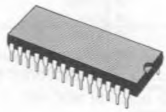
SGS-THOMSON MICROELECTRONICS

L3000
L3091

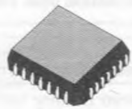
SUBSCRIBER LINE INTERFACE CIRCUIT KIT

ADVANCE DATA

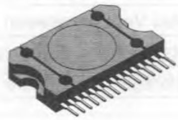
- PROGRAMMABLE DC FEED RESISTANCE AND LIMITING CURRENT (25/42/62mA)
- LOW ON-HOOK POWER DISSIPATION (70mW typ)
- SIGNALLING FUNCTION (off-hook/GND-Key)
- QUICK OFF-HOOK DETECTION IN CVS FOR LOW DISTORTION (< 1%) DIAL PULSE DETECTION
- HYBRID FUNCTION
- RINGING GENERATION WITH QUASI ZERO OUTPUT IMPEDANCE, ZERO CROSSING INJECTION (no ext. relay needed) AND RING TRIP DETECTION
- AUTOMATIC RINGING STOP WHEN OFF-HOOK IS DETECTED
- TEST MODE ALLOWS LINE LENGHT MEASUREMENT
- PARALLEL LATCHED DIGITAL INTERFACE
- LOW NUMBER OF EXTERNAL COMPONENTS WITH STANDARD TOLERANCE ONLY : 9 1% RESISTORS AND 5 10-20% CAPACITORS (for 600 ohm appl.)
- POSSIBILITY TO WORK ALSO WITH HIGH COMMON MODE CURRENTS
- GOOD REJECTION OF THE NOISE ON BATTERY VOLTAGE (20dB at 10Hz ; 40dB at 1KHz)
- INTEGRATED THERMAL PROTECTION



DIP28



PLCC28



FLEXIWATT15

ORDER CODES :
L3091 (DIP28)
L3091P (PLCC28)
L3000 (FLEXIWATT15)

DESCRIPTION

The SLIC KIT (L3000/L3091) is a set of solid state devices designed to integrate many of the functions needed to interface a telephone line. It consists of 2 integrated devices ; the L3000 line interface circuit and the L3091 control unit.

The kit implements the main features of the BORSHT functions :

- Battery feed (balance mode)
- Ringing Injection
- Signalling Detection
- Hybrid Function

The SLIC KIT injects the ringing signal in balanced mode and requires a positive supply voltage of typically + 72V to be available on the subscriber card.

The L3000/L3091 KIT generates the ringing signal internally, avoiding the requirement for expensive external circuitry. A low level 1.5Vrms input is required. (This can be provided by the combo).

A special operating mode limits the SLIC KIT power dissipation to 70mW in on-hook condition keeping the on/off hook detection circuit active.

Through the Digital Interface it is also possible to set an operating mode that allows measurements of loop resistance and therefore of line lenght.

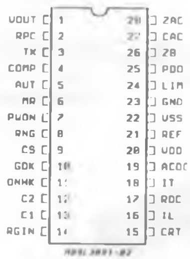
The L3091 is full compatible with L3090 but with additional functions.

This kit is fabricated using a 140V Bipolar technology for L3000 and a 12V Bipolar I2L technology for L3091.

This kit is specially suitable to Private Automatic Branch Exchange (PABX) and Low Range C.O. Applications.

PIN CONNECTIONS

M89L3091-02

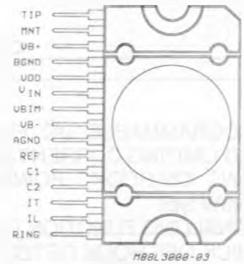


DIP28

M89L3091-01

PLCC28

M89L3091-03



FLEXIWATT15

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_b-	Negative Battery Voltage	– 80	V
V_b+	Positive Battery Voltage	80	V
$\lvert V_b- \rvert + \lvert V_b+ \rvert$	Total Battery Voltage	140	V
V_{dd}	Positive Supply Voltage	+ 5.5	V
V_{ss}	Negative Supply Voltage	– 5.5	V
$\lvert V_{agnd} - V_{bgnd} \rvert$	Max Voltage between Analog Ground and Battery Ground	5	V
T_j	Max Junction Temperature	+ 150	°C
T_{stg}	Storage Temperature	– 55 to + 150	°C

THERMAL DATA

L3000 HIGH VOLTAGE

R_{thjc}	Max Resistance Junction to Case	4	°C/W
R_{thja}	Max Resistance Junction to Ambient	50	°C/W

L3091 LOW VOLTAGE

R_{thja}	Max Resistance Junction to Ambient	80	°C/W

OPERATING RANGE

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{oper}	Operating Temperature Range	0		70	°C
V_b-	Negative Battery Voltage	– 70	– 48	– 24	V
V_b+	Positive Battery Voltage	0	+ 72	+ 75	V
$\lvert V_b- \rvert + \lvert V_b+ \rvert$	Total Battery Voltage		120	130	V
V_{dd}	Positive Supply Voltage	+ 4.5		+ 5.5	V
V_{ss}	Negative Supply Voltage	– 5.5		– 4.5	V
I_{max}	Total Line Current ($I_L + I_T$)			85	mA

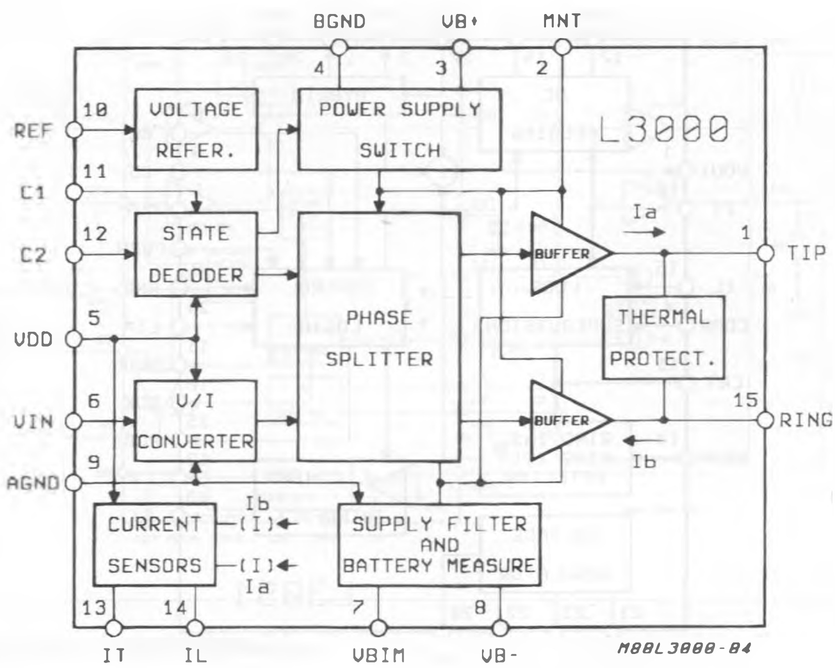
PIN DESCRIPTION (L3000)

N°	Name	Description
1	TIP	A line termination output with current capability up to 100mA (I_a is the current sourced from this pin).
2	MNT	Positive Supply Voltage Monitor
3	V_B+	Positive Battery Supply Voltage
4	BGND	Battery ground relative to the V_B+ and the V_B- supply voltages. It is also the reference ground for TIP and RING signals.
5	V_{DD}	Positive Power Supply + 5V
6	VIN	2 wire unbalanced voltage input.
7	VBIM	Output voltage without current capability, with the following functions : - give an image of the total battery voltage scaled by 40 to the low voltage part. - fliter by an external capacitor the noise on V_B-
8	V_B-	Negative Battery Supply Voltage
9	AGND	Analog Ground. All input signals and the V_{DD} supply voltage must be referred to this pin.
10	REF	Voltage reference output with very low temperature coefficient. The connected resistor sets internal circuit bias current.
11	C1	Digital signal input (3 levels) that defines device status with pin 12.
12	C2	Digital signal input (3 levels) that defines device status with pin 11.
13	I_T	High precision scaled transversal line current signal. $I_T = \frac{I_a + I_b}{100}$
14	IL	Scaled longitudinal line current signal. $IL = \frac{I_a - I_b}{100}$
15	RING	B line termination output with current capability up to 100mA (I_b is the current sunk into this pin).

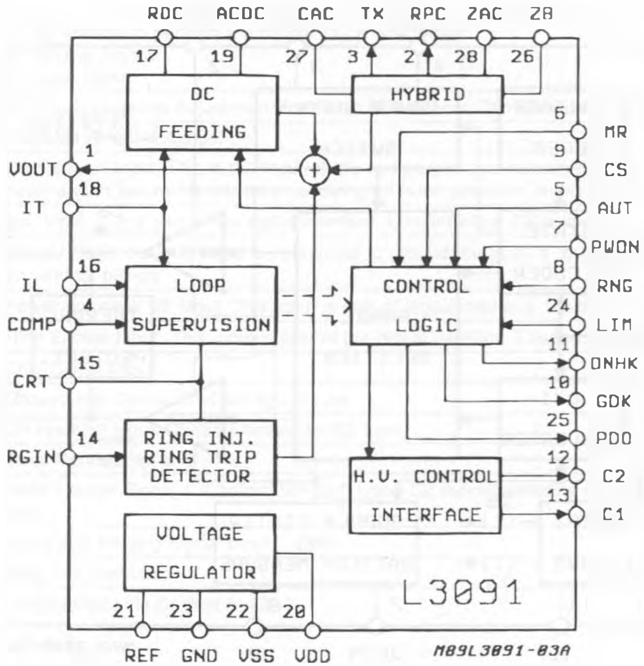
PIN DESCRIPTION (L3091)

N°	Name	Description
1	VOUT	Two wire unbalanced output carrying out the following signals reduced by 40 : 1) DC voltage to perform the proper DC characteristic. 2) Ringing Signal 3) Voice Signal
2	RPC	AC line Impedance Adjustment Protection Resistances Compensation
3	TX	Transmit Amplifier Output
4	COMP	Comparator Input. This is the input of the comparator that senses the line voltage in power down and in automatic stand-by , allowing off hook detection in this mode.
5	AUT	Aut. Input. It is a part of the digital interface. Looded when CS is low.
6	MR	Master Reset Input. When it is connected to ground the SLIC is forced in power down. It has an internal pull-up.
7	PWON	Power on/power off Input. This input is part of digital interface. Loaded when CS is low.
8	RNG	Ring Enable Input, This input is part of the digital interface. Loaded when CS is low.
9	CS	Chip Select Input
10	GDK	Ground Key Output Enabled by CS Low
11	ONHK	On Hook/off Hook Output Enabled by CS Low
12	C2	State Control Signal 2
13	C1	State Control Signal 1. Combination of C1 and C2 define operating mode of the high voltage part.
14	RGIN	Low Level Ringing Signal Input
15	CRT	Ring Trip Detection
16	IL	Longitudinal Line Current Input $IL = \frac{I_a - I_b}{100}$
17	RDC	DC Feeding System
18	IT	Transversal Line Current Input $IT = \frac{I_a + I_b}{100}$
19	ACDC	AC - DC Feedback Input
20	VDD	Positive Supply Voltage, + 5V
21	REF	Bias Setting Pin
22	VSS	Negative Supply Voltage, – 5V
23	GND	Analog and Digital Ground
24	LIM	Limiting Current Selection Input. Looded when CS is low.
25	PDO	Power Down Output. Driving the high voltage part L3000 through the bias resistor RH.
26	ZB	TX Amplifier Negative Input. Performing the two to four wire conversion.
27	CAC	AC Feedback Input
28	ZAC	AC Line Impedance Synthesis

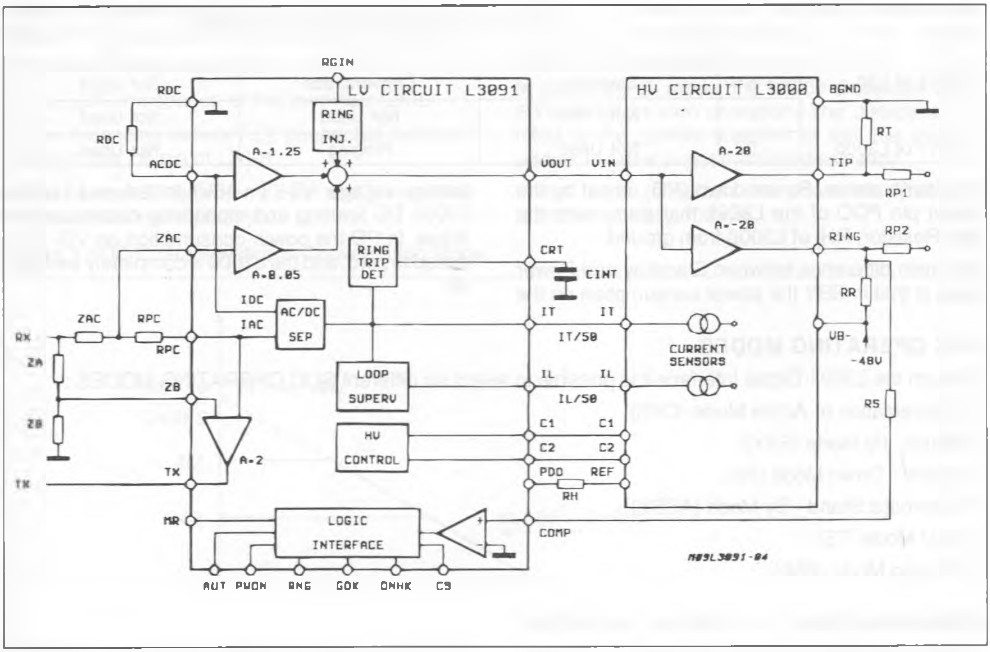
L3000 BLOCK DIAGRAM



L3091 BLOCK DIAGRAM (pins are for DIP28)



FUNCTIONAL DIAGRAM



FUNCTIONAL DESCRIPTION

L3000 - HIGH VOLTAGE CIRCUIT

The L3000 line interface provides battery feed for telephone lines and ringing injection. Both these operations are done in Balance Mode. This is very important in order to avoid the generation of common mode signals in particular during the pulse dialling operation of the telephone set connected to the SLIC. The IC contains a state decoder that under external control can force the following operational modes : stand-by, conversation and ringing.

In addition Power down mode can be forced connecting the bias current resistor of L3000 (RH) to VDD.

Two pins, I_L and I_T, carry out the information concerning line status which is detected by sensing the line current into the output stage.

The L3000 amplifies both the AC and DC signals entering at pin 6 (VIN) by a factor equal to 40.

Separate grounds are provided :

- Analog ground as reference for analog signals
- Battery ground as a reference for the output stages

L3091 - LOW VOLTAGE CIRCUIT

The L3091 Low Voltage Control Unit controls the L3000 line interface module providing set up data to set line feed characteristics and to inject ringing. An on chip digital parallel interface allows a microprocessor or a second generation COMBO as the TS5070 to control all the operations.

L3091 defines working states of Line Interface Circuit and also informs the controller about line status.

L3000 WORKING STATES

In order to carry out the different possible operations, the L3000 has several different working states. Each state is defined by the voltage respectively applied by pin 12 and 13 of L3091 to the pins 12 and 11 of L3000.

Three different voltage levels (5.0, + 5) are available at each connection, so defining nine possible states as listed in tab. 1.

Appropriate combinations of two pins define three of the four possible L3000 working states that are :

a) Stand-by (SBY)
b) Conversation (CVS)
c) Ringing (RING)

Table 1.

		Pin 12 of L309 / Pin 12 of L3000		
		+ 5	0	− 5
Pin 13 of L30	+ 5	Stand-by	Conversation	Not Used
	0	Not Used	Not Used	Not Used
Pin 11 of L3000	− 5	Not Used	Ringing	Not Used

The fourth status, Power down (PD), is set by the output pin PDO of the L3091 that disconnect the Bias Resistor, RH, of L3000 from ground.

The main difference between Stand-by and Power down is that in SBY the power consumption on the battery voltage VB– (– 48V) is reduced but the L3000 DC feeding and monitoring circuits are still active, in PD the power consumption on VB- is reduced to zero, and the L3000 is completely switched off.

SLIC OPERATING MODES

Through the L3091 Digital Interface it is possible to select six different SLIC OPERATING MODES :

1) Conversation or Active Mode (CVS)

2) Stand - By Mode (SBY)

3) Power - Down Mode (PD)

4) Automatic Stand - By Mode (ASBY)

5) Test Mode (TS)

6) Ringing Mode (RNG)

CONVERSATION (CVS) OR ACTIVE MODE

This operating mode is set by the control processor when the Off hook condition has been recognized,

As far as the DC Characteristic is concerned two different feeding conditions are present :

a) Current limiting region : the DC impedance of the SLIC is very high (> 20KΩ) and therefore the system works like a current generator. By the L3091 Digital Interface it is possible to selects the value of the limiting current. :

62mA, 42mA or 25mA.

b) A standard resistive feeding mode : the characteristic is equal to a battery voltage (VB-) minus 5V, in series with a resistor, whose value is set by external components (see external component list of L3091).

Switching between the two regions is automatic without discontinuity, and depends on the loop resistance. The SLIC AC characteristics are guaranteed in both regions.

Fig. 1 shows the DC characteristic in conversation mode.

Fig. 2 shows the line current versus loop resistance for two different battery values and RFS = 200Ω.

The allowed maximum loop resistance depends on the values of the battery voltage (VB), on the RFS and on the value of the longitudinal current (I_{GDK}). With a battery voltage of 48V, RFS = 200Ω and I_{GDK} = 0mA, the maximum loop resistance is over 3000Ω and with I_{GDK} = 20mA is about 2000Ω (see Application Note on maximum loop resistance for L3000/L3090 SLIC KIT).

In conversation mode the AC impedance at the line terminals is synthetized by the external components ZAC and RP, according to the following formula :

$$ZML = \frac{ZAC}{25} + 2 \times RP$$

Depending on the characteristic of the ZAC network, ZML can be either a pure resistance or a complex impedance. This allows for ST SLIC to meet different standards as far as the return loss is concerned. The capacitor CCOMP guarantees stability to the system.

The two to four wire conversion is achieved by means of a circuit that can be represented as a Wheatstone bridge, the branches of which being :

1) The line impedance (Zline).

2) The SLIC impedance at line terminals (ZML).

3) The balancing network ZA connected between RX input and ZB pin of L3091.

4) The network ZB between ZB pin and ground that shall copy the line impedance.

It is important to underline that ZA and ZB are not equal to ZML and to Zline. They both must be multiplied by a factor in the range of 10 to 25, allowing use of smaller capacitors.

In conversation mode, the L3000 dissipates about 500mW for its own operation. The dissipation related to the current supplied to the line shall be added, in order to get the total dissipation.

In the same condition the power dissipation of L3090 is typically 100mW.

Figure 1 : DC Characteristics in Conversation Mode.

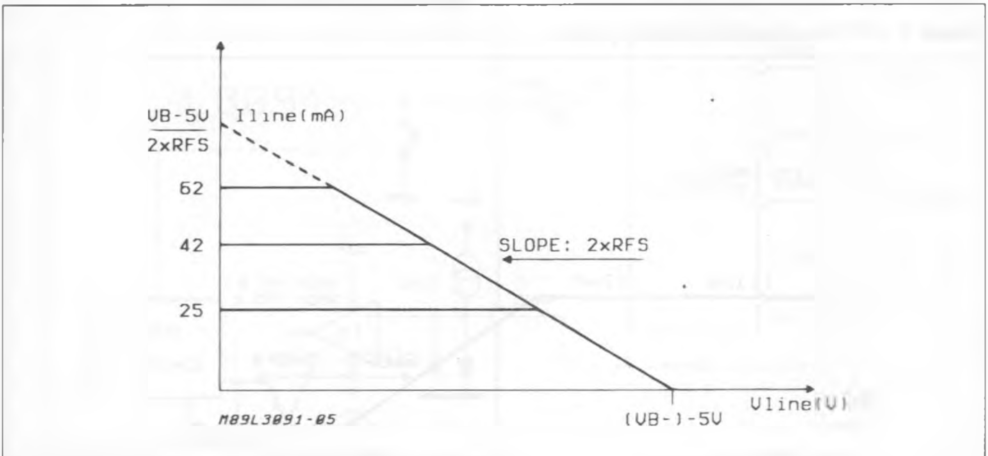
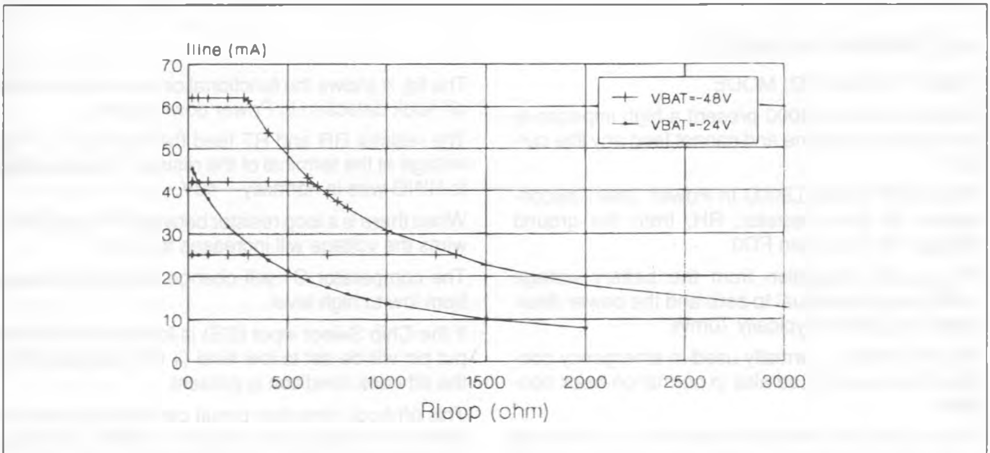


Figure 2 : Line Current versus Loop Resistance - RFS = 200Ω ; Limiting Currents : 25/42/62 mA.



STAND-BY (SBY) MODE

In this mode the bias currents of both L3000 and L3090 are reduced as only some parts of the two circuits are completely active, control interface and current sensors among them. The current supplied to the line is limited at 12mA, and the slope of the DC characteristic corresponds to 2 x RFS.

The AC characteristic in Stand-by corresponds to a low impedance (2 x RP)

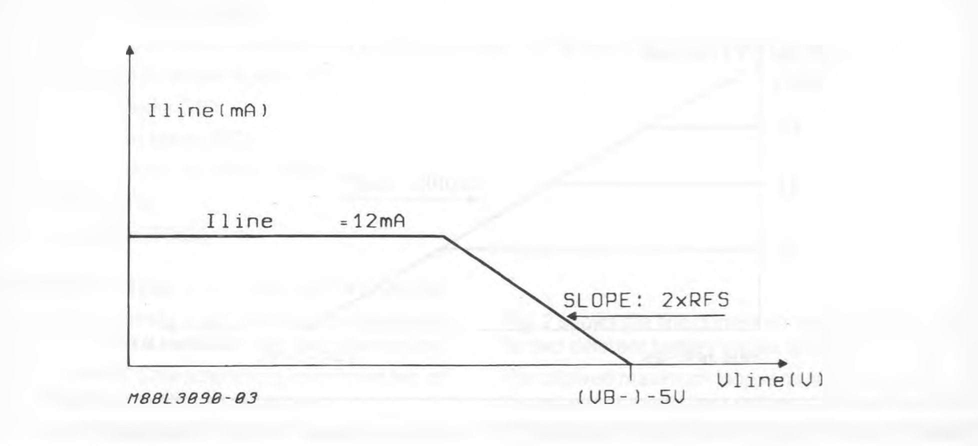
In Stand-by mode the line voltage polarity is just in direct condition, that is the TIP wire more positive than the RING one as in Conversation Mode.

When the SLIC is in Stand-by mode, the power dissipation of L3000 does not exceed 200mW from – 48V) eventually increased of a certain amount if some current is flowing into the line.

The power dissipation of the L3091 in the same condition is typically 70mW.

SBY Mode is usually selected when the telephone is in on-hook. It allows a proper off-hook detection also in presence of high common mode line current or with telephone set sinking few milliAmpere of line current in on hook condition.

Figure 3 : DC Characteristic in Stand-by Mode.



SLIC OPERATING MODES

POWER DOWN (PD) MODE

In this mode the L3000 present a high impedance (> 1 Mohm) to the line and cannot feed any line current.

The L3091 forces L3000 in Power Down disconnecting its bias Resistor, RH, from the ground through the output pin PD0.

The power dissipation from the battery voltage (– VB) is almost equal to zero and the power dissipation of L3091 is typically 70mW.

The PD mode is normally used in emergency condition but can be used also in normal on-hook condition.

In this case the off-hook detection is performed using the line sense comparator integrated in the L3091.

The fig. 4 shows the functional circuit to perform the off hook detection in Power down mode.

The resistor RR and RT feed the line current. The voltage at the terminal of the resistor RS connected to RING wire is normally – 48V.

When there is a loop resistor between TIP and RING wires the voltage will increases to – 24V.

The comparator C1 will change its output voltage from low to high level.

If the Chip Select input (CS) is low the ONHK output pin will be set to low level (+ 0V) indicating that the off hook condition is present.

This off-hook detection circuit can be influenced by common mode signal present on RING Terminal. The capacitor Cs is used to filter this common mode signal.

In the case of very high common mode signal after the detection of an high level on the ONHK output pin, it is suggested to set the SLIC in Stand-by. In this operating mode the off-hook detection circuit is not sensitive to the line common mode signal.

If in Stand-by Mode the off-hook detection is not confirmed (ONHK output set to low level) we suggest after few second to set the SLIC again in Power Down Mode.
Total operation is managed by line card controller.

Figure 4 : Off-hook Detection Circuit in Power Down Mode.

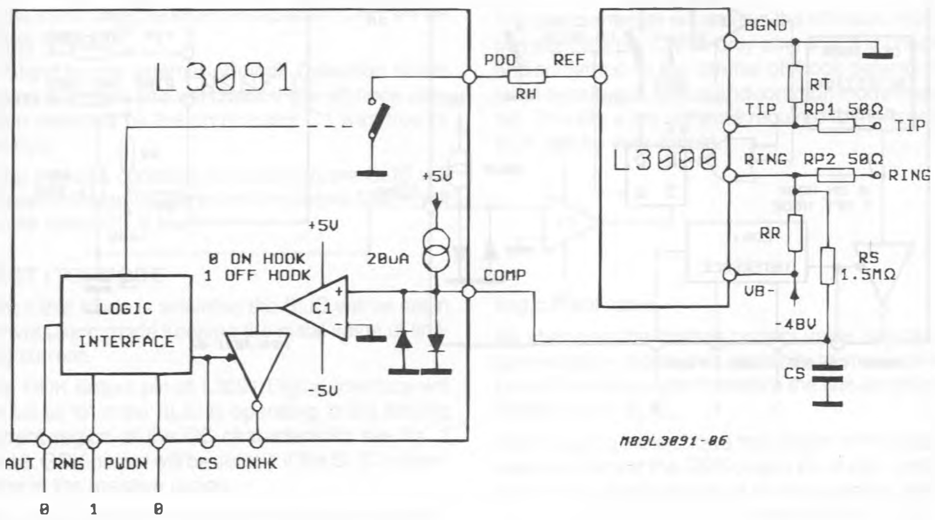
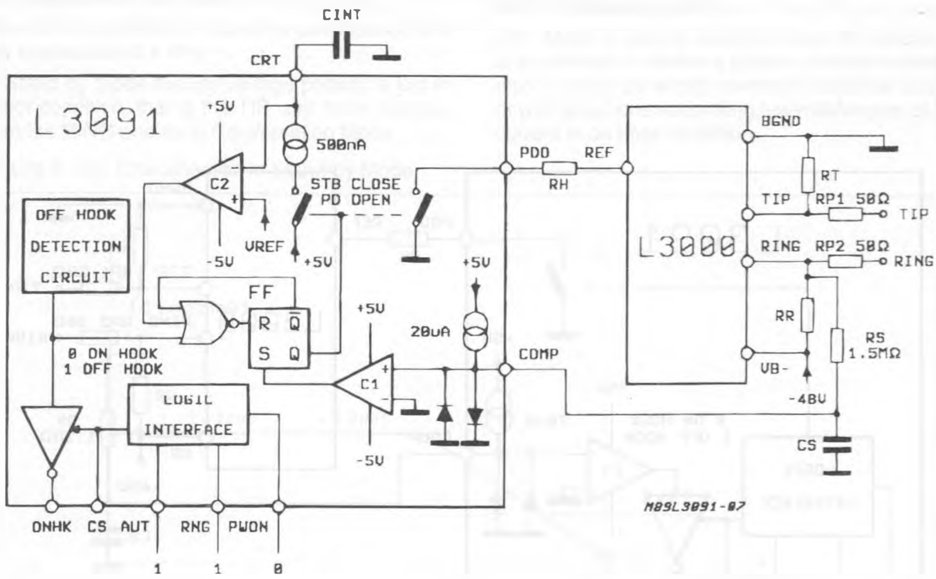


Figure 5 : Off-hook Detection Circuit in Automatic Standby Mode.



AUTOMATIC STAND - BY (ASBY) MODE

This is an operating mode similar to the Power Down Mode, but with the software procedure to detect off-hook condition integrated in hardware on chip.

Fig. 5 shows the functional circuit activated in this mode.

When the off-hook condition occurs RING wire voltage goes high (from - 48V to - 24V).

The output of the comparator C1 will go high setting the output of the flip - flop FF high.

Therefore L3091 will set L3000 in Stand-by providing a ground signal at pin PDO.

At the same time the external capacitor CINT will be slowly charged.

In Stand-by the internal off-hook Detection circuit will be activated and will check if the off-hook condition detected by the comparator C1 was true or not true.

If the off-hook condition is confirmed the SLIC will be kept in Stand-by Mode and the output ONHK will go low when CS is low.

If the off-hook condition is not confirmed the SLIC will be kept in Stand - By only for a few seconds. When the voltage at CRT out put will reach the V_{REF} value the C2 comparator will reset the FF Flip - Flop and therefore the SLIC will be set again in Power Down.

The Automatic Stand-by (ASBY) Mode combine the key characteristics of Power Down (PD) and Stand-by (SBY) Modes in particular it is characterized by a very low power consumption (as the Power Down mode) and a sophisticated off hook detection circuit (as the Stand-By mode).

The card controller will receive the off-hook information from the pin ONHK only after that it is checked and confirmed by the internal off-hook detector that is not sensitive to spikes and common mode line signal. Therefore the software required to manage the SLIC will be very simple.

TEST (TS) MODE

When this mode is activated the SLIC will be set in conversation mode keeping the initial value of limiting current.

The GDK output pin of L3091 Digital Interface will be set to "0" if the SLIC is operating in the limiting current region of the DC characteristic, see fig. 1 and 2. GDK output will be set to 1 if the SLIC is operating in the resistive region.

The SLIC will work in one of the two region depending on the loop resistance and the programmed limiting current value.

By changing the limiting current value selected in conversation mode it is possible to measure the Loop Resistance and therefore the line lenght connected to the SLIC.

The following table shows the ranges of the loop resistance that set the GDK output pin to high and low level in correspondance of all the possible limiting current values (25/42/62mA) with RFS = 200Ω.

Limiting Current	GDK = 0	GDK = 1
62mA	(0 – 300) ohm	> 300 ohm
42mA	(0 – 600) ohm	> 600 ohm
25mA	(0 – 1300) ohm	> 1300 ohm

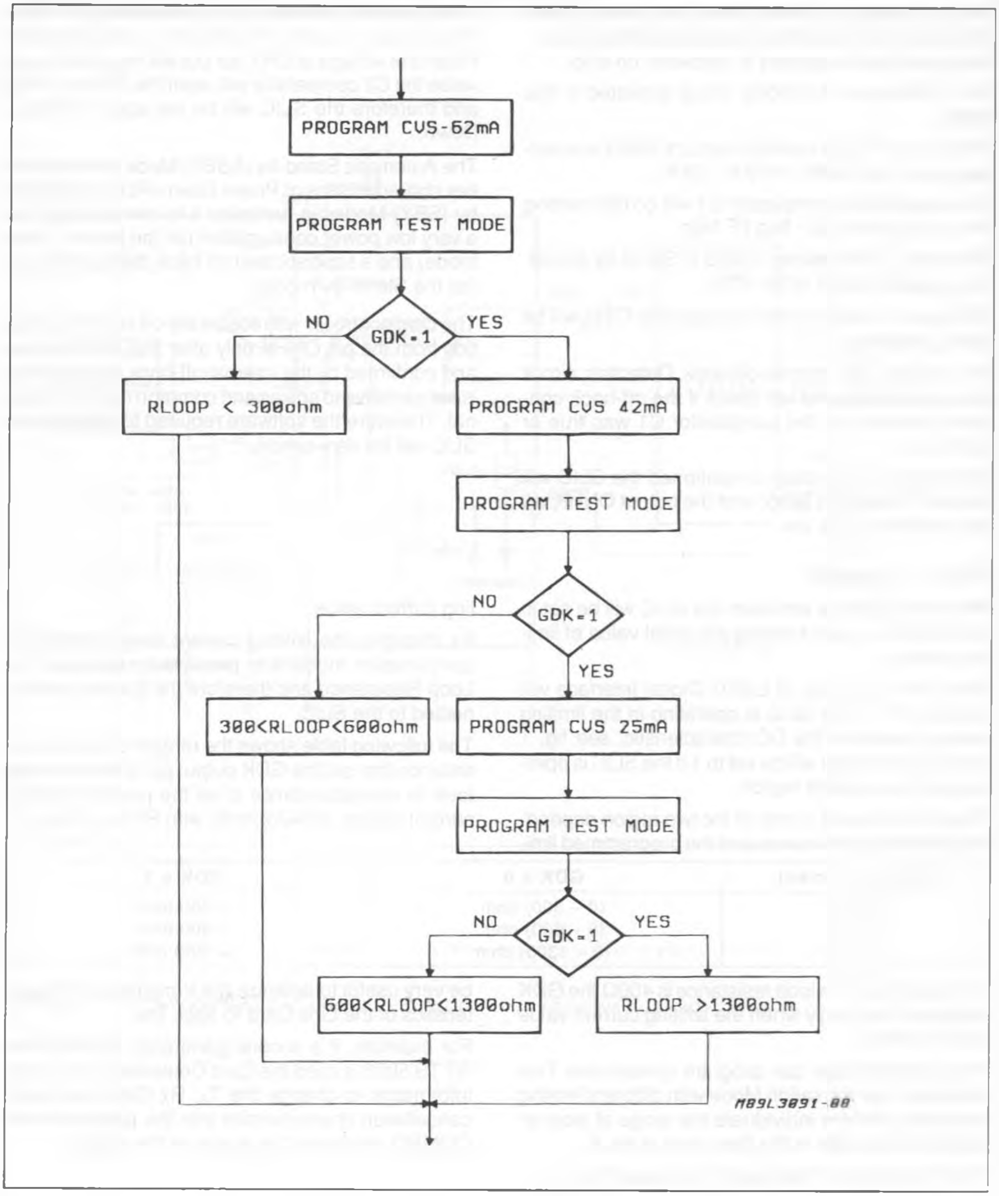
If, for example, the loop resistance is 400Ω the GDK output will be 0 only when the limiting current value is 42 or 25mA.

The card controller can program consecutive Test Mode and Conversation Mode with different limiting current in order to individuate the range of loop resistance as shown in the flow chart of fig. 6.

The information of the Loop Resistance Range can be very useful to optimize the transmission characteristics of the Line Card to each line.

For example, if a second generation COMBO like ST TS 5070 is used the Card Controller can use this information to change the T_X, R_X Gains and echo cancellation characteristics into the programmable COMBO improving the quality of the system.

Figure 6 : Procedure for Loop Resistance Evaluation.



RINGING MODE

When the ringing function is selected by the control processor a low level signal (1.5Vrms) with a frequency in the range from 16 to 70Hz, permanently applied to the L3091 (pin RGIN), is amplified and injected in balanced mode into the line through the L3000 with a super imposed DC voltage of 22V.

This low level sinewave can be obtained also from COMBO connecting RGIN pin to RX COMBO output with a decoupling capacitor.

The first and the last ringing cycles are synchronized by the L3C91 so that the ringing signal always starts and stops when the line voltage crosses zero.

When this mode is activated, the L3000 operates between the negative and the positive battery voltages typically - 48V and + 72V. The impedance to the line is just equal to the two external resistors (typ. 100Ω).

Ring trip detection is performed autonomously by the SLIC, without waiting for a command from the control processor, using a patented system which allows detection during a ringing burst ; when the off-hook condition is detected, the SLIC stops the ringing signal and forces the Conversation Mode.

In this condition, if CS = 0V, the output pin ONHK goes to 0V.

After the detection of the ONHK = 0, the Card Controller must set the SLIC in Conversation Mode to remove the internal latching of the On/Off hook information.

CONTROL INTERFACE BETWEEN THE SLIC AND THE CARD CONTROLLER

The SLIC states and functions are controlled by microprocessor or interface latches of a second generation combo through seven wires that define a parallel digital interface.

The seven pins of the digital interface have the following functions :

- Chip select input (CS)
- Power on/off input (PWON)
- Ring enable input (RNG)
- Automatic SBY input (AUT)
- Limiting current input (LIM)
- On hook/Off hook detection output (ONHK)
- Ground Key detection output (GDK)

The four input pins PWON, RNG, AUT and LIM, set the status of the SLIC as shown in the following table.

The output pin ONHK is equals to 0V when the line is in off-hook condition (I_{line} > 7,5mA) and is equal to + 5V when the line is in On hook condition (I_{line} < 5,5mA).

The output pin GDK monitors the ground key function when the SLIC is in Conversation (CVS) Mode and the DC operating region (limiting or resistive) in Test (TS) Mode. When the SLIC is in Conversation (CVS) Mode and I_{GDK} (longitudinal current) > 12mA, pin GDK is set to 0V ;

Operating Mode	Input Pin				Output Pin	
	RNG	PWON	AUT	LIM	ONHK	GDK
Conversation 25mA Conversation 42mA Conversation 62mA	0 0 0	1 1 1	1 0 0	X 1 0	1 on-hook 0 off-hook	1 Ground key not detected. 0 Ground dey detected.
Boosted Battery 25mA	0	1	HI	X		Disable
Stand-by	0	0	0	X		
Automatic Stand-by	1	0	1	X		
Power-down	1	0	0	X	C1 Comparator Output	Disable
Test Mode	0	0	1	X	1 on-hook 0 off-hook	0 Limiting Region 1 Resistive Region
Ringing Inj. (CVS 25mA) Ringing Inj. (CVS 42mA) Ringing Inj. (CVS 62mA)	1 1 1	1 1 1	1 0 0	X 1 0		Disable

N.B. : When Ringing Mode is selected. you must choose also which of the three possible Conversation Modes. the SLIC will automatically select if Off-Hook condition will be detected during ringing.

When I_{GDK} < 8MA, pin GDK set to + 5V

The longitudinal current (I_{GDK}) is defined as follows :

$$I_{GDK} = \frac{I_A - I_B}{2}$$

Where I_A is the current sourced from pin TIP and I_B is the current sunk into pin RING.

The CS input pin allows to connect the I/O pins of the digital interfaces of many SLIC together.

It is possible to do it because :

When the CS = + 5V the output pins (ONHK, GDK) are in high impedance condition (> 100KΩ). The signals present at the input pins are not transfered into the SLIC.

When the CS = 0V the output pins change in function of the values of the line current (I_{line}) and the longitudinal current (I_{GDK}). The operating status of the SLIC are set by the voltage applied to the input pins.

The rising edge of the CS signal latches the signal applied to the input pins. The status of the SLIC will not change until the CS signal will be again equal to zero.

See timings fig 8 & 9.

An additional input pin MR (Master Reset) can be useful during the system start up phase or in emergency condition.

Infact when this pin is set to "0" the SLIC will be set in POWER DOWN MODE. This pin has an internal pull-up resistor of about 70KΩ

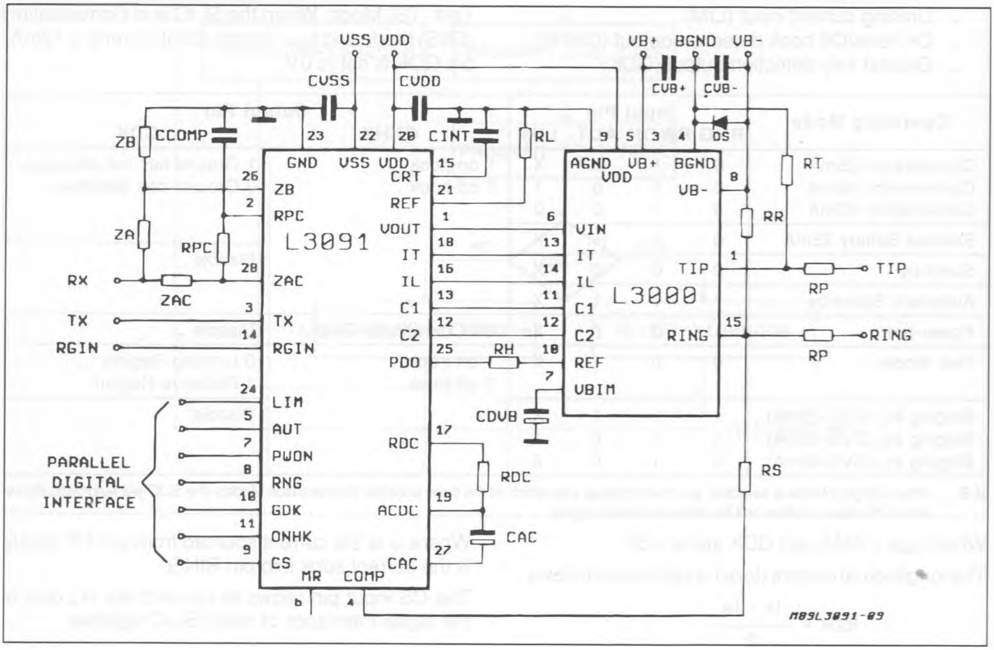
EXTERNAL COMPONENTS LIST

To set up the SLIC kit into operation, the following parameters have to be defined :

- The DC feeding resistance RFS, defined as the resistance of each side of the traditional feeding system (most common value for RFS are 200, 400 or 500).
- The AC input/output SLIC impedance at line terminals, ZML, to which the return loss measurement is refered. It can be real (typically 600Ω) or complex.
- The equivalent AC impedance of the line Z_{line} used for evaluation of the trans-hybrid loss (2/4 wire conversion). It is usually a complex impedance.
- The frequency of the ringing signal Fr (SLIC can work with this frequency ranging from 16 to 68Hz).
- The value of the two resistors RP in series with the line terminals ; main purpose of the a.m. resistors is to allow primary protection to fire..

With these assumptions the following components list is defined :

Figure 7 : Typical Application Circuit.



EXTERNAL COMPONENT LIST FOR THE L3000

Component		Involved Parameter or Function
Ref	Value	
RH	24.9KΩ ± 2%	Bias Resistor
RP	30 to 100Ω	Line Series Resistor
CDVB	47μF – 20WV ± 20%	Battery Voltage Rejection
CVB + (note 1)	0.1μF – 100WV ± 20%	Positive Battery Filter
CVB – (note 1)	0.1μF – 100WV ± 20%	Negative Battery Filter
DS (note 1)	BAT 49	Protective Shottky Diode

EXTERNAL COMPONENT LIST FOR THE L3091

Component		Involved Parameter or Function
Ref	Value	
CVSS	0.1μF – 15WV (note 1)	Negative Supply Voltage Filter
CVDD	0.1μF – 15WV (note 1)	Positive Supply Voltage Filter
CAC	47μF – 10WV ± 20%	AC Path Decoupling
ZAC	25 x (ZML – 2xRP)	2 Wire AC Impedance
CCOMP	$\frac{1}{(6.28 \times 30000 \times ZML \times 25)}$	AC Loop Compensation
RPC	25 x (2xRP)	R_p Insertion Loss Compensation
RDC	2 x (RFS – RP)	DC Feeding Resistor
RL	63.4KΩ ± 1%	Bias Resistor
ZA	K x Z_{ML} (note 2)	SLIC Impedance Balancing Network
ZB	(K x Zline) // ($\frac{25}{K}$ x CCOMP) (note 3)	Line Impedance Balancing Network
CINT	(note 4)	Ring Trip Detection Time Constant
RT	47KΩ	Resistors used only in the automatic stand-by mode.
RR	47KΩ	
RS	1.5MΩ	

Notes :
1. In most applications these components can be shared between all the SLIC s on the Subscriber Card.
2. The structure of this network shall copy the SLIC output impedance multiplied by a factor K = 10 to 25.
3. The structure of this network shall copy the line impedance, Z_{line}, multiplied by a factor K = 10 to 25 and compensate the effect of CCOMP on transhybrid rejection.
4. The CINT value depends on the ringing frequency Fr :

Fr (Hz)	16/18	19/21	22/27	28/32	33/38	39/46	47/55	56/68
CINT (nF)	680	580	470	390	330	270	220	180

The CINT value can be optimized experimentally for each application choosing the lower value that in correspondance of the lower ringing frequency, the minimum line lenght and the higher number of ringers doesn't produce false off-hook detection.

ELECTRICAL CHARACTERISTICS

(VDD = + 5V ; VSS = 5V ; VB + = + 72V ; VB – = – 48V ; Tamb = + 25°C)

STANDBY

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
VLS	Output Voltage at L3000 Terminals	I Line = 0mA		43		V
ILCC	Short Circuit Current		10		14	mA
Iot	Off-hook Detection Threshold		5.6		9.8	mA
Hys	Off-hook/on-hook Hysteresis		1.5		2.5	mA
Vis	Symmetry to Ground	I Line = 0mA			.75	V

CONVERSATION

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
VLO	Output Voltage at L3000 Line Terminals	I Line = 0mA		43		V
Ilim	Current Programmed Through the LIM and AUT Inputs		Ilim – 10%		Ilim + 10%	mA
Iot	Off-hook Detection Threshold		5.6		9.8	mA
Hys	Off-hook/on-hook Hysteresis		1.5		2.5	mA
Iigk	Longitudinal Line Current with GDK Detect		6.5		15	mA

POWER-DOWN

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{CN}	Input Voltage at Pin COMP to Set the Output Pin ONHK = 1				– 50	mV
V_{CF}	Input Voltage at Pin COMP to Set the Output Pin ONHK = 0		50			mV
I_{COM}	Output Current at Pin COMP	COMP = GND		20		µA

SUPPLY CURRENT

Symbol	Parameter		Min.	Typ.	Max.	Unit
I_{DD}	Positive Supply Current CS = 1	Power Down/aut. Stand-by		7.0		mA
		Stand-by		8.8		mA
		Conversation		13.2		mA
		Ringing		12.8		mA
I_{SS}	Negative Supply Current CS = 1	Power Down/aut. Stand-by		6.4		mA
		Stand-by		6.4		mA
		Conversation		8.2		mA
		Ringing		8.2		mA
I_{BAT-}	Negative Battery Supply Current Line Current = ∅mA	Power Down-aut. Stand-by		0		mA
		Stand-by		2.9	4	mA
		Conversation		9.8	12	mA
		Ringing		26	28.5	mA
I_{BAT+}	Positive Battery Supply Current Line Current = ∅mA	Power Down-aut. Stand-by		0		mA
		Stand-by		10	15	µA
		Conversation		10	15	µA
		Ringing		16	18.5	mA

AC OPERATION

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Zlx	Sending Output Impedance on TX				15	Ω
THD	Signal Distortion at 2W and 4W Terminals	Vtx = 0dBm @ 1020Hz			0.5	%
Rl	2W Return Loss	f = 300 to 3400Hz	20			dB
Thl	Transhybrid Loss	f = 300 to 3400Hz	24			dB
Gs	Sending Gain	Vso = 0dBm f = 1020Hz	– 0.25		+ 0.25	dB
Gsf	Sending Gain Flatness vs. Frequency	f = 300 to 3400Hz Respect to 1020Hz	– 0.1		+ 0.1	dB
Gl	Sending Gain Linearity	fr = 1020Hz Vsoref = – 10dBm Vso = + 4/– 40dBm	– 0.1		+ 0.1	dB
Gr	Receiving Gain	Vri = 0dBm ; f = 1020Hz	– 0.25		+ 0.25	dB
Grf	Receiving Gain Flatness	f = 300 to 3400Hz Respect to 1020Hz	– 0.1		+ 0.1	dB
Grl	Receiving Gain Linearity	fr = 1020Hz Vriref = – 10dBm Vri = + 4/– 40 dBm	– 0.1		+ 0.1	dB
Np4W	Psophomet. Noise 4W - Tx Terminals		– 70	– 75		dBmp
NP2W	Psophomet. at Line Terminals		– 70	– 75		dBmp
SVRR	Supply Voltage Rejection Ratio Relative to VB–	f = 10Hz Vn = 0.7Vrms		– 20		dB
		f = 1KHz Vn = 0.7Vrms			– 40	dB
		f = 3.4KHz Vn = 0.7Vrms			– 36	dB
Ltc	Longitudinal to Transversal Conversion	f = 300 to 3400Hz I line = 30mA ZML = 600Ω	49(*)	60		dB
Tlc	Transversal to Longitudinal Conversion		49(*)	60		dB

(*) : up to 52dB using selected L3000.

RINGING PHASE

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Vir	Superimposed DC Voltage	Rloop > 100KΩ	19		29	V
		Rloop = 1KΩ	17		27	V
Vacr	Ringing Signal at Line Terminal	Rloop > 100kΩ V_{RGN} = 1.5Vrms/30Hz	56.0			Vrms
		Rloop = 1KΩ + 1μF V_{RGN} = 1.5Vrms/30Hz	56.0			Vrms
If	DC Off-hook Del Threshold			5.5		mA
Ilim	Output Current Capability		85		130	mA
Vrs	Ringing Symmetry				2	Vrms
THDr	Ringing Signal Distorsion				5	%
Zir	Ringing Amplicat. Input Impedance	L3091's Pin RGIN	50			KΩ
Vrr	Residual of Ringing Signal at Tx Output				100	mVrms
Trt	Ring Trip Detection Time	fring = 25Hz (T = 1/fring) CINT = 470μF		120(3T)		ms
Toh	Off-hook Status Delay after the Ringing Stop				50	μs

DIGITAL INTERFACE ELECTRICAL CHARACTERISTICS

(VDD = + 5V ; VSS = – 5V ; Tamb = 25°C)

STATIC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Vil	Input Voltage at Logical "0"	Pins CS PWON RNG LIM-AUT	0		0.8	V
Vih	Input Voltage at Logical "1"		2.0		5	V
Iil	Input Current at Logical "0"	Vil = 0V			200	μA
Iih	Input Current at Logical "1"	Vih = 5V			100	μA
Vol	Output Voltage at Logical "0"	Pins ONHK GDK Iout = – 1mA			0.4	V
Voh	Output Voltage at Logical "1"	Iout = 1mA	2.4			V
Ilk	Tristate Leak Current	CS = "1"			10	μA
I_{MR}	Pull-up MR Output Current	MR = 0		50		μA

DYNAMIC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Tsd	PWON, RNG, AUT, LIM		400			ns
Thd	PWON, RNG, AUT, LIM		500			ns
Tww	CS Impulse Width (writing op.)		800			ns
Thv	ONHK, GDK Data Out to "0" CS Delay				600	ns
Tvh	ONHK, GDK High Imped. to "1" CS Delay				600	ns
Twr	CS Impulse Width (writing op.)		800			ns

Figure 8 : Writing Operation Timing (controller to SLIC).

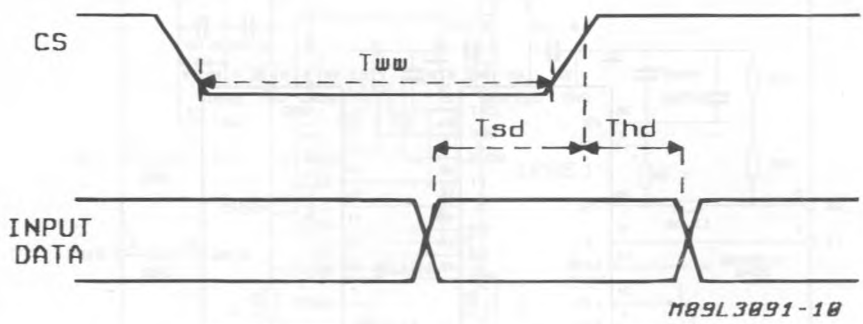


Figure 9 : Reading Operation Timing (from slic to controller).

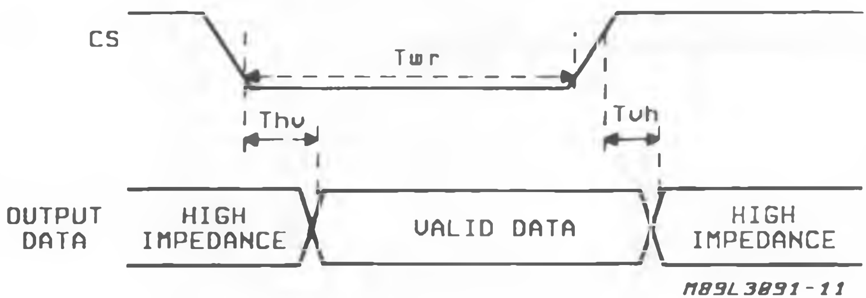
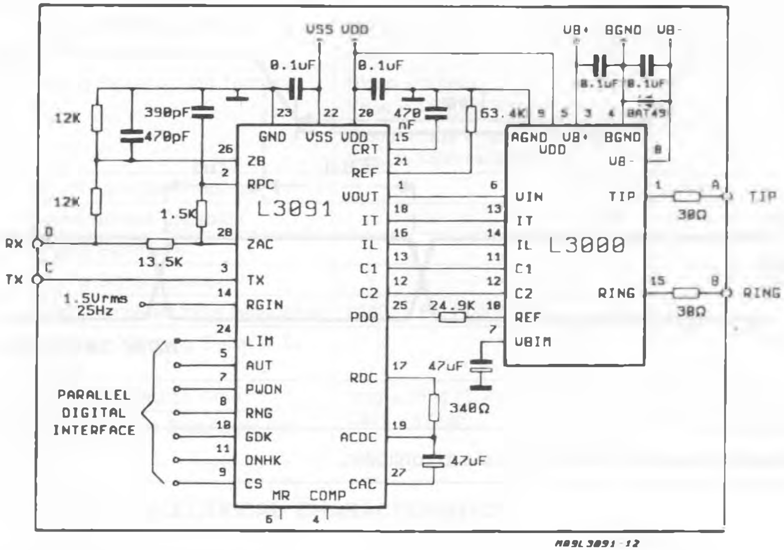
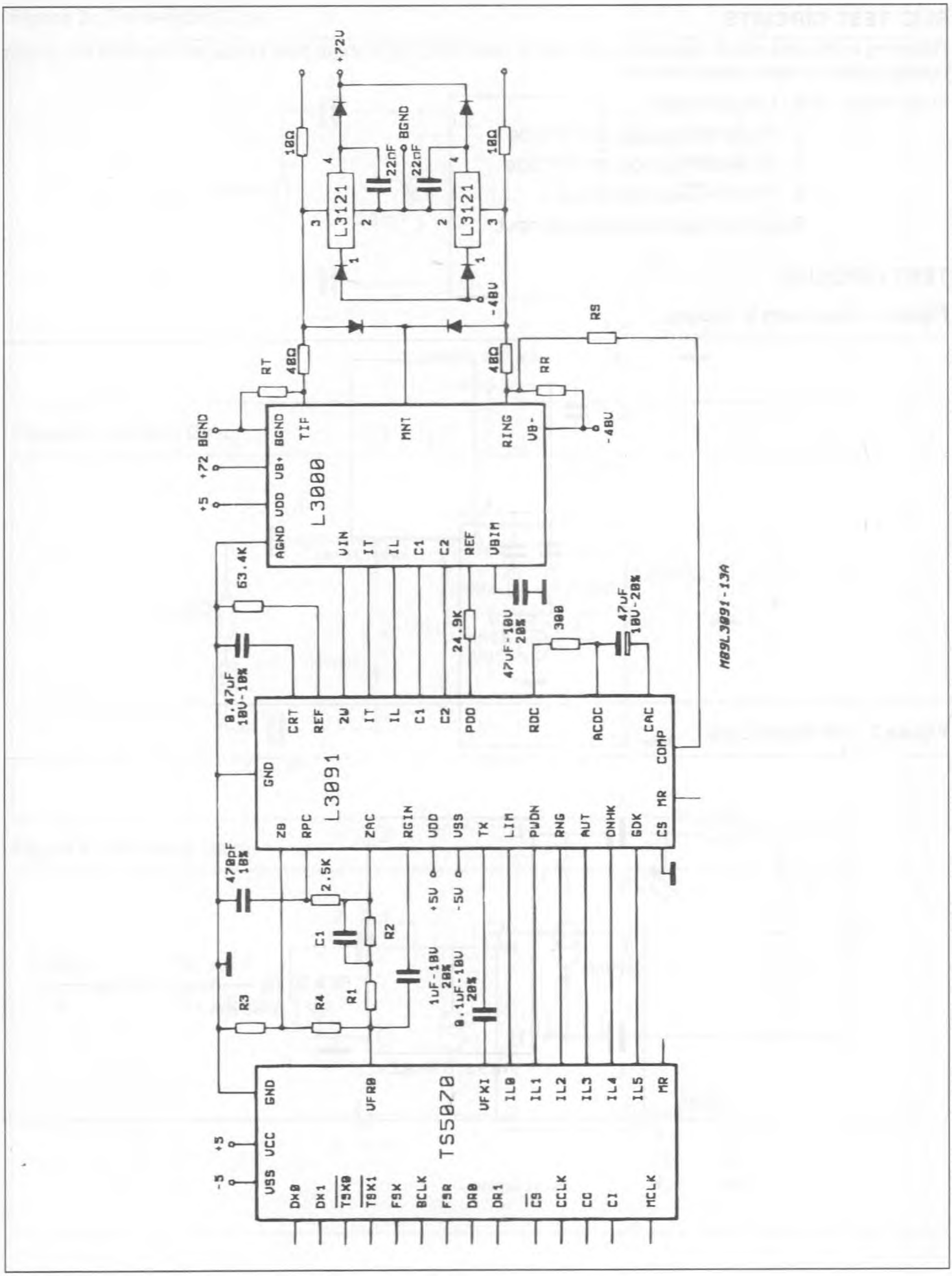


Figure 10 : Test Circuit.



A, B, C, D are test reference points use driving testing.

Figure 11 : Typical Application Circuit for Complete Subscriber Circuit (Protection - SLIC - COMBO).



APPENDIX A

SLIC TEST CIRCUITS

Referring to the test circuit reported at the end of each SLIC data sheet here below you can find the proper configuration for each measurement.

In particular : A-B : Line terminals

C : Tx sending output on 4W side

D : Rx receiving input on 4W Side

E : TTx teletaxe signal input

R_{GIN} : low level ringing signal input.

TEST CIRCUITS

Figure 1 : Symmetry to Ground.

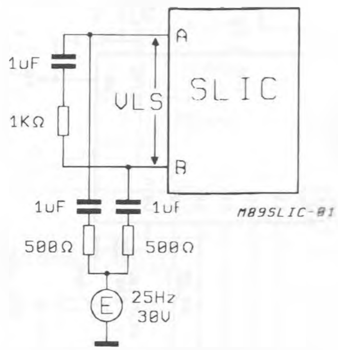
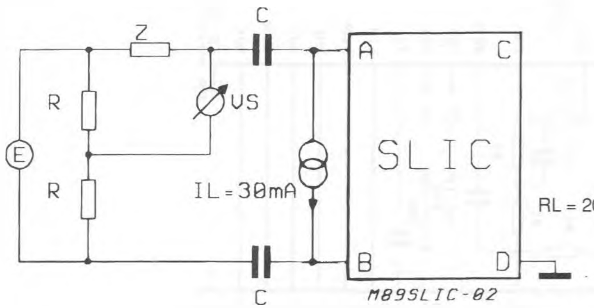


Figure 2 : 2W Return Loss.



$$RL = 20 \log \frac{|Z_{ML} - Z|}{|Z_{ML} + Z|} = 20 \log \frac{|2Vs|}{|E|}$$

TEST CIRCUITS (continued)

Figure 3 : Trans-hybrid Loss.

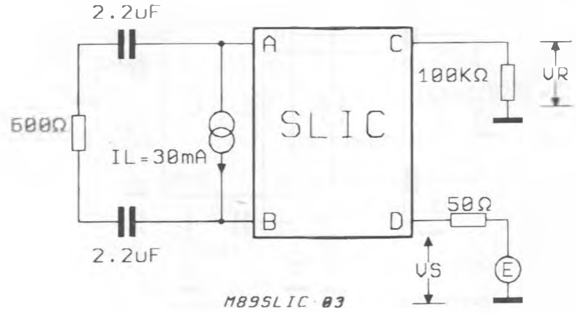


Figure 4 : Sending Gain.

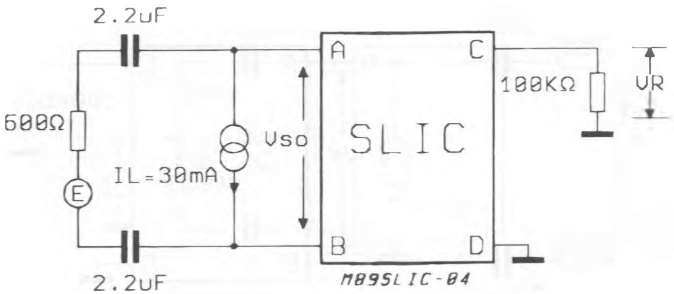
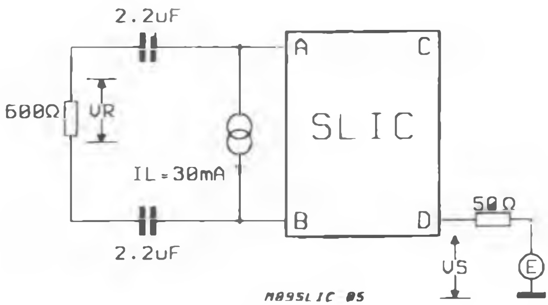


Figure 5 : Receiving Gain.



TEST CIRCUITS (continued)

Figure 6 : PSRR Relative to Battery Voltage VB–.

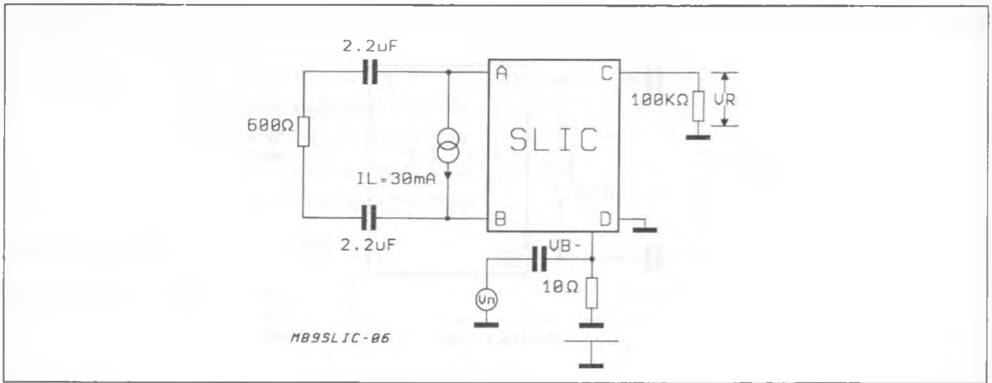


Figure 7 : Longitudinal to Transversal Conversion.

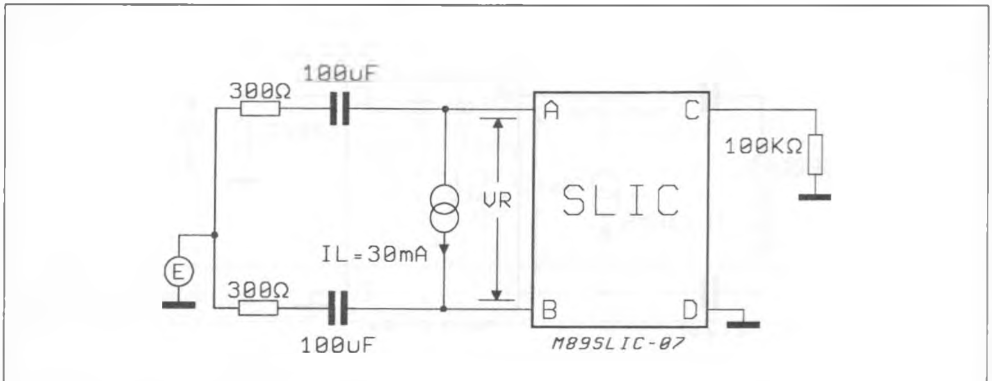
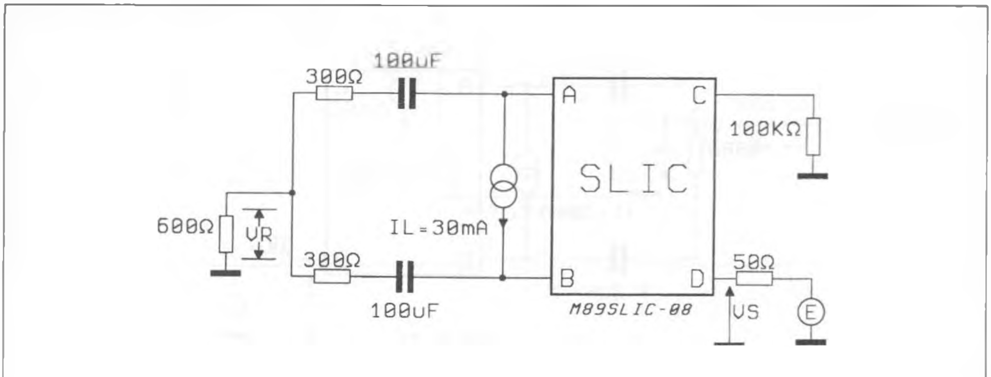


Figure 8 : Transversal to Longitudinal Conversion.



TEST CIRCUITS (continued)

Figure 9 : TTX Level at Line Terminals.

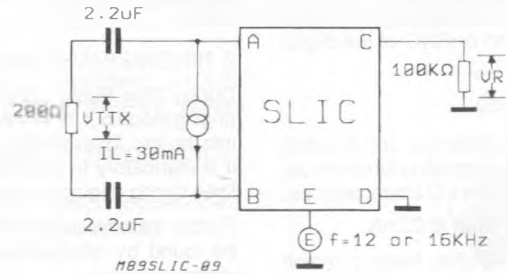
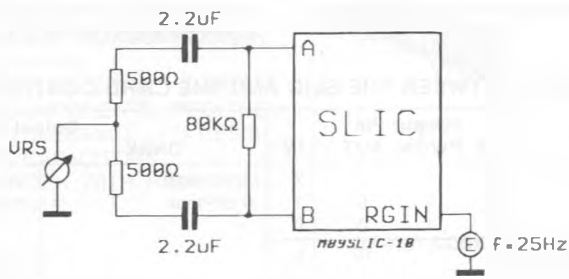


Figure 10 : Ringing Simmetery.



APPENDIX B

ADDITIONAL OPERATING FEATURES

Two further operating modes are provided on the L3091, boosted battery and ring pause. Both of these Modes are accessed by applying a high impedance on inputs AUT and or RNG of the digital interface.

1. BOOSTED BATTERY (BB)

This operating mode is equivalent to conversation mode with respect to AC and signalling functions but with the following changes to the DC characteristics :

(a) Current limiting value is fixed at 25mA.

(b) Characteristic in the resistive feeding region corresponds to a battery voltage equal to $(-15 + |VB-| + VB+)$ Volt in series with the same feeding resistor utilized in the DC characteristic of conversation mode.

BB mode is typically used to feed long lines (20mA/4KΩ) and to implement special functions such as message waiting where high voltage signals are required.

Further information about this operating mode may be found by referring to the L3000/L3030 datasheet.

2. RINGING PAUSE MODE

During Ring Pause - Mode the SLIC is always in ringing mode but the AC ringing signal is not injected into the line. This mode is used in applications where it is mandatory to avoid perturbations on adjacent lines during ringing injection.

Further information about this operating mode may be found by referring to the L3000/L3030 datasheet.

The following table shows all operating modes of L3000/L3091 SLIC KIT. Boosted Battery or Ringing Pause Modes are selected by applying a high impedance (HI) to input pins RNG and/or AUT.

Included also in this table are the operating modes to which the SLIC defaults automatically during ringing mode when OFF HOOK is detected.

CONTROL INTERFACE BETWEEN THE SLIC AND THE CARD CONTROLLER

Operating Mode	Input Pin RNG	Input Pin PWON	Input Pin AUT	Input Pin LIM	Output Pin ONHK	Output Pin GDK
Conversation 25mA	0	1	1	X	1 on-hook 0 off-hook	1 Ground key not detected. 0 Ground key detected.
Conversation 42mA	0	1	0	1		
Conversation 62mA	0	1	0	0		
Boosted Battery 25mA	0	1	HI	X		
Stand-by	0	0	0	X		Disable
Automatic Stand-by	1	0	1	X		
Power-down	1	0	0	X	C1 Comparator Output	Disable
Test Mode	0	0	1	X	1 on-hook 0 off-hook	0 Limiting Region 1 Resistive Region
Ringing Inj. (CVS 25mA)	1	1	1	X	1 on-hook 0 off-hook	Disable
Ringing Inj. (CVS 42mA)	1	1	0	1		
Ringing Inj. (CVS 62mA)	1	1	0	0		
Ringing Inj. (BB 25mA)	1	1	HI	X		
Ringing Pause (CVS 25mA)	HI	1	1	X		
Ringing Pause (CVS 42mA)	HI	1	0	1		
Ringing Pause (CVS 62mA)	HI	1	0	0		
Ringing Pause (BB 25mA)	HI	1	HI	X		

NB : HI = High Impedance.
BB = Boosted Battery.