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Data Sheet, DS2, Nov. 2000

SLICOFI-2/-2S/-2S2

Dual Channel Subscriber Line Interface Codec Filter

PEB 3265 Version 1.3

PEB 3264/-2 Version 1.3

Wired Communications

Infineon technologies

Never stop thinking.

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SLICOFI-2/-2S/-2S2

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Never stop thinking.

SLICOFI-2/-2S/-2S2
Preliminary
Revision History: 2000-11-09 DS2

Previous Version: Data Sheet DS1

Page	Subjects (major changes since last revision)
all	PEB 3264, PEB 3264-2 and PEB 3265 versions changed from 1.2 to 1.3
Page 7	Pin Definitions: Description for pins IO1B, IO2B, IO1A, IO2A and SELCLK changed.
Page 11	**Chapter 3.1** “Functional Overview” completely overworked.
Page 18	**Table 4** “Operating Modes for *SLICOFI-2x* and SLIC”: modes and footnotes added.
Page 22	**Table 9** “SLIC-P Interface Code”: footnote modified. **Table 10** “SLIC-P Modes”: modes added.
Page 24	**Chapter 5** “Signal Path and Test Loops”: new pictures
Page 31	**Chapter 6.1.4** “Power Dissipation SLICOFI-2”: max. limit values added.
Page 32	**Chapter 6.1.5** “Power Dissipation SLICOFI-2S/-2S2”: max. limit values added.
Page 34	**Chapter 6.1.7** “Miscellaneous Characteristics”: Comparator thresholds description changes
Page 41	**Chapter 6.2.2** “Group Delay”: description modified.
Page 43	Chapter **“Input/Output Waveform for AC Tests” on Page 43** added.
Page 45	PCM interface timings **“Single-Clocking Mode” on Page 45** and **“Double-Clocking Mode” on Page 46**: FSC hold time (t_{FSC_h}) renamed to FSC hold time 1 (t_{FSC_h1}), FSC hold time 2 (t_{FSC_h2}) added, formula of max. value for TCA/B delay time off (t_{dTCoff}) modified
Page 49	IOM-2 interface timings **“Single-Clocking Mode” on Page 49** and **“Double-Clocking Mode” on Page 50**: FSC hold time (t_{FSC_h}) renamed to FSC hold time 1 (t_{FSC_h1}), FSC hold time 2 (t_{FSC_h2}) added, parameters and timing of pin DU modified
Page 52	**Chapter 8.1** “List of Abbreviations” updated.

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Preliminary

Preface

Synonyms

To simplify matters, the following synonyms are used:

SLICOFI-2x	Synonym used for all codec versions SLICOFI-2/-2S/-2S2
SLIC:	Synonym used for all SLIC versions SLIC-S, SLIC-S2, SLIC-E, SLIC-E2 and SLIC-P

Organization of this Document

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

- Chapter 1, Overview
  A general description of the product, a list of its key features.
- Chapter 2, Pin Descriptions
- Chapter 3, Functional Description
  The main functions are presented following a functional block diagram.
- Chapter 4, Operational Description
  A brief description of the three operating modes: power down, active and ringing (plus signal monitoring techniques).
- Chapter 5, Interfaces
  Connection information.
- Chapter 6, Electrical Characteristics
  Parameters, symbols and limit values.
- Chapter 7, Package Outlines
  Illustrations and dimensions of the package outlines.
- Chapter 8, Glossary
  List of abbreviations and description of symbols.
- Chapter 9, Index

1 Overview

The Subscriber Line Interface Circuit *SLICOFI-2x* is a highly flexible two channel codec solution for analog line circuits. The *SLICOFI-2x* is programmable via software and can be adapted to all different standards worldwide.

DuSLIC Architecture

The SLICOFI-2 (PEB 3265) and SLICOFI-2S/-2S2 (PEB 3264/-2) chips are part of the DuSLIC chip set and are designed for use with the SLIC-E/-E2/-P (PEB 4265/-2, PEB 4266) and SLIC-S/-S2 (PEB 4264/-2) devices. For an overview about available DuSLIC versions see the DuSLIC Chip Set Selection Guide.

The DuSLIC design splits the traditional SLIC functions to high- and low-voltage functions. The low-voltage functions are handled in the *SLICOFI-2x* device, the high-voltage functions are handled in the SLIC devices.

All *SLICOFI-2x* codec devices are manufactured in an advanced 0.35 µm 3.3 V CMOS process.

For further information see **Chapter 3.1**.

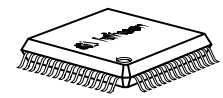
Preliminary

Dual Channel Subscriber Line Interface Codec Filter *SLICOFI-2x*

PEB 3265
PEB 3264
PEB 3264-2

Version 1.3 **CMOS**

1.1 Features SLICOFI-2[1)]



P-MQFP-64-1,-2

- Fully programmable dual-channel codec
- Programmable battery feeding with capability for driving long loops
- Internal balanced/unbalanced ringing capability (up to 85 Vrms balanced / 50 Vrms unbalanced)
- External ringing support
- Ground/loop start signaling
- Polarity reversal
- On-hook transmission
- Programmable Teletax (TTX) generation
- Integrated DTMF generator
- Integrated DTMF decoder
- Integrated Caller ID (FSK) generator
- Integrated fax/modem detection (Universal Tone Detection UTD)
- Integrated Line Echo Cancellation unit (LEC)
- Optimized filter structure for modem transmission
- Message waiting lamp support (for PBX applications)
- Three-party conferencing (in PCM/µC mode)
- 8 and 16 kHz PCM Transmission
- IOM-2 or PCM/µC-interface selectable
- Power optimized architecture
- Power management capability (battery switching)
- Integrated test and diagnosis functions
- Specification in accordance with
  ITU-T Recommendation Q.552 for interface Z, ITU-T Recommendation G.712 and applicable LSSGR

1) Features are indicated for the DuSLIC chip set and are partially realized by the SLICOFI-2 codec.

Type	Package
PEB 3265, PEB 3264, PEB 3264-2	P-MQFP-64-1

1.2 Features SLICOFI-2S/-2S2[1)]

- Fully programmable dual-channel codec
- Programmable battery feed with capability for driving long loops
- Internal balanced ringing capability up to 45 Vrms
- External ringing support
- Ground/loop start signaling
- Polarity reversal
- On-hook transmission
- Programmable Teletax (TTX) generation (not available with SLICOFI-2S2)
- Integrated DTMF generator
- 8 and 16 kHz PCM Transmission
- IOM-2 or PCM/µC-interface selectable
- Power optimized architecture
- Power management capability (battery switching)
- Specification in accordance with
  ITU-T Recommendation Q.552 for interface Z, ITU-T Recommendation G.712 and applicable LSSGR

1) Features are indicated for the DuSLIC chip set and are partially realized by the SLICOFI-2S/-2S2 codec.

1.3 Logic Symbol

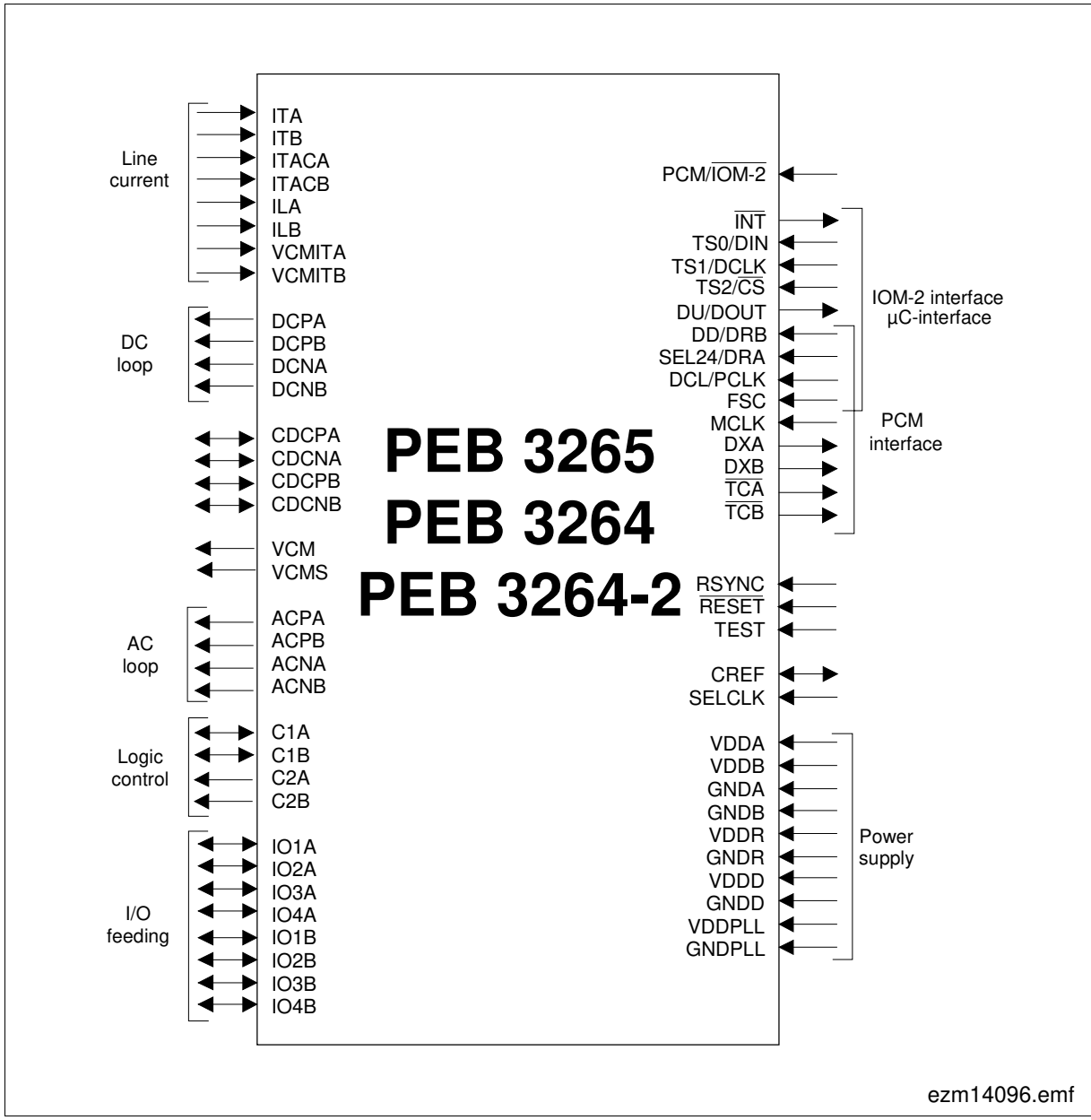


Figure 1 Logic Symbol SLICOFI-2/-2S/-2S2

2 Pin Descriptions

2.1 Pin Diagram

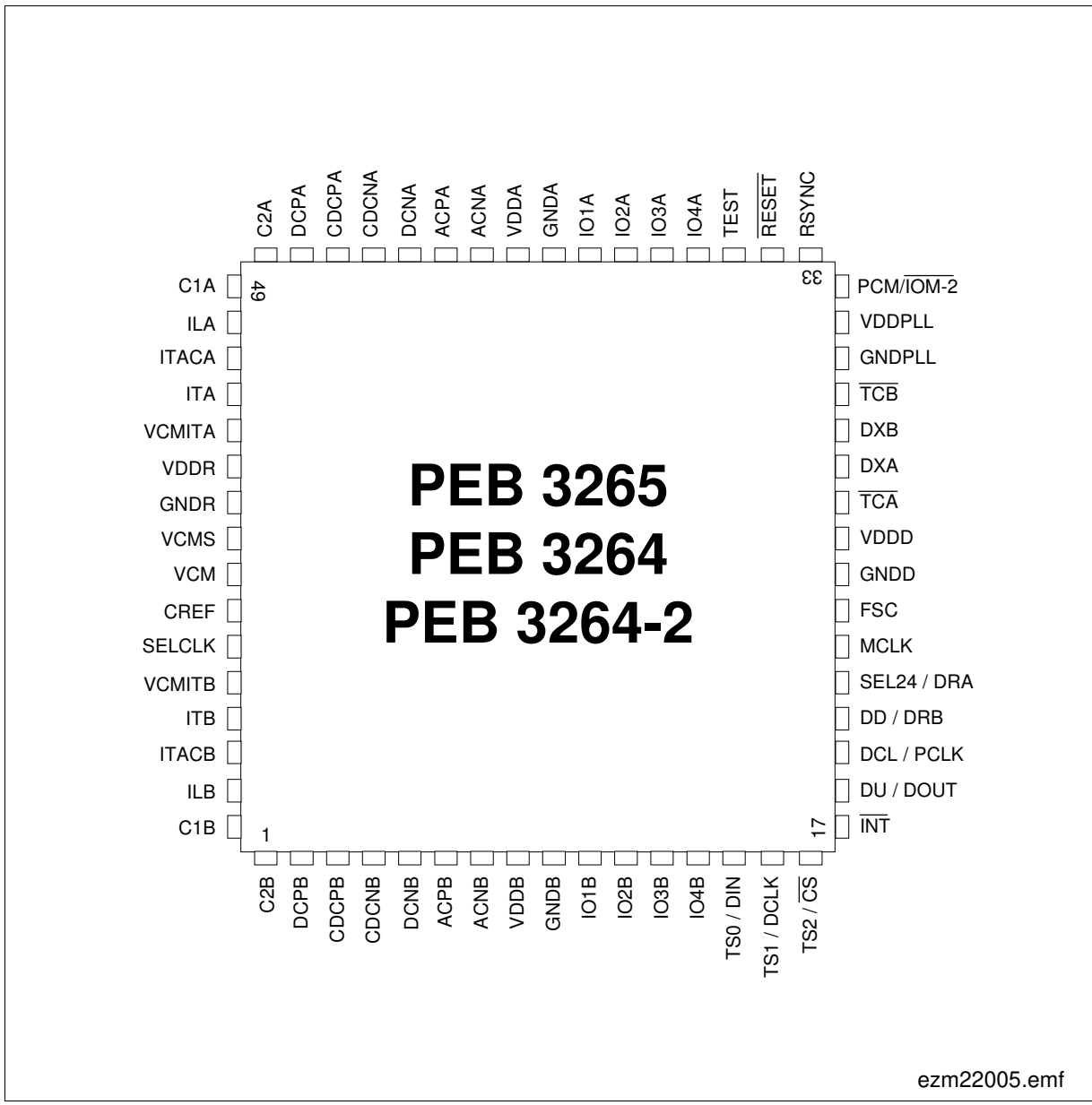


Figure 2 Pin Configuration SLICOFI-2/-2S/-2S2 (top view)

Table 1 Pin Definitions and Functions SLICOFI-2/-2S/-2S2

Pin No.	Sym-bol	Input (I) Output (O)	Function
1	C2B	O	Ternary logic output for controlling the SLIC operation mode (channel B)
2	DCPB	O	Two-wire output voltage (DCP) (channel B)
3	CDCPB	I/O	External capacitance for filtering (channel B)
4	CDCNB	I/O	External capacitance for filtering (channel B)
5	DCNB	O	Two-wire output voltage (DCN) (channel B)
6	ACPB	O	Differential two-wire AC output voltage controlling the RING pin (channel B)
7	ACNB	O	Differential two-wire AC output voltage controlling the TIP pin (channel B)
8	VDDB	Power	+ 3.3 V analog supply voltage (channel B)
9	GNDB	Power	Analog ground (channel B)
10	IO1B	I/O	User-programmable I/O pin (channel B) with relay-driving capability. In external ringing mode IO1 is used to automatically control and drive the ring relay.
11	IO2B	I/O	User-programmable I/O pin (channel B) with relay-driving capability. SLICOFI-2 and SLIC-P: connected to pin C3 of SLIC-P, when two supply voltages for voice transmission and internal ringing are used.[1)]
12	IO3B	I/O	User-programmable I/O pin (channel B) with analog input functionality
13	IO4B	I/O	User-programmable I/O pin (channel B) with analog input functionality
14	TS0 DIN	I I	PCM/$\overline{\text{IOM-2}}$ = 0 (IOM-2 interface): Time slot selection pin 0 PCM/$\overline{\text{IOM-2}}$ = 1 (µC interface): Data in
15	TS1 DCLK	I I	PCM/$\overline{\text{IOM-2}}$ = 0 (IOM-2 interface): Time slot selection pin 1 PCM/$\overline{\text{IOM-2}}$ = 1 (µC interface): Data clock
16	TS2 $\overline{\text{CS}}$	I I	PCM/$\overline{\text{IOM-2}}$ = 0 (IOM-2 interface): Time slot selection Pin 2 PCM/$\overline{\text{IOM-2}}$ = 1 (µC interface): Chip select, low active
17	$\overline{\text{INT}}$	O	PCM/$\overline{\text{IOM-2}}$ = 0 (IOM-2 interface): not connected PCM/$\overline{\text{IOM-2}}$ = 1 (µC interface): Interrupt pin, low active

Table 1 Pin Definitions and Functions SLICOFI-2/-2S/-2S2 (cont'd)

Pin No.	Sym-bol	Input (I) Output (O)	Function
18	DU DOUT	O O	PCM/$\overline{\text{IOM-2}}$ = 0 (IOM-2 interface): Data upstream, open drain PCM/$\overline{\text{IOM-2}}$ = 1 (µC interface): Data out, push/pull
19	DCL PCLK	I I	PCM/$\overline{\text{IOM-2}}$ = 0 (IOM-2 interface): Data clock PCM/$\overline{\text{IOM-2}}$ = 1 (PCM interface): 128 kHz to 8192 kHz PCM clock
20	DD DRB	I I	PCM/$\overline{\text{IOM-2}}$ = 0 (IOM-2 interface): Data downstream PCM/$\overline{\text{IOM-2}}$ = 1 (PCM interface): Receive data input for PCM highway B
21	SEL24 DRA	I I	PCM/$\overline{\text{IOM-2}}$ =0 (IOM-2 interface): SEL24 = 0: DCL = 2048 kHz selected SEL24 = 1: DCL = 4096 kHz selected PCM/$\overline{\text{IOM-2}}$ =1 (PCM-interface): Receive Data input for PCM-highway A
22	MCLK	I	PCM/$\overline{\text{IOM-2}}$ = 0 (IOM-2 interface): not connected PCM/$\overline{\text{IOM-2}}$ = 1 (PCM interface): master clock when PCM/µC interface is used, clock rates are 512 kHz, 1536 kHz, 2048 kHz, 4096 kHz, 7168 kHz, 8192 kHz
23	FSC	I	Frame synchronization clock for PCM/µC or IOM-2 interface, 8 kHz, identifies the beginning of the frame, individual time slots are referenced to this input signal.
24	GNDD	Power	Digital ground
25	VDDD	Power	+ 3.3 V digital supply voltage
26	$\overline{\text{TCA}}$	O	Transmit control output for PCM highway A, active low during transmission, open drain
27	DXA	O	Transmit data output for PCM highway A (goes tristate when inactive)
28	DXB	O	Transmit data output for PCM highway B (goes tristate when inactive)
29	$\overline{\text{TCB}}$	O	Transmit control output for PCM highway B, active low during transmission, open drain
30	GNDPLL	Power	Digital ground PLL
31	VDDPLL	Power	+ 3.3 V supply voltage PLL

Table 1 Pin Definitions and Functions SLICOFI-2/-2S/-2S2 (cont'd)

Pin No.	Sym-bol	Input (I) Output (O)	Function
32	PCM/$\overline{\text{IOM-2}}$	I	PCM/$\overline{\text{IOM-2}}$ = 1: PCM/µC interface selected PCM/$\overline{\text{IOM-2}}$ = 0: IOM-2 interface selected
33	RSYNC	I	External ringing synchronization pin
34	$\overline{\text{RESET}}$	I	Reset pin, low active
35	TEST	I	Testpin for production test, has to be connected to GNDD
36	IO4A	I/O	User-programmable I/O Pin (channel A) with analog input functionality
37	IO3A	I/O	User-programmable I/O Pin (channel A) with analog input functionality
38	IO2A	I/O	User-programmable I/O Pin (channel A) with relay-driving capability. SLICOFI-2 and SLIC-P: connected to pin C3 of SLIC-P, when two supply voltages for voice transmission and internal ringing are used.[1)]
39	IO1A	I/O	User-programmable I/O Pin (channel A) with relay-driving capability. In external ringing mode IO1 is used to automatically control and drive the ring relay.
40	GNDA	Power	Analog ground (channel A)
41	VDDA	Power	+ 3.3 V analog supply voltage (channel A)
42	ACNA	O	Differential two-wire AC output voltage controlling the TIP pin (channel A)
43	ACPA	O	Differential two-wire AC output voltage controlling the RING pin (channel A)
44	DCNA	O	Two-wire output voltage (DCN) (channel A)
45	CDCNA	I/O	External capacitance for filtering (channel A)
46	CDCPA	I/O	External capacitance for filtering (channel A)
47	DCPA	O	Two-wire output voltage (DCP) (channel A)
48	C2A	O	Ternary logic output for controlling the SLIC operation mode (channel A)
49	C1A	I/O	Ternary logic output, controlling the SLIC operation mode (channel A); indicating thermal overload of SLIC if a current of typically 150 µA is drawn out
50	ILA	I	Longitudinal current input (channel A)
51	ITACA	I	Transversal current input (AC) (channel A)

Table 1 Pin Definitions and Functions SLICOFI-2/-2S/-2S2 (cont'd)

Pin No.	Sym-bol	Input (I) Output (O)	Function
52	ITA	I	Transversal current input (AC + DC) (channel A)
53	VCMITA	I	Reference pin for trans./long. current sensing (channel A)
54	VDDR	Power	+ 3.3 V analog supply voltage (bias)
55	GNDR	Power	Analog ground (bias)
56	VCMS	O	Reference voltage for differential two-wire interface, typical 1.5 V
57	VCM	O	Reference voltage for input pins IT, IL, ITAC
58	CREF	I/O	An external capacitor of 68 nF has to be connected to GNDR
59	SELCLK	I	Master clock select. Should be set to GND (internal master clock generation). For test purposes, external master clock generation can be selected (SELCLK = 1). In this case a clock of nominal 32.768 Mhz with a jitter time of less than 1 ns has to be applied to the MCLK pin.
60	VCMITB	I	Reference pin for transversal/longitudinal current sensing (channel B)
61	ITB	I	Transversal current input (AC + DC) (channel B)
62	ITACB	I	Transversal current input (AC) (channel B)
63	ILB	I	Longitudinal current input (channel B)
64	C1B	I/O	Ternary logic output, controlling the SLIC operation mode (channel B); indicating thermal overload of SLIC if a current of typically 150 µA is drawn out

[1] If SLIC-P is selected, IO2 cannot be controlled by the user, but is utilized by the SLICOFI-2 to control the C3 pin of SLIC-P.

3 Functional Description

3.1 Functional Overview

3.1.1 Basic Functions available for all *SLICOFI-2x* Codecs

The functions described in this chapter are integrated in all DuSLIC chip sets (see **Figure 3** for SLICOFI-2S/-2S2 and **Figure 4** for SLICOFI-2).

All BORSCHT functions are integrated:

- Battery feed
- Overvoltage protection
  (realized by the robust high-voltage SLIC technology and additional circuitry)
- Ringing[1)]
- Signaling (supervision)
- Coding
- Hybrid for 2/4-wire conversion
- Testing

An important feature of the DuSLIC design is the fact that all the SLIC and codec functions are programmable via the IOM-2 or PCM/µC-interface of the dual channel *SLICOFI-2x* device:

- DC (battery) feed characteristics
- AC impedance matching
- Transmit gain
- Receive gain
- Hybrid balance
- Frequency response in transmit and receive direction
- Ring frequency and amplitude[1)]
- Hook thresholds
- TTX modes[2)]

Because signal processing within the *SLICOFI-2x* is completely digital, it is possible to adapt to the requirements listed above by simply updating the coefficients that control DSP processing of all data. This means, for example, that changing impedance matching or hybrid balance requires no hardware modifications. A single hardware is now capable of meeting the requirements for different markets. The digital nature of the filters and gain stages also assures high reliability, no drifts (over temperature or time) and minimal variations between different lines.

1) With SLICOFI-2S2 only external ringing is supported
2) Not available with SLICOFI-2S2 codec

The characteristics for the two voice channels within *SLICOFI-2x* can be programmed independently of each other. The DuSLICOS software is provided to automate calculation of coefficients to match different requirements. DuSLICOS also verifies the calculated coefficients.

3.1.2 Additional Functions available for the SLICOFI-2 Codec

The following line circuit functions are integrated only in the SLICOFI-2 (see **Figure 4**):

- Teletax metering

For pulse metering, a 12/16 kHz sinusoidal metering burst has to be transmitted. The DuSLIC chip set generates the metering signal internally and has an integrated notch filter.

- DTMF

DuSLIC has an integrated DTMF generator comprising two tone generators and a DTMF decoder. The decoder is able to monitor the transmit or receive path for valid tone pairs and outputs the corresponding digital code for each DTMF tone pair.

- Caller ID Frequency Shift Keying (FSK) Modulator

DuSLIC has an integrated FSK modulator capable of sending Caller ID information. The Caller ID modulator complies with all requirements of ITU-T recommendation V.23 and Bell 202.

- LEC (Line Echo Cancellation)

DuSLIC contains an adaptive line echo cancellation unit for the cancellation of near end echos (up to 8 ms cancelable echo delay time).

- UTD (Universal Tone Detection)

DuSLIC has an integrated Universal Tone Detection unit to detect special tones in the receive or transmit path (e.g. fax or modem tones).

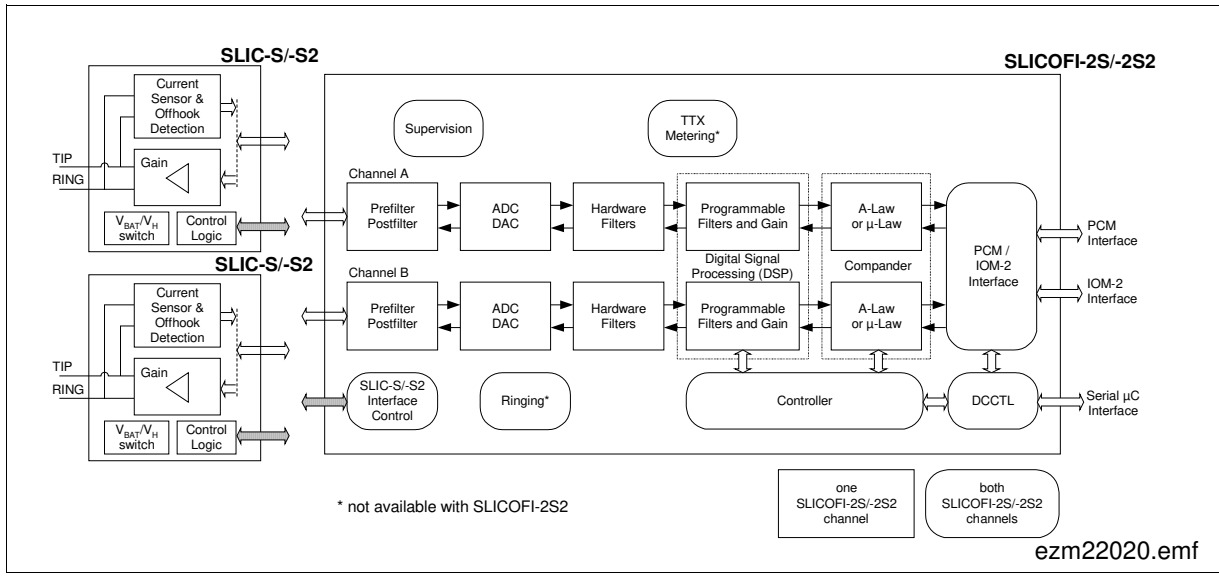


Figure 3 Line Circuit Functions included in the SLICOFI-2S/-2S2

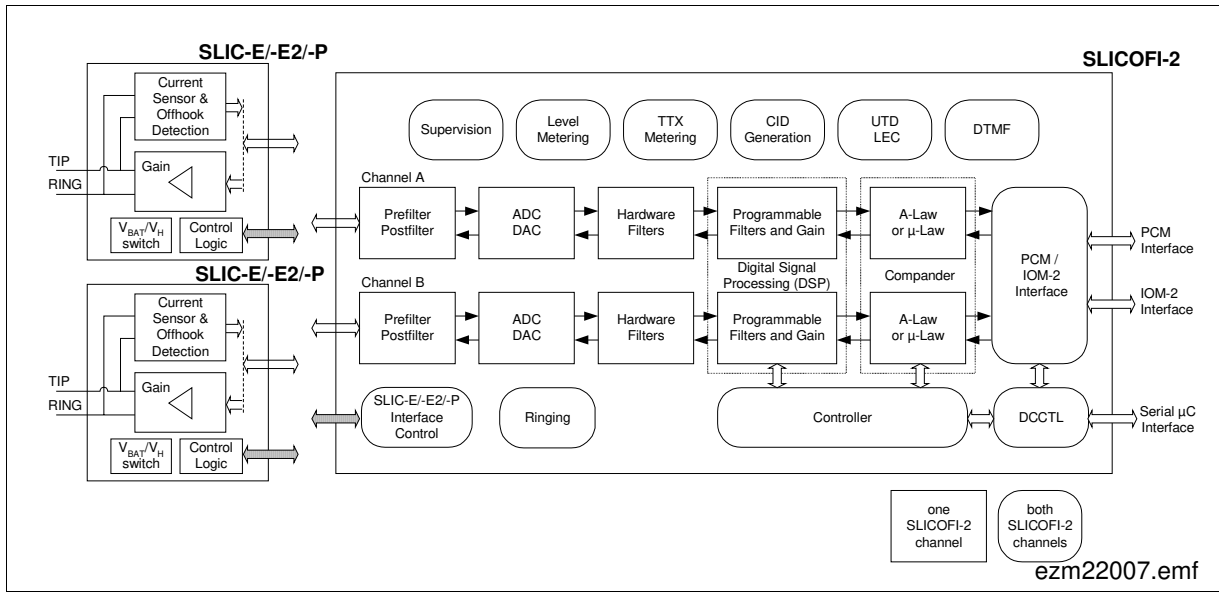


Figure 4 Line Circuit Functions included in the SLICOFI-2

3.2 Block Diagrams

Figure 5 shows the internal block structure of all *SLICOFI-2x* codec versions available. The Enhanced Digital Signal Processor (EDSP) realizing the add-on funtions[1)] is only integrated in the SLICOFI-2 (PEB 3265) device.

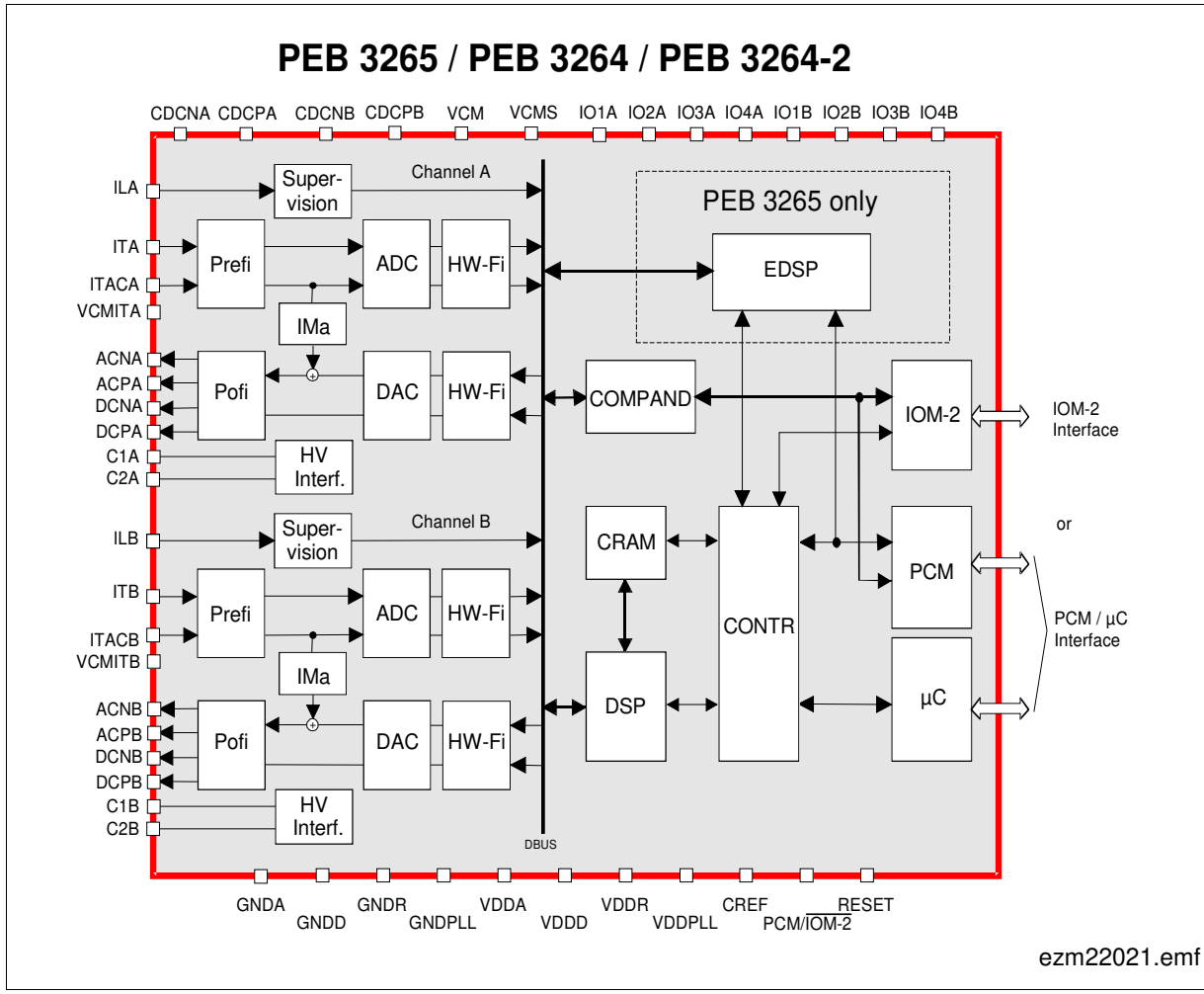


Figure 5 Block Diagram SLICOFI-2/-2S/-2S2 (PEB 3265, PEB 3264/-2)

1) The add-on functions are DTMF detection, Caller ID generation, Message Waiting lamp support, Three-party Conferencing, Universal Tone Detection (UTD), Line Echo Cancellation (LEC) and Sleep Mode.

3.2.1 DTMF Generation

The *SLICOFI-2x* offers programmable DTMF generation for both channels by using the internal tone generators.

3.2.2 DTMF Detection (SLICOFI-2 only)

Both channels (A and B) of the SLICOFI-2 device have a powerful built-in DTMF decoder that will meet most national requirements. The receiver algorithm performance meets the quality criteria for central office/exchange applications. It complies among others with the requirements of ITU-T Q.24, Bellcore GR-30-CORE (TR-NWT-000506) and Deutsche Telekom network (BAPT 223 ZV 5, Approval Specification of the Federal Office for Post and Telecommunications, Germany).

The performance of the algorithm can be adapted according to the needs of the application via the digital interface (detection level, twist, bandwidth and center frequency of the notch filter).

Table 2 shows the performance characteristics of the DTMF decoder algorithm:

Table 2 Performance Characteristics of the DTMF Decoder Algorithm

	Characteristic	Value	Notes
1	Valid input signal detection level	– 48 to 0 dBm0	Programmable
2	Input signal rejection level	– 5 dB of valid signal detection level	–
3	Positive twist accept	< 8 dB	Programmable
4	Negative twist accept	< 8 dB	Programmable
5	Frequency deviation accept	< ± (1.5% + 4 Hz) and < ± 1.8%	Related to center frequency
6	Frequency deviation reject	> ± 3%	Related to center frequency
7	DTMF noise tolerance (could be the same as 14)	– 12 dB	dB referenced to lowest amplitude tone
8	Minimum tone accept duration	40 ms	–
9	Maximum tone reject duration	25 ms	–
10	Signaling velocity	≥ 93 ms/digit	–
11	Minimum inter-digit pause duration	40 ms	–
12	Maximum tone drop-out duration	20 ms	–

Table 2 Performance Characteristics of the DTMF Decoder Algorithm (cont'd)

	Characteristic	Value	Notes
13	Interference rejection 30 Hz to 480 Hz for valid DTMF recognition	Level in frequency range 30 Hz … 480 Hz ≤ level of DTMF frequency + 22 dB	dB referenced to lowest amplitude tone
14	Gaussian noise influence Signal level – 22 dBm0, SNR = 23 dB	Error rate better than 1 in 10000	–
15	Pulse noise influence Impulse noise tape 201	Error rate better than 14 in 10000	–

In the event of pauses < 20 ms:

- If the pause is followed by a tone pair with the same frequencies as before, this is interpreted as drop-out.
- If the pause is followed by a tone pair with different frequencies and if all other conditions are valid, this is interpreted as two different numbers.

DTMF decoders can be switched on or off individually to reduce power consumption. In normal operation, the decoder monitors the Tip and Ring wires via the ITAC pins (transmit path). Alternatively the decoder can be switched also in the receive path. On detecting a valid DTMF tone pair, SLICOFI-2 generates an interrupt via the appropriate INT pin and indicates a change of status. The DTMF code information is provided by a register which is read via the digital interface.

The DTMF decoder also has excellent speech-rejection capabilities and complies with Bellcore TR-TSY-000763. The algorithm has been fully tested with the speech sample sequences in the Series-1 Digit Simulation Test Tapes for DTMF decoders from Bellcore.

3.2.3 Caller ID Generation (SLICOFI-2 only)

The SLICOFI-2 contains a FSK generation unit for sending Caller ID information.

SLICOFI-2 FSK Generation

Different countries use different standards to send Caller ID information. The SLICOFI-2 chip is compatible with the widely used standards Bellcore GR-30-CORE, British Telecom (BT) SIN227, SIN242 or the UK Cable Communications Association (CCA) specification TW/P&E/312. Continuous phase binary frequency shift keying (FSK) modulation is used for coding which is compatible with BELL 202 (see **Table 3**) and ITU-T V.23, the most common standards. The SLICOFI-2 can be easily adapted to these requirements by programming via the microcontroller interface. Coefficient sets are provided for the most common standards.

Table 3 FSK Modulation Characteristics

Characteristic	ITU-T V.23	Bell 202
Mark (Logic 1)	1300 ± 3 Hz	1200 ± 3 Hz
Space (Logic 0)	2100 ± 3 Hz	2200 ± 3 Hz
Modulation	FSK	
Transmission rate	1200 ± 6 baud	
Data format	Serial binary asynchronous	

3.2.4 Line Echo Cancelling (LEC) (SLICOFI-2 only)

The SLICOFI-2 line echo canceller is compatible with applicable standards ITU-T G.165 and G.168. An echo cancellation delay time of up to 8 ms can be programmed (for restrictions see chapter “MIPS requirements for EDSP Capabilities” in the DuSLIC Data Sheet).

4 Operating Modes for the DuSLIC Chip Set

Table 4 Operating Modes for *SLICOFI-2x* and SLICS

***SLICOFI-2x* Mode**	**SLIC Type**			**CIDD/ CIOP[1)]**			**Additional Bits used (Note [2)])**
	SLIC-S/ SLIC-S2	**SLIC-E/ SLIC-E2**	**SLIC-P**	**M2**	**M1**	**M0**	
Sleep (SL)	–	PDRH	PDRH	1	1	1	SLEEP-EN = 1
			PDRR	1	1	1	SLEEP-EN = 1, ACTR = 1
Power Down Resistive (PDR)	PDRH	PDRH	PDRH	1	1	1	SLEEP-EN = 0
			PDRR	1	1	1	SLEEP-EN = 0, ACTR = 1
Power Down High Impedance (PDH)	PDH	PDH	PDH	0	0	0	–
Active High (ACTH)	ACTH	ACTH	ACTH	0	1	0	–
Active Low (ACTL)	ACTL	ACTL	ACTL	0	1	0	ACTL = 1
Active Ring (ACTR)	ACTR	ACTR	ACTR	0	1	0	ACTR = 1
Ringing (Ring)	ACTR[3)]	ACTR	ACTR	1	0	1	–
	–	–	ROT	1	0	1	HIT = 1
	–	–	ROR	1	0	1	HIR = 1
Active with HIT	HIT	HIT	 HIT	0 0	1 1	0 0	HIT = 1 HIT = 1, ACTR = 0
Active with HIR	HIR	HIR	 HIR	0 0	1 1	0 0	HIR = 0 HIR = 0, ACTR = 0
Active with Ring to Ground			ROT	0	1	0	HIT = 1, ACTR = 1
Active with Tip to Ground			ROR	0	1	0	HIR = 1, ACTR = 1
HIRT	–	HIRT	HIRT	0	1	0	HIR = 1, HIT = 1
Active with Metering	ACTx[3)] [4)]	ACTx[4)]	ACTx[4)]	1	1	0	TTX-DIS to select Reverse Polarity or TTX Metering