S+M COMPONENTS Siemens Matsushita Components

Herwig A. Benning

TV in cinema format:
SAW filters drive PALplus

Surface acoustic wave (SAW) filters are indispensable to PALplus – the enhanced version of the PAL standard for wide-screen formats. They are the only type of component which can meet PALplus specifications for frequency response and group delay in the IF stages of TV receivers and video recorders. SAW filters from Siemens Matsushita Components are now used by all major TV manufacturers.

Despite different systems and standards for frequency, color and definition, a common trend can be observed in television technology: the screen format of the future will become wider. Compared to today's TV picture, which has a width to height ratio of 4:3, the future format will have a 16:9 aspect ratio. This comes much closer to the human field of vision, since the area perceived by the eye has a greater horizontal emphasis than a vertical one. What's more, cinema films with their 16:9 format can be projected and broadcast without annoying black bars above and below the picture.

In 1989, broadcasting corporations and consumer electronics companies in Europe set up a project team to develop a standard based on PAL for wide-screen TV. An important requirement was that the new standard, to be known as PALplus, should be 100% downwardly compatible with the existing PAL system.

At the 1993 International Consumer Electronics Exhibition in Berlin, the first experimental PALplus broadcasts began, and the specification was finalized. In November 1994, Nokia launched the first PALplus TV set in Germany, which, incidentally, contained a SAW filter from Siemens Matsushita Components, and all major TV manufacturers now offer PALplus receivers. Since the introduction of regular PALplus broadcasts in January 1994, the new technique has put Europe in the lead in development of 16:9 wide-screen TV. For 1995, broadcasting corporations and companies have planned more than 12,000 program hours (over 5000 of them in Germany alone) in the new PALplus standard.

- Downwardly compatible with standard PAL
- Conversion from 4:3 to 16:9 format possible at all times
- Improved signal quality thanks to greater effective luminance and chrominance bandwidth
- Elimination of cross color and cross luminance
- Improved sound quality (optional)
- Echo suppression (optional)

Table 1 PALplus system requirements

Enhanced signal quality

The improved signal quality (**Table 1**) required for PALplus is achieved in particular by greater effective luminance and chrominance bandwidth. In addition, the Color Plus color coding technique prevents the crosstalk between luminance and chrominance typical of PAL. This technique is designed to process high-frequency luminance and chrominance for two fields at a time. The Color Plus technique has been modified for PALplus to produce a motion-dependent variant, which has proved superior and become an integral part of the PALplus system concept.

16:9 and 4:3 screen formats

Under the PAL standard, a complete frame comprises 625 lines. 576 of these are used to present the actual picture. The remaining 49 lines are located in the vertical blanking interval – invisible to the viewer – and used for various purposes, such as transmitting teletext.

Fig. 1 shows the transmission channel and screen presentation of 4:3 and 16:9 screens. So that the 16:9 picture can fit the frame of the 4:3 screen, it is down-converted in the vertical direction. In this process, 144 of the 576 active lines are used to display black bars at the top and bottom edges of the picture. A total of 432 lines remain for the actual picture. Experts graphically call this compromise the "letterbox picture". This is how wide-screen cinema films have been broadcast on television in the past.

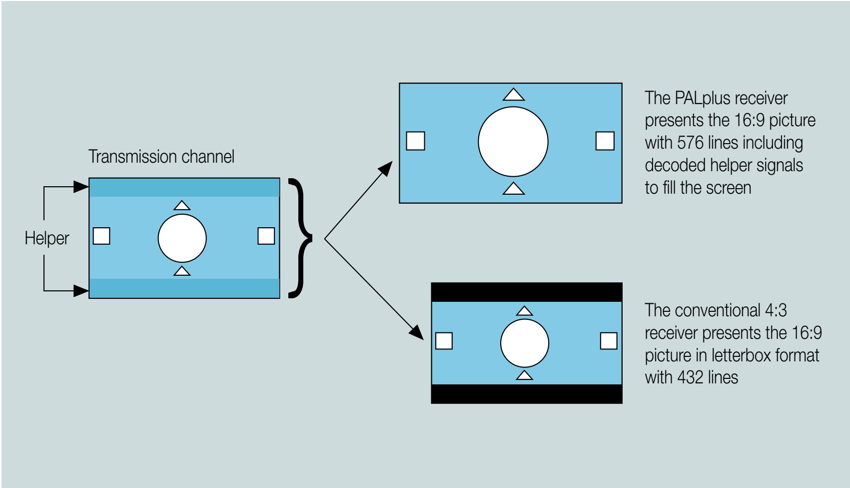


Fig. 1 Transmission channel and screen presentation on 4:3 and 16:9 screens

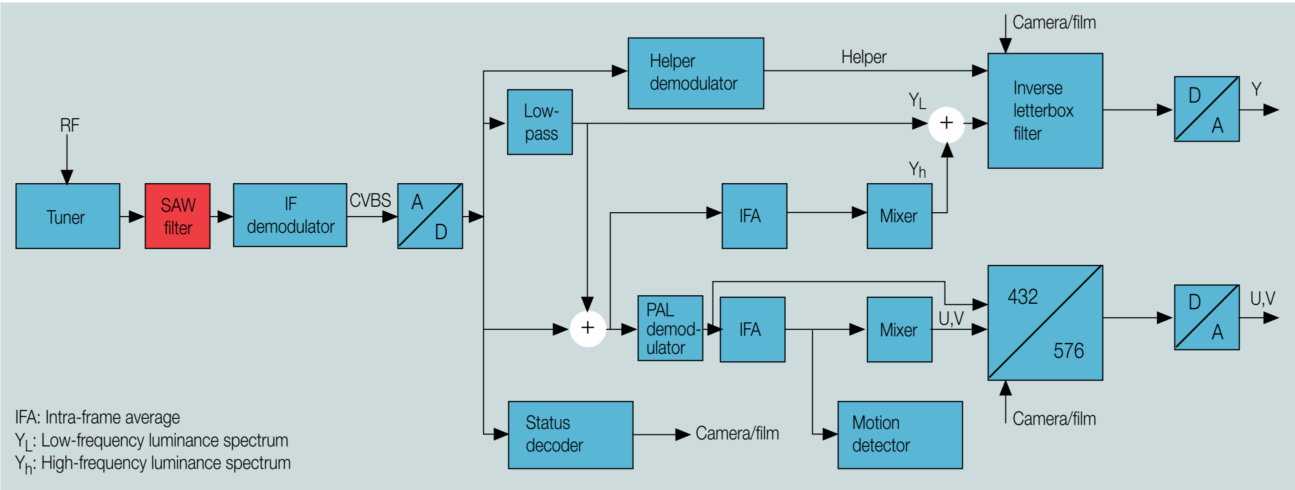


Fig. 2 Block diagram of a PALplus TV receiver

However, as soon as TV sets with a 16:9 aspect ratio matching the wide screen format are available, all 576 active lines can be used with PALplus to produce a picture that completely fills the screen. In view of the required compatibility between PALplus and standard PAL, corresponding techniques must be implemented at both the transmitter and receiver ends.

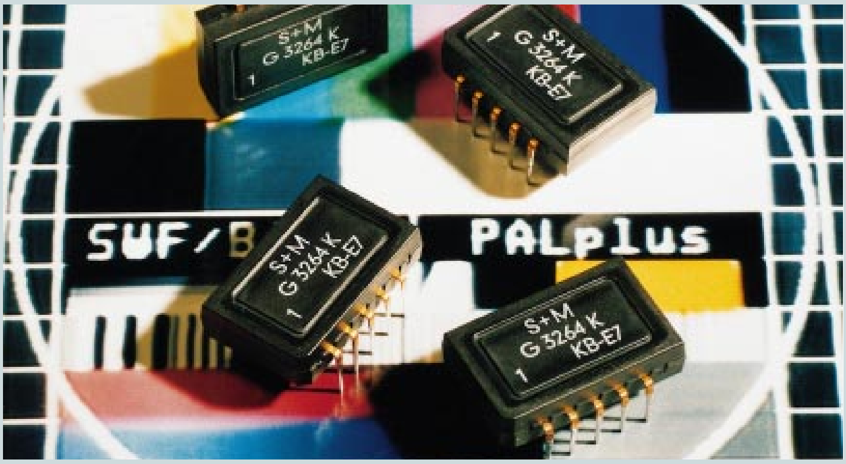
A PALplus receiver requires the 144 "lost" lines as well as the 432 visible lines. The high-pass component suppressed by filtering – the signal known as the vertical helper – is transmitted separately. After a nonlinear amplitude pre-emphasis, it is modulated by the color carrier. Here the energy of the helper signal centers mainly on the region of the color carrier frequency. This color carrier modulation frees the resulting spectrum of the helper from low-frequency signal components. Stability problems are thus avoided in the synchronization stages of older receivers, and visibility of the helper signal is practically ruled out in standard receivers. To ensure further reduction of any interference in reproduction on conventional PAL sets, the helper is transmitted at a reduced signal level.

What a PALplus filter must do

Optimum feeding of the helper signal to the helper demodulator makes exacting demands on the IF stage (including the SAW filter that it contains):

- maximum possible video bandwidth,
- very high color carrier,

How SAW filters work



SAW filters make use of the piezoelectric effect: a change in the applied voltage triggers a mechanical wave on a crystal. Conversely, mechanical pressure leads to changes in potential difference. Lithium niobate is the preferred material for the crystal chip. The lithium niobate substrate has the great advantage of a relatively large physical coupling coefficient. This means that SAW filters can be manufactured with a small insertion loss. The electrodes are comb-shaped with interlocking fingers, the spacing between the fingers being in the order of microns. An RF voltage applied to the input transducers generates a mechanical (acoustic) surface wave on the crystal, which runs to the output transducer and is reconverted there into an electric voltage. Special frequency transmission functions can be implemented by suitable mechanical design of the electrodes, such as the appropriate size, number and spacing of the fingers.
Compared with conventional filters using coils and capacitors, SAW filters are cheaper, smaller, have greater long-term stability, do not need tuning and provide significantly better performance. These reasons explain the predominant use of SAW filters by manufacturers of color TV sets and video recorders around the world. But SAW components are also found in satellite receivers, cordless telephones, cellphones, keyless entry system for cars, garage door openers and many other applications.

- maximum possible suppression of sound carrier (>30 dB) at 33.4 MHz, and
- group delay ripple, very important in the region of the helper signal (34.47 MHz ± 500 kHz)

Many years of experience in volume production (see panel) and the use of state-of-the-art simulation software were instrumental in development of SAW filters for such demanding specifications. The excellent business relations between Siemens Matsushita and its customers opened up a wealth of expertise. This was used for co-development of the new filters to the benefit of components and equipment manufacturers alike.

High-performance filters for PALplus

Basically, only the video filter or the video channel of a quasi split-sound filter have to meet special requirements for PALplus reception. The maximum possible video bandwidth and reduction of the sound carrier at 33.4 MHz are contradictory demands. An extremely steep slope is the only way of implementing a very high color carrier at 34.47 MHz and signal suppression of more than 30 dB at only 1 MHz lower. This was made possible by using a chip of maximum length made from the piezoelectric substrate lithium niobate ($LiNbO_3$). The selection of various SAW filters for PALplus (**Table 2**) results from the different group delay ripples. The very important group delay in the region of the helper signal should be as flat as possible after the IF stage. But the group delay ripple of the TV transmitters, which varies from country to country, as well as the group delay of the SAW filter, also have an effect, as do the group delay of the sound traps or the sound traps themselves. The group delays of the TV transmitters and the sound traps cannot be easily changed, so the SAW filter cancels out the group delay. **Fig. 3** shows the frequency and group delay function of the G3264K (video channel).

The level of the color carrier in the G3264K is 0.1 dB. Despite the very high color carri-

Table 2 Special SAW filters are available for all requirements in PALplus receivers

Filter type	Application	Picture carrier frequency	Color carrier suppression	Sound carrier suppression	Group delay	Package
G3956M	Video filter B/G	38.9 MHz	1.0 dB	39 dB	–85 to 70 ns	SIP-5K
G3258K	Quasi split-sound filter B/G	38.9 MHz	0.2 dB	37 dB	–35 to 40 ns	DIP-10K
G3264K	Quasi split-sound filter B/G	38.9 MHz	0.1 dB	36 dB	–70 to 120 ns	DIP-10K
G3270K	Quasi split-sound filter B/G	38.9 MHz	0.2 dB	43 dB	0 ns	DIP-10K
G3354K	Split-sound filter B/G	38.9 MHz	–0.3 dB	41 dB	–60 to 40 ns	DIP-10K
G3355K	Split-sound filter B/G	38.9 MHz	0.4 dB	48 dB	–55 to 40 ns	DIP-10K
G3356K	Split-sound filter B/G	38.9 MHz	1.2 dB	56 dB	0 ns	DIP-10K
J3352K	Split-sound filter I	39.5 MHz	0.3 dB	55 dB	0 ns	DIP-10K

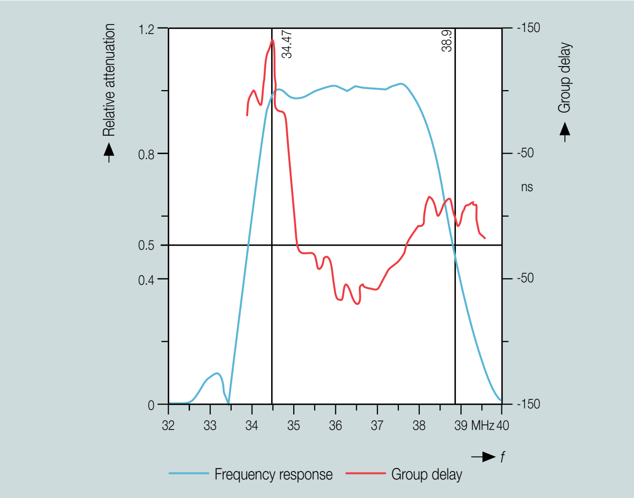


Fig. 3 Frequency and group delay functions of SAW filter G3264K (video channel)

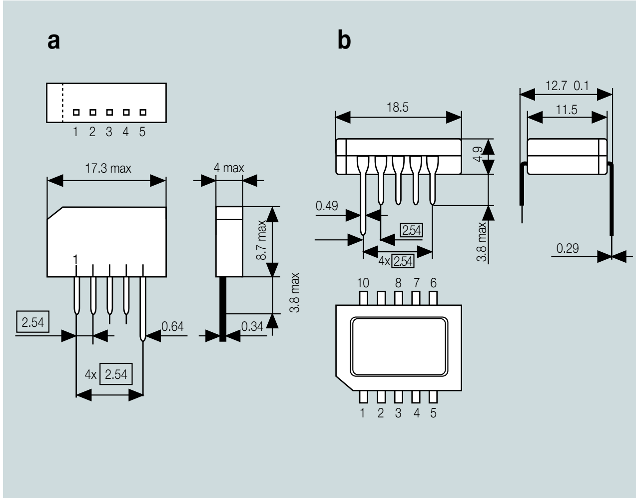


Fig. 4 Dimensional sketch of SIP-5K (a) and DIP-10K (b) packages for automatic placement

er, the sound carrier was suppressed by 36 dB. The group delay perfectly matches the German group delay ripple. Another advantage of this filter is suppression of the adjacent picture and sound carriers in the region of 47 to 60 dB. These figures considerably simplify the CENELEC tests (EN 55020) necessary for TV set manufacturers in Europe. The use of lithium niobate also means that no matching circuits are needed, as the insertion loss of the SAW filter is only 16.0 dB. The quasi split-sound filter is also designed for an input impedance of 50 Ω and an output impedance of 2 kΩ/3 pF. NICAM sound can also be received with the sound channel of the G3264K.

The SAW filters are supplied in two different packages: the SIP-5K and the DIP-10K (**Fig. 4**). The DIP-10K package contains two tracks. In the PALplus SAW filter, these are the audio and video tracks. An advantage of the DIP-10K is that only one filter is needed in the IF stage, instead of two separate SAW filters. This cuts production and logistics costs. The SIP-5K and the DIP 10K packages have the common advantage of automatic placement capability.

These SAW filters are mainly intended for use with the PAL B/G standard (e.g. in Germany, Austria, Switzerland, Spain, Italy, Scandinavia, Benelux and Turkey). A matching filter is also available for the PAL-I standard in the UK.

These SAW filters co-developed by Siemens Matsushita Components and TV set manufacturers are ideal for PALplus reception. Thanks to mass production, they are attractively priced too. ☐

Siemens Matsushita Components: Milestones to success in SAW filters

1978	Mass production of TV IF filters starts, annual output: 2 million filters
1979	Quasi split-sound filters introduced
1980	Acquisition of Crystal Technology, Inc., the leading manufacturer of lithium niobate wafers
1984	Annual output: 10 million filters
1988	Annual output: 20 million filters
1989	Switchable filters for low-cost multistandard applications introduced
1991	Two-channel satellite TV filters introduced
1992	Annual output: 40 million filters
1993	RF and IF filters for mobile communications introduced as SMDs
1994	IF filters for digital TV introduced
1995	Planned annual output: 120 million filters

Herwig A. Benning Dipl.-Ing. (FH),

studied electrical engineering at Munich Polytechnic, specializing in telecommunications. After completing his degree work at Siemens Corporate Research and Technology, he joined Siemens Matsushita Components in Munich 1991. Mr. Benning (29) is involved in marketing SAW components for consumer electronics products, and looks after the Nokia and Thomson key accounts.