SICOFI®4-TE Four Channel Codec Filter for Terminal Application

PSB 2134 Version 2.2

Wired Communications

Never stop thinking.

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Preface

This document summarizes the features of the SICOFI®4-TE Four Channel Codec Filter for Terminal Application. The device as an appropriate choice for an extensive range of analog telephony applications.

Organization of this Document

This *Product Overview* is organized as follows:

- Chapter 1, Overview
  Includes a general description, features list, and logic symbol and identifies typical applications.
- Chapter 2, Functional Description
  Summarizes the architecture, programming and control functions, provides a simplified flow diagram, and summarizes the major functional blocks.
- Chapter 3, Operational Description
  Summarizes the operating modes and includes a state diagram.
- Chapter 4, Interface Descriptions
  Summarizes the four interfaces: Analog, IOM-2 PCM, Signaling, and Microcontroller.
- Chapter 5, Application Hints
  Summarizes and illustrates six applications and indicates the support tools available, including QSICOS software and STUT 2466 Development board.
- Appendix
  Includes a glossary and an index.

Related Documentation

Additional documentation for the SICOFI®4-TE includes a *Product Brief*, *Hardware Reference Manual*, *Programmer's Reference Manual*, and assorted *Application Notes*.

Documentation is also available for other SICOFI Codec devices including the PSB 2132, PEB 2266, and PEB 2466. Documentation is available by accessing our website: http://www.infineon.com/sicofi

1 Overview

The SICOFI®4-TE Signal Processing Codec Filter for terminal applications is a special derivative of the Siemens' programmable codec filter IC family. The SICOFI®4-TE is designed to connect to the IOM-2 bus often used in ISDN or other digital terminals, where it provides four tip/ring interfaces for analog telephones, modems, answering and fax machines.The SICOFI®4-TE PSB 2134 supports the IOM-2 TE structure for terminal applications.

The SICOFI®4-TE is manufactured in an advanced mixed-signal CMOS technology. The PSB 2134 combines four cadets with highly linear analog-to-digital and digital-to-analog converters and a powerful DSP core for four independent digital filter channels. This integrated digital solution offers two significant advantages over discrete or analog implementations:

– the high level of integration requires less board space, and
– as a digital system, the transmission characteristics can be accurately programmed and will not drift over time or temperature.

The SICOFI®4-TE features twenty-eight digital I/O signals for system status control and monitoring.Two interrupt outputs are available to alert a microcontroller of status changes (e.g. on/off hook). Two clock outputs with programmable frequencies provide signal sources for ringing generators or DC/DC converters. Two on-chip tone generators per channel can be used for DTMF dialing or for in-band call process signaling.

The SICOFI®4-TE is programmed through a serial microcontroller interface. Each of the four channels can be assigned to any voice channel on the IOM-2 PCM interface. Internal connections between channels are also possible, saving an external switching matrix IC. The device can be configured for either A-Law or µ-Law encoding.

Figure 1 illustrates the internal and external voice connections possible with the SICOFI®4-TE.

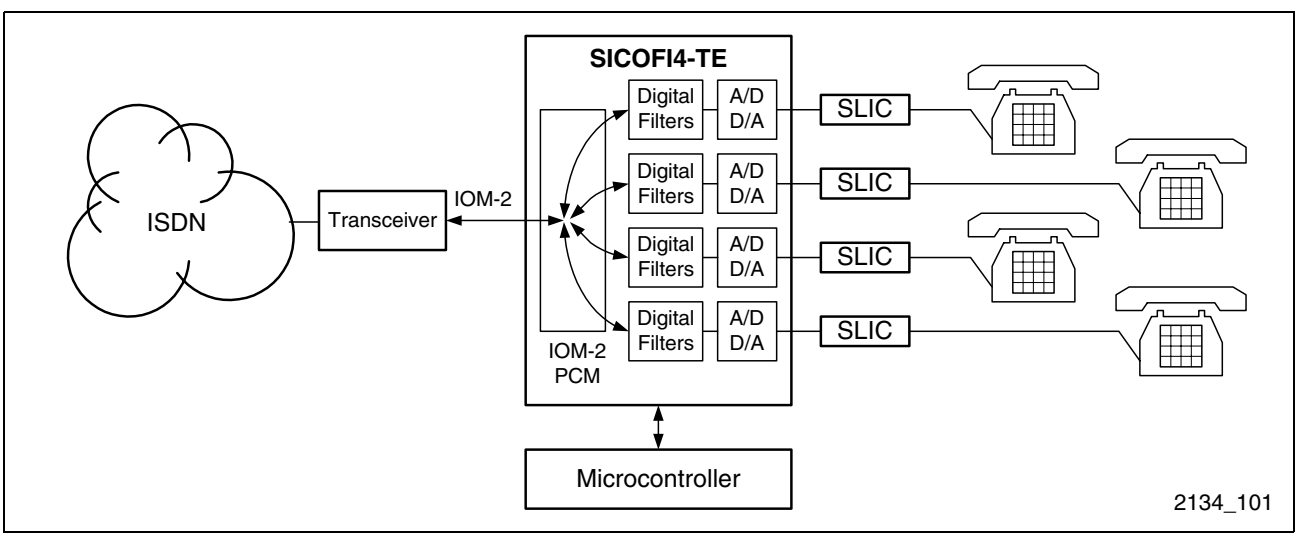


Figure 1 Internal and External Voice Connections with the SICOFI®4-TE

The PSB 2134 is software configurable and downloadable filter coefficients allow easy adaptation to country-specific transmission requirements. QSICOS Coefficient Calculation and Register Configuration Software simulates specific SLICs and external components, calculates the correct coefficients, and optimizes the behavior of the complete system. Several test and diagnostic features have been built into the device and development boards are available to streamline system design.

Infimum Technologies provides a selection of programmable cadets and SLICs with different levels of integration. The SICOFI devices include 2- or 4-channel versions that can be easy fitted into existing switching and transmission environments. Infimum Technologies also offers advanced codec and SLIC combinations which include programmable DC characteristics, and integrated ringing and supervision functions (Music, Dislike).

Table 1 SICOFI Family Tree

Device		Description
SICOFI2-µC	PEB 2266*	Two Channel Codec Filter with PCM and Microcontroller Interface
SICOFI4-µC	PEB 2466*	Four Channel Codec Filter for Terminal Application
SICOFI2-TE	PSB 2132	Two Channel Codec Filter for ISDN Terminal and NT Applications
SICOFI4-TE	PSB 2134	Four Channel Codec Filter for ISDN Terminal and NT Applications

* Also extended temperature devices: PEF 2466, and PEF 2266.

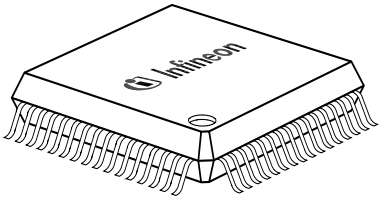
Four Channel Codec Filter for Terminal Application SICOFI®4-TE

PSB 2134

Version 2.2

CMOS

1.1 Features



P-MQFP-64

- Single chip programmable codec and filter to handle four POTS interfaces
- High analog driving capability (300 Ω, 50 if) for direct driving of transformers
- Digital Signal Processing (DSP) technique
- Programmable digital filters to adapt transmission behavior, especially for:
  - AC impedance matching
  - Transhybrid balancing
  - Frequency response
  - Gain
  - A/µ-Law compression and expansion
- High performance ADC and DAC for excellent linearity and dynamic gain
- Programmable Analog Interface to electronic SLICs or transformer solutions
- Seven SLIC-signaling I/O pins per channel with programmable debouncing
- IOM-2 compatible PCM interface (1.536 MHz DCL, 768 kHz Bit Clock)
- Easy to use 4-pin Serial Microcontroller Interface (SPI compatible) for read/write access
- Single supply voltage (5 V)
- Advanced low-power mixed-signal CMOS technology
- Two programmable tone generators per channel (DTMF possible)
- Level metering function for system tests and for analog input signal testing
- Advanced on-chip functions for device and system diagnostics and manufacturing test
  - Five digital loops
  - Four analog loops
- Support tools include:
  - Hardware development board —STUT 2466
  - QSICOS Coefficient Calculation and Register Configuration Software
- Standard P-MQFP-64 package

Type	Package
PSB 2134 Version 2.2	P-MQFP-64

1.2 Logic Symbol

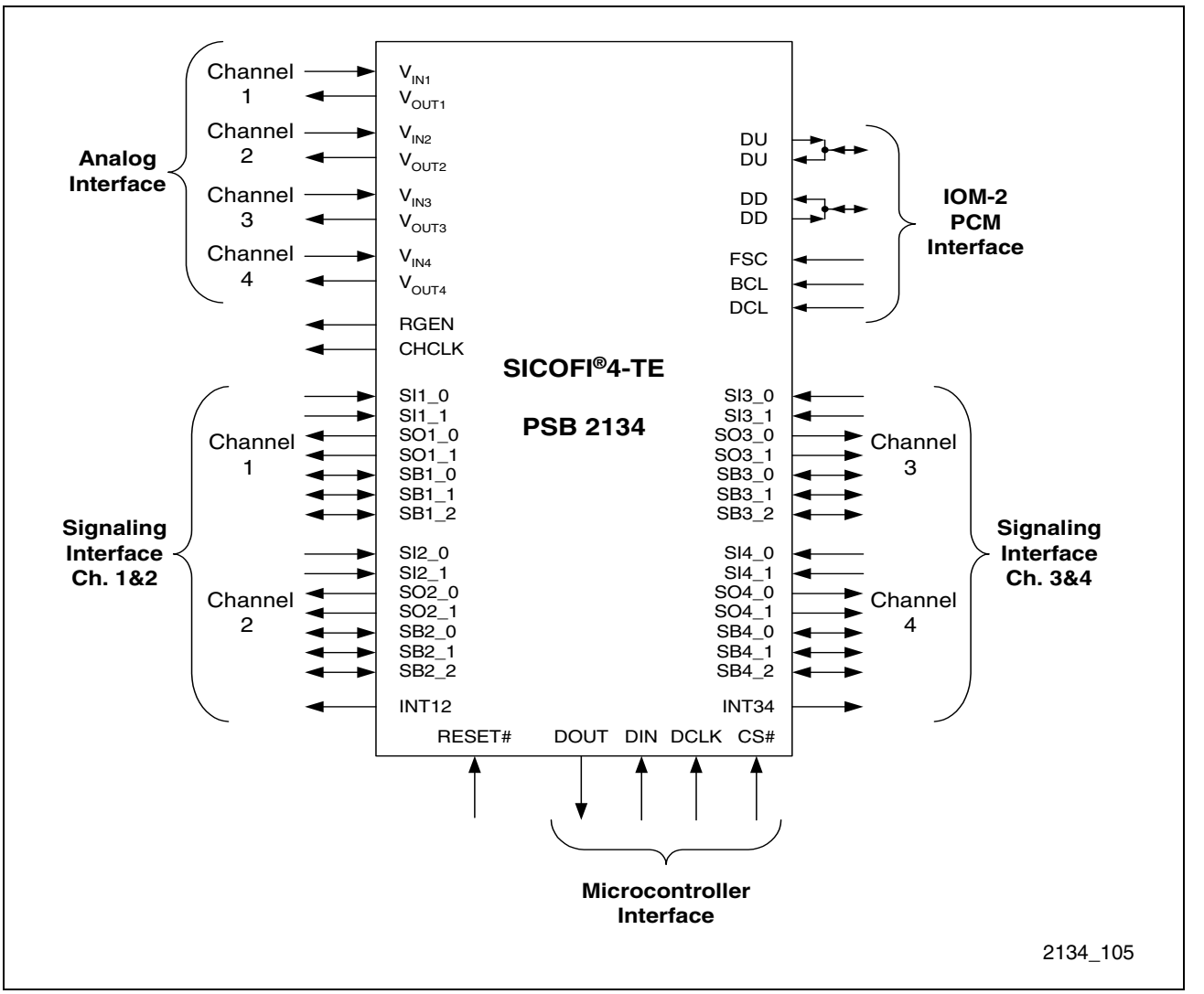


Figure 2 SICOFI®4-TE Logic Symbol

Figure 2 depicts the signals and interfaces available in the SICOFI®4-TE. The Analog Interface in the SICOFI®4-TE has one input pin and one output pin per channel. The Signaling Interface has a total of 28 pins: each channel has two digital inputs, two digital outputs, and three configurable digital inputs/outputs. Two interrupt outputs are available to indicate changes on the signaling inputs. The IOM-2 PCM Interface has one input and one output connected to Data Upstream (DU) and one input and one output connected to Data Downstream (DD). Voice transmission and reception can be assigned to either of the IOM-2 signals, DU or DD, through register programming. Two clock inputs, for frame and bit synchronization, also apply to the IOM-2 PCM Interface. The Serial Microcontroller Interface consists of four signals: one serial input, one serial output, clock supply, and chip select. The SICOFI®4-TE also includes one general reset pin, one ringing signal output, and one universal, programmable clock output. For details, see **Chapter 4** "Interface Description" on page 13.

1.3 Typical Applications

Many applications will benefit from the versatility of the SICOFI®4-TE codec and filter. Product reliability and manufacturability are enhanced by the high level of integration and by fabrication in low-power mixed-signal CMOS technology. The single 5 V supply voltage simplifies system power supply requirements. The inherent flexibility enables several products to be developed around one basic architecture, with the benefit of potentially significant savings in time to market, inventory costs, and support administration. The following list represents some of the typical applications for which the SICOFI®4-TE codec was designed.

- ISDN Terminal Adapter,
- Small PBX or Key Systems,
- Intelligent NTs,
- ISDN Intelligent Network Terminator

Refer to **Chapter 5** "Application Hints" on page 16 for more information.

2 Functional Description

The SICOFI®4-TE in combination with four Subscriber Line Interface Circuits (SLIC) provides four analog telephone lines. The SLIC can be either a transformer or an electronic circuit with op amps. It must have a defined input impedance towards the analog line for maximum power transfer and return loss. Also, the signal reflections that are generated by the hybrid inside the SLIC must be eliminated. Along with its other features, the SICOFI®4-TE has built-in impedance matching and transhybrid balancing to perform these tasks.

2.1 DSP-based Architecture

The impedance matching and transhybrid balancing functions are performed by loop filters between the transmit and the receive path. The filter characteristics must be adjusted according to the local requirements of each market. In the analog domain, filters must be optimized in hardware; this is generally both tedious and time-consuming. This is not so when the DSP-based SICOFI®4-TE four-channel codec is used. Its integrated signal processor implements the impedance matching and transhybrid balancing functions as digital, programmable filters. It also performs frequency response corrections and level adjustments to enable the design of a truly universal and internationally applicable telephone interface. Transmission characteristics and frequency behavior are enhanced by the accuracy of the digital filters, which do not fluctuate over temperature or with age.

QSICOS Coefficient Calculation and Register Configuration Software simulates specific SLICs and external components. QSICOS calculates the correct coefficients and optimizes the behavior of the complete system in accordance with country-specific requirements. As an additional benefit, the DSP-based architecture of the SICOFI®4-TE also provides two tone generators (DTMF is supported) as well as level metering functions.

2.2 Programming and Control

A very simple Microcontroller Interface is used to program the SICOFI®4-TE functions. The same port provides access to 28 general purpose I/O pins of the Signaling Interface. This allows efficient and convenient monitoring and control of other tip/ring functions, such as on-/off-hook detection, ground-key detection, switching of ringing signals and test relays. The Serial Microcontroller Interface provides a programming and control interface and is generic and non-proprietary for use with any microcontroller. It can be implemented with as few as three signal lines, since the data receive and data transmit pins may be strapped together.

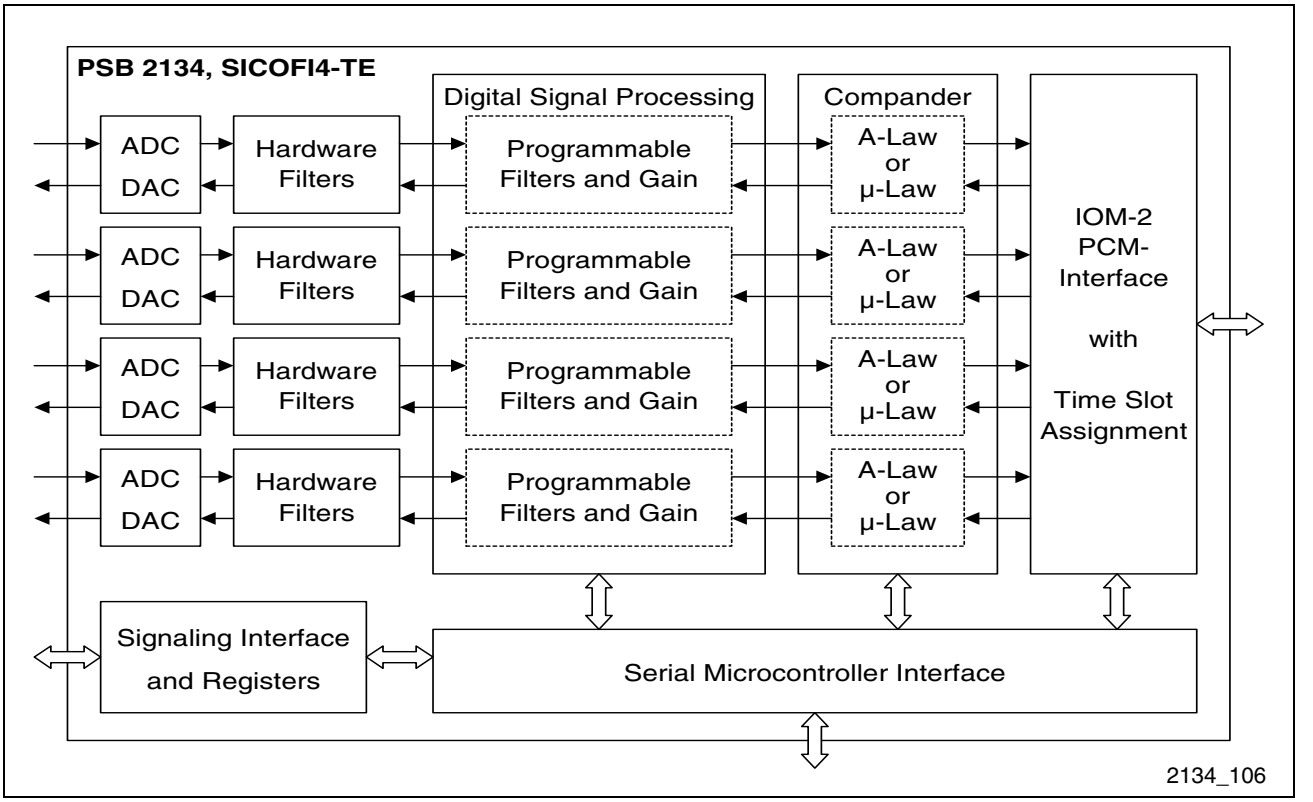


Figure 3 SICOFI®4-TE Block Diagram

2.3 Signal Flow

In digital networks like ISDN, existing analog equipment—such as telephones and fax machines—can still be connected to the network through terminal adapters (TA) or similar devices. The SICOFI®4-TE is an excellent component to interface between the digital network and the Plain Old Telephone Service (POTS) equipment. The quad codec can be used with both integrated and discrete SLICs. The new sigma-delta Analog-to-Digital Converter and Digital-to-Analog Converter with high resolution and accuracy guarantee sufficient gain range in the digital part and achieve excellent performance. Analog anti-aliasing prefilters, smoothing postfilters, and specific hardware filters are integrated on-chip. The specific hardware filters do the decimation and interpolation for the oversampling ADC and DAC.

As shown in Figure 3, the dedicated DSP handles all the necessary algorithms (e.g. for PCM bandpass filtering, sample rate conversion, impedance matching, and transhybrid balancing. An IOM-2 PCM Interface allows easy integration into digital terminal equipment (e.g. ISDN TAs). The IOM-2 data rate supported by the SICOFI®4-TE is 768 kbit/s. The IOM-2 PCM Interface handles digital voice transmission, including A-Law and µ-Law conversion. The Serial Microcontroller Interface manages feature control and programming and provides easy access to the logic state of the SLIC's command and indication pins. For more details on interfaces, refer to **Chapter 4** "Interface Description" on page 13.

2.4 Functional Blocks

The PSB 2134 provides excellent transmission performance and high flexibility. All functional blocks shown in **Figure 4** exist for all four channels and each can be fully programmed independently. The advanced digital filter concept also leads to maximum independence between the different filter blocks within the channels.

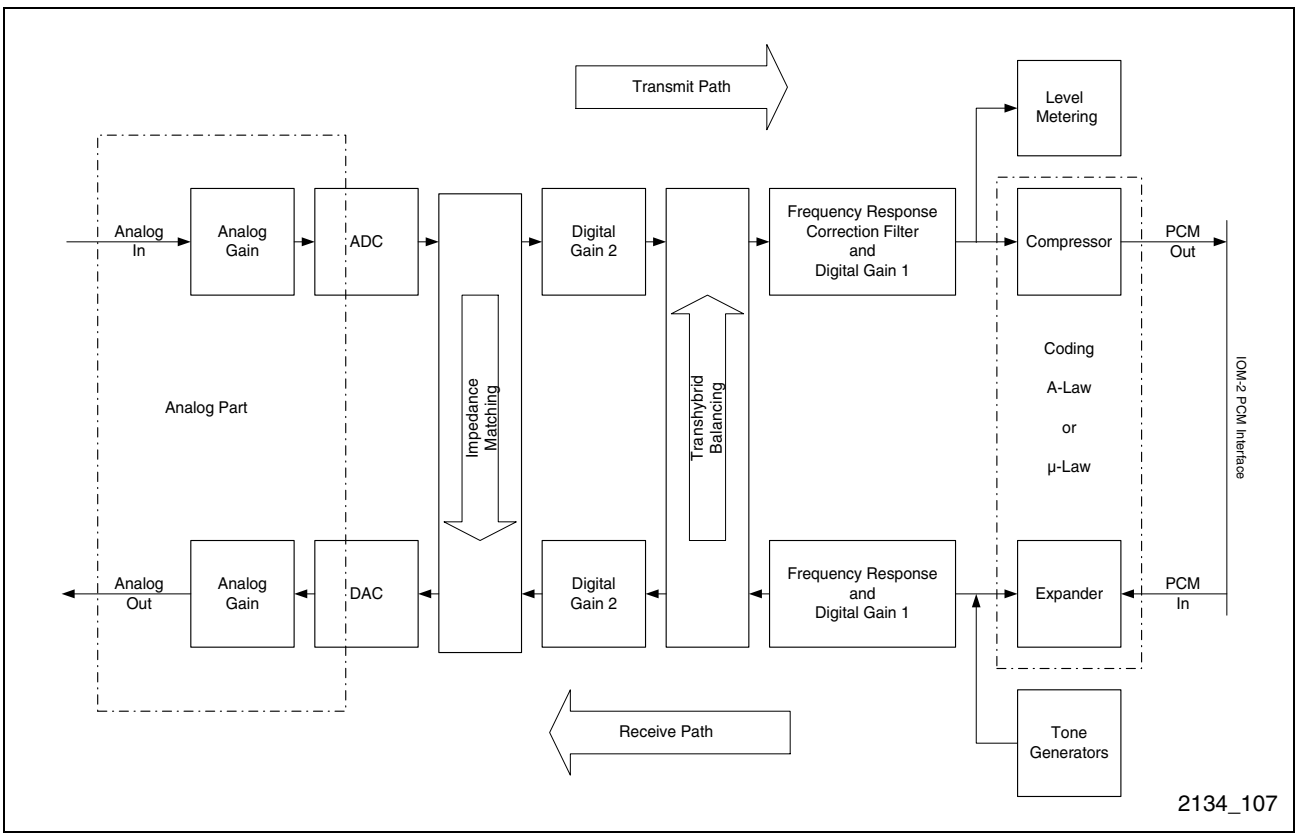


Figure 4 SICOFI®4-TE Simplified Flow Diagram

Analog Gain

Analog Gain stages with 6.02-dB amplification in the transmit direction and 6.02-dB attenuation in the receive direction can be activated through the SICOFI®4-TE configuration registers.

ADC/DAC

Advanced, oversampling sigma-delta Analog-to-Digital Converter and Digital-to-Analog Converter (ADC and DAC) achieve excellent performance in terms of linearity, accuracy, dynamic range, and resolution.

Digital Gain 2

The digital gain stages in both transmit and receive directions allow signal level adjustments with very fine granularity.

Impedance Matching

The programmable loop filters which feed portions of the transmit signal back to the receive path allow highly accurate and stable impedance synthesis of the input impedance towards the telephone line.

Transhybrid Balancing

A certain portion of the receive signal is reflected on the hybrid inside the SLIC, resulting in an echo signal on the transmit path. The SICOFI®4-TE provides a loop filter from the receive path to the transmit path that can be programmed to generate an equivalent of the echo signal. If the equivalent is subtracted from the transmit signal, it cancels the echo produced by the hybrid. This function, called transhybrid balancing, is implemented by programmable loop filters that allow adjustments to different line conditions.

Frequency Response Correction Filters and Digital Gain 1

Terminal Equipment connected to the public network must fulfill the country-specific requirements for frequency response behavior. The SICOFI®4-TE provides digital correction filters in both signal directions between the IOM-2 PCM side and the Analog Interface. These programmable filters and digital gain stages are used to adjust the overall system's frequency response behavior.

A-Law / µ-Law Compressor and Expander

PCM-encoded speech signals on IOM-2 use an 8-bit format with G.711 A-Law or µ-Law compression. For better performance, the DSP inside the SICOFI®4-TE processes 16-bit linear speech samples. The conversion is performed by compressor and expander units between the IOM-2 PCM Interface and the digital filter structures of the SICOFI®4-TE. These blocks can be selected as either A-Law or µ-Law through the configuration registers.

Level Metering

This block compares the level of a band-pass filtered signal on the transmit path with a programmable offset value. The signal can be applied externally or internally by one of the on-chip tone generators. The function can be used for line characterization, field diagnostics, or functional tests.

Tone Generators

Two independent tone generators are available per channel for DTMF dialing and as call-progress tone sources. They also provide the test signal for dynamic system diagnostics, including line characterization when used in combination with the level metering function.

3 Operational Description

For system power management, each channel of the SICOFI®4-TE can be programmed to be in one of two states: “Standby” and “Operating”. “Standby” is a power-saving state. Keeping all unused channels in this state reduces the overall system power dissipation. After applying power to the device (Power On), or after asserting a logic low signal to the RESET# pin (HW Reset), or after programming the RESET bit in the configuration registers, all four channels will be initialized and will enter the “Standby” state. From there, each channel can be switched separately to “Operating” state and back, by programming a bit in the channel-specific configuration registers.

3.1 Operating States

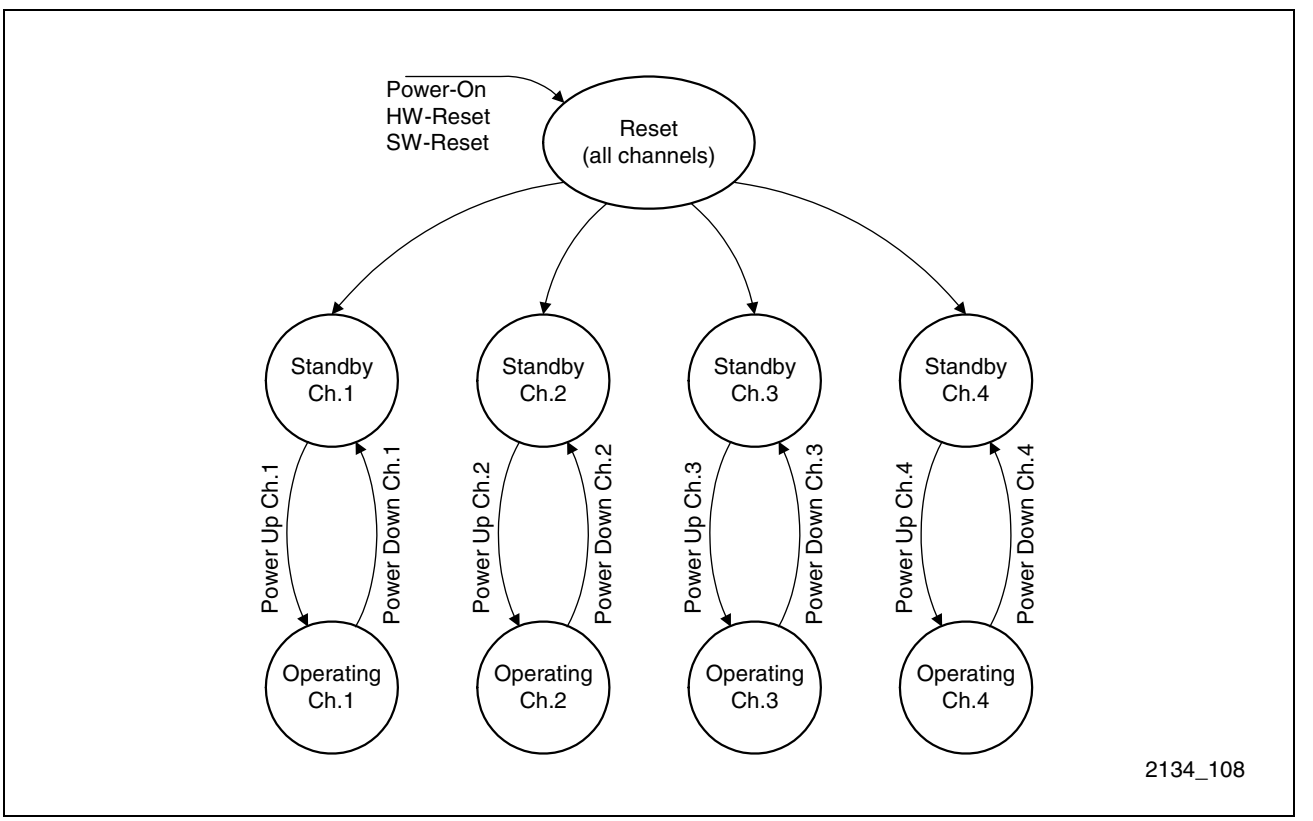


Figure 5 SICOFI®4-TE Simplified State

Reset (Default Setting)

The SICOFI®4-TE enters a default setting Reset state upon initial application of power to the device (Power On), or when the RESET# pin is pulled to ‘0’ during operation (HW Reset), or by programming the RESET bit in the configuration registers (See XOP command in the *Programmer’s Reference Manual*). Default setting means that the SICOFI®4-TE configuration registers of all channels are set to their default values and the I/O pins of the different interfaces exhibit a defined behavior.

All programmable filters, the two tone generators, as well as any test modes, are disabled. The signaling outputs are forced to ground. All programmable command/indication pins are inputs. The debouncing functions are disabled. Receive signaling registers are cleared. Data output of the Serial Microcontroller Interface and the analog outputs are in high impedance state. The SICOFI®4-TE leaves this state automatically after the RESET# pin is released.

Standby

“Standby” is a power-saving state. Keeping all unused channels in this state reduces the overall system power dissipation. After releasing the RESET# pin, the SICOFI®4-TE will enter the Standby state. Each channel of the SICOFI®4-TE can be forced individually to Standby state when Power Down is set in the channel configuration registers. All four channels must be programmed separately. In Standby, the Serial Microcontroller Interface of the SICOFI®4-TE is ready to receive and transmit commands and data. Received voice data on the IOM-2 Interface will be ignored. SICOFI®4-TE configuration registers and Coefficient RAM can be loaded and read back in this state. The debouncing functions of the Signaling Interface can be enabled and data on the signaling input pins can be read via the Serial Microcontroller Interface.

Operating

The “Operating” state for any channel in the SICOFI®4-TE is entered upon recognition of a Power Up bit set to “1” in a configuration register for that specific channel. For any channel set to Operating state, the voice transmission works in both directions. Voice data applied to the IOM-2-input and the Analog-input will be processed according to the programmed contents of the internal registers and filter coefficients, and will appear as Analog-output and IOM-2-output. Programmable filters and tone generators can be enabled. The debouncing functions of the Signaling Interface can be enabled.

4 Interface Description

The SICOFI®4-TE provides four interfaces (Analog, IOM-2 PCM, Signaling, and Microcontroller) for flexible and efficient design implementations. The AC characteristics of the Analog Interface are programmable to enable quick software adaptations to country-specific transmission requirements. The programming is done through the Serial Microcontroller Interface, which also provides access to the device's status and control registers. The Signaling Interface is used to monitor and control the status of the SLIC and the telephone line. Interrupt outputs can be enabled to alert the microcontroller of any change that occurred on the Signaling Interface (e.g. off-hook detection). The IOM-2 PCM Interface transmits and receives A-Law or µ-Law encoded data at a rate of 768 kbit/s.

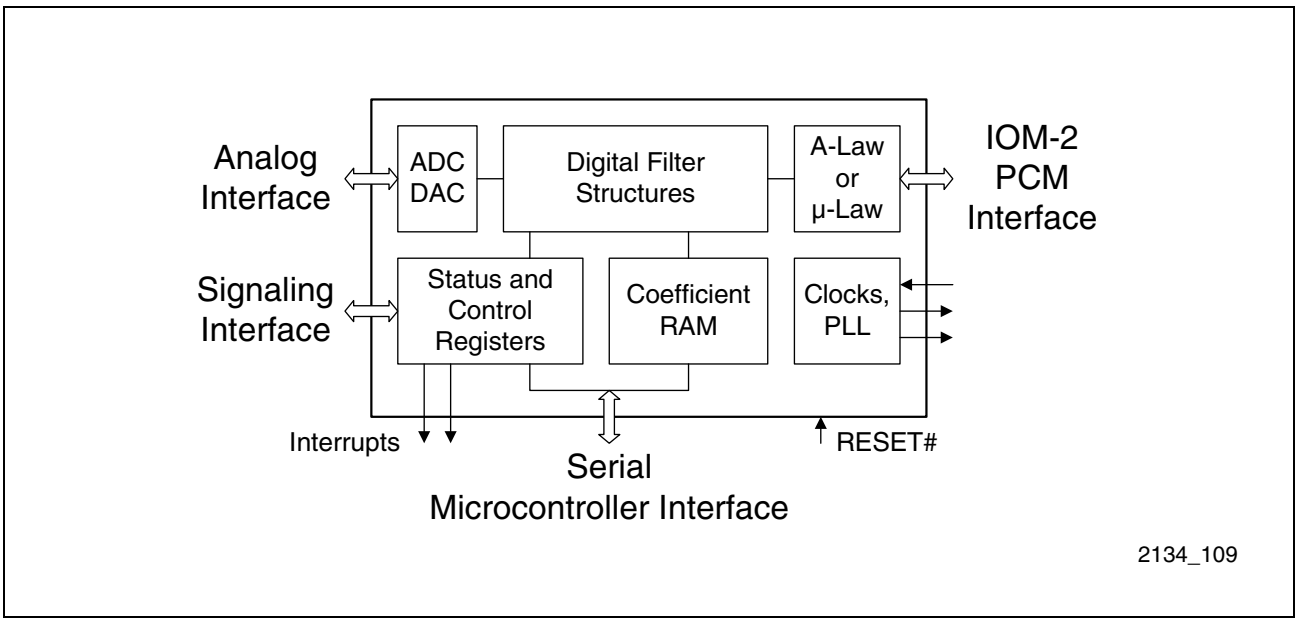


Figure 6 SICOFI®4-TE Interfaces

4.1 Analog Interface

The SICOFI®4-TE includes a programmable Analog Interface with high driving capability for interfacing to electronic SLICs or transformer solutions. The SICOFI®4-TE can drive loads of up to 300 ohms, eliminating the need for an external amplifier that is normally used with transformer SLICs. The only external component needed between the analog I/O pins of the SICOFI®4-TE and the SLIC is a coupling capacitor. (See the *Hardware Reference Manual* for further detail.) Out-of-band signals applied to the analog inputs are suppressed by the on-chip digital hardware filters.

4.2 IOM-2 PCM Interface

One serial IOM-2 PCM Interface is used for the transfer of A- or µ-Law compressed voice data to and from a standard IOM-2 bus. The IOM-2 PCM Interface consists of 5 signals:

one Dual Clock, one Bit Clock, one Frame Synchronization Clock, one hardwired input/output for Data Downstream (DD) and one hardwired input/output for Data Upstream (DU). Voice data in all channels are serialized to 8-bit codes with MSB first. The Frame Synchronization Clock (FSC) pulse identifies the beginning of an IOM-2 frame for all four channels. The Bit Clock (BCL) and the Dual Clock (DCL) are used to synchronize the data transfer on IOM-2 and as a master clock source for the device.

The standard IOM-2 data rate of 768 kbit/s for terminal equipment is supported by the SICOFI®4-TE. An IOM-2 frame consists of 12 time slots of 8-bits each. Any of the four voice channels can be assigned to an individual time slot on either the Data Upstream or the Data Downstream line. Receive and transmit time slots can also be programmed independently. The SICOFI®4-TE facilitates adaptations to non-standard IOM-2 implementations with a programmable sampling slope and delay of up to seven clock cycles, valid for all channels.

4.3 Signaling Interface

The SICOFI®4-TE Signaling Interface provides 28 general purpose digital I/O pins. The logic state of each pin is reflected in dedicated on-chip registers. There are two inputs, two outputs, and three programmable bi-directional pins per channel. Automatic debouncing of the input signals, with configurable debouncing periods, can be enabled. Additionally, two interrupt outputs (INT12, INT34) are provided.

The Signaling Interface is used to implement line supervision, SLIC status monitoring and control, and switching of ringing or test relays, etc. The SICOFI®4-TE accumulates and manages the I/O status of four SLICs. If programmed, any change on the signaling inputs generates an interrupt that alerts the microcontroller: INT12 indicates signaling changes on Channels 1 and 2; INT34 indicates changes on Channels 3 and 4. The microcontroller can read the signaling status directly from the SICOFI®4-TE registers. If the interrupts are not used, the microcontroller can still determine changes on the Signaling Interface (e.g., on-/off-hook) through polling. The PSB 2134 provides two clock output pins: RGEN can be used as a ringing signal source, CHCLK is available for other special purposes, e.g. as chopper clock signals for DC-DC converters.

4.4 Microcontroller Interface

A Serial Microcontroller Interface provides read and write access to the internal configurations registers, the registers of the Signaling Interface, and the Coefficient-RAM (CRAM). The Serial Microcontroller Interface consists of four pins: Chip Select, Data Clock, Data In and Data Out. To reduce the number of lines to the microcontroller, Data In and Data Out may be strapped together to form a single bi-directional data line. A falling edge on Chip Select initiates a serial read or write access. The SICOFI®4-TE interprets the first eight bits received via Data In as a command byte. Subsequent data bytes (the number depends on the type of command) are stored in the selected configuration registers or the selected part of the Coefficient RAM. If the first eight bits received via Data In specify a read-command, the SICOFI®4-TE will initiate a response via Data Out with an identification byte (81_H), followed by the requested number of data bytes (contents of configuration registers, or contents of the CRAM). A clock signal applied to the Data Clock pin synchronizes the serial data transfer. The logic level on Data In is latched at the rising edge of Data Clock, while Data Out changes its logic level with the falling edge of Data Clock. During the execution of a read command, i.e., serial transfer on Data Out, the device will ignore any signals on Data In. The data transfer sequence can be aborted by setting Chip Select to high.

5 Application Hints

5.1 Typical Applications

The programmability of the SICOFI®4-TE makes it suitable for a variety of terminal applications featuring four analog tip/ring interfaces for analog telephones, modems, and fax or answering machines. The inherent flexibility of the device enables several applications and products to be developed around one basic architecture. This design versatility provides potentially significant savings in product development, inventory costs, and support. The following sections describe some of the typical applications for which the SICOFI®4-TE codec was designed.

5.1.1 ISDN Terminal Adapters

ISDN Terminal Adapters (TA) allow ISDN subscribers to connect and operate non-ISDN equipment, e.g., analog telephones. ISDN offers two digital B-channels for two simultaneous voice connections. The TA's microcontroller can assign any of the four channels of the SICOFI®4-TE to any B-channel on IOM-2. When both of the ISDN B-channels are in use for external calls, the two remaining SICOFI®4-TE channels can still be used for internal connections.

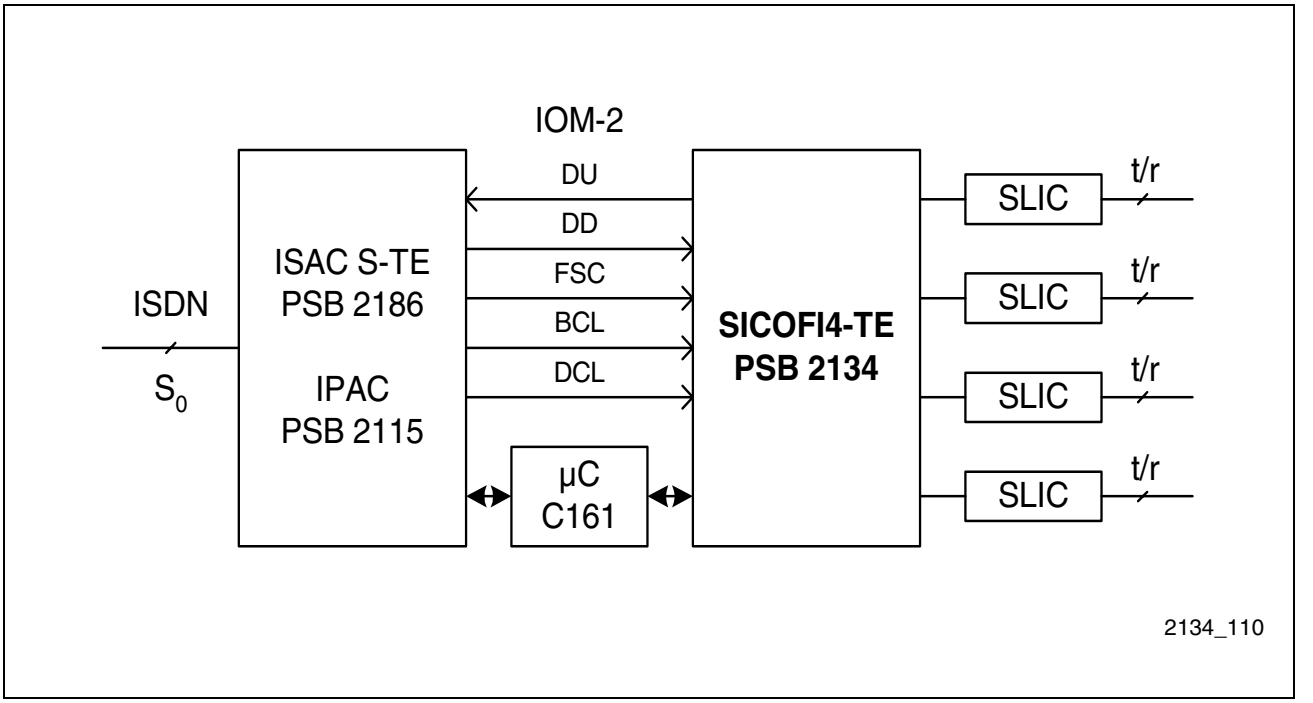


Figure 7 ISDN Terminal Adapter Example

5.1.2 Small PBX or Key Systems

Small PBXs often use ISDN lines for external connections (trunk lines) and provide several internal analog subscriber lines. **Figure 8** shows an example of a small PBX with two external voice channels over one ISDN and six internal analog subscriber lines. The SICOFI®4-TE, a SICOFI®2-TE, and an ISDN transceiver (ISAC-STE) are connected through a common IOM-2 interface. Any of the six SICOFI channels can be routed to either B1 or B2 of the ISDN. There are two additional voice time slots on IOM-2: IC1 and IC2. Each IC channel can be used for an internal connection of two analog subscribers. Thus, all six subscribers can be connected simultaneously.

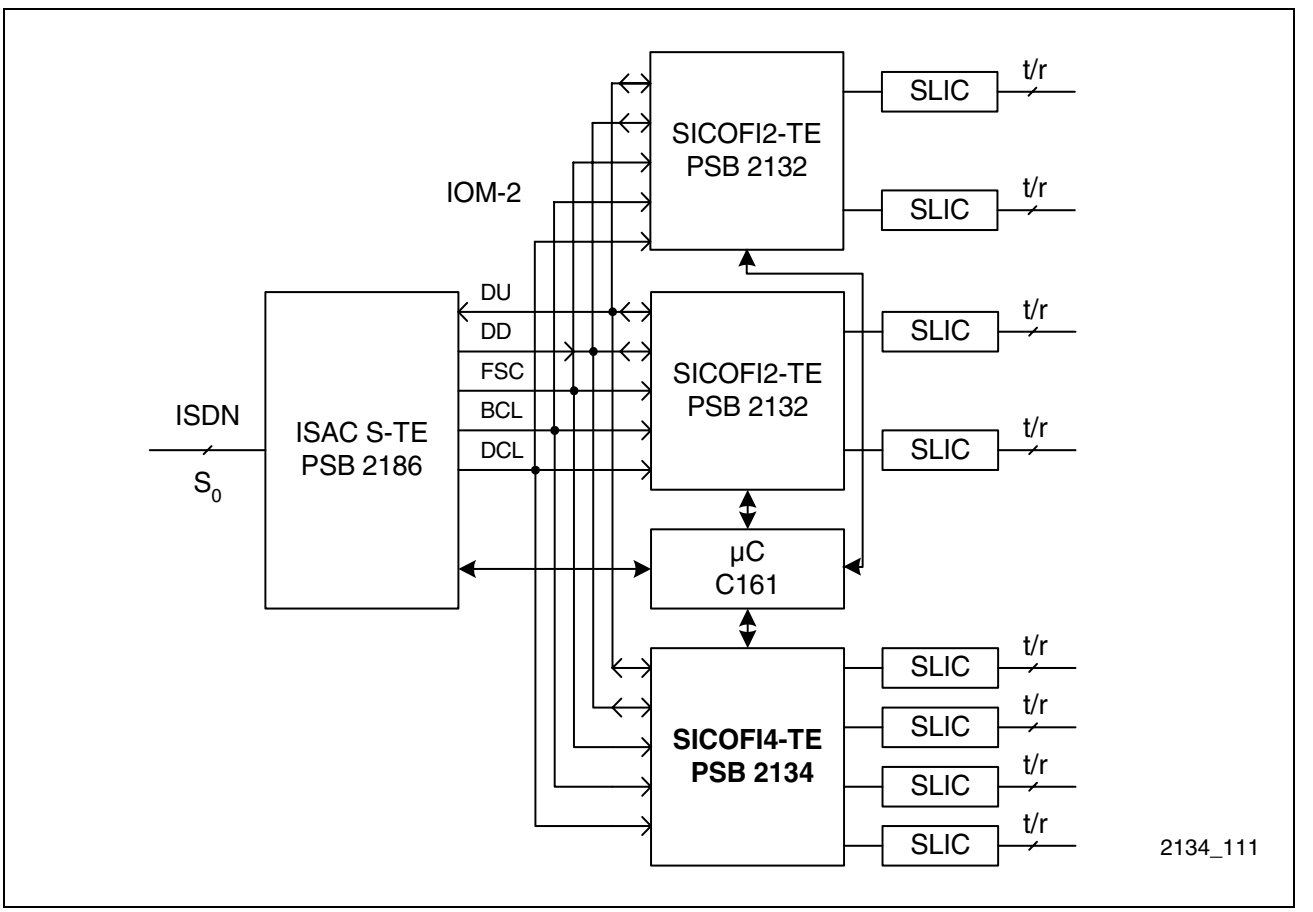


Figure 8 Small PBX or Key System Example

5.1.3 Intelligent Network Terminations (Intelligent NT)

Intelligent Network Terminations combine ISDN Network Termination and Terminal Adapter (TA) functionality. The NT block connects to the ISDN U-interface on the network side and provides an ISDN-S_O interface for digital subscribers (e.g. ISDN PC-Card). The SICOFI®4-TE is used to enhance the standard NT functionality with additional tip/ring interfaces for analog subscriber equipment such as telephones, fax machines, etc.

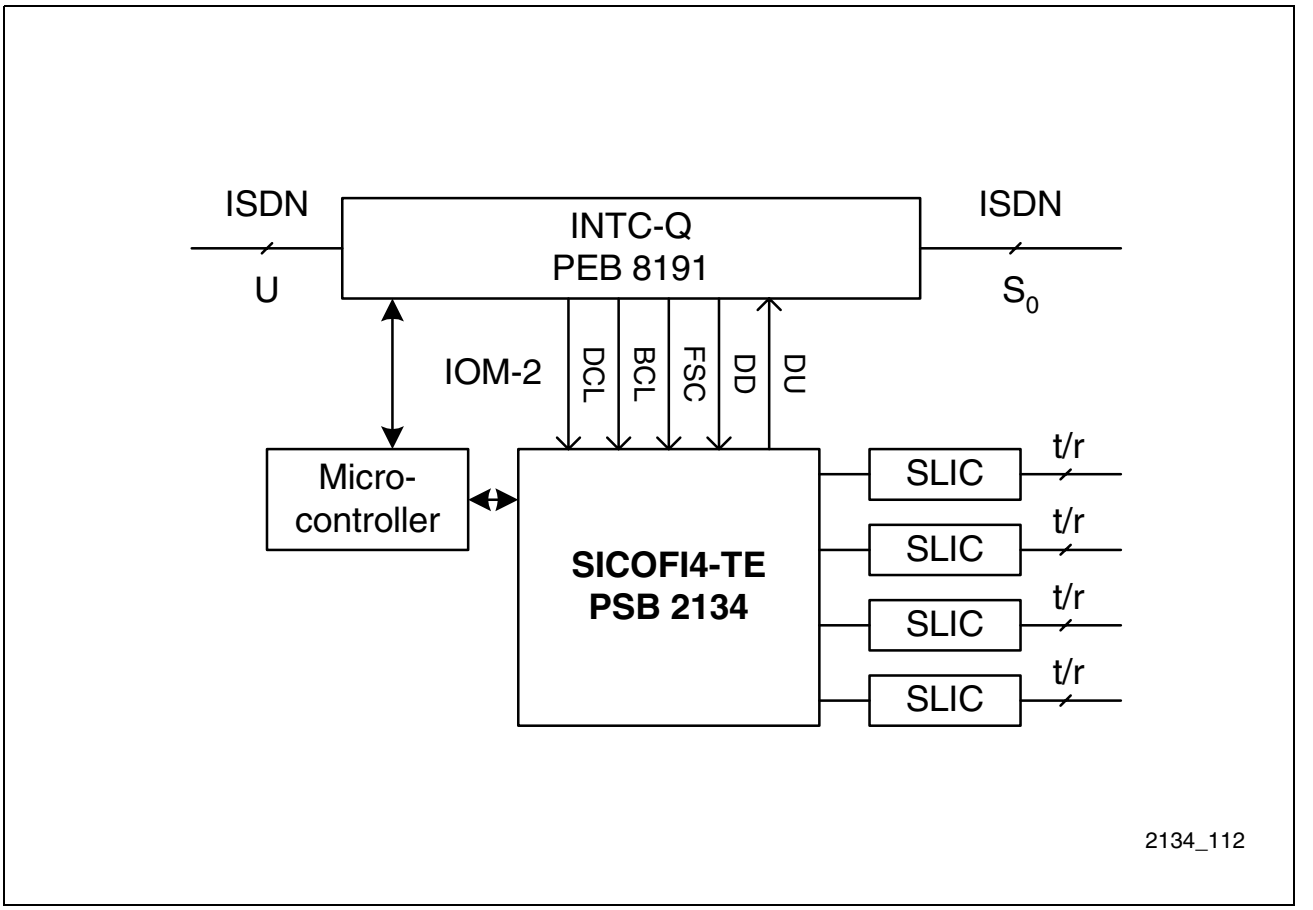


Figure 9 Intelligent Network Terminations Example

Note: The SLIC interrupt must be led directly to the controller.

5.1.4 ISDN PC Cards with POTS/Modem Functionality

ISDN PC Cards often feature analog telephone interfaces for fax, modem, or voice applications over ISDN. A User of such systems can send and receive faxes from the PC, store voice mail on the PC's hard disk, establish and route telephone calls through the PC. The SICOFI®4-TE, in combination with the IPAC (an integrated ISDN/HDLC device) and the PITA (PCI-Bridge), offers a very compact and cost-effective solution for this application.

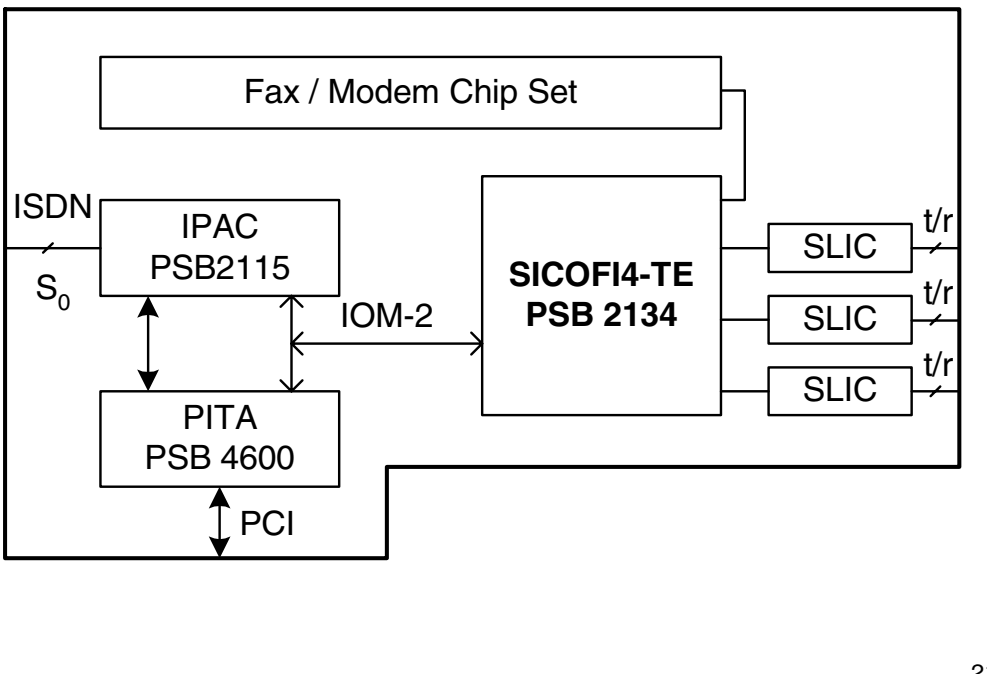


Figure 10 ISDN PC Cards with POTS/Modem Functionality Example

5.2 Support Tools

5.2.1 QSICOS Software

The programmable filters of the SICOFI®4-TE enable adaptation of the AC system behavior to the external circuit, especially to the SLIC and the given country-specific line characteristics.

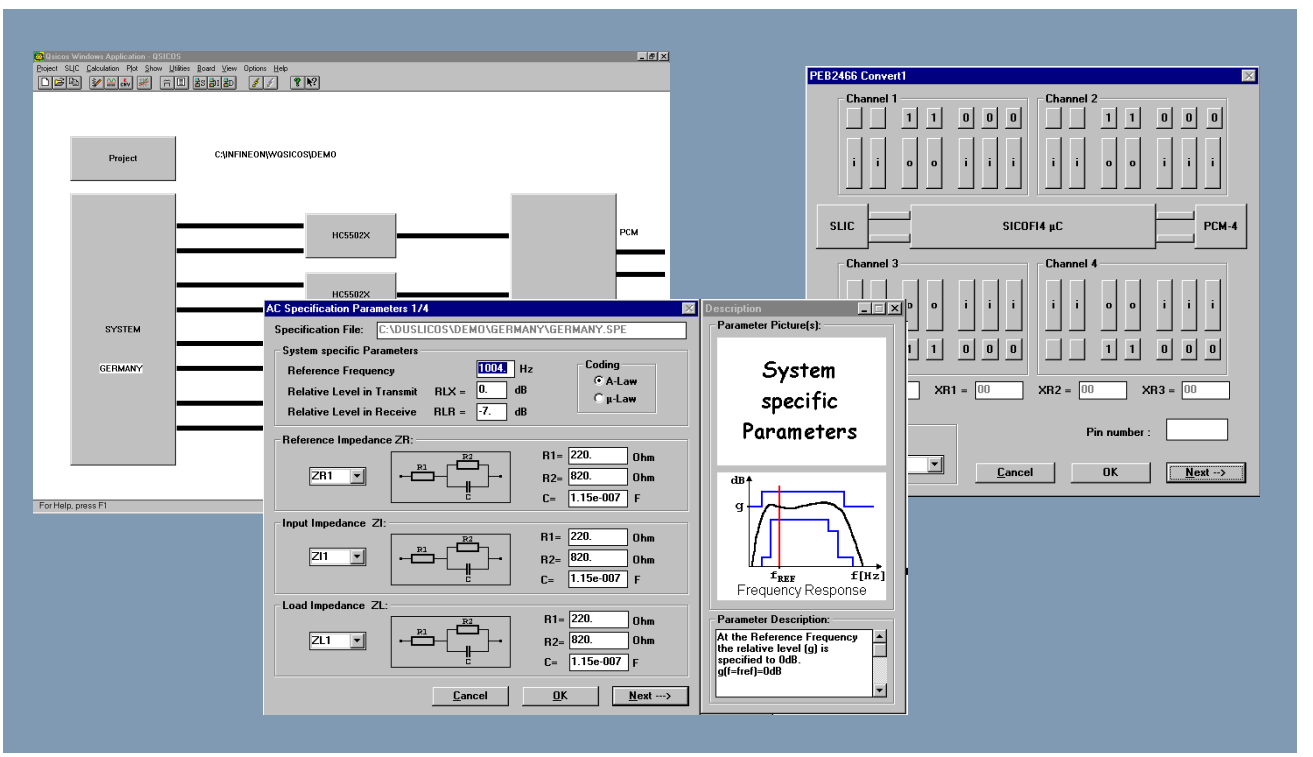


Figure 11 Dialogs of the QSICOS Coefficients Software

The Windows based **Q**uad **SI**COFI **Co**efficient **S**oftware (QSICOS) **Figure 11** allows the calculation of optimized sets of coefficients for programming the SICOFI®4-TE.

As shown in **Figure 12**, the QSICOS software needs the following input files for coefficient optimization:

1. External Circuit Description (K-Parameter Interface File):
   K-parameters are used to describe the electrical properties of the external circuit.

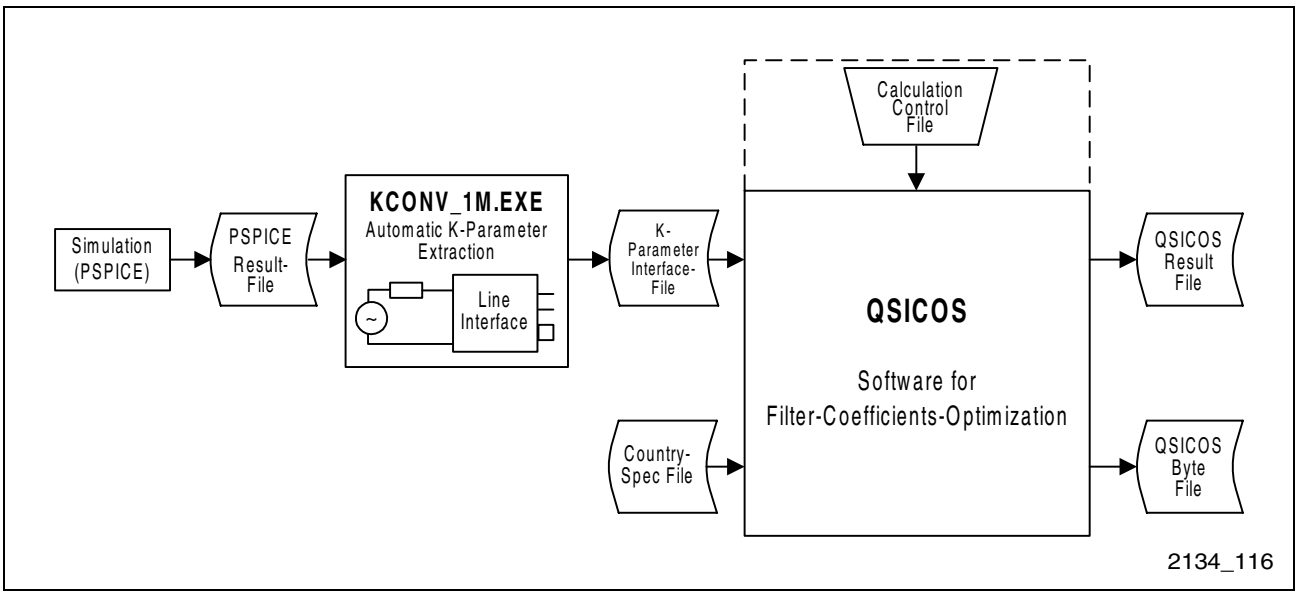


Figure 12 Input Files of QSICOS

To obtain the K-parameters, the results of a Windows based PSPICE® simulation of the external circuit are converted using the conversion program “KCONV_1M.EXE”.

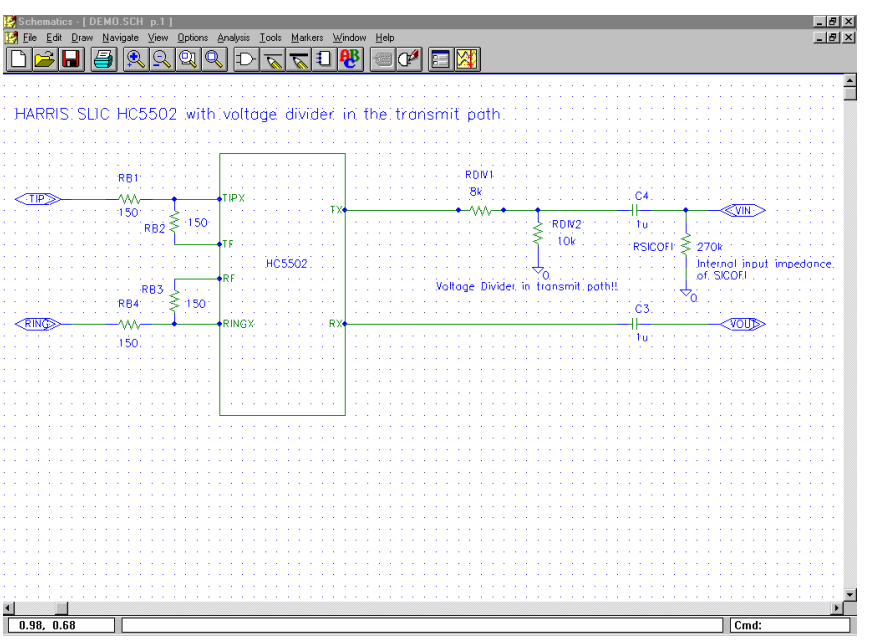


Figure 13 PSpice Schematic Editor

The conversion calculations are made in accordance with the three-port theory. Both the PSPICE Electrical Circuit Simulation Program **Figure 13** (Evaluation Version, V6.2) and the “KCONV_1M.EXE” conversion program are provided with the QSICOS Coefficient Calculation and Register Configuration Software.

2. PTT Specifications (Country-Spec File):
   The particular PTT specifications and the targeted AC behavior are described in the Country-Spec File.

The QSICOS software uses the input from the K-Parameter Interface File and the Country-Spec File to calculate filter coefficients which fulfill the PTT-defined/required AC behavior (**Figure 14**) for the whole system. A Calculation Control File provides additional input information on the optimization process.

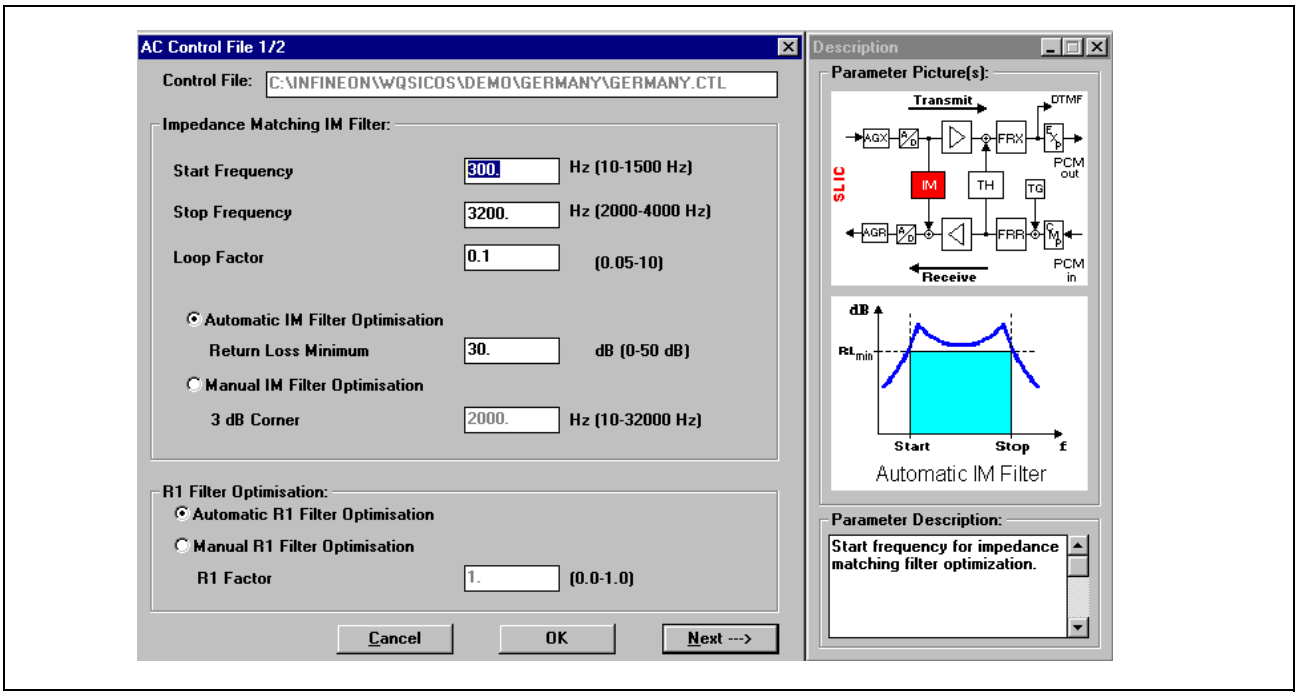


Figure 14 Parameter Settings of the Control File

QSICOS calculates coefficients for the following filters:

- Impedance Matching to adapt the system to the required line-impedance of the local loop (return loss calculation),
- Frequency Response Correction for both the receive and transmit paths,
- Level Adjustment for both the receive and transmit paths,
- Transhybrid Balancing, and
- Two programmable Tone Generators.

During the optimization process, the system behavior is calculated for the desired SLIC and the SICOFI®4-TE. Some calculated functions can be displayed graphically to enable the product designer to quickly verify the required behavior and to easily make any additional optimizations manually. The following calculations are displayed graphically:

- Return loss,
- Frequency response in the receive and transmit paths, and
- Transhybrid loss.

An important feature of the QSICOS software is the ability to verify the calculated coefficients against criteria necessary to maintain overall system stability. The QSICOS software produces both a Byte File and a Result File. The Result File contains all of the numerical simulation results data as well as the programming bytes. After the calculation process the evaluation board can be directly programmed via the QSICOS user control.

5.2.2 EASY 2466 Tool Package

The EASY 2466 Tool Package includes the Evaluation Board which allows simple programming of the SICOFI®4-TE using a personal computer (PC). Conversion utilities are also provided in the tool package which convert the Byte File from the QSICOS software into a downloadable file usable by the evaluation board. This enables the product designer to compare the actual behavior of the hardware against the calculated results from the QSICOS software.

The EASY 2466 evaluation system has connectors for a test instrument to measure the transfer characteristics (e.g., the PCM-4 Channel Measuring Set by Wandel & Goltermann). This feature provides the option of system verification and fine-tuning. When the product designer has produced a set of coefficients which fulfill all required criteria, the values stored in the Byte File can be downloaded to the target hardware via the QSICOS user control, see at **Figure 15**.

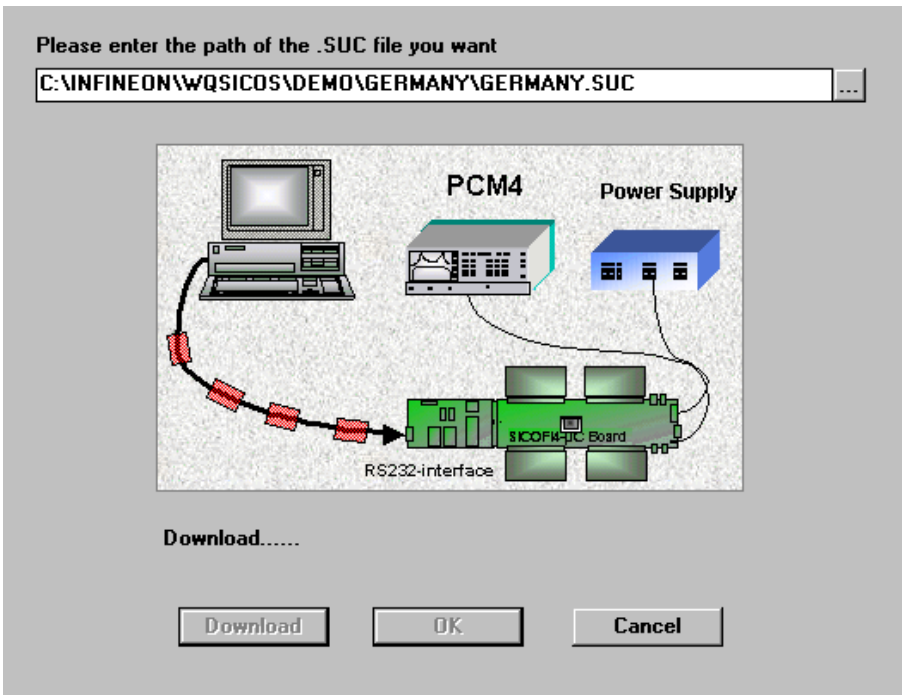


Figure 15 Dialog for Programming the Evaluation Board

6 Glossary

AC	**A**lternating **C**urrent
ADC	**A**nalog-to-**D**igital **C**onverter
CMOS	**C**omplementary **M**etal **O**xide **S**emiconductor
CRAM	**C**oefficient-**RAM**
DAC	**D**igital-to-**A**nalog **C**onverter
DC	**D**irect **C**urrent
DLC	**D**igital **L**oop **C**arrier
DSP	**D**igital **S**ignal **P**rocessor
DTMF	**D**ual **T**one **M**ulti **F**requency
FTTC	**F**iber-**T**o-**T**he-**C**urb
IOM-2	**I**SDN-**O**riented **M**odular 2nd Generation
ISDN	**I**ntegrated **S**ervices **D**igital **N**etwork
ITU	**I**nternational **T**elecommunication **U**nion
ITU-T	**I**nternational **T**elecommunication **U**nion-**T**elecommunication Standardization Sector (formerly CCITT)
NT	**N**etwork **T**ermination
PBX	**P**rivate **B**ranch E**x**change
PCM	**P**ulse **C**ode **M**odulation
POTS	**P**lain **O**ld **T**elephone **S**ystem
PSTN	**P**ublic **S**witched **T**elephone **N**etwork
PTT	**P**ost **T**elephone **T**elegraph
QSICOS	**Q**uad **SI**COFI **Co**efficient **S**oftware
RITL	**R**adio-**I**n-**T**he-**L**oop
RT	**R**emote **T**erminal
SICOFI	**Si**gnal Processor **Co**dec **Fi**lter
SLIC	**S**ubscriber **L**ine **I**nterface **C**ircuit
t/r	**t**ip/**r**ing
TA	**T**erminal **A**dapter

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Symbols

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W

Total Quality Management

Qualität hat für uns eine umfassende Bedeutung. Wir wollen allen Ihren Ansprüchen in der bestmöglichen Weise gerecht werden. Es geht uns also nicht nur um die Produktqualität – unsere Anstrengungen gelten gleichermaßen der Lieferqualität und Logistik, dem Service und Support sowie allen sonstigen Beratungs- und Betreuungsleistungen.

Dazu gehört eine bestimmte Geisteshaltung unserer Mitarbeiter. Total Quality im Denken und Handeln gegenüber Kollegen, Lieferanten und Ihnen, unserem Kunden. Unsere Leitlinie ist jede Aufgabe mit „Null Fehlern“ zu lösen – in offener Sichtweise auch über den eigenen Arbeitsplatz hinaus – und uns ständig zu verbessern.

Unternehmensweit orientieren wir uns dabei auch an „top“ (Time Optimized Processes), um Ihnen durch größere Schnelligkeit den entscheidenden Wettbewerbsvorsprung zu verschaffen.

Geben Sie uns die Chance, hohe Leistung durch umfassende Qualität zu beweisen.

Wir werden Sie überzeugen.

Quality takes on an allencompassing significance at Semiconductor Group. For us it means living up to each and every one of your demands in the best possible way. So we are not only concerned with product quality. We direct our efforts equally at quality of supply and logistics, service and support, as well as all the other ways in which we advise and attend to you.

Part of this is the very special attitude of our staff. Total Quality in thought and deed, towards co-workers, suppliers and you, our customer. Our guideline is “do everything with zero defects”, in an open manner that is demonstrated beyond your immediate workplace, and to constantly improve.

Throughout the corporation we also think in terms of Time Optimized Processes (top), greater speed on our part to give you that decisive competitive edge.

Give us the chance to prove the best of performance through the best of quality – you will be convinced.

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