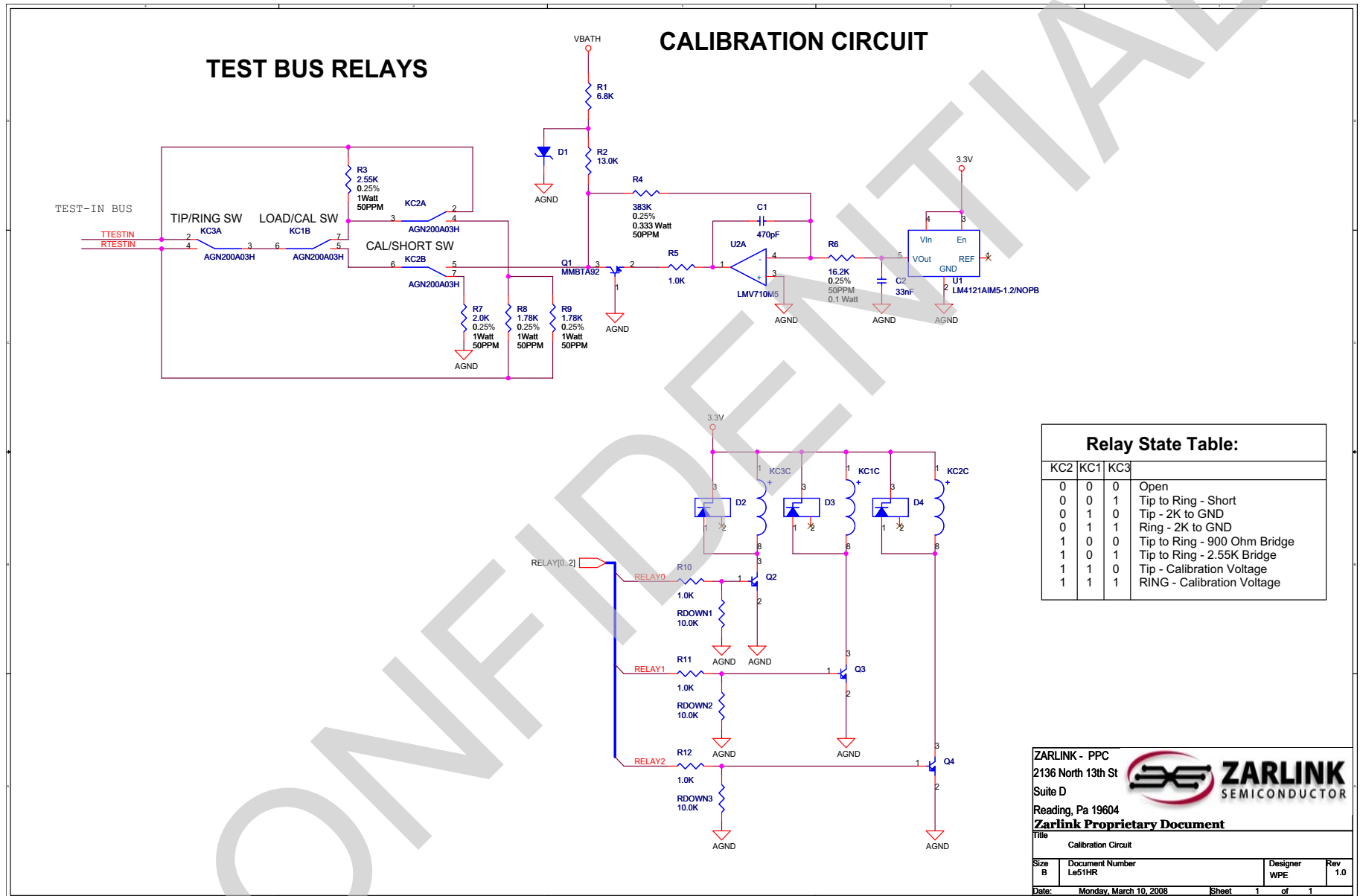
Relay State Table:			
KC2	KC1	KC3	
0	0	0	Open
0	0	1	Tip to Ring - Short
0	1	0	Tip - 2K to GND
0	1	1	Ring - 2K to GND
1	0	0	Tip to Ring - 900 Ohm Bridge
1	0	1	Tip to Ring - 2.55K Bridge
1	1	0	Tip - Calibration Voltage
1	1	1	RING - Calibration Voltage

Table 14.   Calibration Circuit Parts List

Item	Type	Part Number	Manufacturer	Value	Required Tolerance	Rating	T.C.R.
U1	Voltage Reference	LM4121AIM5-1.2	National Semiconductor		±0.2%		50 ppm
U2A	Op Amp	LMV710M5	National Semiconductor			Max offset ±3 mV	
Q1	Transistor	MMBTA92	Diodes Inc.	500 mA		300 V	
Q2, Q3, Q4	NPN Transistor	MMBT3904T	Diodes Inc.	200 mA		40 V	
R1	Resistor	ERJ-1TYJ682U	Panasonic	6.8 kΩ	±5%	1 W	
R2	Resistor	ERJ-6ENF1302V	Panasonic	13 kΩ	±1%	1/10 W	
R3	Resistor	PTN2512H2551BS	Vishay	2.55 kΩ	±0.25%	1 W	50 ppm
R4	Resistor	TNPW1206383KBHTYEA	Vishay	383 kΩ	±0.25%	1/3 W	50 ppm
R5, R10, R11, R12	Resistor	ERJ-2RKF1001X	Panasonic	1.0 kΩ	±10%	1/16 W	
R6	Resistor	TNPW060316K2BHENEA	Vishay	16.2 kΩ	±0.25%		50 ppm
R7	Resistor	PTN2512H2001BS	Vishay	2.0 kΩ	±0.25%	1 W	50 ppm
R8, R9	Resistor	PTN2512H1781BS	Vishay	1.78 kΩ	±0.25%	1 W	50 ppm
C1	Capacitor	C0402C471K5RACTU	Kemet	470 pF	±10%	50 V	
C2	Capacitor	C0402C103K4RACTU	Kemet	33 nF	±10%	50 V	
D1	Zener Diode	1SMA5941	Taiwan Semiconductor	47 V		1.5 W	
D2, D3, D4	Diode	BAS116T	Diodes Inc.			85 V	
KC1C, KC2C, KC3C	DPDT Relay	AGN200A03	Aromat			3 V	

Note:

Listed part numbers may have a tighter tolerance then required.

Termination and Signature Network Diagrams

Figure 6.   M-Socket Termination
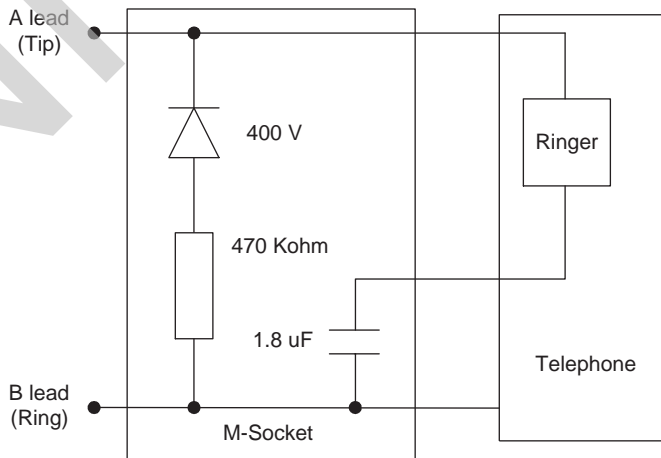
Figure 7.   PPA Termination

b lead
(Tip)

Diode
U = 0.7 V

R_{PT} = 470 Kohm

a lead
(Ring)
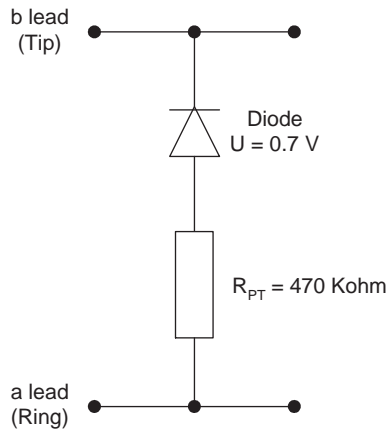
Figure 8.   IAD Signature Networks

B lead
(Ring)

C_{SIG} C_{SIG} = 0.47 uF

U = 6.8 V

Z

U = 6.8 V

R R_{SIG} = 33 Kohm

A lead
(Tip)

B lead
(Ring)

C_{SIG} C_{SIG} = 0.47 uF

U = 6.2 V

Z

U = 6.2 V

R R_{SIG} = 110 Kohm

A lead
(Tip)
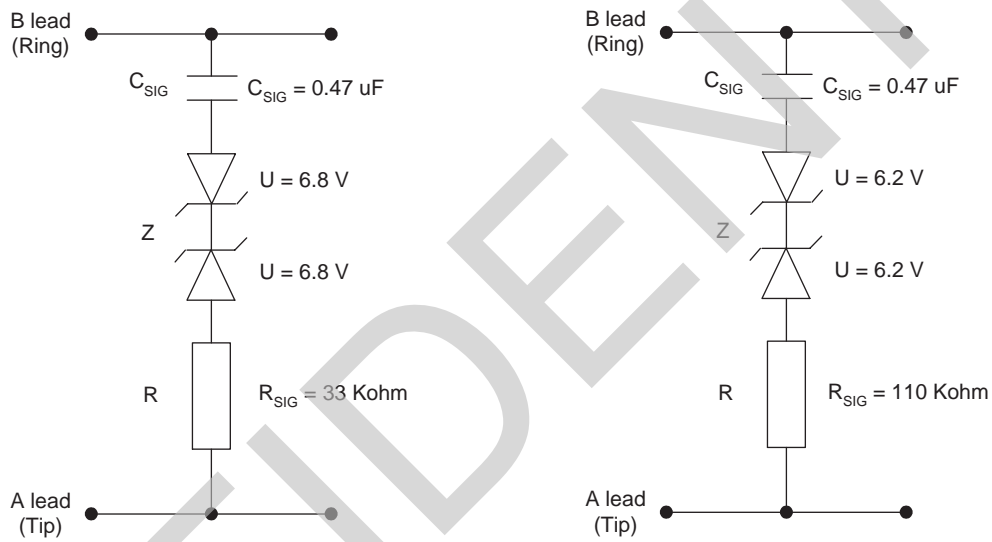
Figure 9.   CPE Splitter Signature Network

B lead
(Ring)

C_{SIG} C_{SIG} = 0.47 uF

U = 6.8 V

Z

U = 6.8 V

R R_{SIG} = 33 Kohm

A lead
(Tip)   TI.413
G.992.1
TR 101 728
ATIS-0600016.2008
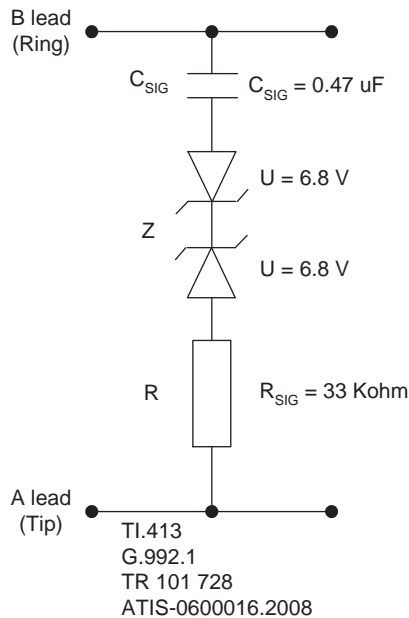
Figure 10.   CO Splitter Signature Networks

A lead (Tip) — D: Diode = 0.7 V — Z: U = 36 V — R: R_{SIG} = 110 Kohm — B lead (Ring) — G.992.1 TR 101 728

A lead (Tip) — D: Diode = 0.7 V — Z: U = 36 V — R: R_{SIG} = 33 Kohm — B lead (Ring) — T1.413 G.992.1 cor 1 G.992.3 TRQ10-2003

A lead (Tip) — D: Diode = 0.7 V — Z: U = 24 V — R: R_{SIG} = 107 Kohm — B lead (Ring) — TR 101 728
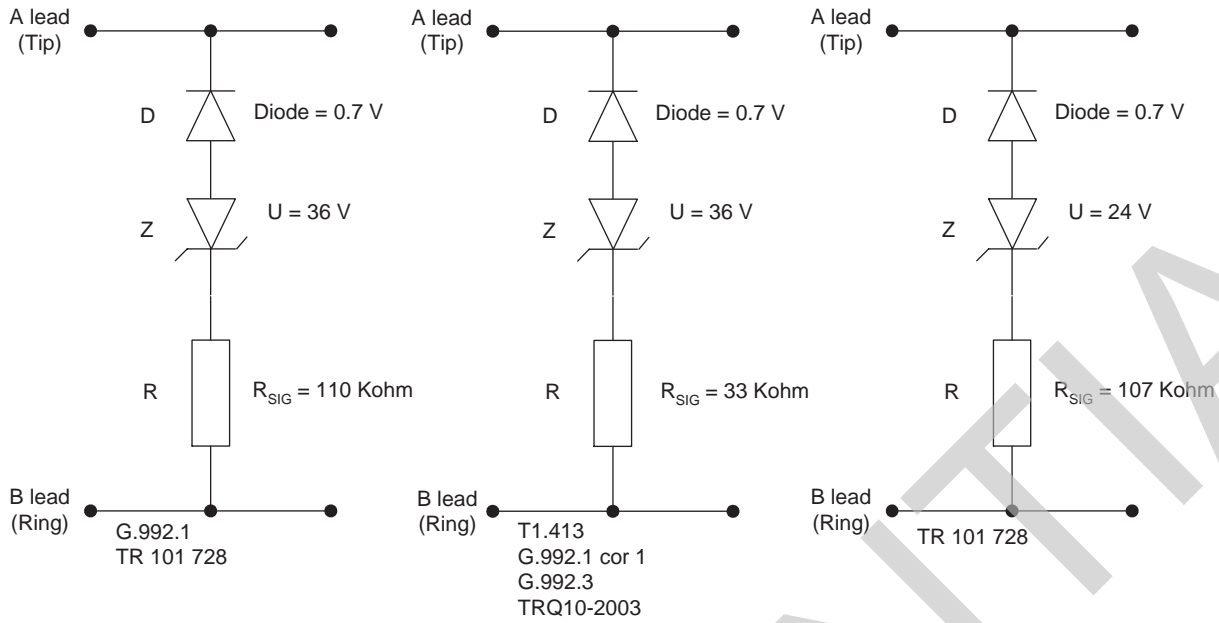
Figure 11.   ETSI CPE Signature Network

A lead (Tip) — D: Diode = 0.7 V — Z: U = 24 V — R: R_{SIG} = 130 Kohm or 215 Kohm or 467 Kohm — B lead (Ring) — TR 101 728
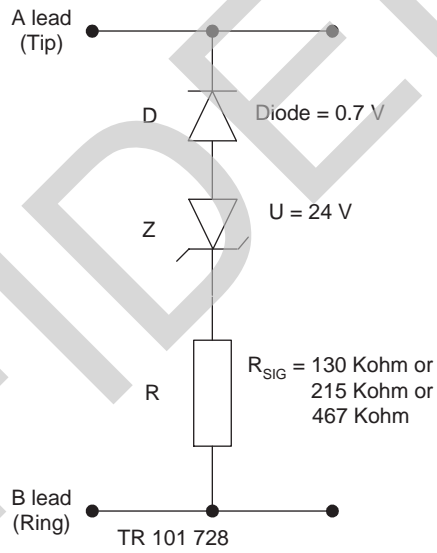
MEMORY REQUIREMENTS

For optimum results, Microsemi recommends the following host platform minimum memory requirements shown in the table below.

Note: Memory requirements are subject to change with every software release.

Table 15.   Approximate Memory Requirements per VCP device

Parameters	Per VCP Device (Bytes)
API Code size	141000
Memory in application space per device	1148
Memory in application space per line	64
PROFILES in application space (one each)	
Device	40
AC	120
DC	41
Ringing	31
Tone	29
Caller ID type 1 (simple)	40
Standard On/Off Ringing Cadence	18
Standard On/Off tone cadence	14
Metering	10
Testing	
Line Testing - Library code size	340000 (ATP), 112000 (BT)
Data size for calibration coefficients per line	84
Data size for test topology per line	84
Data size for test input per line	56
Data size for test result per line	180
Data size test temp buffer per line	2400
Data size for text content per line	52

Note:

The memory size was measured using the Microsemi development platform. Values may vary depending on the compiler used. The compiler used has the following size for the ansi C standard data types:

float = 4 bytes

int = 4 bytes

char = 1 byte

bool = 1 byte

And the API defined variable types:

int16; uint16 = 2 bytes

int32; uint32 = 4 bytes

int8; uint8, uchar = 1 byte

REVISION HISTORY

Revision B1 to C1

- Added the following tests:
  - VPTL_TID_UNBAL_TONE
  - VPTL_TID_INWRD_CUR
  - VPTL_TID_REN_PHASE
  - VPTL_TID_MULTI_TEST
- Added accuracies for VPTL_TID_MONITOR_IV and VPTL_TID_AC_TRANS tests.
- Changed VPTL_TID_DC_LOOP_RES range from 0 to 8 kΩ to 0 to 4 kΩ.
- Minor corrections and supported test updates.

Revision C1 to D1

- Page 1, modified Related Literature.
- Page 18 and 22, DTMF dial pulse test, changed "Make to Break Ratio" to "Break Interval".
- Page 27, added Test Timing Analysis section.
- Page 29, added Memory Requirements section.
- Minor text edits.

Revision D1 to E1

- Page 12, added VPTL_TID_6ELE_RES and VPTL_TID_SUSCEPTANCE_TEST.
- Page 19 and 23, added notes 20-24. Also changed VPTL_TID_TONE_GEN and VPTL_TID_TRANS_HYBRID_LOSS minimum frequency from 100 Hz to 300 Hz. VPTL_TID_TRANS_HYBRID_LOSS maximum frequency from 3800 Hz to 3400 Hz. And VPTL_TID_UNBAL_TONE maximum frequency output from 3400 Hz to 1200 Hz.

Revision E1 to Version 6

- Pages 11 - 14, changed Algorithm Names, descriptions, and ordering to be consistent with Test Library User's Guide.
- Page 12, Added PPA to M-socket description, added CO Splitter Signature Detection, added CPE Splitter and IAD Signature Detection, added ISDN Terminal Detection Test, and added Ringer Equivalency Number with Phase.
- Page 13, Added DTMF and Pulse Digit Measurement Test.
- Pages 17 and 21, Updated VPTL_TID_3ELE_RES, VPTL_TID_4ELE_RES accuracies. Added accuracy for the 1 to 1000 Ω range.
- Pages 18 and 22, Updated VPTL_TID_3ELE_CAP accuracies. Added accuracy for the 10 to 100 µF range.
- Page 19 and 23, Changed Inward Draw and Break Dialtone test range from 0 to -25 dBm to 0 to -20 dBm.
- Page 24, Enhanced note 11 description.
- Pages 27-28, Table 12, Test Timing Analysis, test times made TBD.
- Pages 29-30, Added Termination and Signature Network Diagrams.

Version 6 to 7

- Changed VoicePath Software to LineCare Software.
- Added TestHead package.
- Page 7, example host code removed.
- Page 10, added statement of PCM bus use in testing in Time Slot Requirements section.
- Removed Test Timing Analysis.
- Page 29, Figure 27, added signature network.
- Page 30, Added Figure 10.
- Page 31, Table 12, Updated memory requirements.
- Minor text edits.

Version 7 to 8

- Switched from Zarlink Semiconductor to Microsemi Corporation branding.
- Added Configuration E.
- Page 14, removed Very Low Resistance Measurement Test.
- Page 16, 17, added Foreign AC Voltage with Frequency Measurement Test, Extended Master Socket Test and Continuous

Tone Generation Test to ATP NGVCP Package.

- Page 17, added Electronic Ringer Detection and Extended Group Test.
- Page 20, modified VPTL_TID_OPEN_DC_VOLTAGE, VPTL_TID_OPEN_AC_VOLTAGE, VPTL_TID_MONITOR_IV, VPTL_TID_DC_LOOP_RES, and VPTL_TID_REN accuracies.
- Page 21, modified VPTL_TID_3ELE_RES and VPTL_TID_4ELE_RES accuracies.
- Page 22, modified VPTL_TID_3ELE_CAP and VPTL_TID_FOREIGN_AC_CURRENT accuracies.
- Page 23, modified VPTL_TID_UNBAL_TONE accuracies.
- Page 24, modified VPTL_TID_OPEN_DC_VOLTAGE, VPTL_TID_OPEN_AC_VOLTAGE, VPTL_TID_MONITOR_IV, and VPTL_TID_DC_LOOP_RES accuracies.
- Page 25, modified VPTL_TID_3ELE_RES and VPTL_TID_4ELE_RES accuracies.
- Page 26, modified VPTL_TID_3ELE_CAP and VPTL_TID_FOREIGN_AC_CURRENT accuracies.
- Page 27, modified VPTL_TID_UNBAL_TONE accuracies.
- Page 32, Note 11, changed "Accuracies are set at 95% of the estimated distribution" to "Accuracies are set at 99% of the estimated distribution" and added "Tolerance for any overcurrent protection PTC components is ±10%".
- Page 38, Table 12, updated Memory Requirements.
- Minor text and drawing edits.

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