HARRIS SEMICONDUCTOR

HC-5502B

SLIC
Subscriber Line Interface Circuit

March 1993

Features

- Pin For Pin Replacement For The HC-5502A
- Capable of +12V or +5V (VB+) Operation
- Monolithic Integrated Device
- DI High Voltage Process
- Compatible With Worldwide PBX Performance Requirements
- Controlled Supply of Battery Feed Current for Short Loops (30mA)
- Internal Ring Relay Driver
- Low Power Consumption During Standby
- Switch Hook, Ground Key and Ring Trip Detection Functions
- Selective Denial of Power to Subscriber Loops

Applications

- Solid State Line Interface Circuit for Analog and Digital PBX Systems
- Direct Inward Dial (DID) Trunks
- Voice Messaging PBX's

Description

The Harris SLIC incorporates many of the BORSHT function on a single IC chip. This includes DC battery feed, a ring relay driver, supervisory and hybrid functions. This device is designed to maintain transmission performance in the presence of externally induced longitudinal currents. Using the unique Harris dielectric isolation process, the SLIC can operate directly with a wide range of station battery voltages.

The SLIC also provides selective denial of power. If the PBX system becomes overloaded during an emergency, the SLIC will provide system protection by denying power to selected subscriber loops.

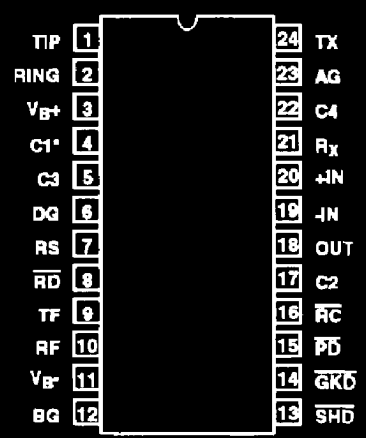
The Harris SLIC is ideally suited for the design of new digital PBX systems, by eliminating bulky hybrid transformers.

Ordering Information

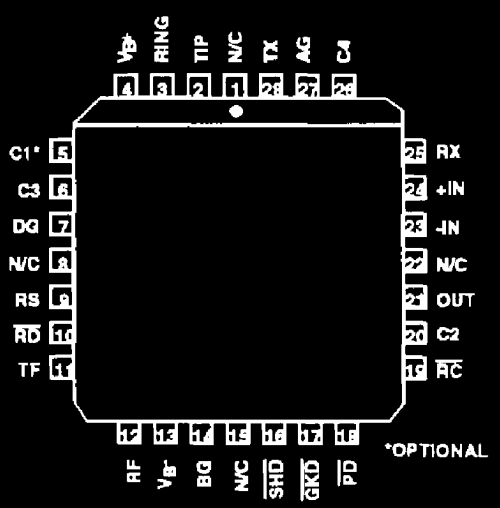
PART NUMBER	TEMPERATURE RANGE	PACKAGE
HC1-5502B-5	0°C to +75°C	24 Lead Ceramic DIP
HC1-5502B-9	-40°C to +85°C	24 Lead Ceramic DIP
HC3-5502B-5	0°C to +75°C	24 Lead Plastic DIP
HC3-5502B-9	-40°C to +85°C	24 Lead Plastic DIP
HC4P5502B-5	0°C to +75°C	28 Lead PLCC
HC4P5502B-9	-40°C to +85°C	28 Lead PLCC
HC9P5502B-5	0°C to +75°C	24 Lead SOIC
HC9B5502B-9	-40°C to +85°C	24 Lead SOIC

Pinouts

HC-5502B
(PDIP, CDIP, SOIC)
TOP VIEW



HC-5502B
(PLCC)
TOP VIEW



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Absolute Maximum Ratings (Note 1)

Supply Voltage
- (V_B-) ..... -60 to +0.5V
- (V_B+) ..... -0.5 to +15V
- (V_B+ - V_B-) ..... +75V

Relay Drive Voltage (V_{RD}) ..... -0.5 to +15V
Junction Temperature (Ceramic) ..... +175°C
Junction Temperature (Plastic Package) ..... +150°C
Lead Temperature (Soldering 10 Sec.) ..... +300°C

Operating Conditions

Relay Driver Voltage (V_{RD}) ..... +5V to +12V
Positive Supply Voltage (V_B+) ..... 4.75V to 5.25V or 10.8V to 13.2V
Negative Supply Voltage (V_B-) ..... -42V to -58V
High Level Logic Input Voltage 2.4V
Low Level Logic Input Voltage 0.6V
Loop Resistance (R_L) ..... 200 to 1200Ω
Operating Temperature Range
- HC-5502B-5 ..... 0°C to +75°C
- HC-5502B-9 ..... -40°C to +85°C

Storage Temperature Range ..... -65°C to +150°C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications

Unless Otherwise Specified, V_B- = -48V, V_B+ = +12V and +5V, AG = BG = DG = 0V, Typical Parameters T_A = +25°C. Min-Max Parameters are Over Operating Temperature Range.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
On Hook Power Dissipation	I_{Long}* = 0, V_B+ = +12V	-	135	235	mW
Off Hook Power Dissipation	R_L = 600Ω, I_{Long}* = 0, V_B+ = +12V	-	450	690	mW
Off Hook IB+	R_L = 600Ω, I_{Long}* = 0, T_A = -40°C	-	-	6.0	mA
Off Hook IB+	R_L = 600Ω, I_{Long}* = 0, T_A = +25°C	-	-	5.3	mA
Off Hook IB-	R_L = 600Ω, I_{Long}* = 0	-	-	39	mA
Off Hook Loop Current	R_L = 1200Ω, I_{Long}* = 0	-	21	-	mA
Off Hook Loop Current	R_L = 1200Ω, V_B- = -42V, I_{Long}* = 0, T_A = +25°C	17.5	-	-	mA
Off Hook Loop Current	R_L = 200Ω, I_{Long}* = 0	25.5	30	34.5	mA
Fault Currents					
TIP to Ground		-	14	-	mA
RING to Ground		-	47	-	mA
TIP to RING		-	30	-	mA
TIP and RING to Ground		-	47	-	mA
Ring Relay Drive V_{OL}	I_{OL} = 62mA	-	0.2	0.5	V
Ring Relay Driver Off Leakage	V_{RD} = +12V, $\overline{RC}$ = 1 = HIGH, T_A = +25°C	-	-	100	µA
Ring Trip Detection Period	R_L = 600Ω, T_A = +25°C	-	2	3	Ring Cycles
Switch Hook Detection Threshold	$\overline{SHD}$ = V_{OL}	10	-	-	mA
	$\overline{SHD}$ = V_{OH}	-	-	5	mA
Ground Key Detection Threshold	$\overline{GKD}$ = V_{OL}	20	-	-	mA
	$\overline{GKD}$ = V_{OH}	-	-	10	mA
Loop Current During Power Denial	R_L = 200Ω	-	±2	-	mA
Dial Pulse Distortion		0	-	5	ms
Receive Input Impedance	(Note 2)	-	110	-	kΩ
Transmit Output Impedance	(Note 2)	-	10	20	Ω

Electrical Specifications Unless Otherwise Specified, V_B- = -48V, V_B+ = +12V and +5V, AG = BG = DG = 0V, Typical Parameters T_A = +25°C. Min-Max Parameters are Over Operating Temperature Range. **(Continued)**

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Two Wire Return Loss	Referenced to 600Ω +2.16µF (Note 2)				
SRL LO		-	15.5	-	dB
ERL		-	24	-	dB
SRL HI		-	31	-	dB
Longitudinal Balance	$1V_{RMS}$ 200Hz - 3400Hz, (Note 2)				
2 Wire Off Hook	IEEE Method $0°C \le T_A \le +75°C$	58	65	-	dB
2 Wire On Hook		60	63	-	dB
4 Wire Off Hook		50	58	-	dB
Low Frequency Longitudinal Balance	R.E.A. Method, (Note 2) R_L = 600Ω, $0°C \le T_A \le +75°C$	-	-	23	dBrnC
		-	-	-67	dBm0p
Insertion Loss 2 Wire - 4 Wire, 4 Wire - 2 Wire	at 1kHz, 0dBm Input Level, Referenced 600Ω	-	±0.05	±0.2	dB
Frequency Response	200 - 3400Hz Referenced to Absolute Loss at 1kHz and 0dBm Signal Level (Note 2)	-	±0.02	±0.05	dB
Idle Channel Noise 2 Wire - 4 Wire, 4 Wire - 2 Wire	(Note 2)	-	1	5	dBrnC
		-	-89	-85	dBm0p
Absolute Delay 2 Wire - 4 Wire, 4 Wire - 2 Wire	(Note 2)	-	-	2	µs
Trans Hybrid Loss	Balance Network Set Up for 600Ω Termination at 1kHz	36	40	-	dB
Overload Level 2 Wire - 4 Wire, 4 Wire - 2 Wire	V_B+ = +5V	1.5			V_{PEAK}
	V_B+ = +12V	1.75	-	-	V_{PEAK}
Level Linearity	at 1kHz, (Note 2) Referenced to 0dBm Level				
2 Wire - 4 Wire, 4 Wire - 2 Wire	+3 to -40dBm	-	-	±0.05	dB
	-40 to -50dBm	-	-	±0.1	dB
	-50 to -55dBm	-	-	±0.3	dB
Power Supply Rejection Ratio	(Note 2) 30 - 60Hz R_L = 600Ω				
V_B+ to 2 Wire		15	-	-	dB
V_B+ to Transmit		15	-	-	dB
V_B- to 2 Wire		15	-	-	dB
V_B- to Transmit		15	-	-	dB
V_B+ to 2 Wire	200 - 16kHz R_L = 600Ω	30	-	-	dB
V_B+ to Transmit		30	-	-	dB
V_B- to 2 Wire		30	-	-	dB
V_B- to Transmit		30	-	-	dB
Logic Input Current (RS, $\overline{RC}$, $\overline{PD}$)	$0V \le V_{IN} \le +5V$	-	-	±100	µA

Electrical Specifications Unless Otherwise Specified, V_B- = -48V, V_B+ = +12V and +5V, AG = BG = DG = 0V, Typical Parameters T_A = +25°C. Min-Max Parameters are Over Operating Temperature Range. **(Continued)**

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Logic Inputs					
Logic '0' V_{IL}		-	-	0.8	V
Logic '1' V_{IH}		2.0	-	5.5	V
Logic Outputs					
Logic '0' V_{OL}	I_{LOAD} 800µA, V_B+ = +12V, +5V	-	0.1	0.5	V
Logic '1' V_{OH}	I_{LOAD} 80µA, V_B+ = +12V	2.7	5.0	5.5	V
	I_{LOAD} 40µA, V_B+ = +5V	2.7	-	5.0	V

* I_{Long} = Longitudinal Current

Uncommitted Op Amp Specifications

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage		-	±5	-	mV
Input Offset Current		-	±10	-	nA
Input Bias Current		-	20	-	nA
Differential Input Resistance	(Note 2)	-	1	-	MΩ
Output Voltage Swing	R_L = 10kΩ, V_B+ = +12V	-	±5	-	V_{PEAK}
	R_L = 10kΩ, V_B+ = +5V	-	±3	-	V_{PEAK}
Output Resistance	A_{VCL} = 1 (Note 2)	-	10	-	Ω
Small Signal GBW	(Note 2)	-	1	-	MHz

NOTES:

1. Absolute maximum ratings are limiting values, applied individually, beyond which the serviceability of the circuit may be impaired. Functional operability under any of these conditions is not necessarily implied.
2. These parameters are controlled by design or process parameters and are not directly tested. These parameters are characterised upon initial design release, upon design changes which would affect these characteristics, and at intervals to assure product quality and specification compliance.

Pin Descriptions

28 PIN PLCC	24 PIN DIP/SOIC	SYMBOL	DESCRIPTION
2	1	TIP	An analog input connected to the TIP (more positive) side of the subscriber loop through a 150Ω feed resistor and a ring relay contact. Functions with the Ring terminal to receive voice signals from the telephone and for loop monitoring process.
3	2	RING	An analog input connected to the RING (more negative) side of the subscriber loop through a 150Ω feed resistor and a ring relay contact. Functions with the Tip terminal to receive voice signals from the telephone and for loop monitoring purposes.
4	3	V_B+	Positive Voltage Source - Most positive supply. V_B+ is typically 12V or 5V.

Pin Descriptions (Continued)

28 PIN PLCC	24 PIN DIP/SOIC	SYMBOL	DESCRIPTION
5	4	C1	Capacitor #1 - Optional Capacitor used to improve power supply rejection. This pin should be left open if unused.
6	5	C3	Capacitor #3 - An external capacitor to be connected between this terminal and analog ground. Required for proper operation of the loop current limiting function, and for filtering V_B- supply. Typical value is 0.3µF, 30V.
7	6	DG	Digital Ground - To be connected to zero potential and serves as a reference for all digital inputs and outputs on the SLIC.
9	7	RS	Ring Synchronization Input - A TTL - compatible clock input. The clock should be arranged such that a positive transition occurs on the negative going zero crossing of the ring voltage source, ensuring that the ring relay is activated and deactivated when the instantaneous ring voltage is near zero. If synchronization is not required, tie to +5V.
10	8	$\overline{RD}$	Relay Driver - A low active open collector logic output. When enabled, the external ring relay is energized.
11	9	TF	Tip Feed - A low impedance analog output connected to the TIP terminal through a 150Ω feed resistor. Functions with the RF terminal to provide loop current, feed voice signals to the telephone set, and sink longitudinal current.
12	10	RF	Ring Feed - A low impedance analog output connected to the RING terminal through a 150Ω feed resistor. Functions with the TF terminal to provide loop current, feed voice signal to the telephone set, and sink longitudinal current.
13	11	V_B-	Negative Voltage Source - Most negative supply. V_B- is typically -48 volts with an operational range of -42V to -58V. Frequently referred to as "battery".
14	12	BG	Battery Ground - To be connected to zero potential. All loop current and some quiescent current flows into this ground terminal.
16	13	$\overline{SHD}$	Switch Hook Detection - A low active LS TTL - compatible logic output. This output is enabled for loop currents exceeding 10mA and disabled for loop currents less than 5mA.
17	14	$\overline{GKD}$	Ground Key Detection - A low active LS TTL - compatible logic output. This output is enabled if the DC current into the ring lead exceeds the DC current out of the tip lead by more than 20mA, and disabled if this current difference is less than 10mA.
18	15	$\overline{PD}$	Power Denial - A low active TTL - Compatible logic input. When enabled the switch hook detect ($\overline{SHD}$) and ground key detect ($\overline{GKD}$) are not necessarily valid, and the relay driver ($\overline{RD}$) output is disabled.
19	16	$\overline{RC}$	Ring Command - A low active TTL - Compatible logic input. When enabled, the relay driver ($\overline{RD}$) output goes low on the next rising edge of the ring sync ($\overline{RS}$) input, as long as the SLIC is not in the power denial state ($\overline{PD}$ = 0) or the subscriber is not already off- hook ($\overline{SHD}$ = 0).
20	17	C2	Capacitor #2 - An external capacitor to be connected between this terminal and digital ground. Prevents false ground key indications from occurring during ring trip detection. Typical value is 0.15µF, 10V. This capacitor is not used if ground key function is not required.
21	18	OUT	The analog output of the spare operational amplifier.
23	19	-IN	The inverting analog input of the spare operational amplifier.
24	20	+IN	The non-inverting analog input of the spare operational amplifier.
25	21	RX	Receive Input, Four Wire Side - A high impedance analog input which is internally biased. Capacitive coupling to this input is required. AC signals appearing at this input differentially drive the Tip feed and Ring feed amplifiers, which in turn drive tip and ring through 300Ω of feed resistance on each side of the line.

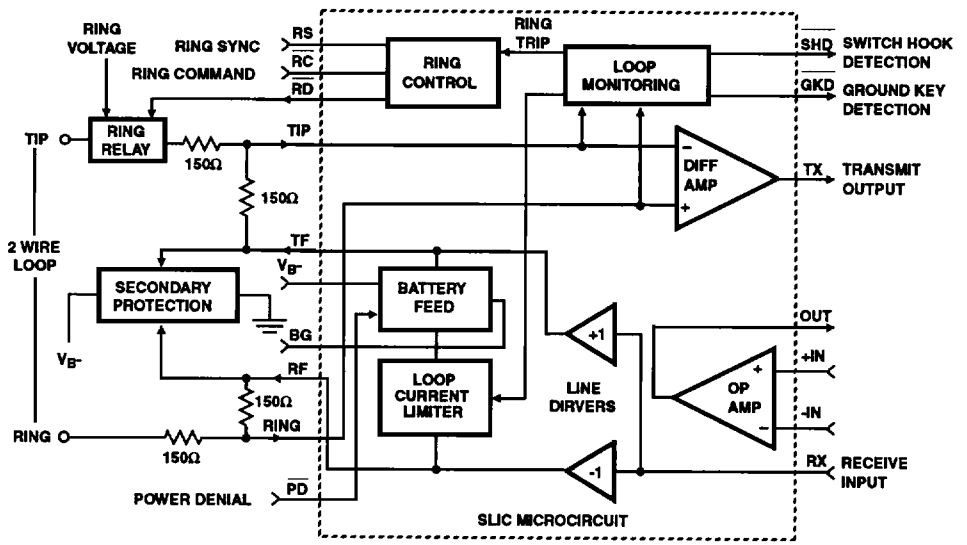
Pin Descriptions (Continued)

28 PIN PLCC	24 PIN DIP/SOIC	SYMBOL	DESCRIPTION
26	22	C4	Capacitor #4 - An external capacitor to be connected between this terminal and analog ground. This capacitor prevents false ground key indication and false ring trip detection from occurring when longitudinal currents are induced onto the subscriber loop from nearby power lines and other noise sources. This capacitor is also required for the proper operation of ring trip detection. Typical value is 0.5µF to 1.0µF, 20V. This capacitor should be nonpolarized.
27	23	AG	Analog Ground - To be connected to zero potential and serves as a reference for the transmit output (TX) and receive input (RX) terminals.
28	24	TX	Transmit Output, Four Wire Side - A low impedance analog output which represents the differential voltage across Tip and Ring. Transhybrid balancing must be performed (using the SLIC microcircuit's spare op amp) beyond this output to completely implement two to four wire conversion. This output is unbalanced and referenced to analog ground. Since the DC level of this output varies with loop current, capacitive coupling to the next stage is essential.
1, 8, 5, 22		NC	No Internal Connection.

NOTE:

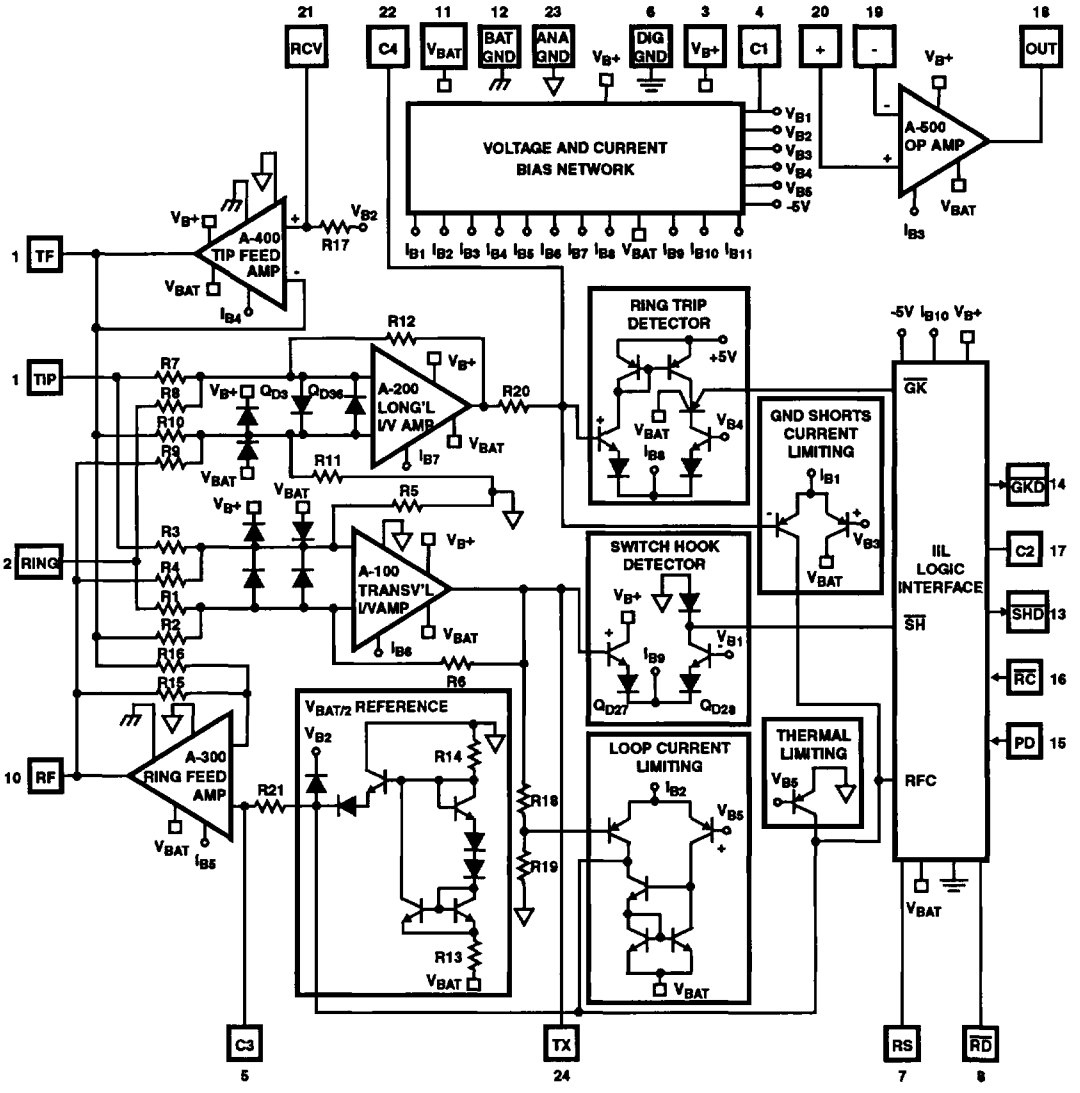
1. All grounds (AG, BG, & DG) must be applied before V_B+ or V_B-. Failure to do so may result in premature failure of the part. If a user wishes to run separate grounds off a line card, the AG must be applied first.

Functional Diagram



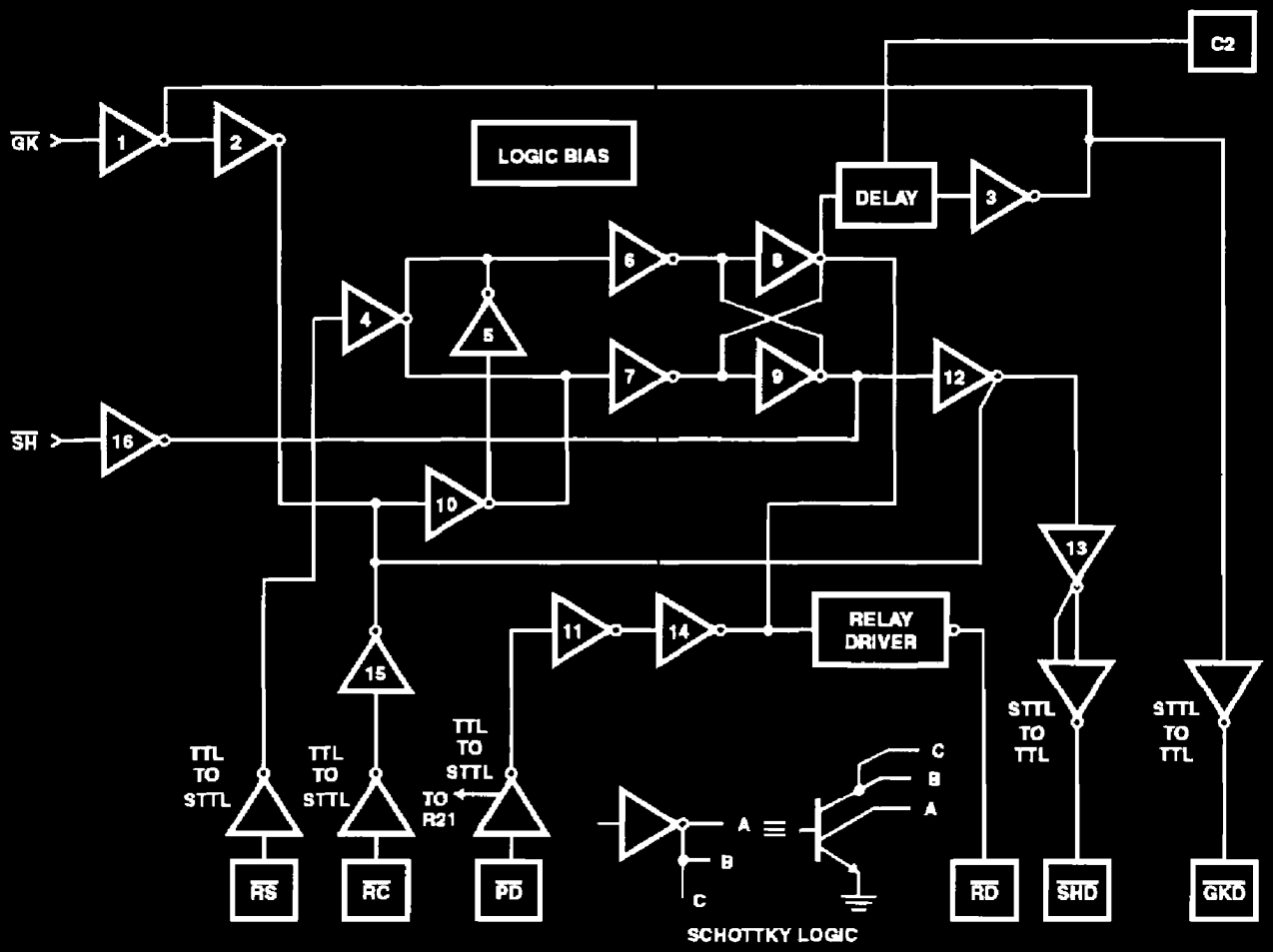
Schematic

HC-5502B SLIC FUNCTIONAL SCHEMATIC
Pin Numbers for DIP/SOIC Package



Logic Diagram

HC-5502B LOGIC GATE SCHEMATIC



Die Characteristics

Transistor Count	183
Diode Count	33
Die Dimensions	137 x 102 mils
Substrate Potential	V_{B^-}
Process	Bipolar-DI

Thermal Constants (°C/W)	θ_{JA}	θ_{JC}
Ceramic DIP	52	15
Plastic DIP	52	22
PLCC	67	29
SOIC	76	24

Overvoltage Protection and Longitudinal Current Protection

The SLIC device, in conjunction with an external protection bridge, will withstand high voltage lightning surges and power line crosses.

High voltage surge conditions are as specified in Table 1.

The SLIC will withstand longitudinal currents up to a maximum or $30mA_{RMS}$, $15mA_{RMS}$ per leg, without any performance degradation.

TABLE 1

PARAMETER	TEST CONDITION	PERFORMANCE (MAX)	UNITS
Longitudinal Surge	10µs Rise/	±1000 (Plastic)	V_{PEAK}
	1000µs Fall	±500 (Ceramic)	V_{PEAK}
Metallic Surge	10µs Rise/	±1000 (Plastic)	V_{PEAK}
	1000µs Fall	±500 (Ceramic)	V_{PEAK}
T/GND	10µs Rise/	±1000 (Plastic)	V_{PEAK}
R/GND	1000µs Fall	±500 (Ceramic)	V_{PEAK}
50/60Hz Current			
T/GND	11 Cycles	700 (Plastic)	V_{RMS}
R/GND	Limited to 10Arms	350 (Ceramic)	V_{RMS}

Applications Diagram

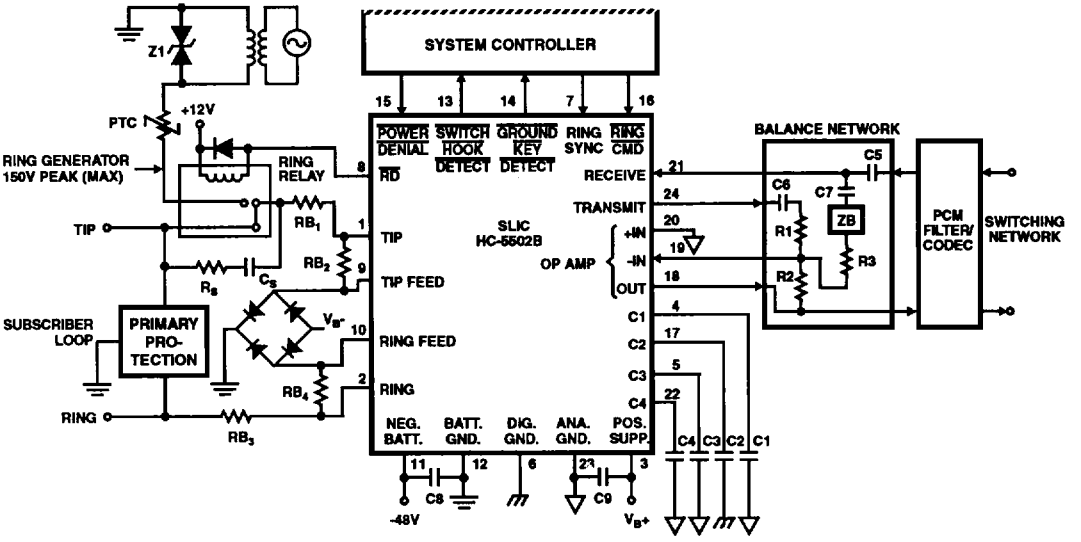


FIGURE 1. TYPICAL LINE CIRCUIT APPLICATION WITH THE MONOLITHIC SLIC

Typical Component Values

C1 = 0.5µF (Note 1)

C2 = 0.15µF, 10V

C3 = 0.3µF, 30V

C4 = 0.5µF to 1.0µF, 10%, 20V (Should be nonpolarized)

C5 = 0.5µF, 20V

C6 = C7 = 0.5µF (10% Match Required) (Note 2), 20V

C8 = 0.01µF, 100V

C9 = 0.01µF, 20V, ±20%

R1 = R2 = R3 = 100kΩ (0.1% Match Required, 1% absolute value), ZB = 0 for 600Ω Terminations (Note 2)

$RB_1 = RB_2 = RB_3 = RB_4 = 150\Omega$ (0.1% Match Required, 1% absolute value)

R_S = 1kΩ, C_S = 0.1µF, 200V typically, depending on V_{RING} and line length.

Z1 = 150V to 200V transient protection. PTC used as ring generator ballast.

NOTES:

1. C1 is an optional capacitor used to improve V_B+ supply rejection. This pin must be left open if unused.
2. To obtain the specified transhybrid loss it is necessary for the three legs of the balance network, C6-R1 and R2 and C7-ZB-R3, to match in impedance to within 0.3%. Thus, if C6 and C7 are 1µF each, a 20% match is adequate. It should be noted that the transmit output to C6 sees a -22V step when the loop is closed. Too large a value for C6 may produce an excessively long transient at the op amp output to the PCM Filter/CODEC.

   A 0.5µF and 100kΩ gives a time constant of 50msec. The uncommitted op amp output is internally clamped to stay within ±5.5V and also has current limiting protection.
3. Secondary protection diode bridge recommended is a 2A, 200V type.
4. All grounds (AG, BG, & DG) must be applied before V_B+ or V_B-. Failure to do so may result in premature failure of the part. If a user wishes to run separate grounds off a line card, the AG must be applied first
5. Pin numbers given for DIP/SOIC package.

Additional information is contained in Application Note 549, "The HC-550X Telephone SLICs" By Geoff Phillips.