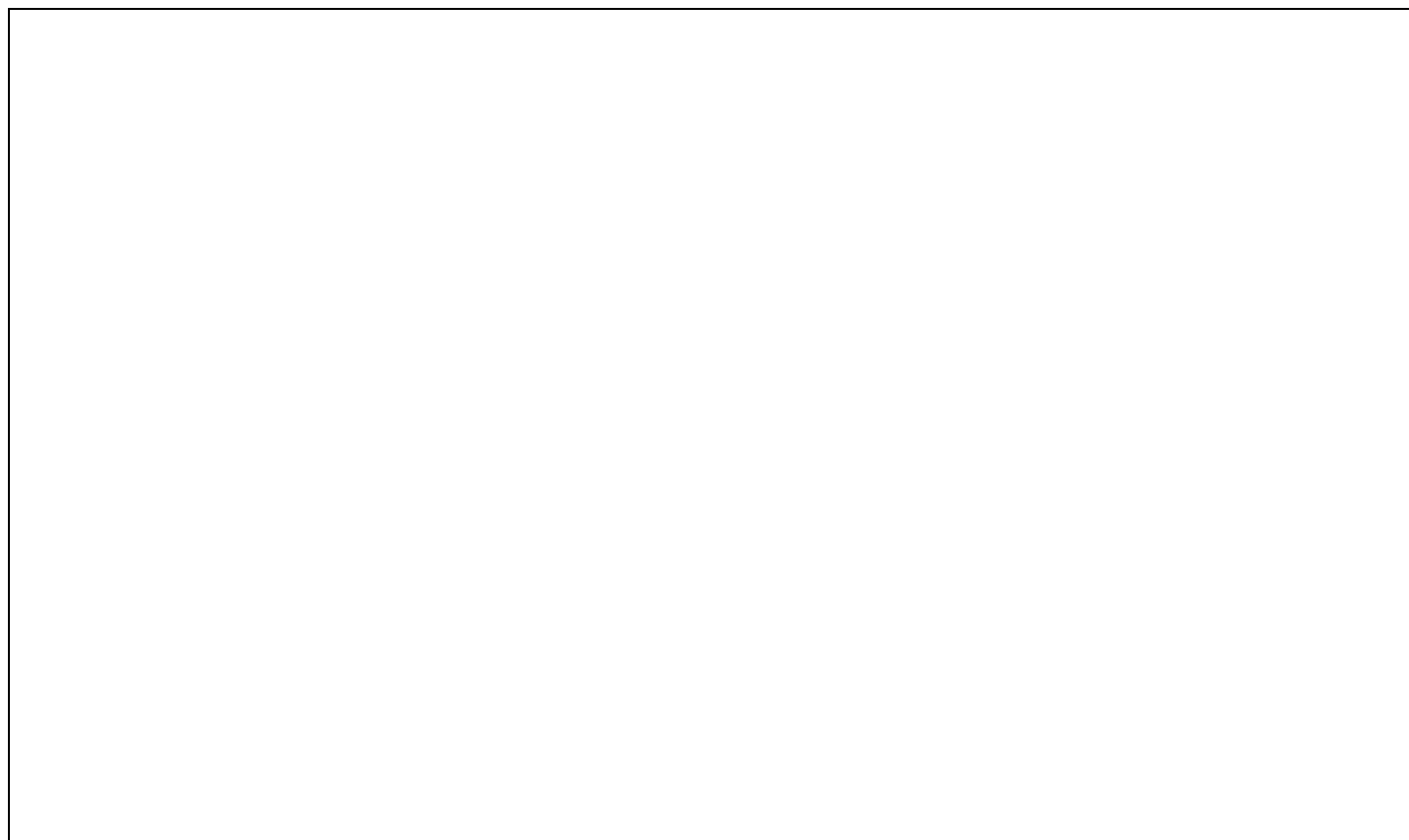




## ICs for Communications

Multipoint Switching and Conferencing Unit - Attenuation  
MUSAC-A

PEB 2445 Version 1.2

Data Sheet 02.96

| <b>PEB 2445</b>                                                           |                             |                                                                                                      |
|---------------------------------------------------------------------------|-----------------------------|------------------------------------------------------------------------------------------------------|
| <b>Revision History:</b>                                                  |                             | <b>Current Version: 02.96</b>                                                                        |
| Previous Version: Digital Switching and Conferencing IC's Data Book 01.94 |                             |                                                                                                      |
| Page<br>(in Version<br>01.94)                                             | Page<br>(in new<br>Version) | Subjects (major changes since last revision)                                                         |
| 220                                                                       | 11                          | Version 1.2                                                                                          |
| 220                                                                       | 11                          | P-DIP-40 package not further available                                                               |
| 224, 227,<br>243                                                          | 16, 19, 36                  | Motorola Mode not available                                                                          |
| 249                                                                       | 40                          | Figure (Initializing the ... 4096-kHz Device Clock) corrected                                        |
| –                                                                         | 56                          | Abs. Max. Ratings: $I_{LPD}$ definition                                                              |
|                                                                           | 59                          | $t_{WD \text{ min.}} = 20 \text{ ns}$                                                                |
|                                                                           | 59                          | $t_{S \text{ min.}} = 15 \text{ ns}$                                                                 |
|                                                                           | 60                          | $t_{SS8 \text{ min.}} = 20 \text{ ns}$ , $t_{SH4 \text{ max.}} = t_{CP4} - 10 \text{ ns} + t_{CP4H}$ |
| –                                                                         | 60                          | $t_{SPL \text{ min.}} = 100 \text{ ns}$ added                                                        |
| –                                                                         | 66                          | Appendix: Design sheets added                                                                        |

#### Edition 02.96

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## 1 Overview

### A Complete Family of Efficient Solutions

If the issue is digital switching and conferencing, the solution is flexibility, capacity, and economy.

Siemens Semiconductor offers the most economical answer to all conceivable applications in this field. Our complete family of switching network devices satisfies even the most rigorous switching demands.

### A Complete Family of Efficient Solutions

Take our **MTSC (Memory Time Switch CMOS) PEB 2045** with a switching capability of 512 incoming PCM channels to 256 outgoing PCM channels. It has the perfect size to economically build medium sized switches. The design of a non-blocking switch for 512 PCM channels is possible with a simple parallel configuration with a second MTSC.

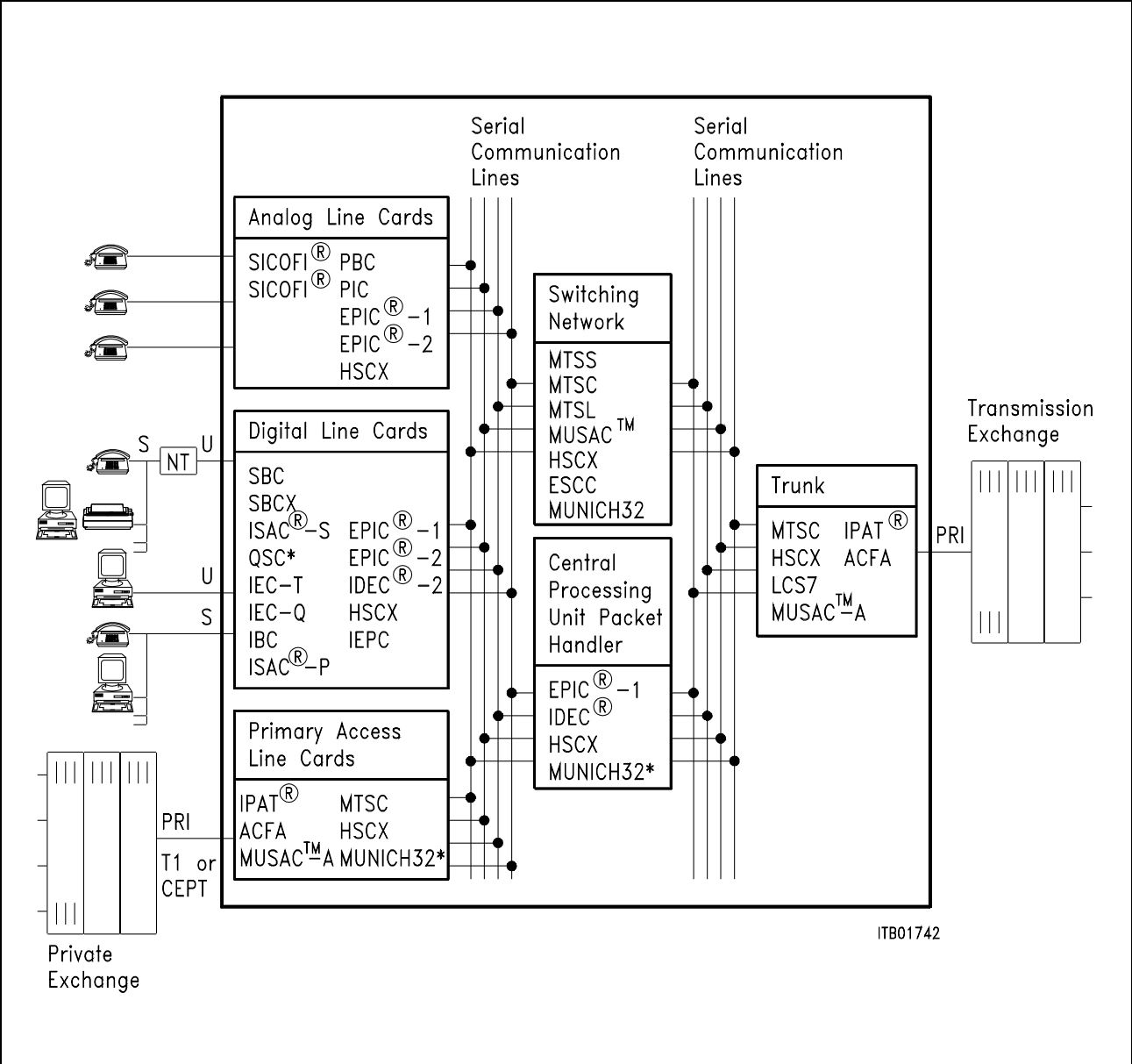
If you need a non-blocking switch for up to 256 channels, we offer a smaller version of the MTSC, the **MTSS (Memory Time Switch Small) PEB 2046**. And the **MTSL (Memory Time Switch Large) PEB 2047**, the largest in our family, is capable of switching 1024 PCM channels.

Siemens also supplies the best solution for conferencing, our **MUSAC (Multipoint Switching and Conferencing Unit) PEB 2245** performs the complete switching functions of the MTSC, and offers a signal processor for handling up to 64 conferencing channels in any combination. The input and output channels can also be attenuated individually to achieve best transmission quality.

The **MUSAC-A (Multipoint Switching and Conferencing Unit) PEB 2445** is an upward compatible device to the MTSC and MUSAC. It offers in addition the attenuation and amplification of every time slot.

Pin compatible device allow simplicity in hardware and software design. To allow for more flexibility, the PCM data rate can be 2, 4, or 8 Mbit/s – configurable also for mixed use.

The figure below shows the general architecture of a digital exchange.



**Figure 1**  
**General Exchange Architecture**

**System Background**

Digital exchanges put calls through by newly arranging the speech signals coded with 8-bit words (PCM time-slots). The code words are transmitted serially on PCM lines. The sampling frequency of 8 kHz produces PCM frames with a duration of 125  $\mu$ s. The transmission rate on the line determines how many code words (speech channels) can be accommodated within a sampling period. With a data rate of 2048 kbit/s for example, there are 32 time-slots of 8 bits each. 4 lines with a data rate of 8192 kbit/s have a transmission capacity of 512 channels.

Overview

An overview on the complete switching and conferencing IC-family is shown in the following table:

Table 1  
Complete Switching and Conferencing IC Family

|                                 | MTSC<br>PEB 2045      | MTSS<br>PEB 2046     | MTSL<br>PEB 2047      | MTSL 16<br>PEB 2047-16   | MUSAC<br>PEB 2245       | MUSAC-A<br>PEB 2445          | EPIC-1<br>PEB 2055     | EPIC-S<br>PEB 2054    |
|---------------------------------|-----------------------|----------------------|-----------------------|--------------------------|-------------------------|------------------------------|------------------------|-----------------------|
| Switching capacity (time-slots) | 512 × 256             | 256 × 256            | 1024 × 512            | 1024 × 1024              | 512 × 256               | 512 × 256                    | 256 × 256              | 256 × 256             |
| Input/output lines              | 16/8                  | 8/8                  | 16/8                  | 16/8                     | 16/8                    | 16/8                         | 8/8<br>SLD/IOM/<br>PCM | 6/6<br>IOM/PCM        |
| PCM-data rate (Mbit/s)          | 2/4/8 +<br>mixed mode | 2                    | 2/4/8 +<br>mixed mode | 2/4/8/16 +<br>mixed mode | 2/4/8 +<br>mixed mode   | 2/4/8 +<br>mixed mode        | up to 8                | up to 8               |
| Clock rate (MHz)                | 4.096<br>8.192        | 4.096<br>8.192       | 4.096<br>8.192        | 4.096/8.192<br>16.384    | 4.096<br>8.192          | 4.096<br>8.192               | up to 8.192            | up to 8.192           |
| Conferencing                    |                       |                      |                       |                          | 64 channels             | 64 channels                  |                        |                       |
| Attenuation                     |                       |                      |                       |                          | 64 channels<br>3/6/9 dB | all channels<br>– 4 to 12 dB |                        |                       |
| PRI/T1 mode                     | yes                   |                      |                       |                          | yes                     | yes                          |                        |                       |
| Fractional T1 data bundling     |                       |                      | yes                   | yes                      |                         |                              | 128-Kbit/s<br>channel  | 128-Kbit/s<br>channel |
| µC access                       |                       |                      | read                  | read                     |                         |                              | yes                    | yes                   |
| Multipoint switching            |                       |                      |                       |                          | yes                     | yes                          |                        |                       |
| Power (mW) max. consumption typ | 50                    | 50                   | 100                   | 170                      | 100                     | 100                          | 50                     | 50                    |
| Package                         | P-DIP-40<br>P-LCC-44  | P-DIP-40<br>P-LCC-44 | P-LCC-44              | P-LCC-44                 | P-LCC-44                | P-LCC-44                     | P-LCC-44               | P-LCC-44              |

1) in definition

## Conferencing

An important task in PCM voice handling is conferencing. I.e. several subscribers of a digital PBX system would like to arrange a conference call. This task will be done in the central switching network. Modern switching IC like the MUSAC-A fulfill this important task in a cost effective way in the central switching unit. A powerful on chip Digital Signaling Processor handles this requirement.

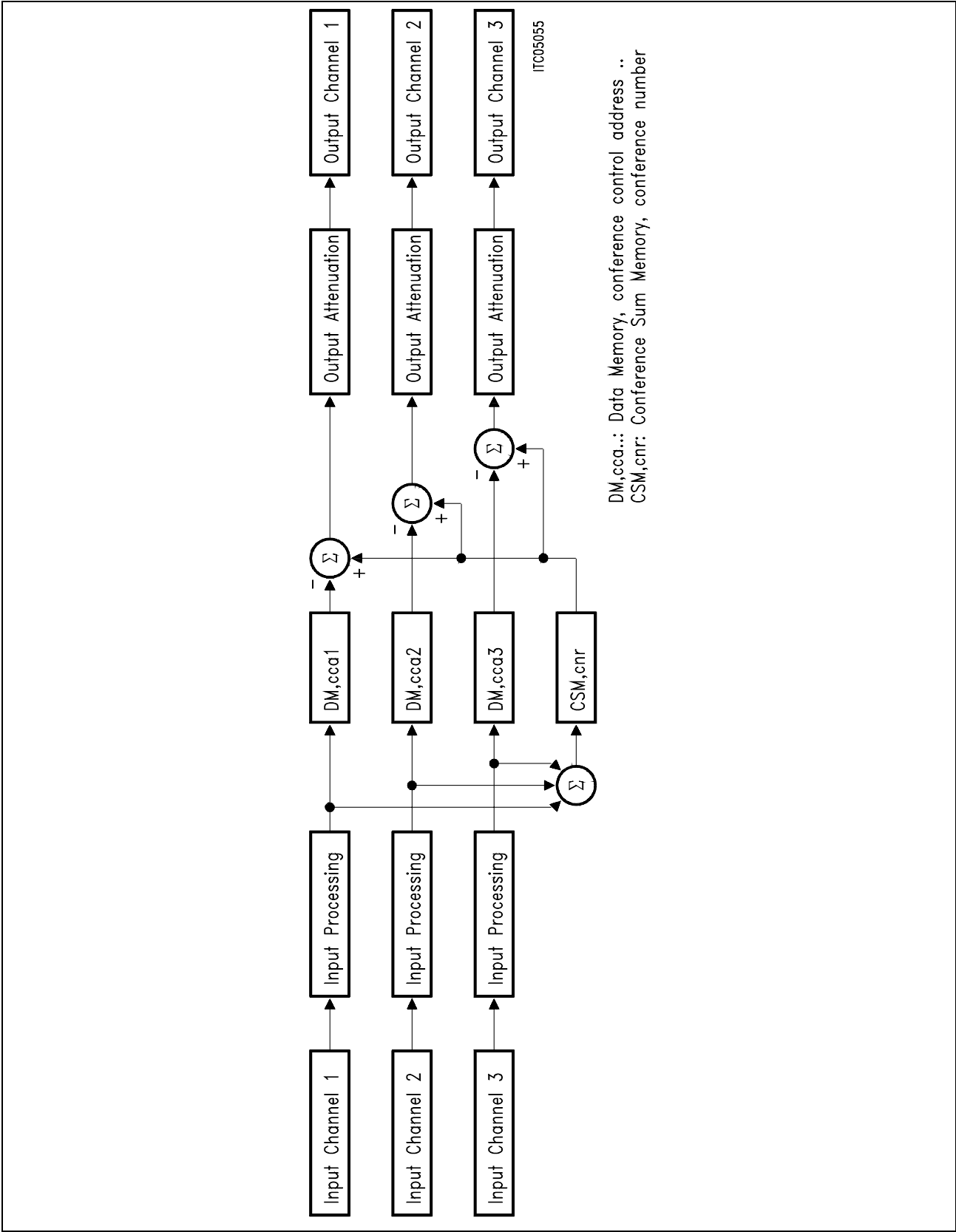
Definite time-slots will be added together to one subscriber signal. In order to ensure an acceptable speech quality and reduce of echo and 'singing' problems, the input and output channels have to be attenuated individually. Additionally, input signals below a threshold programmable to different levels are disregarded. Another trick to lessen the risk of instability in multiparty conferences is to invert every second voice channel. Odd and even channels are subtracted from one other.

## Conferencing with the MUSAC™-A

Conferencing means that PCM data of several subscribers are processed such that each subscriber receives the contribution of the PCM data transmitted by all participants of the conference. Except the data transmitted by himself.

Each subscriber is qualified by an input channel which corresponds to a certain input line and time-slot of the MUSAC-A, and an output channel which corresponds to a certain output line and time-slot of the MUSAC-A.

The data flow through the MUSAC-A in case of conferencing is illustrated in **figure 2**.



**Figure 2**  
**Data Flow through the MUSAC-A in Case of Conferencing**

## Overview

The PCM samples of each input channel first pass through an input processing stage. In this stage, an input attenuation level (0, 3, 6 or 9 dB) and a noise suppression threshold can be programmed individually for each channel. Following the input processing the PCM data is expanded according to the A- or  $\mu$ -law encoding rules and written to the Data Memory (DM). Additionally the PCM data of each input channel is added to the Conference Sum Memory (CSM). The DM location (1 out of 64) is specified by the Conference Control Address (CCA) and the CSM location (1 out of 21) is specified by the conference number when writing to the Conference Control Memory (CCM).

The PCM data then passes through a subtractor stage such that the resulting output channel for a given subscriber contains the contribution of all the other channels in the conference except its own. Finally the PCM data is forwarded to the output channel after PCM compression and an optional output attenuation of 3 dB.

## Attenuation

Attenuation is a new requirement for PBX switching systems. The purpose is to avoid echo and noise problems on a PBX network for voice connections with access to the public network. Further a certain loudness rating on a definite point for different terminals and phones could be fixed (see **figure 3**).

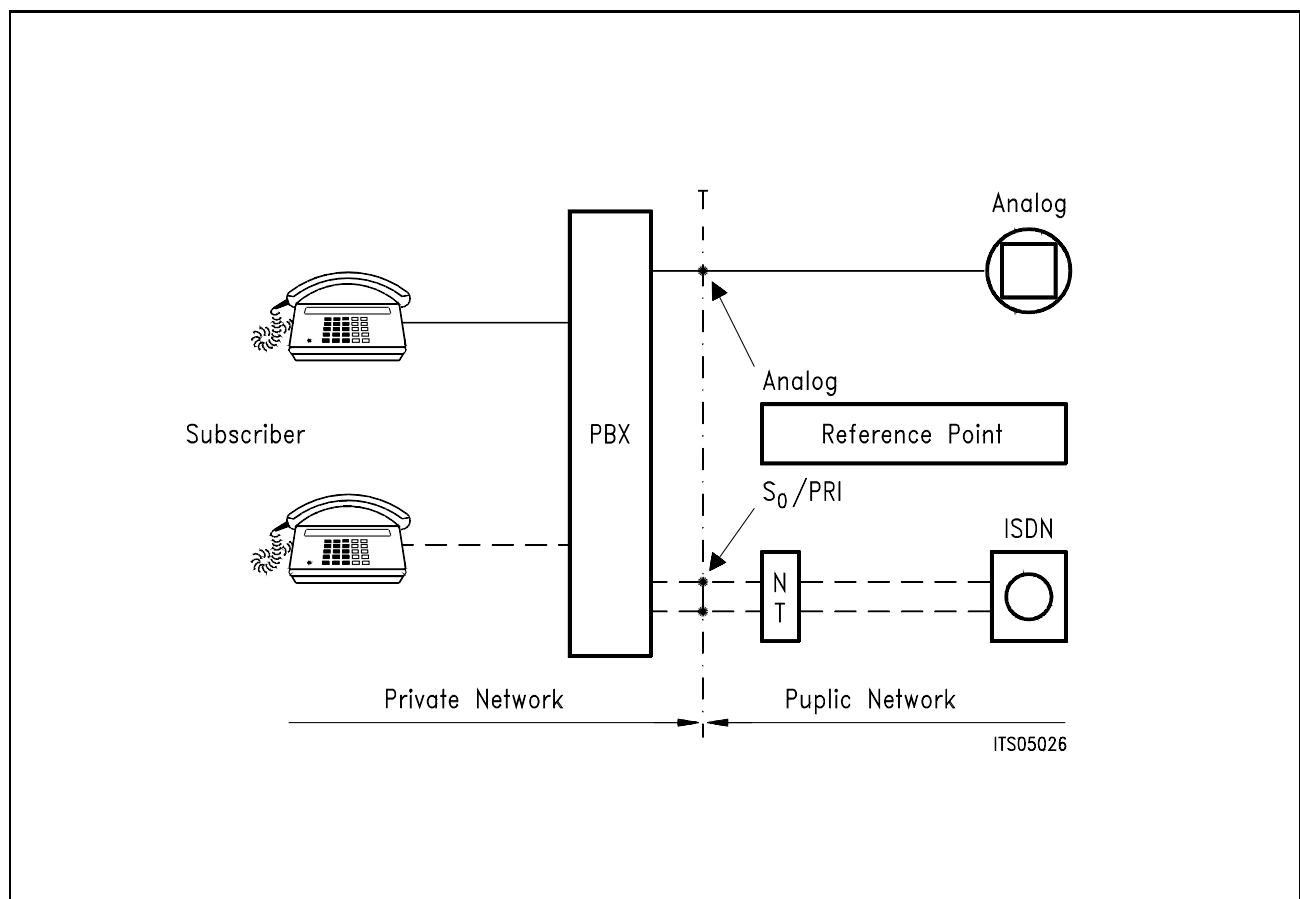


Figure 3

**Multipoint Switching and Conferencing  
Unit - Attenuation  
MUSAC™-A**

**PEB 2445**

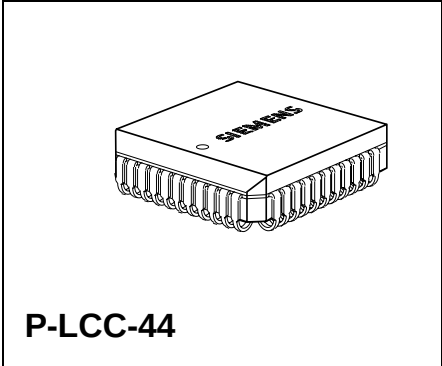
**Version 1.2**

**CMOS IC**

**1.1 Features**

**Switching**

- Time/space switch for 2048-, 4096- or 8192-kbit/s PCM systems
- Switching of up to 512 incoming PCM channels to up to 256 outgoing PCM channels
- 16 input and 8 output PCM lines
- Different kinds of modes (2048, 4096, 8192 kbit/s or mixed mode)
- Configurable for a 4096- and 8192-kHz device clock
- Tristate function for further expansion and tandem operation



**Attenuation and Amplification**

- Attenuation and amplification of every time-slot
- Attenuation range from 0 to 12 dB
- Amplification range from 0 to 4 dB

| Type       | Version | Ordering Code | Package        |
|------------|---------|---------------|----------------|
| PEB 2445-N | V1.2    | Q67100-H6298  | P-LCC-44 (SMD) |

## Conference Mode

- Up to 64 conference channels in any combination
- Up to 21 independent conferences simultaneously (3 subscribers)
- Programmable attenuation (0/3/6/9 dB) on each input channel
- Programmable attenuation (0/3 dB) on each output channel
- Programmable PCM-level adaption (attenuation or amplification) of up to 64 channels
- Programmable noise suppression (four thresholds)
- Conference overflow handling
- Tone insertion capability
- A-law /  $\mu$ -law compatible
- Compatible with all kinds of PCM-byte formats

## Multipoint Switching

- Multiple independent LAN's within one PBX
- Multiplexing of up to 64 channels
- 64-kbit/s channels

## General

- 8-bit  $\mu$ P interface
- Single + 5 V power supply
- Advanced low power CMOS technology
- TTL-compatible inputs/outputs
- Upward compatible to MTSC and MUSAC

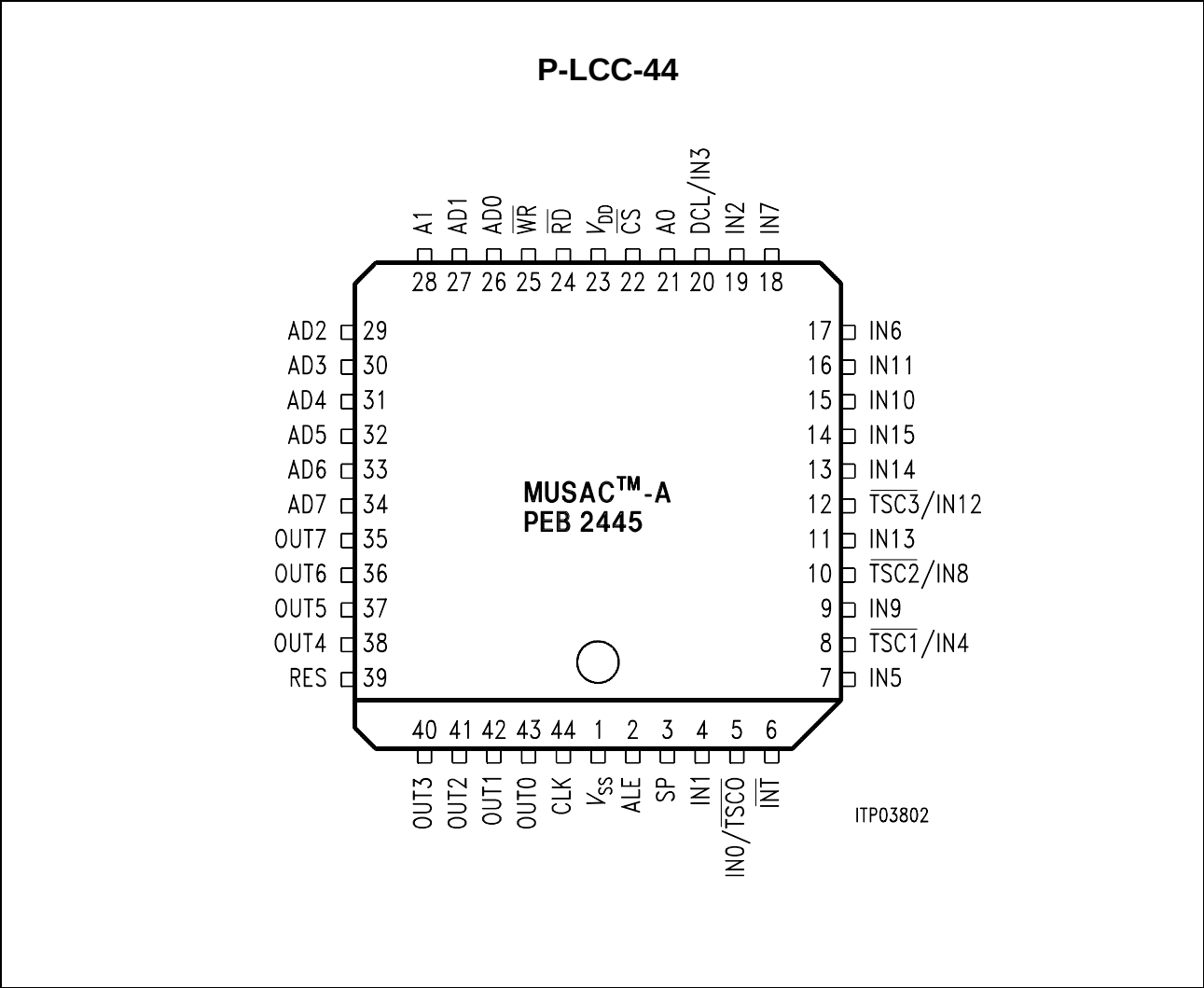
## General Description

The MUSAC-A is an upward compatible device to the reliable components MTSC and MUSAC. Additionally to the standard MUSAC features switching and conferencing, the MUSAC-A supports enlarged attenuation functions.

Every time-slot is freely programmable in 1-dB step resolutions to an attenuation range from 0 to 12 dB and amplified from 0 to 4 dB.

With enlarged attenuation functions to every time-slot the MUSAC-A fulfills the ability for new requirements. I.e. different PBX terminals could be adapted to a certain reference point from the private network to the public network.

1.2 Pin Configuration  
(top view)



1.3 Pin Definitions and Functions

| Pin No.<br>P-LCC | Symbol                         | Input (I)<br>Output (O) | Function                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------|--------------------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                | V <sub>SS</sub>                | I                       | Ground (0 V)                                                                                                                                                                                                                                                                                                                                                                                                              |
| 6                | $\overline{\text{INT}}$        | OD<br>open drain        | <b>Interrupt Request:</b> The signal is activated when a conference overflow is detected. The microprocessor may determine the specific conference in overflow by reading the conference status register (CST). The interrupt is maskable. $\overline{\text{INT}}$ is an open drain output, thus a 'wired-or' combination of interrupt request outputs of several MUSAC-As is possible (a pull up resistor is necessary). |
| 3                | SP                             | I                       | <b>Synchronization Pulse:</b> The MUSAC-A is synchronized relative to the PCM system via this line.                                                                                                                                                                                                                                                                                                                       |
| 4                | IN1                            | I                       | <b>PCM-Input Ports:</b> Serial data is received at these lines at standard TTL levels.                                                                                                                                                                                                                                                                                                                                    |
| 7                | IN5                            | I                       |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 9                | IN9                            | I                       |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 11               | IN13                           | I                       |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 13               | IN14                           | I                       |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 14               | IN15                           | I                       |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 15               | IN10                           | I                       |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 16               | IN11                           | I                       |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 17               | IN6                            | I                       |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 18               | IN7                            | I                       |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 19               | IN2                            | I                       |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 5                | IN0/ $\overline{\text{TSC0}}$  | I/O                     | <b>PCM-Input Port / Tristate Control:</b> In standard configuration these pins are used as input lines, in primary access configuration they supply control signals for external devices.                                                                                                                                                                                                                                 |
| 8                | IN4/ $\overline{\text{TSC1}}$  | I/O                     |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 10               | IN8/ $\overline{\text{TSC2}}$  | I/O                     |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 12               | IN12/ $\overline{\text{TSC3}}$ | I/O                     |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 20               | IN3/DCL                        | I/O                     | <b>PCM-Input Port / Data Clock:</b> In standard configuration IN3 is the PCM-input line 3, in primary access configuration it provides a 2048-kHz data clock for the synchronous interface.                                                                                                                                                                                                                               |
| 21               | A0                             | I                       | <b>Address for Direct Register Access:</b><br>These pins are only active if a demultiplexed $\mu\text{P}$ -interface mode is selected.<br>If A1 is not connected it will be set to ground internally.                                                                                                                                                                                                                     |
| 28               | A1                             | I                       |                                                                                                                                                                                                                                                                                                                                                                                                                           |

## 1.3 Pin Definitions and Functions (cont'd)

| Pin No.<br>P-LCC | Symbol          | Input (I)<br>Output (O) | Function                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------|-----------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 22               | $\overline{CS}$ | I                       | <b>Chip Select:</b> A low level selects the MUSAC-A for a register access operation.                                                                                                                                                                                                                                                                                                                                                                        |
| 23               | $V_{DD}$        | I                       | <b>Supply Voltage:</b> 5 V $\pm$ 5 %                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 24               | $\overline{RD}$ | I                       | <b>Read:</b> This signal indicates a read operation and is internally sampled only if $\overline{CS}$ is active. The MUSAC-A puts data from the selected internal register on the data bus with the falling edge of $\overline{RD}$ . $\overline{RD}$ is active low (Siemens/Intel bus mode).                                                                                                                                                               |
| 25               | $\overline{WR}$ | I                       | <b>Write:</b> This signal initiates a write operation. The $\overline{WR}$ input is internally sampled only if $\overline{CS}$ is active. In this case the MUSAC-A loads an internal register with data from the data bus at the rising edge of $\overline{WR}$ . $\overline{WR}$ is active low (Siemens/Intel bus mode).                                                                                                                                   |
| 2                | ALE             | I                       | <b>Address Latch Enable:</b> In the Intel type multiplexed $\mu$ P-interface mode a logical high on this line indicates an address of a MUSAC-A internal register on the external address/data bus. In the Intel type demultiplexed $\mu$ P-interface mode this line is hardwired to $V_{SS}$ , in the demultiplexed Motorola type $\mu$ P-interface mode it should be connected to $V_{DD}$ . If ALE is not connected it will be set to ground internally. |
| 26               | AD0             | I/O                     | <b>Address Data Bus:</b> If the multiplexed address/data $\mu$ P-interface bus mode is selected these pins transfer data and addresses between the $\mu$ P and the MUSAC-A.<br><br>If a demultiplexed mode is used, these bits interface with the system data bus.                                                                                                                                                                                          |
| 27               | AD1             | I/O                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 29               | AD2             | I/O                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 30               | AD3             | I/O                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 31               | AD4             | I/O                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 32               | AD5             | I/O                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 33               | AD6             | I/O                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 34               | AD7             | I/O                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

1.3 Pin Definitions and Functions (cont'd)

| Pin No.<br>P-LCC | Symbol | Input (I)<br>Output (O) | Function                                                                                                                                                                                         |
|------------------|--------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 35               | OUT7   | O                       | <b>PCM-Output Port:</b> Serial data is sent by these lines at standard CMOS- or TTL levels. These pins can be tristated.                                                                         |
| 36               | OUT6   | O                       |                                                                                                                                                                                                  |
| 37               | OUT5   | O                       |                                                                                                                                                                                                  |
| 38               | OUT4   | O                       |                                                                                                                                                                                                  |
| 40               | OUT3   | O                       |                                                                                                                                                                                                  |
| 41               | OUT2   | O                       |                                                                                                                                                                                                  |
| 42               | OUT1   | O                       |                                                                                                                                                                                                  |
| 43               | OUT0   | O                       |                                                                                                                                                                                                  |
| 39               | RES    | I                       | <b>Reset:</b> A high signal on this input forces the MUSAC-A into reset state. The minimum pulse length is four clock periods. If this pin is not connected it will be set to ground internally. |
| 44               | CLK    | I                       | <b>Clock:</b> 4096- or 8192-kHz device clock                                                                                                                                                     |

1.4 Functional Symbols

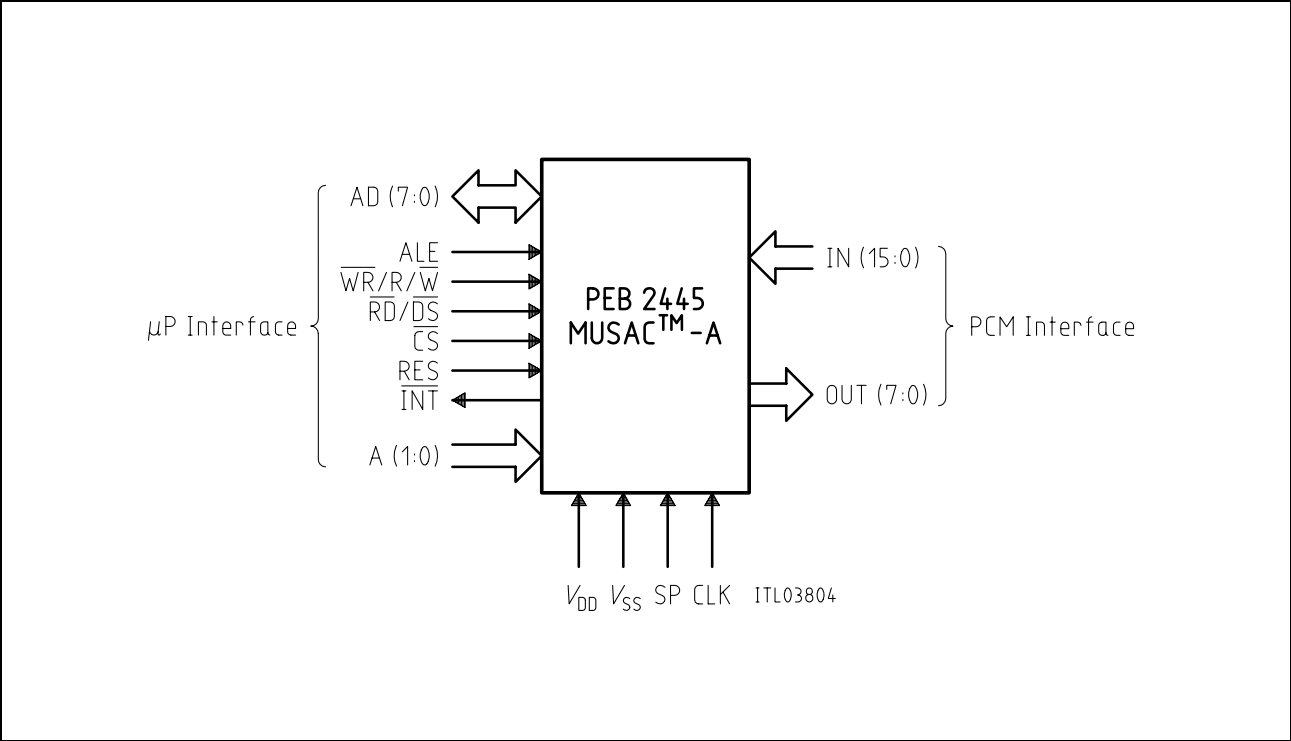


Figure 4  
Functional Symbol for the Standard Configuration

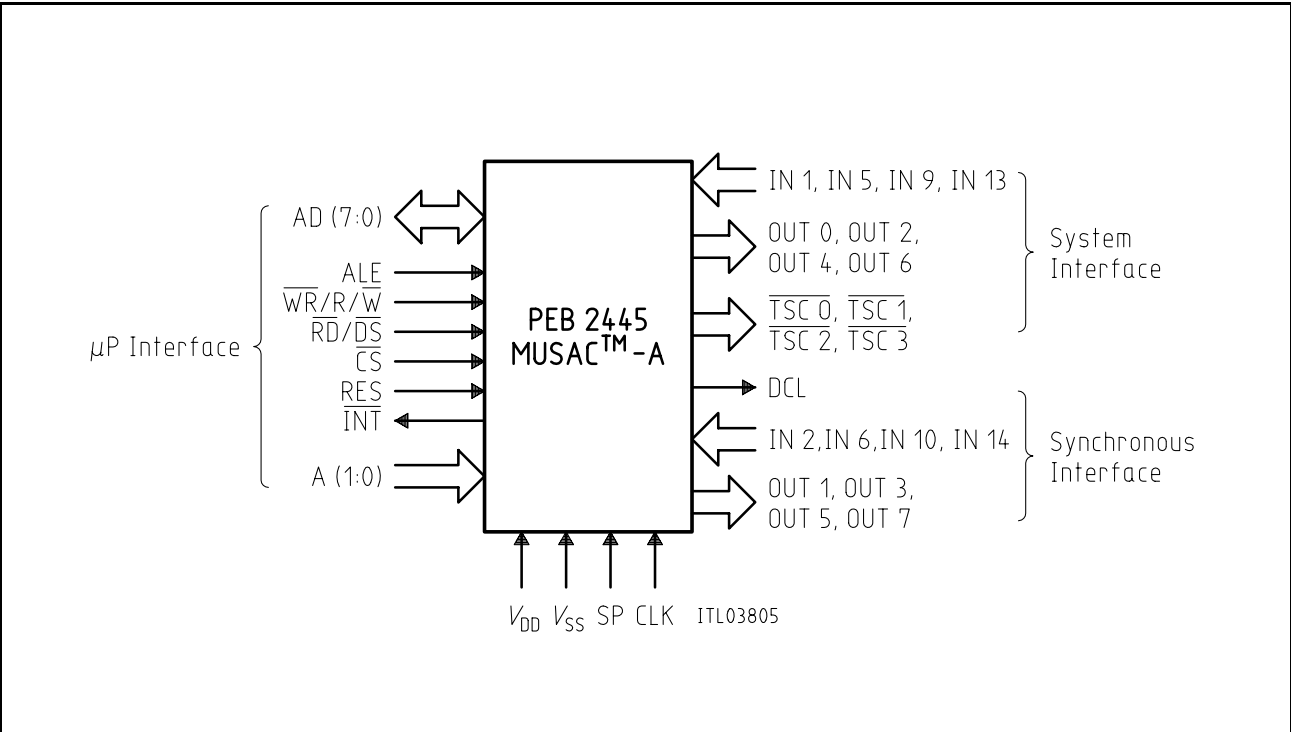


Figure 5  
Functional Symbol for the Primary Access Configuration

### 1.5 Device Overview

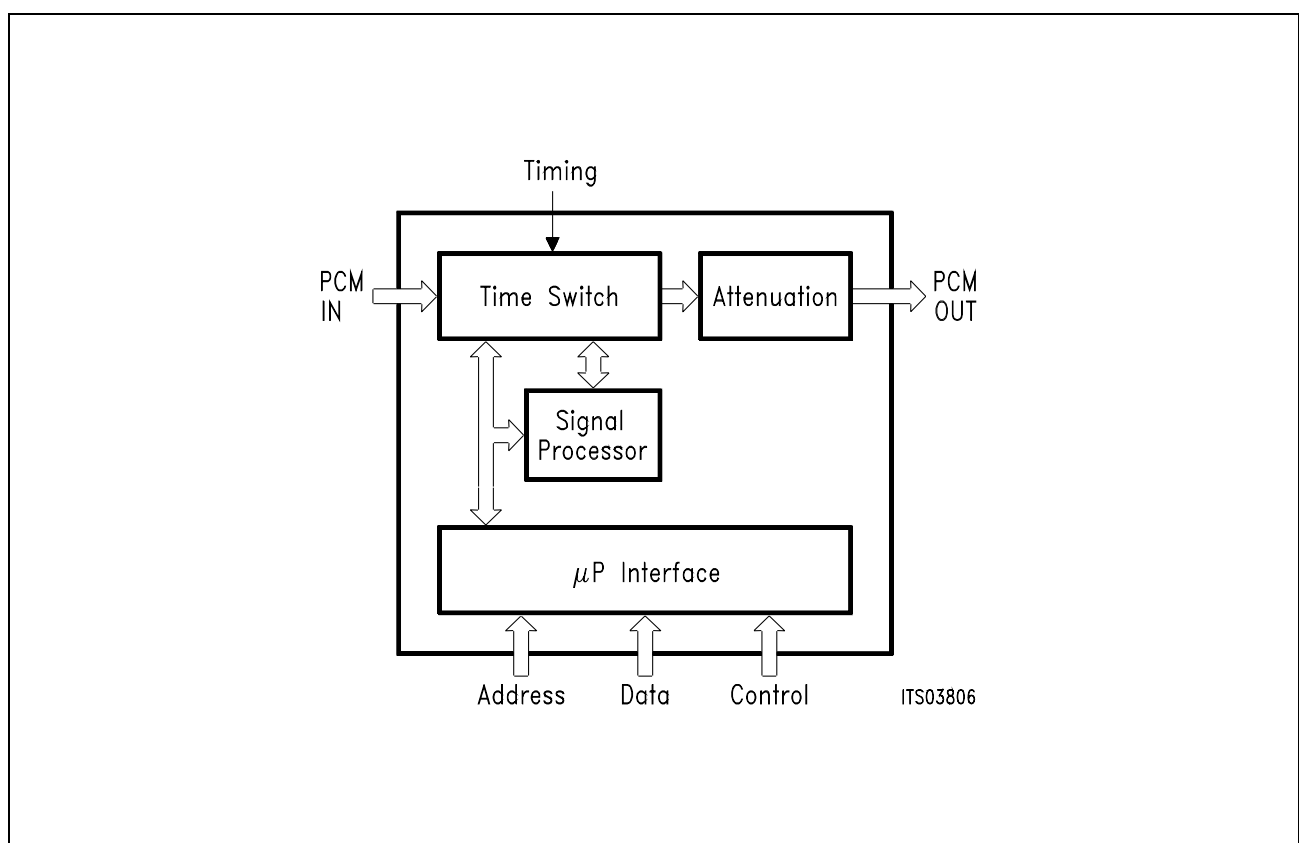
The Multipoint Switching and Conferencing Unit (MUSAC-A) combines a time switch unit (MTSC) and a powerful signal processor on one chip. The MUSAC-A enhances the capabilities of a PBX by supporting teleconferencing and multipoint data communication over voiceband channels. Digital signal processing techniques are used to implement the conferencing algorithms. Up to 64 channels of the 512 incoming PCM channels may be manipulated by the signal processor and output to any of 256 outgoing PCM channels. All functions are programmed and controlled via an 8-bit standard  $\mu$ P interface (Intel type).

The MUSAC-A is fabricated using the advanced CMOS technology from SIEMENS and is mounted in a P-LCC-44 package. Inputs and outputs are TTL-compatible.

The PEB 2445 is pin and register compatible to the PEB 2045.

In addition, it includes the following features:

- Conference Unit
- Programmable attenuation for each output channel in the range of – 4 dB up to 12 dB.
- The attenuations of the outputs and the attenuations in the conference unit can be selected independent of one another.



**Figure 6**  
**Block Diagram of the PEB 2445**

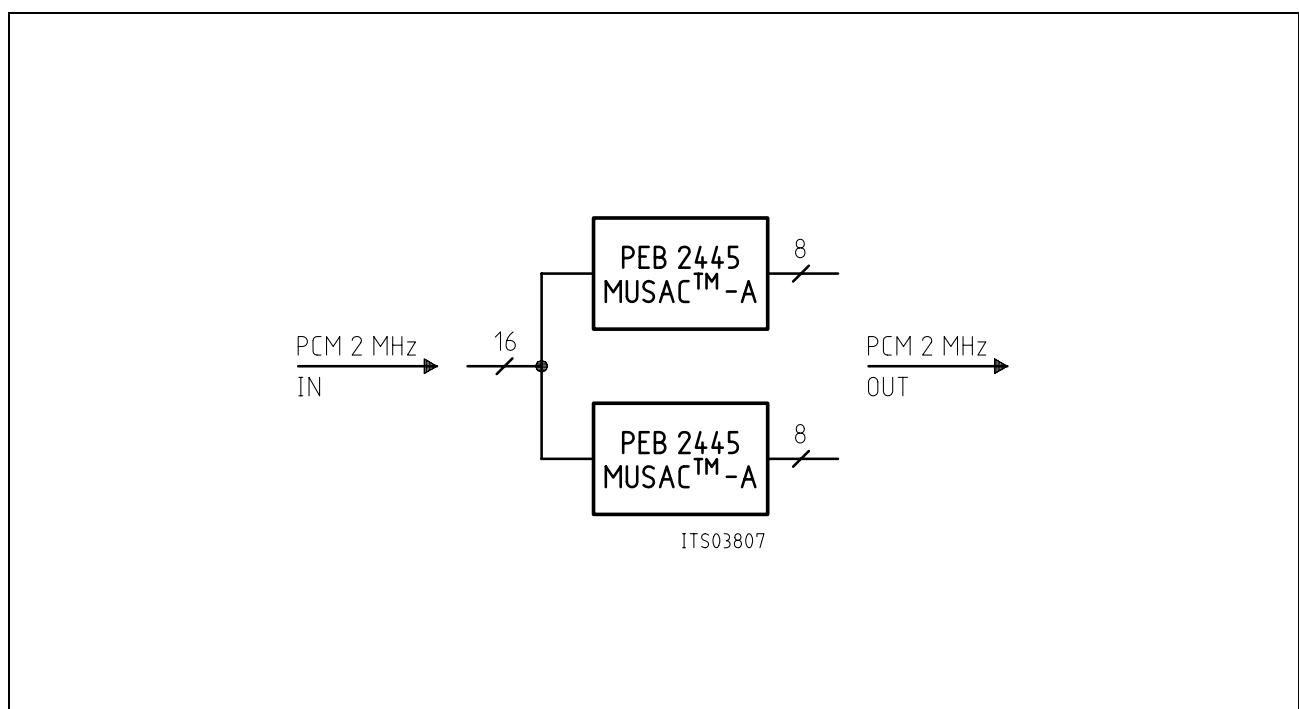
## 1.6 System Integration

### Conferencing

The MUSAC-A is designed to connect any of the 512 PCM-input channels to any of 256 output channels. Any input channel up to a total number of 64 can be handled in 21 independent conferences simultaneously. Any conference combination from 3 subscribers in 21 conferences up to 64 subscribers in only one conference is possible. In order to ensure an acceptable speech quality and to reduce echo and 'singing' problems, the input channels can be attenuated individually by 0, 3 dB, 6 dB or 9 dB and the output channels by 0 or 3 dB; additionally, input signals below a threshold programmable to four different levels are disregarded (see **chapter 4.5**).

To lessen the risk of instability in multiparty conferences the voice signal from every second channel can be inverted so that disturbance signals in odd and even channels are subtracted from one another.

If more capacity is needed, several devices can be connected. By connecting the 16 PCM-input lines in parallel to two MUSAC-As, a non-blocking switching matrix for 512 subscribers can be implemented: 128 input channels can be selected for up to 42 independent, simultaneous conferences. **Figure 7** shows such an arrangement. Due to the tristate capability of the MUSAC-A larger switches with conferencing capability can be easily formed.



**Figure 7**  
**Memory Time Switch 16/16 for a Non-Blocking 512 Channel Switch**  
**with Conferencing Capability**

Overview

Figure 8 shows the architecture of a primary access board with common channel signaling using four CMOS devices.

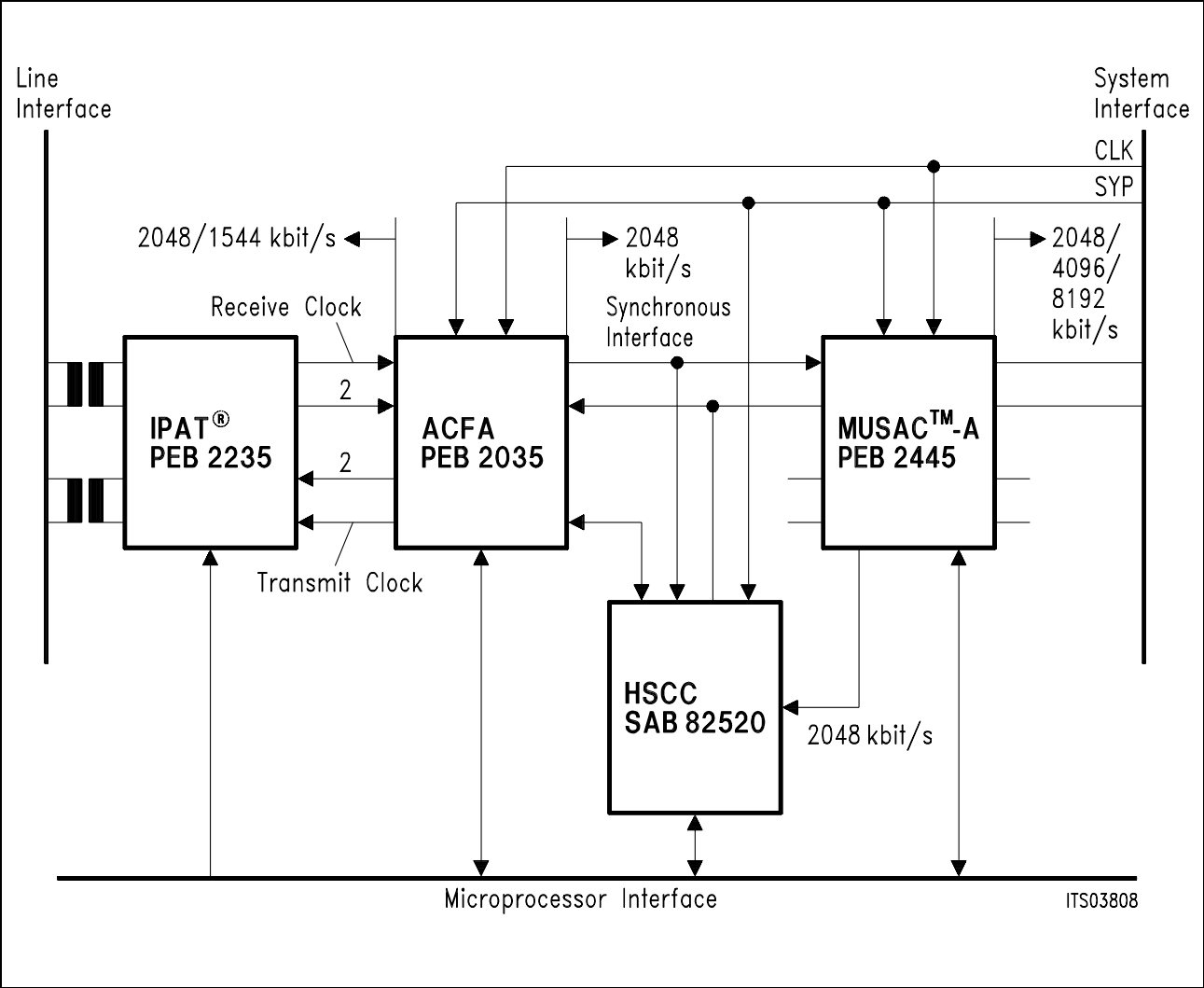
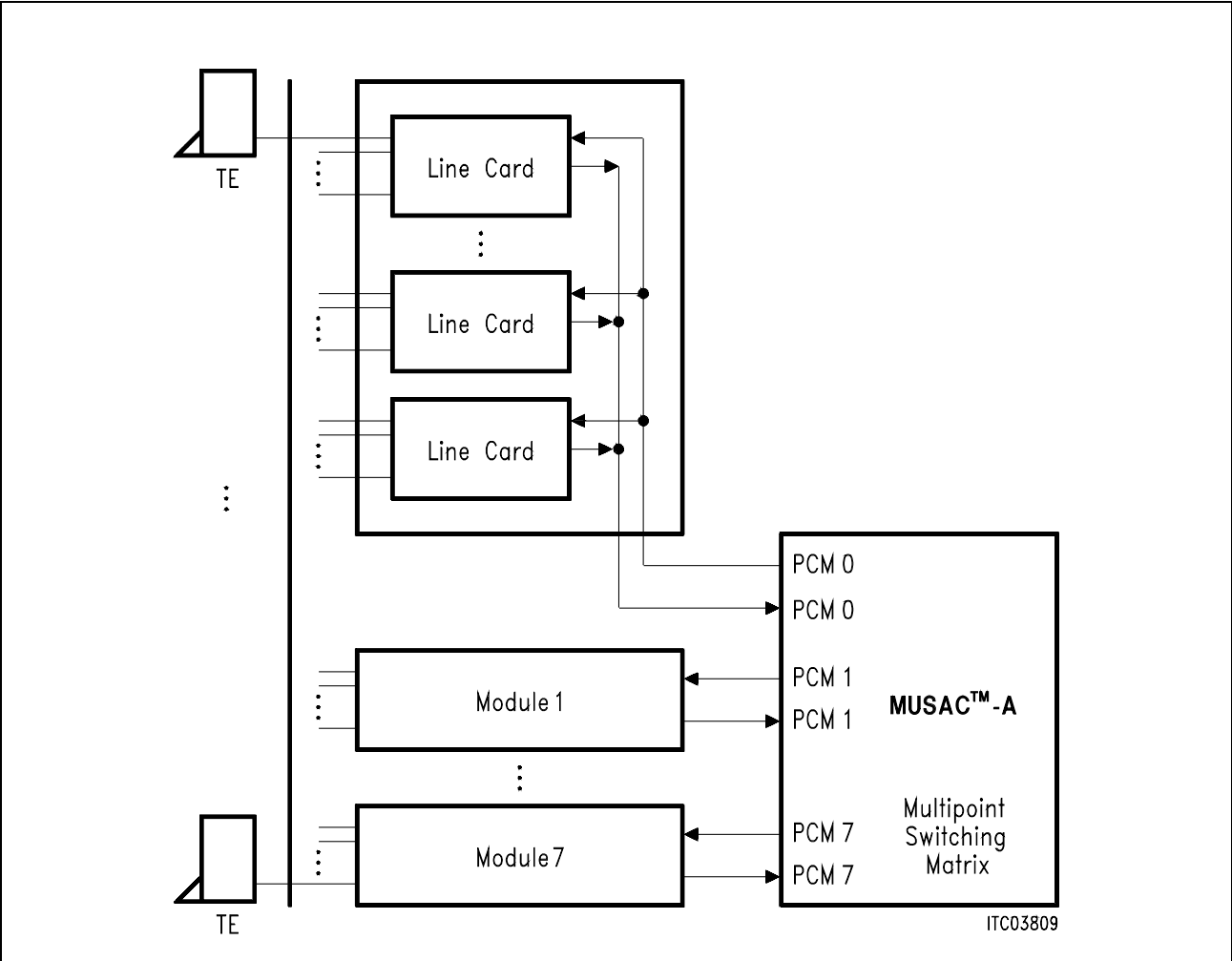


Figure 8  
Architecture of a Primary Access Board

Multipoint Switching

In a multipoint configuration the communication between different stations is done by using a common media. In a PBX system this can be achieved by connecting all stations to one (or more) time-slots and transmitting the information back. Multipoint-switching is a special form of conferencing for data communication. In contrast to audio conferences terminals broadcast data to the MUSAC-A which are only 'or-connected'. That is, at each bit time, the 'conference sum' is '1' if the input of one or more terminals is '1'; otherwise, the result is '0'. A simple example of such a system using Siemens VLSI switching devices is shown in **figure 9**.

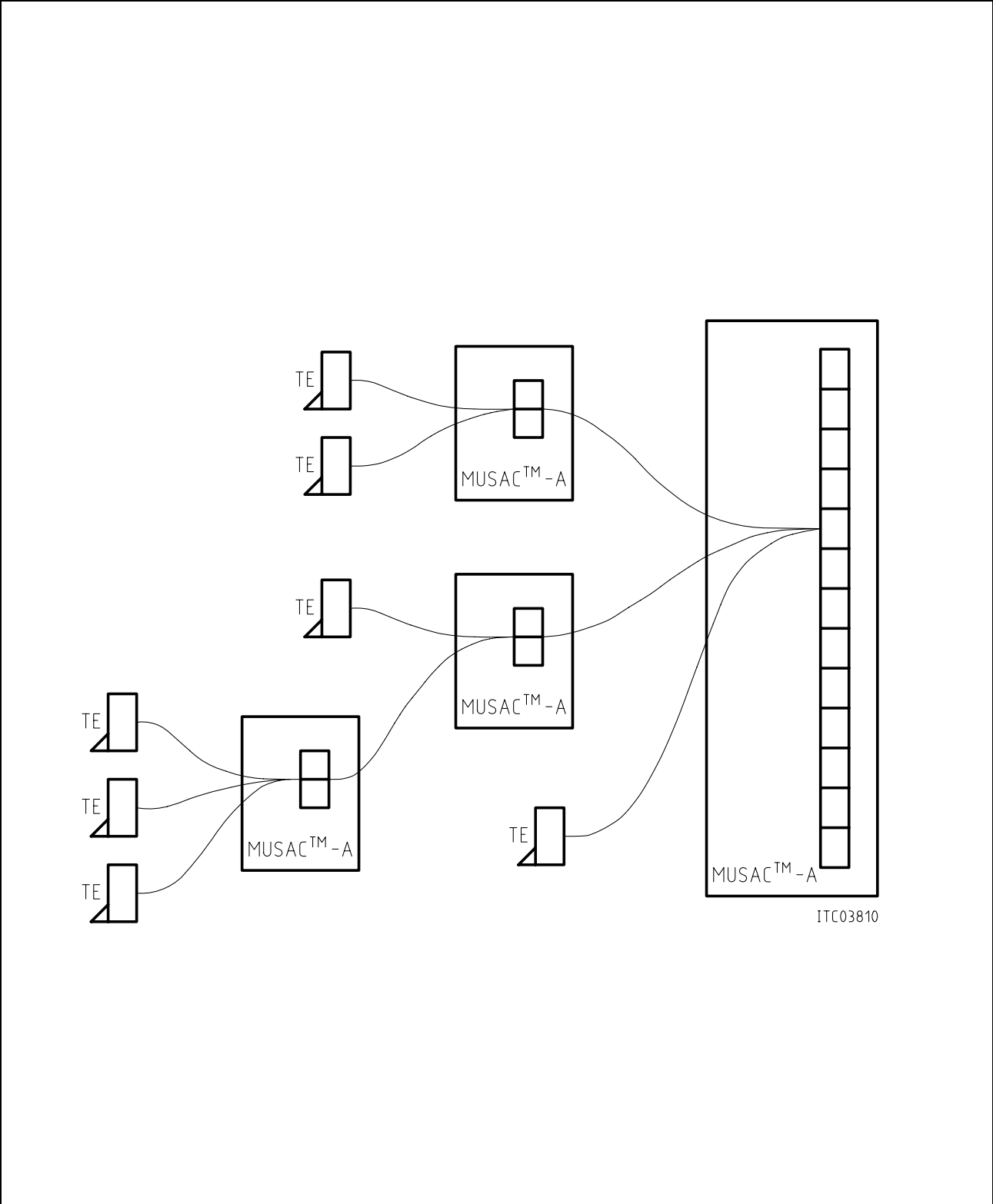
ISDN subscribers are connected via line cards and PCM highways to a multipoint switching matrix. The data from different terminals are summed up in the multipoint switching matrix and transmitted back to all stations. The switching matrix is build by using just one MUSAC-A. Every combination of subscribers may be switched to the same transport media (time-slot), in this way enabling a number of powerful multipoint communication systems.



**Figure 9**  
**Multipoint System Configuration for ISDN Subscribers**

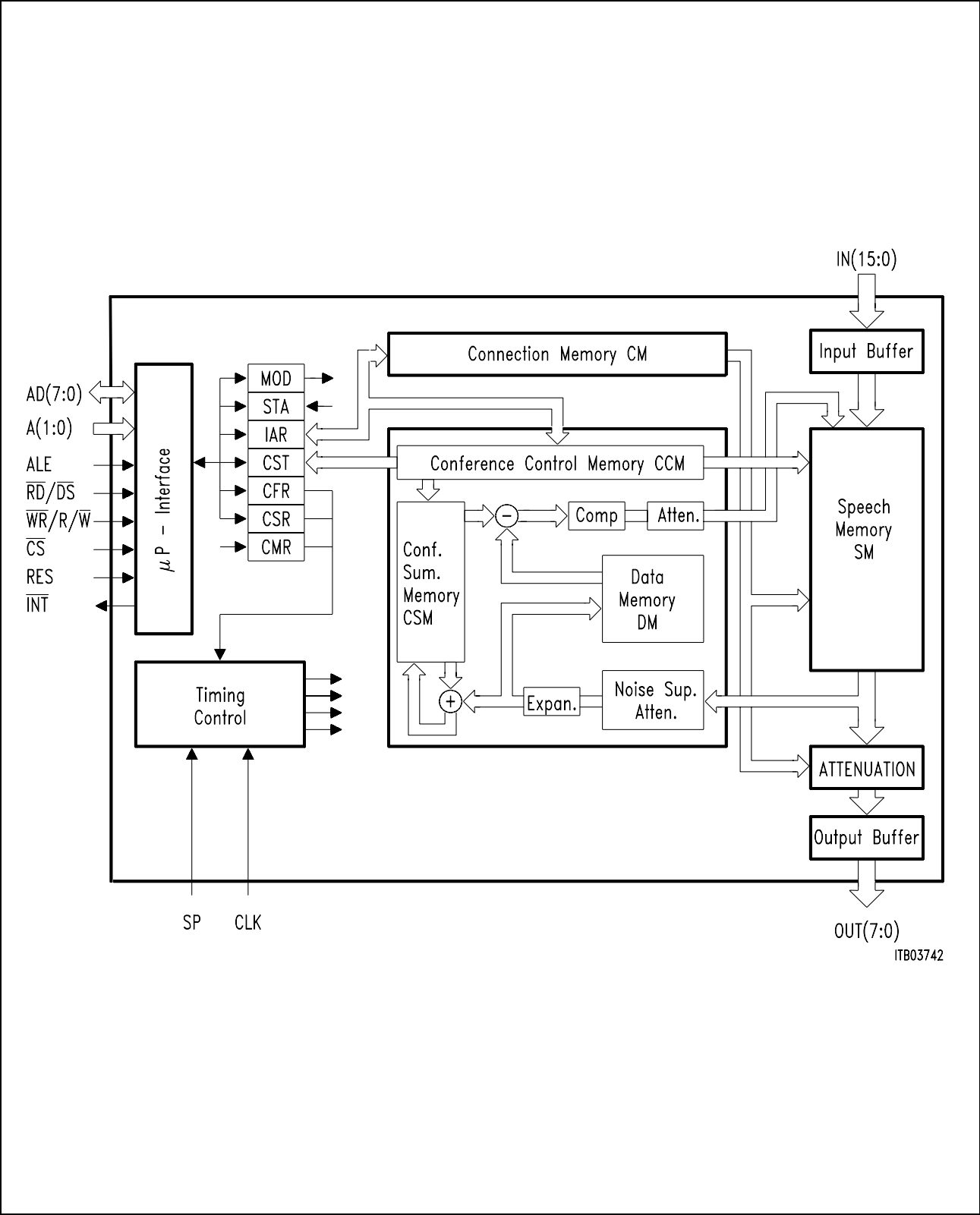
Overview

In order to establish a multipoint-connection with more than 64 terminals, you can form a multistage arrangement, as shown in **figure 10**.



**Figure 10**  
**Multistage Arrangement**

2 Functional Description



**Figure 11**  
**Detailed Block Diagram of the PEB 2445**

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Functional Description

## 2.1 Basic Functional Principles

The MUSAC-A is a memory time switch device for a PCM PBX system, offering a variety of additional features like multipoint switching, conference calls, programmable noise suppression and attenuation. The MUSAC-A works either in standard configuration for usual switching applications or in the primary access configuration, where it realizes, together with the PEB 2035 (ACFA) and the PEB 2235 (IPAT), the system interface for up to four primary multiplex access lines. In both configurations the conference and multipoint switching capability can be used.

The block diagram is shown in **figure 11**. The MUSAC-A is designed to connect any of 512 PCM- input channels to any of 256 output channels. Any input channel up to a total number of 64 can be handled in 21 independent conferences simultaneously. Any conference combination from 3 subscribers in 21 conferences up to 64 subscribers in only one conference is possible. Not more than 8 subscribers should be connected to a single conference, however, in order to ensure an acceptable speech quality. It can be improved by selecting an additional attenuation and activating the noise suppression: The input channels can be attenuated by 0, 3 dB, 6 dB or 9 dB and the output channels by 0 or 3 dB. Input signals below a threshold programmable to four different levels are disregarded.

The input information of a complete frame is stored in the on-chip 4-Kbit Speech Memory (SM). The incoming 512 channels of 8 bits each are written in sequence into fixed positions in the SM with a repetition rate of 8 kHz. Additionally, in the second half of the frame the 64 conference output channels of 8 bit each are written into the SM. The memory access is normally controlled by the input counter in the timing control block when writing into the SM but by the conference unit when writing the conference output channels. The read access is independent of the write access, so that both input and conference output channels can be read at any time.

For outputting, the Connection Memory (CM) is read in sequence. Each location in the CM points to a location in the Speech Memory. Before the byte in this SM location is read into the current output time-slot, it can be attenuated. The attenuation takes care of the compressed data format (A-law,  $\mu$ -law). The attenuations for all 256-output channels are stored in the CM and can be chosen between – 4 dB (amplification) to 12 dB (attenuation). The read access of the CM is controlled by the output counter also contained in the timing control block. In addition, in the first half of the frame the input channels connected to a conference are read in sequence by the Conference Unit (CU).

All connections are set up by an external controller which programs the Connection Memory (CM) and the Conference Control Memory (CCM) using the microprocessor interface. The CM address corresponds to one particular output time-slot and line number. The contents of this CM-location points to a particular input time-slot and line number in the transparent mode. In the conference mode or multipoint switching mode it contains the conference address and points to a conference output location in the SM instead. The same conference address is used to access the CCM. The parameters

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**Functional Description**

stored in the CCM include the input time-slot and line number, the associated conference number as well as the noise suppression thresholds and the attenuation levels. The conference number defines a unique location in the Conference Sum Memory (CSM) used to store the accumulated samples for each conference. The Conference Sum Memory is alternately loaded in the first half of the frame and unloaded in the following second half. In the first half the input samples are processed to implement the noise suppression, the expansion according to the European A-law or the US  $\mu$ -law and the attenuation function. The Data Memory (DM) buffers these samples for output processing. The CSM is used to accumulate these samples and store the resulting sum. During output processing the input sample is retrieved from the Data Memory and the appropriate sum from the Conference Sum Memory for subtraction, so that the channel output signal contains the contribution of all the other channels in the conference except its own. After output attenuation and PCM compression, the data are written in the Speech Memory for output switching.

If one result of the subtractions exceeds the full scale value, a saturation appears and the MUSAC-A signals this conference overflow condition by an interrupt. The conference number of the conference in overflow is buffered in the Conference Status Register (CST) which can be retrieved by the external controller.

A tone to be inserted into a conference is handled as an additional conference subscriber using any input PCM channel (access to CCM) but without assigning an output time-slot (no access to CM).

Multipoint Switching is a special form of conferencing for data communication. In the multipoint switching mode several terminals are connected together. Normally only one should transmit at a time; its signal is distributed to the other terminals. For collision detection purposes all input signals are summed up to construct the output signal. In contrast to audio conferences terminals broadcast data to the MUSAC-A which are only 'or-connected'. That is, at each bit time, the 'conference sum' is '1' if the input of one or more terminals is '1'; otherwise, the result is '0'. The data memory, the subtractor, the linearization and attenuation are of no use in this mode. The general procedure is the same as for conferencing.

All attenuations of the PCM values are calculated by the following mechanism

1. Expansion according CCITT Rec. G. 711
2. Attenuation by  
$$\text{lin. value} \times 2^{-(x/6)}, x = \text{Attenuation}$$
3. Comparison according CCITT Rec. G. 711

These functions are implemented by a PLA/ROM.

The chip architecture makes it possible to decrease the delay between incoming and outgoing PCM channels. The processed input samples are transmitted either in the same frame or in the next frame at the latest.

Functional Description

Definitions

- The PEB 2445 works with either an 8192-kHz clock or a 4096-kHz clock. Henceforth, the respective clock periods are referred to as  $t_{CP8}$  and  $t_{CP4}$ .
- The bits of a time-slot are numbered 0 through 7. Bit 0 (MSB) of a time-slot is the first bit to be received or transmitted by the MUSAC-A, bit 7 (LSB) the last.

Preparation of the Input Data (Input Buffer)

The PEB 2445 works in 2048-, 4096- or 8192-kbit/s PCM systems. The frame frequency is 8000 Hz in all 3 types of systems. Therefore a frame consists of 32-, 64- or 128 time-slots of 1 byte each, respectively. In order to fill the speech memory, which has a fixed capacity of 512 channels, either 16-, 8- or 4 input lines are necessary, respectively. Thus, in 4- and 8-MHz systems only some of the 16 input lines can be used. Moreover, the PEB 2445 can also work with two different input data rates simultaneously. In this case some of the PCM-input lines operate at one data rate, while others operate at another. **Table 2** states how many input lines are operating at the different data rates for all possible input data rate combinations. In the following they will be referred to as input modes.

The input mode the PEB 2445 is actually working in has to be programmed into the mode register, bits MI1, MI0, MO1, MO0. In **chapter 4.1** you will find a complete description which input line is connected to which system, for each of the input modes.

Table 2  
Possible Input Modes

| Input Modes |   |          |        | Type        |
|-------------|---|----------|--------|-------------|
| 16          | × | 2048     | kbit/s | Single mode |
| 8           | × | 4096     | kbit/s | Single mode |
| 4           | × | 8192     | kbit/s | Single mode |
| 2 × 8192    | + | 8 × 2048 | kbit/s | Mixed mode  |
| 4 × 4096    | + | 8 × 2048 | kbit/s | Mixed mode  |

The PEB 2445 runs with either a 4096- or a 8192-kHz device clock as selected with **CFR:CPS**. Data rates and clock frequencies may be combined freely. However, processing 8192-kbit/s data, an 8192-kHz clock must be supplied.

The preparation of the input data according to the selected input mode is made in the input buffer. It converts the serial data of a time-slot to parallel form.

In **standard configuration** time-slot 0 begins with the rising edge of the SP pulse as shown in upper half of **figure 12** denoted **CSR:(0000XXXX)**.

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**Functional Description**

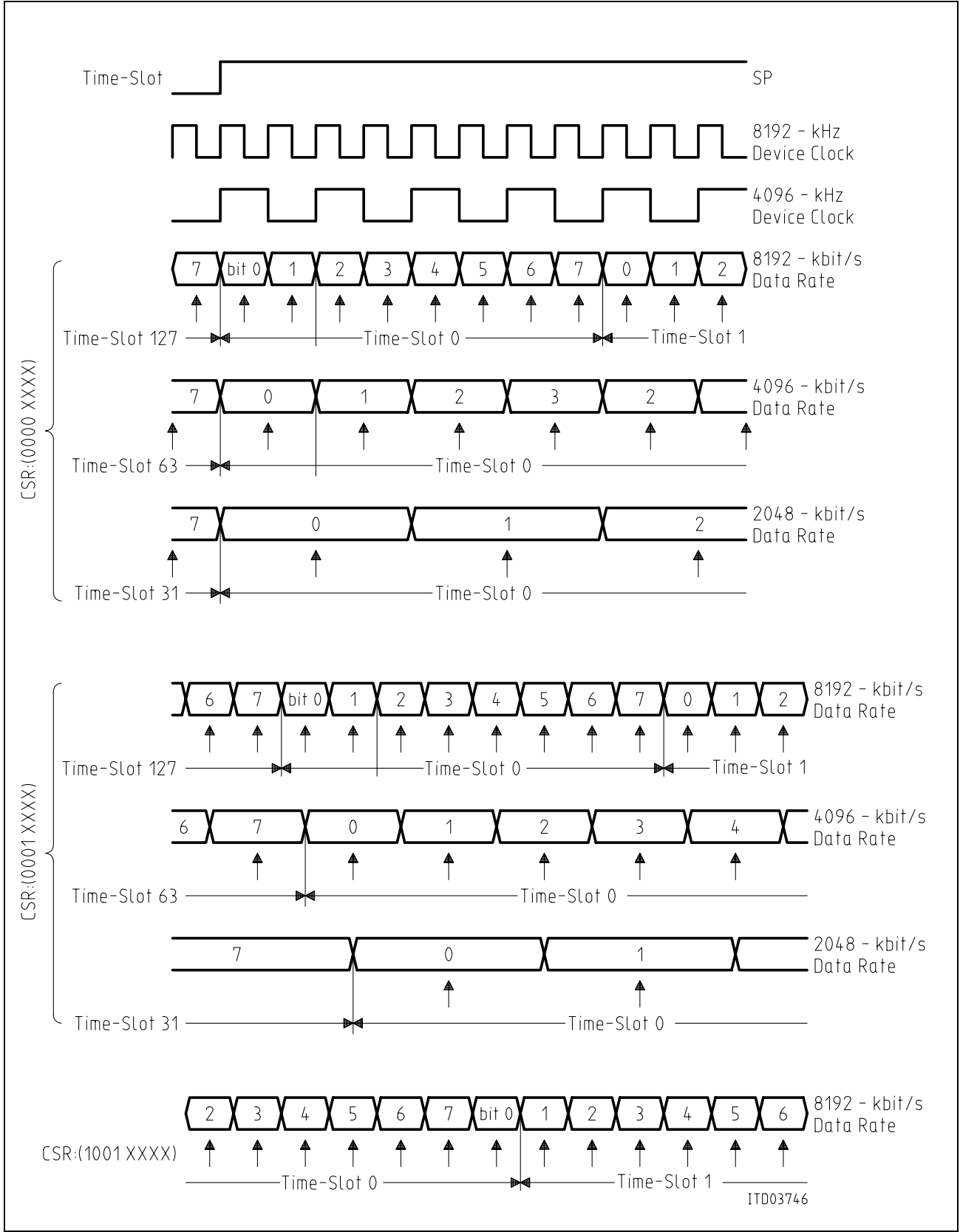
As can be seen there the beginning of a input time-slot is defined such, that the input lines have settled to a stable value, when the datum is actually sampled.

4096- and 8192-kbit/s data is sampled in the middle of the bit period at the falling edge of the respective data clock. 2048-kbit/s data is sampled after 3/4 of the according bit period, i.e. with the rising edge of the 4<sup>th</sup> 8192-kHz clock cycle or the falling edge of the 2<sup>nd</sup> 4096-kHz clock cycle of the considered bit period.

In the **primary access configuration** a different timing scheme may apply to the odd physical input lines. They are affected by the content of the clock shift register (**CSR**), which can be programmed via the  $\mu$ P interface (see **chapter 2.2**).

The clock shift register holds the information, how the frame structure is shifted in the primary access configuration. Its content defaults to 00<sub>H</sub> after power up and is also set to this value, whenever the standard configuration is selected.

Functional Description



**Figure 12**  
**Latching Instant for Input Data**

Functional Description

The four most significant bits of the clock shift register are of interest for the input lines. They only affect the odd input lines (see **chapter 4.6.2**): The frame structure can be advanced by the number of bit periods programmed to the RS2, RS1 and RS0 bits of the **CSR**. For example, programming the **CSR** with (1100XXXX) a new frame starts 6-bit periods before the rising edge of the SP pulse.

Selecting RRE to logical 1 the frame is delayed by half a bit period (see **figure 12**). The data is then sampled in the middle of the respective bit period for all data rates.

The last line of **figure 12** shows the sampling instants for the **CSR** entry (1001XXXX). Then the input frame is advanced by 4-bit periods and delayed by a half resulting in an 3 1/2-clock period advancement of the input frame. For further examples refer to **figure 20**.

Thus the frame structure may be selected to begin at any 1/2-bit period value between an resulting advancement of 7-bit periods and a resulting delay of 1/2 a bit period.

Setting **CSR** = 0X<sub>H</sub> the same timing conditions apply to even and odd inputs. Then all system interface inputs are processed in the same way they are in the standard configuration.

Output Buffer

The output buffer rearranges the data read from the speech memory. It basically converts the parallel data to serial data. Depending on the validity bit the output buffer outputs the data or switches the line to high impedance. The most significant bits of the 256 words in the connection memory are interpreted as validity bits for the 256 possible output channels: A logical 0 enables the programmed connection, a logical 1 tristates the output.

The mode register (**MOD**) bits MI1, MI0, MO1 and MO0 control this process. The possible output modes are listed in **table 3**.

Table 3  
Possible Output Modes

| Output Modes |   |          |        | Type        |
|--------------|---|----------|--------|-------------|
| 8            | × | 2048     | kbit/s | Single mode |
| 4            | × | 4096     | kbit/s | Single mode |
| 2            | × | 8192     | kbit/s | Single mode |
| 1 × 8192     | + | 4 × 2048 | kbit/s | Mixed mode  |
| 2 × 4096     | + | 4 × 2048 | kbit/s | Mixed mode  |

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Functional Description

**Figure 13** shows when the single bits are output. In standard configuration they are clocked off at the rising clock edge at the beginning of the considered bit period. Time-slot 0 starts two  $t_{CP8}$  before the falling edge of the SP pulse.

In primary access configuration the even output lines are affected by the XS2, XS1, XS0 and XFE entries in the clock shift register. The output frame is synchronized with the rising edge of the SP signal.

Assuming a **CSR** entry  $X0_H$  the output frame starts with the rising edge of the SP pulse. Programming the XS2, XS1 and XS0 bits with a value deviating from binary 000 the output frame is delayed by  $8_D - (XS2, XS1, XS0)_B$  bit periods. E.g, a **CSR** entry of (XXXX0010) delays the output frame by 7-bit periods relative to the rising SP-pulse edge.

Programming **CSR:(XXXXXXXX1)** the output frame is delayed by another half a **device** clock period. In **figure 13** the outputting instants are shown for a device clock of 4096 and 8192 kHz and a **CSR:(XXXX0001)**.

The last line in **figure 13** shows an even 8192-kbit/s output line for the **CSR** entry (XXXX1101) and an 8192-kHz device clock. The output frame is delayed by 2 1/2-bit periods. For further examples refer to **figure 20**.

Functional Description

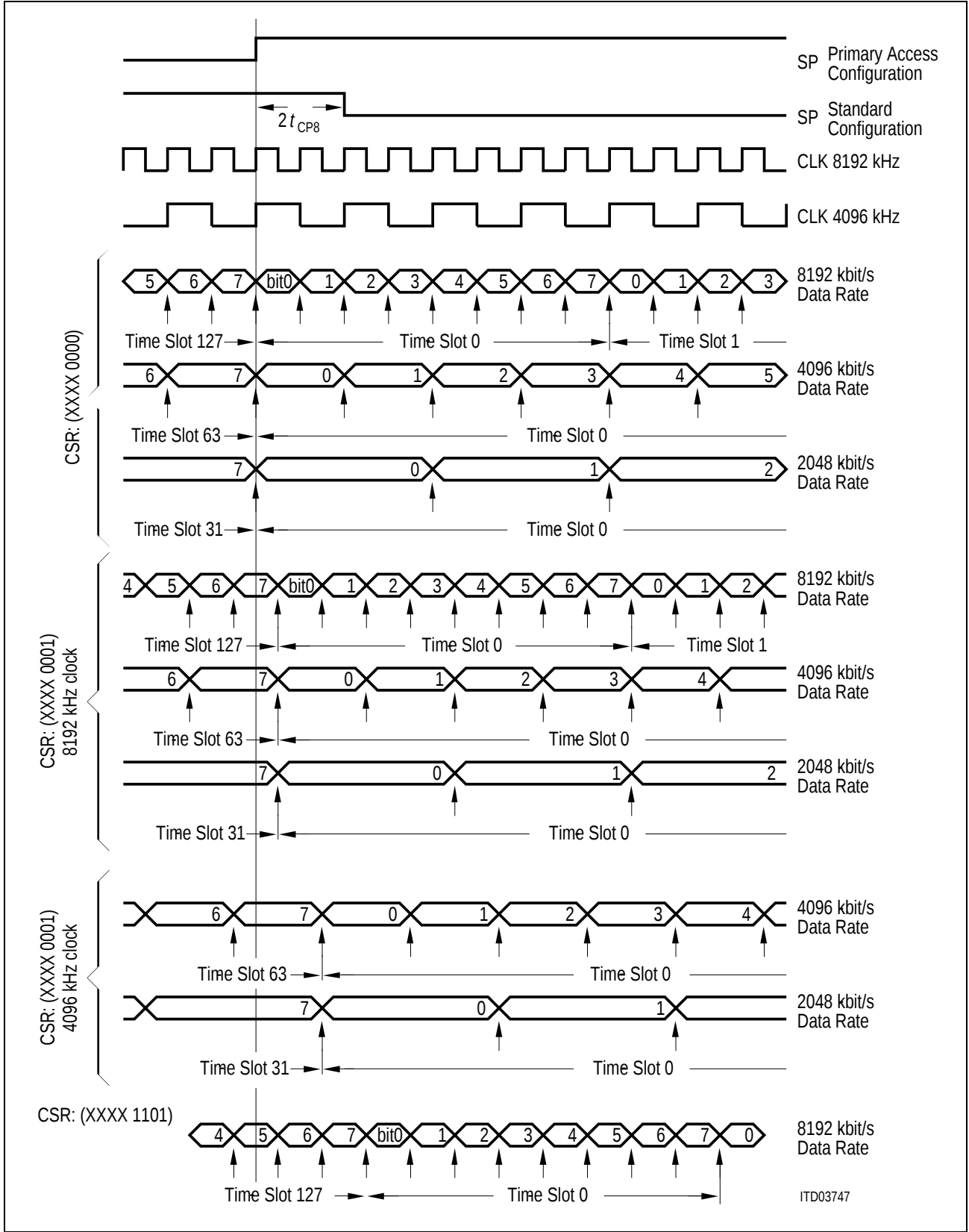


Figure 13  
Clocking Off Instant of Output Data

Configuration Type

The MUSAC-A works either in the standard configuration for usual switching applications or in the primary access configuration. In these both configurations the conference and multipoint switching capability can be used.

Standard Configuration

A logical 1 in the **CFS** bit of the configuration register sets the PEB 2445 in standard mode (default after power up). All modes from **table 7** can be used. It has to be ensured that the data rate is not higher than the selected device clock (4096 or 8192 kHz).

In this application 512 channels per frame are written into the speech memory. Each one of them can be connected to any output channel.

Any output channel can be attenuated independently of each other.

According to **table 8** and **table 12** and depending on the selected mode the least significant bits of the connection memory address and data contain the logical pin numbers, the most significant bits the time-slot number of the output and input channels.

The following example explains the programming sequence.

Time-slot 7 of the incoming 8192-kbit/s input line IN 14 shall be connected to time-slot 6 of the output line OUT 5 of an 2048-kbit/s system. The attenuation for this connection should be 7 dB. According to **table 8** in 8192-kbit/s systems the input line IN 14 is the logical input line 2. Output line number and logical output number are identical to one another. According to **chapter 4.5** C3 ... C0 is set to 7<sub>H</sub>.

Therefore the following byte sequence on the address data bus has to be used to program the CM properly (see **table 12**):

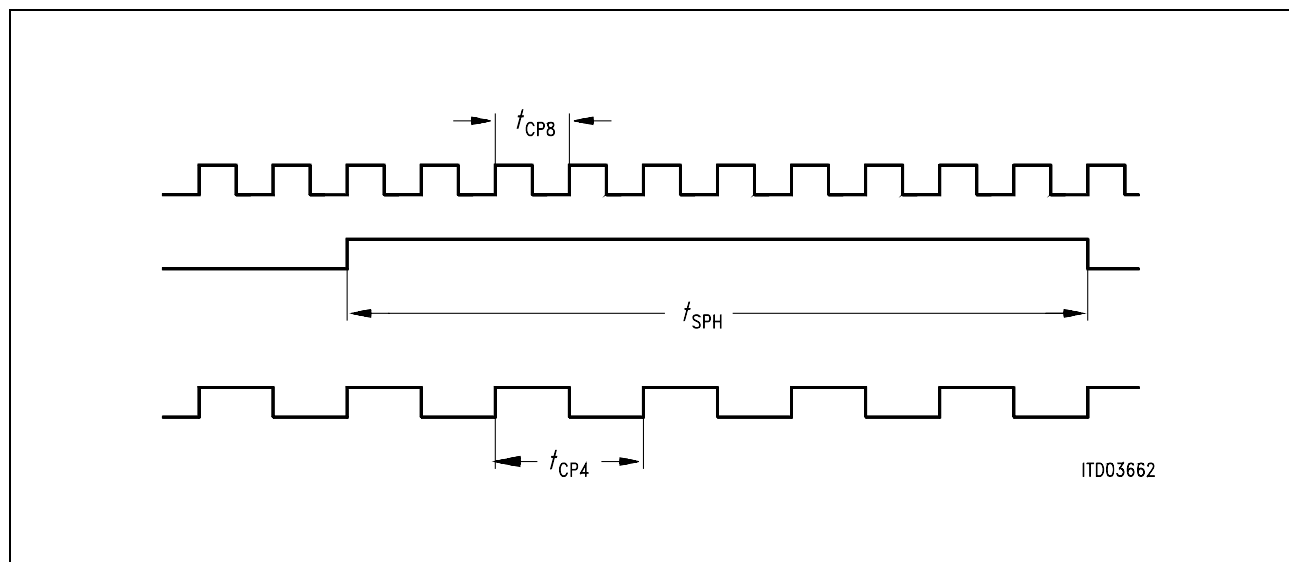
|          |                |    |          |                |
|----------|----------------|----|----------|----------------|
| 01101100 | (Control Byte) | or | 01011100 | (Control Byte) |
| 00011110 | (Data Byte)    |    | 00011110 | (Data Byte)    |
| 00110101 | (Address Byte) |    | 00110101 | (Address Byte) |

The frame, for all input channels, starts with the rising edge of the SP signal. The frame for all output channels begins two  $t_{CP8}$  (with 8192-kHz device clock) or one  $t_{CP4}$  period (4096-kHz device clock) before the falling SP edge. The period of time between the rising and falling edge of the SP pulse should be

$$\begin{aligned} t_{SPH} &= (2 + N \times 4) t_{CP8} && (0 \leq N \leq 255) \\ &= (1 + N \times 2) t_{CP4} \end{aligned}$$

## Functional Description

N is an user defined integer. By varying N,  $t_{SPH}$  can be varied in 2048-kHz clock period steps. For an example using  $N = 2$  refer to **figure 14**.



**Figure 14**  
**SP Duration for  $N = 2$**

## Primary Access Configuration

A logical 0 in the **CFS** bit of the configuration register selects the PEB 2445 for primary access applications. In this case the MUSAC-A is an interface device connecting a standard PCM interface (system interface) with another PCM interface e.g. an intermediate interface for connections to primary loops (synchronous interface). For both a serial interface is provided.

The synchronous 2048-kbit/s interface consists of four input and four output lines with a bit rate of 2048-kbit/s. This interface can be used to connect the PEB 2445 to up to four primary trunk lines via coding/decoding devices with frame alignment function (e.g. PEB 2035 ACFA) and line transceivers with clock and data recovery (e.g. PEB 2235 IPAT) and to signaling processors (e.g. the SAB 82520 HSCC).

The system interface is not confined to one data rate but can operate at the full choice of the PEB 2445 data rates: 2048, 4096 and 8192 kbit/s. A clock shift in a range of 7 1/2 clock steps with half clock step resolution may be programmed independently for inputs and outputs.

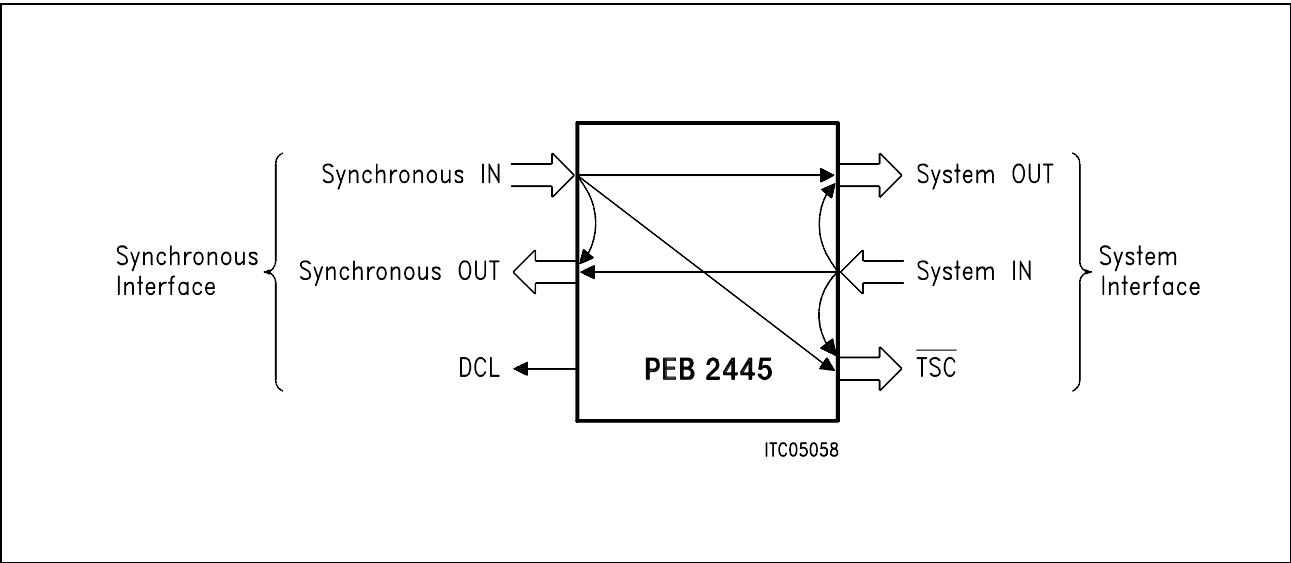
The frame for all input- and output lines starts with the rising edge of the SP signal.

In the primary access mode the signals  $\overline{TSC0}$ ,  $\overline{TSC1}$ ,  $\overline{TSC2}$  and  $\overline{TSC3}$  indicate when the associated system interface output is valid. The signal DCL supplies a 2-MHz clock which can be used for other devices at the synchronous interface, e.g. the High Level Serial Communication Controller HSCC (SAB 82520).

Functional Description

In the primary access configuration only those modes which support at least 4 input and 4 output lines at 2048 kbit/s can be used. These are the modes MI1, MI0, MO1, MO0 = 0<sub>H</sub>, A<sub>H</sub>, F<sub>H</sub> (see **table 7**). Programming the CM in the primary access configuration is described in **tables 8, 13 and 14**. The attenuations are programmed in the same way as in the standard configuration. The least significant 2 bits of the data byte and the least significant bit of the address byte determine the type of interface, the more significant bits define the logical line number and time-slot number.

According to **figure 15** in the primary access configuration the connection memory is usually programmed to switch the system and synchronous interface inputs to the synchronous and system interface outputs, respectively. However, it is also possible to connect the system interface inputs to the system interface outputs as well as the synchronous interface inputs to the synchronous interface outputs. This connection possibility allows for test loops at the system and the synchronous interfaces.



**Figure 15**  
**Connection Choices in the Primary Access Configuration**

2.2 Microprocessor Interface and Registers

The MUSAC-A is programmed via the  $\mu$ P interface. It consists of the address data bus AD7 ... AD0, the address bits A1 ... A0, the Write ( $\overline{WR}$ ), the Read ( $\overline{RD}$ ), the Address Latch Enable (ALE), the Interrupt ( $\overline{INT}$ ) and the Chip Select ( $\overline{CS}$ ) signal, as shown in figure 16.

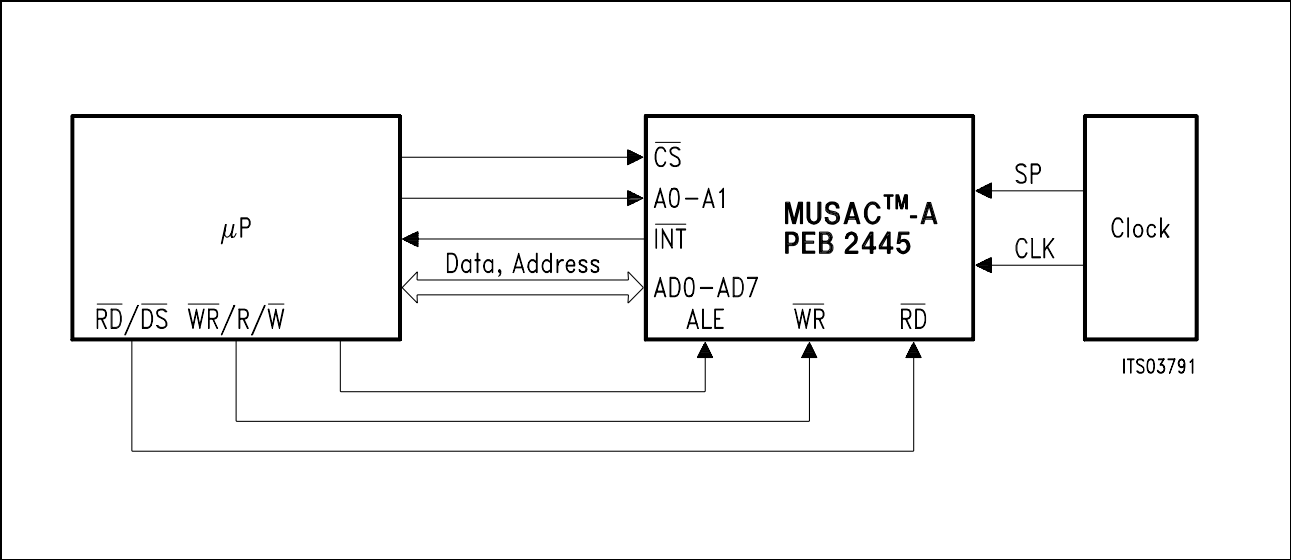


Figure 16  
The MUSAC™-A Controlled by a Microprocessor

The standard 8-bit  $\mu$ P interface can communicate with Intel multiplexed/demultiplexed microprocessors. It gives access to the internal registers and to the control memories (Connection Memory, Conference Control Memory).

Table 4  
 $\mu$ P-Interface Functions

| ALE             | Type of $\mu$ P Interface | Bus Structure | Pin 24          | Pin 25          |
|-----------------|---------------------------|---------------|-----------------|-----------------|
| Fixed to ground | Intel                     | demultiplexed | $\overline{RD}$ | $\overline{WR}$ |
| Switching       | Intel                     | multiplexed   | $\overline{RD}$ | $\overline{WR}$ |

ALE is internally set to ground if it is not connected.  
For a demultiplexed  $\mu$ P interface the address bits A1 and A0 are needed for addressing a register. For the  $\mu$ P-interface timing please refer to **chapter 5.3**.

Functional Description

Five directly addressable registers are provided:

- Mode register (MOD)
- Status register (STA)
- Conference Status register (CST)
- Conference Mask Register (CMR)
- Indirect Access Register (IAR)

Two other registers and the control memories are accessed by a simple three byte indirect access method:

- Configuration Register (CFR)
- Clock Shift Register (CSR)
- Connection Memory (CM)
- Conference Control Memory (CCM)

The status register (STA) and the conference status register (CST) are read-only-registers, the conference mask register (CMR) is a write-only-register; MOD, CFR, CSR, IAR and CM or CCM can be read or written. An indirect access scheme is used to access the CFR, CSR, CM or CCM using the indirect access register (IAR).

The following direct registers may be accessed:

Table 5  
Addressing the Direct Registers

| Address                   |                          | Write Operation | Read Operation |
|---------------------------|--------------------------|-----------------|----------------|
| Demultiplexed Mode A(1:0) | Multiplexed Mode AD(7:0) |                 |                |
| 0 <sub>H</sub>            | 0 <sub>H</sub>           | MOD             | STA            |
| 1 <sub>H</sub>            | 2 <sub>H</sub>           | IAR             | IAR            |
| 2 <sub>H</sub>            | 4 <sub>H</sub>           | CMR             | CST            |
| 3 <sub>H</sub>            | 6 <sub>H</sub>           | —               | MOD            |

If A1 is not connected in the demultiplexed mode neither an access to the CMR, CST nor a read access to the MOD register is possible.

In this case A1 is fixed to ground internally.

Functional Description

Indirect access to the CFR, CSR, CM or CCM:

An indirect access is performed by reading/writing three consecutive bytes (first byte = control byte, second byte = data byte, third byte = address byte) to/from IAR.

| Bit 7 |     |     |     |     |     | Bit 0 |     |              |
|-------|-----|-----|-----|-----|-----|-------|-----|--------------|
| C3    | C2  | K1  | K0  | C1  | C0  | D9    | D8  | Control Byte |
| D7    | D6  | D5  | D4  | D3  | D2  | D1    | D0  | Data Byte    |
| IA7   | IA6 | IA5 | IA4 | IA3 | IA2 | IA1   | IA0 | Address Byte |

The control byte determines whether the CFR, the CSR, the CM or the CCM shall be accessed, whether a write or read operation shall be performed and whether the first or the second memory access shall be executed. (To describe a conference two accesses to the CCM are necessary). The bits D7 ... D0 contain the information which shall be written into the control memories or the indirect registers. In the case of programming the CM the output attenuation is included either in the control byte (transparent switch) or in the data bits (conference switch). The address byte indicates which one of the indirect registers shall be accessed or in which memory location the data shall be written. An exact definition is given in **chapter 4.5**.

Before an indirect access is started, the Z- and B bits of the status register must be 0. With the first instruction the Z bit is set (see **chapter 4.2**). After the third instruction the MUSAC-A accesses the memory location. This access requires maximally 900 ns. After the access is finished the Z bit is reset.

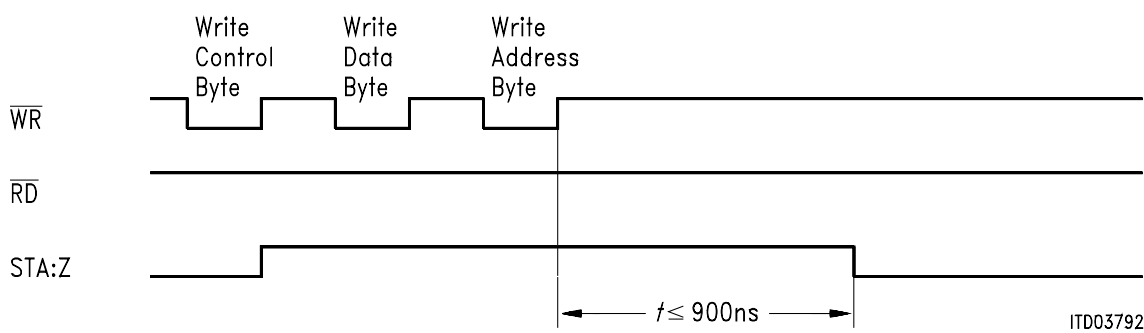
**Figure 17 a)** illustrates a write operation on the IAR.

It is possible to read or write the direct access registers while an indirect access is in progress. Thus a register may be read in the time intervals that separate the three sequential indirect access instructions. Also, the current indirect access may be aborted by setting the MOD:RI. One indirect register access has to be completed before the next one can be started.

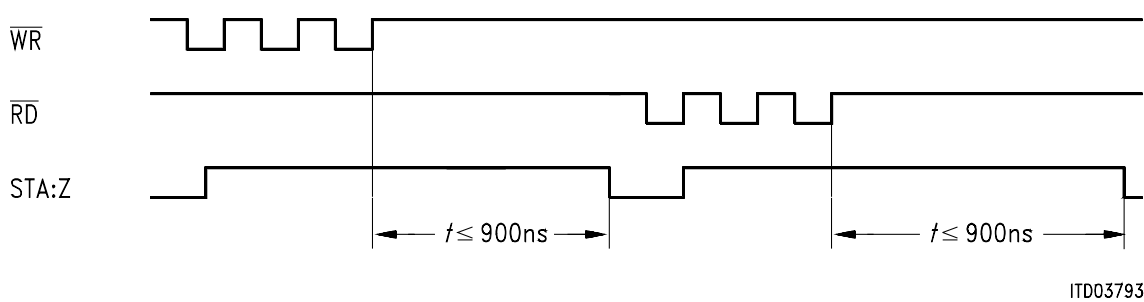
To read the indirect registers or the CM two sequences of three instructions each have to be programmed. In the first sequence the MUSAC-A is instructed which register or CM address to read. The data transferred to the PEB 2445 in this first sequence is of no significance. With the first write instruction STA:Z is set. After the first 3 instructions the MUSAC-A needs 900 ns to write the result to the IAR. The status register bit Z is reset after maximally 900 ns. Then 3 read operations follow. Again, STA:Z is set with the first read instruction. The 3 instructions read 3 bytes from the IAR. **Figure 17 b)** shows this procedure. After the third read operation the PEB 2445 needs another 900 ns to reset the indirect access mechanism and the Z bit in the status register. In CCM read accesses three sequences of three instructions (two identical write sequences and one read sequence; see **figure 17 c)** are necessary.

Functional Description

a) Write IAR (CFR, CSR, CM, CCM)



b) Read CFR, CSR or CM



c) Read CCM

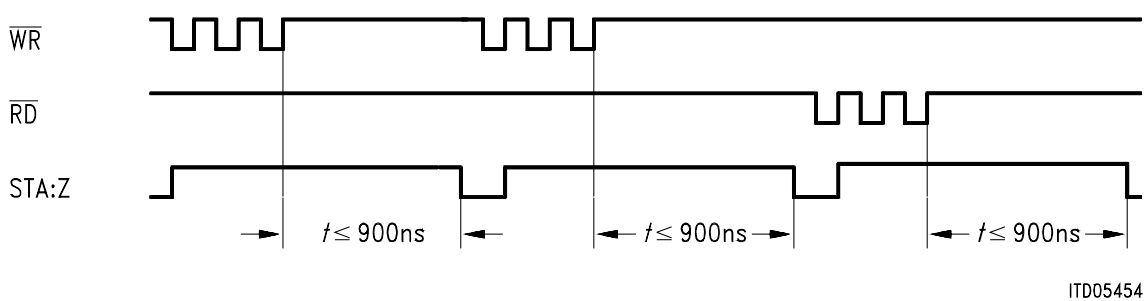


Figure 17  
Timing Diagrams of IAR

3 Operational Description

3.1 Reset State

After a hardware reset (RES) or power up the MUSAC-A is set to its initial state. The MOD- and CFR register bits are all set to logical 1; the CSR-, CST- and CMR-register bits are set to logical 0. The STA register **B** bit is undefined, the **Z** bit contains logical 0.

3.2 Initialization Procedure

After reset a few internal signals and clocks need to be initialized. This is done with the initialization sequence. To give all signals and clocks a defined value only 4 SP pulses are necessary. The SP pulses may be of any length allowed in normal application, the time interval between the two SP pulses may be of any length down to 250 ns.

With all signals being defined, the CM needs to be reset. To do that a logical 0 is written into MOD:RC. STA:B is set. The resulting CM reset is finished after max. 250 μs and is indicated by the status register B bit being logical 0. Changing the pulse shaping factor N during CM reset may result in a CM-reset time longer than 250 μs.

After resetting the CM, all bits in the CM are reset to 0, except for the D9-bit, which is set to one, causing the output lines to be tristated.

To prepare the MUSAC-A for programming the CM and CCM, the RI bit in the mode register must be reset. Note that one mode register access can serve to reset both RC- and RI bits as well as configuring the chip (i.e. selecting operating mode etc.).

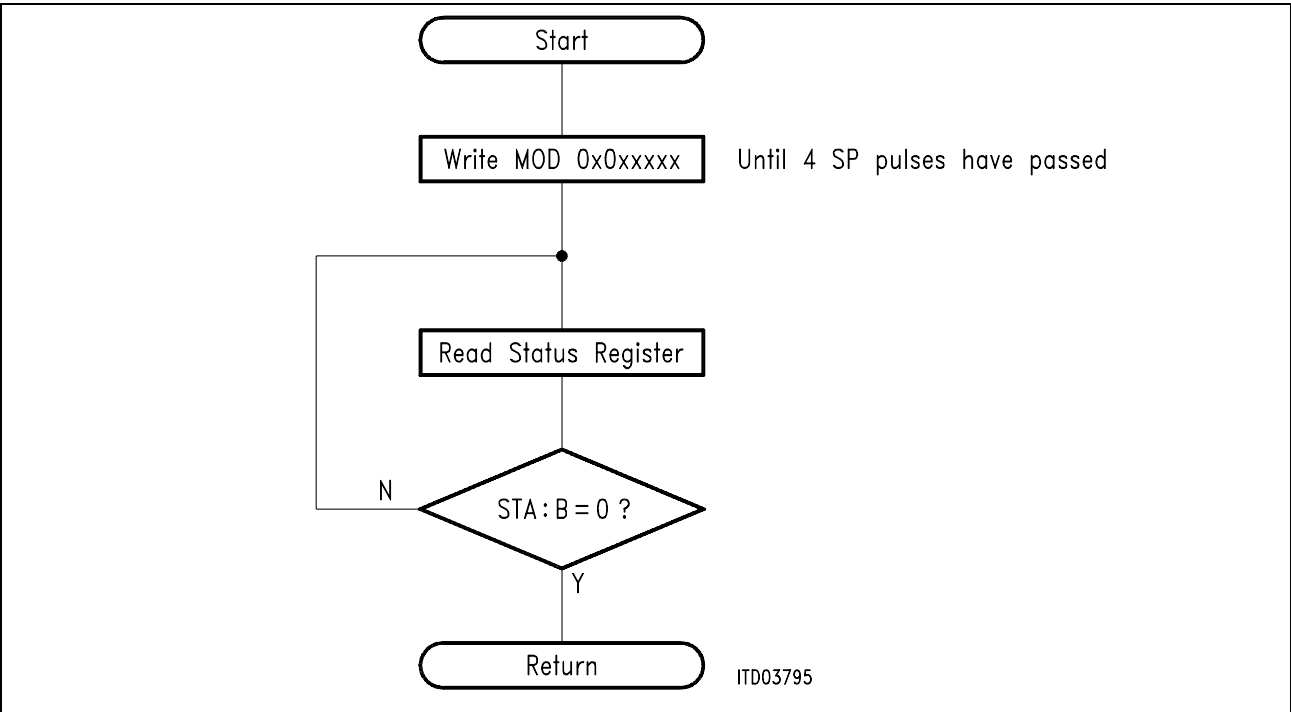
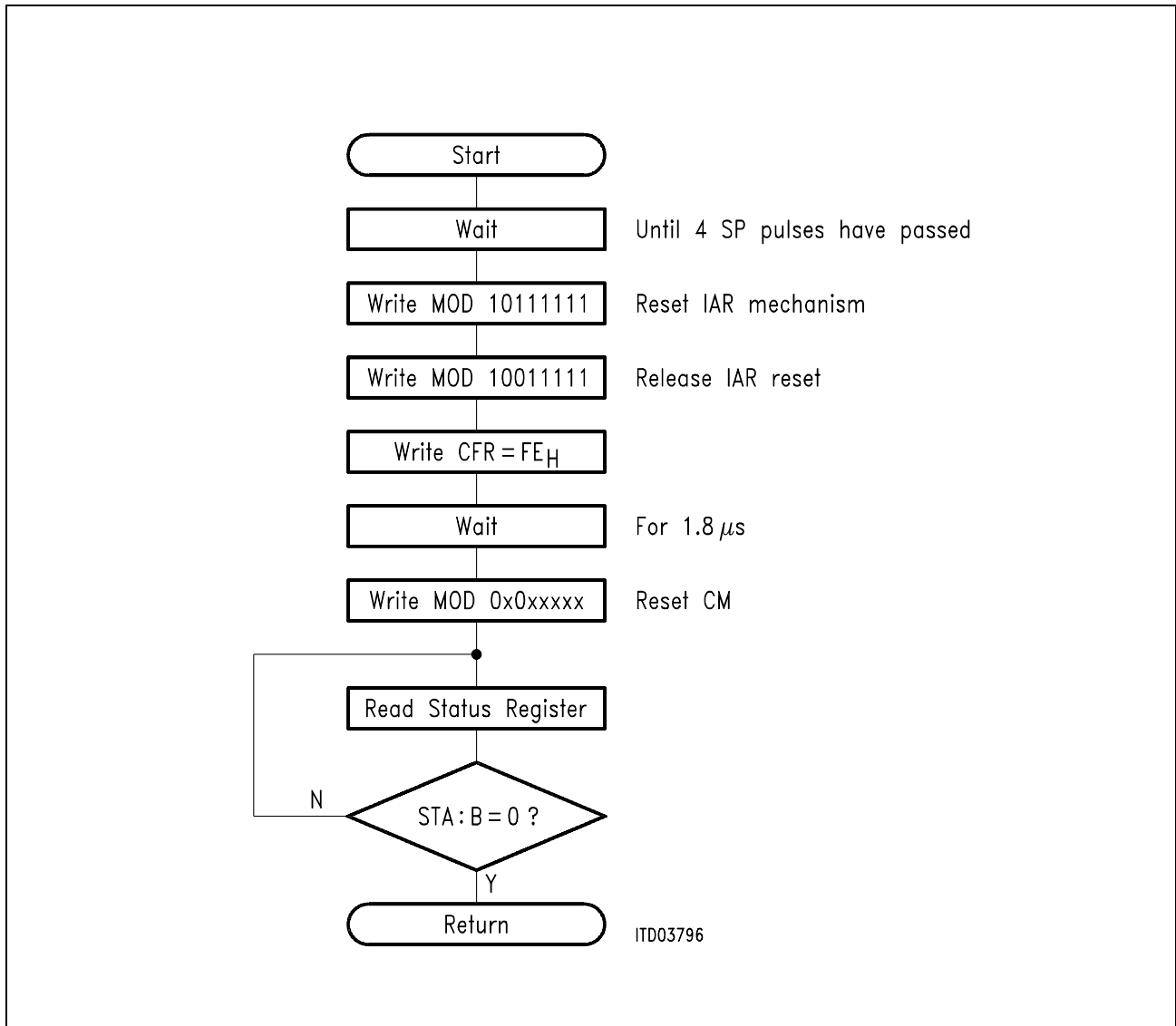


Figure 18  
Initializing the PEB 2445 for a 8192-kHz Device Clock

## Operational Description



**Figure 19**  
**Initializing the PEB 2445 for a 4096-kHz Device Clock**

### 3.3 Operation with a 4096-kHz Device Clock

In order for the MUSAC-A to operate with a 4096-kHz device clock the CPS bit in the CFR register needs to be reset. This has to be done before the CM reset and needs 1.8  $\mu$ s. For a flow chart of this process refer to **figure 19**.

### 3.4 Standby Mode

With MOD:SB being logical 1 the MUSAC-A works as a backup device in redundant systems. It can be accessed via the  $\mu$ P interface and works internally like an active device. However, the outputs are high impedance. If the SB bit is reset, the outputs are switched to low impedance for the programmed active channels and this MUSAC-A can take over from another device which has been recognized as being faulty.

Detailed Register Description

4 Detailed Register Description

The following registers may be accessed:

Table 6  
Addressing the Direct Registers

| Address                      |                             | Write Operation | Read Operation |
|------------------------------|-----------------------------|-----------------|----------------|
| Demultiplexed Mode<br>A(1:0) | Multiplexed Mode<br>AD(7:0) |                 |                |
| 0 <sub>H</sub>               | 0 <sub>H</sub>              | MOD             | STA            |
| 1 <sub>H</sub>               | 2 <sub>H</sub>              | IAR             | IAR            |
| 2 <sub>H</sub>               | 4 <sub>H</sub>              | CMR             | CST            |
| 3 <sub>H</sub>               | 6 <sub>H</sub>              | —               | MOD            |

If A1 is not connected it is internally set to ground. In the demultiplexed mode neither an access to the CMR, CST nor a read access to the MOD register is possible.

The paragraphs in this section cover the registers in detail.

4.1 Mode Register (MOD)

Access in the multiplexed  $\mu$ P-interface mode: Write, address: 0<sub>H</sub> read, address: 6<sub>H</sub>

Access in the demultiplexed  $\mu$ P-interface mode: Write, address: 0<sub>H</sub> read, address: 0<sub>H</sub>

Reset value: BF<sub>H</sub>

| AD7 |   |    |    | AD0 |     |     |     |
|-----|---|----|----|-----|-----|-----|-----|
| RC  | 0 | RI | SB | MI1 | MI0 | MO1 | MO0 |

**RC**      **Reset Connection** memory; writing a zero to this bit causes the complete connection memory to be overwritten with 200<sub>H</sub> (tristate). During this time STA:B is set. The maximum time for resetting is 250  $\mu$ s.

**RI**      **Reset Indirect** access mechanism; setting this bit resets the indirect access mechanism. RI has to be cleared before writing/reading IAR after reset.

**SB**      **Stand By**; By selecting SB = 1 all PCM outputs are tristated. The connection memory works normally. The MUSAC-A can be activated immediately by resetting SB.

**MI1/0**      **Input/Output** operation **Mode**; these bits define the bit rate of the input and  
**MO1/0**      output lines. The bitrates are given in **table 7**, the corresponding pin functions in **table 8** (standard configuration).

## Detailed Register Description

**Table 7**  
**Input/Output Operating Modes**

| MI1 | MI0 | MO1 | MO0 | Input Mode    |        | Output Mode   |                      |
|-----|-----|-----|-----|---------------|--------|---------------|----------------------|
| 0   | 0   | 0   | 0   | 16 × 2        | Mbit/s | 8 × 2         | Mbit/s <sup>2)</sup> |
| 0   | 0   | 0   | 1   | 16 × 2        | Mbit/s | 2 × 8         | Mbit/s               |
| 0   | 0   | 1   | 0   | 16 × 2        | Mbit/s | 4 × 2 / 1 × 8 | Mbit/s               |
| 0   | 1   | 0   | 0   | 4 × 8         | Mbit/s | 8 × 2         | Mbit/s               |
| 0   | 1   | 0   | 1   | 4 × 8         | Mbit/s | 2 × 8         | Mbit/s               |
| 0   | 1   | 1   | 0   | 4 × 8         | Mbit/s | 4 × 2 / 1 × 8 | Mbit/s               |
| 1   | 0   | 0   | 0   | 2 × 8 / 8 × 2 | Mbit/s | 8 × 2         | Mbit/s               |
| 1   | 0   | 0   | 1   | 2 × 8 / 8 × 2 | Mbit/s | 2 × 8         | Mbit/s               |
| 1   | 0   | 1   | 0   | 2 × 8 / 8 × 2 | Mbit/s | 4 × 2 / 1 × 8 | Mbit/s <sup>2)</sup> |
| 0   | 0   | 1   | 1   | 8 × 4         | Mbit/s | 4 × 4         | Mbit/s               |
| 0   | 1   | 1   | 1   | 4 × 8         | Mbit/s | 4 × 4         | Mbit/s               |
| 1   | 1   | 1   | 1   | 4 × 4 / 8 × 2 | Mbit/s | 4 × 2 / 2 × 4 | Mbit/s <sup>2)</sup> |
| 1   | 0   | 1   | 1   | 8 × 4         | Mbit/s | 2 × 8         | Mbit/s               |
| 1   | 1   | 0   | 1   | 16 × 8        | Mbit/s | 2 × 8         | Mbit/s <sup>1)</sup> |
| 1   | 1   | 0   | 0   | unused        |        | unused        |                      |
| 1   | 1   | 1   | 0   | unused        |        | unused        |                      |

<sup>1)</sup> for space switch application only; the conference or multipoint switching capability cannot be used in this operating mode

<sup>2)</sup> can also be used for primary access configuration

*Note: In the mixed modes the first bit rate refers to the odd line numbers, the second one to the even line numbers.*

Detailed Register Description

Input Pin Arrangement

Table 8  
Input and Output Pin Arrangement for the Standard Configuration

| Pin No. | 16 × 8 Mbit/s<br>16 × 2 Mbit/s | 4 × 8<br>Mbit/s | 8 × 2 + 2 × 8<br>Mbit/s | 8 × 4<br>Mbit/s | 8 × 2 + 4 × 4<br>Mbit/s |
|---------|--------------------------------|-----------------|-------------------------|-----------------|-------------------------|
| 4       | IN1                            |                 |                         |                 |                         |
| 5       | IN0                            |                 | IN0                     |                 | IN0                     |
| 7       | IN5                            |                 |                         |                 |                         |
| 8       | IN4                            |                 | IN4                     |                 | IN4                     |
| 9       | IN9                            |                 |                         | IN1             | IN1                     |
| 10      | IN8                            |                 | IN8                     | IN0             | IN8                     |
| 11      | IN13                           | IN1             | IN1                     | IN5             | IN5                     |
| 12      | IN12                           | IN0             | IN12                    | IN4             | IN12                    |
| 13      | IN14                           | IN2             | IN14                    | IN6             | IN14                    |
| 14      | IN15                           | IN3             | IN3                     | IN7             | IN7                     |
| 15      | IN10                           |                 | IN10                    | IN2             | IN10                    |
| 16      | IN11                           |                 |                         | IN3             | IN3                     |
| 17      | IN6                            |                 | IN6                     |                 | IN6                     |
| 18      | IN7                            |                 |                         |                 |                         |
| 19      | IN2                            |                 | IN2                     |                 | IN2                     |
| 20      | IN3                            |                 |                         |                 |                         |

*Note: The input line numbers shown are the logical line numbers to be used for programming the connection memory and the conference control memory. In the case of 16 input lines the logical line numbers are identical to the pin names.*

Output Pin Arrangement

| Pin No. | 8 × 2<br>Mbit/s | 2 × 8<br>Mbit/s | 4 × 2 + 1 × 8<br>Mbit/s | 4 × 4<br>Mbit/s | 4 × 2 + 2 × 4<br>Mbit/s |
|---------|-----------------|-----------------|-------------------------|-----------------|-------------------------|
| 35      | OUT7            |                 | OUT7                    |                 | OUT7                    |
| 36      | OUT6            |                 |                         |                 |                         |
| 37      | OUT5            |                 | OUT5                    |                 | OUT5                    |
| 38      | OUT4            |                 |                         |                 |                         |
| 40      | OUT3            |                 | OUT3                    | OUT3            | OUT3                    |
| 41      | OUT2            |                 |                         | OUT2            | OUT2                    |
| 42      | OUT1            | OUT1            | OUT1                    | OUT1            | OUT1                    |
| 43      | OUT0            | OUT0            | OUT0                    | OUT0            | OUT0                    |

*Note: The logical output line numbers shown above are identical to the pin names.*

Detailed Register Description

Table 9  
Input, Output and Tristate Pin Arrangement for the Primary Access Configuration

|                          | Pin No. | System Interface Mode    |                          |                          |                                                                     |
|--------------------------|---------|--------------------------|--------------------------|--------------------------|---------------------------------------------------------------------|
| Pin Name                 | P-LCC   | 2 MHz                    | 4 MHz                    | 8 MHz                    |                                                                     |
| $\overline{\text{TSC0}}$ | 5       | $\overline{\text{TSC0}}$ | $\overline{\text{TSC0}}$ | $\overline{\text{TSC0}}$ | System interface tristate control signals, clock shift programmable |
| $\overline{\text{TSC1}}$ | 8       | $\overline{\text{TSC1}}$ | $\overline{\text{TSC1}}$ |                          |                                                                     |
| $\overline{\text{TSC2}}$ | 10      | $\overline{\text{TSC2}}$ |                          |                          |                                                                     |
| $\overline{\text{TSC3}}$ | 12      | $\overline{\text{TSC3}}$ |                          |                          |                                                                     |
| OUT0                     | 43      | OUT0                     | OUT0                     | OUT0                     | System interface outputs, clock shift programmable                  |
| OUT2                     | 41      | OUT1                     | OUT1                     |                          |                                                                     |
| OUT4                     | 38      | OUT2                     |                          |                          |                                                                     |
| OUT6                     | 36      | OUT3                     |                          |                          |                                                                     |
| IN13                     | 11      | IN3                      | IN1                      | IN0                      | System interface inputs, clock shift programmable                   |
| IN9                      | 9       | IN2                      | IN0                      |                          |                                                                     |
| IN5                      | 7       | IN1                      |                          |                          |                                                                     |
| IN1                      | 4       | IN0                      |                          |                          |                                                                     |
| OUT1                     | 42      | OUT0                     | OUT0                     | OUT0                     | Synchronous 2-MHz interface outputs                                 |
| OUT3                     | 40      | OUT1                     | OUT1                     | OUT1                     |                                                                     |
| OUT5                     | 37      | OUT2                     | OUT2                     | OUT2                     |                                                                     |
| OUT7                     | 35      | OUT3                     | OUT3                     | OUT3                     |                                                                     |
| IN14                     | 13      | IN3                      | IN3                      | IN3                      | Synchronous 2-MHz interface inputs                                  |
| IN10                     | 15      | IN2                      | IN2                      | IN2                      |                                                                     |
| IN6                      | 17      | IN1                      | IN1                      | IN1                      |                                                                     |
| IN2                      | 19      | IN0                      | IN0                      | IN0                      |                                                                     |
| Mode                     |         | 0000                     | 1111                     | 1010                     | MI1, MI0, MO1, MO0                                                  |

Note: The input, output and tristate control line numbers shown in the center columns of this table are logical line numbers. The corresponding pin names are listed in the left most column.

Detailed Register Description

4.2 Status Register (STA)

Access in the multiplexed  $\mu$ P-interface mode:

Read, address: 0<sub>H</sub>

Access in the demultiplexed  $\mu$ P-interface mode:

Read, address: 0<sub>H</sub>

|     |   |   |   |     |     |     |     |
|-----|---|---|---|-----|-----|-----|-----|
| AD7 |   |   |   | AD0 |     |     |     |
| B   | Z | X | X | VN3 | VN2 | VN1 | VN0 |

- X

don't care
- B

**Busy:** The chip is busy resetting the connection memory (B = 1). B is undefined after power up and logical 0 after the device initialization. The three byte indirect access register is not accessible.  
*Note: The maximum time for resetting is 250  $\mu$ s.*
- Z

Incomplete instruction; a three byte indirect instruction is not completed (Z = 1). Z is 0 after power up.  
*Note: Z is reset and the indirect access is cancelled by setting MOD:RI or resetting MOD:RC.*

VN (3:0) Version Number according to the table below:

| VN3 | VN2 | VN1 | VN0 | Device Versions |
|-----|-----|-----|-----|-----------------|
| 1   | 0   | 0   | 0   | A1              |
| 1   | 0   | 0   | 1   | V 1.2           |

4.3 Conference Status Register (CST)

Access in the multiplexed  $\mu$ P-interface mode:

Read, address: 4<sub>H</sub>

Access in the demultiplexed  $\mu$ P-interface mode:

Read, address: 2<sub>H</sub>

Reset value: 00<sub>H</sub>

|     |    |     |     |     |     |     |     |
|-----|----|-----|-----|-----|-----|-----|-----|
| AD7 |    |     |     | AD0 |     |     |     |
| X   | IR | COV | CN4 | CN3 | CN2 | CN1 | CN0 |

- X

don't care
- IR

**Initialization Request.** The connection memory and the conference control memory may have lost data (IR = 1). The IR bit is set after power failure or inappropriate clocking and is reset by reading CST.
- COV

**Conference Overflow** (overflow  $\Rightarrow$  logical 1)
- CN4 ... CN0

**Conference Number** of the conference in overflow

Detailed Register Description

4.4 Conference Mask Register (CMR)

Access in the multiplexed  $\mu$ P-interface mode: Write, address:  $4_H$   
Access in the demultiplexed  $\mu$ P-interface mode: Write, address:  $2_H$   
Reset value:  $00_H$

|     |    |     |   |     |   |   |   |
|-----|----|-----|---|-----|---|---|---|
| AD7 |    |     |   | AD0 |   |   |   |
| 0   | IR | COV | 0 | 0   | 0 | 0 | 0 |

A logical 1 disables the corresponding interrupt.

**IR**     **Initialization Request** mask; the initialization request is masked ( $IR = 1$ )  
**COV**   **Conference Overflow** mask; the conference overflow is masked ( $COV = 1$ )

4.5 Indirect Access Register (IAR)

Access in the multiplexed  $\mu$ P-interface mode: Read/write, address:  $2_H$   
Access in the demultiplexed  $\mu$ P-interface mode: Read/write, address:  $1_H$

An indirect access is performed by reading/writing three consecutive bytes (first byte = control byte, second byte = data byte, third byte = address byte) to/from IAR.

|       |     |     |     |     |     |     |       |              |
|-------|-----|-----|-----|-----|-----|-----|-------|--------------|
| Bit 7 |     |     |     |     |     |     | Bit 0 |              |
| C3    | C2  | K1  | K0  | C1  | C0  | D9  | D8    | Control Byte |
| D7    | D6  | D5  | D4  | D3  | D2  | D1  | D0    | Data Byte    |
| IA7   | IA6 | IA5 | IA4 | IA3 | IA2 | IA1 | IA0   | Address Byte |

**K1, K0**     control the indirect access according to the following table  
**C3 – C0**     additional programming bits

| K1, K0 | C3 – C0                   | D8 | Type of Access                                                   |
|--------|---------------------------|----|------------------------------------------------------------------|
| 00     | $X_H$                     | –  | Read CM                                                          |
| 10/01  | $0_H, 2_H$<br>$4_H – F_H$ | –  | Write CM: transp. switch, att. value programmable with C3 ... C0 |
|        | $1_H, 3_H$                | –  | Write CM: conf. switch, att. value programmable with D8 – D6     |
| 11     | $4_H$                     | –  | Write CCM, first access                                          |
|        | $6_H$                     | –  | Read CCM, first access                                           |
|        | $8_H$                     | –  | Write CCM, second access                                         |
|        | $A_H$                     | –  | Read CCM, second access                                          |
|        | $0_H$                     | 0  | Write indirect register                                          |
|        | $0_H$                     | 1  | Read indirect register                                           |

X = don't care; – is not needed to define type of access

Detailed Register Description

Attenuation

Table 10  
Transparent Switching

| C3 ... C0      | Attenuation |
|----------------|-------------|
| 0 <sub>H</sub> | 0 dB        |
| A <sub>H</sub> | 1 dB        |
| 2 <sub>H</sub> | 2 dB        |
| B <sub>H</sub> | 3 dB        |
| 4 <sub>H</sub> | 4 dB        |
| 5 <sub>H</sub> | 5 dB        |
| 6 <sub>H</sub> | 6 dB        |
| 7 <sub>H</sub> | 7 dB        |
| 8 <sub>H</sub> | 8 dB        |
| 9 <sub>H</sub> | 10 dB       |
| F <sub>H</sub> | 12 dB       |
| E <sub>H</sub> | – 2 dB      |
| D <sub>H</sub> | – 3 dB      |
| C <sub>H</sub> | – 4 dB      |

Table 11  
Conference Switching

| C3 ... C0      | D8 – D6                      | Attenuation |
|----------------|------------------------------|-------------|
| 1 <sub>H</sub> | 0 <sub>H</sub>               | 0 dB        |
|                | 1 <sub>H</sub> <sup>1)</sup> | –           |
|                | 2 <sub>H</sub>               | 2 dB        |
|                | 3 <sub>H</sub> <sup>1)</sup> | –           |
|                | 4 <sub>H</sub>               | 4 dB        |
|                | 5 <sub>H</sub>               | 5 dB        |
|                | 6 <sub>H</sub>               | 6 dB        |
|                | 7 <sub>H</sub>               | 7 dB        |
| 3 <sub>H</sub> | 0 <sub>H</sub>               | 8 dB        |
|                | 1 <sub>H</sub>               | 10 dB       |
|                | 2 <sub>H</sub>               | 1 dB        |
|                | 3 <sub>H</sub>               | 3 dB        |
|                | 4 <sub>H</sub>               | – 4 dB      |
|                | 5 <sub>H</sub>               | – 3 dB      |
|                | 6 <sub>H</sub>               | – 2 dB      |
|                | 7 <sub>H</sub>               | 12 dB       |

<sup>1)</sup> may not select

Detailed Register Description

Access to CM

|                       |                                                                                                                                                     |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
|                       | Transparent Switching (i.e. the MUSAC-A works exactly like a MTSC)<br>C3 ... C0 = 0 <sub>H</sub> , 2 <sub>H</sub> , 4 <sub>H</sub> – F <sub>H</sub> |
| D9                    | Validity bit: A logical 0 enables the programmed connection, a logical 1 tristates the outputs                                                      |
| D8 ... D0             | Logical line and time-slot number of the inputs                                                                                                     |
| IA7... IA0            | Logical line and time-slot number of the outputs                                                                                                    |
| C3 ... C0,<br>D9 – D0 | Is written to the CM address IA7 – IA0                                                                                                              |
|                       | Conference switching or multipoint switching mode C3 ... C0 = 1 <sub>H</sub> , 3 <sub>H</sub>                                                       |
| D9                    | Validity bit: A logical 0 enables the programmed connection, a logical 1 tristates the outputs                                                      |
| D8 ... D6             | Output attenuation                                                                                                                                  |
| D5 ... D0             | Conference control address                                                                                                                          |
| IA7 ... IA0           | Logical line and time-slot number of the outputs                                                                                                    |
| C3 ... C0,<br>D9 – D0 | Is written to the CM address IA7 – IA0. D5 – D0 contain the address which points to the appropriate CCM location.                                   |

D8 – D0 and IA7 – IA0 contain the information for the logical line and time-slot numbers of the programmed connection, D8 – D0 for the inputs, IA7 – IA0 for the outputs. **Table 12** shows the programming of these bits for standard configuration, **table 13 and 14** for the primary access configuration.

Detailed Register Description

Standard Configuration

Table 12  
Time-Slot and Line Programming for Standard Configuration

|                                                            |     |     |    |     |                     |
|------------------------------------------------------------|-----|-----|----|-----|---------------------|
| Standard configuration, all modes except space switch mode |     |     |    |     |                     |
| 2-Mbit/s input lines                                       | Bit | D3  | to | D0  | Logical line number |
|                                                            | Bit | D8  | to | D4  | Time-slot number    |
|                                                            | Bit | D9  |    |     | Validity bit        |
| 4-Mbit/s input lines                                       | Bit | D2  | to | D0  | Logical line number |
|                                                            | Bit | D8  | to | D3  | Time-slot number    |
|                                                            | Bit | D9  |    |     | Validity bit        |
| 8-Mbit/s input lines                                       | Bit | D1  | to | D0  | Logical line number |
|                                                            | Bit | D8  | to | D2  | Time-slot number    |
|                                                            | Bit | D9  |    |     | Validity bit        |
| 2-Mbit/s output lines                                      | Bit | IA2 | to | IA0 | Line number         |
|                                                            | Bit | IA7 | to | IA3 | Time-slot number    |
| 4-Mbit/s output lines                                      | Bit | IA1 | to | IA0 | Line number         |
|                                                            | Bit | IA7 | to | IA2 | Time-slot number    |
| 8-Mbit/s output lines                                      | Bit | IA0 |    |     | Line number         |
|                                                            | Bit | IA7 | to | IA1 | Time-slot number    |

Detailed Register Description

Primary Access Configuration

Table 13  
Time-Slot and Line Programming for the Primary Access Configuration

|                       |     |     |    |     |                                |
|-----------------------|-----|-----|----|-----|--------------------------------|
| 2-Mbit/s input lines  | Bit | D1  | to | D0  | Interface select in            |
|                       | Bit | D3  | to | D2  | Line number                    |
|                       | Bit | D8  | to | D4  | Time-slot number               |
|                       | Bit | D9  |    |     | Validity bit                   |
| 4-Mbit/s input lines  | Bit | D1  | to | D0  | Fixed to 01 (system interface) |
|                       | Bit | D2  |    |     | time slot number               |
|                       | Bit | D8  | to | D3  | Time-slot number               |
|                       | Bit | D9  |    |     | Validity bit                   |
| 8-Mbit/s input lines  | Bit | D1  | to | D0  | Fixed to 01 (system interface) |
|                       | Bit | D8  | to | D2  | Time slot number               |
|                       | Bit | D9  |    |     | Validity bit                   |
| 2-Mbit/s output lines | Bit | IA0 |    |     | Interface select out           |
|                       | Bit | IA2 | to | IA1 | Line number                    |
|                       | Bit | IA7 | to | IA3 | Time-slot number               |
| 4-Mbit/s output lines | Bit | IA0 |    |     | Fixed to 0 (system interface)  |
|                       | Bit | IA1 |    |     | Line number                    |
|                       | Bit | IA7 | to | IA2 | Time-slot number               |
| 8-Mbit/s output lines | Bit | IA0 |    |     | Fixed to 0 (system interface)  |
|                       | Bit | IA7 | to | IA1 | Time-slot number               |

Detailed Register Description

The interface select bits have to be programmed as shown in the following table:

Table 14  
Interface Selection Bits

|              | System Interface | Synchronous 2-MHz Interface |
|--------------|------------------|-----------------------------|
| Input lines  | 01               | 10                          |
| Output lines | 0                | 1                           |

Access 1 to CCM

- C3 ... C0      Logical 4<sub>H</sub>, 6<sub>H</sub>
- D9      Inversion bit: In a multiparty conference there is some risk of instability due to reflections at the hybrid. If these reflections are not cancelled, they will be summed up in the conference sum and will be transmitted to the subscriber, where again they could be reflected. In very big conferences (>> 4 subscribers) this behaviour could result in an instability.  
To avoid this the PEB 2445 has the ability to invert every second conference channel, which has no audible influence on the speech quality. By this the noise due to reflections is compensated to a high degree. The feature can also be applied to reduce noise due to line impedance mismatch.
- D8 ... D0      Logical line and time-slot number of the inputs (see table 12, 13 and 14)
- IA7/IA6      Logical 0
- IA5 ... IA0      Conference control address

Access 2 to CCM

- C3 ... C0      Logical 8<sub>H</sub>, A<sub>H</sub>
- D9/D8      Noise suppression threshold
- D7/D6      Input attenuation level
- D5      Output attenuation level  
*Note: D7, D6, D5 are only relevant to conference mode; in the multipoint switching mode these bits must be logical 0.*
- D4 ... D0      Conference number: 21 independent simultaneous conferences are possible. By using the conference number 1F<sub>H</sub> an attenuation or noise suppression can be inserted in a channel without conferencing.
- IA7/IA6      Logical 0
- IA5 ... IA0      Conference control address

Detailed Register Description

Table 15

| D9 | D8 | Noise Suppression Threshold   |
|----|----|-------------------------------|
| 0  | 0  | No noise suppression          |
| 0  | 1  | Fifth step, first segment     |
| 1  | 0  | Ninth step, first segment     |
| 1  | 1  | Sixteenth step, first segment |

Table 16

| D7 | D6 | Input Attenuation Level |
|----|----|-------------------------|
| 0  | 0  | 0 dB                    |
| 0  | 1  | 3 dB                    |
| 1  | 0  | 6 dB                    |
| 1  | 1  | 9 dB                    |

Table 17

| D5 | Output Attenuation Level |
|----|--------------------------|
| 0  | 0 dB                     |
| 1  | 3 dB                     |

*Note: The sequence of programming (access 1, access 2) is important.*

Detailed Register Description

4.6 Indirect Registers

4.6.1 Configuration Register (CFR)

Access: Read or write at address FE<sub>H</sub>

Reset value: FF<sub>H</sub>

|     |   |      |      |      |    |     |     |
|-----|---|------|------|------|----|-----|-----|
| AD7 |   |      |      | AD0  |    |     |     |
| 1   | 1 | CUA2 | CUA1 | CUA0 | FS | CFS | CPS |

**CPS**                      **Clock Period Select:** Device clock is set to 8192 kHz (logical 1) or 4096 kHz (logical 0).

**CFS**                      **Configuration Select:** The MUSAC-A works either in the primary access configuration (CFS = 0) or in the standard configuration (CFS = 1).

**FS**                        **Function Select:**  
FS = 0: Multipoint switching  
FS = 1: Conferencing

**CUA0 ... CUA2**      PCM encoding law and PCM-byte format

| CUA0 | Encoding Law |
|------|--------------|
| 1    | A-law        |
| 0    | μ-law        |

| CUA2 | CUA1 | PCM-Byte Format    |
|------|------|--------------------|
| 0    | 0    | No bits inverted   |
| 0    | 1    | Even bits inverted |
| 1    | 0    | Odd bits inverted  |
| 1    | 1    | All bits inverted  |

Detailed Register Description

4.6.2 Clock Shift Register (CSR)

Access: Read or write at address FF<sub>H</sub>

Reset value: 00<sub>H</sub>

|     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|
| AD7 |     |     |     | AD0 |     |     |     |
| RS2 | RS1 | RS0 | RRE | XS2 | XS1 | XS0 | XFE |

- RS2 ...RS0

Receive clock Shift, bits 2 – 0. The received data stream is shifted in bit period steps.
- RRE

Receive with Rising Edge. The data is sampled with the falling (RRE = 0) or rising edge (RRE = 1) of the data equivalent clock.
- XS0 ...XS2

Transmit clock Shift, bits 2 – 0. The transmitted data stream is shifted.
- XFE

Transmit with Falling Edge; data is transmitted with the rising (XFE = 0) or falling edge (XFE = 1) of the device clock.

Data stream manipulation according to these register entries only affects the system interface and only in the primary access configuration. The frame structure can be moved relative to the SP slope by up to 7 clock periods in half clock period steps. This register can hold non-zero values only for a CFR:CFS value of logical 0.

Identical non-zero entries for RS2 – RS0 and XS2 – XS0 as well as identical RRE and XFE generate an output time-slot structure which is 1 time-slot late relative to the input time-slot structure.

Identical 000 entries for RS2 – RS0 and XS2 – XS0 as well as RRE and XFE being logical 0 cause the input and output frames to coincide in time.

Detailed Register Description

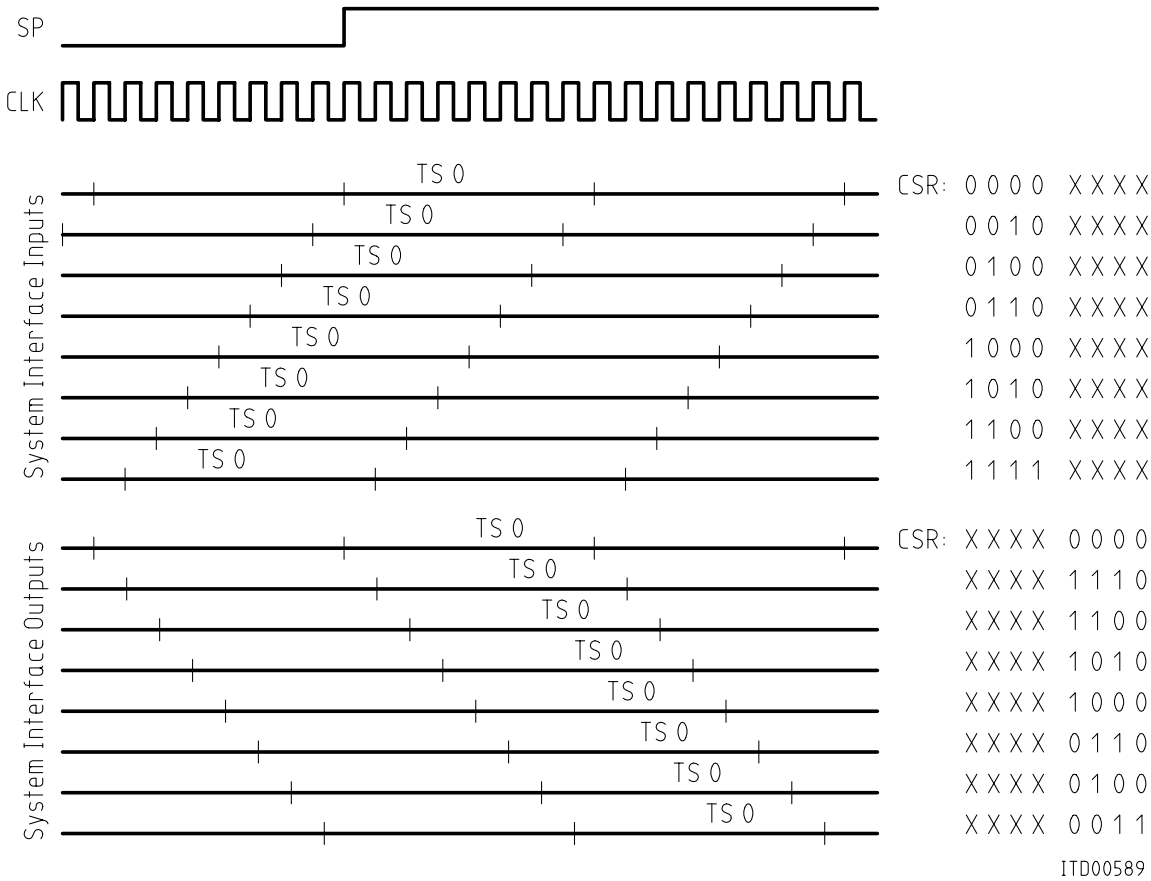


Figure 20  
Clock Shifting

Electrical Characteristics

5 Electrical Characteristics

Absolute Maximum Ratings

| Parameter                                 | Symbol           | Limit Values            | Unit |
|-------------------------------------------|------------------|-------------------------|------|
| Ambient temperature under bias: PEB       | $T_A$            | 0 to 70                 | °C   |
| Storage temperature                       | $T_{\text{stg}}$ | – 65 to 125             | °C   |
| Voltage on any pin with respect to ground | $V_S$            | – 0.4 to $V_{DD} + 0.4$ | V    |
| Maximum voltage on any pin                | $V_{\text{max}}$ | 7                       | V    |

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

*Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.*

5.1 DC Characteristics

$T_A = 0 \text{ to } 70 \text{ }^\circ\text{C}$ ;  $V_{DD} = 5 \text{ V} \pm 5 \%$ ,  $V_{SS} = 0 \text{ V}$

| Parameter                                               |                            | Symbol    | Limit Values   |                                  | Unit          | Test Condition                                                       |
|---------------------------------------------------------|----------------------------|-----------|----------------|----------------------------------|---------------|----------------------------------------------------------------------|
|                                                         |                            |           | min.           | max.                             |               |                                                                      |
| L-input voltage                                         |                            | $V_{IL}$  | – 0.4          | 0.8                              | V             |                                                                      |
| H-input voltage                                         |                            | $V_{IH}$  | 2.0<br>2.7     | $V_{DD} + 0.4$<br>$V_{DD} + 0.4$ |               | CLK and $\overline{WR}$ only                                         |
| L-output voltage                                        |                            | $V_{OL}$  |                | 0.45                             | V             | $I_{OL} = 2 \text{ mA}$                                              |
| H-output voltage                                        |                            | $V_{OH}$  | 2.4            |                                  | V             | $I_{OH} = - 400 \text{ }\mu\text{A}$                                 |
| H-output voltage                                        |                            | $V_{OH}$  | $V_{DD} - 0.5$ |                                  | V             | $I_{OH} = - 100 \text{ }\mu\text{A}$                                 |
| Power supply current                                    | operational                | $I_{CC}$  |                | 5                                | mA            | $V_{DD} = 5 \text{ V}$ , Inputs at 0 V or $V_{DD}$ , no output loads |
|                                                         | CLK = 4 MHz<br>CLK = 8 MHz |           |                | 10                               | mA            |                                                                      |
| Input leakage current                                   |                            | $I_{LI}$  |                | 10                               | $\mu\text{A}$ | $0 \text{ V} < V_{IN} < V_{DD}$ to 0 V                               |
| Output leakage current                                  |                            | $I_{LO}$  |                |                                  |               | $0 \text{ V} < V_{OUT} < V_{DD}$ to 0 V                              |
| Input leakage current at inputs with internal pull-down |                            | $I_{LPD}$ |                | 700                              | $\mu\text{A}$ | $0 \text{ V} < V_{IN} < V_{DD}$ to 0 V<br>RES, ALE, A0, A1 only      |

*Note: The listed characteristics are ensured over the operating range of the integrated circuit. Typical characteristics specify mean values expected over the production spread. If not otherwise specified, typical characteristics apply at  $T_A = 25^\circ\text{C}$  and the given supply voltage.*

Electrical Characteristics

5.2 Capacitances

$T_A = 25\text{ }^{\circ}\text{C}$ ;  $V_{DD} = 5\text{ V} \pm 5\%$ ,  $V_{SS} = 0\text{ V}$

| Parameter          | Symbol    | Limit Values |      | Unit |
|--------------------|-----------|--------------|------|------|
|                    |           | min.         | max. |      |
| Input capacitance  | $C_{IN}$  |              | 10   | pF   |
| Output capacitance | $C_{OUT}$ |              | 15   | pF   |
| I/O                | $C_{I/O}$ |              | 20   | pF   |

5.3 AC-Characteristics

Ambient temperature under bias range,  $V_{DD} = 5\text{ V} \pm 5\%$ .

Inputs are driven to 2.4 V for a logical '1' and to 0.4 V for a logical '0'.

Timing measurements are made at 2.0 V for a logical '1' and at 0.8 V for a logical '0'.

The AC-testing input/output wave forms are shown below.

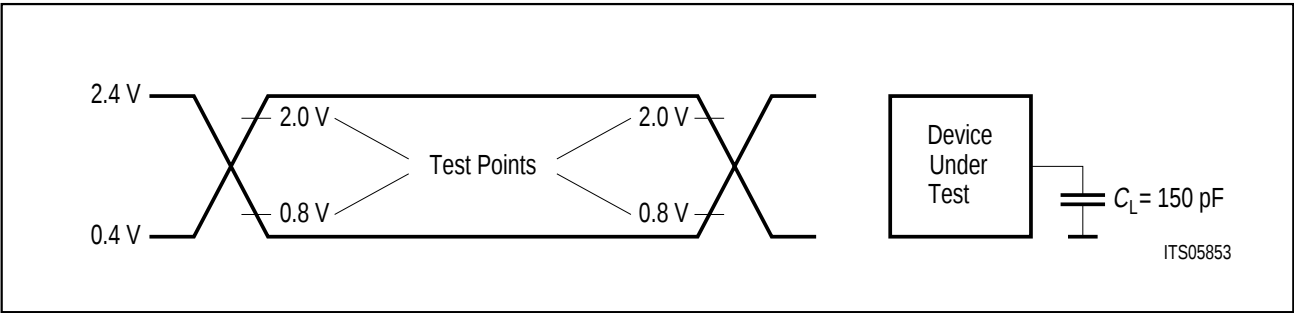


Figure 21  
I/O-Wave Form for AC-Test

5.3.1 Microprocessor Interface Timing

5.3.1.1 Intel Bus Mode

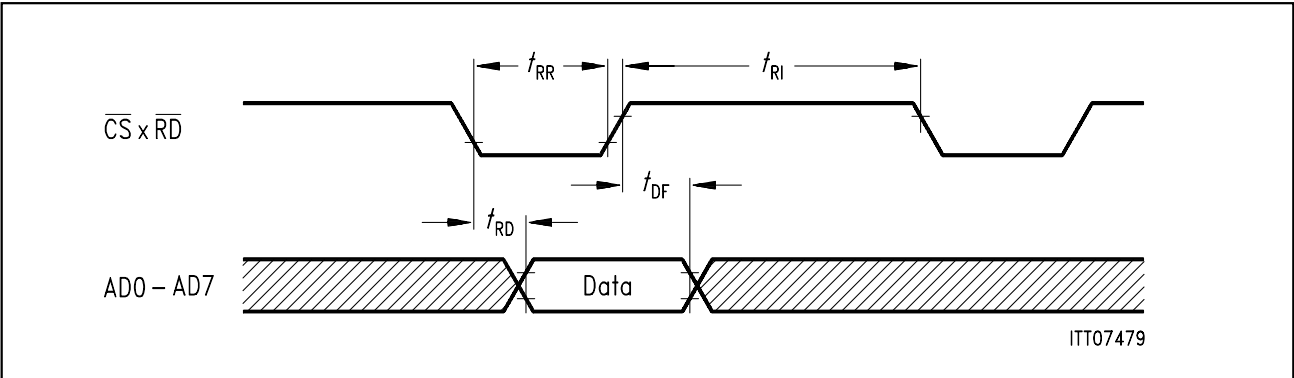


Figure 22  
 $\mu\text{P}$  Read Cycle

Electrical Characteristics

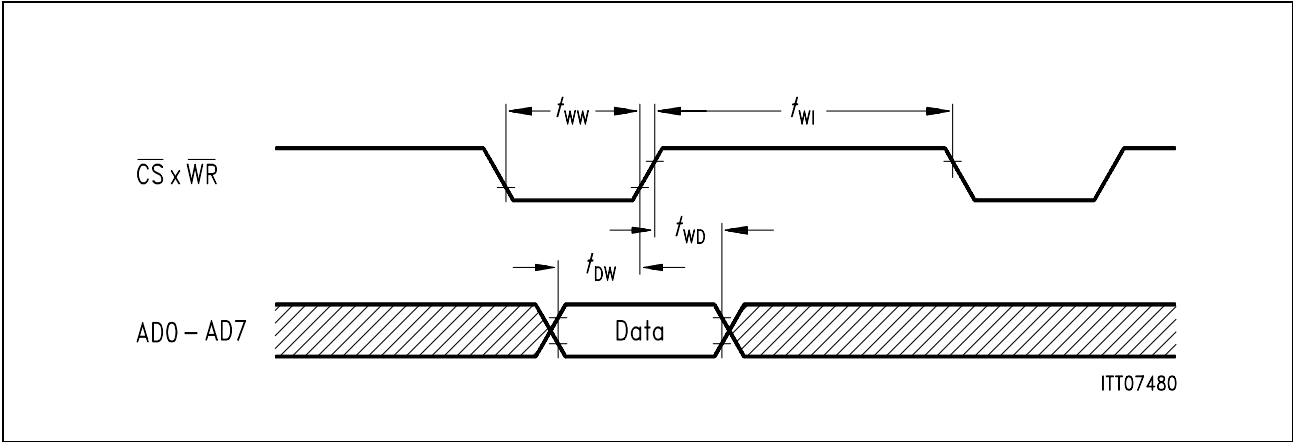


Figure 23  
 $\mu$ P Write Cycle

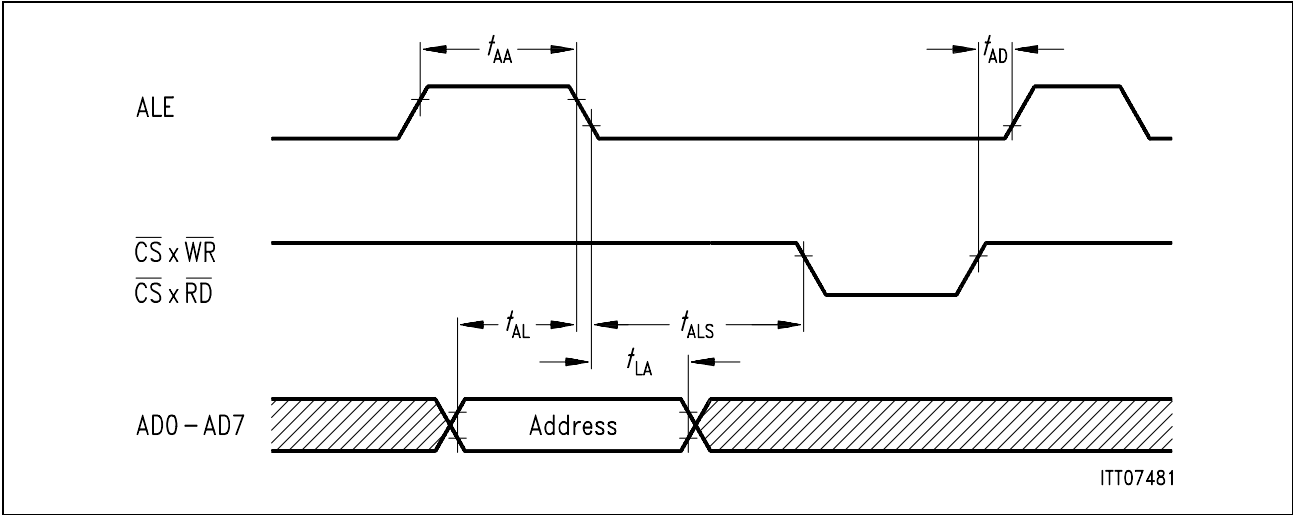


Figure 24  
Multiplexed Address Timing

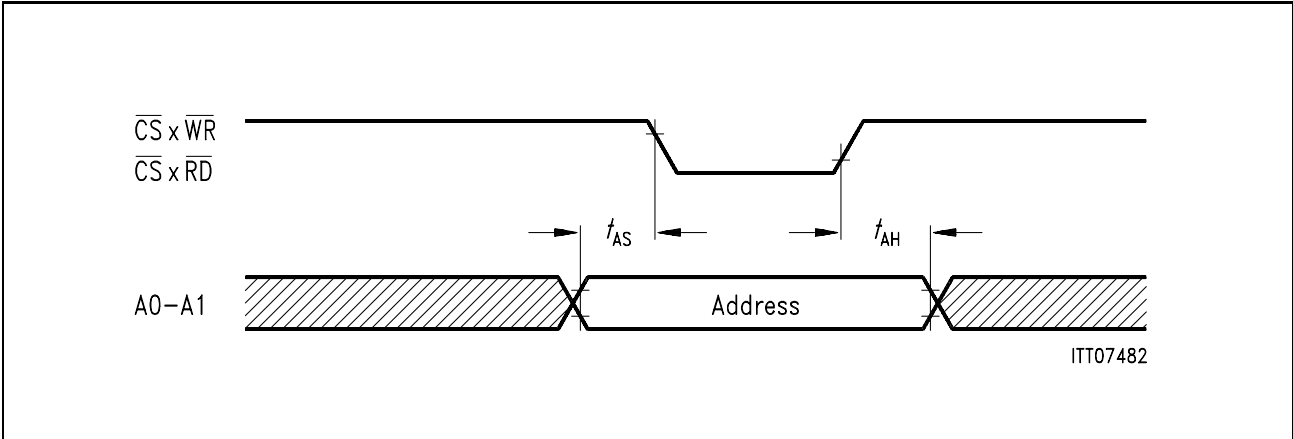


Figure 25  
Non-multiplexed Address Timing

Electrical Characteristics

Table 18  
Microprocessor Interface Timing

| Parameter                                                | Symbol    | Limit Values |      | Unit | Test Condition |
|----------------------------------------------------------|-----------|--------------|------|------|----------------|
|                                                          |           | min.         | max. |      |                |
| ALE pulse width                                          | $t_{AA}$  | 50           | —    | ns   | —              |
| Address setup time to ALE                                | $t_{AL}$  | 20           | —    | ns   | —              |
| Address hold time from ALE                               | $t_{LA}$  | 10           | —    | ns   | —              |
| Address latch setup time to $\overline{WR}$ , RD         | $t_{ALS}$ | 0            | —    | ns   | —              |
| Address setup time to $\overline{WR}$ , $\overline{RD}$  | $t_{AS}$  | 10           | —    | ns   | —              |
| Address hold time from $\overline{WR}$ , $\overline{RD}$ | $t_{AH}$  | 20           | —    | ns   | —              |
| ALE pulse delay                                          | $t_{AD}$  | 15           | —    | ns   | —              |
| $\overline{RD}$ pulse width                              | $t_{RR}$  | 110          | —    | ns   | —              |
| Data output delay from $\overline{RD}$                   | $t_{RD}$  | —            | 110  | ns   | —              |
| Data float from $\overline{RD}$                          | $t_{DF}$  | —            | 25   | ns   | —              |
| $\overline{RD}$ control interval                         | $t_{RI}$  | 70           | —    | ns   | —              |
| $\overline{WR}$ pulse width                              | $t_{WW}$  | 60           | —    | ns   | —              |
| Data setup time to $\overline{WR}$ + $\overline{CS}$     | $t_{DW}$  | 35           | —    | ns   | —              |
| Data hold time from $\overline{WR}$ + $\overline{CS}$    | $t_{WD}$  | 20           | —    | ns   | —              |
| $\overline{WR}$ control interval                         | $t_{WI}$  | 70           | —    | ns   | —              |

5.3.2 PCM Interface Timing

Table 19  
PCM Interface Timing

| Parameter       | Symbol | Limit Values |      | Unit |
|-----------------|--------|--------------|------|------|
|                 |        | min.         | max. |      |
| PCM input setup | $t_S$  | 15           | —    | ns   |
| PCM input hold  | $t_H$  | 30           | —    | ns   |
| Output Delay    | $t_D$  | —            | 45   | ns   |
| Tristate Delay  | $t_T$  | —            | 66   | ns   |

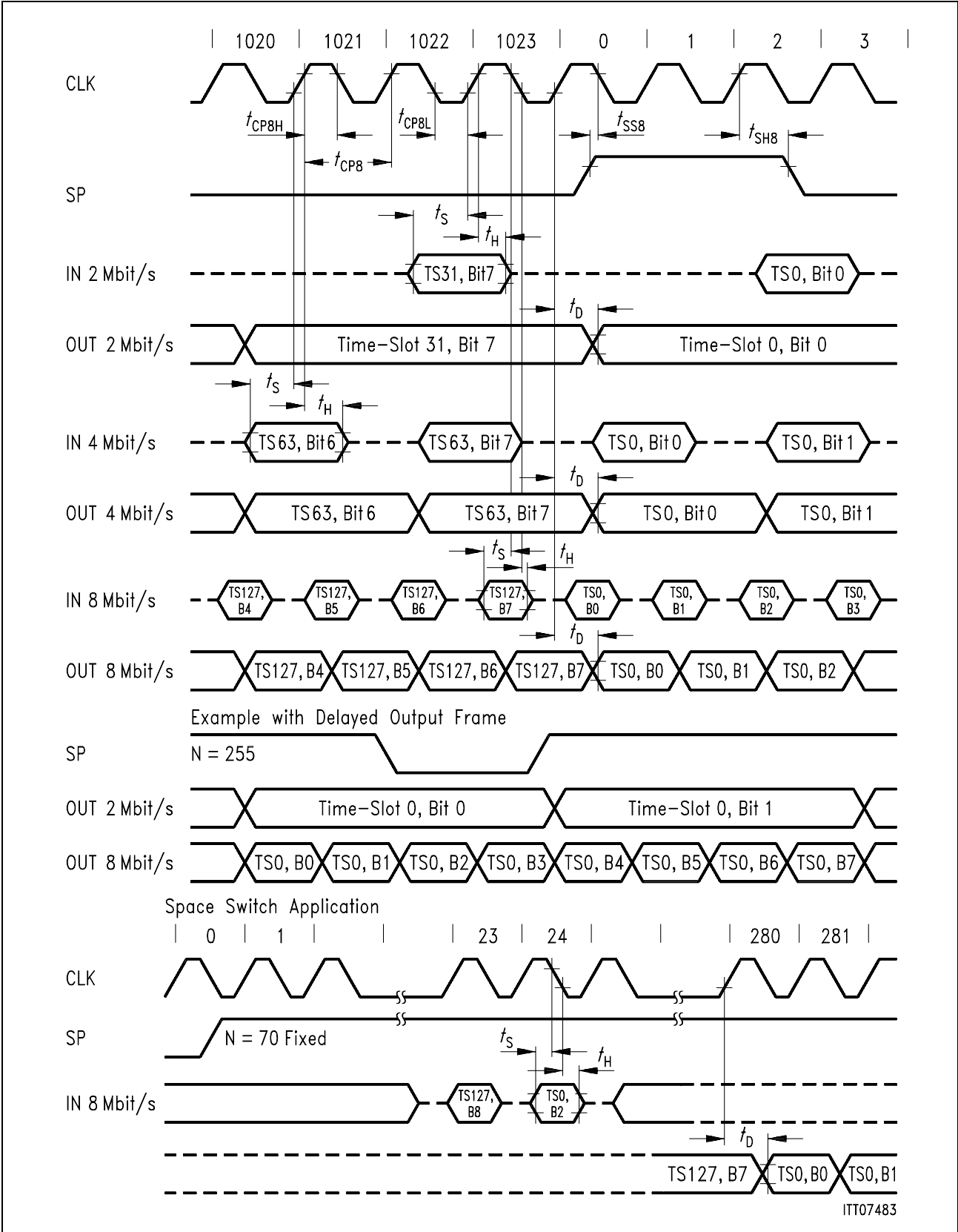
Electrical Characteristics

5.3.3 Clock and Synchronization Timing

Table 20  
PCM Interface Timing

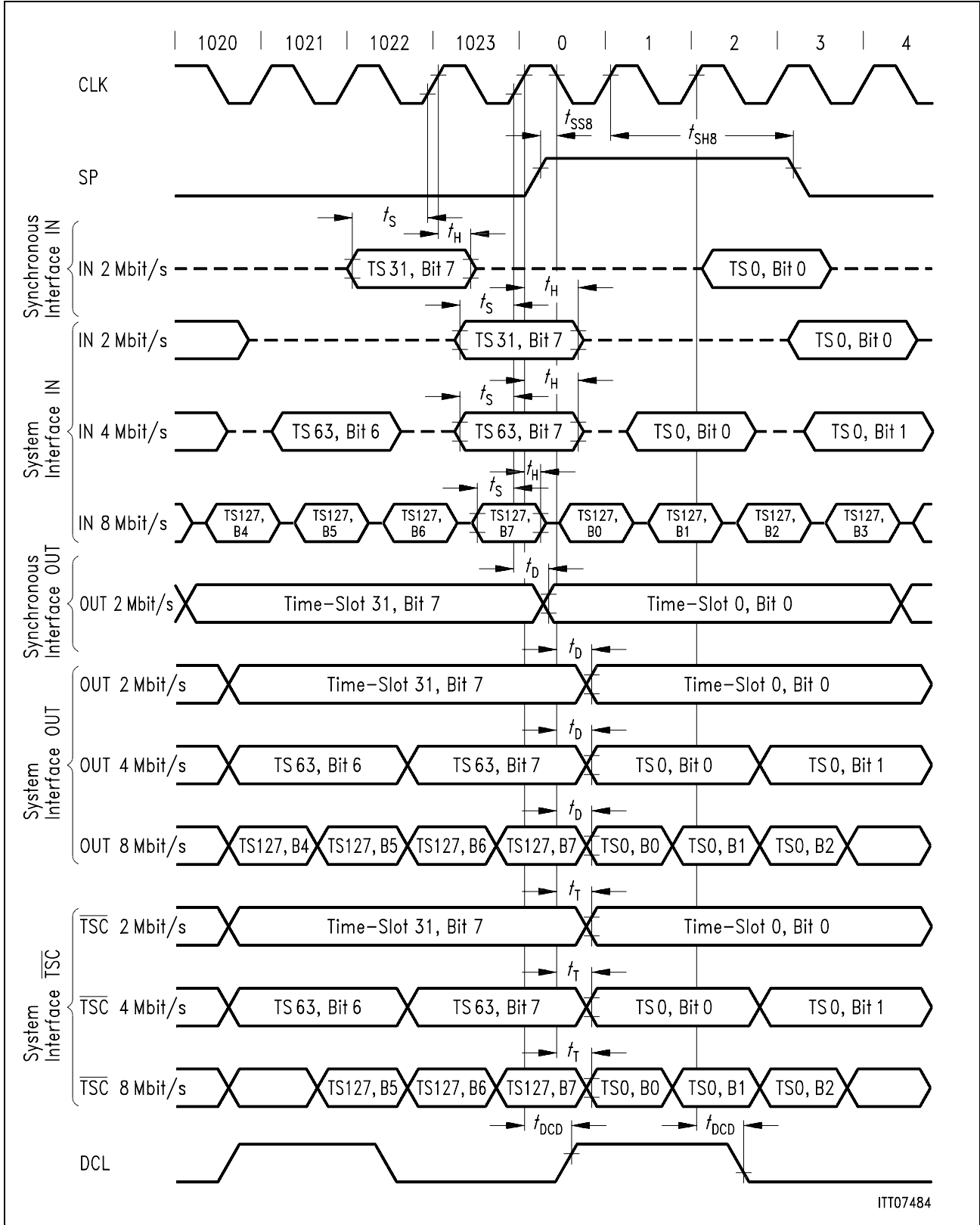
| Parameter                         | Symbol     | Limit Values |                                | Unit |
|-----------------------------------|------------|--------------|--------------------------------|------|
|                                   |            | min.         | max.                           |      |
| Clock period 8 MHz high           | $t_{CP8H}$ | 40           | —                              | ns   |
| Clock period 8 MHz low            | $t_{CP8L}$ | 48           | —                              | ns   |
| Clock period 8 MHz                | $t_{CP8}$  | 120          | —                              | ns   |
| Synchronization pulse setup 8 MHz | $t_{SS8}$  | 20           | $t_{CP8} - 20$                 | ns   |
| Synchronization pulse delay 8 MHz | $t_{SH8}$  | 0            | $t_{CP8} - 20$                 | ns   |
| Clock period 4 MHz high           | $t_{CP4H}$ | 90           | —                              | ns   |
| Clock period 4 MHz low            | $t_{CP4L}$ | 90           | —                              | ns   |
| Clock period 4 MHz                | $t_{CP4}$  | 240          | —                              | ns   |
| Synchronization pulse setup 4 MHz | $t_{SS4}$  | 20           | $t_{CP4} - 30$                 | ns   |
| Synchronization pulse delay 4 MHz | $t_{SH4}$  | 30           | $t_{CP4} - 10$<br>$+ t_{CP4H}$ | ns   |
| Data clock delay                  | $t_{DCD}$  | —            | 100                            | ns   |
| Synchronization pulse low         | $t_{SPL}$  | 100          | —                              | ns   |

Electrical Characteristics



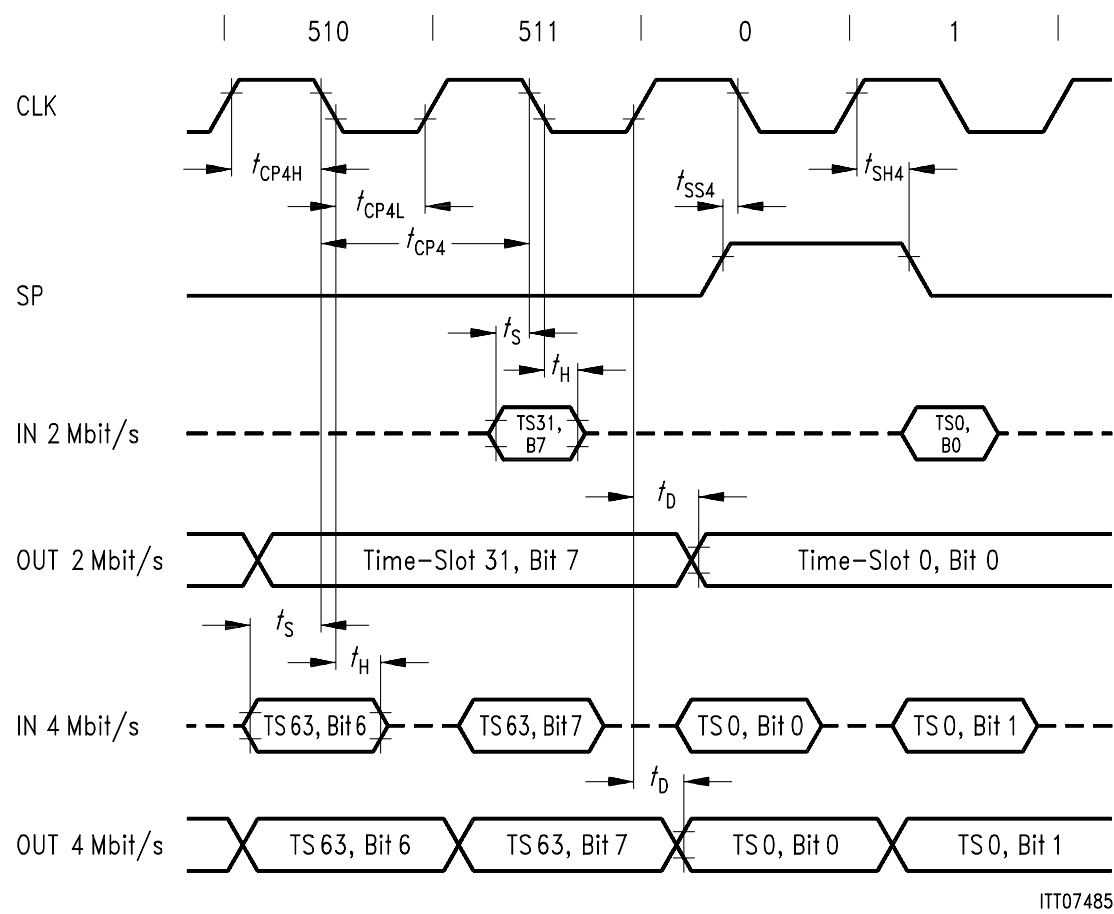
**Figure 26**  
**PCM Line Timing in Standard Configuration with a 8 MHz Device Clock**

Electrical Characteristics



**Figure 27**  
**PCM Line Timing in Primary Access Configuration with a 8 MHz Device Clock and a CSR Entry (00010001)**

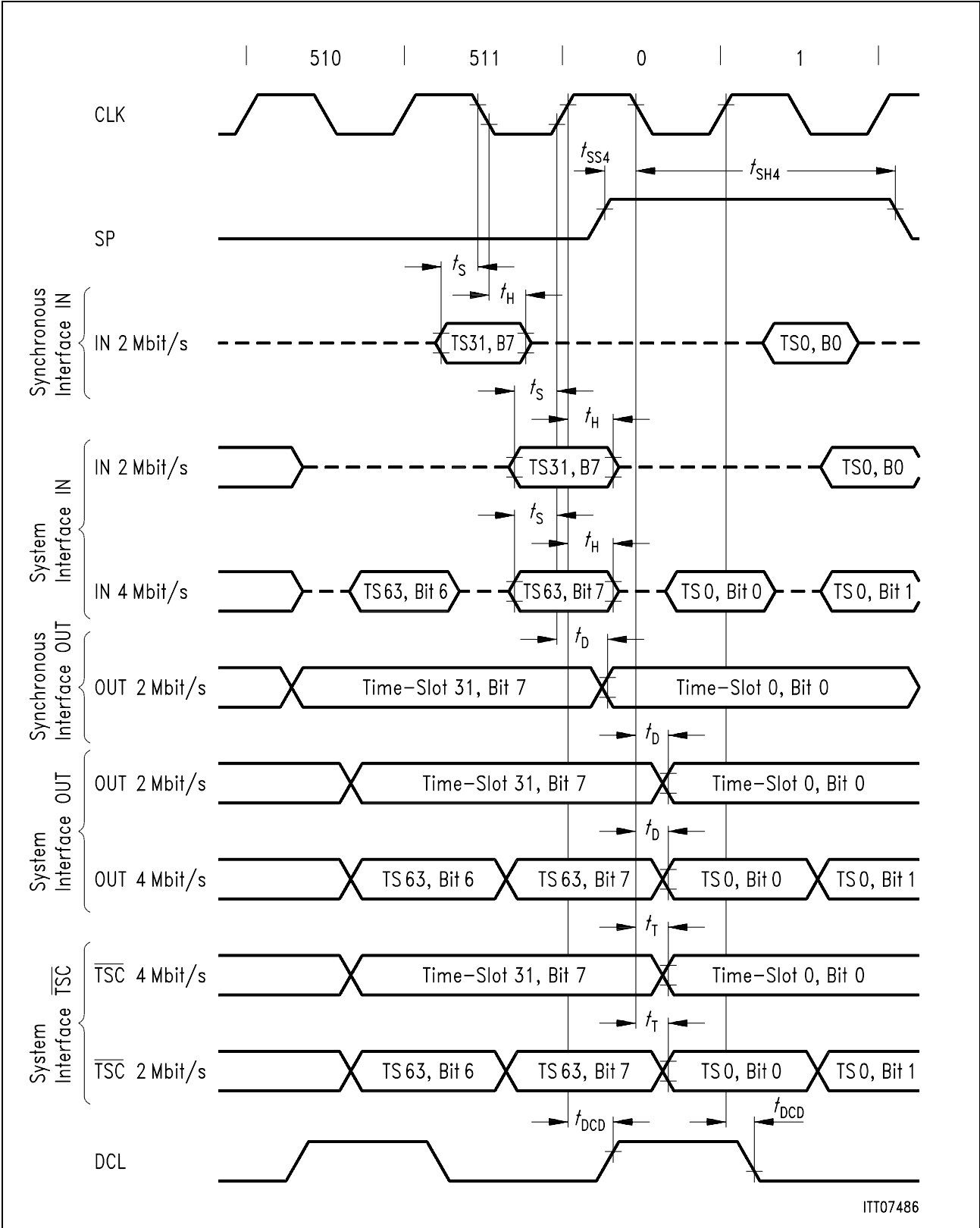
Electrical Characteristics



ITT07485

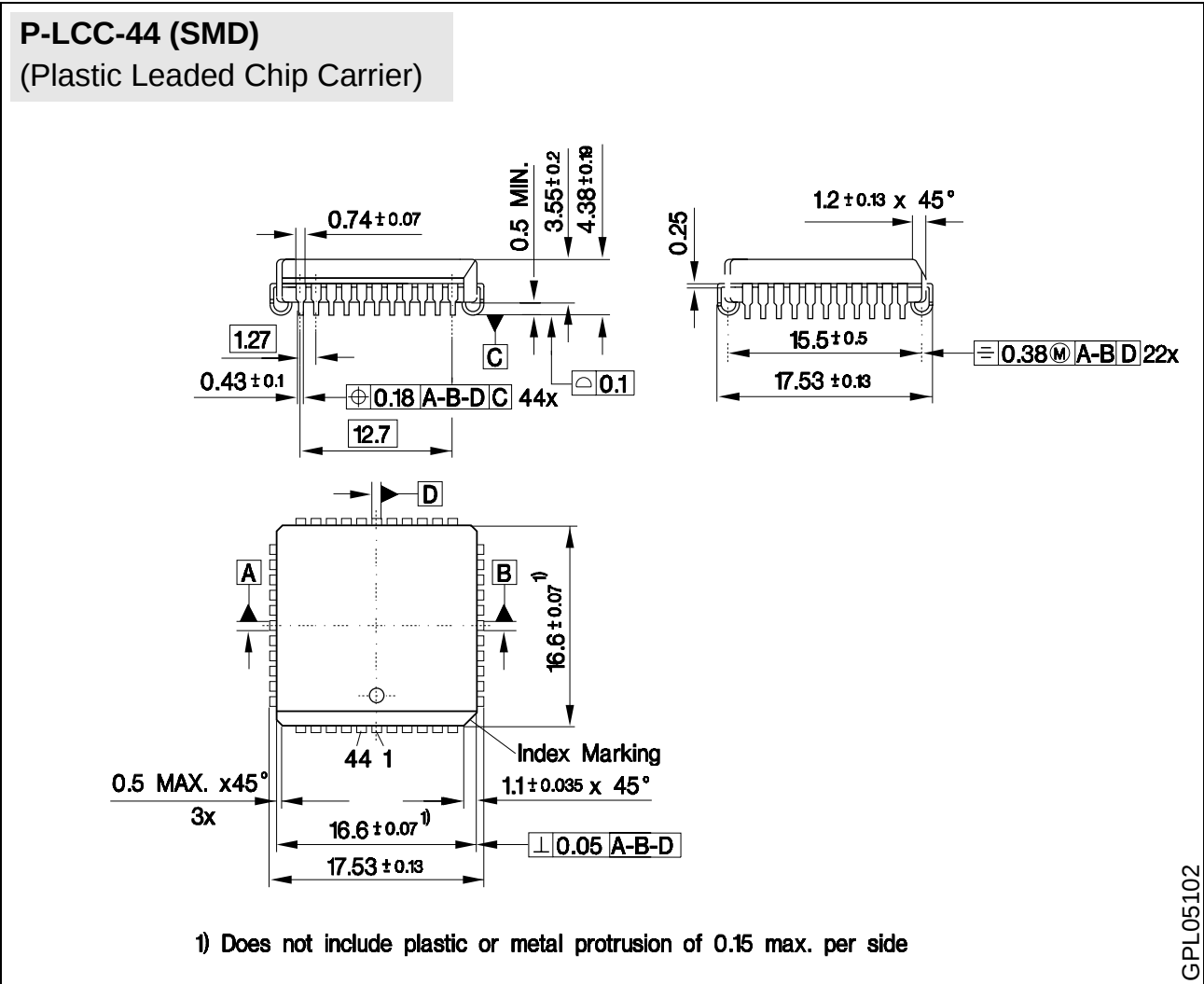
**Figure 28**  
**PCM Line Timing in Standard Configuration with a 4 MHz Device Clock**

Electrical Characteristics



**Figure 29**  
**PCM Line Timing in Primary Access Configuration with a 4 MHz Device Clock and a CSR Entry (00010001)**

6 Package Outlines



GPL05102

Sorts of Packing

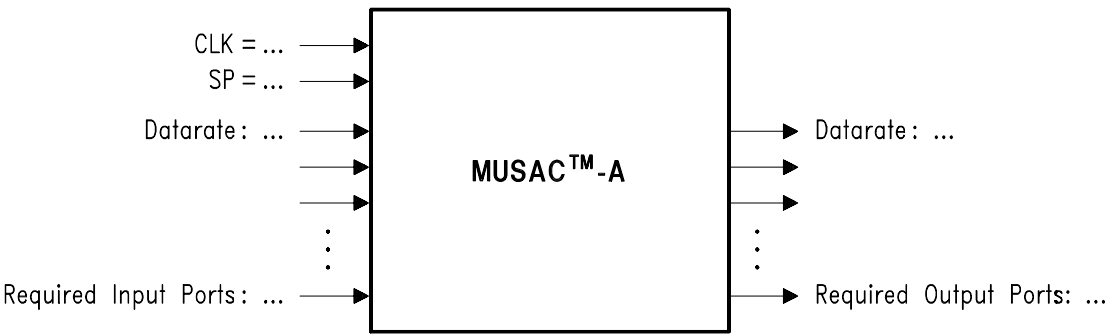
Package outlines for tubes, trays etc. are contained in our Data Book "Package Information".

MD = Surface Mounted Device

Dimensions in mm

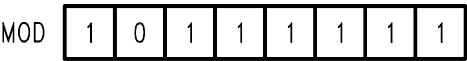
7 Appendix

7.1 Initialization for Conferencing in a PBX

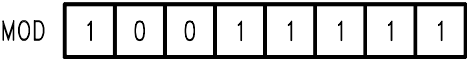


ITS07487

- 1.) Fill in the system parameters
- 2.) Reset indirect access mechanism  
    disable all outputs (standby mode)

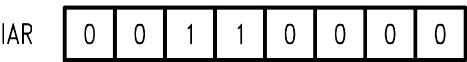


- 3.) Release IAR reset; stay in standby mode



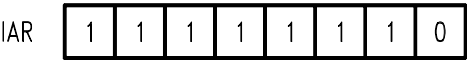
- 4.) Do the hardware settings:

3 byte IAR access  
to register CFR



0 1 1 = A-Law  
0 0 0 = u-Law

0 = 4 MHz  
1 = 8 MHz

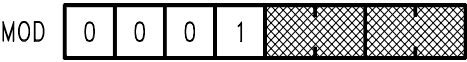


- 5.) Wait for 1.8 μs if device clock = 4 MHz

- 6.) Select the output mode:<sup>1)</sup>  
    the input mode:<sup>1)</sup>

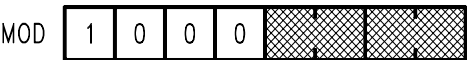
MOD:MO 0...1  
MOD:MI 0...1

- 7.) Reset CM; standby mode



- 8.) Wait for STAR:B = 0

- 9.) Turn off standby mode



- 10.) Assign the physical to the logical ports using the selected mode.<sup>2)</sup>

ITD07488

<sup>1)</sup> See table 7  
<sup>2)</sup> See table 8

7.2 Programming a Conference in a PBX

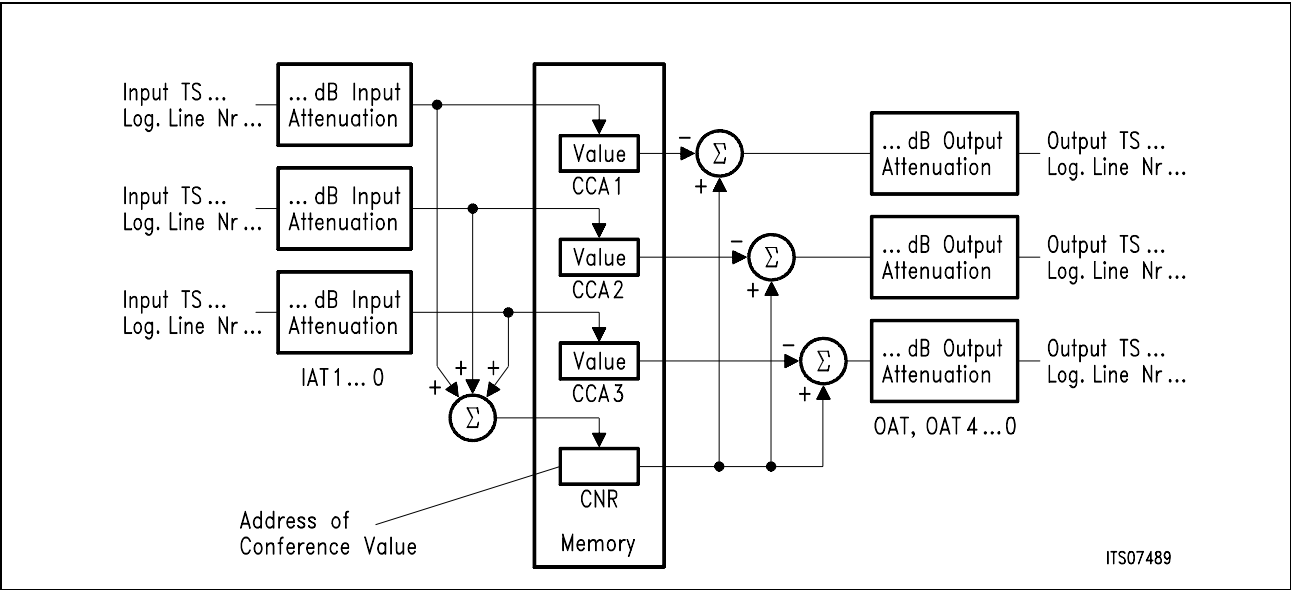


Figure 30

Table 21

| Procedure for each Conference                                                                                                                                                                                 | Bits in IAR             | Values for Subscribers |        |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|------------------------|--------|--------|
|                                                                                                                                                                                                               |                         | TE 'A'                 | TE 'B' | TE 'C' |
| 1. Make a list of the conference subscribers                                                                                                                                                                  |                         |                        |        |        |
| 2. Determine the input time slot<br>Determine the logical input port                                                                                                                                          | ITS6 ... 0<br>L3 ... 0  |                        |        |        |
| 3. Determine the output time slot<br>Determine the logical output port                                                                                                                                        | OTS6 ... 0<br>OL2 ... 0 |                        |        |        |
| 4. Find an unused conference number                                                                                                                                                                           | CNR4 ... 0              |                        |        |        |
| 5. Assign an unused conference control address to every conference input                                                                                                                                      | CCA5 ... 0              |                        |        |        |
| 6. Fix the input attenuation                                                                                                                                                                                  | IAT1 ... 0              |                        |        |        |
| 7. Fix the output attenuation                                                                                                                                                                                 | OAT,<br>OAT4 ... 0      |                        |        |        |
| 8. Fix the noise suppression threshold                                                                                                                                                                        | NOI1 ... 0              |                        |        |        |
| 9. Insert the determined values in the corresponding bit positions of the 'MUSAC-A Work Sheet' (see <b>chapter 7.3</b> and <b>7.4</b> ). Write the 9 bytes to the CM and CCM using the three byte IAR access. |                         |                        |        |        |

7.3 Programming Procedure for Switching TS's

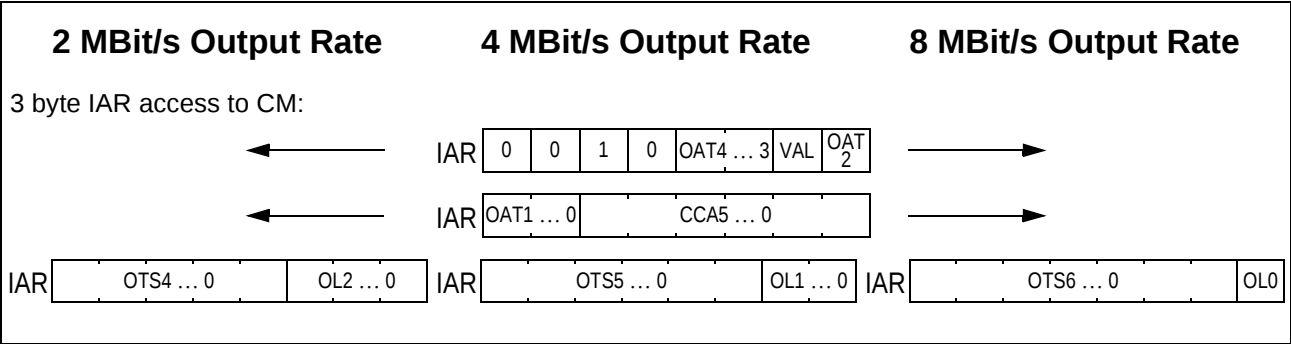
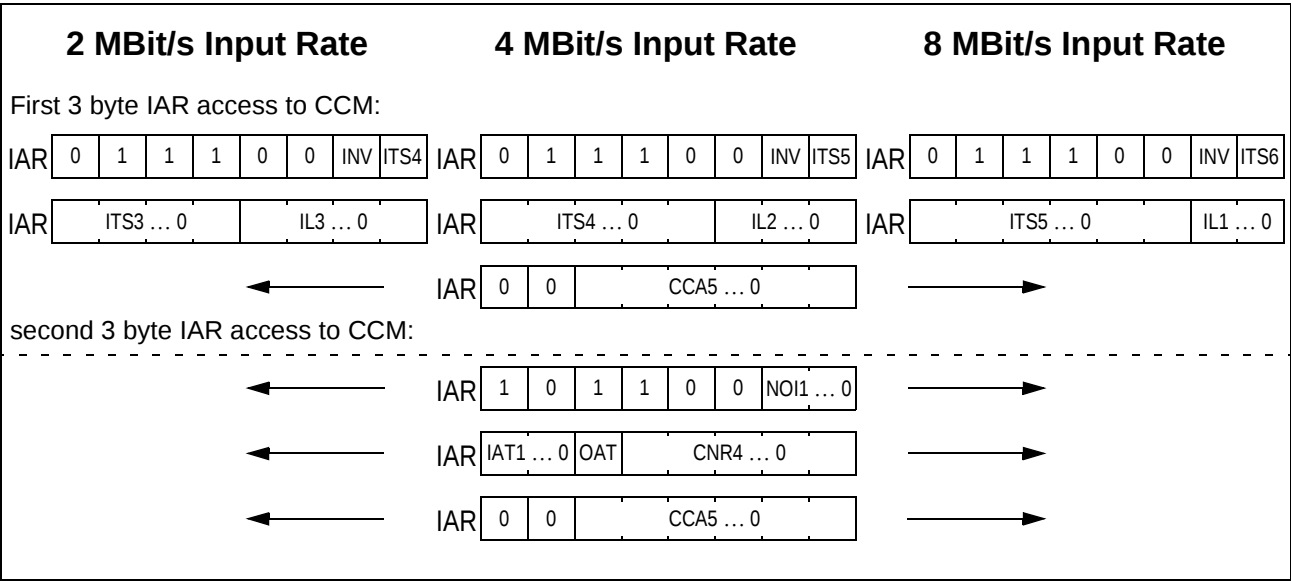
- Select a column for input and output rate
- Fill in the values of the bits
- Write the 3 bytes (from top to bottom) to register IAR

| 2 MBit/s Output Rate                                                                                        | 4 MBit/s Output Rate | 8 MBit/s Output Rate |          |          |      |      |                                                                                                             |          |   |   |          |     |      |                                                                                                             |          |   |   |          |     |      |
|-------------------------------------------------------------------------------------------------------------|----------------------|----------------------|----------|----------|------|------|-------------------------------------------------------------------------------------------------------------|----------|---|---|----------|-----|------|-------------------------------------------------------------------------------------------------------------|----------|---|---|----------|-----|------|
| 3 byte IAR access to CM:                                                                                    |                      |                      |          |          |      |      |                                                                                                             |          |   |   |          |     |      |                                                                                                             |          |   |   |          |     |      |
| IAR <table><tr><td>OAT3...2</td><td>1</td><td>0</td><td>OAT1...0</td><td>VAL</td><td>ITS4</td></tr></table> | OAT3...2             | 1                    | 0        | OAT1...0 | VAL  | ITS4 | IAR <table><tr><td>OAT3...2</td><td>1</td><td>0</td><td>OAT1...0</td><td>VAL</td><td>ITS5</td></tr></table> | OAT3...2 | 1 | 0 | OAT1...0 | VAL | ITS5 | IAR <table><tr><td>OAT3...2</td><td>1</td><td>0</td><td>OAT1...0</td><td>VAL</td><td>ITS6</td></tr></table> | OAT3...2 | 1 | 0 | OAT1...0 | VAL | ITS6 |
| OAT3...2                                                                                                    | 1                    | 0                    | OAT1...0 | VAL      | ITS4 |      |                                                                                                             |          |   |   |          |     |      |                                                                                                             |          |   |   |          |     |      |
| OAT3...2                                                                                                    | 1                    | 0                    | OAT1...0 | VAL      | ITS5 |      |                                                                                                             |          |   |   |          |     |      |                                                                                                             |          |   |   |          |     |      |
| OAT3...2                                                                                                    | 1                    | 0                    | OAT1...0 | VAL      | ITS6 |      |                                                                                                             |          |   |   |          |     |      |                                                                                                             |          |   |   |          |     |      |
| IAR <table><tr><td colspan="3">ITS3...0</td><td colspan="3">IL3...0</td></tr></table>                       | ITS3...0             |                      |          | IL3...0  |      |      | IAR <table><tr><td colspan="3">ITS4...0</td><td colspan="3">IL2...0</td></tr></table>                       | ITS4...0 |   |   | IL2...0  |     |      | IAR <table><tr><td colspan="3">ITS5...0</td><td colspan="3">IL1...0</td></tr></table>                       | ITS5...0 |   |   | IL1...0  |     |      |
| ITS3...0                                                                                                    |                      |                      | IL3...0  |          |      |      |                                                                                                             |          |   |   |          |     |      |                                                                                                             |          |   |   |          |     |      |
| ITS4...0                                                                                                    |                      |                      | IL2...0  |          |      |      |                                                                                                             |          |   |   |          |     |      |                                                                                                             |          |   |   |          |     |      |
| ITS5...0                                                                                                    |                      |                      | IL1...0  |          |      |      |                                                                                                             |          |   |   |          |     |      |                                                                                                             |          |   |   |          |     |      |
| IAR <table><tr><td colspan="3">OTS4...0</td><td colspan="3">OL2...0</td></tr></table>                       | OTS4...0             |                      |          | OL2...0  |      |      | IAR <table><tr><td colspan="3">OTS5...0</td><td colspan="3">OL1...0</td></tr></table>                       | OTS5...0 |   |   | OL1...0  |     |      | IAR <table><tr><td colspan="3">OTS6...0</td><td colspan="3">OL0</td></tr></table>                           | OTS6...0 |   |   | OL0      |     |      |
| OTS4...0                                                                                                    |                      |                      | OL2...0  |          |      |      |                                                                                                             |          |   |   |          |     |      |                                                                                                             |          |   |   |          |     |      |
| OTS5...0                                                                                                    |                      |                      | OL1...0  |          |      |      |                                                                                                             |          |   |   |          |     |      |                                                                                                             |          |   |   |          |     |      |
| OTS6...0                                                                                                    |                      |                      | OL0      |          |      |      |                                                                                                             |          |   |   |          |     |      |                                                                                                             |          |   |   |          |     |      |

|            |                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ITS6 ... 0 | Input time slot number                                                                                                                                                                                                                                                                                                                                                                           |
| IL0 ... 3  | Logical input line number                                                                                                                                                                                                                                                                                                                                                                        |
| VAL        | <b>Validity:</b> output enabled (= 0)<br>output disabled (= 1)                                                                                                                                                                                                                                                                                                                                   |
| OTS6 ... 0 | Output time slot                                                                                                                                                                                                                                                                                                                                                                                 |
| OL2 ... 0  | Logical output line number                                                                                                                                                                                                                                                                                                                                                                       |
| OAT3 ... 0 | <b>Output attenuation:</b><br>0 <sub>H</sub> = 0 dB<br>A <sub>H</sub> = 1 dB<br>2 <sub>H</sub> = 2 dB<br>B <sub>H</sub> = 3 dB<br>4 <sub>H</sub> = 4 dB<br>5 <sub>H</sub> = 5 dB<br>6 <sub>H</sub> = 6 dB<br>7 <sub>H</sub> = 7 dB<br>8 <sub>H</sub> = 8 dB<br>9 <sub>H</sub> = 10 dB<br>F <sub>H</sub> = 12 dB<br>E <sub>H</sub> = – 2 dB<br>D <sub>H</sub> = – 3 dB<br>C <sub>H</sub> = – 4 dB |

7.4 Programming Procedure for a PBX Conference

- Select a column for input and output rate
- Fill in the values of the bits by aid of **chapter 7.1** and **7.2**
- Write the 9 bytes (from top to bottom) to register IAR



Appendix

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| INV        | PCM data inverted (= 1) or not (= 0)                                                                                                                                                                                                                                                                                                                                                                                                           |
| ITS6 ... 0 | Input time slot number                                                                                                                                                                                                                                                                                                                                                                                                                         |
| IL0 ... 3  | Logical input line number                                                                                                                                                                                                                                                                                                                                                                                                                      |
| CCA5 ... 0 | Conference control address                                                                                                                                                                                                                                                                                                                                                                                                                     |
| NOI1 ... 0 | <b>Noise suppression threshold:</b><br>00 = no noise suppression<br>01 = 5 <sup>th</sup> step, first segment<br>10 = 9 <sup>th</sup> step, first segment<br>11 = 16 <sup>th</sup> step, first segment                                                                                                                                                                                                                                          |
| IAT1 ... 0 | <b>Input attenuation:</b><br>00 = 0 dB<br>01 = 3 dB<br>10 = 6 dB<br>11 = 9 dB                                                                                                                                                                                                                                                                                                                                                                  |
| CNR4 ... 0 | Conference number                                                                                                                                                                                                                                                                                                                                                                                                                              |
| VAL        | <b>Validity:</b> output enabled (= 0)<br>output disabled (= 1)                                                                                                                                                                                                                                                                                                                                                                                 |
| OTS6 ... 0 | Output time slot                                                                                                                                                                                                                                                                                                                                                                                                                               |
| OL2 ... 0  | Logical output line number                                                                                                                                                                                                                                                                                                                                                                                                                     |
| OAT        | <b>Output attenuation:</b> 0 = 0 dB, 1 = 3 dB                                                                                                                                                                                                                                                                                                                                                                                                  |
| OAT4 ... 0 | <b>Output attenuation:</b><br>01000 = 0 dB                      01111 = 7 dB<br>11010 = 1 dB                      11000 = 8 dB<br>01010 = 2 dB                      11001 = 10 dB<br>11011 = 3 dB                      11111 = 12 dB<br>01100 = 4 dB                      11100 = – 4 dB<br>01101 = 5 dB                      11101 = – 3 dB<br>01110 = 6 dB                      11110 = – 2 dB<br><b>other bit combinations not allowed!</b> |