Operation of the HC5503C, HC5503T Family of SLICs Evaluation Board (HC5503XEVAL1)

Application Note | November 1998 | AN9813.1

Features

- One Evaluation Board for Performance Testing of the HC5503C, HC5503J and HC5503T Family of SLICs
- Includes On-Board Op Amp and Cross Point Switch for Evaluation of “Junctor” Applications
- Monitoring of Switch Hook Detect (SHD) via On Board LED
- Automatic On/Off Controller for Cross Point Switch Connection

Functional Description

Evaluation Board

To facilitate testing of all 3 parts on one evaluation board, the board is equipped with one Double Pole Double Throw (DPDT) toggle switch S_1. The DPDT switch determines the connection of the SLIC’s Transmit (TX) and Receive (RX) outputs. The outputs are either connected to banana jacks TX or RX for full evaluation of the voice and DC feeding characteristics (reference Figure 4) or the Onboard Op Amp and Cross Point Switch for evaluation of the end-to-end application (reference Figure 6).

The HC5503C/J/T evaluation board is configured to match a 600Ω line impedance via the tip and ring feed resistors R_{B1}, R_{B2}, R_{B3} and R_{B4}. Provided with the evaluation board are two generic HC5503X samples.

HC5503C

The HC5503C is a low cost Subscriber Line Interface Circuit (SLIC), that replaces the components of an **unbalanced** discrete Analog circuit design.

HC5503J

The HC5503J is a low cost Subscriber Line Interface Circuit (SLIC), that replaces discrete or thick film hybrid “Junctor” unbalanced design solutions [1].

HC5503T

The HC5503T is a low cost Subscriber Line Interface Circuit (SLIC), that replaces the components of a discrete Transformer Analog circuit design.

Power Requirements for the HC5503C/J/T

Power Supply Connections

The HC5503C/J/T Evaluation Board requires three external power supplies. The SLIC is powered by two supplies V_{BAT} = -48V (Typ) and V_{CC} = +5V. The third supply (V_{EE} = -5V) powers the external Op Amps and Cross Point Switch for the Junctor application.

Ground Connections

The HC5503C/J/T evaluation board has tied the analog, digital and battery grounds to a common ground plane designated GND. It is recommended that the analog, digital and battery grounds of the SLIC be tied together as close to the device pins as possible. The three external power supplies should each be grounded to the evaluation board.

Getting Started

Verify that the sample is oriented in its socket correctly. Correct orientation is with pin 1 pointing towards the onboard pin 1 designator located in the upper left hand corner of the sockets. (Reference the data sheet for location of device pin 1.)

Verifying Basic SLIC Operation

The operation of the sample parts can be verified by performing 4 tests:

1. Power Supply Current Verification.
2. Normal Loop Feed Verification.
3. Tip and Ring Voltage Verification.
4. Gain Verification (4-wire to 2-wire).

The above 4 tests require the following equipment: a 600Ω load, a sine wave generator, an AC volt meter and two external supplies (V_{BAT}, V_{CC}).

Application Tip: When terminating tip and ring, it is handy to assemble terminators using a Pomona MDP dual banana plug connector as the terminating resistor receptacle. Refer to Figure 1 for details.

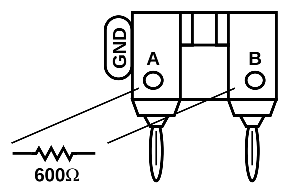

FIGURE 1. TERMINATION ADAPTER

Using the termination shown in Figure 1 provides an unobtrusive technique for terminating tip and ring while still providing access to both signals using the banana jack feature of the MDP connector. Posts are also available that fit into holes A and B, providing a solderable connection for the terminating resistor.

Test #1 Power Supply Current Verification

A quick check of evaluation board and the sample is to measure the supply currents. The readings should be similar to the values listed in Table 1. The measurements can be made using a series ammeter on each supply, or power supplies with current displays.

Discussion

The currents measured include those of the SLIC and supporting circuitry (i.e., 2nd HC5503X SLIC, Op Amp, Channel A's LED, the Cross Point Switch and Transistors Q_1 and Q_2). For SLIC supply currents consult the applicable data sheet.

Setup

1. Connect the power supplies to the Evaluation board.
2. Set V_{BAT} to -48V, V_{CC} to +5V and Ground the V_{EE} pin (V_{EE} supply not required for this test).
3. Set the DPDT switch (S1) to standard operation. This connects the Transmit and Receive outputs to banana jacks TX and RX.
4. Terminate tip and ring Channel A with a 600Ω load (Channel B is disconnected during standard operation).
5. Measure the supply currents and compare to those in Table 1.

TABLE 1.

HC5503C, HC5503J, HC5503T		
SUPPLY	**RL (Ω)**	**TYP (mA)**
V_{CC} = +5V	600	10.9
V_{BAT} = -48V	600	33.5

Test #2 Normal Loop Feed Verification

This test verifies loop current operation and loop current detection via the onboard LED.

Discussion

When power is applied to the SLIC a loop current will flow from tip to ring through the 600Ω load. Loop current detection occurs when this loop current triggers an internal detector that pulls the output of $\overline{SHD}$ low, illuminating the LED through the +5V supply.

Setup

1. Connect the power supplies to the Evaluation board.
2. Set V_{BAT} to -48V, V_{CC} to +5V and Ground the V_{EE} pin (V_{EE} supply not required for this test).
3. Set the DPDT switch (S1) to standard operation. This connects the Transmit and Receive outputs to banana jacks TX and RX.
4. Terminate tip and ring Channel A with a 600Ω load (Channel B is disconnected during standard operation).

Verification:

1. The $\overline{SHD}$ LED is on when tip and ring are terminated with 600Ω.
2. The $\overline{SHD}$ LED is off when tip and ring are an open circuit.

Test #3 Tip and Ring Voltage Verification

This test verifies the tip and ring voltages.

Setup

1. Connect the power supplies to the Evaluation board.
2. Set V_{BAT} to -48V, V_{CC} to +5V and Ground the V_{EE} pin (V_{EE} supply not required for this test).
3. Set the DPDT switch (S1) to standard operation. This connects the Transmit and Receive outputs to banana jacks TX and RX.
4. Terminate tip and ring Channel A with a 600Ω load (Channel B is disconnected during standard operation).
5. Measure tip and ring voltages with respect to ground and compare to those in Table 2.

TABLE 2.

BATTERY	TIP TYP (V)	RING TYP (V)
V_{BAT} = -48V	-12.8	-30.6

Test #4 Gain Verification (4-Wire to 2-Wire)

This test will verify the SLIC is operating properly and that the 4-wire to 2-wire gain is 1.0 or 0.0dB.

Discussion

When terminated with 600Ω load, the SLIC will exhibit unity gain from the RX input pin to across tip and ring (VTR). When an open circuit exists, a mismatch occurs and the tip to ring voltage doubles. The dB gain is calculated in Equation 1.

$$dB = 20\log\frac{V_{TR}}{V_{RX}} \qquad \text{(EQ. 1)}$$

Setup

1. Connect the power supplies to the Evaluation board.
2. Set V_{BAT} to -48V, V_{CC} to +5V and Ground the V_{EE} pin (V_{EE} supply not required for this test).
3. Set the DPDT switch (S1) to standard operation. This connects the Transmit and Receive outputs to banana jacks TX and RX.
4. Terminate tip and ring Channel A with a 600Ω load (Channel B is disconnected during standard operation).
5. Connect a sine wave generator, referenced to ground, to the RX input.
6. Set the generator for $1V_{RMS}$ at 1kHz.
7. Connect an AC voltmeter across tip and ring.

Verification

1. Tip to ring AC voltage of $1V_{RMS}$ when terminated.
2. Tip to ring AC voltage of $2V_{RMS}$ when not terminated.

Verifying Junctor Operation

The operation of the Junctor application circuit using the 2 HC5503X samples provided can be verified by performing 4 tests:

1. Channel to Channel Transhybrid Balance.
2. Inter-Channel Transhybrid Balance.
3. Channel to Channel Gain.
4. Intra-Channel Transhybrid Balance with different loads.

The above 4 tests require the following equipment: Two 600Ω loads, a sine wave generator, an AC volt meter and three external supplies (V_{BAT}, V_{CC}, V_{EE}).

Definition of Junctor Circuit

The function of the Junctor application circuit is to convert a two port network with a Transmit Output (TX) and a Receive Input (RX) into a one-port network. The conversion to a one-port network now makes it easy to connect phone lines in a small PBX or Key System through a single Cross Point. This conversion is accomplished by the connection of a Differential Amplifier and a Summing Amplifier. The Differential Amplifier and Summing Amplifier are used to cancel the return signal and prevent echo (reference Figure 6). In this one-port network, echo can occur in two ways: Channel to Channel and Intra-Channel. Reference Figure 5 for signal path for both channel-to-channel and intra-channel signals.

Test #5 Channel to Channel Transhybrid

Definition

The removal of the receive signal from the transmit signal, to prevent an echo on the transmit side is defined as Channel to Channel Transhybrid Balance. In other words, Channel to Channel Transhybrid signals occur when the receive signal (from Channel B) is retransmitted along with the transmit signal of Channel A back to Channel B.

Channel to Channel Transhybrid Balance is performed by the Summing Amplifier (the output of this amplifier is SUM A and SUM B in Figure 6).

Setup

1. Connect the power supplies to the Evaluation board.
2. Set V_{BAT} to -48V, V_{CC} to +5V and V_{EE} to -5V.
3. Set the DPDT switch (S1) to Junctor operation. This connects the Onboard Op Amp, Cross Point Switch and the second HC5503X SLIC to the Transmit and Receive outputs of Channel A.
4. Terminate tip and ring of **both** Channel A and Channel B with a 600Ω load.
5. Connect a sine wave generator in parallel with the 600Ω load across tip and ring of Channel A. The output of this generator needs to be floating.
6. Set the generator for $1V_{RMS}$ at 1kHz.
7. Connect an AC volt meter between test point DIFF B and ground. This will measure the AC voltage at the output to the Differential Amplifier (DIFF B).
8. Connect an AC volt meter between test point SUM B and ground. This will measure the AC voltage at the output of the Summing Amplifier (SUM B).
9. The Channel to Channel Transhybrid Balance is calculated using the following formula in Equation 2.

$$dB = 20\log\frac{SUMB}{DIFFB} \quad \text{(EQ. 2)}$$

10. To measure Channel to Channel Transhybrid Balance on Channel A, connect the sine wave generator in parallel with the 600Ω load across tip and ring of Channel B and repeating steps 7 through 9 in a similar fashion. Voltage measurements taken at DIFF A and SUM A. Results for both Channels should be the same.
11. Compare results to that listed in Table 3.

Test #6 Intra-Channel Transhybrid

Definition

Intra-Channel Transhybrid Balance is defined as the removal of the transmit signal from the receive signal, and thereby cancellation of echo, within a channel. In other words, Intra-Channel Transhybrid Balance is when the transmit signal from Channel A is feed back into the input of Channel A.

Intra-Channel Transhybrid Balance is performed by the Differential Amplifier (the output of this amplifier is DIFF A and DIFF B in Figure 6).

Calculation of resistor value (R_4) for optimum Intra-Channel Transhybrid Balance is discussed in Test #8.

Setup

1. Connect the power supplies to the Evaluation board.
2. Set V_{BAT} to -48V, V_{CC} to +5V and V_{EE} to -5V.
3. Set the DPDT switch (S1) to Junctor operation. This connects the Onboard Op Amp, Cross Point Switch and the second HC5503X SLIC to the Transmit and Receive outputs of Channel A.
4. Terminate tip and ring of **both** Channel A and Channel B with a 600Ω load.
5. Connect a sine wave generator in parallel with the 600Ω load across tip and ring of Channel A. The output of this generator needs to be floating.
6. Set the generator for $1V_{RMS}$ and 1kHz.
7. Connect an AC volt meter between test point SUM A and ground. This will measure the AC voltage at the input to the Differential Amplifier (SUM A).
8. Connect an AC volt meter between test point DIFF A and ground. This will measure the AC voltage at the output of the Differential Amplifier (DIFF A).
9. The Inter-Channel Transhybrid Balance is calculated using the following formula in Equation 3.

$$dB = 20\log\frac{DIFFA}{SUMA} \quad \text{(EQ. 3)}$$

10. To measure Inter-Channel Transhybrid Balance on Channel B, connect the sine wave generator in parallel with the 600Ω load across tip and ring of Channel B and repeating steps 7 through 9 in a similar fashion. Voltage measurements taken at SUM B and DIFF B. Results for both Channels should be the same.
11. Compare results to that listed in Table 3.

TABLE 3.

TEST	SUM TYP (V_{RMS})	DIFF TYP (V_{RMS})	TRANSHYBRID BALANCE (dB)
Channel to Channel Transhybrid Balance			
Channel A to B	18.45m	1.009	-34.7
Channel B to A	20.79m	1.007	-33.7
Intra-Channel Transhybrid Balance			
Channel A	0.986	64.9m	-23.6
Channel B	0.990	67.0m	-23.4

Test #7 Channel A to Channel B Gain

This demo board is configured to have a Channel to Channel gain of 1 or 0dB. This test will illustrate a procedure for calculating the proper R_4 resistor value to achieve a Channel to Channel gain of 1 with any Cross Point or network used to connect the two line cards. Also included is an easy procedure to verify the calculations.

Discussion

Channel to Channel gain is dependent upon: the 2-wire to 4-wire and the 4-wire to 2-wire gains of the HC5503X being one, the gain setting resistors of the differential amplifier (R_4, R_5, R_{14}, and R_{15}), the resistance of the Cross Point Switch (Rx) and resistors R_6 and R_{16} (Reference Figure 5). The resistance values of R_6 and R_{16} are generally set to 604Ω for impedance matching to a transformer line card. If impedance matching to a 600Ω transformer is not a design requirement, then the values of R_6 and R_{16} are not critical and can be set to match various impedances. It is important however, that R_6 equal R_{16}.

Figure 2 is a simplified version of the Junctor circuit and shows the critical components required to calculate the optimum R_{14} value to obtain a Channel A to Channel B gain of one. Because the 2-wire to 4-wire gain of the HC5503X is one, the voltage appearing at V1 is the tip to ring voltage of Channel A (Summing amplifier configured for a gain of one). The tip to ring voltage of Channel B is equal to the voltage at VO, because the 4-wire to 2-wire gain of the HC5503X is also one. Writing an equation for VO in terms of V1 will enable the gain to be set to one and the corresponding resistor values determined.

Equation 4 can be used to determine the output voltage of the differential amplifier, and therefore the tip to ring voltage of Channel B, in terms of the voltage at V2.

$$VO = V2\left(1 + \frac{R_{14}}{R_{15}}\right) \quad \text{(EQ. 4)}$$

The voltage at V2, with respect to V1, is:

$$V2 = \left(\frac{R_{16}}{R_6 + R_X + R_{10} + R_{16}}\right)V1 \quad \text{(EQ. 5)}$$

Substituting Equation 5 into Equation 4 and defining $R_X{}' = R_X + R_{10}$. Where $R_X{}'$ is the total network resistance connecting Junctor A and Junctor B input/outputs.

$$VO = V1\left(\frac{R_{16}}{R_6 + R_X{}' + R_{16}}\right)\left(1 + \frac{R_{14}}{R_{15}}\right) \quad \text{(EQ. 6)}$$

Dividing both sides by V1 yields an equation for Channel A to Channel B gain.

$$\frac{VO}{V1} = \frac{\text{ChannelB}}{\text{ChannelA}} = \left(\frac{R_{16}}{R_6 + R_X{}' + R_{16}}\right)\left(1 + \frac{R_{14}}{R_{15}}\right) \quad \text{(EQ. 7)}$$

Setting V0/V1 equal to one and rearranging to solve for R_{14}, assuming $R_6 = R_{16}$, yields Equation 8.

$$R_{14} = R_{15}\left(1 + \frac{R_X{}'}{R_6}\right) \quad \text{(EQ. 8)}$$

Equation 8 can be used for the calculation of R_{14} to achieve a Channel A to Channel B Gain of one. A similar analysis for the calculation of R_4 to achieve a Channel B to Channel A gain of one is given in Equation 9.

$$R_4 = R_5\left(1 + \frac{R_X{}'}{R_6}\right) \quad \text{(EQ. 9)}$$

The value of R_{14} and R_4 can now be determined for any network resistance. The network resistance is defined as the total resistance between the Junctor inputs/outputs. In the case of the demo board the network resistance is the resistance of the Cross Point Switch (50Ω) and R_{10} (100Ω). If $R_1 = R_{11} = R_2 = R_{12} = R_5 = R_{15} = 10kΩ$, $R_6 = R_{16} = 604Ω$ and the Network = 150Ω then $R_4 = 12.48kΩ$. Closest standard value is 12.7kΩ. If the Network resistance is equal to 50Ω (Single CD22M3493 Cross Point), then $R_4 = 10.83kΩ$. Closest standard value is 10.7kΩ.

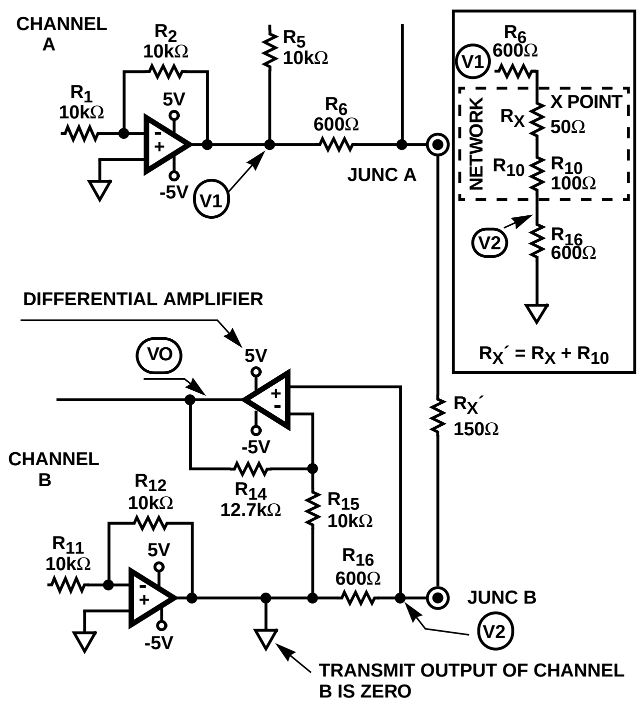

FIGURE 2. CHANNEL TO CHANNEL TRANSHYBRID BALANCE

Verification

The following procedure can be used to verify the above calculations.

Setup

1. Connect the power supplies to the Evaluation board.
2. Set V_{BAT} to -48V, V_{CC} to +5V and V_{EE} to -5V.
3. Set the DPDT switch (S1) to Junctor operation. This connects the Onboard Op Amp, Cross Point Switch and the second HC5503X SLIC to the Transmit and Receive outputs of Channel A.
4. Terminate tip and ring of **both** Channel A and Channel B with a 600Ω load.

5. Connect a sine wave generator in parallel with the 600Ω load across tip and ring of Channel A. The output of this generator needs to be floating.
6. Set the generator for $1V_{RMS}$ and 1kHz.
7. Measure the AC voltage across tip and ring (VTR) of both Channels A and B.
8. The Channel A to Channel B Gain is calculated using the following formula in Equation 10.

$$dB = 20\log\frac{VTR(channelB)}{VTR(channelA)} \quad \text{(EQ. 10)}$$

9. To measure Channel B to Channel A Gain connect the sine wave generator in parallel with the 600Ω load across tip and ring of Channel B and repeating steps 7 and 8 in a similar fashion. Results for both Channels should be about the same.
10. Compare results to that listed in Table 4.

TABLE 4.

TEST	TIP TO RING CHANNEL A (V_{RMS})	TIP TO RING CHANNEL B (V_{RMS})	GAIN (dB)
Channel A to Channel B Gain	1.0074	1.0063	-0.01
Channel B to Channel A Gain	1.0035	1.0068	-0.03

Test #8 Intra-Channel Transhybrid Balance with Different Loads

This evaluation board is configured to give the optimum Intra-Channel Transhybrid Balance for an impedance of 150Ω between the two Junctor inputs/outputs. This test will illustrate a procedure for calculating the proper R_4 and R_{14} resistor values to optimize the Intra-Channel Transhybrid Balance when a different Cross Point or network is used. Also included is an easy procedure to verify the calculations.

Discussion

Intra-Channel Transhybrid Balance is performed by the Differential Amplifier (Reference Figure 3). The goal is to cancel all of the transmit signal of Channel A by the Differential Amplifier, so that none of the transmit signal is feed back into the receive terminal of channel A. The transmit signal can be cancelled by the differential amplifier by adjusting the value of resistor R_4. The value of R_4 is dependent upon: the resistance value of R_6, the resistance of the network that connects the two Junctor inputs/outputs together (Cross Point + R_{10}) and resistor R_{16}. Figure 3 is a simplified version of the Junctor circuit and shows the critical components required to calculate the optimum R_4 value for Intra-Channel Transhybrid Balance.

Equation 11 is the characteristic equation for the output voltage of the Differential Amplifier.

$$VO = V1\left(1 + \frac{R_4}{R_5}\right) - V2\frac{R_4}{R_5} \quad \text{(EQ. 11)}$$

The voltage at V2, with respect to V1, where R_X = resistance of Cross Point Switch is:

$$V2 = \left(\frac{R_X + R_{10} + R_{16}}{R_X + R_{10} + R_{16} + R_6}\right)V1 \quad \text{(EQ. 12)}$$

Substituting Equation 12 into Equation 11, setting V0 equal to Zero, defining $R_X' = R_X + R_{10}$ and rearranging to solve for R4:

$$R_4 = \frac{R_5(R_X' + R_{16})}{R_{16}} \quad \text{(EQ. 13)}$$

Equation 13 can be used for the calculation of R_4 to achieve a good Intra-Channel Transhybrid Balance in Channel A. A similar analysis for Channel B is given in Equation 14.

$$R_{14} = \frac{R_{15}(R_X' + R_6)}{R_6} \quad \text{(EQ. 14)}$$

The value of R_4 and R_{14} can now be determined for any network resistance. In the case of the demo board, the network resistance (R_X') is the resistance of the Cross Point Switch (50Ω) and R10 (100Ω). If $R_1 = R_{11} = R_2 = R_{12} = R_5 = R_{15}$ = 10kΩ, $R_6 = R_{16}$ = 604Ω and the Network = 150Ω then R_4 = 12.48kΩ. Closest standard value is 12.7kΩ. If the Network resistance is equal to 50Ω (Single CD22M3493 Cross Point), then R_4 = 10.83kΩ. Closest standard value is 10.7kΩ.

Notice that the calculated value of R_4 and R_{14} for both Channel to Channel and Intra-channel are the same. This is because the gain from Channel to Channel is set for one. If the Channel to Channel gain was set to anything other than one, the Intra-channel Transhybrid Balance would become unacceptable. Proper operation of this circuit requires that the Channel to Channel gain be set to one.

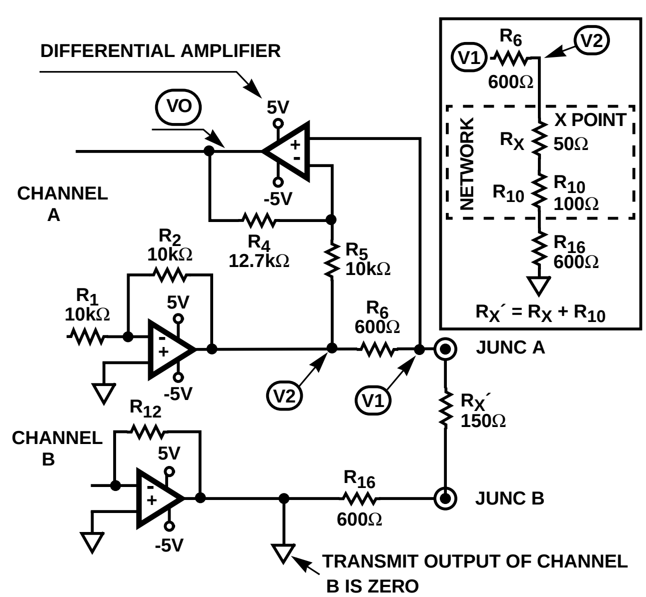

FIGURE 3. INTRA-CHANNEL TRANSHYBRID BALANCE

Verification

The following procedure can be used to verify the above calculations.

Setup

1. Replace resistors R_4 and R_{14} with a 10.7kΩ resistor as calculated above. Note, R_{14} is Channel B's equivalent of Channel A's R_4.
2. Connect the power supplies to the Evaluation board.
3. Set V_{BAT} to -48V, V_{CC} to +5V and V_{EE} to -5V.
4. Set the DPDT switch (S_1) to Junctor operation. This connects the Onboard Op Amp, Cross Point Switch and the second HC5503J SLIC to the Transmit and Receive outputs of Channel A.
5. Replace resistor R_{10} with a short. This will result in a network resistance of 50Ω total.
6. Terminate tip and ring of **both** Channel A and Channel B with a 600Ω load.
7. Connect a sine wave generator in parallel with the 600Ω load across tip and ring of Channel A. The output of this generator needs to be floating.
8. Set the generator for $1V_{RMS}$ and 1kHz.
9. Connect an AC volt meter between test point SUM A and ground. This will measure the AC voltage at the input to the Differential Amplifier (SUM A).
10. Connect an AC volt meter between test point DIFF A and ground. This will measure the AC voltage at the output of the Differential Amplifier (DIFF A).
11. The Intra-Channel Transhybrid Balance is calculated using the following formula in Equation 15.

$$dB = 20\log\frac{DIFFA}{SUMA} \qquad \text{(EQ. 15)}$$

12. To measure Intra-Channel Transhybrid Balance on Channel B, connect the sine wave generator in parallel with the 600Ω load across tip and ring of Channel B and repeating steps 8 through 11 in a similar fashion. Voltage measurements taken at SUM B and DIFF B. Results for both Channels should be the same.
13. Compare results to that listed in Table 3 section "Intra-Channel Transhybrid Balance."

Functional Circuit Component Descriptions

A brief description of each component is provided below. The components will be grouped by function to provide further insight into the operation of the HC5503C/J/T board.

TABLE 5. TWO WIRE SIDE, TIP AND RING

R_{B1}, R_{B2}, R_{B3}, R_{B4}, R_{B5}, R_{B6}, R_{B7}, R_{B8}	Feed resistors (R_{B1}, R_{B2}, R_{B3}, R_{B4}, R_{B5}, R_{B6}, R_{B7} and R_{B8}) that set the 2-wire impedance to 600Ω. R_{B2}, R_{B4}, R_{B6} and R_{B8} are used for loop current detection. R_{B1}, R_{B3}, R_{B5} and R_{B7} are used for current limiting during a surge event.
D_1, D_2, D_3, D_4, D_5, D_6, D_7, D_8	Secondary surge protection.

TABLE 6. JUNCTOR CIRCUIT

CA324E	Intersil Quad Op Amp.
R_1, R_2, R_3, R_{11}, R_{12}, R_{13}	Transhybrid Balance and Gain setting resistors for the Summing Amplifiers.
R_4, R_5, R_{14}, R_{15}	Transhybrid Balance and Gain setting resistors for the Differential Amplifiers.
C_8, C_{17}, C_{25}, C_{26}, C_{23}, C_{24}	Compensation Capacitors to roll of the high frequency gain of the Summing and Differential Amplifier. C_{23} and C_{24} prevent a DC loop.
R_6, R_{16}	Provides a 600Ω termination looking into the Junctor input.
R_{10}	Series resistor to bring the total resistance of the "Network" to 150Ω. The "Network" is defined as the total resistance that connects Junctor A to Junctor B.
C_4, C_5, C_6, C_7, C_{21}, C_{22}	AC decoupling capacitors for the HC5503X Transmit (TX) and Receive (RX) outputs.
CDM22M3493	Cross Point Switch. The resistance of the switch (X0 to Y0) is approximately 50Ω.
S_1	DPDT Switch used to connect the SLIC's Transmit and Receive outputs of Channel A to either banana jacks TX and RX or the onboard Op Amp and Cross Point for evaluation of the Junctor circuit.
Q_1, Q_2, R_7, R_8, R_9, D_9	Automatic on/off controller of the Cross Point Switch. This circuit senses the $\overline{SHD}$ outputs of both SLICs. If both SLICs are in the off-hook condition, then the Cross Point Switch is activated and the Junctor A and Junctor B outputs are connected together. If either SLIC is in the On-hook condition, the Cross Point Switch is off and Junctor A and Junctor B outputs are disconnected.

TABLE 7. FILTER CAPACITOR

C_1, C_{18}	C_1 and C_{18} are required for proper operation of the SLIC's loop current limit function.

TABLE 8. SUPPLY DECOUPLING CAPACITORS

C_2, C_3, C_9-C_{16}, C_{19}, C_{20}	Supply decoupling capacitors.

TABLE 9. $\overline{SHD}$ LEDs

R_9, R_{20}, D_9, D_{10}	R_9 and R_{20} are the Current limiting resistors for the $\overline{SHD}$ LEDs (D_9 and D_{10}).

TABLE 10. PULLUP RESISTORS

R_{17}, R_{19}	Pull up resistors (R_{17}, R_{19}). Required for proper operation of the SLIC.

Reference

[1] HC5503J - Future Product. For more information call Don LaFontaine at (321) 729-5604.

Schematic Diagram for Standard Operation

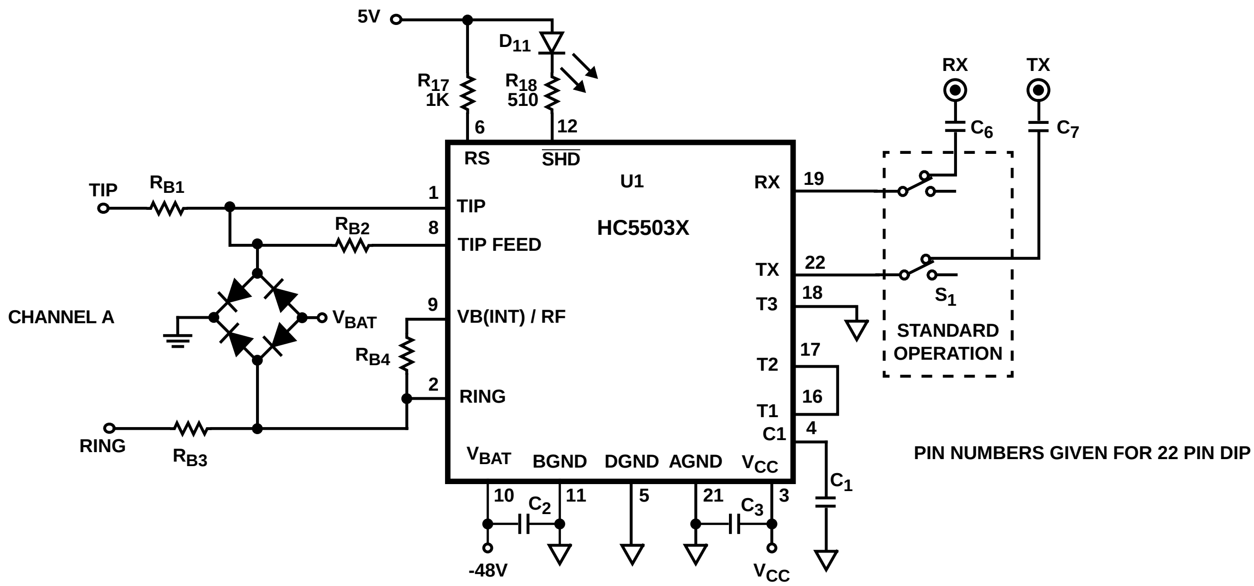

FIGURE 4. APPLICATION SCHEMATIC FOR STANDARD OPERATION

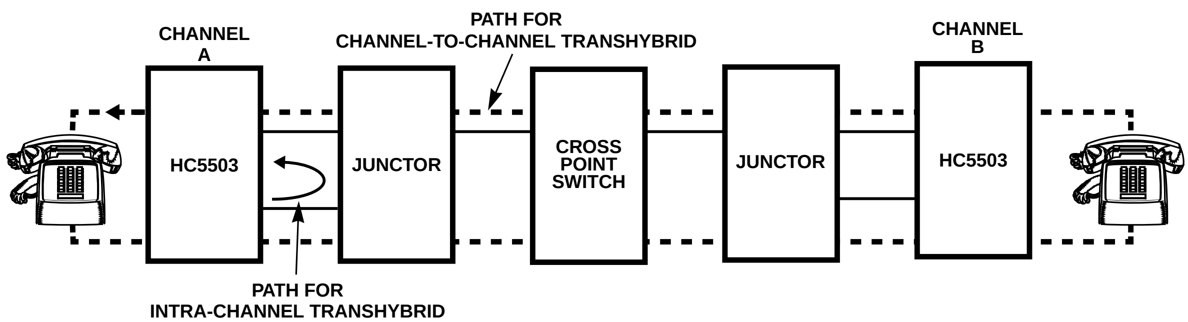

FIGURE 5. INTRA-CHANNEL AND CHANNEL-TO-CHANNEL PATHS THROUGH THE SYSTEM

HC5503C/J/T Evaluation Board Parts List

COMPONENT	VALUE	TOLERANCE	RATING	COMPONENT	VALUE	TOLERANCE	RATING
SLIC	U1 U2	HC5503X HC5503X		C_2, C_{19}	0.01µF	20%	100V
Quad Op Amp	U3	CA324E		C_3, C_{20}	0.01µF	20%	50V
Cross Point Switch	U4	CD22M3493		C_4, C_5, C_6, C_7, C_{21}, C_{22}	0.47µF	20%	50V
R_1, R_2, R_3, R_5, R_9, R_{11}, R_{12}, R_{13}, R_{15}	10kΩ	1%	1/4W	C_8, C_{17}, C_{25}, C_{26}	.001µF	10%	50V
R_{B1}, R_{B2}, R_{B3}, R_{B4}, R_{B5}, R_{B6}, R_{B7}, R_{B8}	150Ω	1%	2W	C_{23}, C_{24}	0.82µF	20%	50V
R_8	5.62kΩ	1%	1/4W	C_9, C_{11}, C_{13}, C_{15} Supply Decoupling	0.1µf	10%	50V
R_4, R_{14}	12.7kΩ	1%	1/4W	C_{10}, C_{12}, C_{14}, C_{16} Supply Decoupling	0.01µF	10%	50V
R_6, R_{16}	604Ω	1%	1/4W	D_1, D_2, D_3, D_4, D_5, D_6, D_7, D_8, D_{11}	1N40007	n/a	100V, 1A
R_{18}, R_{20}	510Ω	5%	1/4W	D_9, D_{10}	LED, RED		
R_7, R_{17}, R_{19}	1.0kΩ	5%	1/4W	S_1	SPDT CO PC Mount Switch		
C_1, C_{18}	0.33µF	10%	50V	R10	100Ω	1%	1/4W

Schematic Diagram for Junctor Application

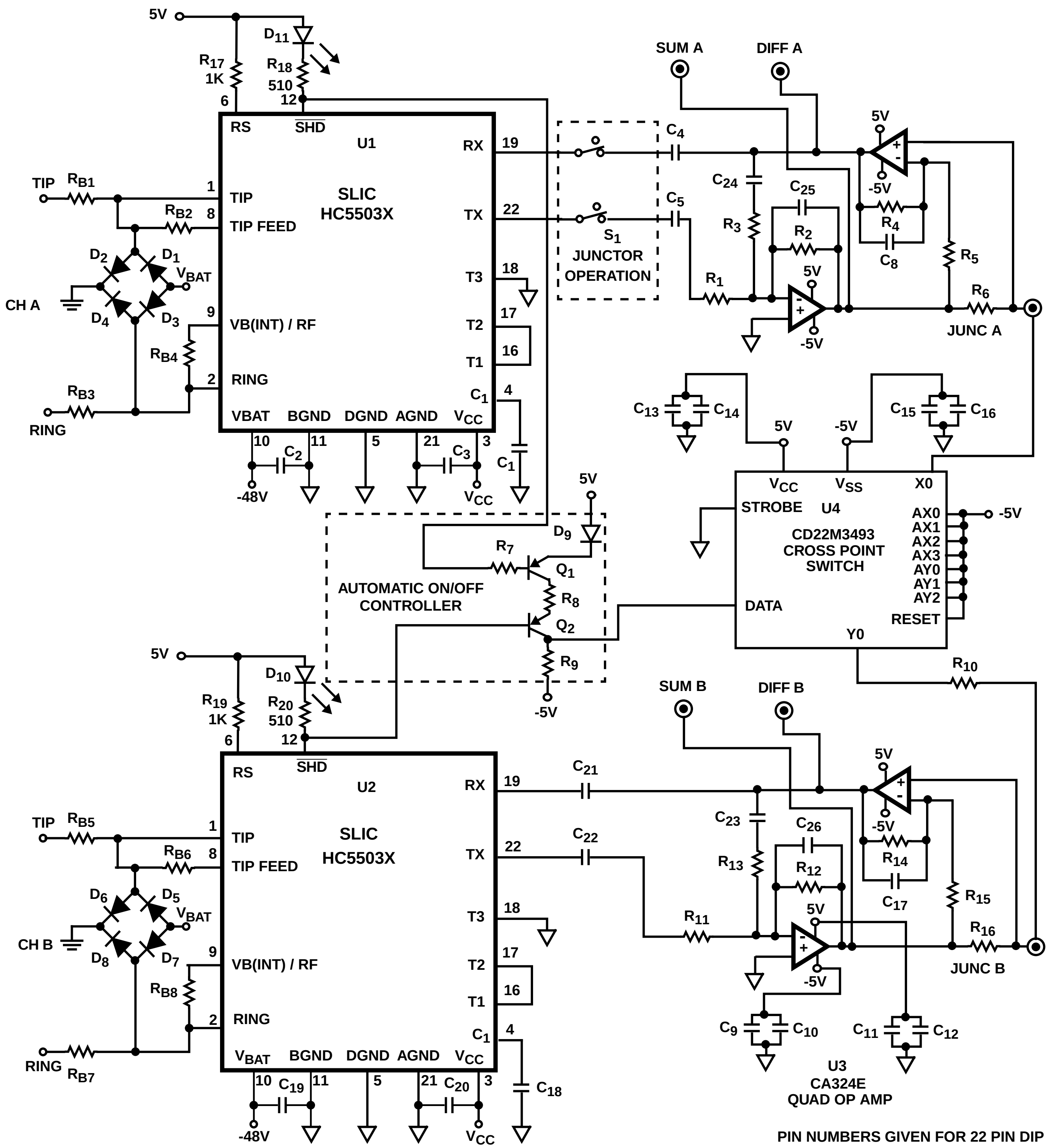

FIGURE 6. APPLICATION SCHEMATIC FOR JUNCTOR OPERATION