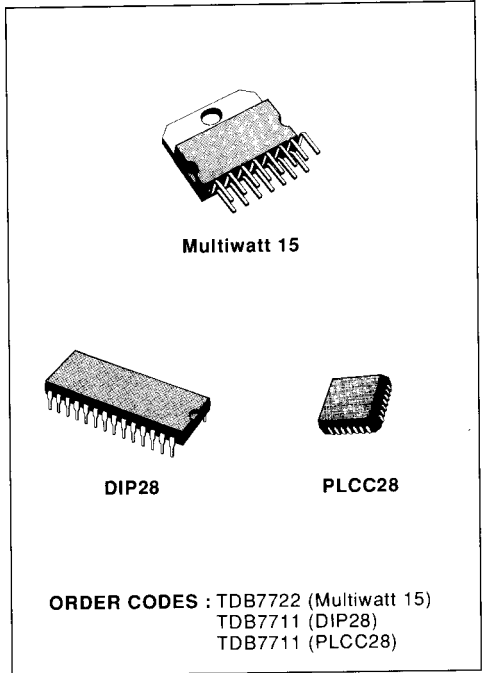


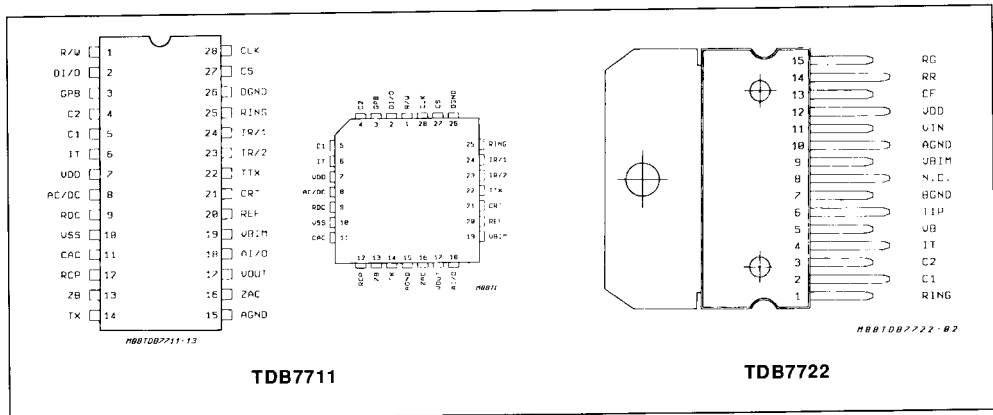


SUBSCRIBER LINE INTERFACE CIRCUIT KIT

- PROGRAMMABLE DC FEEDING RESISTANCE AND LIMITING CURRENT (seven values)
- LONGITUDINAL BALANCE PERFORMANCE : UP TO 63 dB
- FOUR OPERATING MODES (power-down, stand-by, conversation, ringing control)
- POWER SAVING FEATURE
- SIGNALLING FUNCTION (off-hook/ground key)
- HYBRID FUNCTION
- EXTERNAL RINGING ALLOWING BALANCED AND UNBALANCED RINGING WITH ZERO CROSSING INJECTION AND RING TRIP DETECTION
- AUTOMATIC RINGING STOP WHEN OFF-HOOK IS DETECTED
- LOW POWER CURRENT CONSUMPTION IN STAND-BY MODE (90 mW)
- LOW NUMBER OF EXTERNAL COMPONENTS. THESE COMPONENTS REQUIRE ONLY STANDARD TOLERANCE : 1 % RESISTORS AND 10-20 % CAPACITORS
- POSSIBILITY TO WORK WITH HIGH COMMON MODE CURRENTS
- TELETAXE
- ANALOG INPUT/OUTPUT
- GENERAL PURPOSE BIT
- INTEGRATED THERMAL PROTECTION



PIN CONNECTION



DESCRIPTION

The ST SLIC KIT (TDB7722/7711) is a set of solid state devices designed to integrate the main functions needed to interface a telephone line.

It consists of 2 integrated devices : the TDB7722 line interface circuit and the TDB7711 control unit. This kit performs main of the BORSHT functions :

- Battery feed
- Overvoltage protection with double trisil device and 2 protection resistors
- Ringing control
- Signalling
- Hybrid

The ST SLIC KIT has been designed to achieve performant transmission characteristics like excellent longitudinal balance and very low consumption.

In addition, this kit controls an external ringing relay with zero crossing injection.

This kit is fabricated using a 80 V Bipolar, junction isolated technology, with accurate thin film resistors for the TDB7722 and a 10 V Bipolar I2L technology for TDB7711.

This kit is suitable for all applications, C.O or PBX, where balanced or unbalanced ringing are requested.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_b	Negative Battery Voltage	72	V
V_{dd}	Positive Supply Voltage	+ 5.5	V
V_{ss}	Negative Supply Voltage	- 5.5	V
$V_{agnd}-V_{bgnd}$	Maximum Voltage Between Analog GND and Battery GND	± 2	V
T_j	Maximum Junction Temperature	+ 150'	°C
T_{stg}	Storage Temperature	- 55' to 150'	°C

THERMAL DATA

TDB7722 HIGH VOLTAGE

R_{thjc}	Max. Resistance Junction to Case	3	°C/W
R_{thja}	Max. Resistance Junction to Ambient	40	°C/W

TDB7711 LOW VOLTAGE

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

Symbol	Characteristics	Min.	Typ.	Max.	Unit.
T_{oper}	Operating Temperature Range	0		70	°C
V_b	Negative Battery Voltage	- 72		- 20	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			120	mA

PIN DESCRIPTION

TB7722

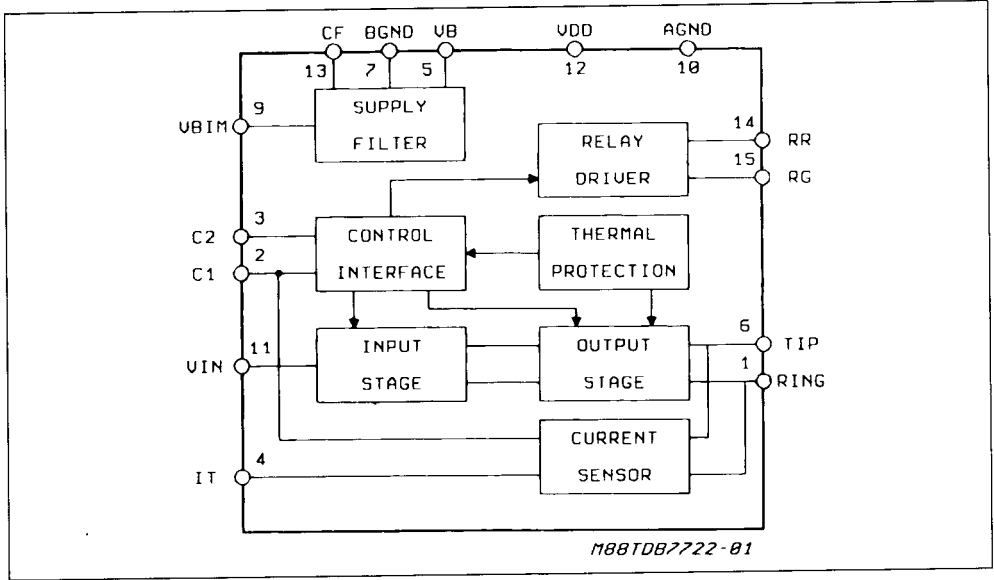
N'	NAME	DESCRIPTION
1	RING	B Line Termination Output with Current Capability up to 120 mA (I_b is the current sunk into this pin).
2	C ₁	Digital signal input (3 voltage levels) that defines device status with pin 3. Longitudinal current is also provided.
3	C ₂	Digital signal input (3 voltage levels) that defines device status with pin 2. Thermal warning current is also provided by TDB7722 through this pin.
4	I _T	High precision scaled transversal line current signal. It is a current generator referred to AGND. $I_T = \frac{I_a + I_b}{200}$.
5	V _B	Negative Battery Supply Voltage.
6	TIP	A Line Termination Output with Current Capability up to 120 mA (I_a is the current sourced from this pin).
7	BGND	Battery Ground Relative to V _B Supply Voltage. It is also the reference ground for TIP and RING signals.
8	NC	Not connected, this pin is connected to internal circuitry and should not be used as a tiepoint for external circuitry.
9	V _{BIM}	This voltage output provides V _{REF} /40 Voltage to TDB7711 V _{REF} : Filtered Battery Voltage - ($ V_{BAT} - 2.1$ V)
10	A _{GND}	Analog ground, all input signals and V _{DD} supply voltage must be referred to this pin.
11	V _{IN}	2 Wire Unbalanced Voltage Input
12	V _{DD}	Positive Power Supply + 5 V
13	CF	An external capacitor connected between this pin and BGND filters battery noise.
14	RR	Ring relay driver : output used to drive a 5 V or 12 V external ring relay.
15	RG	Ring Relay Ground

PIN DESCRIPTION

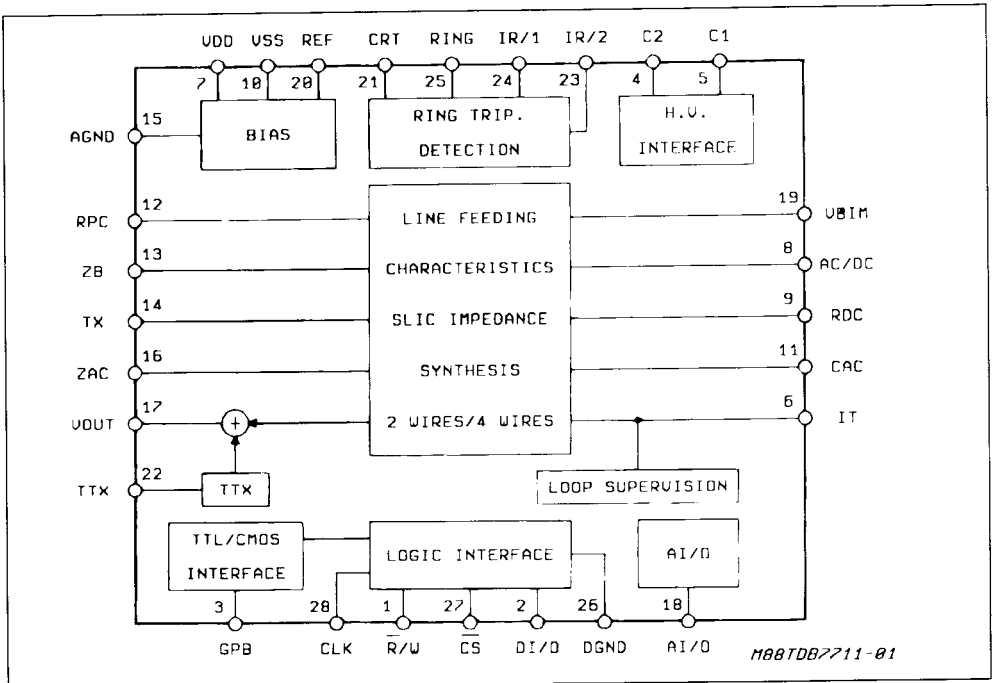
TB7711

N°	NAME	DESCRIPTION
1	R/W	Read/Write Command of the Serial Digital SLIC Control
2	DI/O	Data Input/output for SLIC Serial Control
3	GPB	General Purpose Bit. TTL/CMOS Output Available for any Specific Application.
4	C2	State control signal output (3 voltage levels) used also as thermal warning current input from TDB7722.
5	C1	State controll signal output (3 voltage levels) used also as scaled transversal line current input from TDB7722. C1 and C2 combination defines operating mode of the high voltage part.
6	I _T	Scaled down Transversal Line Current Input $I_T = \frac{I_a + I_b}{200}$
7	V _{DD}	Positive Supply Voltage, + 5 V.
8	AC/DC	AC-DC Feedback Input.
9	RDC	DC Feeding System.
10	V _{SS}	Negative Supply Voltage, - 5V.
11	CAC	AC Feedback Input.
12	RPC	AC Line Impedance Adjustment.
13	ZB	Tx amplifier negative input performing the two to four wire conversion.
14	Tx	Transmit Amplifier Output.
15	AGND	Analog Ground. V _{DD} and V _{SS} supply voltages are referenced to this pin.
16	ZAC	AC Line Impedance Synthesis.
17	VOUT	Two wire unbalanced output carrying out following signals : - DC voltage to perform the proper DC characteristic - Voice signal - Teletax
18	AI/O	Programmable analog input/output pin, used to feed the SLIC with a low voltage battery offering power saving capability. Also used to detect line short circuits.
19	V _{BIM}	V _{REF} /40 Voltage Input from TDB 7722.
20	REF	Bias Setting Pin
21	C _{RT}	Ringin filter Capacitor used also to filter longitudinal current and to shape teletax signal.
22	TTX	Teletax Signal Analog Input.
23	IR/2	Differential line current inputs in ringing network.
24	IR/1	
25	RING	Ringin Signal Input for Synchronisation.
26	DGND	Digital Ground
27	CS	Chip Select Input
28	CLK	Clock 128 kHz

TDB7722 BLOCK DIAGRAM



TDB7711 BLOCK DIAGRAM



FUNCTIONAL DIAGRAM

Figure 1 : Simplified Block Diagram.

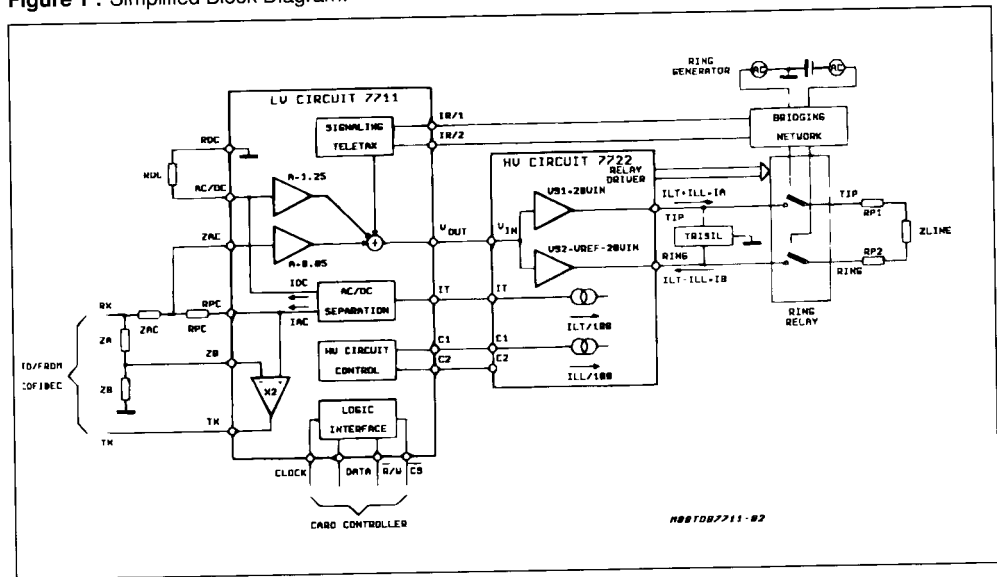


Figure 2 : Functional Diagram - DC Path.

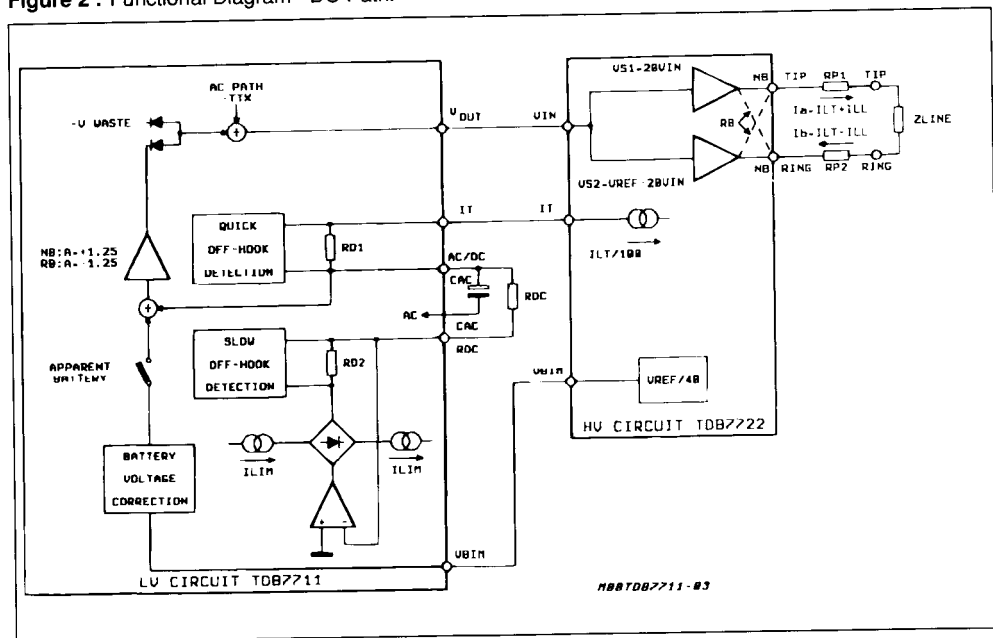


Figure 3 : Functional Diagram - AC Path.

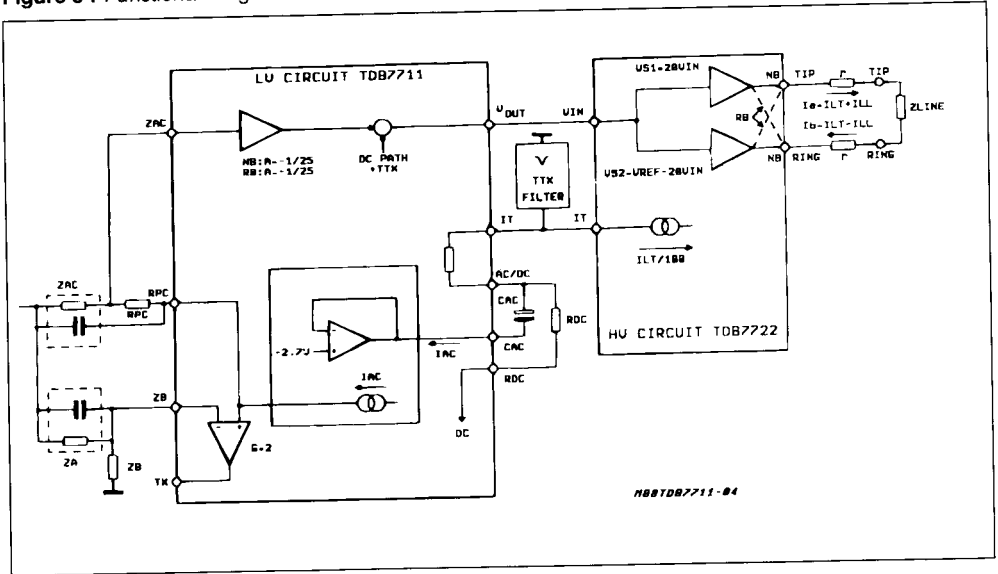
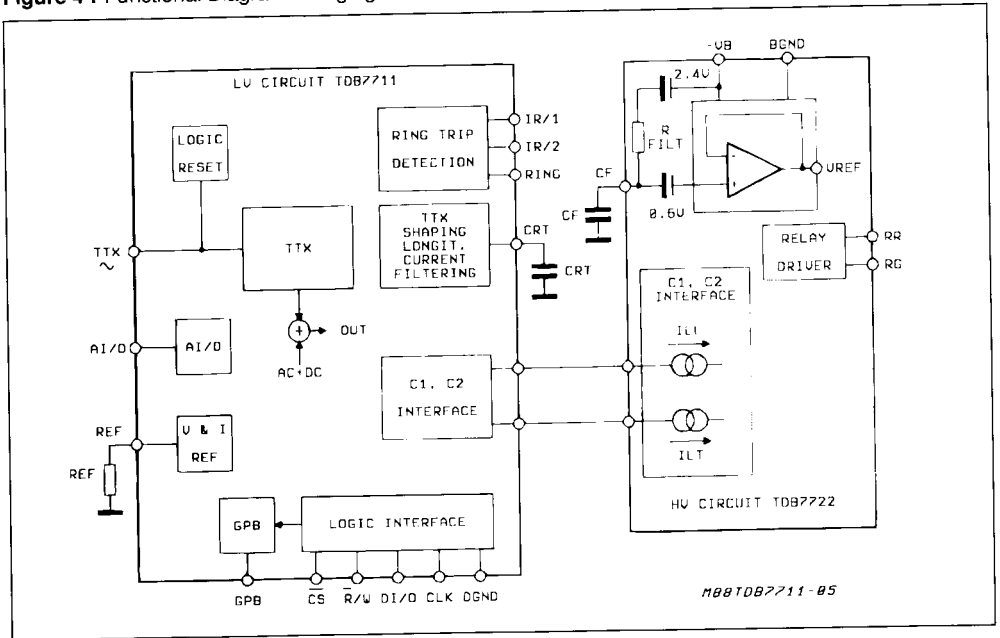


Figure 4 : Functional Diagram - Ringing and Miscellaneous Functions.



FUNCTIONAL DESCRIPTION

TDB7722 - HIGH VOLTAGE CIRCUIT

The TDB7722 line interface provides a battery feeding and drives a ring relay.

The TDB7722 contains a state decoder which is under control of the low voltage TDB7711. This decoder selects :

- one of the following operational modes : power down, stand-by, conversation, ring relay control, power saving
- direct or reverse battery operation.

The circuit makes the sum and difference of the two wire currents (I_a, I_b) to provide the transverse and longitudinal components to the LV SLIC (Scaled down : 1/100).

The scaled down transverse current flows by I_T pin. The scaled down longitudinal current flows by C_1 pin.

In addition, TDB7722 provides thermal warning current to the low voltage chip via pin C_2 .

The TDB7722 amplifies both the AC and DC signals entering pin 11 (VIN).

Separate grounds are provided :

- analog ground as a reference for analog signals
- battery ground as a reference for the output stages

TDB7711 - LOW VOLTAGE CIRCUIT

1) The TDB7711 low voltage control unit controls TDB7722 line interface module, giving the proper informations to set line feed characteristics (drop voltage mode, feed resistance mode, current limitation) for several working modes :

- apparent battery
- real battery
- special DC characteristic

2) The transmission characteristics of the SLIC are the following :

- a 2/4 wires conversion
- longitudinal current rejection
- based on TDB7722 informations and external components configuration, the TDB7711 handles the impedance synthesis and hybrid balance

3) Signalling features are :

- teletax (shaping and filtering)
- (described in application note AN298)
- ring trip detection
- (described in application note AN298)
- pulse dialing
- ground key detection

4) Other features

- analog input/output pin
- (described in application note AN298)
- general purpose bit
- (described in application note AN298)
- interface with the card controller through a 4 wire serial bus
- thermal warning

WORKING STATES OF THE KIT

In order to carry out the various operation modes, the ST SLIC kit has several different working states. Each mode, externally selected by microcontroller, is defined by the voltage respectively applied by pins 5 and 4 of TDB7711 to the pins 2 and 3 of TDB7722.

Three different voltage levels (1,4 ; 0 ; + 1,4) are available at each connection, defining all possible states as listed in table 1.

		C1			
		Pin 5 of TDB7711			Pin 2 of TDB7722
			+ 1.4	0	- 1.4
C2	Pin 4 of TDB7711	+ 1.4	Power Down	Reverse Battery	Not Allowed
	Pin3 of TDB7722	0	Power Down	Normal Battery	Ringing
		- 1.4	Power Down	Standby	Not Allowed

Appropriate combinations of two pins define the four possible status of the kit, that are :

- a) Stand-by (SBY)
- b) Conversation (CVS)
- c) Ringing (RING)
- d) Power down (PD)

The main difference between stand-by and power down is that in SBY the power consumption on the voltage battery V_B- (-48 V) is reduced but the SLIC can feed the line, recognize the on-hook, off-hook status and ground key status.

In power down, the power consumption is closed to zero, tip and ring terminals are in high impedance and all line detection circuits are disabled.

The SBY status should be used when the telephone is in on-hook and PD status only in emergency condition when it is mandatory to cut any possible power dissipation with no running operation.

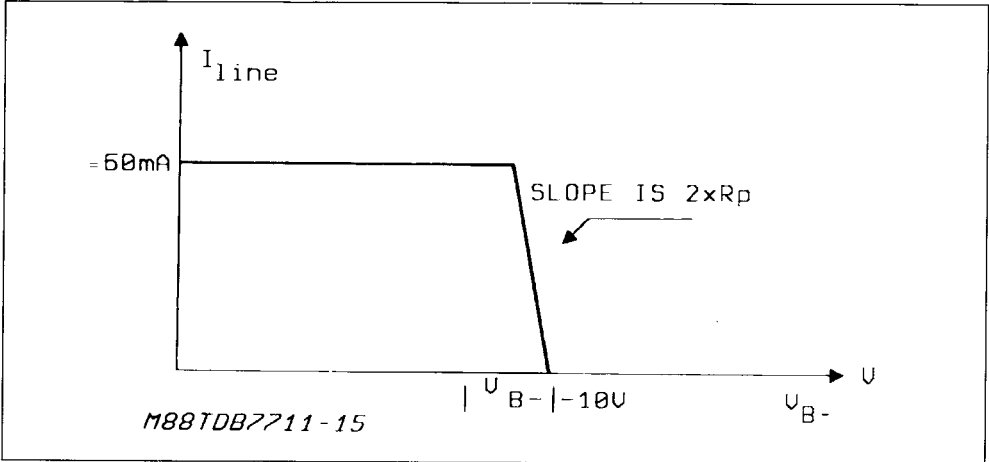
OPERATION MODES

STAND-BY (SBY) MODE. In this mode, most of the functions of both low voltage and high voltage cir-

cuit are not active in order to reduce the power consumption.

The only working functions are following :

- * Line feeding
- line voltage |Vbat| – 10 V
- current supplied to the line limited to 60 mA
- output resistance = protection resistance (Rp)



*** On/off hook detection**

The current of the 2 wires are sensed and the scaled down transverse current is provided to low voltage SLIC for signalling detection.

In this mode, the polarity of the battery should be direct (TIP wire more positive than RING one).

When the SLIC is set in SBY mode, the power dissipation of TDB7711/TDB7722 kit is 90 mW.

CONVERSION (CVS) MODE. This operation mode is set when the off-hook condition has been recognized.

As far as the DC characteristic is concerned, three different feeding conditions are present :

- a) Current limiting region
The DC impedance of the SLIC is very high (> 20 Kohms) and therefore the system works like a current generator.

The limiting current is defined by programming via the logic interface and selected among the seven following values :
12 mA, 20 mA, 30 mA, 32 mA, 42 mA, 50 mA, 62 mA

b) A standard resistive feeding mode

The characteristic is :

V_{BAT} minus a voltage equal to $R_{feed} \times I_{line}$ with R_{feed} defined by external resistor RDC ($RDC = 2 (R_{feed} Rp)$)

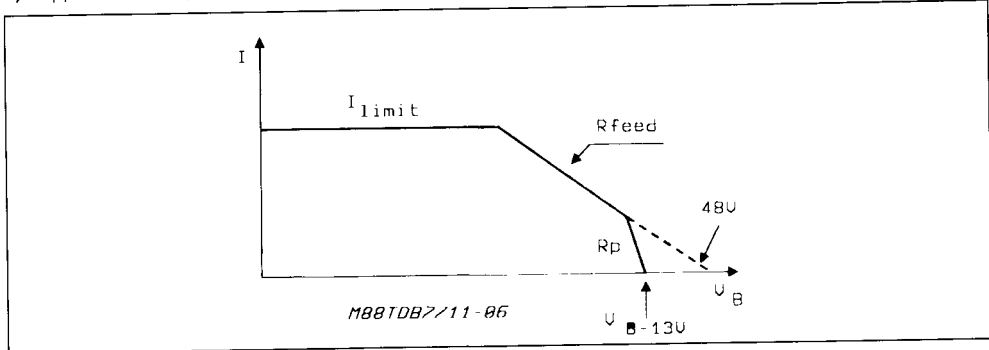
c) A nearly constant voltage mode

The voltage value is $|V_{BAT}| - 13\text{ V}$. This 13 V drop voltage allows the output amplifiers to keep a good linearity.

For $|V_{BAT}| > 48 + 13 = 61\text{ V}$, this mode does not exist.

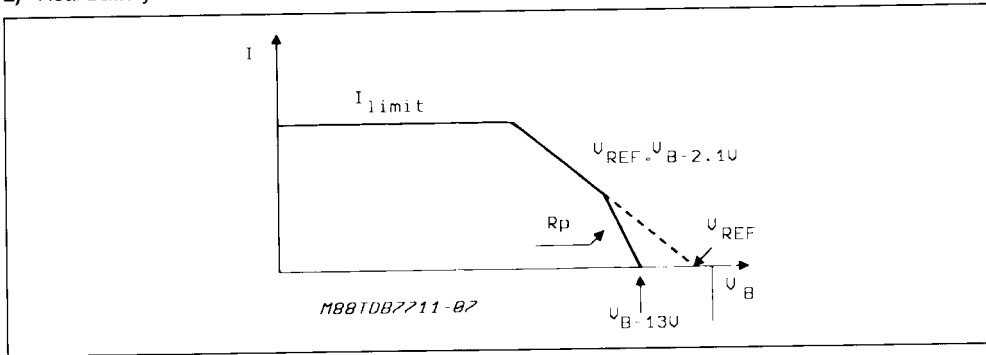
The three different feeding conditions are applicable or not in the three different following feeding modes. These three feeding modes are controlled by the two digital eight bits word written in the low voltage circuit.

1) Apparent Battery.



In this mode, the three feeding conditions are available, the line sees an apparent voltage of 48 V whatever the actual battery voltage is.

2) Real Battery.



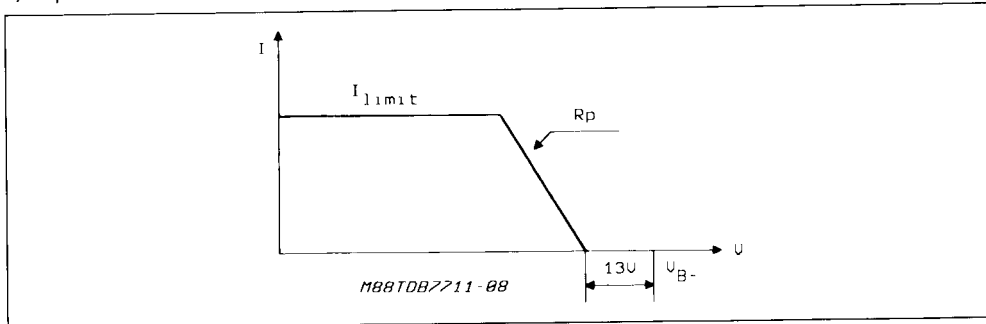
This solution is same as apparent battery except for the standard resistive mode where the voltage value is :

Therefore the line voltage depends on the current battery voltage V_B .

$$|V_{line}| = |V_{REF}| - R_{feed} \times I_{line}$$

with $|V_{REF}| = |V_B| - 2,1 V$

3) Special Characteristic.



In this mode, there is no standard resistive feeding region. This mode is specially suitable for PBX applications.

The three feeding modes above can operate either in normal polarity or in reverse polarity.

RINGING MODE (RING). When ringing, the SLIC must be in normal battery mode.

An external circuit applies ringing signal through the ringing network and the ring relay.

This circuit consists of a balanced or unbalanced sinus generator (70 to 100 VRMS) in serie with the battery (-48 V).

When the ringing control is selected (by software), ring relay is energized at the zero crossing point of

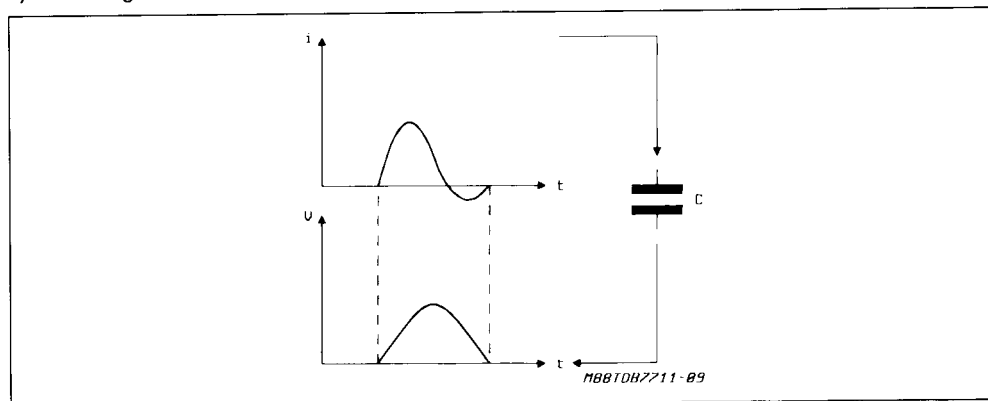
the ringing generator. The ring relay is disenergized either when ring trip is detected or by software, using one bit of the second byte written in the SLIC (see page 13: data input).

There is a sophisticated ring trip detection circuitry insensitive to parasitic noise on the line. The ring trip principle is as follows :

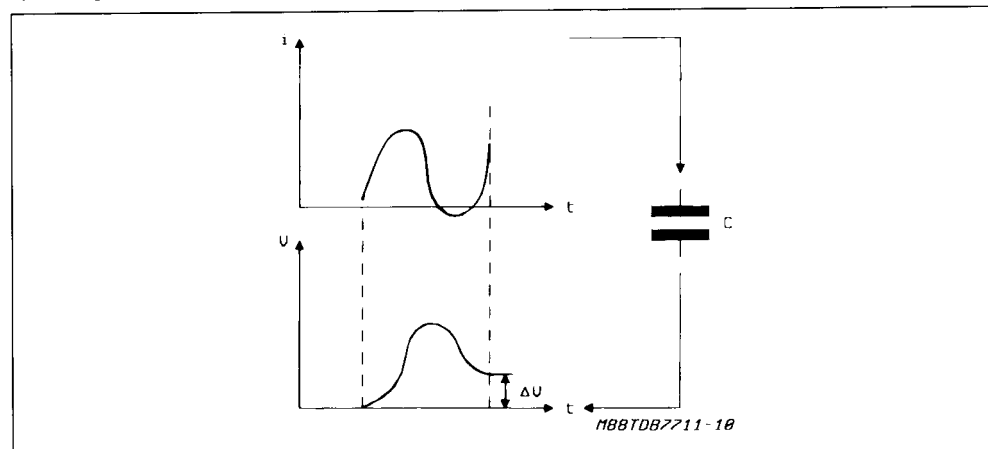
- the line current is sensed by a resistive network, not sensitive to longitudinal current.
- a fraction of the line current is sent in a capacitor during one period of the ringing signal.
- V is measured at the beginning and at the end of the period.

2 cases :

- 1) No Voltage Difference and Therefore No DC Component Exists in Line Current.



- 2) Voltage Difference and Therefore a DC Component Exists in Line Current.



POWER DOWN MODE (PD). In case of overtemperature or on logic control (see page 13: data output) the high voltage SLIC TDB7722 can be set in power down mode. In this case, the power consumption is very low, the line drivers amplifiers (TIP and RING) are set in high impedance state and cannot deliver any current.

DIGITAL CONTROL INTERFACE

The programmable functions of the SLIC are set by the contents of two 8-bits registers in the TDB7711 (low voltage) chip.

Connection between TDB7711 and the card controller is realized through a 4-wire serial bus.

The four pins have following functions :

CLK : Shift Clock (128 kHz max)

CS : Chip select (active low)

DI/O : Bidirectional pin : data-in (2 bytes), data-out (12 bit word)

R/W : Read (if "o") or write (if "1")

The datas are shifted into the low voltage TDB7711 on the rising edge of each CLK pulse, if CS = 0 and R/W = 1.

The datas are shifted out from TDB7711 on the rising edge of each CLK pulse, if CS = 0 and R/W = 0. The first bit B0 can even be read without any CLK pulse, as soon as CS = 0 and R/W = 0.

This bit is read again, as B0, upon the first CLK rising edge of a read operation.

When CS = 1, the DI/O pin is in high impedance, allowing several SLICs to share the same data link.

Data input

Two bytes can be written into the SLIC to program its registers.

B0 = 0 = First Byte Selected		Note 2
B1 = Standby	0 = Power up 1 = Standby	
B2 = Normal/Special Characteristic	0 = Normal 1 = Special	
B3 = Real/Apparent Battery	0 = Apparent 1 = Real	
B4 = Current Limitation 1	0 = 0 mA 1 = 30 mA	Note 1
B5 = Current Limitation 2	0 = 0 mA 1 = 20 mA	Note 1
B 6 = Current Limitation 3	0 = 0 mA 1 = 12 mA	Note 1
B 7 = Validation	0 = This word is not stored into the SLIC 1 = This word is stored into the SLIC on rising edge of CS	

- Notes :
1. The current values can be added. Therefore seven values are available from 12 mA to 62 mA.
 2. The B0 bit is always the first bit shifted into or shifted out from the DI/O pin.
 3. The SLIC is set in POWER DOWN mode if B1 = 1 and B4 = B5 = B6 = 0.

B0 = 1 = Second Byte Selected		Note 1
B1 = General Purpose Bit	0 = Low Level Voltage on GPB Pin 1 = High Level Voltage on GPB Pin	
B2 = Analog Input/Output Pin	0 = Input Mode 1 = Output Mode	
B3 = Teletax	0 = Teletax Off 1 = Teletax On	
B4 = Direct/Reverse Battery	0 = Direct Battery 1 = Reverse Battery	
B5 = Ringing	0 = Ringing Off 1 = Ringing On	
B6 = TTX Drop Voltage Variation	0 = Variation 1 = No Variation	
B7 = Validation	0 = This word is not stored into the SLIC 1 = This word is stored into the SLIC upon rising edge of \overline{CS}	

Note : 1. The B0 bit is always the first bit shifted into or shifted out from the D/I/O pin.

Data output

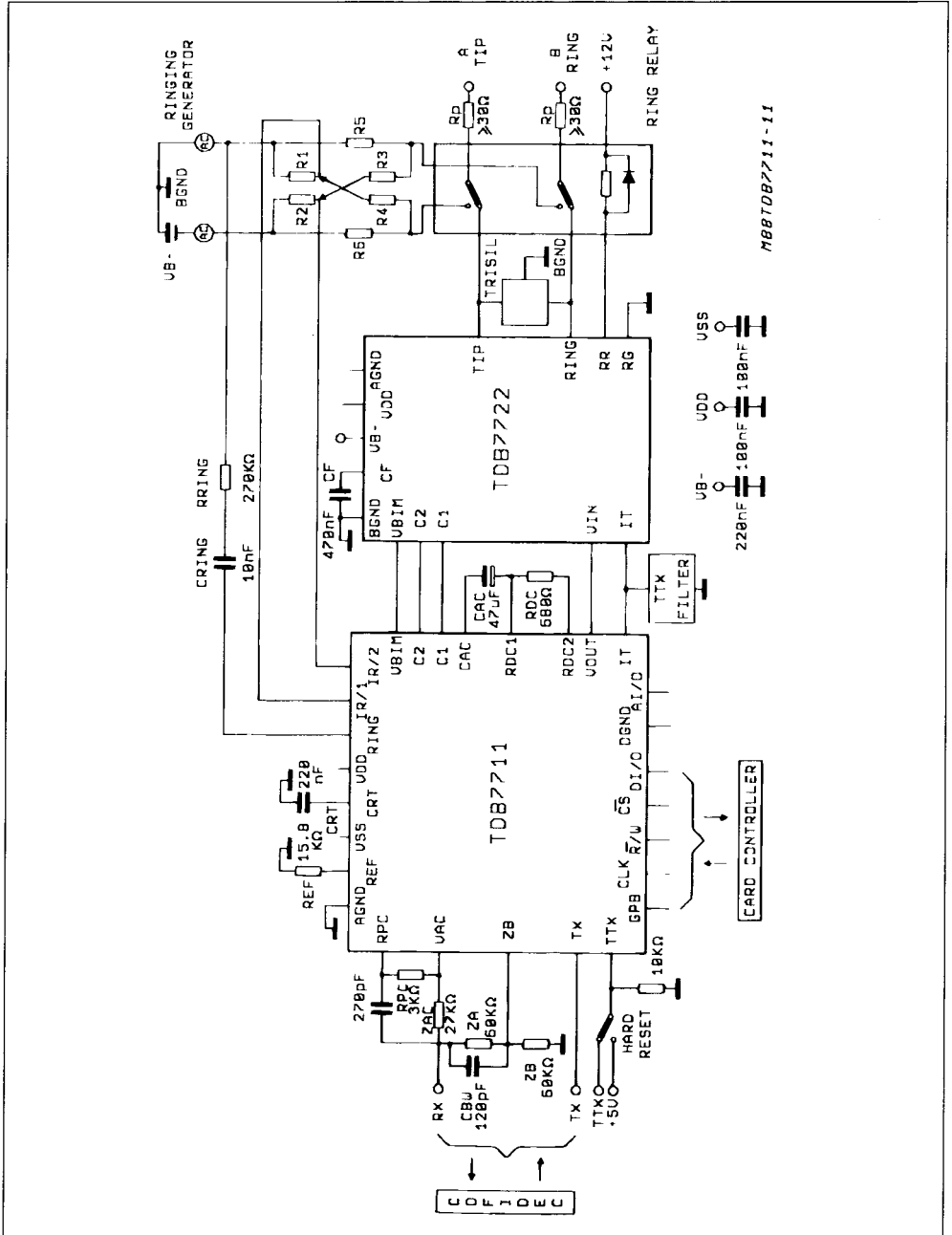
One twelve bit word can be read from the SLIC.

B0 = Hook Status (HS)	0 = On Hook Status 1 = Off Hook	Note 1
B1 = Comparison Result Bit (CRB)	0 = !line voltage! > voltage set on AI/O pin 1 = !line voltage! < voltage set on AI/O pin	
B2 = Ground Key (GK)	0 = No Ground Key 1 = Ground Key	
B3 = Thermal Warning (TW)	0 = Normal 1 = HV Circuit Temperature > 150° C	
B4 to B11 = Last byte written into the SLIC for checking		

Note : 1. The B0 bit is always the first bit shifted into or shifted out from the D/I/O pin.

Reset : The logic circuitry is automatically reset at power on, or by hardware, when applying the V_{DD} voltage on the TTX pin.

APPLICATION DIAGRAM



EXTERNAL COMPONENTS LIST

TDB7722 (high voltage)

Component		
Ref	Value	Function
RP CF	> = 30 OHMS 470 nF/100 V (20 %)	Protection Resistor Battery Voltage Rejection

TBD7711 (low voltage)

Component		
Ref	Value	Function
REF	15.8 Kohms (1 %)	Bias Resistor
RDC	680 ohms	Feeding Bridge Resistor
CAC	47 μ F/10 V (20 %)	AC Path Decoupling
ZAC	27 Kohms (Z0 = 600 ohms)	Scaled AC Impedance
RPC	3 Kohms (Rp = 30 ohms)	PTC Resistor Compensation
ZA	60 Kohms (Z0 = 600 ohms)	SLIC Impedance Balance Network
ZB	60 Kohms (Z0 = 600 ohms)	Line Impedance Balance Network
CBW	270 pF/10 V (10 %)	Bandwith Capacitor
C'BW	120 pF/10 V (10 %)	Bandwith Capacitor Compensation
CRT	220 nF/10 V (20 %)	Ring Trip Capacitor
R1 to R4 R5 and R6	560 Kohms (5 %) 220 ohms/2 W	Line Current Sensing During Ringing
RRing	270 Kohms (10 %)	Ring Generator Zero Crossing Detection
CRING	10 nF (20 %)	Ring Generator Zero Crossing Detection

Note : For external components definition, please refer to application note AN298

ELECTRICAL OPERATING CHARACTERISTICS

The characteristics apply when the application diagram (see figure 1) has nominal value of typical external components and unless otherwise specified :

$T_{amb} = 25\text{ }^{\circ}\text{C}$, $V_B = -30\text{ to }-72\text{ V}$, $V_{DD} = +5\text{ V} \pm 5\%$, $V_{SS} = -5\text{ V} \pm 5\%$

Transverse Line Current (I_{LT}) = 30 mA

LINE FEEDING CHARACTERISTICS

Symbol	Parameter	Min.	Typ.	Max.	Unit.
I_{lim}	Loop Current at Constant Current Feed	- Range	12	62	mA
		- Accuracy	- 0	+ 10	%
R_{feed}	Feed Resistance	- Range	300	1000	Ω
		- Accuracy	- 5	+ 5	%
V_{app}	Apparent Battery Voltage	- 50.4	- 48	- 45.6	V

ELECTRICAL OPERATING CHARACTERISTICS (continued)

SIGNALLING

Symbol	Parameter	Min.	Typ.	Max.	Unit.
I_H (off)	Off Hook Detection Threshold Power up or Power Down	5		8	mA
I_H (on)	On Hook Detection Threshold Power up or Power Down	4		7	mA
I_H (hys)	Off/On Hook Hysteresis		1		mA
	Dialing Distortion			3	ms
	Off Hook Reponse Time Transverse Line Current $I_{LT} = 20$ mA Power Down			70	ms
I_{GK} (on)	Ground Key Detection Threshold	3.5		7	mA
	Ground Key Detection Reponse Time Longitudinal Line Current $I_{LL} = 20$ mA			250	ms
I_R (ton)	Ring Trip Detection Threshold	5		10	mA
F_R	Ringing Frequency	16		70	Hz
	Ring Trip Delay $I_{LT} = 15$ mA			4/ F_R	s
V_{TTX}	Teletax Sending (with TT_X Filter) $F \leq 18$ kHz				
		Line Level	2.2	2.5	V_{rms}
G_{TTX}	$R_L = 200 \Omega$	Gain	7	8	9

2 WIRE PORT TRANSMISSION

Symbol	Parameter	Min.	Typ.	Max.	Unit.
	Overload Level 100 < F < 4000 Hz	6			dBm
	Return Loss 300 < F < 3400 Hz	20			dB
	Longitudinal Impedance On or Off Hook $R_p =$ Protection Resistance	$r - 10$		$r + 10$	Ω per wire
	Longitudinal Balance Conversation Mode Off-Hook 200<F<1000Hz Off-Hook F=3000Hz On-Hook 200<F<3400	58 53 50	63 58 53		dB
	Longitudinal Signal Generation 100 < F < 3400 Hz	52	60		dB
	Longitudinal Handling Capability	35			mArms

ELECTRICAL OPERATING CHARACTERISTICS (continued)

4 WIRE PORT TRANSMISSION

Symbol	Parameter		Min.	Typ.	Max.	Unit.
	Overload Level	On RX On TX	3 3			dBm dBm
	TX Output Offset Voltage				100	mV
Z_{TX}	TX Output Impedance				10	Ω
G_{RX}	RX to Line Gain	$F = 1020 \text{ Hz}$, $V_{RX} = 0 \text{ dBm}$	-0.15	0	0.15	dB
G_{TX}	Line to TX Gain	$V_{TX} = 0 \text{ dBm}$	-0.15	0	0.15	dB
	Frequency Response	$300 < F < 3400 \text{ Hz}$	-0.1	0	0.1	dB
	Gain Linearity	$F = 1020 \text{ Hz}$, V_{TX} or V_{RX} + 3 to - 40 dBm - 40 to - 50 dBm - 50 to - 55 dBm	-0.05 - 0.1 - 0.2		0.05 0.1 0.2	dB dB dB
	Transhybrid Loss	$V_{RX} = 0 \text{ dBm}$ $300 < F < 3400 \text{ Hz}$	30		40	dB
THD	Total Harmonic Distorsion	$F < 1020 \text{ Hz}$, 0 dBm	- 50			dB
N_p	Psophometric Noise on TX, or on the Line		- 75			dBmp
PSRR	Power Supply Rejection Ratio	$300 < F < 3400 \text{ Hz}$ V_B V_{DD} , V_{SS}	- 34 - 20			dB dB

RELAY DRIVER

Symbol	Parameter		Min.	Typ.	Max.	Unit.
I_{sink}	Sink Current				100	mA
	Leakage Current				100	μA
	Voltage Drop	Switch On			1	V
	Breakdown Voltage	$I_C = 200 \mu\text{A}$	75			V

DIGITAL INTERFACE

Symbol	Parameter		Min.	Typ.	Max.	Unit.
	Clock Frequency			128	150	KHz

SUPPLY CURRENT

Symbol	Parameter		Min.	Typ.	Max.	Unit.
I_{CC}^+	Positive Supply	Standby Power up			8 22	mA mA
I_{CC}^-	Negative Supply Current	Standby Power up			6 24	mA mA
I_{BAT}	Battery Supply Current	Standby Power up			0.7 5	mA mA

TIMING DIAGRAM (controller to SLIC to controller)

