



Voice Channel Testing Using Kozio Diagnostic Software Tools

Overview

Kozio delivers pre-built test commands and suites providing focus and flow validation of FXS and FXO ports. Test commands are also provided to validate voice ports, by validating data transmitted between FXS and FXO ports.

The extensive Kozio diagnostic test library supports testing of the following items on relevant custom board designs:

- FXS port tests
- FXO port tests
- Voice port tests

This document provides examples, steps, and figures, using an ADI Engineering Coyote IXP425 Gateway platform and a Texas Instruments TNETV1060 development platform. The Coyote is based on the Intel[®] IXP425 processor, and the FXS ports are based on the Silicon Labs Si3210 chipset. The TNETV1060 is based on a MIPS 4Ke processor, TI DSP, and the Silicon Labs Si3210 and Si3050 chipsets.

The Kozio interactive diagnostics software, kDiagnostics, executes directly on the target platform and does not require a boot loader or operating system. In this manner, direct testing of the voice hardware can be performed before the boot loader and operating system drivers are ready or tested. The Kozio software is loaded into flash memory at the starting boot address and has been used to validate a single voice port in ten (10) seconds, greatly reducing the setup and touch-time of producing testing.

Kozio software provides complete configuration of the hardware system, for example, complete configuration of the PCM bus, including clock frequency, frame sync frequency, frame size, etc. Kozio software uses the Telephony Interface to generate a PCM clock of 2.048 MHz, and a frame clock of 8000 Hz on the Coyote platform. The TNETV1060 supports generation of the PCM clocking from the McBSP interface.

FXS Port Testing

The Foreign eXchange Subscriber (FXS) ports are also referred to as Subscriber Line Interface Circuit (SLIC) by the Silicon Laboratories documentation. The FXS ports design is centered on the Silicon Labs Si3210 SLIC, and uses discrete components for the line-side circuitry. There are two primary software interfaces used for communicating with the FXS ports; namely, the serial peripheral interconnect (SPI) bus is used to access control registers for configuring and calibration of the FXS ports, and the PCM bus used for transmission and reception of 8-bit voice data. The Si3210 is configured to convert the raw 16-bit data from the analog to digital converter (ADC) to 8-bit data using

the μ -Law companding algorithm. In the figure below (taken from the Si3210 datasheet), the line interface is shown on the left, while the PCM data interface is on the right.

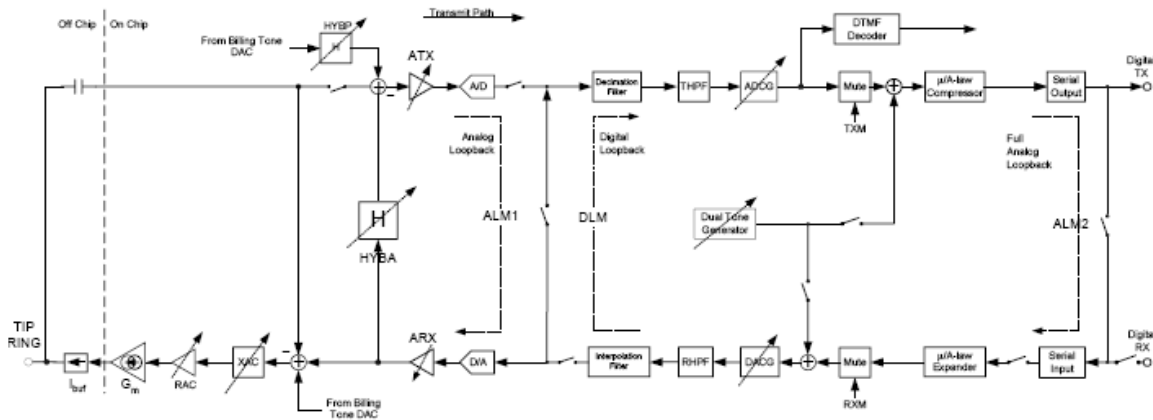


Figure 1 Si3210 Signal Path

FXS Port Tests

Kozio diagnostic software provides the following tests for validation of FXS ports.

Test	Description	User Interaction
Basic SPI Communication	Validates that register reads and writes across the SPI bus are functional.	This test is fully automatic and requires no user interaction.
FXS Calibration	This test configures the FXS port for operation and includes calibration of the DC-DC converter.	This test is fully automatic and requires no user interaction.
DTMF Loopback	This test validates the PCM bus connection in the transmit direction and validates the DTMF detection circuitry of the Si3210. This test configures the FXS port for digital loopback mode (indicated as DLM in Figure 1) and transmits prerecorded touch tones across the PCM bus. The Si3210 loops the data back to the receive path where the DTMF decoder resides and generates an interrupt for each DTMF tone detected.	This test is fully automatic and requires no user interaction. The test passes if all DTMF tones generated are properly detected by the Si3210.
DTMF Input	This test requires the connection of a standard phone to the FXS port. This test validates the receive path internal to the Si3210 from the line up to the DTMF decoder.	The user is prompted to force the connected phone off-hook, pick up the receiver, and to dial all keys on the keypad. Once all keys have been pressed the test passes. If the correct keys are not received after 5 seconds, the test fails.
1 kHz Tone Generation	This test transmits from the DSP to the line, the 1 kHz "digital milliwatt" signal. For a working FXS port, this generates a perfect 1 kHz sinusoid on the line, and one milliwatt (mW) of power.	To run the test, the user connects a standard phone to the FXS port and picks up the receiver. While the test is running, the 1 kHz tone can be heard in the receiver. In addition, connecting an oscilloscope to the line, while the phone is off-hook, can be used to validate the frequency and amplitude of the signal generated.
Prerecorded Playback	This test transmits from the DSP to the line a	The user must use a standard phone to listen



Full Feature	<p>prerecorded message that is approximately 3 seconds in length. The text of the message is “Kozio voice buffer playback test”.</p> <p>This test validates all the major features of the FXS port.</p>	<p>to and validate the test.</p> <p>The user connects a phone to the FXS port and starts the test. The user picks up the receiver, verifies that a dial-tone is heard, and then presses all keys on the keypad. Upon detection of all keys, the test plays a busy tone. The user is then prompted to record a short voice message which is then played back to the user.</p> <p>Interactive debugging.</p>
Analog Loopback 1 Enable	<p>This command is meant as a debugging aid for test failures or noise issues and enables analog loopback mode 1 (indicated as ALM1 in Figure 1). This loopback option allows the testing of the analog signal processing of the Si3210 completely independent from any activity in the DSP.</p>	<p>Interactive debugging.</p>
Analog Loopback 2 Enable	<p>This command is meant as a debugging aid for test failures or noise issues and enables analog loopback mode 2 (indicated as ALM2 in Figure 1). This loopback option tests almost all the circuitry of the transmit and receive paths internal to the Si3210.</p>	<p>Interactive debugging.</p>
Digital Loopback Enable	<p>This command is meant as a debugging aid for test failures or noise issues and enables digital loopback mode (indicated as DLM in Figure 1). This is the same loopback option employed by the DTMF loopback test.</p>	<p>Interactive debugging.</p>

FXS Test Commands

All tests are available from the “Voice Test Menu” or directly from the command line with the commands shown below. In all cases “[N]” represents the specific FXS port to test. For example, the commands `test. sl i c0. spi` and `test. sl i c1. spi` test the SPI communication to FXS ports 0 and 1, respectively.

<i>Test</i>	<i>Command</i>
Basic SPI Communication	<code>test. sl i c[N]. spi</code>
FXS Calibration	<code>test. sl i c[N]. enabl e</code>
DTMF Loopback	<code>test. voi ce[N]. l oopback</code>
DTMF Input	<code>test. voi ce[N]. dtmf. i nput</code>
1 kHz Tone Generation	<code>voi ce[N]. 1k</code>
Prerecorded Playback	<code>voi ce[N]. pl ay</code>
Full Feature	<code>test. voi ce[N]. veri fy</code>
Analog Loopback 1 Enable	<code>sl i c[N]. l oopback. anal og1</code>
Analog Loopback 2 Enable	<code>sl i c[N]. l oopback. anal og2</code>
Digital Loopback Enable	<code>sl i c[N]. l oopback. di gi ti al</code>
Disable All Loopback Modes	<code>sl i c[N]. l oopback. di sabl e</code>

FXO Port Testing

The FXO ports (Foreign eXchange Office) are also referred to as Direct Access Arrangement (DAA) by the Silicon Laboratories documentation. The FXO ports design is centered on the Silicon Labs Si3050 DAA with the Si3050 line side driver. Like the FXS ports, there are two primary software interfaces used for communicating with the FXO ports; namely, the serial peripheral interconnect (SPI) bus used to access control registers for configuring and calibrating the FXO ports, and the PCM bus used for transmission and reception of 8-bit voice data. The Si3050 is configured to convert the raw 16-bit data from the analog to digital converter (ADC) to 8-bit data using the μ -Law companding algorithm. In the figure below (taken from the Si3050 datasheet), the line interface is shown in the upper right (CO designator), while the PCM data interface is on the lower left (indicated by DTX and DRX).

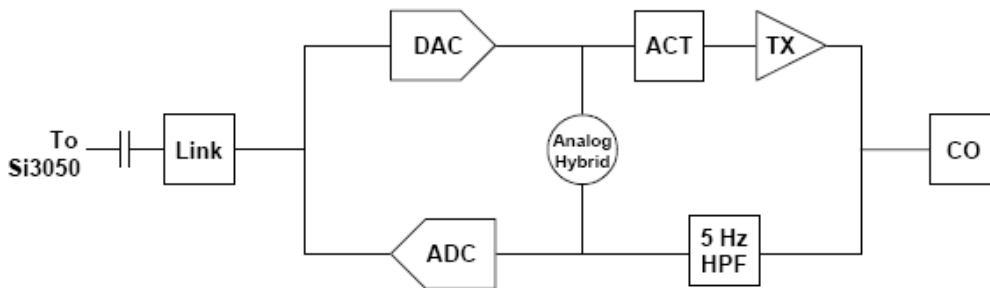


Figure 25. Si3018/19 Signal Flow Diagram

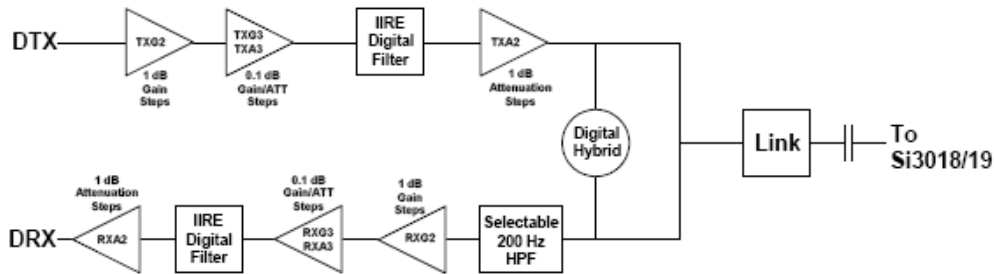


Figure 2 Si3050 Signal Path

FXO Port Tests

Kozio diagnostic software provides the following tests for validation of FXO ports.

<i>Test</i>	<i>Description</i>	<i>User Interaction</i>
FXO Calibration and Enable	Validates communication over the SPI bus and configures and calibrates the FXO port for operation. As a final step, the FXO port is forced off-hook.	This test is fully automatic and requires no user interaction.
1 kHz Tone Generation	This test transmits from the DSP to the line, the 1 kHz “digital milliwatt” signal. For a working FXO port, this generates a perfect 1 kHz sinusoid on the line, and one milliwatt (mW) of power.	To run the test, the user connects the FXO port to an FXS port or device. While the test is running, the 1 kHz tone can be validated by connecting an oscilloscope to the line.
Prerecorded Playback	This test transmits from the DSP to the line a	The user must use a standard phone to listen



	prerecorded message that is approximately 3 seconds in length. The text of the message is “Kozio voice buffer playback test”.	to and validate the test.
Force Off-hook	This command forces the FXO port off-hook and connects to the line.	Interactive testing.
Force On-hook	This command forces the FXO port on-hook and disconnects from the line.	Interactive testing.
Enable Analog Loopback	This command enables “PCM analog” loopback as documented in the Si3050 datasheet. The analog signal received from the line is converted to digital, passed through receiver filter and looped back to the transmit path at the PCM interface. This command can be used to help diagnose any test failures or problems with signal quality.	Interactive debugging.

FXO Test Commands

All tests are available from the “Voice Test Menu” or directly from the command line with the commands shown below. In all cases “[N]” represents the specific FXO port to test. For example, the commands `test. daa0. enable` and `test. daa1. enable` test the calibration of the FXO ports 0 and 1, respectively.

<i>Test</i>	<i>Command</i>
FXO Calibration and Enable	<code>test. daa[N]. enable</code>
1 kHz Tone Generation	<code>daa[N]. 1k</code>
Prerecorded Playback	<code>daa[N]. play</code>
Force Off-hook	<code>daa[N]. off-hook</code>
Force On-hook	<code>daa[n]. on-hook</code>
Enable Analog Loopback	<code>daa[n]. loopback. analog</code>
Disable All Loopback Modes	<code>daa[n]. loopback. disable</code>



Other Voice Tests

In addition to the FXS and FXO port tests detailed in the previous sections, there are two additional commands that can be used to validate voice ports.

```
<src_port> <dst_port> voi ce. forward. start  
<src_port> voi ce. forward. stop
```

The “voi ce. forward. start” command copies real-time data received on an FXS or FXO port to a different FXS or FXO port. Ports 0 and 1 are FXS ports, ports 2 and 3 are FXO ports. The command “voi ce. forward. stop” cancels the real-time copy of voice data.

These commands are most useful for validating the voice data transmitted or received by an FXO port.

For example, to test transmission of FXO port 0, FXO port 0 is connected to FXS port 0. FXS port 1 is then connected to a phone. To validate voice transmission (DSP to line) from FXO port 0, the user executes this command:

```
0 1 voi ce. forward. start
```

The user then begins the 1 kHz tone test or the voice playback test to FXO port 0 with these commands:

```
daa0. 1k  
daa0. pl ay
```

The user validates the test by listening to the receiver.

In a similar fashion, to test reception by FXO port 0, connect FXO port 0 to FXS port 0 and run these commands:

```
2 1 voi ce. forward. start  
voi ce0. 1k  
voi ce0. pl ay
```



Summary

Kozio's advanced diagnostic software, voice port test commands, script interface, and pre-built test suites provide a streamlined mechanism to test voice ports contained on custom processor-based platforms. The commands and features described in this application note are available as a feature of the kDiagnostics™, kManufacturing™, kField™, and kPOST™ products.

Using Kozio commands, one can automatically test FXS or FXO ports. Commands are provided for automatic testing, interactive testing, and debugging of voice ports.

Using embedded software, running on the target platform at full processor speed, provides the best mechanism for validating voice ports. Using software provided by Kozio allows you to test and characterize a custom system with no reliance on the availability or correctness of final application software. Kozio software products deliver turnkey solutions at a fraction of the cost it would take to develop them internally.

Contacts for Additional Information

Kozio, Inc.
2400 Trade Centre Ave
Longmont, CO 80503
+1 (303) 776-1356 x1
sales@kozio.com
www.kozio.com

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About Kozio, Inc.

Kozio, Inc. is the leader in embedded test solutions for today's electronic products. Kozio delivers turnkey software providing a comprehensive suite of hardware diagnostics used for debugging and testing custom boards implementing processors from AMCC, ARM, IBM, Intel, Freescale, TI or MIPS. Kozio's clients build state-of-the-art products where successful use of the newest technologies with shortened development cycles requires them to constantly innovate to stay ahead of their competition. Kozio software improves their test methodologies and streamlines their development process with proven solutions for board bring-up diagnostics, manufacturing test, environmental test, power-on self-test, in-field diagnostics, and returns testing. By delivering thorough software diagnostics ahead of the hardware, Kozio reduces project schedule risk and development costs while increasing test coverage. Headquartered in Longmont, Colorado, Kozio products are available through a direct sales force and worldwide distributors. For more information, please visit www.kozio.com.