1.13 Interfaces to EN 50 083-9

The signal interfaces open the door to the "DVB room" of the "digital TV house" (see 1.1, Introduction), where the transport stream is applied to a DVB or ATSC modulator.

1.13.1 SPI Synchronous Parallel Interface

Electrical characteristics	
Technology used	LVDS (low voltage differential signalling)
Connector	25-contact D-SUB (to ISO Doc. 2110 (1989))
Cable	25-contact ribbon cable (with twisted-pair wires)
Max. cable length	approx. 10 m
Output	balanced (DATA X A = $\overline{\text{DATA X B}}$)
Common-mode voltage	nominal 1.25 V (1.125 V to 1.375 V)
Signal amplitude	nominal 330 mV (247 mV to 454 mV)
Input	balanced
max. voltage	2 V_{pp}
min. voltage	0.1 V_{pp}

Table 1.7 Data of SPI interface

Pin #	Signal	Pin #	Signal
1	Clock A	14	Clock B
2	System ground	15	System ground
3	Data 7 A (MSB)	16	Data 7 B
4	Data 6 A	17	Data 6 B
5	Data 5 A	18	Data 5 B
6	Data 4 A	19	Data 4 B
7	Data 3 A	20	Data 3 B
8	Data 2 A	21	Data 2 B
9	Data 1 A	22	Data 1 B
10	Data 0 A	23	Data 0 B
11	DVALID A	24	DVALID B
12	PSYNC A	25	PSYNC B
13	Cable shield		

Table 1.8 Contact assignment of SPI interface

The clock, DVALID (data valid) and PSYNC (TS packet sync byte) signals enable immediate synchronization to the byte clock and the start of the TS packets. PLLs are not essential for data regeneration.
The clock frequency f_T (byte clock) is dependent on the TS data rate f_D:

$f_T = f_D / 8$ (without Reed Solomon error protection)

$f_T = (204 / 188) \times f_D / 8$ (with Reed Solomon error protection)

Note:
In the MPEG2 standard, mention is made only of 188 bytes per TS packet.

1.13.2 SSI Synchronous Serial Interface

The parallel SPI data (bits 0 to 7) undergo parallel-to-serial conversion and are transmitted at a clock rate eight times that of SPI data. Bits with the value "1" are biphase mark coded. Bits with the value "0" have a constant level for the duration of the bit. If several consecutive bits with the value "0" occur, the polarity of these bits is alternately reversed.

Data coding:

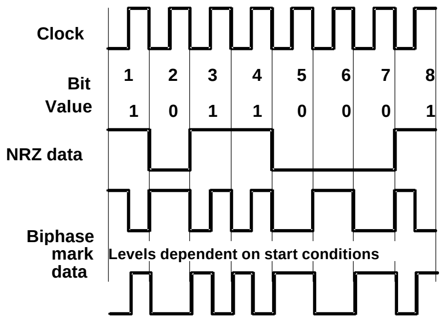

Fig. 1.33 Biphase mark coding

This type of coding yields a data signal that contains at least one edge per bit so that PLLs can easily synchronize.

Electrical characteristics	
Coaxial or fibre-optic cable	75 Ω BNC
Cable type and max. cable length	RG 59 BU 100 m RG 216 U 220 m
Pulse shape	rectangular, conforming to masks defined by EN 50083-9
Max. voltage	1 V_{pp} ±10 %
Return loss	15 dB (from 3.5 MHz to 105 MHz)
Jitter	J_{pp} = 2 ns

Table 1.9 Data of SSI interface

1.13.3 ASI Asynchronous Serial Interface

The 8-bit MPEG2 TS data are converted to 10-bit words using predefined tables. The data transmission rate is 270 Mbit/s in the serial mode. The typical TS data rate is today less than 50 Mbit/s (see section 1.8, Transport Stream (TS)), so comma bytes are used for stuffing the data rate up to 270 Mbit/s. There are several predefined comma bytes.

The bytes commonly used are designated K28.5. They are invalid characters after 8-bit/10-bit conversion. The ASI receiver ignores the comma bytes.

The eye opening for SDI transmission should be within the mask defined by EN 50083-9.

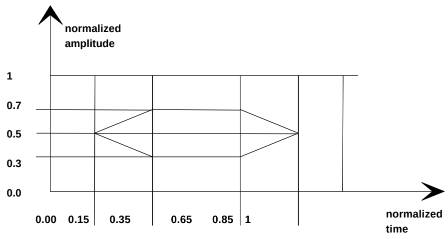

Fig. 1.34 Typical eye diagram of ASI transmitter to EN 50083-9

Electrical characteristics	
Coaxial (or fibre-optic cable)	75 Ω BNC
Cable type and max. cable length (with cable equalizer, otherwise not specified)	Beldon 8281 280 m
Output voltage	800 mV_{pp} ±10 %
Effective jitter	8 % of bit duration ⇒ 300 ps
Return loss	≤-15 dB (from 5 MHz to 270 MHz) (preliminary)
Max. rise/fall time 20 % to 80 %	1.2 ns

Table 1.10 Data of ASI interface

1.13.4 SDTI Serial Digital Transport Interface to SMPTE 326M

Modern studios use digital technology to ITU-R BT.601 throughout and so have the optimal infrastructure for the transmission of SDI data at a rate of 270 Mbit/s.

While the ASI interface is capable of handling the same data rate and can therefore use the same interface chips, i.e. to ITU-R BT.601/656, it is subject to the restriction that only the non-inverting signal outputs of the driver chips can be used. This means that on average only 50 % of the existing 75 Ω coaxial cable infrastructure can be used. The SDTI interface, by contrast, transports MPEG2 data using both the inverting and the non-inverting signal outputs and will therefore be the preferable choice in the digital studios of the future.

The SDTI interface is based on the SDI protocol for the transmission of TS data at 270 Mbit/s. The MPEG2 coded video and audio data and the contents of the data container are transmitted to MPEG2 specifications in the active line between SAV (start of active video) and EAV (end of active video). The last byte of each active line is the CRC value for the line.
SDI employs 10-bit words. In SDTI transmission, the lowermost 8 bits carry MPEG2 data; bits 9 and 10 are set to "1". Between EAV and SAV, a header is inserted in the first field that announces that not SDI data but MPEG2 transport stream data will be transported. The header is inserted for the duration of the lines used for data transmission, i.e. in the 625-line standard from line 9 to the last data-transmitting line in the first field.

Standards SMPTE 305M and SMPTE 326M provide a detailed description of the transmission protocol and data processing.

The simplest SDTI transmission model is illustrated by Fig. 1.32 below:

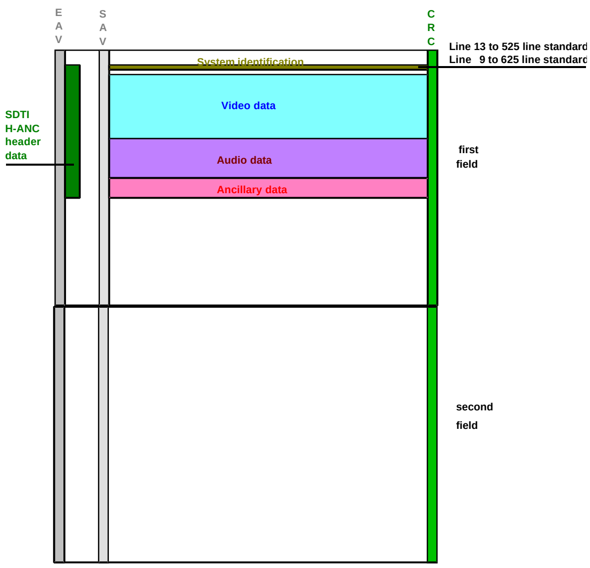

Fig. 1.35 Structure of SDTI data

The four interface types discussed above are suitable in particular for short-distance transmission. For SPI, connectors should not be more than 3 m to 5 m apart (even if larger distances could be bridged using special flat cables). With SSI, the length of the coaxial cable depends on the data transmission rate and is in the order of several 10 m. With ASI and SDTI, the 75 Ω cable may have a maximum length of about 280 m.

In the following, long-distance links of up to 100 km and more will be discussed.

1.13.5 **HDB3** High Density Bipolar of Order 3

The HDB3 interface defined in CCITT Rec. G.703 is based on DC-free three-level signal coding. This interface is today mainly used by telecommunication network operators for the transmission of digitized CCVS signals at a rate of 34.368 Mbit/s (also known as E3 mode in PDH (plesiochronous digital hierarchy) networks in Europe). This infrastructure too is suitable for the transmission of TS packets. While the data rate is somewhat too low for DVB-C and DVB-S, it is adequate for DVB-T. The HDB3 interface is ideal for feeding data from the studio to the DVB-T transmitter, taking into account that today's analog TV parent transmitters and tomorrow's DVB-T transmitters in an SFN (single frequency network) will practically always be accommodated in the same building.
Fig. 1.27 illustrates a short section of an HDB3-coded signal.

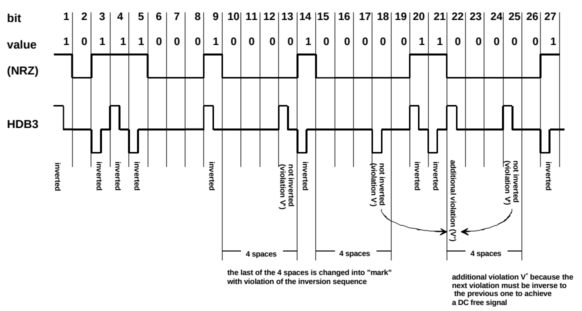

Fig. 1.36 Example of HDB3 coding

1.13.6 ATM with SDH/PDH

Asynchronous Transfer Mode
Synchronous/Plesiochronous Digital Hierarchy

TV signals must be transmitted in realtime. Errors occurring in signal distribution cannot be remedied by way of query and retransmission. The realtime requirement in conjunction with the demand for a high data rate is met with the ATM mode, which utilizes the existing optical-fibre infrastructure of PDH and SDH systems for data distribution.
A broadcaster who intends to use ATM data transmission concludes a contract with a PDH/SDH network operator in which limit values are specified to guarantee the desired performance. These are known as QoS (quality of service) values and include the following:

Cell loss — defines whether or not the loss of cells should be tolerated during peak-load periods of a network.

Cell delay — defines the maximum delay to be expected until a cell arrives at the point of destination.

Cell delay variation — defines the permissible deviation from cell delay.

Compliance with agreed QoS values guarantees the correct transmission of ATM cells, so optimally supporting the fulfilment of the realtime requirement.
Achievable data rates for PDH are about 139.264 Mbit/s (E4, Europe) and 44.736 Mbit/s (T3, U.S.). In SDH environments, data rates of 155.52 Mbit/s (STM1, Europe and STS3, U.S.) to 2 488.32 Mbit/s (STM16, Europe and STS48, U.S.) are common today. Data rates of up to 9 953.28 Mbit/s (STS 192, U.S.) are employed on a trial basis.

With ATM, the 188-byte TS packets at ATM adaptation layer 1 (AAL1) are divided into four sections of 47 bytes. To each section, a 5-byte ATM packet header and the 1-byte overhead for AAL1 are added, which yields an ATM packet of 5+1+47 = 53 bytes.

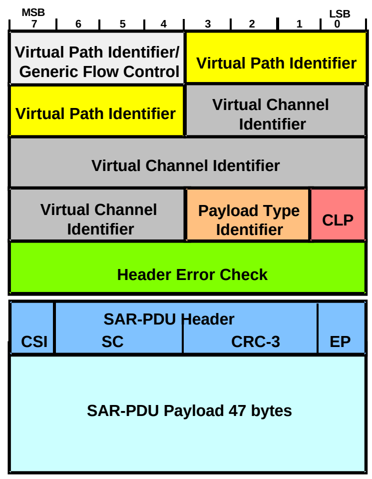

Fig. 1.37 Structure of ATM packet at AAL1
Featuring Reed Solomon forward error protection (124, 4, 2) in conjunction with block interleaving at AAL1, the ATM mode is ideal for long-distance MPEG2 data transmission.

Layer AAL1 is today used, for example, in the distribution systems of the German ARD (Hybnet) and the German Telekom (Rundfunk Service Multiplexer) for interconnecting studio complexes and feeding TS data from the studio to the DVB-T transmitter.

1.13.7 Summary

The interfaces most widely used today are SPI for very short distances (3 m to 5 m) and ASI for distances of up to 280 m (length depending on cable type used). ATM with SDH/PDH and fibre-optic cable will increasingly be used in the future for signal distribution from the studio to cable headends, satellite uplinks and DVB-T transmitters. At present, these links are frequently implemented as radio relay links.