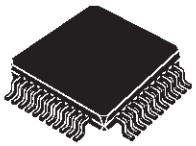
STLC3080

SUBSCRIBER LINE INTERFACE CIRCUIT

PRELIMINARY DATA

- MONOCHIP SLIC SUITABLE FOR PUBLIC APPLICATIONS
- IMPLEMENTES ALL KEY FEATURES OF THE BORSHT FUNCTION
- DUAL CONTROL MODE CONFIGURATION: SLAVE MODE OR AUTOMATIC ACTIVATION MODE.
- SOFT BATTERY REVERSAL WITH PROGRAMMABLE TRANSITION TIME
- ON HOOK TRANSMISSION
- LOOP START/GROUND START FEATURE WITH PROGR. THRESHOLD
- LOW POWER DISSIPATION IN ALL OPERATING MODES
- AUTOMATIC DUAL BATTERY OPERATION
- INTEGRATED RING TRIP DETECTION WITH AUTOMATIC AND SYNCRONISED RING DISCONNECTION
- METERING PULSE INJECTION
- SURFACE MOUNT PACKAGE
- THREE RELAY DRIVERS FOR RING AND TESTING



TQFP44 (10 x 10)

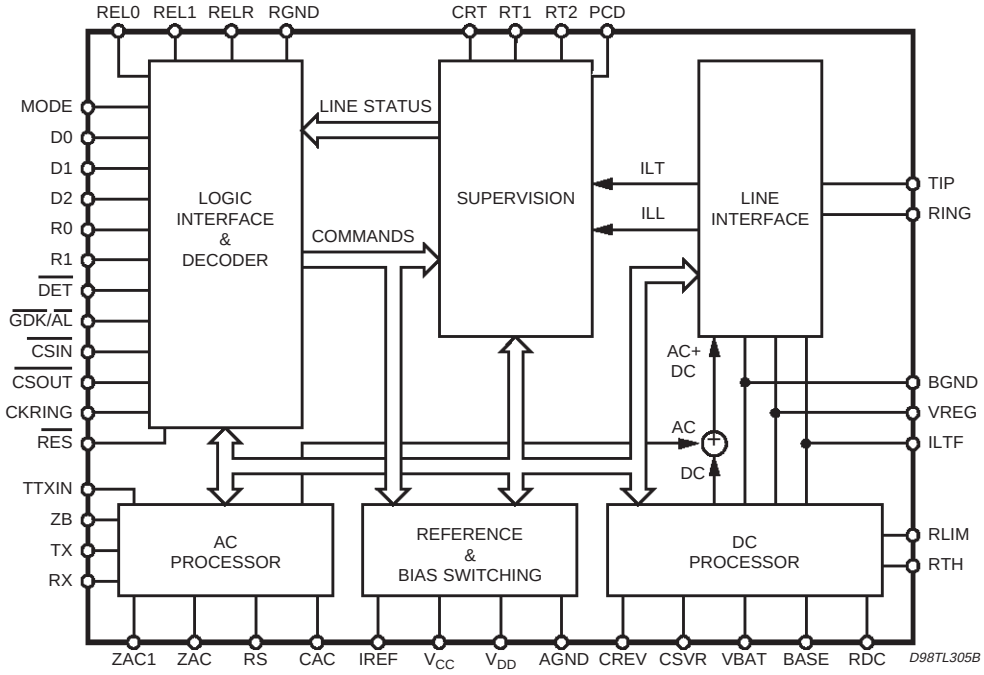
ORDERING NUMBER: STLC3080

- -40 TO +85°C OPERATING RANGE

DESCRIPTION

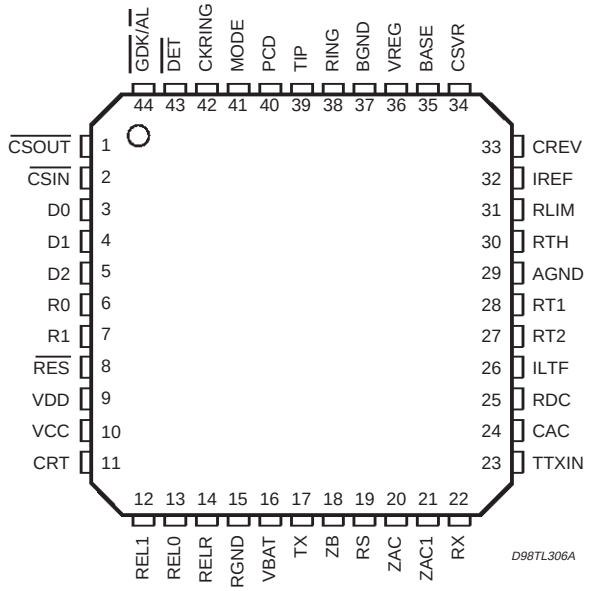
The STLC3080 is a SLIC device suitable for a wide range of applications: public (CO), transmission (DLC) and private (PABX). The SLIC provides the standard battery feeding with full programmability of the DC characteristic. In particular two external resistors allow to set the limiting current value (up to 50mA) and the value of the resistive feeding when not in constant current region.

BLOCK DIAGRAM



This is preliminary information on a new product now in development or undergoing evaluation.

PIN CONNECTION



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{BAT}	Battery voltage	-80 + V_{CC} to +0.4 -80 + V_{REL} to + 0.4	V V
V_{CC}	Positive supply voltage	-0.4 to +7	V
V_{DD}	Control Interface Supply Voltage	-0.4 to +7	V
I_{REL}	Current into relay drivers	80	mA
A/R/BGND	AGND respect BGND respect RGND	-2 to +2	V

OPERATING RANGE

Symbol	Parameter	Value	Unit
T_{opT}	Operating temperature range	-40 to +85	°C
V_{CC}	Positive supply voltage	4.75 to 5.25	V
V_{DD}	Control Interface Supply Voltage	3 to 5.25	V
V_{BAT}	Battery voltage if VREL > V_{CC}	-73 to -15 -78 + V_{REL} to -15	V V
A/R/BGND	AGND respect BGND respect RGND	-0.3 to +0.3	V
PD (70)	Max. power dissipation @ Tamb = 70°C	1.1	W
PD(85)	Max. power dissipation @ Tamb = 85°C	0.9	W

THERMAL DATA

Symbol	Parameter	Value	Unit
$R_{th\ j\text{-}amb}$	Thermal resistance Junction to Ambient Typ.	60	°C/W

PIN DESCRIPTION

Pins	Name	Description
1	$\overline{\text{CSOUT}}$	Chip-Select for output control bits $\overline{\text{DET}}$ and $\overline{\text{GDK}}$. Active Low. (*)
2	$\overline{\text{CSIN}}$	Chip-Select for input control bits latches D0 D1 D2 R0 R1 . Active Low. (*)
3	D0	Control Interface input bit 0. (*)
4	D1	Control Interface input bit 1. (*)
5	D2	Control Interface input bit 2. (*)
6	R0	Relay driver 0 command. Active High. (*)
7	R1	Relay driver 1 command. Active High. (*)
8	$\overline{\text{RES}}$	Reset Input; active low.
9	V_{DD}	Control interface Power Supply. V_{DD} = 3.3V or V_{DD} = V_{CC}.
10	V_{CC}	Positive Power Supply (+5V).
11	CRT	Ring-Trip time constant capacitor.
12	REL1	Relay 1 driver output.
13	REL0	Relay 0 driver output.
14	RELR	Ringer Relay driver output.
15	RGND	Relay drivers ground.
16	V_{BAT}	Negative Battery Supply.
17	TX	4 wires output stage (Transmitting Port).
18	ZB	Cancelling input of Balance Network for 2 to 4 wires conversion.
19	RS	Protection resistors image. The image resistor is connected between this node and ZAC.
20	ZAC	AC impedance synthesis.
21	ZAC1	RX buffer output/ AC impedance is connected between this node and ZAC.
22	RX	4 wires input stage (Receiving Port). A 100K external resistor must be connected to AGND to bias the input stage.
23	TTXIN	Metering Signal Input (AC) and Line Voltage Drop Programming (DC). If not used must be connectd to AGND.
24	CAC	AC feedback input/ AC-DC split capacitor is connected between this node and ILTF.
25	RDC	DC current feedback input. The RDC resistor is connected between this node and ILTF.
26	ILTF	Transversal Line Current Image.
27	RT2	Input pin to sense ringing current , for Ring-Trip detection.
28	RT1	Input pin to sense ringing current , for Ring-Trip detection.
29	AGND	Analog ground.
30	RTH	Off-Hook threshold programming pin.
31	RLIM	Limiting current programming pin.
32	IREF	Voltage reference output to generate internal reference current.
33	CREV	Reverse polarity transition time programming.
34	CSVR	Battery supply filter capacitor.
35	BASE	Driver of the external transistor. Connected to the base.
36	VREG	Regulated voltage. Provides the negative supply to the power line drivers. It is connected to the emitter of the external transistor.
37	BGND	Battery ground.
38	RING	B wire termination output. IB is the current sunk into this pin.
39	TIP	A wire termination output. IA is the current sourced from this pin.
40	PCD	Power Cross Detection Input
41	MODE	Interface Control Mode selection.
42	CKRING	Clock at ringing frequency for relay synch and time reference for Automatic activation
43	$\overline{\text{DET}}$	Off-hook and Ring-Trip detection bit. Tri-State Output/Active Low.
44	$\overline{\text{GDK/ AL}}$	Ground-Key/Alarm detection bit. Tri-State Output. Active Low.

* Input pins provided with 15µA sink to AGND pull-down.

CONTROL INTERFACE
Slave mode (MODE=Low).

INPUTS					OPERATING MODE	OUTPUTS	
R0	R1	D0	D1	D2		$\overline{DET}$ (Active Low)	$\overline{GDK/AL}$ (Active Low)
X	X	0	0	0	Power down	disable	disable
X	X	0	0	1	Stand-by	off/hk	gnd-key
X	X	0	1	0	Active N.P.	off/hk	gnd-key
X	X	0	1	1	Active R.P.	off/hk	gnd-key
X	X	1	0	0	Ringing (with SLIC Active N.P.)	ring/trip	disable
X	X	1	0	1	Ringing (with SLIC Active R.P.)	ring/trip	disable
X	X	1	1	0	Ground start	off/hk	gnd-key
X	X	1	1	1	High Impedance Feeding	off/hk	disable
0/1	X	X	X	X	Rel 0 (on = 1, off = 0)	def by D0-D2	def by D0-D2
X	0/1	X	X	X	Rel 1 (on = 1, off = 0)	def by D0-D2	def by D0-D2

A parallel interface allow to control the operation of STLC3080 through a control bus:

- D0 D1 D2 latched input bits defining the Slic operation mode
- R0 R1 latched input bits (active High) drive the test relays.
- $\overline{DET}$ and $\overline{GDK/AL}$, tri-state outputs, signal the status of the loop: On/Off-Hook and Ground-Key. Pin $\overline{GDK/AL}$ goes low also when the device thermal protection is activated or a line fault (Tip to Ring, Tip and/or Ring to Ground or VBAT) is detected (flowing current ≥ 7.5mA).
- $\overline{CSIN}$: chip select for input bits, active Low, strobes the data present on the control bus into the internal latch.
- $\overline{CSOUT}$: chip select for output bits ; active Low , when high $\overline{DET}$ and $\overline{GDK/AL}$ goes tri-state.

D0 D1 D2 R0 R1 $\overline{CSIN}$ and $\overline{CSOUT}$ inputs are provided with a 15µA pull-down current to prevent uncontrolled conditions in case the control bus goes floating.

According to the above table, 8 operating modes can be set:

1) Power-Down.
2) Stand-By.
3) Active N.P.
4) Active R.P.
5) Ringing (with SLIC Active N.P.).
6) Ringing (with SLIC Active R.P.).
7) Ground start.
8) High Impedance Feeding.

Power-Down

It's an idle state characterised by a very low power consumption; any functionality is disabled; only relays Rel0 and Rel1 can be driven by proper setting of bits R0 and R1.

It can be set during out of service periods just to reduce the power consumption.

It is worth noticing that two other conditions can set the Slic in idle state but with some differences as reported in the table:

Idle State	Rel0/1 Drive	$\overline{DET}$	$\overline{GDK/AL}$
Power Down	Enable	Disable	Disable
Reset	Disable	Disable	Disable
Thermal Alarm	Enable	Low	Low

Stand-By.

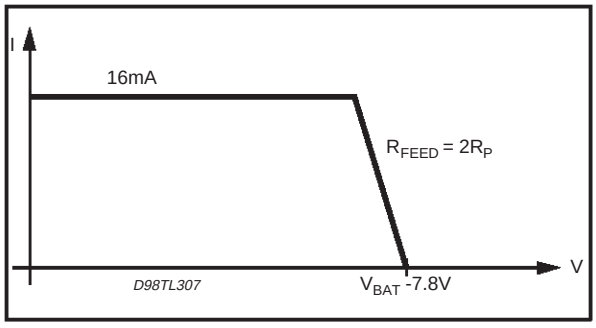
Mode selected in On-Hook condition when high immunity to common mode currents is needed for the $\overline{DET}$ bit.

To reduce the current consumption, AC feedback loop is disabled and only $\overline{DET}$ and $\overline{GDK/AL}$ detectors are active.

DC current is limited at 16mA (not programmable); feeding characteristic shown in fig. a.

The voltage drop in on-hook condition is 7.8V.

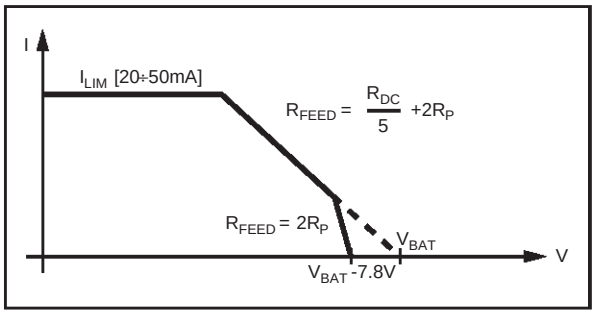
Figure a: STLC3080 DC Characteristic in Stand-By Mode.



Active

Mode selected to allow voice signal transmission. When in ACTIVE mode the voltage drop in on-hook condition is 7.8V in order to allow proper on-hook transmission (Fig. b).

Figure b. STLC3080 DC Characteristic in Active Mode.



Resistive Region is programmable by means of external resistor R_{DC}, limiting current can be selected by R_{LIM} resistor.

Concerning AC characteristic the STLC3080 allows to set 2W termination impedance by means of one external scaled impedance that may be complex. Two to four wire conversion is provided by an external network. Such network can be avoided in case of application with COMBOII, in this case the two to four wire conversion is implemented inside the COMBOII by means of the programmable Hybal filter.
When in ACTIVE mode it is also possible to perform battery reversal in soft mode (with programmable transition time) without affecting the AC signal transmission.

Ringing

When Ringing mode is selected the STLC3080 activates the ring relay injecting the ringing signal on the line. As the ring trip is detected the logic indicator $\overline{DET}$ is set low and the ringing is automatically disconnected without waiting for the card controller command (auto ring trip).

$\overline{DET}$ remains latched Low untill the operative mode is modified.

If required , the ringing relay drive signal RELR can be synchronised to a clock applied to CKRING input.

This clock is derived from the ringing signal with proper time delay, according to the activation/deactivation time of the relay.

RELR is activated on the low level of CKRING clock. The duty cycle of CKRING can be modified in order to activate the RELR when required: CKRING low must last 1µs minimum.

If the synchronisation is not required, CKRING input must be steadily kept Low.

All the STLC3080 relay drivers are open drain with the source connected to the RGND pin. Each relay drivers integrates a protection structure that allows to avoid external kick - back diodes, using both 5V or 12V relays.

The ring trip circuit and its behaviour is described in Appendix D.

Ground Start.

This mode is selected when the SLIC is adopted in a system using the Ground Start feature. In this mode the TIP termination is set in High Impedance (100kΩ) while the RING one is active and fixed at Vbat +4.8V. In the case of connection of RING termination to GND the sinked current is limited to 30mA. When RING is connected to GND both Off-Hook and Ground-Key detectors become active. Power dissipation in this mode with a -48V battery voltage is 100mW

High Impedance Feeding.

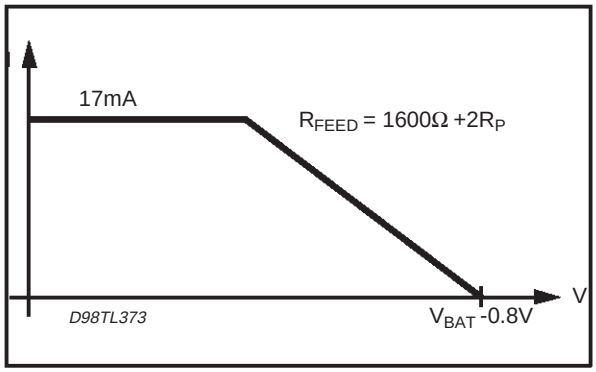
As Stand-By, this mode is set in On-Hook condition, with further reduced power consumption.

Higher power efficiency turns back a lower immunity of the Off-Hook detector to line common mode currents.

The DC feeding shows a constant current characteristic (I_{lim} = 17mA) followed by a resistive range with an equivalent series resistance R_{FEED} = 1600Ω + 2Rp.
Thermal protection circuit is still active, preventing the junction temperature, in case of fault condition, to exceed 150°C

In High Impedance Feeding most of the circuit is switched off, only the circuit, dedicated to Off-Hook detection, is powered. This allows to reduce the total power consumption in On-hook to 30mW (typical).
The Off-Hook detection threshold is not programmable but defined at a fixed $\overline{IDET}_{HI}$ = 8mA(max.)

Figure c. STLC3080 DC Characteristic in High Impedance Feeding



CONTROL INTERFACE
Automatic activation mode (MODE=High).

Inputs						Operating Mode (Mode = High)	Outputs	
R0	R1	D0	D1	D2	RES		DET	GDK/AL
X	X	0	0	0	1	Power Down	disable	disable
X	X	0	0	1	1	Ringing	Ring-Trip	disable
X	X	0	1	0	1	On-Hook Transmission Reverse Polarity	Off-Hook Fault	Fault
X	X	0	1	1	1	On-Hook Transmission Direct Polarity	Off_Hook Fault	Fault
X	X	1	0	0	1	Active Direct Polarity (default)	Off_Hook Fault	Fault
X	X	1	0	1	1	Active Direct Polarity (default)	Off_Hook Fault	Fault
X	X	1	1	0	1	Active Reverse Polarity	Off_Hook Fault	Fault
X	X	1	1	1	1	Active Direct Polarity (default)	Off_Hook Fault	Fault
0/1	X	X	X	X	1	R0 = 0/1: Rel0 = off/on	(1)	(1)
X	0/1	X	X	X	1	R1 = 0/1: Rel1 = off/on	(1)	(1)
X	X	X	X	X	0	Power Down; Rel0/1 = off	disable	disable

DET: On/Off Hook Signalling; together with GDK/AL it is set Low also in case of Thermal Alarm or Ground-Key.
GDK/AL : Thermal Alarm or Ground-Key Signalling
(1) : DET and GDK/AL signalling function is related to D0,D1,D2 and it doesn't depend on R0 and R1 setting.

As in Slave mode the control is performed through a parallel bus, with independent chip selects, CSIN and CSOUT, for inputs and outputs.

In Automatic Activation, once Active mode is selected the device automatically selects the proper operating mode (Active, Stand By or H.I. feeding) depending on the loop status in order to optimise the power consumption.

In order to guarantee the proper behaviour of the internal state machine the "CKRING" signal must be always applied, this signal in fact is used to generate the "WTIME" delay (see Appendix) necessary to properly perform automatic state change.

Power-Down

It's an idle state characterised by a very low power consumption; any functionality is disabled; only relays Rel0 and Rel1 can be driven by proper setting of bits R0 and R1.

It can be set during out of service periods just to reduce the power consumption.

It is worth noticing that two other conditions can set the Slic in idle state but with some differences as reported in the table:

Idle State	Rel0/1 Drive	DET	GDK/AL
Power Down	Enable	Disable	Disable
Reset	Disable	Disable	Disable
Thermal Alarm	Enable	Low	Low

Ringing

When Ringing mode is selected the STLC3080 activates the ringing relay injecting the ringing signal on the line.

As a Ring-Trip is detected the logic indicator DET is set Low and the ringing relay is automatically switched-off without waiting for the card controller command (auto ring-trip).

DET remains latched Low until the operative mode is modified.

Ringing relay drive signal RELR must be synchronised to a clock applied to CKRING input. This clock is derived from the ringing signal with proper time delay, according to the activation / deactivation time of the relay.

RELR is activated on the low level of CKRING clock. The duty cycle of CKRING can be modified in order to activate the RELR when required: CKRING low must last 1µs minimum.

All the relay drivers are open-drain with the source connected to RGND pin.

Each relay driver integrates a protection structure to avoid external kick-back diodes using both 5V or 12V relays.

The ring trip circuit and its behaviour is described in Appendix D.

On-Hook Transmission.

Sets the Slic for conversation even though the line is in On-Hook; it is required for On/Hook transmission purposes; Active mode cannot support a conversation when the line is in On-Hook as it automatically turns in High Impedance Feeding.

Active.

The relevant feature of this setting is that when Active Mode (D0D1D2=1XX) is set by the external control , internally, the device is able to select between three operative states according to the status of the line:

- High Impedance Feeding :

entered after a Power-On Reset or 1XX word, this status is set during steady On/Hook condition;

most of the circuitry is idle and only a low power Off-Hook detection circuit is kept alive.

Direct Polarity only is assumed , independently of the selected one.

To minimise the power consumption the Off-Hook detection circuit has low common mode current rejection.

- Stand by

Notice that in Stand-By state the Off-Hook detector is sensitive only to the transversal component of the line current with high immunity to common mode disturbances; this performance implies an increasing in power consumption: for that reason Stand-By is not used as a quiescent state.

- Active state gets operative for conversation after an Off-Hook validity check performed in Stand-By state, set after any Off-Hook detected in High Impedance Feeding.

If the Off-Hook condition is confirmed in Stand By, Active mode is set ; if not (in case of spurious detection), false activation is prevented, and High Impedance Feeding is resumed.

In order to have the device falling back in HI-feeding mode after the line is back in on-hook condition. It is necessary to select as input state the active direct polarity mode (default).

During Active state On/Off-Hook status will affect in real time $\overline{DET}$ signalling bit.

In order to allow Pulse-Mode Dialling, once Active state is set, it cannot be changed by fast On-Hook , but it is turned back to High Impedance Feeding only if an On-Hook condition lasts longer than 128 x CKRING period.

Automatic activation (and deactivation) is based on an internal state-machine which is clocked by a free running internal oscillator.
A detailed description is reported in the Appendix A.

DUAL BATTERY CONFIGURATION

STLC3080 is also meant for low power consumption systems using Dual Battery solution. It is sufficient to connect the collector of the external transistor, through a diode, to the reduced battery (see Fig. 2 for single battery solution and Fig. 3 for dual battery solution). The activation of the batteries is automatic, only depending on the DC load at the RING and TIP terminals; no controllers action is required.

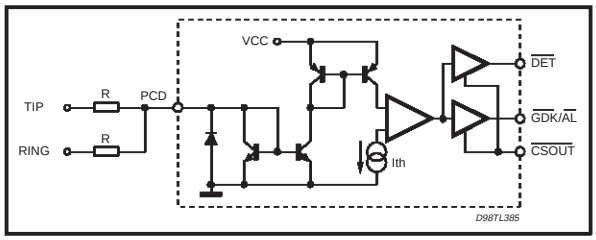
PROTECTION CIRCUIT

- Suggested protection circuit is based on programmable Trisils (like LCP1511/2) as shown in Fig.2 and Fig. 3, and the surge current is limited by the resistors RPT2 and RPR2, which are PTC types , protecting the device against both lightning and power-cross.
- Additionally, STLC3080 is provided with the PCD input to directly monitor overvoltages applied to the line wires.

When the current injected into PCD exceeds a threshold of 320µA (+/- 30%) , $\overline{DET}$ and $\overline{GDK/AL}$ are set Low signalling a fault condition. No change on the SLIC mode is performed.

Voltage threshold is defined by proper value of the series resistors (see Fig.1)

Figure 1.



This circuit gives the possibility to protect the device against power crosses through a relay instead of PTCs; once the fault condition is detected the controller drives this relay disconnecting the Slic from the line terminals.

METERING PULSE INJECTION

STLC3080 provides external pins and components for Metering Pulse injection. TTXIN pin is the input for the 12kHz or 16kHz Metering Pulse injection. This pin also provides a DC constant current source that is injected into the external RDA resistor (typ. 10kΩ to obtain 2.2Vrms on 200Ω) connected between TTXIN pin and AGND. The voltage drop across TIP and RING line amplifiers and, consequentallythe AC swing available.

When Metering Pulse injection is not used and voltage drop is not required, TTXIN must be shorted to AGND and RTTX, RDA and CTTX external components must be removed. The TTX cancellation is obtained through an external RTTX and CTTX network connected between TTXIN and CAC pins.

Fault detection

The device provides current sense on TIP and RING wires that allow to detect longitudinal DC current (I_{LL}). When this I_{LL} current becomes higher than a threshold (see detectors table inside electrical characteristics) a fault indication is provided on DET and GDK pin (both outputs become low). The fault indication is active till the fault cause persists. With this circuit the following fault condition can be detected.

TIP to VB1
TIP to GND
RING to VB1
RING to GND
RING to TIP to VB1

When a fault is detected the line current is limited in order to avoid any damage on the device itself and also on the external transistor.

MISCELLANEOUS

- Thermal overload: the integrated thermal protection is activated when Tj reaches 150°C typ.: the Slic is forced in Power-down mode, DET and AL are set Low. The RELR relay driver is turned off while it is still possible to control REL0 and REL1 through R0 and R1 inputs.
- One low cost external transistor allows to reduce the power dissipated in the SLIC itself allowing the use of extreme small size package (TQFP44). The external transistor size/package can be selected depending on the max. power requested by the particular application.
- The SLIC supports loop start lines and gives the possibility to set loop current indicator threshold by means of one external resistor.

EXTERNAL COMPONENTS LIST

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

- The DC feeding resistance "Rfeed" defined as the resistance of the traditional feeding system (most common Rfeed values are: 400, 800, 1000 ohm).
- The AC SLIC impedance at line terminals "Zs" to which the return loss measurements is referred. It can be real (typ. 600 ohm) or complex.
- The equivalent AC impedance of the line "Zl" used for evaluation of the trans-hybrid loss performance (2/4wire conversion). It can be a complex impedance.
- The value of the two protection resistors Rp in series with the line termination.
- The reverse polarity transition time defined as "$\Delta V_{TR}/\Delta T$".
- The constant current limit value "I_{lim}".
- Rth: sets the OFF/Hook DETection threshold

Once, the above parameters are defined, it is possible to calculate all the external components using the following table.

EXTERNAL COMPONENTS

Name	Function	Formula	Typical Value
CVCC	Positive Supply Filter		100nF ±20%
CVB	Battery Supply Filter		100nF ±20% 100V
R_{REF} (*)	Internal current reference programming resistor	$I_{REF} = \frac{1.16}{R_{REF}}$	30.1kΩ ± 1%
C_{SVR}	Battery ripple rejection capacitance	$C_{SVR} = \frac{1}{2\pi \cdot fp \cdot 1.3M\Omega}$	100nF ±10% 100V @ fp = 1.22Hz
C_{RT}	Ring Trip capacitance	see Appendix D	470nF ±20% 6V @ 25Hz
R_{DC}	DC sinthesized resistance programming resistor	$R_{DC} = 5[R_{feed} - 2Rp]$ $R_{DC} \geq 1k\Omega$	1.5kΩ ±1%
C_{AC}	AC/DC splitter capacitance	$C_{AC} = \frac{1}{2\pi \cdot fsp \cdot R_{DC}}$	10µF ±20% 15V @ fsp = 10Hz
R_S	Protection resistor image	$R_S = 25 \cdot 2Rp$	2.5kΩ ±1%
ZAC	2 wire AC impedance	$Z_{AC} = 25[Zs - 2Rp]$	12.5kΩ ±1%
ZA	SLIC impedance balancing network	$ZA = 25 \cdot Zs$	15kΩ ±1%
ZB	Line impedance balancing network	$ZB = 25 \cdot Zl$	15kΩ ±1%
C_{COMP}	AC feedback compensation capacitance	$C_{COMP} = \frac{2}{2\pi \cdot fo[100 \cdot Rp]}$	220pF ±20% @ fo = 250kHz
RR	Feeding resistance for Ring Injection	≥400Ω	600Ω 2W
RS1	Sensing resistor for Ring Trip	1000 · RR	600kΩ ±1%
RS2	Sensing resistor for Ring Trip	1000 · RR	600kΩ ±1%
RT	Feeding resistance for Ring Injection	≥0Ω	0Ω
Q_{EXT}	External transistor	(1)	BD140
RPT1	Line series resistor	≥20Ω	
RPR1	Line series resistor	≥20Ω	20Ω 1/4W ±1%

EXTERNAL COMPONENTS (continued)

Name	Function	Formula	Typical Value
R_{LIM} (*)	Current limiting setting resistor	$R_{LIM} = 10^3 \cdot \frac{1.16}{I_{LIM}}$ 23.2kΩ ÷ 58kΩ	51.1kΩ ±1%
R_{TH} (**)	OFF/HOOK $\overline{\text{DET}}$ection threshold setting resistor.	$R_{TH} = 200 \cdot \frac{1.16}{I_{TH}}$ 21.1kΩ ÷ 77.3kΩ	26.1kΩ ±1%
C_{REV}	Polarity reversal transition time programming	$C_{REV} = \frac{K}{\frac{\Delta V_{TR}}{\Delta T}}$; $K = \frac{1}{3750}$	47nF for 5.67V/ms
RDA	Output Voltage Drop Adjustment	$RDA = \frac{\Delta Drop \cdot 20k\Omega}{9.6 - \Delta Drop}$	10kΩ (ΔDrop = 3.2V) (2)
R1, R2	Power Cross Detection		240kΩ (3)
R_{TTX}	Teletax Cancellation Resistor	$R_{TTX} = 12.5 \cdot [Re(ZL_{TTX}) + 2R_P]$	3.75kΩ
C_{TTX}	Teletax Cancellation Capacitor	$C_{TTX} = \frac{1}{(12.5 \cdot I_m(ZL_{TTX}) \cdot 2\pi \cdot f_{TTX})}$	20Ω 1/4W ±1%
RPT2	Protection resistor	≥ 8Ω	
RPR2	Protection resistor	≥ 8Ω	
D1	Overvoltage protection		1N4448
D2	Dual Battery Operation		1N4448
CH	Trans-Hybrid Loss Frequency Compensation	CH = CCOMP	220pF ±30%

Notes:

(1) Transistor characteristics: $h_{FE} \geq 25$, $I_C \geq 100mA$, $V_{CEO} \geq 60V$, $f_T \geq 20MHz$ in all operating range (Ic from 1 to 100mA). PDISS depends on application, see Appendix.
For SMD application possible alternatives are MJD350 in D-PACK or BCP53 in SOT223

(2) Typical value needed for 2.2Vrms metering pulse level, if no metering RDA = 0Ω.

(3) These resistors are needed to activate the power cross detection circuit, they should withstand the typical lighting voltage. If the power cross detection is not needed R1, R2 can be avoided.

(*) R_{REF} and RLIM should be connected close to the corresponding pins of STLC3080.
Avoid any digital line or high voltage swing line to pass close to I_{REF} and R_{LIM} pins. Eventually screen these pins with a GND track.

(**) Inside the formula the coefficient 1.16 must be changed to 1.20 if the selected value of I_{th} is lower than 5mA.

Figure 2. Typical application diagram.

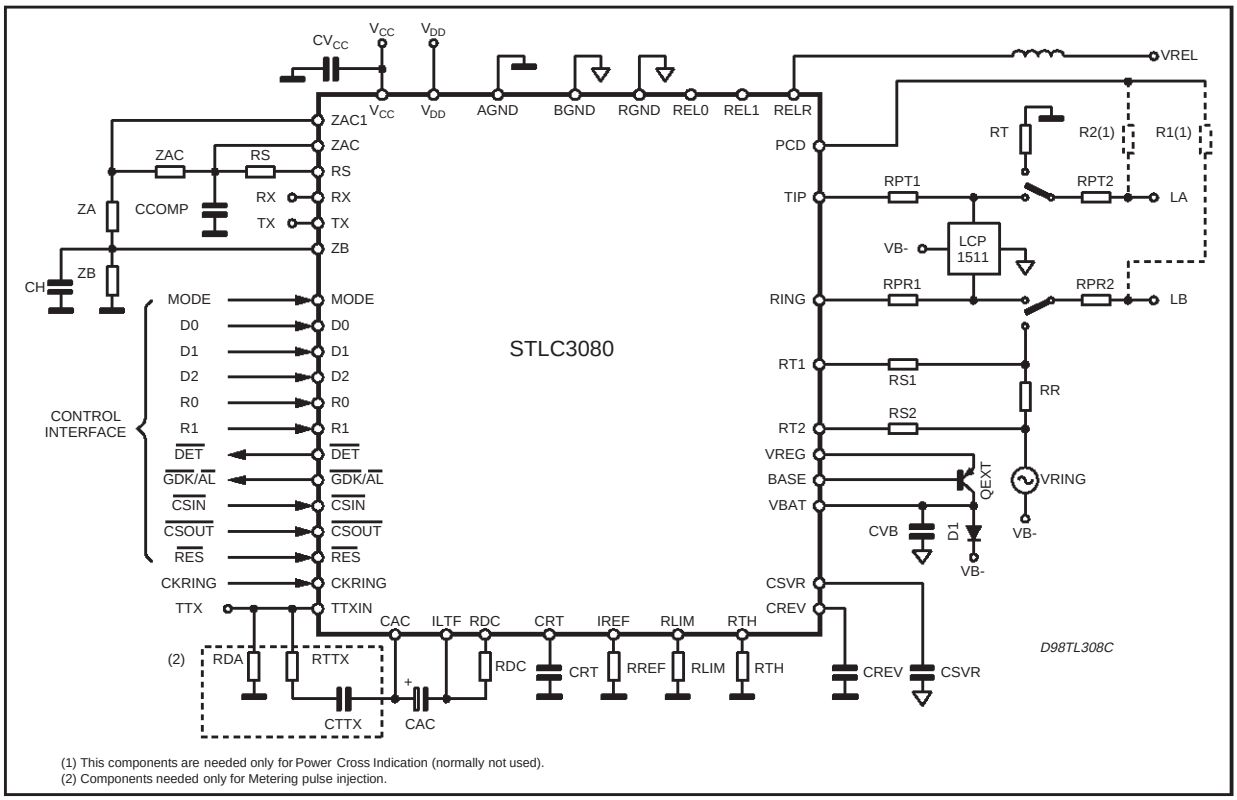
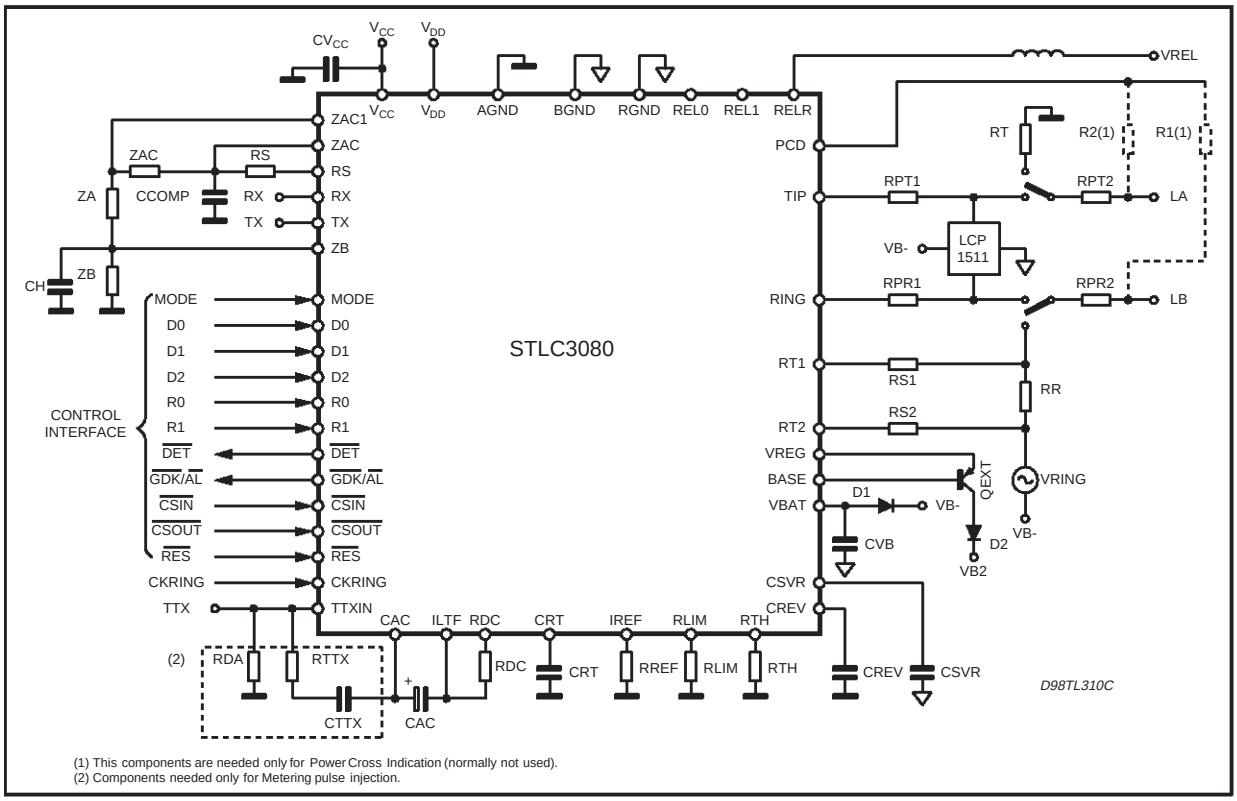


Figure 3. Typical dual battery application diagram.



ELECTRICAL CHARACTERISTICS (Test Condition, unless otherwise specified: V_{CC} = 5V, V_{DD} = 3.3V, V_{B-} = -48V, AGND = BGND = RGND, T_{amb} = 25°C).

Note: the limits below listed are guaranteed with the specified test condition and in the 0 to 70°C temperature range. Performances over -40 to +85°C range are guaranteed by product characterisation.

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
AC CHARACTERISTICS							
Zil	Long. Impedance	each wire			40	Ω	
I_{il}	Long. Current Capability AC	H.I. feeding per wire (ON-HOOK)		5		mApk	
		STANDBY or ACTIVE per wire (ON-HOOK)		13		mApk	
		ACTIVE per wire (OFF-HOOK). I_T = Transversal Current		80 -I_T		mApk	
L/T	Long. to transv.	NP with nominal R_P at 300Hz	60			dB	C5
		NP with nominal R_P at 1020Hz	60			dB	
		NP with nominal R_P at 3400Hz	55			dB	
T/L	Transv. to long	NP with nominal R_P at 300Hz	37			dB	
		NP with nominal R_P at 1020Hz	40			dB	
		NP with nominal R_P at 3400Hz	40			dB	
2wRL	2W return loss.	300 to 3400Hz	22			dB	C6
THL	trans-hybrid loss.	1020Hz; 20Log |VRX/VTX|	30			dB	C2
Ovl	2W overload level	ACTIVE MODE at line terminals on ref. imped.	3.2			dBm	
TXoff	TX output offset		-200		200	mV	
G24	Transmit gain abs.	0dBm 1020Hz	-12.38		-12.02	dB	C4
G42	Receive gain abs.	0dBm 1020Hz	5.74		6.1	dB	C1
G24fq	tx gain variation vs. frequency	rel. 1020Hz, 0dBm 300 to 3400Hz	-0.1		0.1	dB	
G42fq	rx gain variation vs. frequency	rel. 1020Hz, 0dBm 300 to 3400Hz	-0.1		0.1	dB	
G24lv	Tx gain variation vs. level	f = 10120Hz, input level from 3dBm to -40dBm	-0.1		0.1	dB	
G42lv	Rx gain variation vs. level		-0.1		0.1	dB	
V2wp	idle channel noise at line terminals	psophometric, Active On Hook		-82	-78	dBmp	C8
V4wp	idle channel noise at TX port	psophometric, Active On Hook		-90	-84	dBmp	C7
Thd	total harm. dist. 2w-4w, 4w-2w	0dBm, 1KHz Il = 20 to 45mA			-50	dB	
G_{TTX}	Transfer Gain	V_{TTX} = 100mV_{RMS} @ 16kHz $G_{TTX} = 20\text{Log}\left(\frac{V_L}{V_{TTX}}\right)$ with R_L = 200Ω		14.5		dB	
THD (TTX)	TTX Harmonic Distortion	2.2V_{RMS} = on 200Ω			3	%	
DC CHARACTERISTICS (TTX pin connected to ground)							
Vlohi	Line voltage	Il = 0, H.I. feeding	47	47.4	47.8	V	
Vlo	Line voltage	Il = 0, SBY/ACTIVE/ON-HOOK	38.9	39.9	40.9	V	
Ilims	Short circ. curr.	R_{loop} = 0, SBY	14	16	18	mA	
Ilimb	Short circ. curr.	R_{loop} = 0, H.I. feeding	11	17	20	mA	
Ilima	Lim. current accuracy	Rel to progr. val. 20 to 50mA ACTIVE NP, RP	-10		10	%	
V_{IREF}	Bang up reference		1.08	1.16	1.24	V	
Rfeed	Feed res. accuracy	ACTIVE NP, RP	-10		10	%	
Rfeed H.I.	Feeding resistance	H.I. feeding	1100		2100	Ω	

ELECTRICAL CHARACTERISTICS (continued)

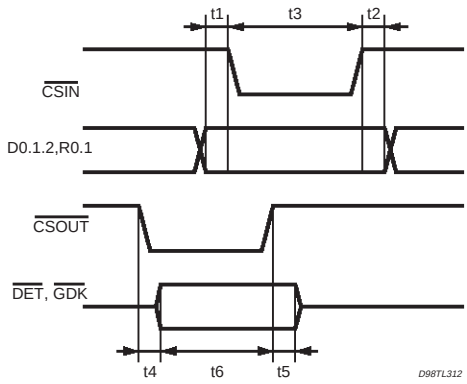
Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
Ilact	Feed current ACTIVE	ACTIVE NP, RP Rloop = 1900Ω RDC = 1.5kΩ	18	20		mA	
Ilsby	Feed current STBY	STY, Rloop = 2.2KΩ RDC = 1.5kΩ	13			mA	
I_{TIP}	Tip leackage current	Ground Start			1	µA	
I_{GS}	Ring Lead Current	Ground Start Ring to GND		33		mA	
I_{DA}	Reference current sourced by TTX IN pin for Voltage Drop programming	V_{TTX} = 0V	-70	-60	-45	µA	
DETECTORS							
I_{det}	Off-hook current threshold ST-BY, ACTIVE	Rel. to progr. val. 7 to 11mA	-10		+10	%	
		Rel. to progr. val. 3 to 6mA	-20		+20	%	
I_{det} H.I.	Off-Hook current threshold	H.I. feeding	5		8	mA	
Hys	Off/On hook hyst.	ST-BY, ACTIVE		15% I_{det}		mA	
Td	Dialling distortion	ACTIVE	-1		+1	ms	
I_{LL}	Ground Key Current threshold $I_{LL} = I_B - I_A$	TIP to RING to GND or RING to GND		7.5		mA	
Igst	Ground Start detection threshold	Igst = 2 · I_{det} GROUND START	-10		+10	%	
DIGITAL INTERFACE INPUTS: D0, D1, D2, R0, R1, $\overline{CSIN}$, $\overline{CSOUT}$							
Vih	Input high voltage	V_{DD} = 3.3V	2			V	
Vil	Input low voltage	V_{DD} = 3.3V			0.8	V	
Iih	Input high current				30	µA	
Iil	Input low current				10	µA	
OUTPUTS: $\overline{DET}$, $\overline{GDK}$ /AL							
Vol	Output low voltage	Iol = 0.75mA; $\overline{CSOUT}$ = LOW			0.5	V	
Voh	Output high voltage	Ioh = 0.1mA; $\overline{CSOUT}$ = LOW	2.4			V	
I_{OZ}	Tri-State Output Current	$\overline{CSOUT}$ = High	-10		+10	µA	
OUTPUTS: RELR, REL0, REL1							
Ird	Current capability		40			mA	
Vr	Output voltage	Ird = 40mA			0.6	V	
		Ird = 70mA			1.1	V	
Iik	Off leakage current				3	µA	
POWER SUPPLY REJECTION							
PSRRC	V_{CC} to 2W port	Vripple = 0.1Vrms 50 to 4000Hz	27			dB	C9
PSRRB	Vbat to 2W port	Vripple = 0.1Vrms 50 to 4000Hz	30			dB	C9
POWER CONSUMPTION							
I_{CC}	V_{CC} supply current	H. I. Feeding On-Hook From 0 to 70°C From -40 to 85°C			 1.0 1.5	 mA mA	
		SBY On-Hook From 0 to 70°C From -40 to 85°C			 3.5 4	 mA mA	
		Active On-Hook From 0 to 70°C From -40 to 85°C			 5.0 5.5	 mA mA	
		Power Down From 0 to 70°C From -40 to 85°C			 1.0 1.5	 mA mA	

ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
I_{BAT}	V_{BAT} supply current	H. I. Feeding On-Hook From 0 to 70°C From -40 to 85°C			 0.5 1.0	 mA mA	
		SBY On-Hook From 0 to 70°C From -40 to 85°C			 2.5 3.5	 mA mA	
		Active On-Hook From 0 to 70°C From -40 to 85°C			 4.0 5.0	 mA mA	
		Power Down From 0 to 70°C From -40 to 85°C			 0.5 1.0	 mA mA	
I_{DD}	V_{DD} Supply Current	Any operating mode		100	320	µA	

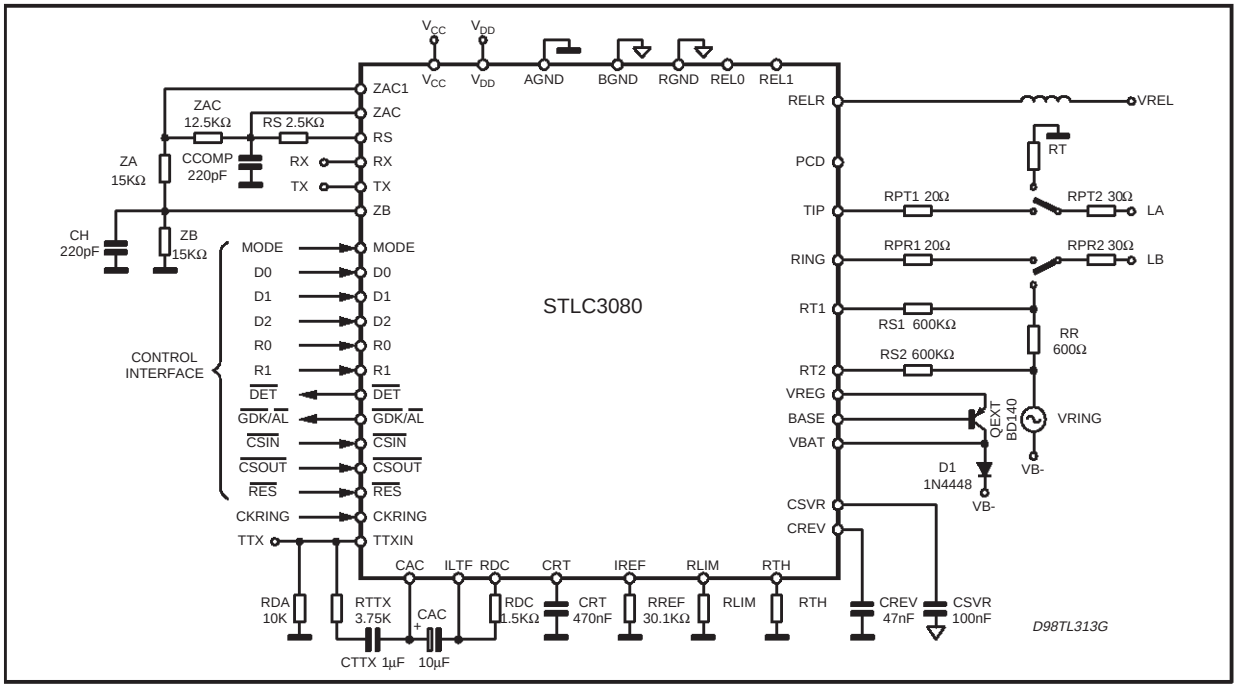
LOGIC INTERFACE INPUT TIMING

	Min.	Max
t1	100ns	
t2	100ns	
t3	250ns	
t4		100ns
t5		100ns
t6	250ns	



Note: All measurements are performed with 100pF on outputs pin and with TTL compatible voltage levels.

Figure 4. Test Circuit.



APPENDIX A

The flow-chart in Fig.A1 describes the sequence of state machine supervising the STLC3080 operation when the control is set for Active mode, D0 D1 D2= 1 X X.

The state machine is a synchronous sequential circuit internally clocked by a free running oscillator ; the ringing frequency applied at the CKRING input is used to generate the long time delay WTIME=128xCKRING necessary for proper operation as further described.

External control is supposed to be set for Active mode :

D0 D1 D2= 1 X X.

OH-HI : line status flag , set High when Off-Hook condition is detected in High Impedance Feeding; it differs from OHK because it's sensitive to the longitudinal current.

OHK: line status flag , set High when Off-Hook condition is detected in Stand-By or in Active mode; it differs from OH-HI for its immunity to longitudinal current .

DLY: time-out flag, it is set High to resume, with a given delay, the High Impedance Feeding when an On-Hook condition (OHK=Low) is detected in Stand-By or Active state.

1) Note that in this section the word "mode" has been used to indicate the operating status set with D0, D1 and D2 pin: the word "state" has been used to indicate an internal status of the finite state machine.

Flow-chart Description

H) A Reset condition, generated at Power On or setting RES pin Low, forces a Power-Down condition.

A) High Impedance Feeding is entered after the Active mode word is set and its maintained until an Off-Hook condition is detected (OH-HI=High) ; in this case Stand-By state entered.

B) Stand-By state is set to perform a validity check of the Off-Hook status of the line before entering Active state. If it is confirmed (OH=High), immediately Active state is entered.
If not , Stand-By state remains set for a time period WTIME generated through a counter that times out after 128 x CKRING ; DLY=High signals the state machine the time out to resume the High Impedance Feeding.
An OHK = High detected during WTIME will immediately enter Active state.

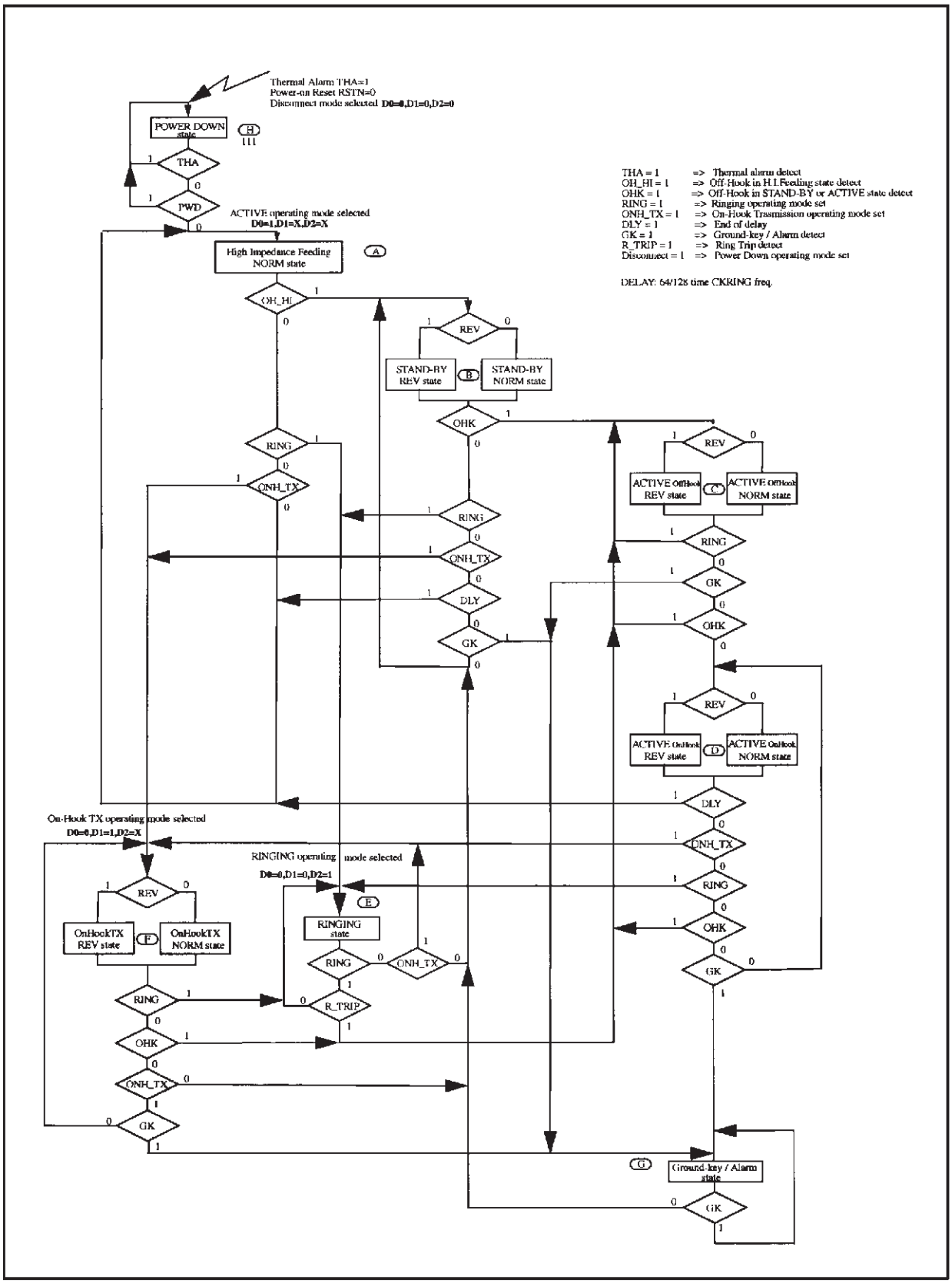
C) Active state is set for conversation and $\overline{DET}$=Low signals to the controller the Off-Hook condition of the line.
The status remains set as long as OHK=High (Off-Hook).

D) When OHK=Low is detected (On Hook), $\overline{DET}$ is immediately set High whereas Active state is maintained for the period WTIME; when it expires DLY is set High and High Impedance Feeding is resumed.
If, during WTIME, OHK=High is detected Off Hook), the state is returned to C) , i.e. Active with $\overline{DET}$=Low.

E) Ringing mode is set when D0 = D1 = 0 and D2 = 1. After ring trip detection the SLIC is automatically set in Active state (reverse or normal polarity according to D2 value set before ringing mode). Ring trip detection is indicated by $\overline{DET}$ pin: when it happens the SW must remove the ringing mode word (001) and set the Active mode word (100).

F) On-Hook Tx mode is selected when D0 = 0, D1 = 1 and D2 = X.
After Off Hook detection the SLIC is automatically set in Active state.

Figure A1.


Thermal Alarm THA=1
Power-on Reset RSTN=0
Disconnect mode selected D0=0,D1=0,D2=0
POWER DOWN state
H
111
THA
PWD
ACTIVE operating mode selected
D0=1,D1=X,D2=X
High Impedance Feeding NORM state
A
OH_HI
REV
STAND-BY REV state
B
STAND-BY NORM state
OHK
RING
ONH_TX
DLY
GK
ACTIVE OffHook REV state
C
ACTIVE OffHook NORM state
ACTIVE OnHook REV state
D
ACTIVE OnHook NORM state
On-Hook TX operating mode selected
D0=0,D1=1,D2=X
RINGING operating mode selected
D0=0,D1=0,D2=1
OnHookTX REV state
F
OnHookTX NORM state
RINGING state
E
R_TRIP
Ground-key / Alarm state
G
THA = 1 => Thermal alarm detect
OH_HI = 1 => Off-Hook in H.I.Feeding state detect
OHK = 1 => Off-Hook in STAND-BY or ACTIVE state detect
RING = 1 => Ringing operating mode set
ONH_TX = 1 => On-Hook Trasmission operating mode set
DLY = 1 => End of delay
GK = 1 => Ground-key / Alarm detect
R_TRIP = 1 => Ring Trip detect
Disconnect = 1 => Power Down operating mode set
DELAY: 64/128 time CKRING freq.

APPENDIX B

STLC3080: allowed Rfeed values vs. Ilim

The STLC3080 device has been designed in order to fit in a small SMD package (TQFP44). This target has been achieved by using a dedicated circuit for power management based on one external transistor (Qext).

The particular power management circuit adopted allows to define the percentage of power dissipated on the SLIC itself and on the Qext. The sharing percentage is defined by the Rfeed value, in particular the higher is Rfeed, the higher is the percentage dissipated on the SLIC.

Rfeed represents the DC feeding impedance at TIP/RING terminals (including 2xRp) when the SLIC is in the resistive feed region of the DC characteristics.

Since the max. power dissipation inside the SLIC is limited it is important to know which value of Rfeed can be implemented without exceeding the max power allowed in the SLIC.

In order to define the allowed Rfeed values several other parameters should be considered, in particular:

Pdslic:
Max allowed power dissipation on SLIC, two values are considered:
1.1W for 70°C T_{amb} application;
0.9W for 85°C T_{amb} application;

Pdqext:
Max allowed power dissipation on Qext, three values are considered:
1.0W
1.5W
2.0W
These values depend on the package and the assembly of the Qext.

Ilim:
Programmed constant current value, continuous variations are considered from 20mA to 50mA.

Vbat:
Battery voltage, three values are considered:
48V
54V
62V

The following diagrams show the allowed Rfeed values depending on the above parameters. three diagrams are shown each one for a particular battery (Vbat = -48V, -54V, -60V).
In each diagrams you can find an upper and a lower limits for the Rfeed value:

The upper limit is defined by one of the two b1, b2 curves.

- b1 is the limit when max. power on SLIC is equal to 0.9W (T_{amb} = 85°C)
- b2 is the limit when max. power on SLIC is equal to 1.1W (Tamb = 70°C)

The lower limit is defined by one of the three a1, a2, a3 curves.

- a1 is the limit when max. power allowed on Qext is equal to 1.0W
- a2 is the limit when max. power allowed on Qext is equal to 1.5W
- a3 is the limit when max. power allowed on Qext is equal to 2.0W

Figure B1. Rfeed allowed values vs. Ilim (Vbat = -48V).

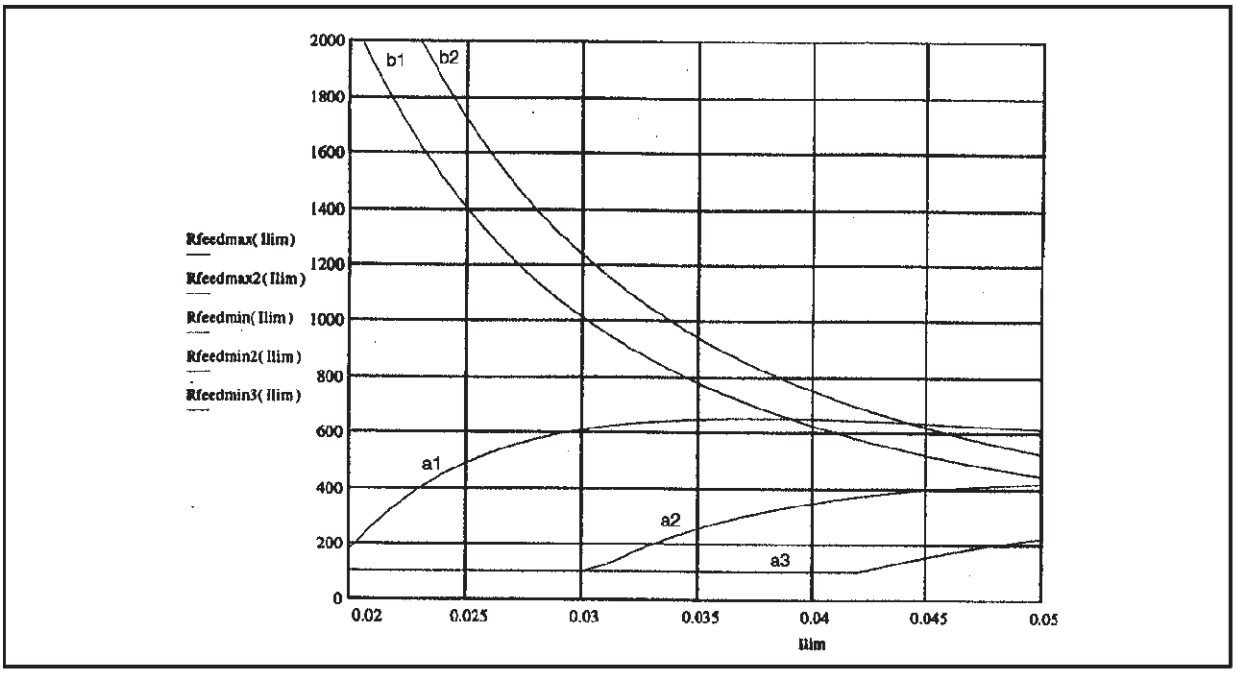


Figure B2. Rfeed allowed values vs. Ilim (Vbat = -54V).

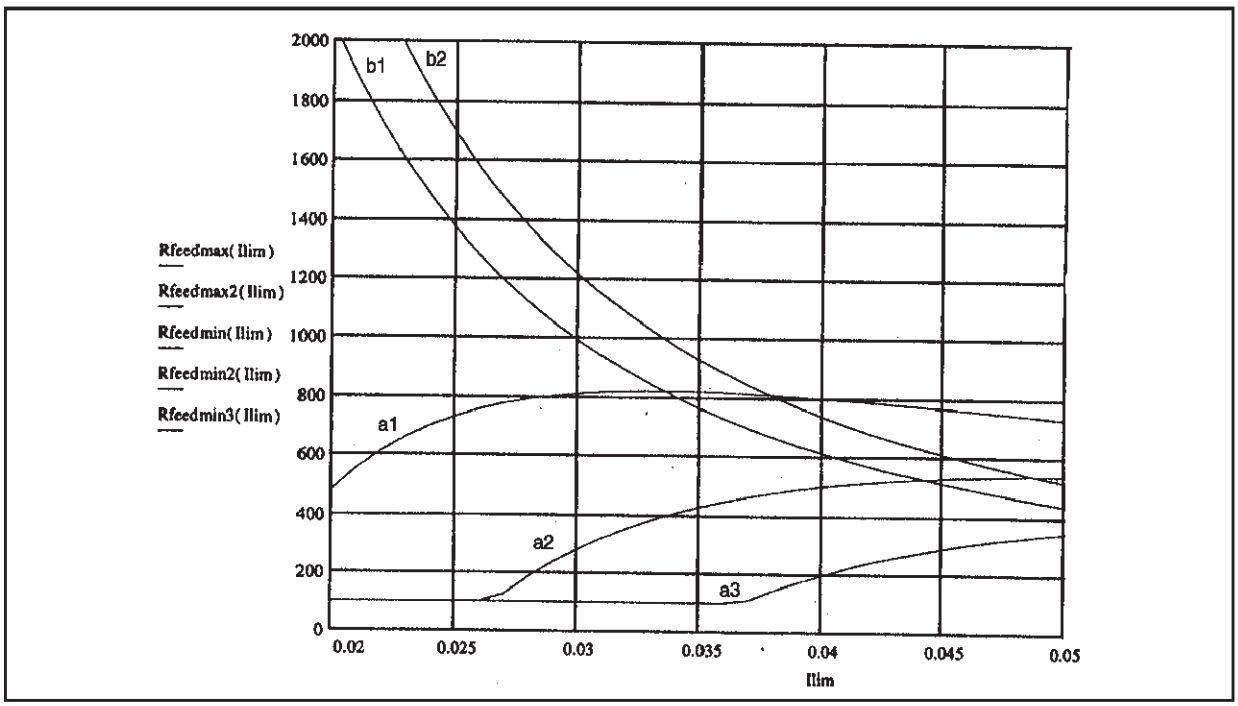
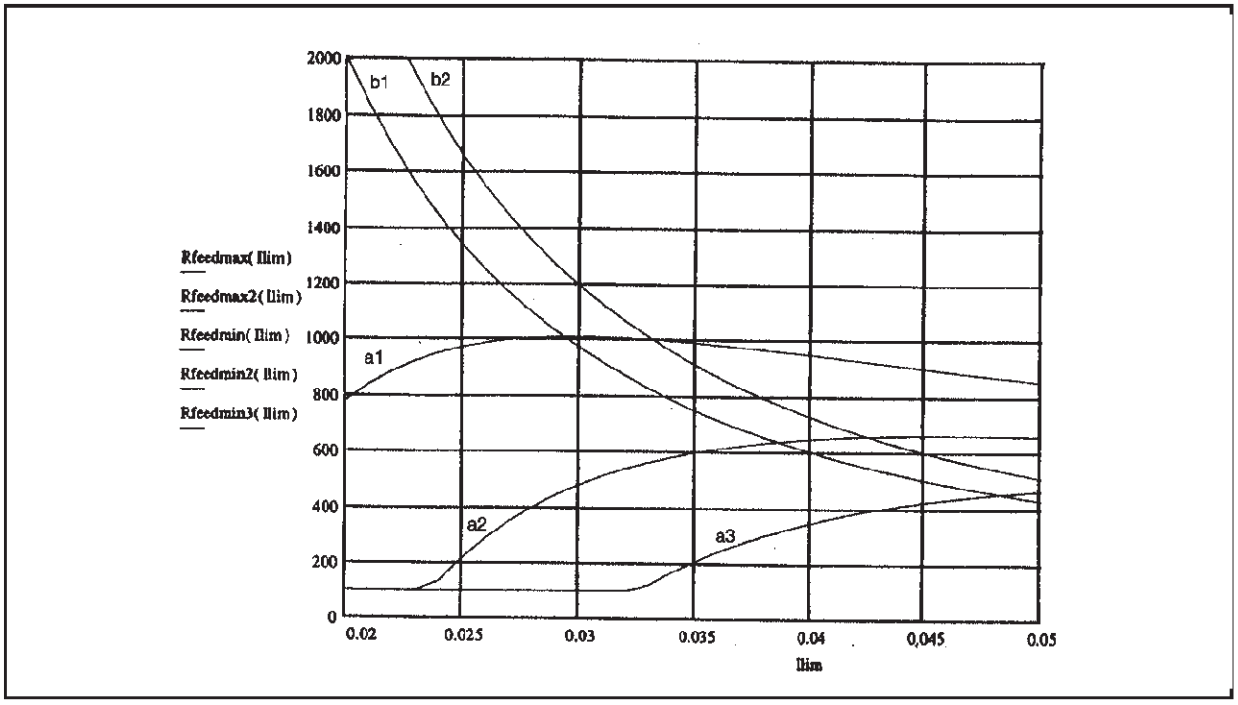


Figure B3. Rfeed allowed values vs. Ilim (Vbat = -60V).



EXAMPLE:

Considering the following parameters:

Vbat = -48V, max Tamb = 70°C, Ilim = 25mA, Qext able to dissipate 1W, the possible values of Rfeed can be found in fig. 1 and are limited by the b2 curve (upper limit) and the a1 curve (lower limit).

In particular considering the Ilim = 25mA the Rfeed allowed range will be:

500Ω < Rfeed < 1700Ω

APPENDIX C

STLC3080 Test Circuits referring to the application diagram shown in figure 4 and using as external components the typ. values specified in the "External Components", find below the proper configuration for each measurement.

Figure C1. Receive Gain.

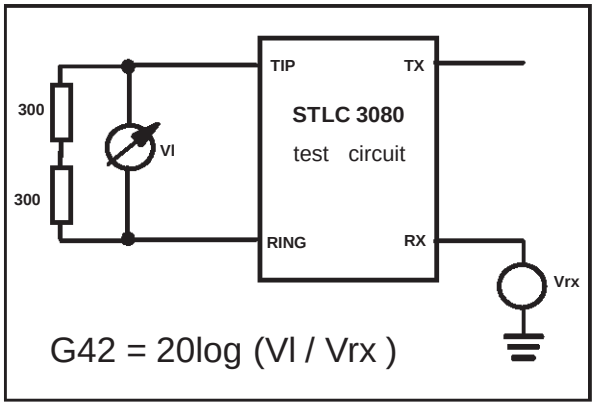


Figure C2. THL Trans Hybrid Loss.

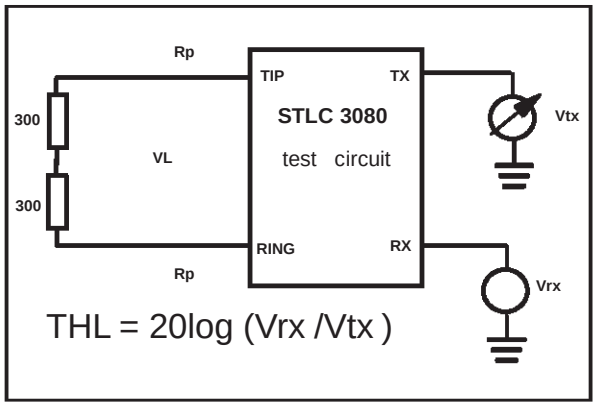


Figure C3. T/L Transversal to Longitudinal Conversion

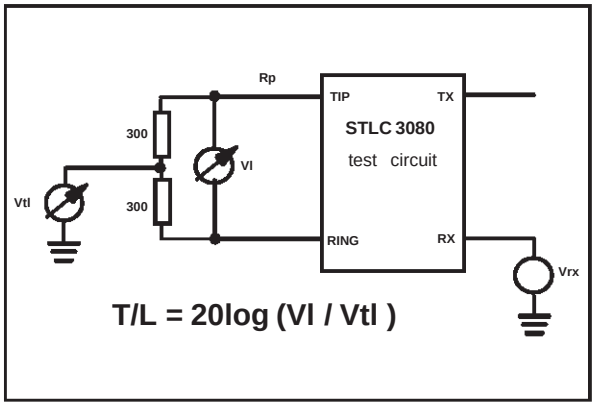


Figure C4. Transmit Gain.

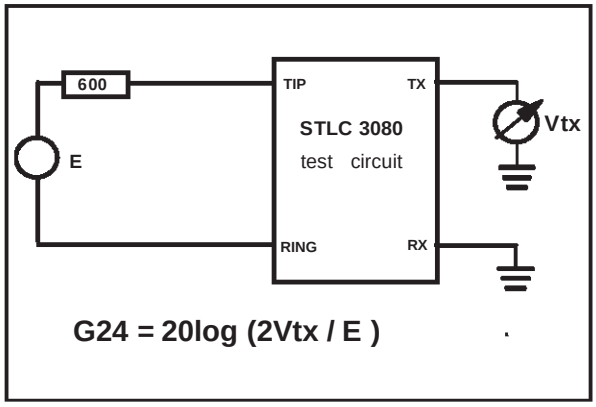


Figure C5. L/T Longitudinal to transversal Conversion.

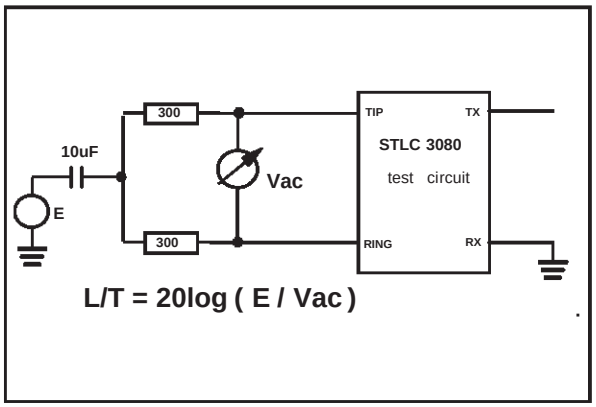


Figure C6. 2W Return Loss.

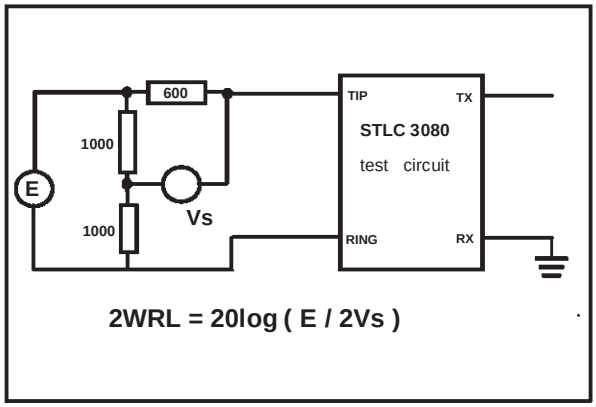


Figure C7. Idle channel psophometric noise at TX port.

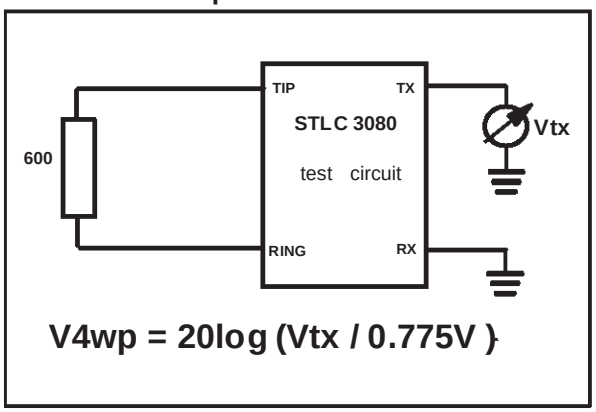


Figure C8. Idle channel psophometric noise at line terminals.

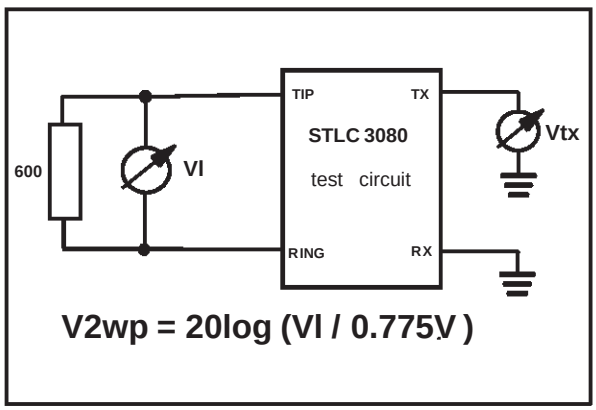
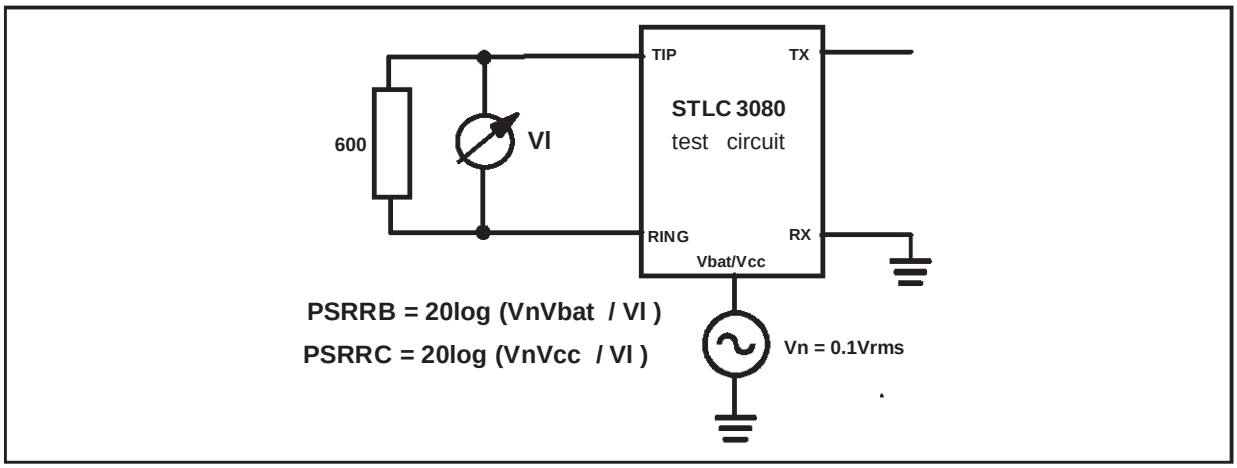


Figure C9. PSRRC = Power Supply Rejection V_{CC} to 2W Port
PSRRB = Power Supply Rejection V_{BAT} to 2W Port



APPENDIX D
RINGING MODE AND RING TRIP DETECTION

In ringing mode the STLC3080 provides:

- Relay driver capability (relay is synchronized with low level of CKRING)
- Ring-Trip detection

The monitor of the line state is performed by sensing the line current converted into a voltage drop across the RR resistor connected in series to the line. This voltage is read via RS1and RST2 input pins of a differential stage that identifies, during the ringing phase, the ON/OFF HOOK state of the line (see Fig. D1).

The Ring-Trip condition is detected by sensing the DC component of the line current, rejecting the AC component. With RR = 600Ω the Ring-Trip threshold is: Iline>7.5mA

When the Ring-Trip is detected, the STLC3080:

- deactivates the ringing relay RELR (if CKRING is low);
- indicates the ring-trip detection by setting DET=low;
- forces the Active state.

The information at RELR and DET pins is lached and it doesn't change opening the current loop. To reset the latched informations the Active or On-Hook Transmission mode have to be entered (in general changing the device mode the latched information is removed).

Although the ring-trip detection sets DET to signal the line status, there is a substantial difference respect to the on/off-hook detection. In Ringing mode on-hook condition, an AC current is present on the line. The ring-trip detector rejects the AC component by integrating the line current: the detection threshold can be reached only if the line current has a DC component higher than the threshold. As a consequence the response is not immediate (as it is for off-hook in Active state): it takes an amount of time that is dependent on the DC current value (i.e. on the line length). The AC rejection and the delay depend on the CRT capacitor value (see Fig.D1).

When the voltage on the capacitor exceeds 3V, the Ring-Trip is detected (see fig.D3). CRT should be selected in order to avoid that during one half sinewave cycle, in on-hook, its voltage VCRT exceeds 3V (ring-trip threshold). The minimum value of CRT can be carried out with the following formula:

$$Ccrt > 6\mu F/Fring$$

With Fring = 20Hz, you obtain a Ccrt = 390nF.

When the CRT capacitor is selected, it must be considered that it is also used for the rejection of the common mode current. In this case the minimum value of the CRT capacitor can be carried out with the following formula:

$$Ccrt > (Ip/Fl) \cdot 560\mu F$$

Where Ip is the peak of the longitutudinal current and Fl is the frequency of this current. With Ip = 25mA @ Fl = 50Hz you obtain 330nF.

For this reasons the suggested value for typical central office application is 470nF.

Figure D1.ring trip circuit block diagram.

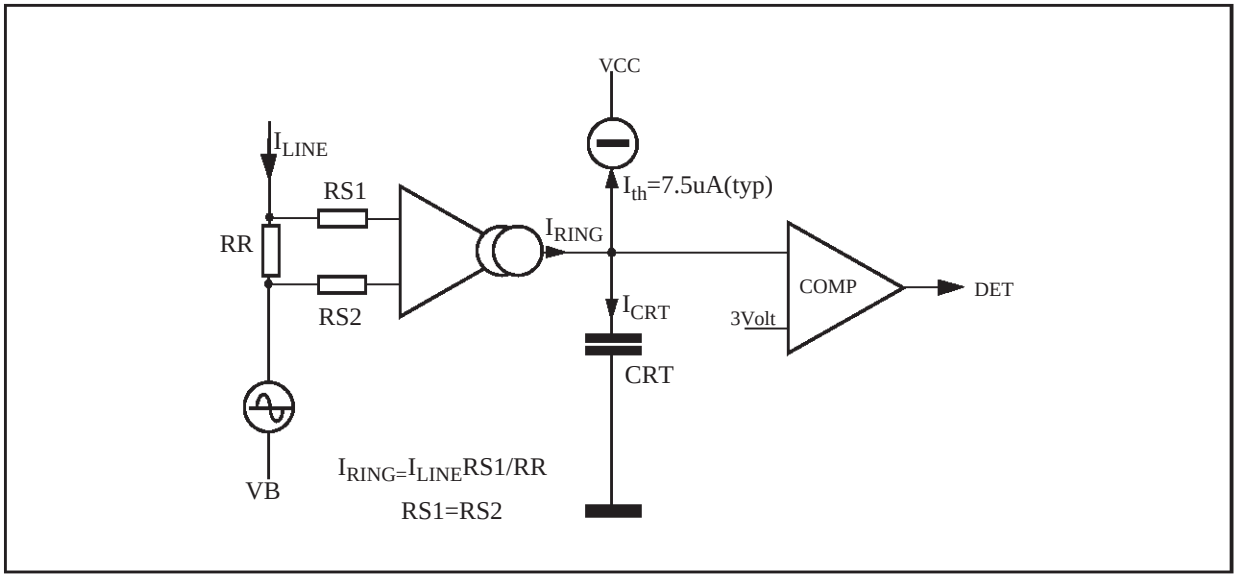
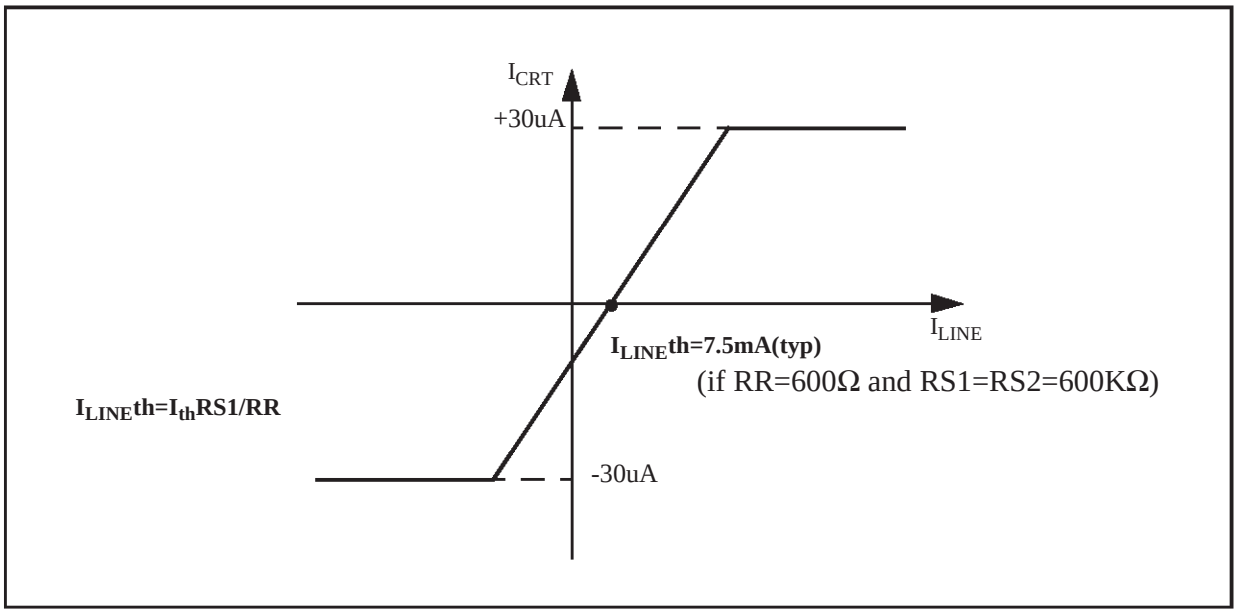


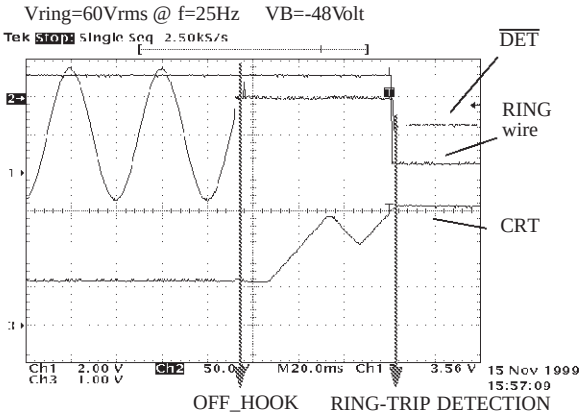
Figure D2. relation between Icrt and Iline.



RS1 must be connected to the positive RR; RR should be connected directly to the ringing generator as it is in the figure. The ratio between RS1 and RR must be chosen considering that there is an offset current in the input stage equal to 7.5µA. This offset has been introduced to take in account the leackage current of the line.

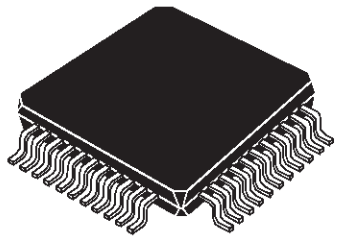
In fig.D2 is shown the relation between the CRT charging current I_{CRT} and the line current I_{LINE}. In the range -30µA<ICRT<+30µA ICRT is proportional to ILINE while it remains limited to ±30µA for higher value of I_{LINE}. Consequently, in case of short loops, the ring-trip detection time is independent on the loop resistance, as the CRT charging is performed at a fixed current. In case of long loops the detection time will increase as the I_{CRT} decreases proportionally to the loop resistance.

Figure D3. Ring Trip detection signals.

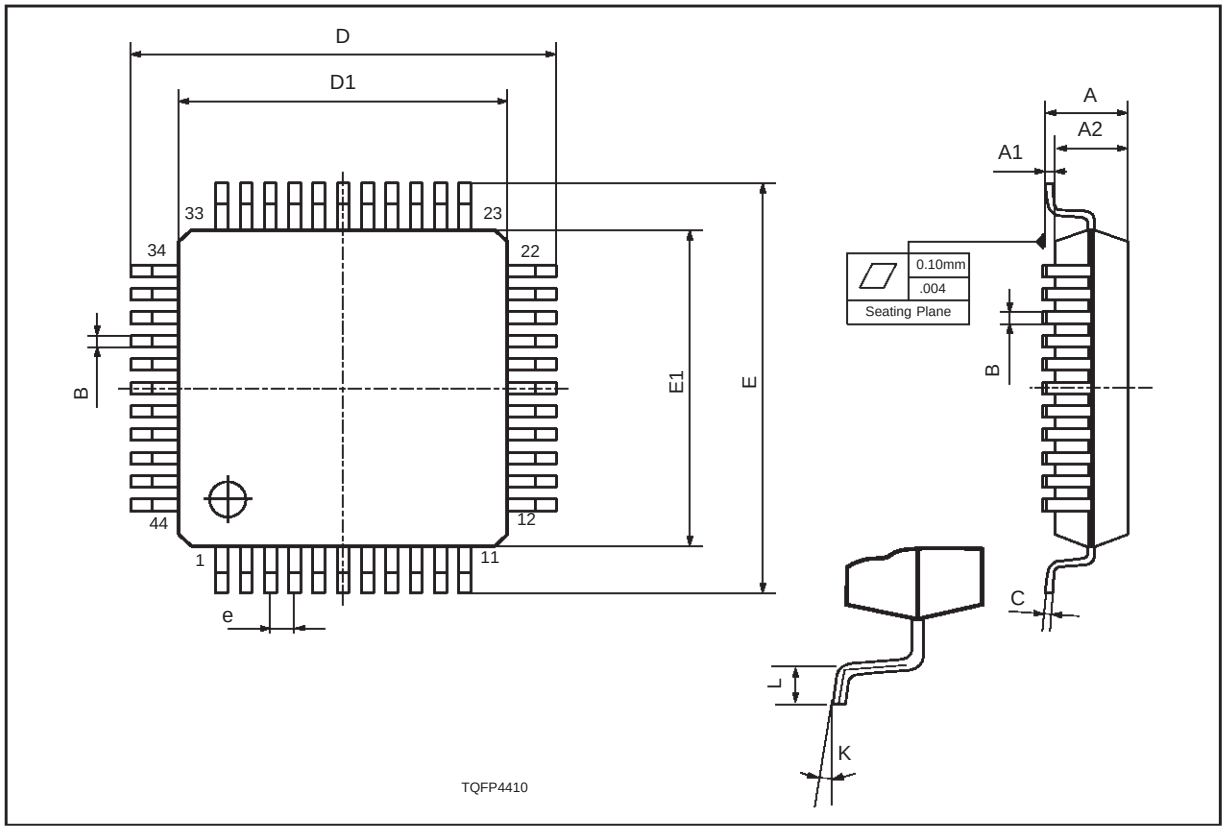


DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.60			0.063
A1	0.05		0.15	0.002		0.006
A2	1.35	1.40	1.45	0.053	0.055	0.057
B	0.30	0.37	0.45	0.012	0.014	0.018
C	0.09		0.20	0.004		0.008
D		12.00			0.472	
D1		10.00			0.394	
D3		8.00			0.315	
e		0.80			0.031	
E		12.00			0.472	
E1		10.00			0.394	
E3		8.00			0.315	
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1.00			0.039	
K	0°(min.), 3.5°(typ.), 7°(max.)					

OUTLINE AND MECHANICAL DATA



TQFP44 (10 x 10)



ESD - The STMicroelectronics Internal Quality Standards set a target of 2 KV that each pin of the device should withstand in a series of tests based on the Human Body Model (MIL-STD 883 Method 3015): with C = 100pF; R = 1500Ω and performing 3 pulses for each pin versus V_{CC} and GND.

Device characterization showed that, in front of the STMicroelectronics Internaly Quality Standards, all pins of STLC3080 withstand at least 1000V. One particular pin (pin N° 41) withstand 500V only.

The above points are not expected to represent a pratical limit for the correct device utilization nor for its reliability in the field. Nonetheless they must be mentionned in connection with the applicability of the different SURE 6 requirements to STLC3080.