Preliminary Data Sheet, DS1, July 2002

TSLIC-S

Twin Subscriber Line Interface Circuit Standard Feature Set

PEB 4364 Version 1.2

Wired Communications

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Never stop thinking.

TSLIC-S
Preliminary

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Table of Contents

Page

List of Figures

Page

List of Tables **Page**

Preface

This document describes the Twin High Voltage Subscriber Line Interface Circuit PEB 4364 (TSLIC-S) which is part of the DuSLIC and VINETIC chip set family.
For more DuSLIC or VINETIC related documents please see our webpages at http://www.infineon.com/duslic or http://www.infineon.com/vinetic.

As the two channels of the TSLIC-S are identical, channel independent pin names are used throughout the document (for example "TIP" in place of "TIPA/TIPB"). Channel related pin names are only used for the pin description and specific figures.

Organization of this Document

This Preliminary Data Sheet is divided into six chapters. It is organized as follows:

- **Chapter 1**, **Overview**
  A general description of the product, its key features, and pin configuration.
- **Chapter 2**, **Functional Description**
  The main functions and operating modes are presented.
- **Chapter 3**, **Typical Application Circuit for DuSLIC and VINETIC**
  Application circuit including bill of material and protection.
- **Chapter 4**, **Electrical Characteristics**
  Parameters, symbols and limit values.
- **Chapter 5**, **Test Figures**
  Test figures including external components.
- **Chapter 6**, **Package Outlines**
  Illustrations and dimensions of the package outlines.

1 Overview

The Twin High Voltage Subscriber Line Interface Circuit PEB 4364 (TSLIC-S) is a reliable two channel interface between the telephone line and the codec devices of the DuSLIC or VINETIC chip sets. It is fabricated using Infineon Technologies proven Smart Power Technology SPT4.

The PEB 4364 provides battery feeding between –15 V and –65 V and internal balanced ringing up to 45 Vrms. In order to achieve this, an auxiliary positive battery voltage is used during ringing to enhance the useable voltage range to 90 V.

The TSLIC-S is designed for a voltage-feeding/current-sensing line interface concept and senses the transversal and longitudinal current.

To minimize system power dissipation, a power-down mode can be used; the TSLIC-S is switched off and the line outputs go to a high-impedance mode. Off-hook supervision is provided by activating a simple line current sensor with negligible power consumption.

For saving power in active mode an integrated switch enables the use of a lower battery voltage in short loop applications.

The PEB 4364 is compatible with both 3.3 V and 5 V V_{DD} supplies.

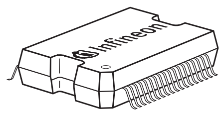
TSLIC-S **PEB 4364**

Twin Subscriber Line Interface Circuit Standard Feature Set

Version 1.2

1.1 Features

- Two channels
- High-voltage line feeding
- Two battery voltages (–15 V … –65 V)
- Integrated balanced ringing up to 45 Vrms
- Power-saving active mode (ACTL) with reduced battery voltage
- Sensing of transversal and longitudinal line currents
- Small P-DSO-36-15 package
- Compatible with 3.3 V and 5 V V_{DD}
- Enables high packing densities on board



P-DSO-36-12, -10

Type	Package
TSLIC-S	P-DSO-36-15

1.2 Logic Symbol

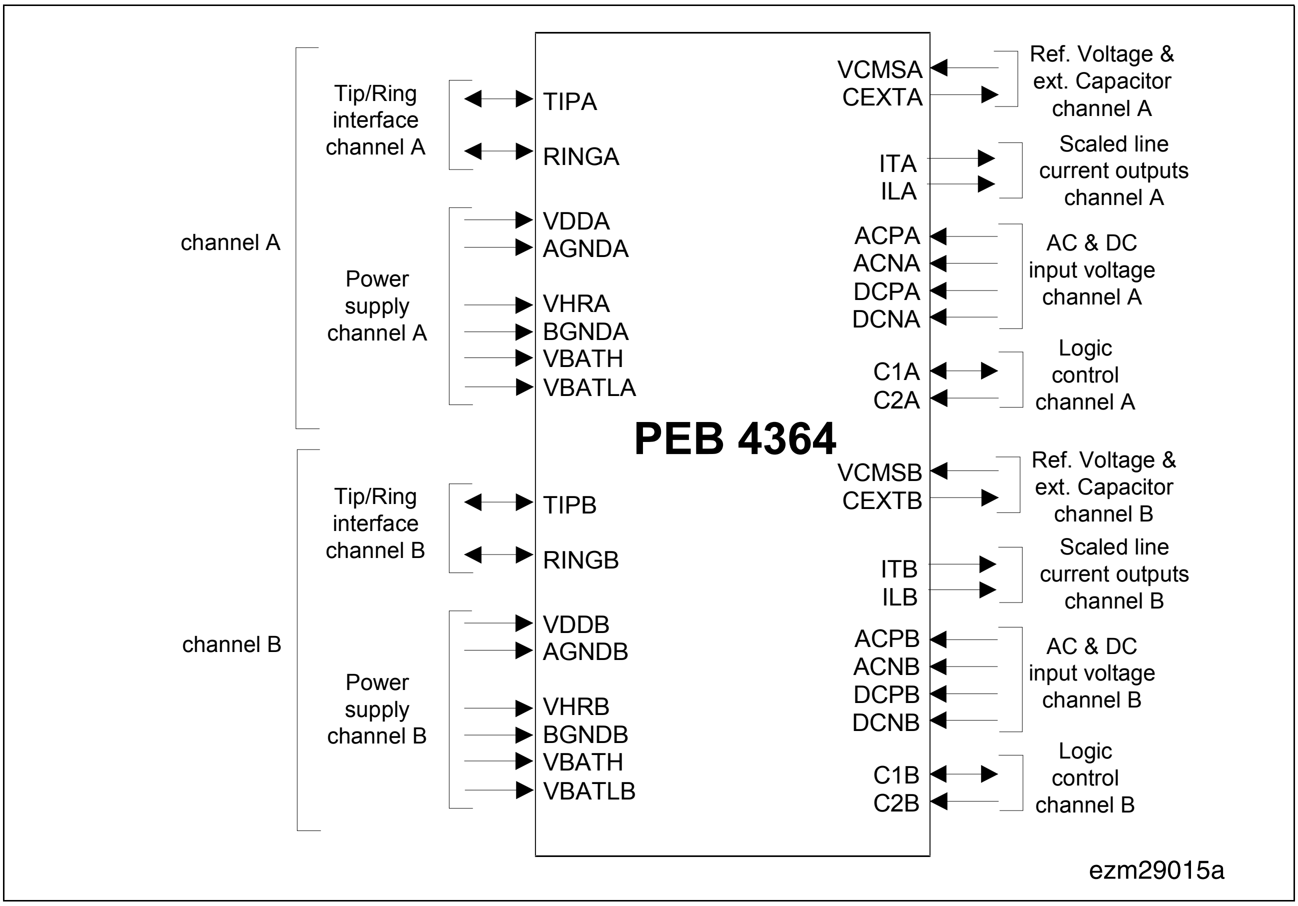


Figure 1 Logic Symbol

1.3 Pin Configuration

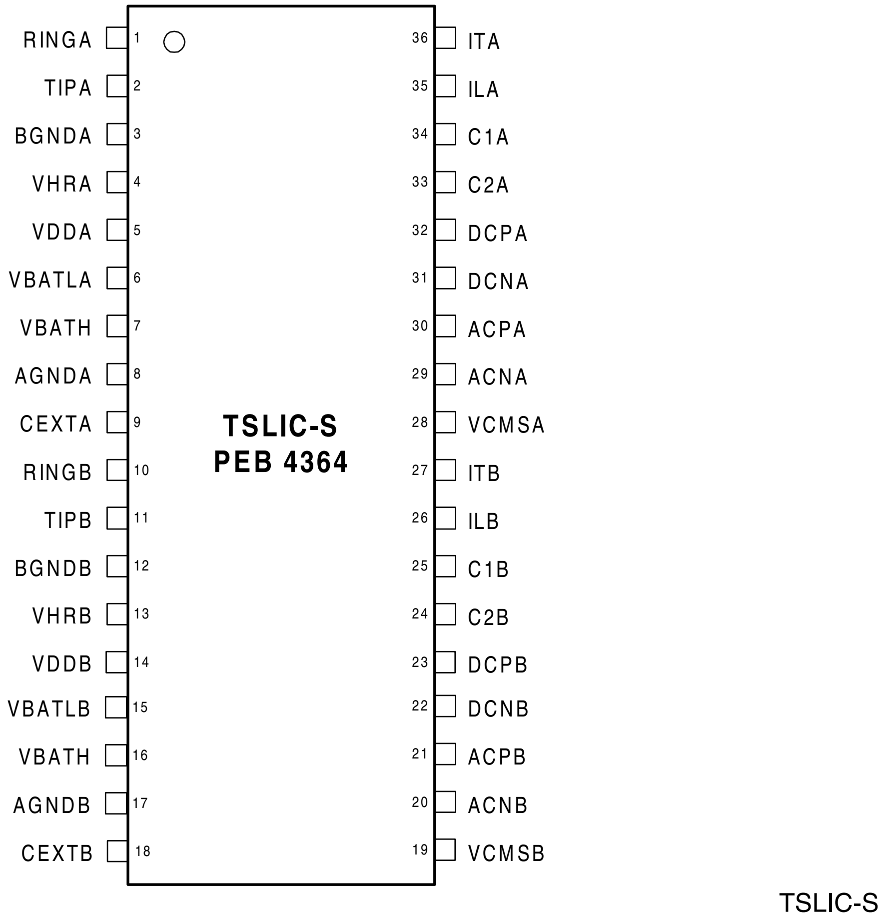


Figure 2 Pin Configuration (top view)

Attention: ***The heatslug (see Figure 19) is connected to VBATH via the chip substrate. Due to the high voltages of up to 90 V between VHRA (VHRB) and VBATH, touching of the heatslug or any attached conducting part can be hazardous.***

1.4 Pin Definitions and Functions TSLIC-S

Table 1 Pin Definitions and Functions TSLIC-S

Pin No.	Symbol	Input (I) Output (O)	Function
1 10	RINGA RINGB	I/O	Subscriber loop connection RING
2 11	TIPA TIPB	I/O	Subscriber loop connection TIP
3 12	BGNDA BGNDB	Power	Battery ground: TIP, RING, V_{BATH}, V_{BATL} and V_{HR} refer to this pin.
4 13	VHRA VHRB	Power	Auxiliary positive battery supply voltage ($5\ V \leq V_{HR} \leq 45\ V$)used in ringing mode.
5 14	VDDA VDDB	Power	Positive supply voltage ($3.1\ V \leq V_{DD} \leq 5.5\ V$), referred to AGND.
6 15	VBATLA VBATLB	Power	Negative battery supply voltage ($-15\ V \geq V_{BATL} \geq V_{BATH}$)
7 16	VBATH	Power	Most negative battery supply voltage ($-20\ V \geq V_{BATH} \geq -65\ V$). Same pin name for both channels due to connection via substrate. **An external connection via PCB is required!!**
8 17	AGNDA AGNDB	Power	Analog ground: V_{DD}, and all signal and control pins with the exception of TIP and RING refer to AGND.
9 18	CEXTA CEXTB	O	Output of voltage divider defining DC line potentials; an external capacitance allows supply voltage filtering (output resistance 50 kΩ).
28 19	VCMSA VCMSB	I	Reference voltage for differential two wire interface of typically 1.5 V.
29, 30 20, 21	ACNA, ACPA ACNB, ACPB	I	Differential two-wire AC input voltage; multiplied by –6 and related to $(V_{HI} + V_{BI})/2$, ACN appears at TIP and ACP at RING output, respectively.

Table 1 Pin Definitions and Functions TSLIC-S (cont'd)

Pin No.	Symbol	Input (I) Output (O)	Function
31, 32 22, 23	DCNA, DCPA DCNB, DCPB	I	Differential two-wire DC input voltage; multiplied by –30 (ACTH and ACTL mode) or –60 (ACTR mode) and related to $(V_{HI} + V_{BI})/2$[1], DCN appears at TIP and DCP at RING output, respectively.
33 24	C2A C2B	I	Ternary logic input, controlling the operation mode.
34 25	C1A C1B	I/O	Ternary logic input, controlling the operation mode; in case of thermal overload (chip temperature exceeding 165 °C) this pin sinks a current of typically 150 µA.
35 26	ILA ILB	O	Current output: longitudinal line current scaled down by a factor of 100.
36 27	ITA ITB	O	Current output representing the transversal current scaled down by a factor of 50.

[1] V_{HI} is the output voltage of the positive battery switch,
V_{BI} is the output voltage of the negative battery switch (see **Figure 3**).

1.5 Functional Block Diagram

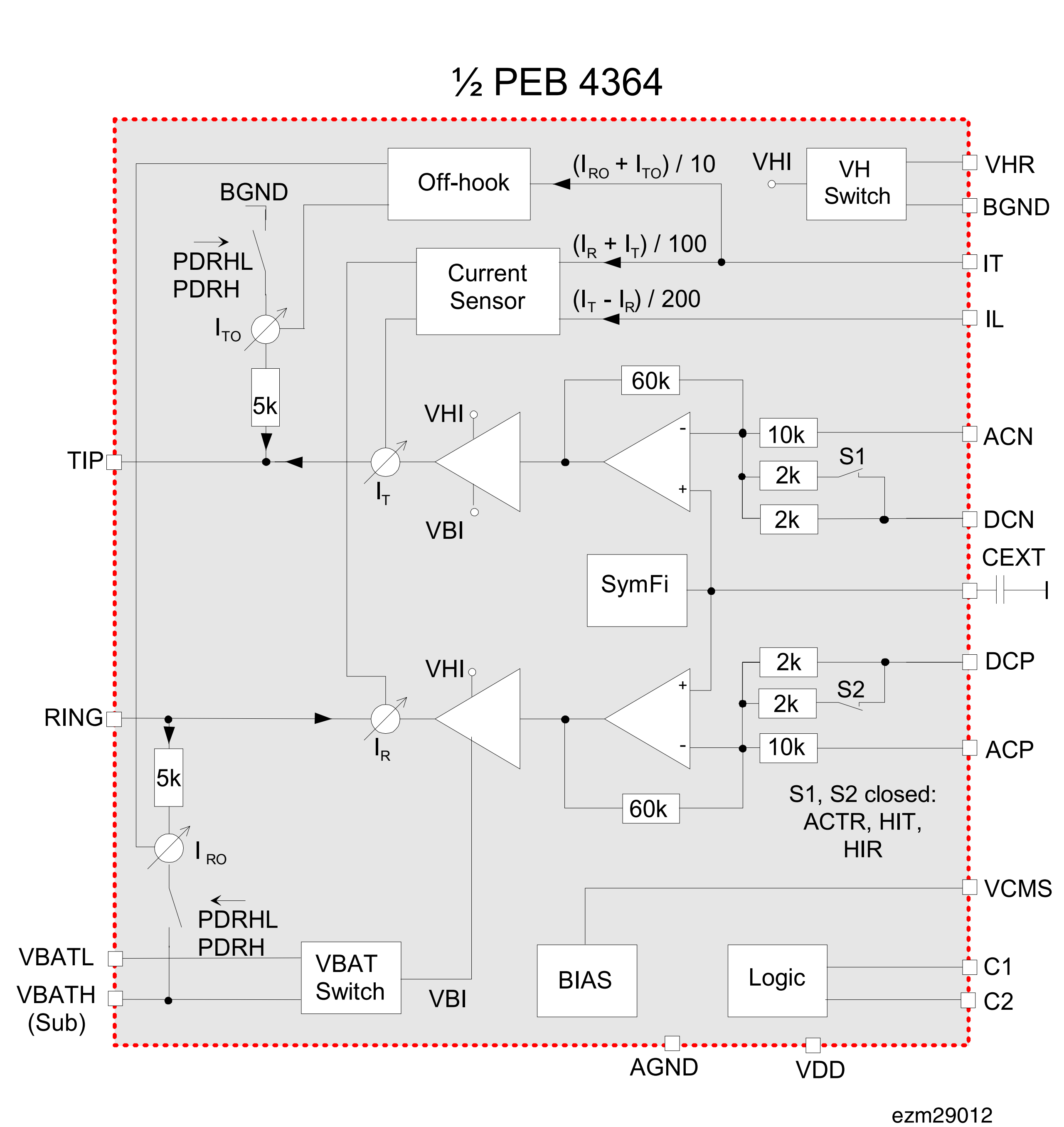


Figure 3 Block Diagram (one Channel)

Note: As the two channels of the TSLIC-S are identical, channel independent pin names are used throughout the document (for example "TIP" in place of "TIPA/TIPB"). Channel related pin names are only used for the pin description and specific figures.

2 Functional Description

The PEB 4364 supports AC and DC control loops for each channel based on feeding a voltage V_{TR} to the line and sensing the transversal line current I_{Trans} and the longitudinal current I_{Long} (**Figure 4**).

In receive direction DC and AC voltages are handled separately with different gains on the TSLIC-S. Both are applied differentially via pins DCP and DCN or ACP and ACN, respectively.

The line voltages V_R and V_T are the amplified input voltages, related to the mean supply voltage $V_M = (V_{HI} + V_{BI})/2$. Depending on the operation mode, V_{HI} is switched either to V_{HR} or to BGND via the VH switch and V_{BI} is switched either to V_{BATL} or to V_{BATH} via the VBAT switch (see **Figure 3**).

In the active modes ACTH with $V_M = V_{BATH}/2$ and ACTL with $V_M = V_{BATL}/2$, the line voltages are given by

$$V_T = V_{TIP} = V_M - 30 \times (V_{DCN} - V_{CMS}) - 6 \times (V_{ACN} - V_{CMS})$$
$$V_R = V_{RING} = V_M - 30 \times (V_{DCP} - V_{CMS}) - 6 \times (V_{ACP} - V_{CMS})$$

and in ringing mode ACTR with $V_M = [V_{HR} + V_{BATH}]/2$,

$$V_T = V_{TIP} = V_M - 60 \times (V_{DCN} - V_{CMS}) - 6 \times (V_{ACN} - V_{CMS})$$
$$V_R = V_{RING} = V_M - 60 \times (V_{DCP} - V_{CMS}) - 6 \times (V_{ACP} - V_{CMS})$$

The transversal line voltage $V_{TR} = V_T - V_R$ is simply related to the input voltages:

$V_{TR} = V_{TIP} - V_{RING} = V_{ab} =$

$= 30 \times (V_{DCP} - V_{DCN}) + 6 \times (V_{ACP} - V_{ACN})$ for mode ACTH, ACTL

$= 60 \times (V_{DCP} - V_{DCN}) + 6 \times (V_{ACP} - V_{ACN})$ for mode ACTR

A reversed polarity of V_{TR} is easily obtained by changing the sign of $(V_{DCP} - V_{DCN})$.

In transmit direction the transversal and longitudinal currents are measured in the buffers and scaled images are provided at the IT and IL pin, respectively:

$I_{IT} = (I_T + I_R)/100 = I_{Trans}/50$	$I_{IL} = (I_T - I_R)/200 = I_{Long}/100$
$I_{Trans} = (I_T + I_R)/2$	$I_{Long} = (I_T - I_R)/2$

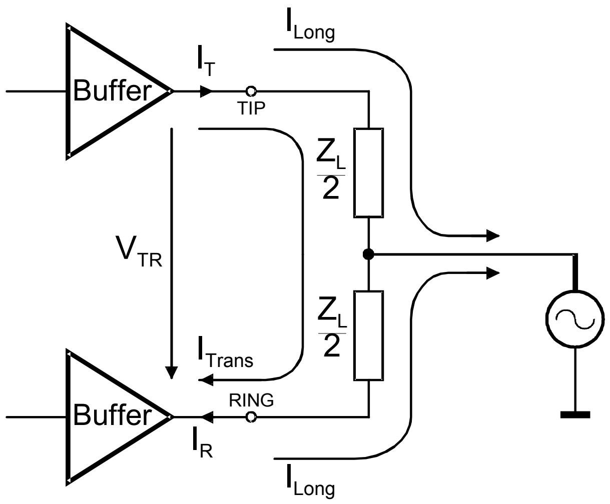


Figure 4 Definition of Output Current Directions

For off-hook detection, in PDRH mode 5 kΩ resistors are connected from TIP to BGND and from RING to VBATH, respectively.

The currents through these resistors, I_{T0} and I_{R0} are sensed, scaled and provided at the IT pin (see **Figure 3**):

$I_{IT0} = (I_{T0} + I_{R0})/10 = I_{TRANS0}/5$

The TSLIC-S consists of two SLICs, which can be operated completely independent. Also the supply voltages V_{HR} and V_{BATL} of each of the SLICs can be chosen independently from each other. That means V_{HRA} and V_{BATLA} might be different from V_{HRB} and V_{BATLB}.

Caution: V_{BATH} supply voltage has to be the same for both SLIC channels. All VBATH pins of TSLIC-S must be connected externally.

2.1 Operating Modes

Each channel of the PEB 4364 (TSLIC-S) operates in one of the following modes controlled by ternary logic signals at the respective C1 and C2 input pins:

Table 2 TSLIC-S Interface Code

		C2[1]		
		L	**M**	**H**
C1[1]	**L[2]**	PDH	PDRHL	PDRH
	M	ACTL	ACTH	ACTR
	H	HIRT	HIT	HIR

1) As the two channels of the TSLIC-S are identical, channel independent pin names are used throughout the document (for example "C1" in place of "C1A/C1B"). Channel related pin names are only used for the pin description and specific figures.

2) No 'Overtemp' signaling possible via pin C1 if C1 is low.

The operating modes of channels A and B can be chosen completely independent. Any combination is allowed; thermal restrictions (max. chip temperature), however, have to be obeyed.

Table 3 TSLIC-S Modes

TSLIC-S Mode	Mode Description	Internal Supply Voltages V_{BI}, V_{HI}
PDH	Power Down High Impedance	(supply switches open)
PDRH	Power Down Resistive High	(supply switches open)
PDRHL	Power Down Resistive High Load	(supply switches open)
ACTL	Active Low	V_{BATL}, BGND
ACTH	Active High	V_{BATH}, BGND
ACTR	Active Ring	V_{BATH}, V_{HR}
HIRT	High Impedance on RING and TIP	V_{BATH}, V_{HR}
HIT	High Impedance on TIP	V_{BATH}, V_{HR}
HIR	High Impedance on RING	V_{BATH}, V_{HR}

Power Down High Impedance (PDH)

PDH offers high impedance at TIP and RING; it can be used for testing purposes or when an error condition occurs. In PDH mode all functions are switched off. Off-hook detection is not available.

Power Down Resistive High (PDRH)

Power consumption is reduced to a minimum by switching completely off all voice transmission functions. To allow off-hook detection, PDRH provides a connection of 5 kΩ each from TIP to BGND and RING to VBATH , respectively, while the output buffers show high impedance (see **Figure 3**). The current through these resistors is sensed and transferred to the IT pin for off-hook supervision.

Power Down Resistive High Load (PDRHL)

PDRHL is used as a transition state at a mode change from PDRH or PDH to ACTH mode (automatically initiated by the codec device at a mode change). It causes fast preloading of C_{EXT} in order to suppress line voltage transients.

Active Low (ACTL), Active High (ACTH)

These are the regular transmission modes for voiceband. The line-driving section is operated between V_{BATL} or V_{BATH} and BGND.

Active Ring (ACTR)

Utilizing an additional positive battery voltage V_{HR}, this mode allows balanced ringing of up to 45 Vrms or feeding of very long telephone lines.

High Impedance (HIR, HIT, HIRT)

In these modes each of the line outputs can be programmed to show high impedance. HIT switches off the TIP buffer, while HIR switches off the RING buffer. The current through the active buffer can still be measured by IT or IL. In the HIRT mode both buffers show high impedance. The current sensor remains active thus allowing sensor offset calibration (for test purposes).

2.2 Current Limitation / Overtemperature

In any operating mode (except Power Down) the total current delivered by the output drivers is limited to approximately 100 mA.

If, however, the chip temperature exceeds a threshold of typically 165 °C, this current limit is further reduced in order to keep temperature constant.

Besides, pin C1 sinks a signalling current I_{therm}. The temperature threshold for switching on I_{therm} depends on V_{DD}:

- if operated at 5 V, both signalling and current limit reduction start simultaneously
- at 3.3 V, the temperature threshold for signalling is about 5 - 10 °C higher than for the onset of current reduction.

As the two TSLIC-S channels are thermally coupled, overtemperature conditions may affect both channels.

3 Typical Application Circuit for DuSLIC and VINETIC

Figure 5 (**Figure 6**) shows one channel of an application circuit including a TSLIC-S and a SLICOFI-2/-2S or VINETIC-4VIP/-4M/-8M chip (for latest information please refer to the DuSLIC or VINETIC Data Sheet). Pins of an unused channel of TSLIC-S can be left open. **Table 4** shows the external passive components needed for a dual-channel solution as shown in **Figure 5** and **Figure 6**.

Table 4 External Components DuSLIC / VINETIC for 2 Channels

No.	Symbol	Value	Unit	Tol.	Rating	DuSLIC Systems	VINETIC Systems
2	R_{IT1}	470	Ω	1 %		x	
2	R_{IT1}	510	Ω	1 %			x
2	R_{IT2}	680	Ω	1 %		x	x
2	R_{IL}	1.6	kΩ	1 %		x	x
4	R_{STAB}	30	Ω	1 %[1]		x	x
4	R_{PROT}[2]	20 ... 50	Ω	1 %[1]		x	x
4	C_{STAB}	15 (typ.)	nF	10 %	100 V	x	x
2	C_{DC}	120	nF	10 %	10 V	x	
2	C_{DC}	220	nF	10 %	10 V		x
2	C_{ITAC}	680	nF	10 %	10 V	x	
2	C_{ITAC}	1	µF	10 %	10 V		x
1	C_{PRE}[3]	18	nF	5 %	10 V		x
2	C_{VCMIT}	680	nF	10 %	10 V	x	
1	C_{REF}	68	nF	20 %	10 V	x	x
2	C_{EXT}	470	nF	20 %	10 V	x	x
12	C_1	typ. 100	nF	10 %		x	x
1	C_2	4.7	µF	20 %	10 V, Tantal	x	
2	D_1	BAS 21	–	–	–	x	x
4	D_2	BAS 21	–	–	–	x	x
2	U_1[2]	Overvoltage Protection Element	–	–	–	x	x

[1] Matching tolerance dependent on longitudinal balance requirements (for details see the Application Note *External Components*).

[2] For protection see the Application Note *Protection of DuSLIC / VINETIC Linecard Chip Sets against Overvoltages and Overcurrents*.

[3] C_{PRE} is only necessary when TTX (12 or 16 kHz metering) is used.

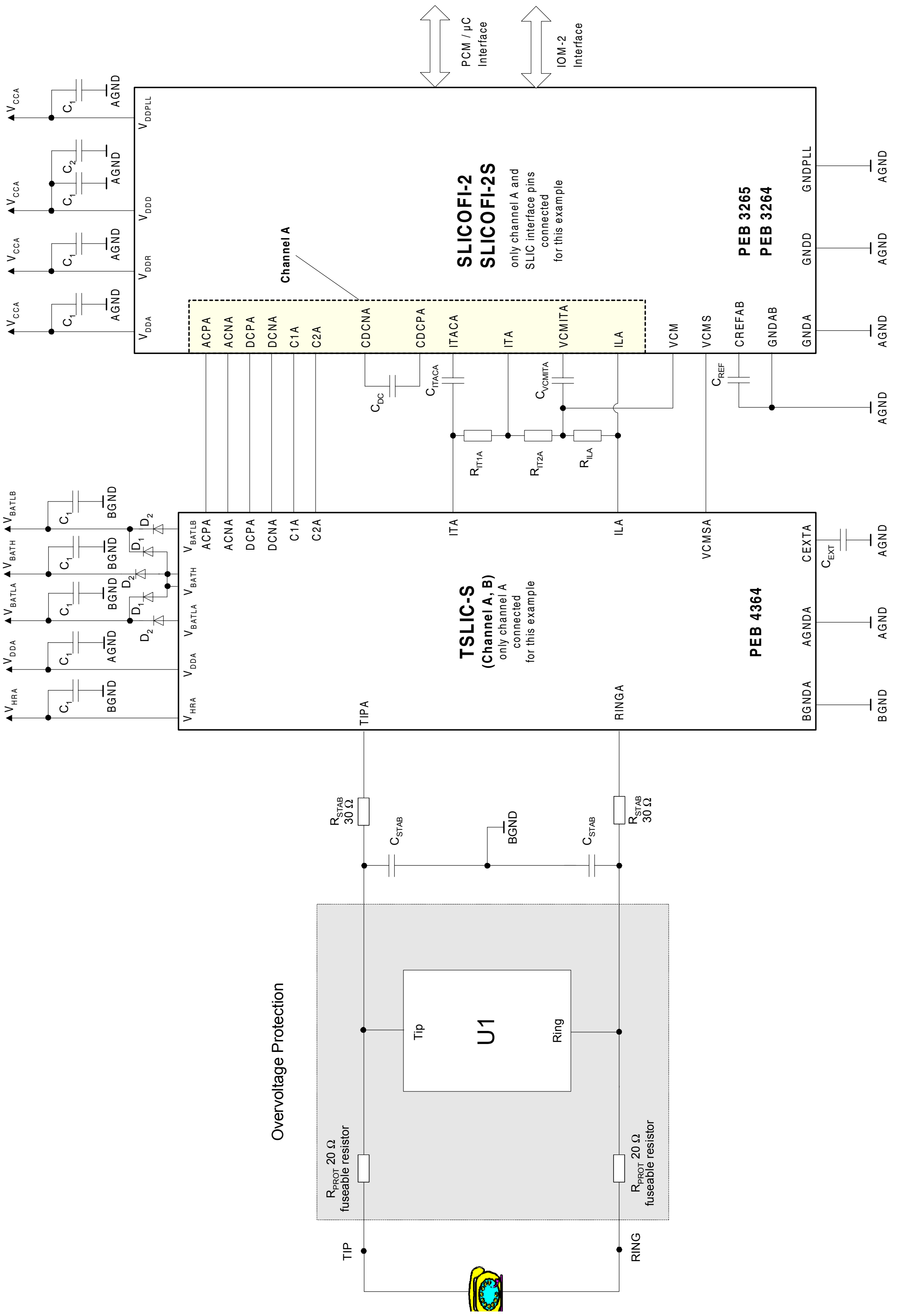


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Figure 5 Application Circuit DuSLIC (only Channel A connected)

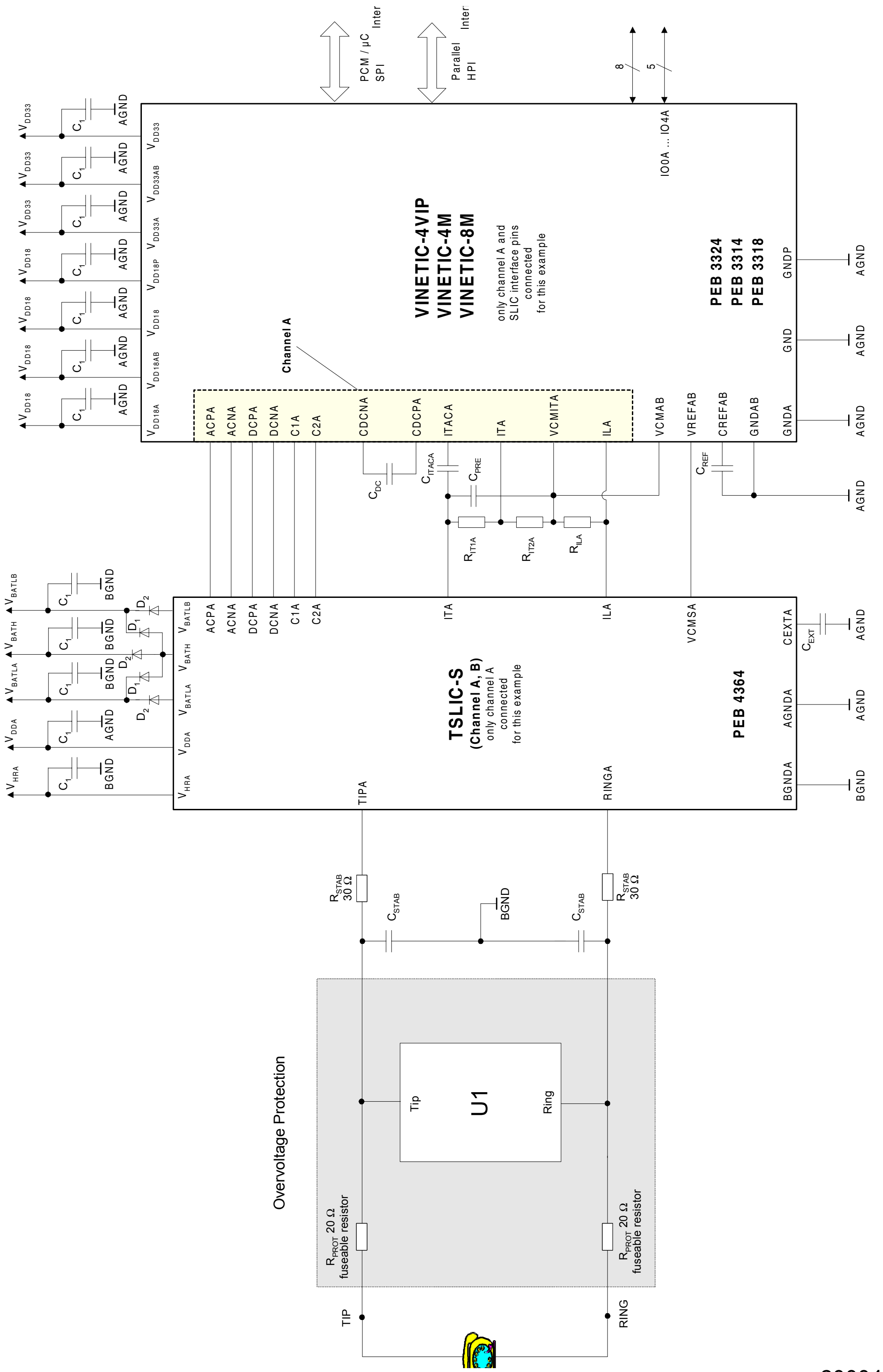

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Figure 6 Application Circuit VINETIC (only Channel A connected)

4 Electrical Characteristics

4.1 Absolute Maximum Ratings

Table 5 Absolute Maximum Ratings

Parameter	Symbol	Limit Values		Unit	Note
		min.	max.		
Battery voltage low	V_{BATL}	–65	0.4	V	Referred to BGND
Battery voltage high	V_{BATH}	–70	0.4	V	Referred to BGND
Batter voltage difference	$V_{BATL} - V_{BATH}$	–0.4	–	V	–
Auxiliary supply voltage	V_{HR}	–0.4	50	V	Referred to BGND
Total battery supply voltage, continuous	$V_{HR} - V_{BATH}$	–0.4	90	V	–
V_{DD} supply voltage	V_{DD}	–0.4	7	V	Referred to AGND
Ground voltage difference BGND, AGND	–	–0.4	0.4	V	–
Input voltages	V_{DCP}, V_{DCN}, V_{ACP}, V_{ACN}, V_{C1}, V_{C2}, V_{CMS}	–0.4	V_{DD} + 0.4	V	Referred to AGND
Voltages on current outputs	V_{IT}, V_{IL}	–0.4	V_{DD} + 0.4	V	Referred to AGND
Junction temperature	T_j	–	150	°C	–
ESD voltage, all pins	–	–	1	kV	SDM (Socketed Device Model)[1]

[1] EOS/ESD Assn. Standard DS5.3-1993.

Note: Stresses above those listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect the reliability of the device.

4.2 Foreign Line Voltages

External voltages applied at the line outputs cause a current flow in the TSLIC-S. The resulting on-chip power dissipation has to be limited to avoid thermal destruction, because overtemperature protection cannot react fast enough at high local power density. The value of allowed power dissipation strongly depends on its duration. It can be expressed in terms of voltage and current limits directly at the TIP/RING outputs.

Table 6 Voltage Limits on Output Pins

Duration of Voltage	pins	min. Voltage [V]	max. Voltage [V]
continuous	TIP, RING	$V_{BATH} - 0.4$	$V_{HR} + 5$
< 10 ms	TIP, RING	$V_{BATH} - 5$	$V_{HR} + 10$
< 100 µs	TIP, RING	$V_{BATH} - 10$	$V_{HR} + 20$
< 1 µs	TIP, RING	$V_{BATH} - 15$	$V_{HR} + 40$

Table 7 Current Limits on Output Pins

Duration of Current	pins	min. current [A]	max. current[A]
continuous	TIP, RING	– 0.1	0.1
< 10 ms	TIP, RING	– 0.5	0.5
< 100 µs	TIP, RING	– 1	1.0
< 1 µs	TIP, RING	– 1.5	1.5

The above limits (**Table 6** and **Table 7**) have to be regarded as typical. They are valid simultaneously. Together with external circuitry they determine protection requirements (see Application Note of the DuSLIC/VINETIC chip set on overvoltages and overcurrents).

4.3 Power Up Sequence of Supply Voltages

It is recommended to apply the TSLIC-S supply voltages for each channel in the following order to the respective pins:

1) AGND, BGND
2) V_{DD}
3) V_{BATH}
4) V_{HR}
5) V_{BATL}

When powering down the TSLIC-S, the supply voltages have to be removed in reverse order.

With the use of the diodes D_1 and D_2 (see application circuits **Figure 5** and **Figure 6**) it is not necessary to keep the recommended power up sequence.

4.4 Operating Range

Table 8 Operating Range

Parameter	Symbol	Limit Values		Unit	Note
		min.	max.		
Battery voltage L [1]	V_{BATL}	–60	–15	V	Referred to BGND
Battery voltage H [1]	V_{BATH}	–65	–20	V	Referred to BGND
Auxiliary supply voltage	V_{HR}	3.1	45	V	Referred to BGND
Total battery supply voltage	$V_{HR} - V_{BATH}$	–	90	V	–
V_{DD} supply voltage	V_{DD}	3.1	5.5	V	Referred to AGND
Ground voltage difference BGND, AGND	–	–0.4	0.4	V	–
Voltage at pins IT, IL	V_{IT}, V_{IL}	–0.4	3.5	V	Referred to AGND
Input range V_{DCP}, V_{DCN}, V_{ACP}, V_{ACN}	V_{ACDC}	0	3.3	V	Referred to AGND
Ambient temperature	T_{amb}	–40	85	°C	–
Junction temperature	T_J	–	125[2]	°C	–

[1] If the battery switch is not used, pins VBATL and VBATH should be connected externally. In this case the full voltage range of –15 V to –65 V can be used.

[2] Operation up to T_J = 150 °C possible. However, a permanent junction temperature exceeding 125 °C could degrade device reliability.

4.5 Thermal Resistances

Table 9 Thermal Resistances

Parameter	Symbol	Typical Values	Unit	Condition
Junction to case	$R_{th, jC}$	2	K/W	–
Junction to ambient	$R_{th, jA}$	20	K/W	P-DSO-36-15, 4-layer PCB; die pad soldered to 20 x 20 mm² cooling area (footprint see **Chapter 6.1**)

The allowed power dissipation can be calculated as:

$P_{max} = P_A + P_B = (T_{j,max} - T_{amb})/R_{th,jA}$

P_A ... Power Dissipation Channel A
P_B ... Power Dissipation Channel B

4.6 Electrical Parameters

Minimum and maximum values are valid within the full operating range.

Testing is performed according to the specific test figures at V_{BATH} = –48 V, V_{BATLA} = V_{BATLB} = –24 V, V_{HRA} = V_{HRB} = +32 V and V_{DDA} = V_{DDB} = +3.3 V.

Functionality and performance is guaranteed for T_A = 0 to 70 °C by production testing. Extended temperature range operation at –40 °C < T_A < 85 °C is guaranteed by design, characterization and periodically sampling and testing production devices at the temperature extremes.

Identical specifications are valid for both TSLIC-S channels A and B. So they are not distinguished in the following parameter tables.

4.6.1 Supply Currents and Power Dissipation (Values per Channel)

Table 10 Supply Currents, Power Dissipation (I_R = I_T = 0 A; V_{RT} = 0 V)

No.	Parameter	Symbol	Mode	Limit Values			Unit
				min.	typ.	max.	
Power Down High Impedance, Power Down Resistive High							
1.	V_{DD} current	I_{DD}	PDx	–	200	300	µA
2. 3.	V_{BATH} current	I_{BATH}	PDH PDRH	– –	50 120	100 200	µA µA
4.	V_{BATL} current	I_{BATL}	PDx	–	0	10	µA
5.	V_{HR} current	I_{HR}	PDx	–	10	20	µA
Active Low							
6.	V_{DD} current	I_{DD}	ACTL	–	1	1.3	mA
7.	V_{BATH} current	I_{BATH}	ACTL	–	100	150	µA
8.	V_{BATL} current[1)]	I_{BATL}	ACTL	–	2.5	3.2	mA
9.	V_{HR} current	I_{HR}	ACTL	–	10	20	µA

Table 10 Supply Currents, Power Dissipation ($I_R = I_T = 0$ A; $V_{RT} = 0$ V) (cont'd)

No.	Parameter	Symbol	Mode	Limit Values			Unit
				min.	typ.	max.	
Active High							
10.	V_{DD} current	I_{DD}	ACTH	–	1	1.3	mA
11.	V_{BATH} current[1)]	I_{BATH}	ACTH	–	3	4	mA
12.	V_{BATL} current	I_{BATL}	ACTH	–	0	10	µA
13.	V_{HR} current	I_{HR}	ACTH	–	10	20	µA
Active Ring							
14.	V_{DD} current	I_{DD}	ACTR	–	0.6	0.8	mA
15.	V_{BATH} current[1)]	I_{BATH}	ACTR	–	2.2	3.2	mA
16.	V_{BATL} current	I_{BATL}	ACTR	–	0	10	µA
17.	V_{HR} current[1)]	I_{HR}	ACTR	–	1.4	2	mA
High Impedance on RING, High Impedance on TIP							
18.	V_{DD} current	I_{DD}	HIR, HIT	–	0.6	0.8	mA
19.	V_{BATH} current[1)]	I_{BATH}	HIR, HIT	–	1.8	2.5	mA
20.	V_{BATL} current	I_{BATL}	HIR, HIT	–	0	10	µA
21.	V_{HR} current[1)]	I_{HR}	HIR, HIT	–	1.1	1.6	mA

[1)] Current depending on supply voltage (see **Table 11**)

The total power dissipated in the SLIC consists of the quiescent power P_Q due to the supply currents and the output stage power P_O caused by any line current I_{TRANS} (see **Table 12**).

$$P_{tot} = P_Q + P_O$$

The TSLIC-S´s total power dissipation can be estimated by adding the power dissipated in channel A and channel B:

$$P_{tot} = P_{Q,A} + P_{Q,B} + P_{out,A} + P_{out,B}$$

with $P_Q = V_{DD} \times I_{DD} + |V_{BATH}| \times I_{BATH} + |V_{BATL}| \times I_{BATL} + V_{HR} \times I_{HR}$

The supply currents I_{BATL} , I_{BATH} and I_{HR} are dependent on the respective supply voltages. They can be calculated from the specified values I_{BATL} (-24 V), I_{BATH} (-48 V) and I_{HR} (32 V) by the formulas in **Table 11**.

Table 11 Voltage Dependance of Supply Currents

Operating Mode	Equation for I Calculation
ACTL	$I_{BATL}(V_{BATL}) = I_{BATL}(-24V) + (\lvert V_{BATL}\rvert - 24)/50\ k\Omega$
ACTH	$I_{BATH}(V_{BATH}) = I_{BATH}(-48V) + (\lvert V_{BATH}\rvert - 48)/50\ k\Omega$
ACTR[1)]	$I_{BATH}(V_{BATH}) = I_{BATH}(-48V) + (\lvert V_{BATH}\rvert - 48)/50\ k\Omega$ $I_{HR}(V_{HR}) = I_{HR}(32V) + (V_{HR} - 32)/200\ k\Omega$

1) valid for $\lvert V_{BATH}\rvert > V_{HR}$

Table 12 Output Stage Power Dissipation

Operating Mode	Equation for P_O Calculation
ACTL	$P_O = (1.05 \times \lvert V_{BATL}\rvert - V_{TR}) \times I_{Trans}$
ACTH	$P_O = (1.05 \times \lvert V_{BATH}\rvert - V_{TR}) \times I_{Trans}$
ACTR	$P_O = (1.02 \times V_{HR} + 1.05 \times \lvert V_{BATH}\rvert - V_{TR}) \times I_{Trans}$ (ohmic load) $P_O = [4 \times (V_H + \lvert V_{BATH}\rvert) - \pi \times V_P \times \cos\varphi] \times V_P / (2 \times \pi \times Z_L)$ (complex load $Z = Z_L e^{i\varphi}$, V_P ... peak ring voltage)

4.6.2 DC Characteristics

Table 13 DC Characteristics

No.	Parameter	Symbol	Mode	Limit Values			Unit	Test Condition
				min.	typ.	max.		
Line Termination TIP, RING								
22.	DC line voltage	$V_{TR, DC}$	ACTL, ACTH, ACTR	–0.4		0.4	V	$V_{DCP} = V_{DCN} = V_{ACP} = V_{ACN} = 1.5$ V
23.		$V_{TIP, DC}$	ACTL	–13	–12	–11	V	
24.			ACTH	–25	–24	–23	V	
25.			ACTR	–10.5	–9.5	–8.5	V	
26.		$V_{TR, DC}$	ACTH	23.5	24	24.5	V	$V_{DCP} - V_{DCN} = 0.8$ V, $V_{ACP} = V_{ACN} = 1.5$ V
27.				–24.5	–24	–23.5	V	$V_{DCP} - V_{DCN} = -0.8$ V, $V_{ACP} = V_{ACN} = 1.5$ V
28.	DC line voltage drop (see **Figure 7**)	$-V_{BATH} - V_{TR, max}$	ACTH	–	2	3	V	$I_{Trans,DC} = 20$ mA, $V_{DCP} - V_{DCN} = 2.5$ V, $V_{ACP} = V_{ACN} = 1.5$ V
29.	Output current limit (see **Figure 11**)	$\lvert I_{R, max}\rvert$, $\lvert I_{T, max}\rvert$	ACTL, ACTH, ACTR, HIR HIT	75		115	mA	
30.	Open loop resistance TIP to V_{BGND} (see **Figure 12**)	R_{TG}	PDRH	4.7	5.5	6.3	kΩ	$I_T = 2$ mA, Temp = 25 °C 1)
31.	Open loop resistance RING to V_{BATH} (see **Figure 12**)	R_{RB}	PDRH	4.7	5.5	6.3	kΩ	$I_R = 2$ mA, Temp = 25 °C 1)
32.	Open loop line voltage	V_{TR}	PDRH		47		V	
33.	Power down output leakage current	$I_{Leak,R}$, $I_{Leak,T}$	PDH	–30		30	µA	$V_{R,T} = V_{BATH}$
34.					50	80	µA	$V_{R,T} = V_{HR}$

Table 13 DC Characteristics (cont'd)

No.	Parameter	Symbol	Mode	Limit Values			Unit	Test Condition
				min.	typ.	max.		
35.	High impedance output leakage current	$I_{Leak,R}$	HIR, HIRT	–30		30	µA	$V_{BATH} < V_R < V_{HR} – 3$
36.		$I_{Leak,T}$	HIT, HIRT	–30		30	µA	$V_{BATH} < V_T < V_{HR} – 3$

Inputs DCP, DCN, ACP, ACN, Output C_{EXT}

No.	Parameter	Symbol	Mode	min.	typ.	max.	Unit	Test Condition
37.	Input resistance DCP, DCN	R_{DC}	ACTR, HIR, HIT	–	1	–	kΩ	
38.			ACTL, ACTH	–	2	–	kΩ	
39.	Input resistance ACP, ACN	R_{AC}	all	–	10	–	kΩ	
40.	Output resistance on C_{EXT}		all	–	50	–	kΩ	

Current Outputs IT, IL

No.	Parameter	Symbol	Mode	min.	typ.	max.	Unit	Test Condition
41.	IT output current (see Figure 13)	I_{IT}	ACTx	–15	0	15	µA	$I_R = I_T = 0$ mA
42.				380	400	420	µA	$I_R = I_T = 20$ mA
43.				–420	–400	–380	µA	$I_R = I_T = –20$ mA
44.	Transversal current ratio (guaranteed by design, see Figure 13)	$1/G_{IT,DC}$ 2)	ACTx	49	50	51	–	$I_R = I_T = 20$ mA, $I_R = I_T = –20$ mA
45.	Off-hook output current on IT		PDRH	650	800	950	µA	TIP/RING shorted Temp = 25 °C[3)]
46.	IL output current (see Figure 13)	I_{IL}	ACTx	–20	0	20	µA	$I_R = I_T = 20$ mA
47.				30	50	70	µA	$I_R = 15$ mA, $I_T = 25$ mA
48.				–160	–125	–90	µA	$I_R = 62.5$ mA, $I_T = 37.5$ mA

Table 13 DC Characteristics (cont'd)

No.	Parameter	Symbol	Mode	Limit Values			Unit	Test Condition
				min.	typ.	max.		
Control Inputs C1, C2								
49.	H-input voltage	V_{IH}	–	2.7	–	V_{DD} + 0.3	V	–
50.	M-input voltage	V_{IM}	–	1.2	–	2.1	V	–
51.	L-input voltage	V_{IL}	–	–0.3	–	0.6	V	–
52.	Input leakage current	I_{Leak}	–	–5	0	5	µA	–
53.	Thermal overload current C1	I_{therm}	ACTx, HIx	120	150	250	µA	V_{C1} = 1.20 V
54.	Max. junction temperature[4)]	T_{jLIM}	ACTx, HIx	–	165	–	°C	–

1) The systematic temperature dependency of this resistance is +0.1%/°C.

2) The offset ($I_R = I_T$ = 0 mA) has to be taken into account.

3) The systematic temperature dependency of this current is –0.1%/°C.

4) Overtemperature protection (guaranteed by design)

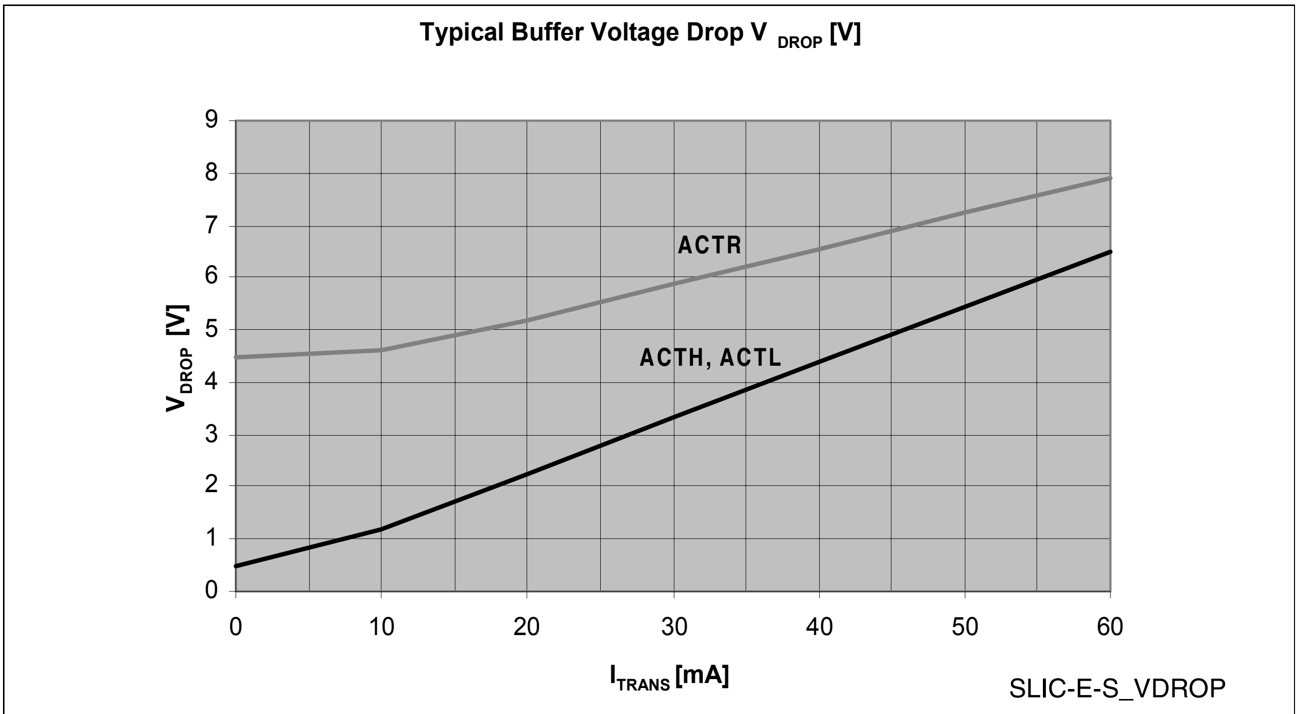


Figure 7 Typical Buffer Voltage Drop in Operating Modes ACTL, ACTH, ACTR

4.6.3 AC Characteristics

If not otherwise stated, AC characteristics are tested at a DC line current of 25 mA and –25 mA, respectively; they are valid in all active modes.

Table 14 AC Characteristics

No.	Parameter	Symbol	Mode	Limit Values			Unit	Test Condition
				min.	typ.	max.		
Line Termination TIP, RING								
55.	Receive gain (see **Figure 14**)	G_r		5.925	6.0	6.075	–	$V_{ACP} - V_{ACN}$ = 640 mVrms f = 1015 Hz
56.	Total harmonic distortion V_{TR} (see **Figure 14**)	THD		–	0.03	0.3	%	$V_{ACP} - V_{ACN}$ = 640 mVrms f = 1015 Hz
57.	Teletax distortion	$THDTTX$		–	0.1	1	%	$V_{TR,AC}$ = 5 Vrms f = 16 kHz, R_L = 200 Ω
58.				–	1	3	%	$V_{TR,AC}$ = 5 Vrms f = 16 kHz, R_L = 200 Ω, $I_{Trans,DC}$ = 0 mA
59.	Psophometric noise (see **Figure 14**)	N_{pVTR}		–	–80	–76	dBmp	
60.	Longitudinal to transversal rejection ratio V_{long}/V_{TR} (see **Figure 15**)	$LTRR$		60	70	–	dB	V_{long} = 3 Vrms 300 Hz < f < 3.4 kHz
61.	Longitudinal to transversal rejection ratio V_{long}/V_{TR} (loop) (see **Figure 16**)	$LTRR$		54	58	–	dB	V_{long} = 3 Vrms 300 Hz < f < 1 kHz
62.		$loop$		52	56	–	dB	3.4 kHz
63.	Transversal to longitudinal rejection ratio V_{TR}/V_{long} (see **Figure 17**)	$TLRR$		48	58	–	dB	$V_{ACP} - V_{ACN}$ = 1920 mVrms 300 Hz < f < 3.4 kHz

Table 14 AC Characteristics (cont'd)

No.	Parameter	Symbol	Mode	Limit Values			Unit	Test Condition
				min.	typ.	max.		
	Power supply rejection ratio	*PSRR*						$V_{SupplyAC}$ = 100 mVp 300 Hz < f < 3.4 kHz
64.	V_{BATL}/V_{TR}			40	60		dB	
65.	V_{BATH}/V_{TR}			40	60		dB	
66.	V_{HR}/V_{TR}			33	50		dB	
67.	V_{DD}/V_{TR} (see Figure 8, 9, 10)			33	50		dB	
68.	Interchannel crosstalk $V_{TR,B}/V_{TR,A}$		Ch. A: ACTL, ACTH, ACTR, Ch. B: ACTL, ACTH, ACTR	–	–80	t.b.d.	dB	Voiceband
69.			Ch. A: ACTL, ACTH, ACTR, Ch. B: PDH	–	–80	t.b.d.	dB	Voiceband
70.	Ringing amplitude TIP/RING	V_{RNG0}	ACTR		51		Vrms	$V_{DCP} - V_{DCN}$ = 0.15 V (DC) + 0.85 Vrms (sine wave), V_{HR} = 42 V R_R = 450 Ω, C_R = 3.4 µF, f = 20 Hz
71.	Ringing distortion (see Figure 18)	*RD*		–	0.1	2	%	

Transversal Current IT

No.	Parameter	Symbol	Mode	min.	typ.	max.	Unit	Test Condition
	Transversal current ratio	$1/G_{it}$					–	$V_{ACP} - V_{ACN}$ = 640 mVrms f = 1015 Hz
72.	(see Figure 14)			49.5	50	50.5		$I_{Trans,DC}$ = 25 mA
73.				49	50	51		$I_{Trans,DC}$ = –25 mA
74.	Total harmonic distortion V_{IT}	THD_{IT}		–	0.02	0.3	%	$I_{Trans,DC}$ = 25 mA $V_{ACP} - V_{ACN}$ = 640 mVrms f = 1015 Hz

Table 14 AC Characteristics (cont'd)

No.	Parameter	Symbol	Mode	Limit Values			Unit	Test Condition
				min.	typ.	max.		
75.	Psophometric noise (see **Figure 14**)	N_{pVIT}		–	–110	–105	dBmp	
76.	Longitudinal to transversal current output rejection ratio V_{long}/V_{IT} (see **Figure 15**)	*LITRR*		78			dB	V_{long} = 3 Vrms 300 Hz < f < 3.4 kHz
	Power supply rejection ratio	*PSRR*						$V_{SupplyAC}$ = 100 mVp 300 Hz < f < 3.4 kHz
77.	V_{BATL}/V_{IT}			50	70	–	dB	
78.	V_{BATH}/V_{IT}			50	70	–	dB	
79.	V_{HR}/V_{IT}			50	70	–	dB	
80.	V_{DD}/V_{IT}			50	70	–	dB	

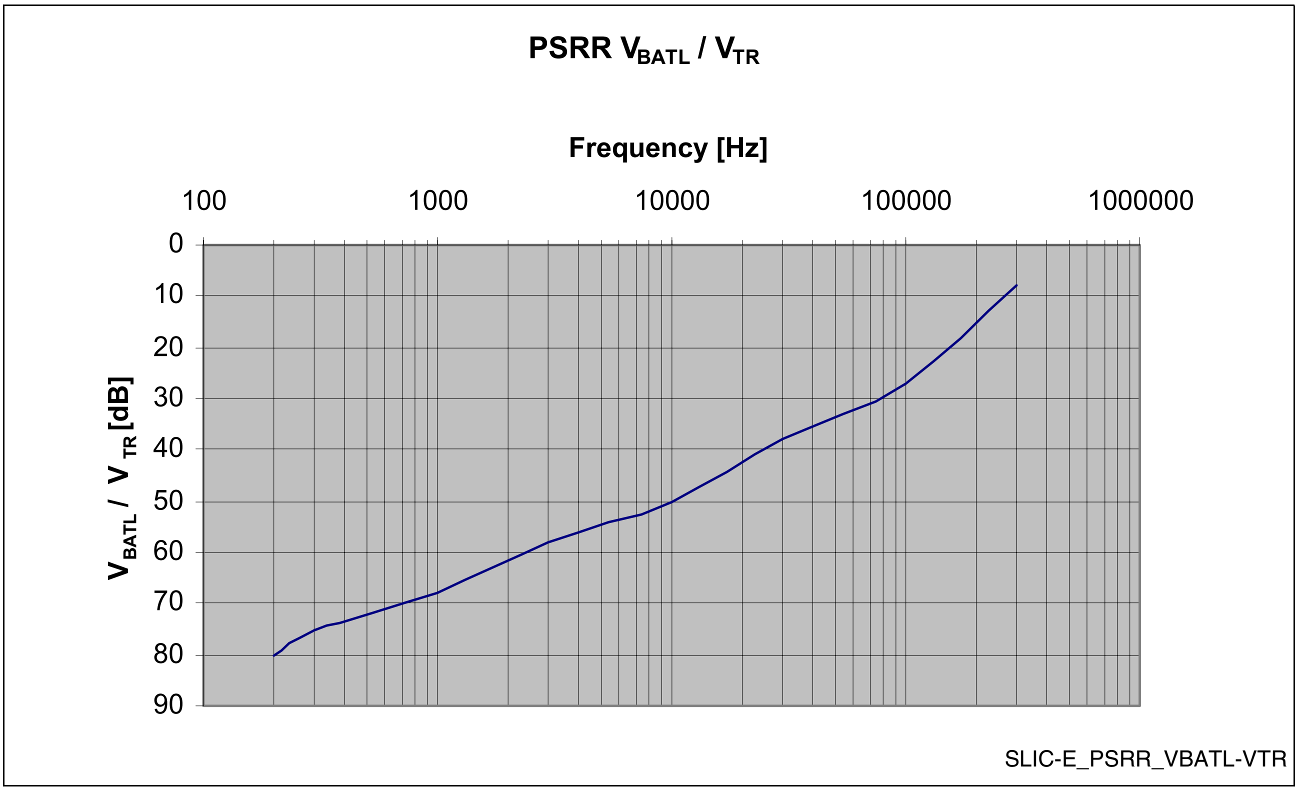


Figure 8 Typical Frequency Dependence of PSRR VBATL/VTR

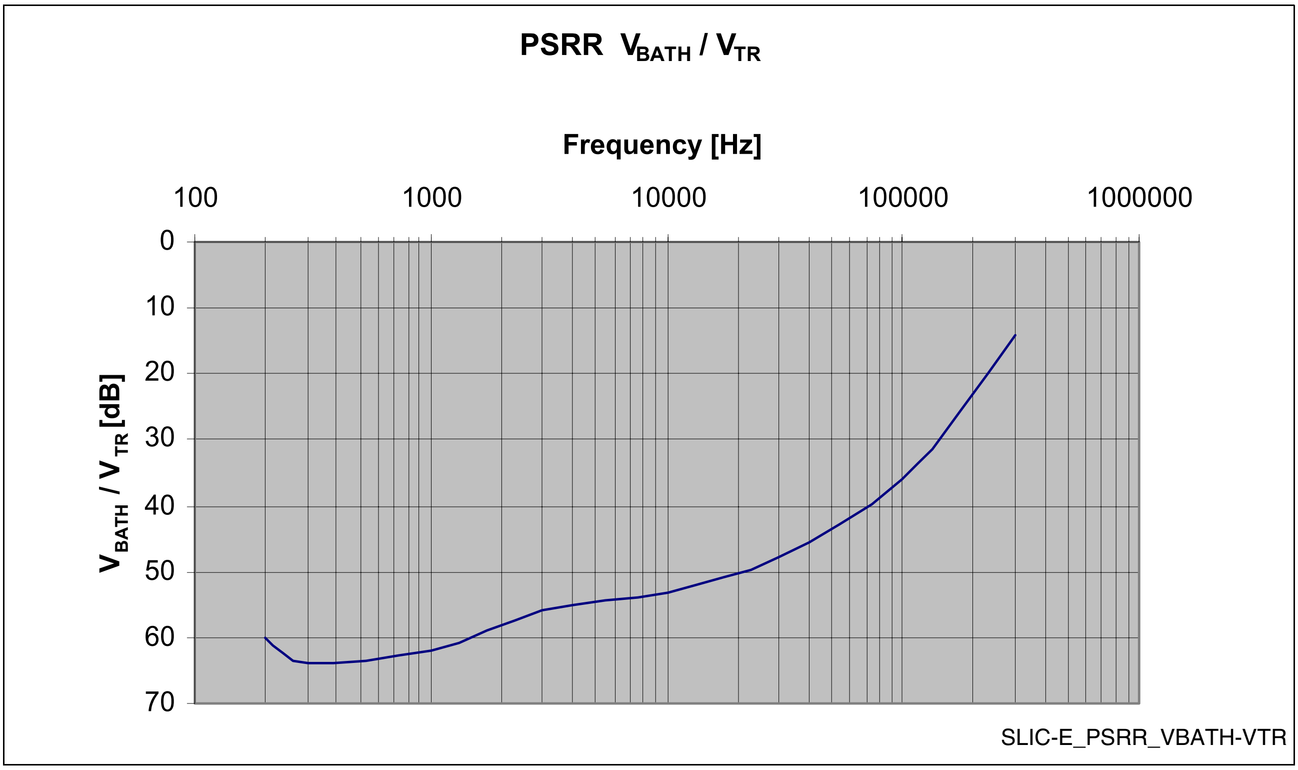


Figure 9 Typical Frequency Dependence of PSRR VBATH/VTR

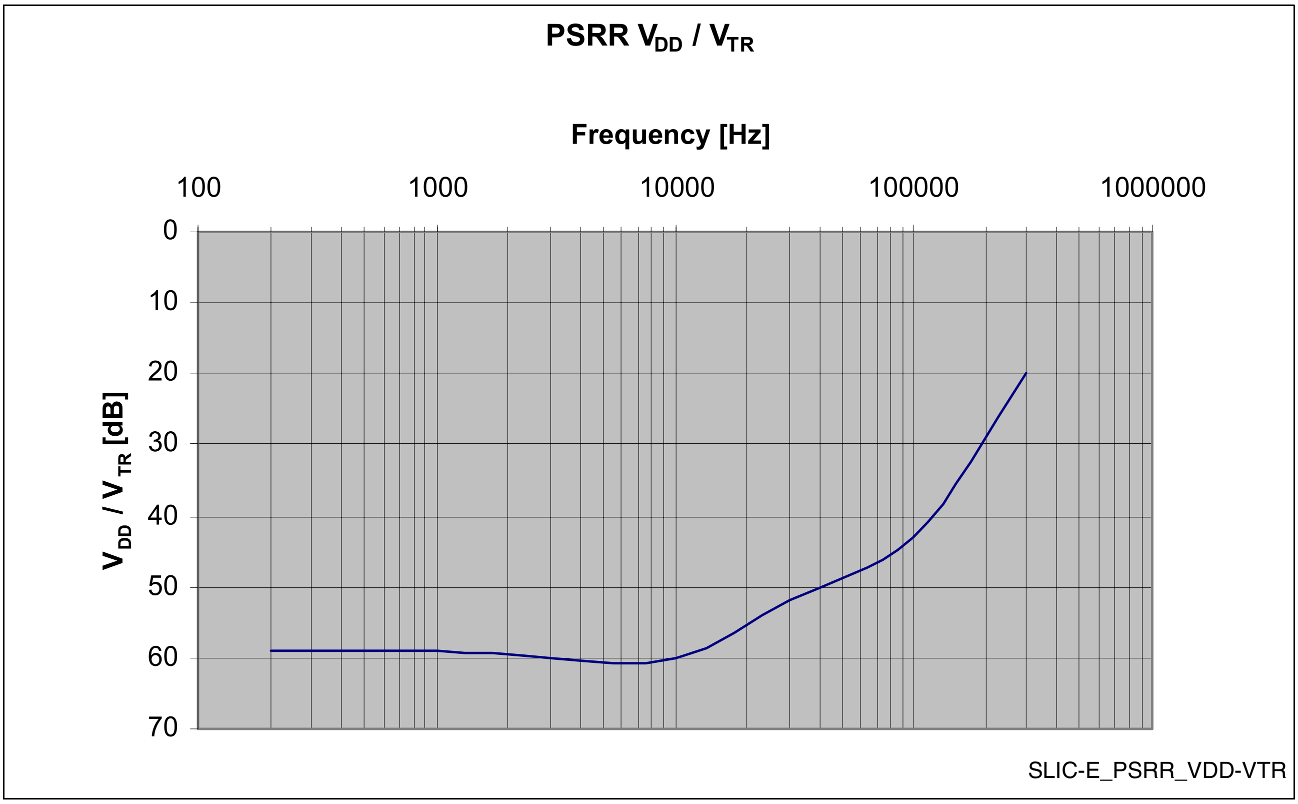


Figure 10 Typical Frequency Dependence of PSRR VDD/VTR

5 Test Figures

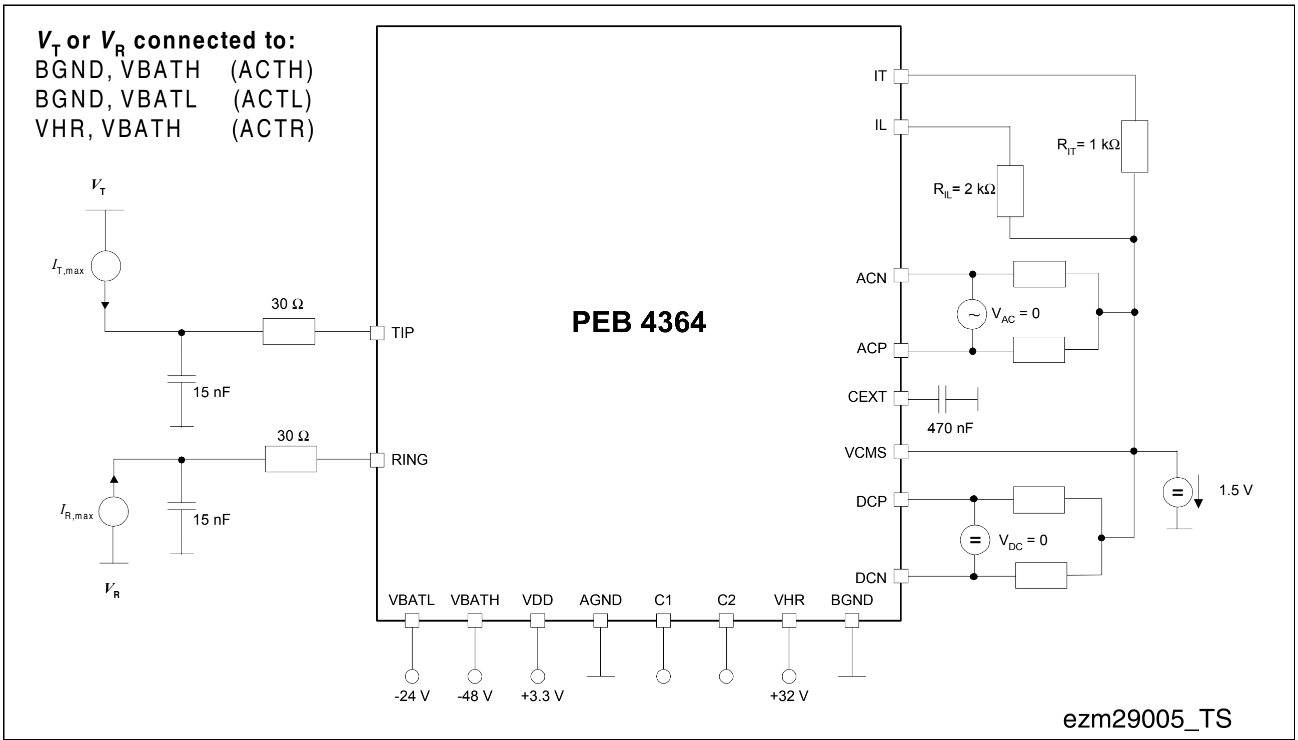


Figure 11 Output Current Limit (one Channel)

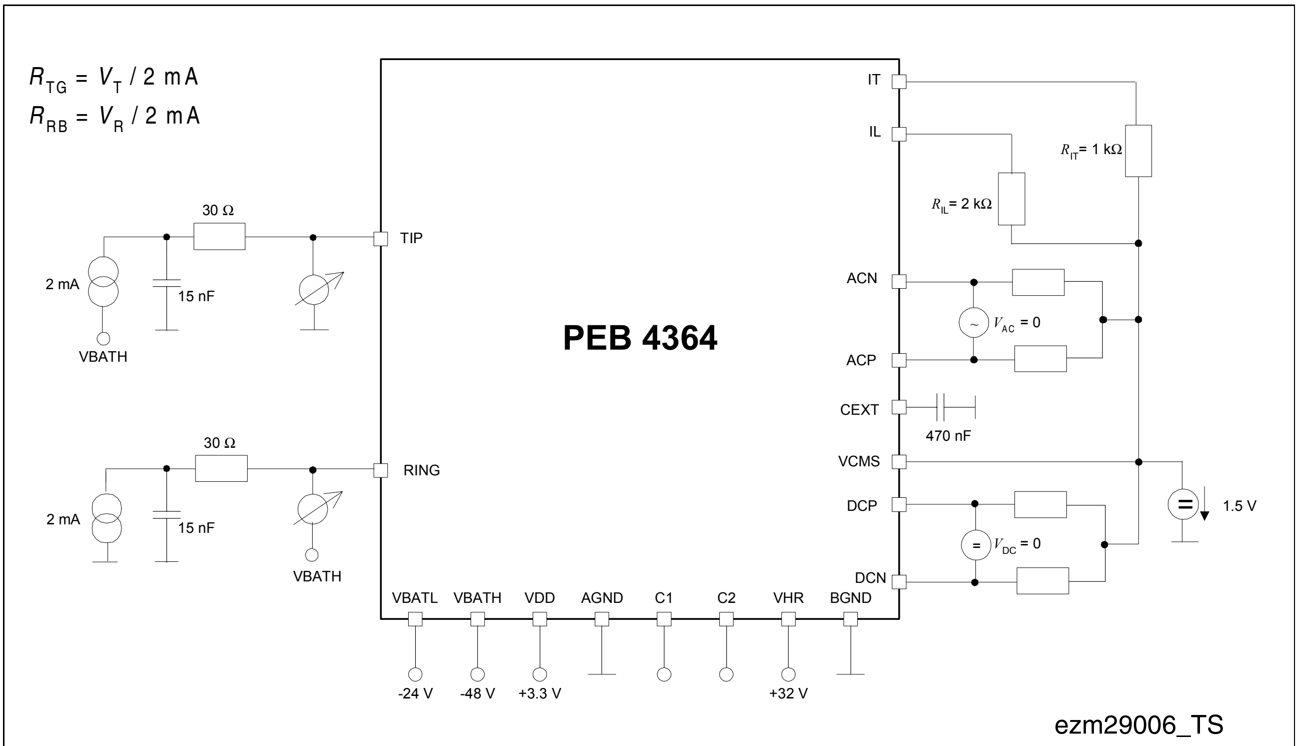


Figure 12 Output Resistance PDRH, PDRHL (one Channel)

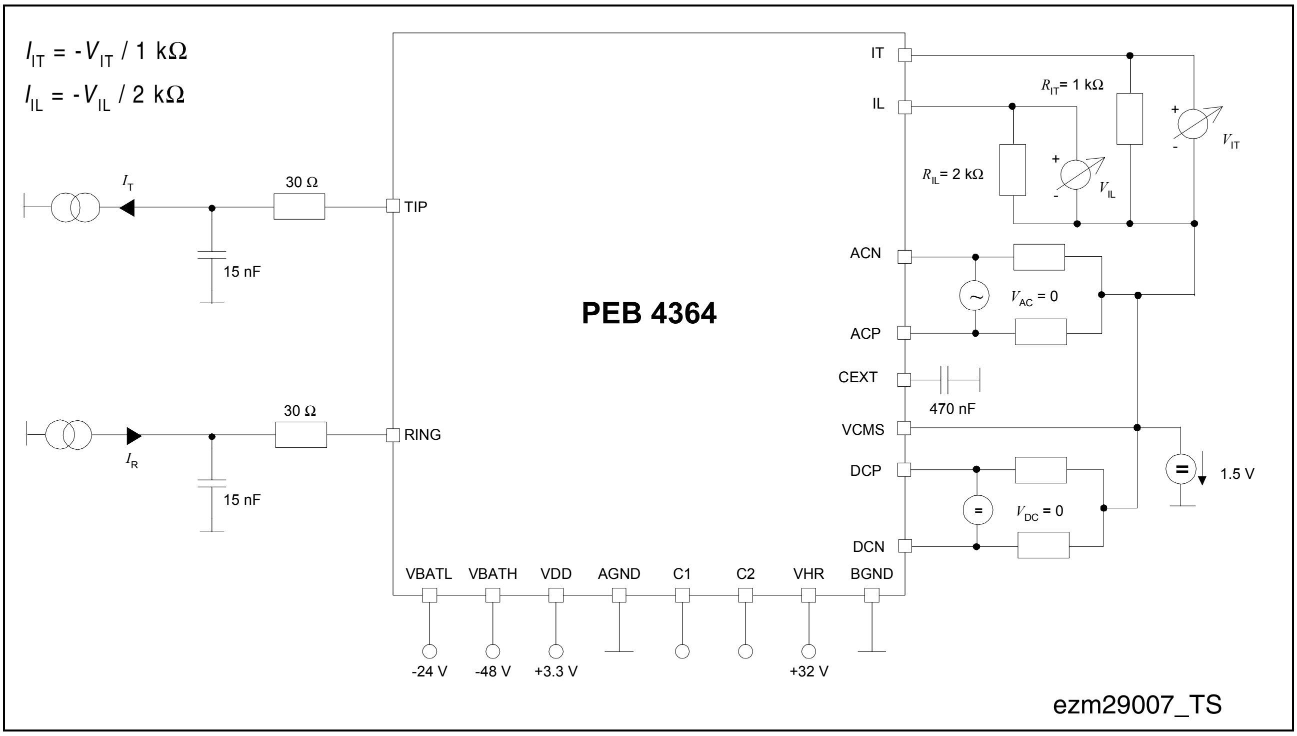


Figure 13 Current Outputs IT, IL (one Channel)

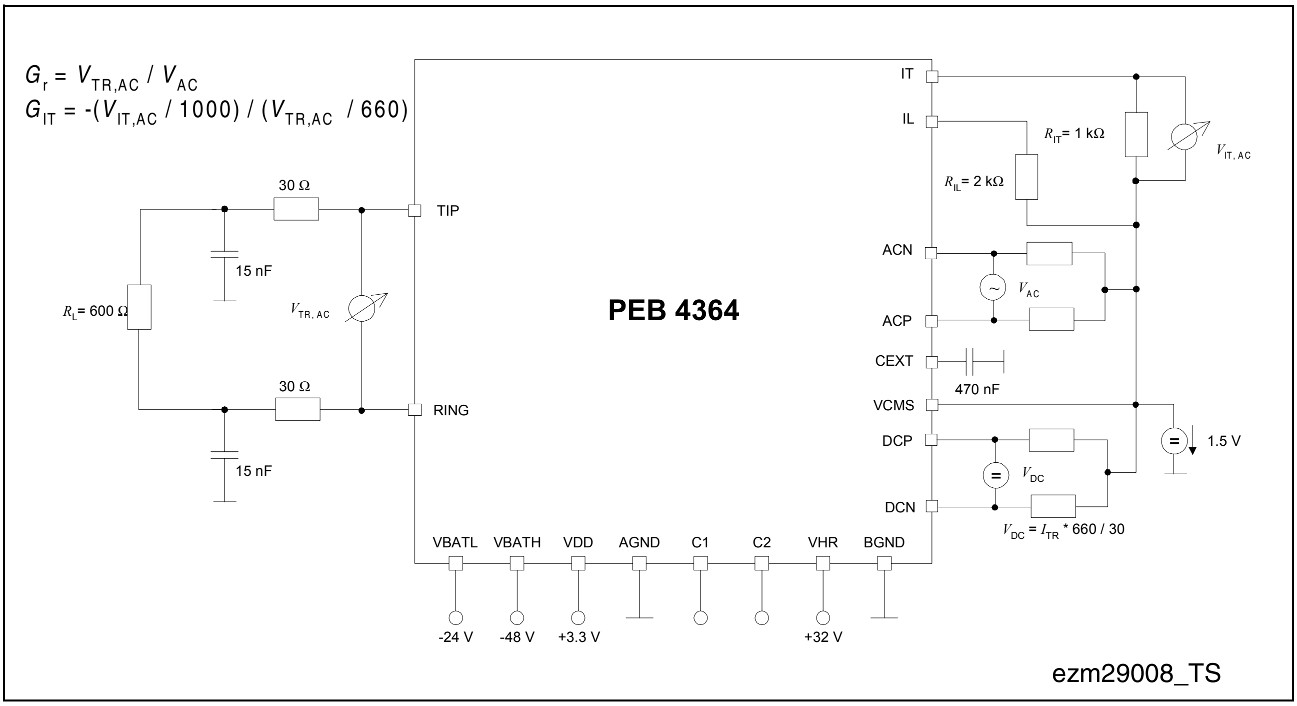


Figure 14 Transmission Characteristics (one Channel)

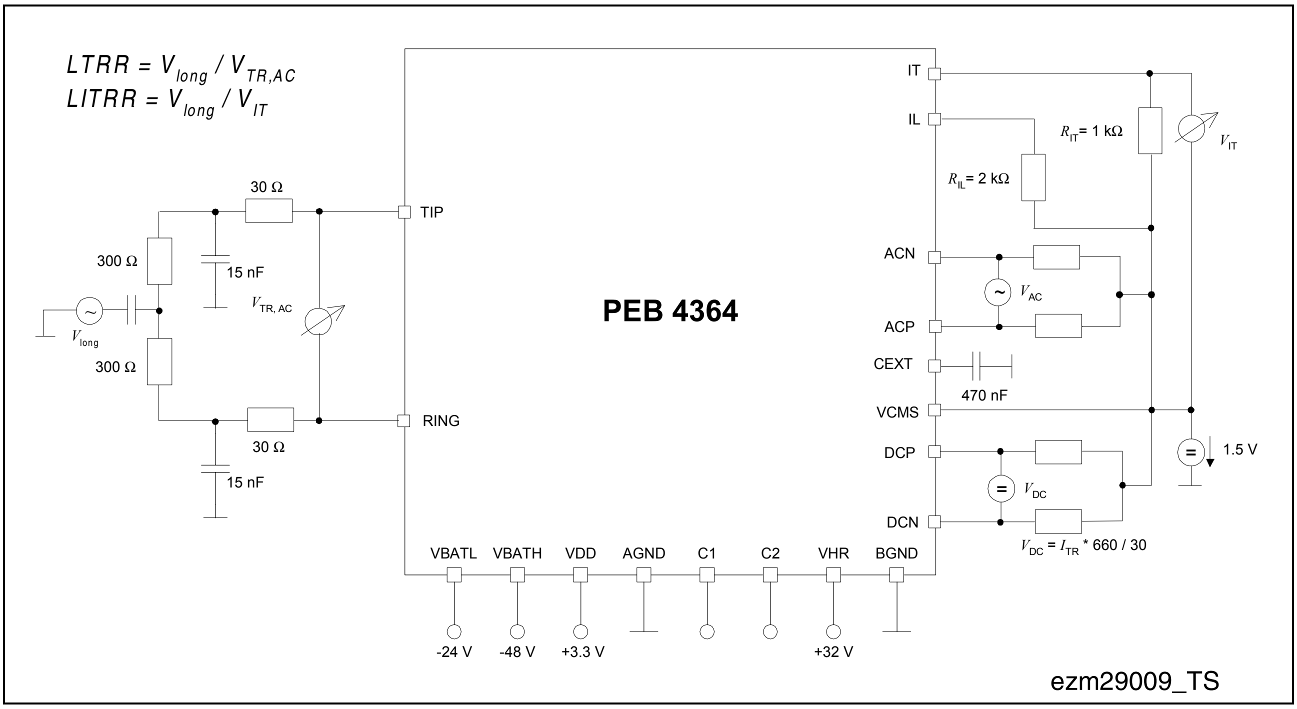


Figure 15 Longitudinal to Transversal Rejection (one Channel)

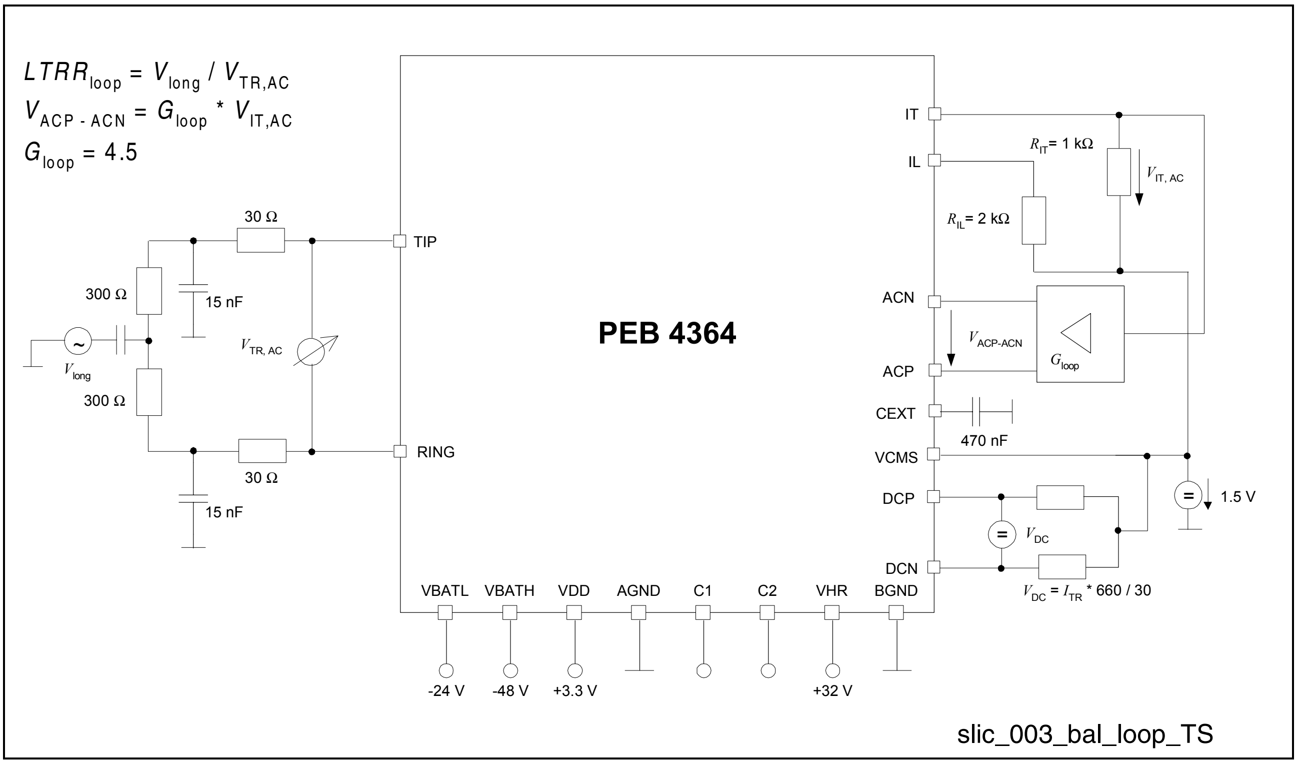


Figure 16 Longitudinal to Transversal Rejection Loop (one Channel)

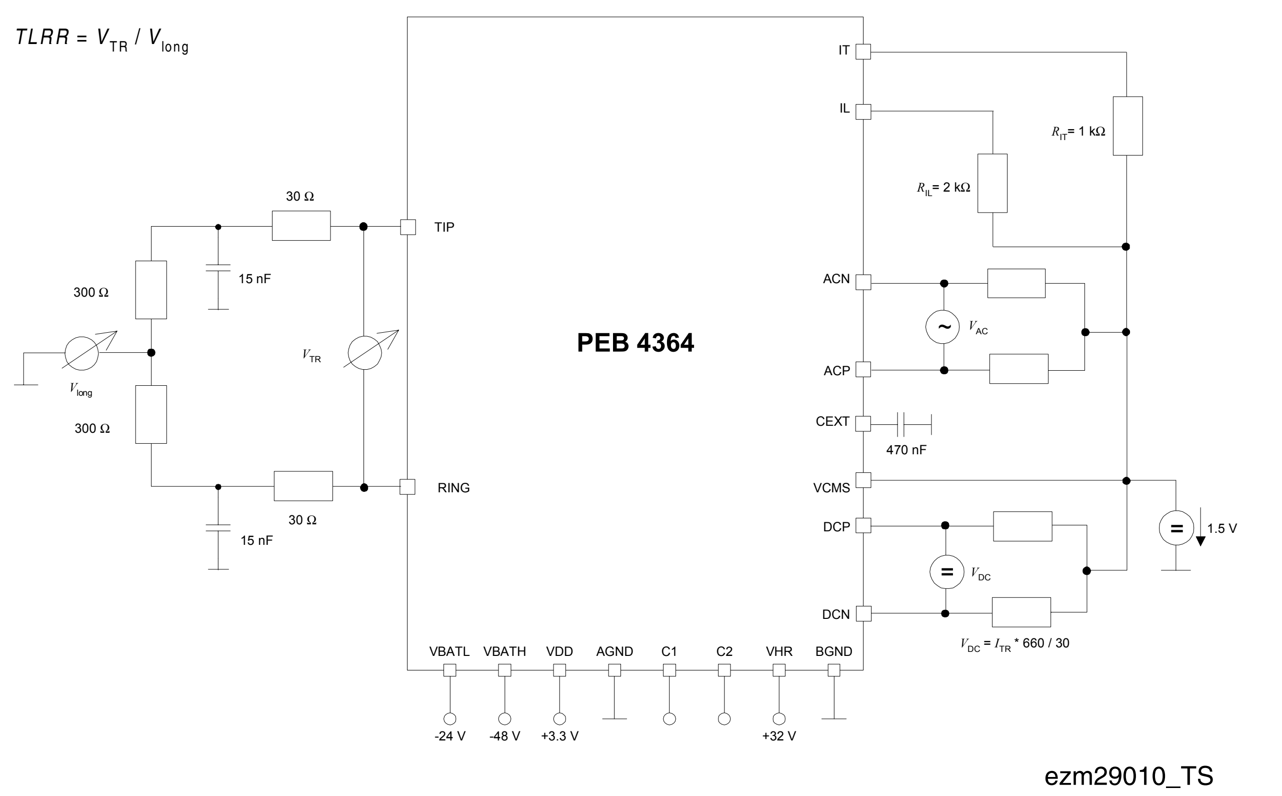


Figure 17 Transversal to Longitudinal Rejection (one Channel)

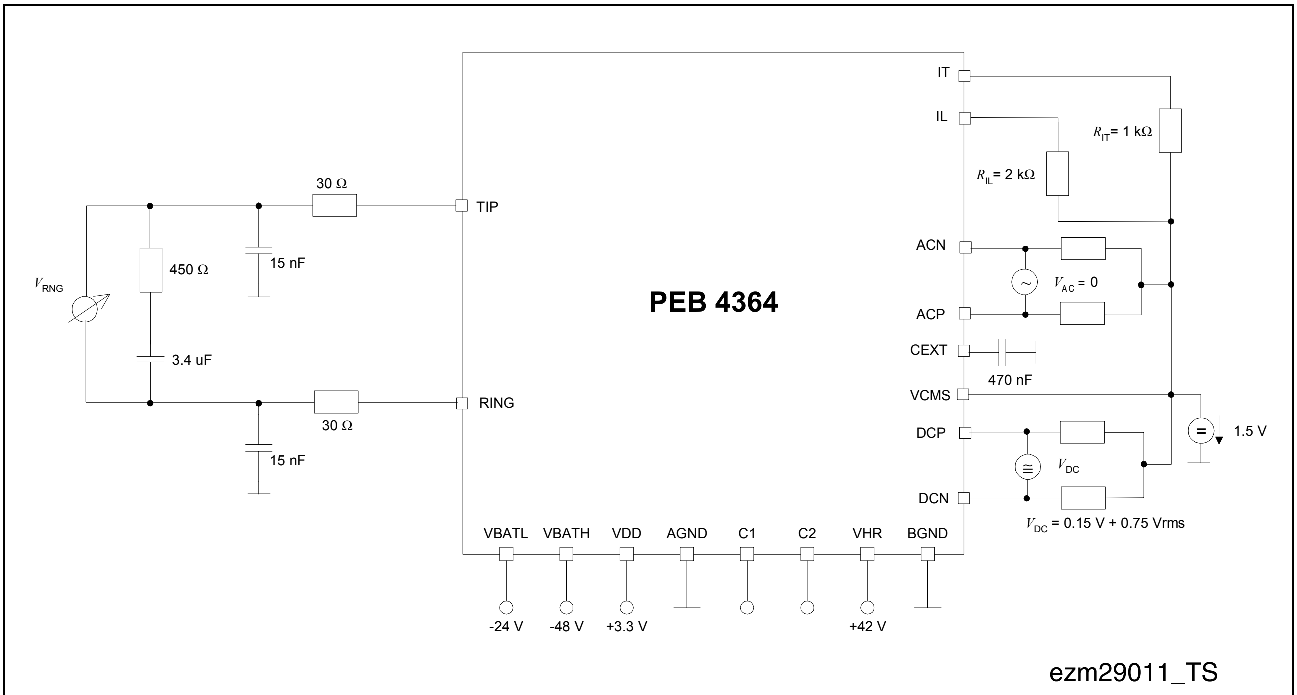
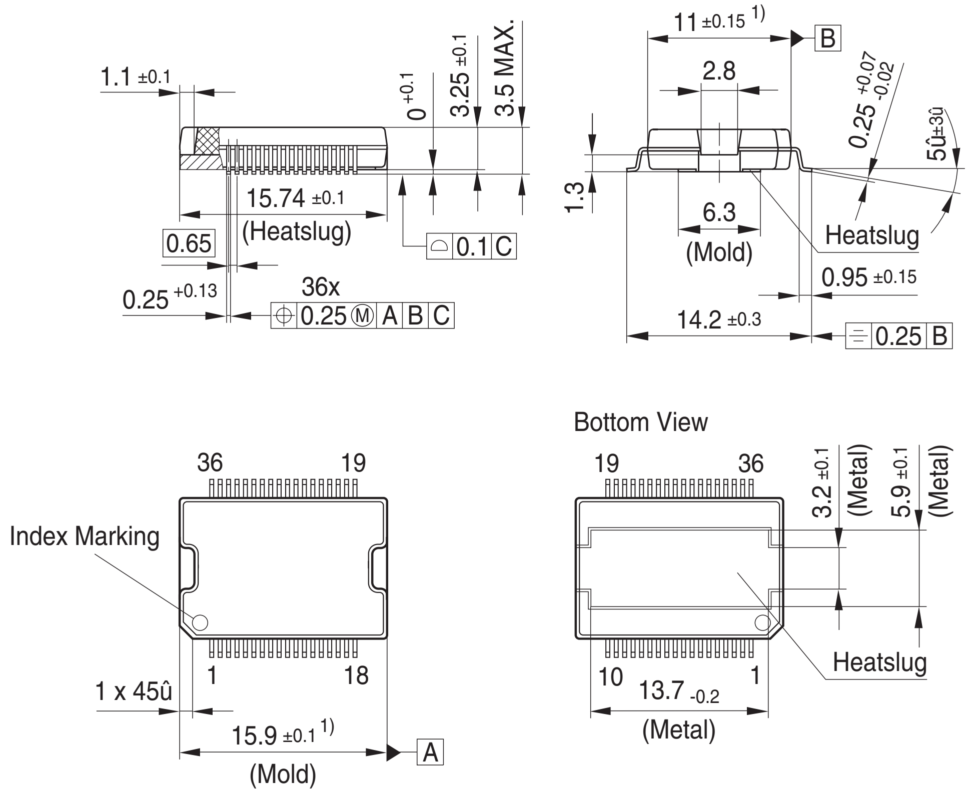


Figure 18 Ring Amplitude (one Channel)

6 Package Outlines

P-DSO-36-15 (TSLIC-S)
(Plastic Dual Small Outline)



1) Does not include plastic or metal protrusion of 0.15 max. per side

gps09181

Figure 19 Package Outline P-DSO-36-15

Attention: ***The heatslug (see Figure 19) is connected to VBATH via the chip substrate. Due to the high voltages of up to 90 V between VHRA (VHRB) and VBATH, touching of the heatslug or any attached conducting part can be hazardous.***

You can find all of our packages, sorts of packing and others in our Infineon Internet Page “Products”: http://www.infineon.com/products.

SMD = Surface Mounted Device

Dimensions in mm

6.1 Recommended PCB Foot Print Pattern for the P-DSO-36-15

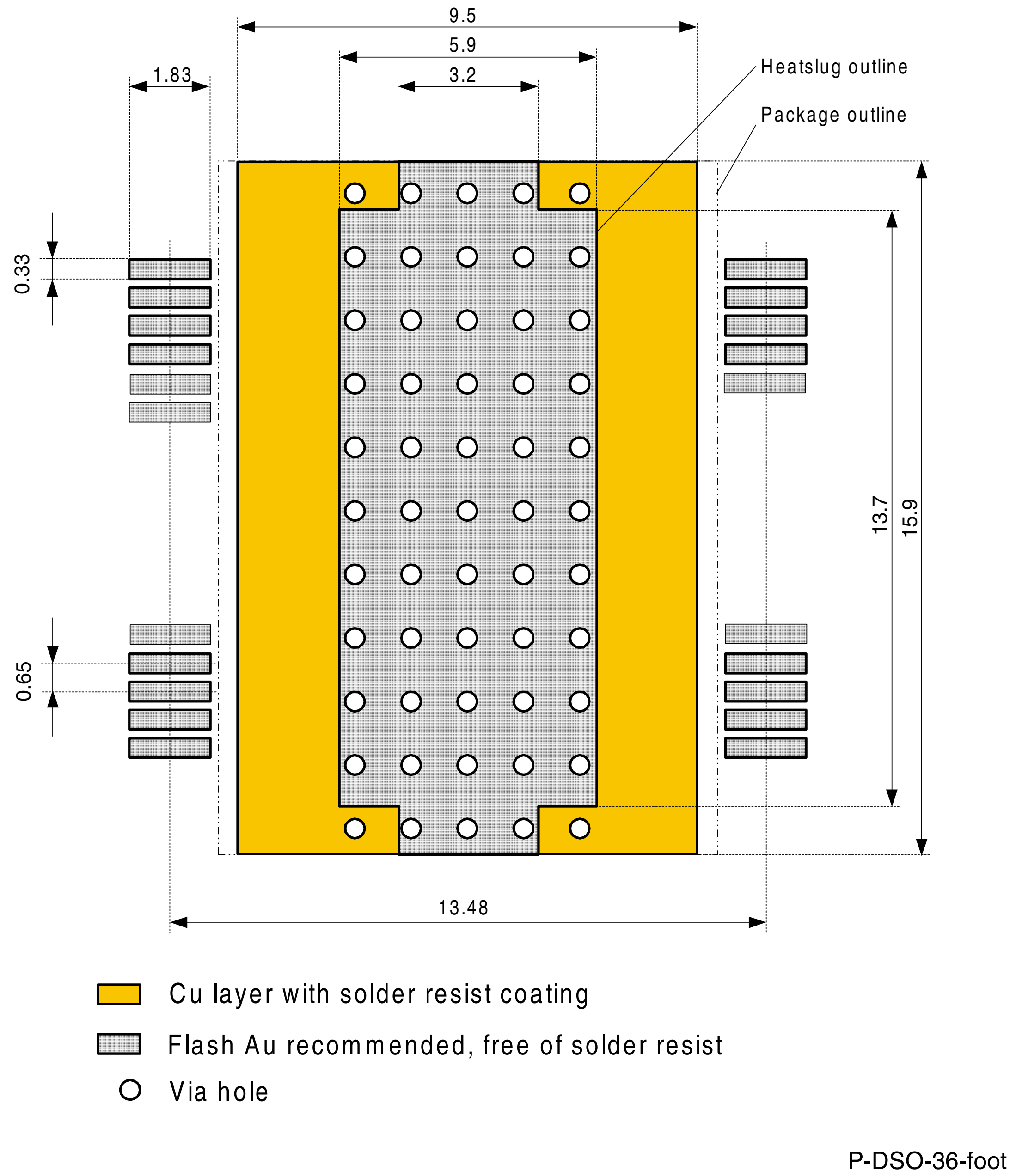


Figure 20 Foot Prints for P-DSO-36-15

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“Business excellence means intelligent approaches and clearly defined processes, which are both constantly under review and ultimately lead to good operating results.
Better operating results and business excellence mean less idleness and wastefulness for all of us, more professional success, more accurate information, a better overview and, thereby, less frustration and more satisfaction.”

Dr. Ulrich Schumacher

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