DIGIT2000 Digital TV System

The highly integrated circuits introduced and described in brief on the following pages are components of the **all-digital color television concept "DIGIT2000"** from ITT Semiconductors. This IC set is the world's first (and still the only) television system in which picture, sound and text are all processed digitally. Since its introduction to the market in 1983, the system has been continuously refined and perfected and has reached a high level of sophistication. Today, more than 20 million TV sets worldwide have already been equipped with DIGIT2000 ICs.

Prepared for future developments

DIGIT2000 is capable of processing signals in all present and future TV broadcasting standards: PAL, SECAM, NTSC, C-MAC, D-MAC, D2-MAC and NICAM – received via aerial, cable or satellite. Furthermore, the system guarantees upward compatibility with HD-MAC, the high-definition TV (*HDTV*) standard of the 'nineties. Thanks to its completely digital conception, DIGIT2000 is being acknowledged more and more as the technical standard of the future. That's because only digital technology guarantees **compatibility with all future developments**, whether in terms of improvements in quality or new features. Even today, it is already possible to implement some additional **features** that have only existed in theory up to now. Furthermore, significant **improvements in picture quality** are possible with various systems, especially with adaptive comb filter algorithms, intermediate storage facilities and automatic ghost compensation, which are not feasible at all with conventional analog technology.

A flexible and programmable "kit"

In addition to these benefits, digital signal processing offers TV set manufacturers a whole range of **practical advantages**, too. To start with, digital circuits are tolerance-free and are not subject to drift or ageing phenomena. This considerably simplifies factory alignment of the sets and even permits **fully automated, computer-controlled alignment.**

Second: DIGIT2000 components are **programmable**. This means that the level of user convenience and the set's capabilities or features can be tailored to the manufacturer's individual requirements via the software.

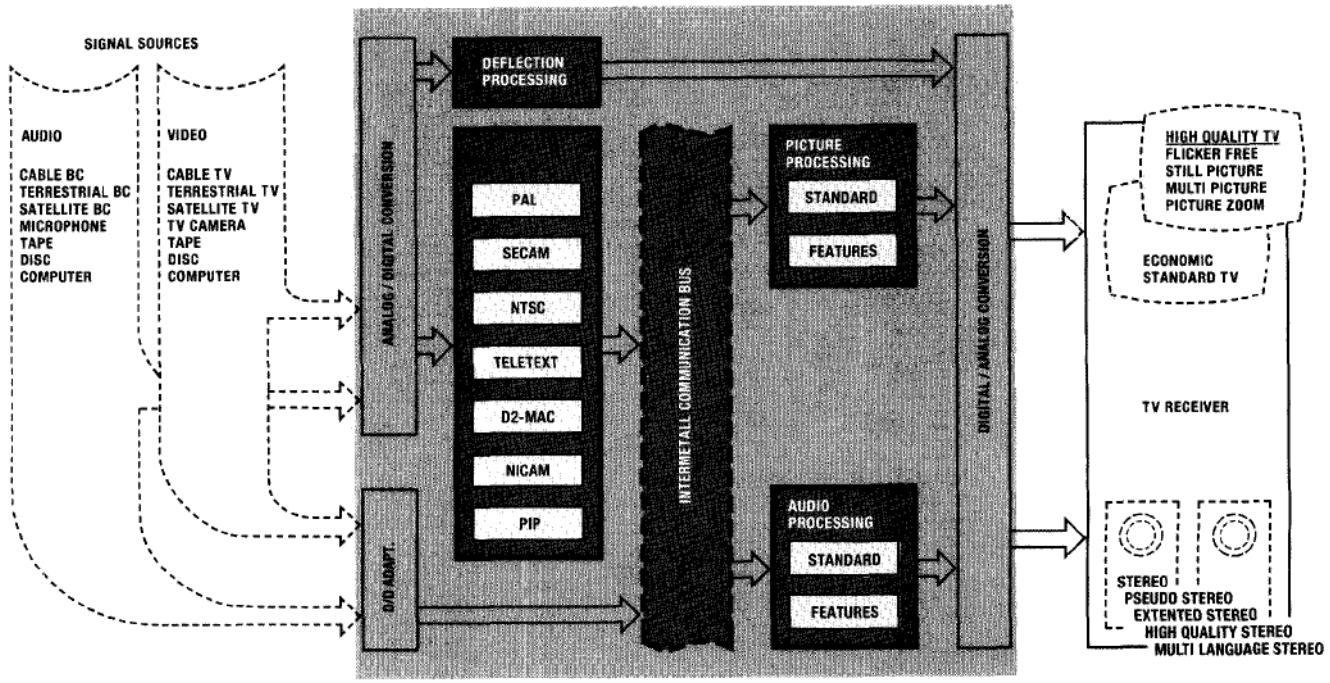
Third: DIGIT2000 is a **modular** system with a **standard circuit architecture**. All the ICs of the system are compatible with each other so that TV models of **various specifications** can be realized. These range from the low-cost standard set to the high-performance all-features multi-standard satellite receiver incorporating a host of special functions – Figure 1 gives an overview of the various possibilities which DIGIT2000 offers.

Fully automated set manufacture

Modular construction with a handful of VLSI components and little external circuitry means that set assembly can be **fully automated**, too. Together with automatic alignment, the production process can be greatly simplified and accelerated in this way. In fact, the "insides" of digital sets look very simple and "tidy".

As figure 2 shows, the modular design of DIGIT2000 is reflected in the subdivision of the system into **functional blocks** on different levels, each of which has its own data bus structure (more about this below).

Fig. 1: Overview of possible DIGIT2000 Realizations

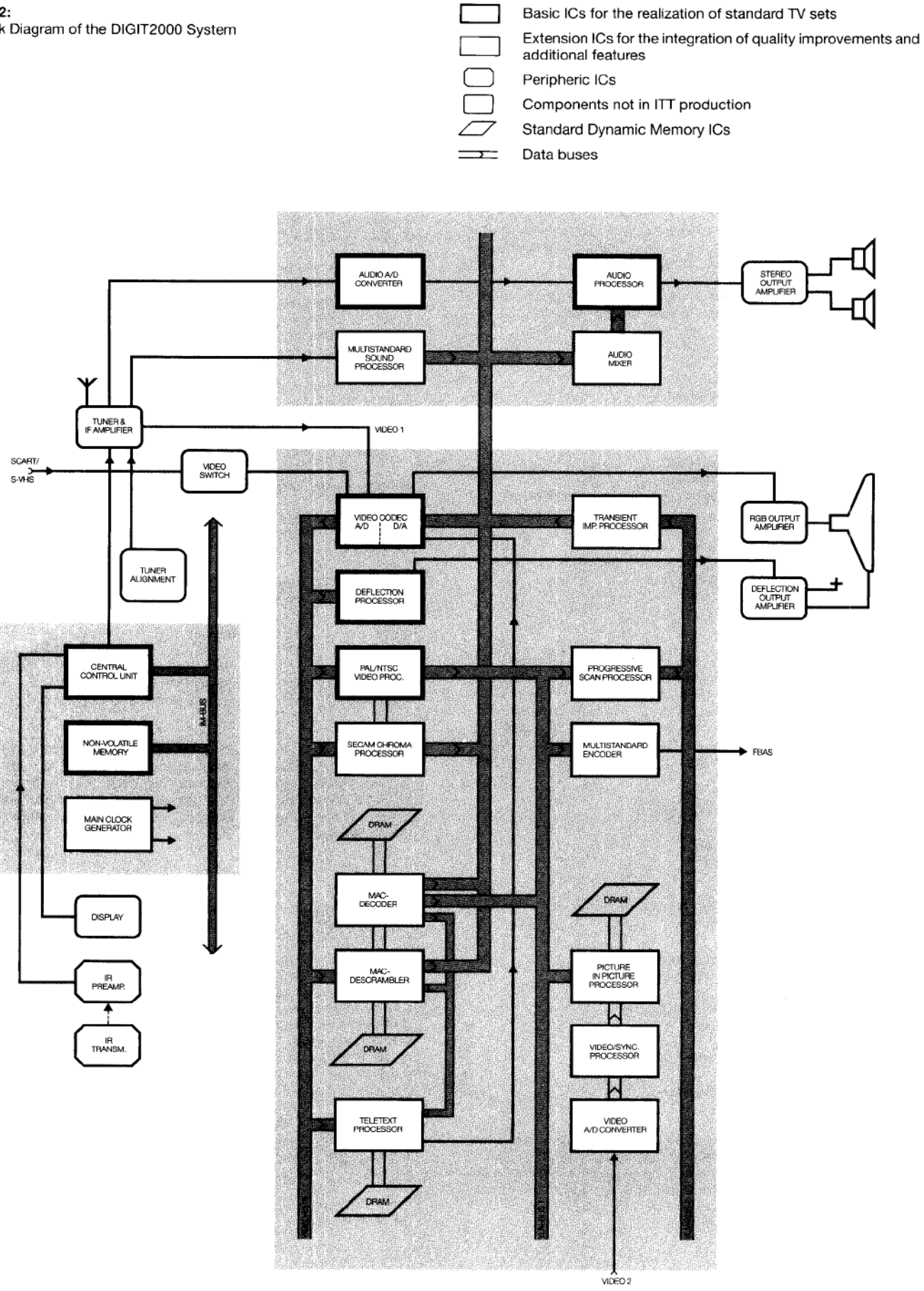


Signals of any existing or future signal source, analog or digital, can be processed: the video, audio and text processing units can handle all transmission standards.

All processing is coordinated centrally by an 8 bit microcontroller via the IM Communication Bus.

The flexibility of the modular construction permits the realization of standard TV sets as well as the gradual extension to high quality TV. The highest level of integration contains several improvements and features which cannot be realized easily with conventional analog techniques.

Fig. 2:
Block Diagram of the DIGIT2000 System



Five groups of components

1. Central Control Units (CCUs)

All the signal processing components of the DIGIT2000 system are controlled by a **central 8-bit microcomputer** (the *Central Control Units, CCUs*) via the bi-directional *IM bus*. This arrangement of the ICs around a central bus makes it possible to expand the system constantly and thereby add on further improvements in the picture, sound and text processing as well as new features. The CCU is linked to a non-volatile memory in which the factory settings are stored. These are continuously compared with the present settings; in this way, it is even possible to correct deviations that are due to voltage and temperature fluctuations as well as those due to ageing phenomena in the analog components. As a result, for example, **the picture quality remains unchanged for the whole lifetime of the set.**

At present, ten different controller ICs are available which differ mainly in terms of the manner and scope of their programmability:

– CCU2030	**Central Control Unit**
	(with 6.8 KByte ROM)
– CCU2050	(with 8 KByte ROM)
– CCU2070	(with 16 KByte ROM)
– CCU2050PI	(with programmable remote
– CCU2070PI	control decoder)
– CCU3000	**New generation CCU**
– CCU3001	(with 32 KByte ROM)
– CCU3002	(with text representation in three-layer window technique)
– TFPO2065	**Tuning Processor**
	(with on-screen display and frequency synthesis)
– TVPO2066	(with voltage synthesis)

2. Standard Video ICs

The video processing section has two internal bus systems: the video bus (7 bit parallel) which carries the composite video signal from the A/D section of the video codec to the individual processors, and the YUV bus which passes on the resulting luminance and chrominance signal (8 + 8 bit parallel on 12 lines in time-division multiplex) for further processing in the picture improvement ICs PSP and DTI (see paragraph on feature ICs) or direct to the A/D section of the video codec.

The following standard ICs are available:

– PVPU2204	**Video Processor**
	(including S-VHS)
– VCU2133	**Video Codec**
– VCU2134	(for double-scan NTSC)
– VCU2136	(including S-VHS)
– DPU2553	**Deflection Processor**
– DPU2554	(for NTSC with progressive scan)
– SPU2243	**SECAM Chroma Processor**
	(including S-VHS)
– VSP2860	**Video/Sync Processor**
– VAD2150	**Video A/D Converter**
– VAD2170	(for S-VHS)

Notice that quality improvements like the **new video recording standards S-VHS and ED-Beta** or Double-scan (for NTSC) can be provided by the choice of the corresponding ICs. Several other improvement circuits will be introduced below as *Feature ICs*, among these the **comb filter processors** (ACVP, CVPU) which may be used instead or in addition to the PVPU.

3. Standard Audio ICs

The digital concept facilitates the processing of the new digital sound broadcasting standards as well as the input of external signal sources, such as *Digital Audio Tape* (DAT) and *Compact Disc* (CD).

Mono, stereo and multi-lingual broadcasts are automatically recognized through the software and processed accordingly. Here, the high resolution of the A/D-D/A converters permits sound quality on a par with CD (assuming digital transmission – see comments on NICAM and MAC below). The data transfer between the components of the audio section takes place via the *S bus* which, in particular, has the task of connecting the digital audio outputs of the MAC and NICAM decoders with the audio mixer AMU2481, the audio processors APU2471 and AMU2481VS. It transmits the audio information in 64-bit frames which are divided into a series of four 16-bit samples in accordance with the four audio channels.

The **audio processor** ACP2371, offers on one chip the functions of the A/D-D/A converters and those of a powerful, programmable signal processor and is therefore capable of carrying out the complete audio signal processing in the baseband.

The new audio processors ACP2371VS and AMU2481VS were developed specially for use in videorecorders and satellite receivers (together with MSP2400). During the reception of satellite signals the adaptive preemphasis of the audio subcarrier can be compensated by these processors.

Available are the following standard ICs:

– ADC2301E	**Audio A/D Converter**
– ADC2311E	(with preemphasis)
– ADC2320U	(for U.S.A.)
– AMU2481	**Audio Mixer**
	(for the processing of digital MAC audio signals)
– APU2471	**Audio Processor**
– APU2421U	(for U.S.A.)
– ACP2371	(with A/D-D/A converters on chip)
– ACP2371VS	(for video recorders and satellite receivers)
– AMU2481VS	(for video recorders and satellite receivers)

With the **Multistandard audio processor** (MSP) introduced in the next paragraph, the audio processing can be designed to accommodate multi-standard. This is because MSP processes not only the new digital NICAM Hifi sound standards, but also all the analog standards currently in use throughout Europe, including audio subcarriers from satellite receivers.

4. Feature ICs

With the DIGIT2000 system it is possible to implement a whole host of interesting features – many of them simply by fitting a single additional IC. The established television standards PAL, SECAM and NTSC are part of the standard specification of a DIGIT2000 receiver. When it comes to receiving the new MAC satellite standards and the new NICAM audio broadcasting standards with digital sound, a **D2-MAC** or a **Multi-MAC decoder/descrambler** chip set (DMA) and a **Multistandard sound processor** (MSP) are required, respectively. Substantial improvements in picture and sound can be achieved: for instance, the D2-MAC broadcasting standard offers stereo sound in CD quality or the transmission of sound commentaries in up to eight languages simultaneously.

To record the MAC signals with videorecorder the component signals of the MAC decoder have to be encoded into an FBAS signal (PAL, SECAM, NTSC). For this purpose a **Multistandard Encoder** was developed.

Remarkable improvements in picture quality and innovative features can also be realized for the existing video standards by means of inter-

mediate storage techniques: working on this basis, the newly developed **Adaptive comb filter processor** ACVP2205 is capable to eliminate almost completely the familiar cross-talk interferences between the color and brightness components (*cross-color* and *cross-luminance*) of the video signal without producing other phenomena such as "hanging dots". The resulting PAL and NTSC pictures have S-VHS quality.

Another line storage circuit is the **Progressive scan processor** (PSP) for line frequency doubling with NTSC **(Double Scan)**, which "smoothens" the visible line structure of NTSC pictures.

Clearer color separation is achivied with the **Digital chroma transient improvement processor** (DTI). The latest version of this (the DTI2250) offers an additional special feature: It can represent television pictures broadcast in the conventional 4:3 aspect ratio free from distortion on the new 16:9 format HDTV picture tubes. The inverse format conversion from 16:9 to 4:3 ("Panning") is done by the MAC descramblers. Therefore, along with the DTI2250, a chip set is available for processing **all picture formats** – an important step on the way of compatible transition to HDTV.

Another interesting feature is the facility for inserting a second (small) picture from another program or from an external source in the main picture. All that is needed to realize this **picture-in-picture** facility is a PIP IC and a few other components.

The digital **text and graphics processors** (TPUs) can not only process and display **teletext** in all the world's television and teletext (TTX) standards, they also permit implementation of a **menu-controlled user guidance system** and a **"service mode"** with text displays on the screen which facilitate both operation and servicing of the increasingly complex TV sets. The TPUs are also suitable, of course, for processing text and graphics from external signal sources (e. g. from personal computers). As far as teletext transmissions are concerned, the TPU recognizes the broadcast standard and language and automatically selects the appropriate character set for representation on-screen.

A further textinformation called **Closed Caption** for hearing impaired (similar to Teletext) will be introduced in the United States by law from 1993. The CCD3000 is able to decode Closed-Caption transmissions in NTSC, PAL and SECAM TV standards and can handle all of the TV's display functions.

Available are the following feature ICs:

– MSP2400	**Multistandard Sound Processor**
– DMA2271	**D2-MAC Decoder**
– DMA2275	**D2-MAC Descrambler**
– DMA2280	**D-MAC Decoder**
– DMA2285	**D-MAC Descrambler**
– DMA2281	**Multi-MAC Decoder**
– DMA2286	**Multi-MAC Descrambler**
– MSE3000	**Multistandard Encoder**
– ACVP2205	**Adaptive Comb Filter Video Processor**
– CVPU2270	**NTSC Comb Filter Video Processor** (for double-scan and/or S-VHS)
– PSP2210	**Progressive Scan Processor**
– DTI2223	**Digital Transient Improvement Processor**
– DTI2250	(including picture compression function)
– CCD3000	**Closed-Caption Decoder**
– TPU2735	**Teletext Processor** (for PAL/NTSC/D2-MAC, TTX level 1.5, FLOF, TOP)
– TPU2740	Multistandard TPU
– BVT2710	**Videotext and Teletext Processor**
– PIP2250	**Picture-in-picture Processor**

5. Peripheral ICs

The following list contains some additional ICs like clock generators (MCUs), memories (MDA, NVM), remote control transmitters (IRTs, SAAs) etc.:

– MCU2600	**Clock Generator**
– MCU2632	(for Double-scan)
– MDA2062	**1024 bit EEPROM**
– NVM3060	4096 bit EEPROM
– TFIR6400	**Tap Programmable FIR Filter**
– IRT1250	**Remote-Control Transmitter**
– IRT1260	**Remote-Control Transmitter**
– SAA1250	**Remote-Control Transmitter**
– SAA1293A	Remote Control and Tuning Microcomputer
– TBA2800	**Infrared Preamplifier**

Forward-looking technology

It is clear from all this that DIGIT2000 will not only keep pace with, but will play a major part in shaping the future development of television. Its kit-like structure and programmable flexibililty allows new standards and desirable features to be integrated into the system with ease. Current developments prove this: With Multi-MAC and variable aspect ratio (DMA + DTI2250), the first steps have been taken towards the high definition wide-format television of the future; the adaptive comb filter has made a significant contribution to the improvement of present television pictures; the MSP2400 gives the NICAM audio system access to the TV set and, at the same time, accomodates a wide range of existing audio standards, too.

Another development objective has been to simplify TV set construction. Here, highly integrated solutions such as the one-chip audio processor ACP2371 or, available in the near future, the complete multistandard receiver on one chip, demonstrate the possibilities that are opened up by digital television technology.

ITT Semiconductors has, today, the modern technology without which such ambitious projects could not be realized. TV sets of numerous brands (more than 80) are already equipped with DIGIT 2000 ICs on all five continents. And manufacturers throughout the world can rely on the continuous support and assistance of ITT Semiconductors' own design centers in Europe and the Far East.

On the following pages each of the DIGIT2000 ICs listed above will be introduced by a short description of its basic characteristics.