APPLICATION NOTE

TV Sound Processing with QSS or Intercarrier Demodulation

AN96142

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Abstract

This application note describes the differences of the Quasi Split Sound(QSS) and Intercarrier sound demodulation concepts . The NICAM and Analog two carrier (A2) sound demodulation concepts in the Standards L and BG were compared regarding critical video signals ,picture carrier to sound carrier ratios and various RF input levels.

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TV Sound Processing with QSS or Intercarrier Demodulation

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Keywords

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Summary

This report should help to find a decision pro or contra using an conventional intercarrier or QSS-SR IF-demodulation for specific TV set concepts. It shows some critical points which have to be considered.

It compares different concepts of processing the TV sound from the first sound IF to the baseband sound signal.

The NICAM and a two soundcarrier system(A2) are compared in standard L and BG.

A frontend with a TDA9815 was used in quasi split sound single reference and a frontend with a TDA9812 and the two FM demodulators of the TDA9815 were used for the conventional intercarrier mode. They were connected to a SAA7284 NICAM decoder or a TDA9840 stereo decoder for 2 sound carrier demodulation and decoding.

CONTENTS

1. Introduction

This report should give some information about the advantages and disadvantages of Quasi Split Sound Single Reference concepts versus conventional Intercarrier concepts.

In chapter 2 possible tolerances for the NICAM and two sound carrier system in the standards BG and L will be discussed and the worst case condition will be deduced. Error mechanisms for NICAM and the two carrier concept will be discussed and from these mechanisms critical video signals can be found.

After these background informations some measurements with more focus on sound processing than on video processing will be discussed and interpreted in chapter 3. Other ICs will lead to different results but the principles will remain the same.

Chapter 4 is a conclusion which gives hints when to use QSS-SR or conventional intercarrier and will resume the technical consequences.

2. Description of the measurements

2.1 Video demodulation and Sound processing modes (QSS-SR/Intercarrier)

Two main concepts are known for video and TV sound processing - the quasi split sound concept (QSS) and the intercarrier concept. The difference between both concerning the sound processing is the generation of the second sound IF like for example 5.5MHz.

Figure 2.1-1 shows a principle block diagram for standard BG

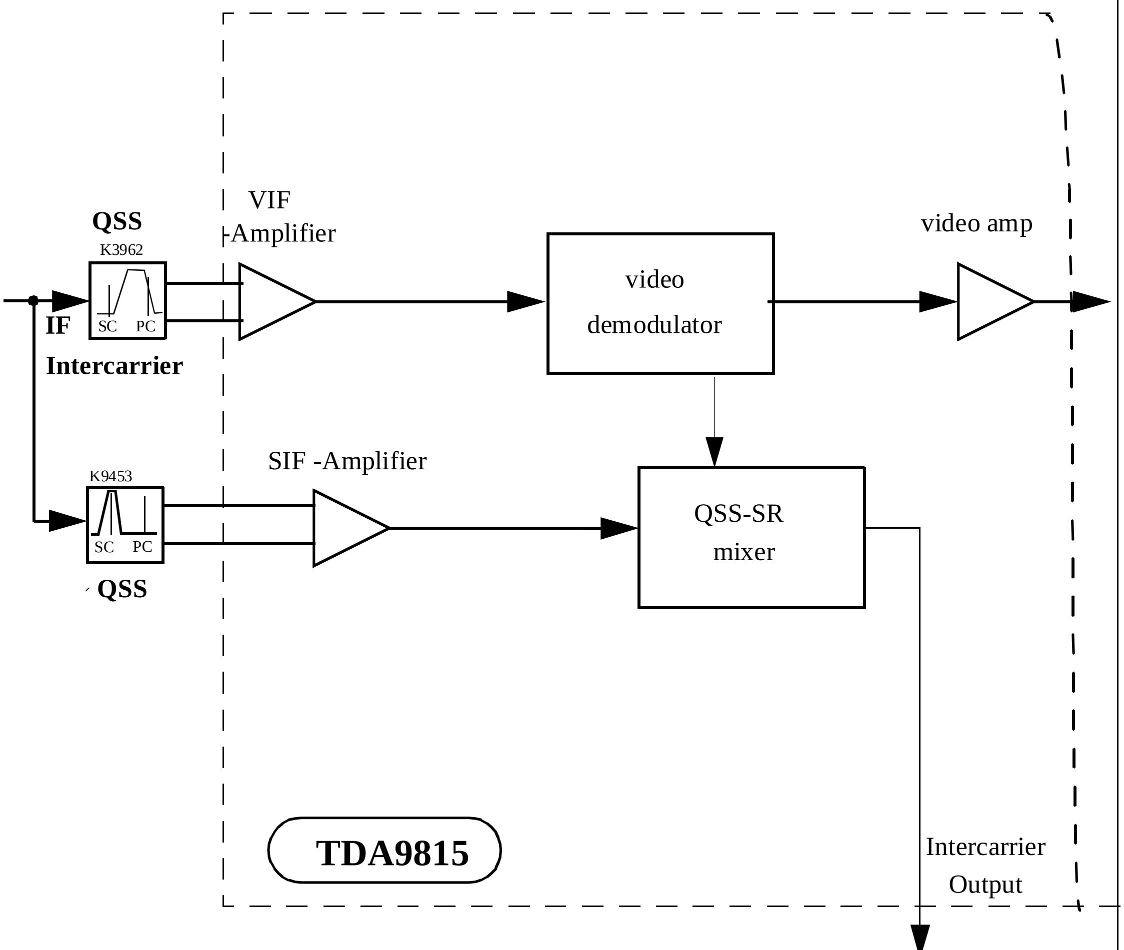


Figure 2.1-1 The TDA9815 in QSS-SR mode application

Figure 2.1-2 shows a principle block diagram for standard BG in intercarrier mode

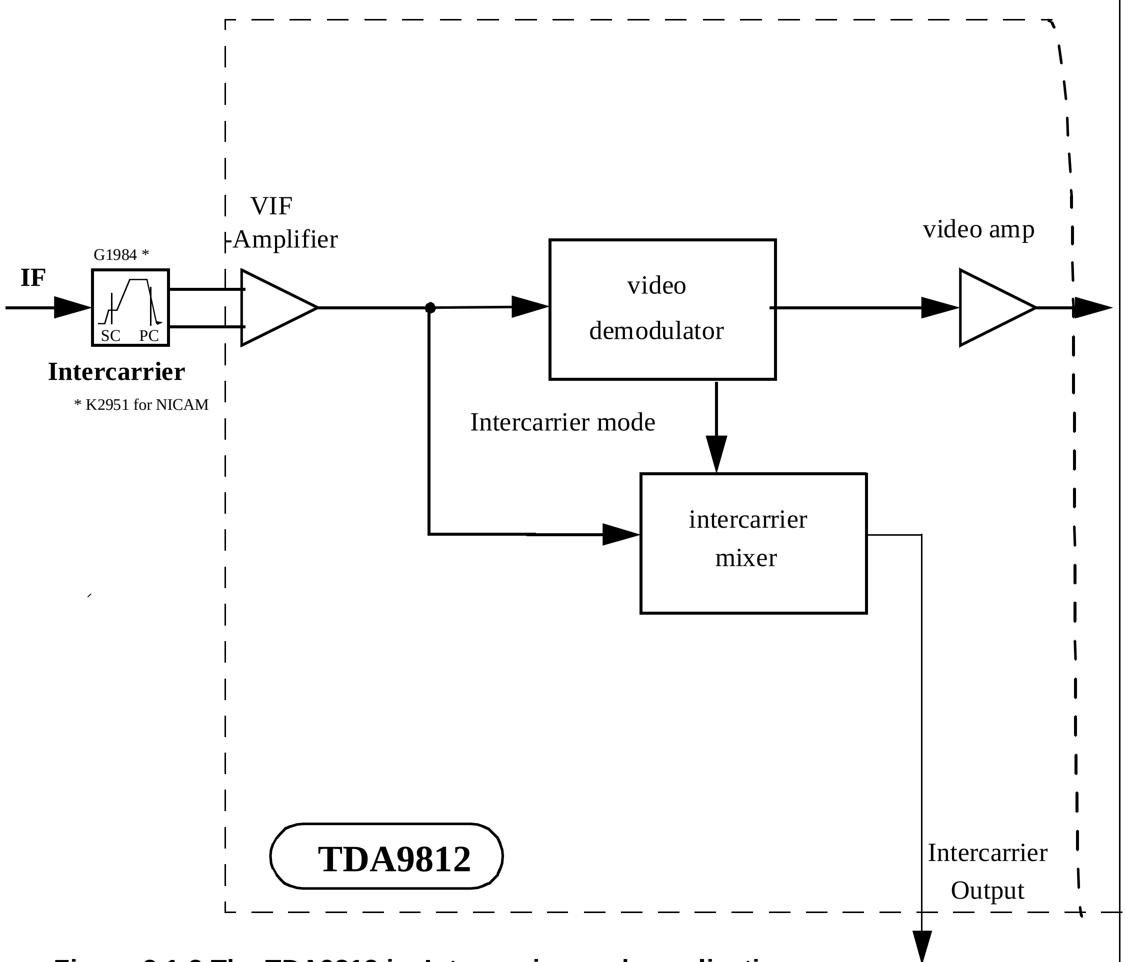


Figure 2.1-2 The TDA9812 in Intercarrier mode application

In classical QSS -systems two completely separated signal pathes with two references were used to get the video demodulation and for the mixing of the first sound carrier to get the sound carrier (intercarrier). So for example to get a second sound carrier (intercarrier) of 5.5MHz a separate reference of 38.9 MHz is used for mixing with the first sound carrier of 33.4 MHz.

In classical QSS -systems the picture carrier and the sound carriers pass a SAW filter which is shown in figure 2.1-3. For the picture carrier the filter is symmetrical and so the two sidebands of the AM - modulated picture carrier will have the same amplitude.

In most of the actual IF - concepts so called single reference systems are used. In this case the picture carrier is positioned in the middle of the nyquist slope and his sidebands have unequal lengths depending on the modulation frequency (distance from the middle of the nyquist slope) and the amplitude of the modulation signal.

In these cases a phase modulation is introduced also in the reference oscillator for generating the intercarrier frequency. In single reference QSS systems (QSS -SR) this PM is transferred to the intercarrier, however reduced for higher frequencies by the PLL transfer function.

Figure 2.1.4 shows the system with the principal SAW filter shapes and the vector of the modulated picture carrier.

Because only one IC and only one reference circuit is needed for the QSS-SR today most often these systems are used in spite of having this principle error mechanism. In this report we will just deal with the QSS-SR system.

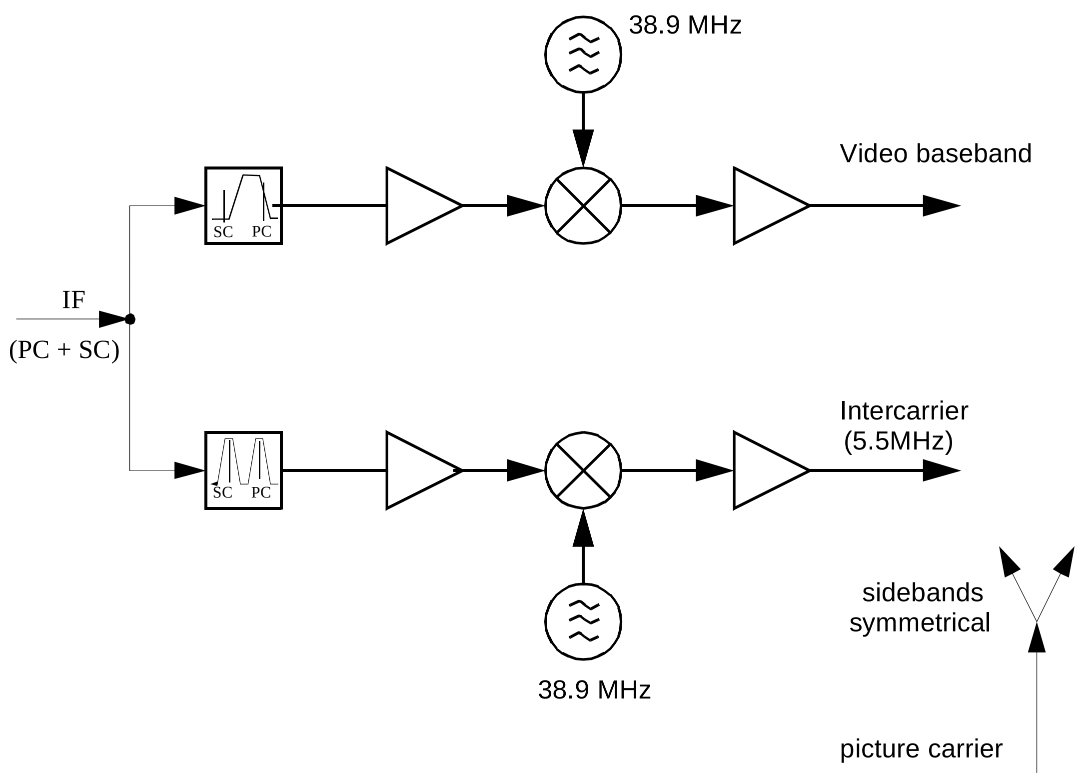


Figure 2.1-3 Classical QSS concept with two references

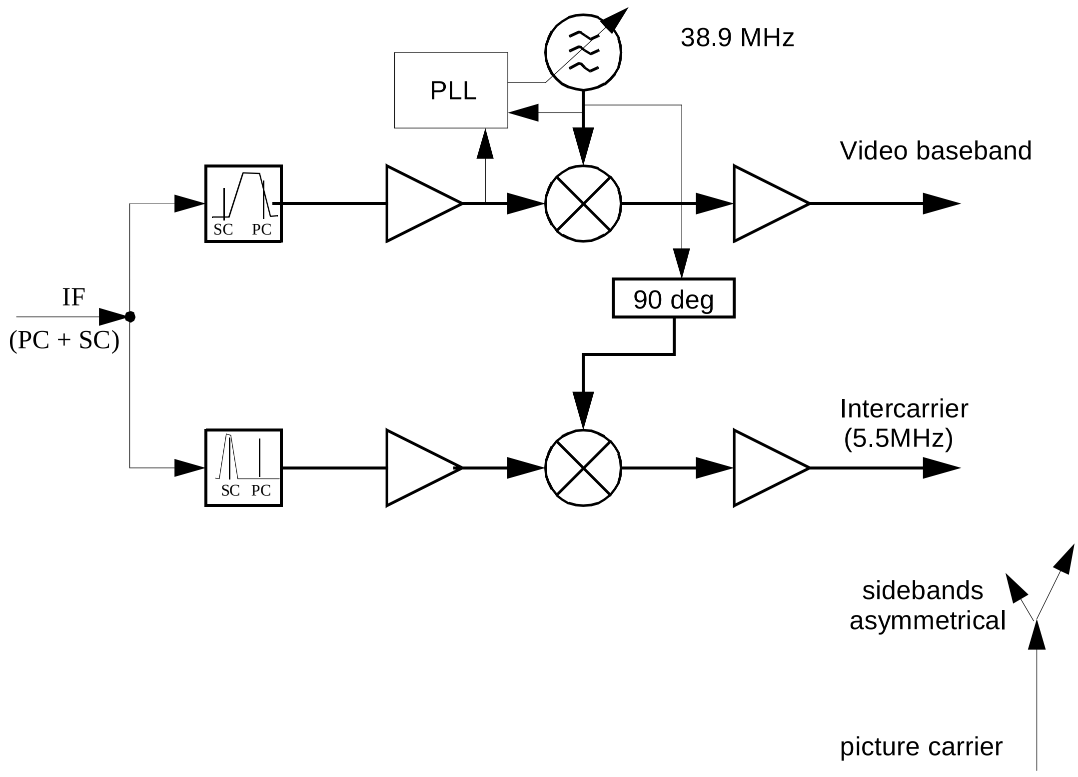


Figure 2.1-4 QSS-SR concept with one single reference(QSS-SR)

The QSS-SR concept has great advantage compared with the Intercarrier concept concerning disturbances from video signal to sound IF because SIF and VIF go through different paths.

In the intercarrier principle the chance for unwanted crossmodulation which depends on the linearity of the IF amplifier and video-demodulator is much higher. So for example a 250 kHz videosignal might be crossmodulated to the 5.5MHz first sound carrier and might have an influence on the second sound carrier(5.742 MHz) signal directly or to the ident signal.

To check this phenomenon critical signals are those which will cause crossmodulation like 250 kHz or harmonics of for example about 5.5MHz/2 or 5.5MHz/3.

Other specific video signals will be of interest which might influence the ident signals or the pilot regeneration.This will be explained in more detail in chapter 2.2.

For the concrete measurements a TDA9815 was used for QSS-SR mode and the TDA9812 was used with the internal FM demodulators of the TDA9815 for the intercarrier mode because the TDA9840 needs double FM demodulators in front.

2.2 Error mechanisms and corresponding critical video signals

There are different sources for the sound disturbances caused by the video modulation :

Crossmodulation

The one is the cross modulation from the picture carrier to the intercarrier(5.5MHz for example) which is caused by the common use of the same IF amplifier by PC and SC1 and SC2 .For TDA9800(an economic VIF-)IC also the demodulator stage is the same for both. In this case the linearity of this stage is very important.

Also the sound shelf as defined in figure 2.1-4 of the intercarrier SAW filter has an influence.With a 20 dB sound shelf for example the intercarrier is more suppressed and more sensible for video signal distortions than with a 14 dB sound shelf.

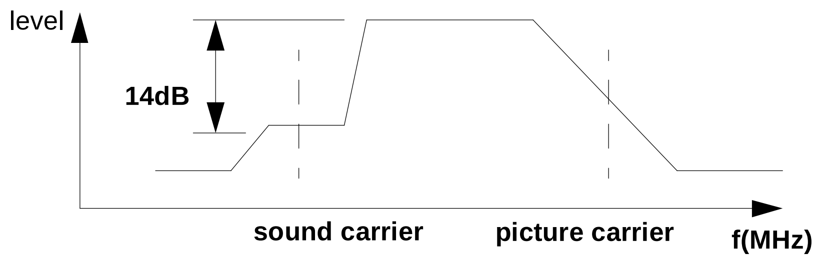


Fig. 2.2-1 Typical intercarrier filter with 14 dB sound shelf

So here the cause for sound processing errors is mainly the nonlinear effects and the relatively high level of the disturbing video signals compared to the sound signals.

What does this crossmodulation do ?

The error mechanisms are mainly due to disturbing signals from video to the sound intercarrier signals which will have an influence on the ident signals and on the sound signal itself.

Figure 2.2-1 shows the pilot signal and the ident signals for stereo and dual in the baseband.

The ident signals of the A2 system are AM modulated on the pilot carrier of around 54 kHz. This modulated signal is than FM-modulated on the second sound carrier (5.742 MHz for example)

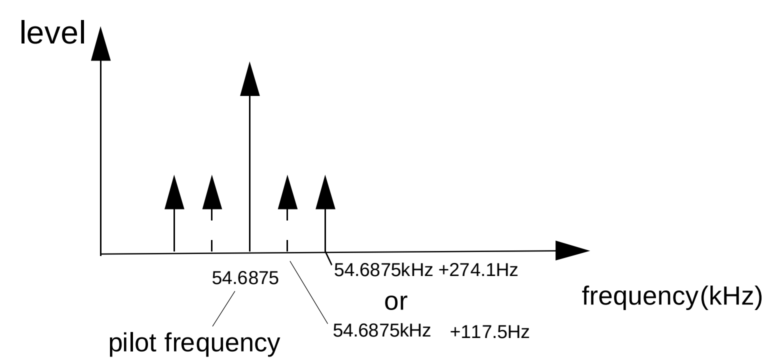


Fig. 2.2-2 Two sound carrier concept- pilot and ident signals

To disturb the ident function spuriouses have to fall into the place of the modulated ident signals (fp +/- f_{id}). The disturbing signal is yet present at the first sound IF and is converted to the baseband. Here disturbing frequencies may fall on the pilot or the ident frequencies.

So every video frequency or an integer portion of this frequency or combinations which fall on the ident frequency is dangerous for the system.

Table 2.2-1 summarizes critical video frequencies for this kind of disturbance:

a) maximum PAL color subcarrier for BG and I
to check signalhandling limitations of AGC
b) fsc2 - fsc1 + fp + fid for analog 2 sound carrier system
check incidental phase modulation (ICPM).SC1 gets sidebands that are at the position of the analog 2 sound carrier system ident signal of SC2
c) fpilot + fid for analog 2 sound carrier system
to check ICPM.SC2 gets sidebands that are at the position of the ident
d) (fsc2 + fp + fid)/2 for analog 2 sound carrier system
to check harmonics that are at the position of the ident
e) (fsc2 + fp + fid)/3 for analog 2 sound carrier system
to check harmonics that are at the position of the ident
f) maximum SECAM deviation(L)
to check crosstalk from modulated color carrier to the NICAM signal
g) fsc2 - fsc1 for NICAM
check crossmodulation. SC1 gets sidebands that are stronger than the NICAM signal
h) fsc2/2 for NICAM
to check harmonics. SC1 gets sidebands that are stronger than the NICAM level which can influence the AGC or also the PLL locking behaviour.
i) fsc2/3 for NICAM
to check harmonics. SC1 gets sidebands that are stronger than the NICAM level

Table 2.2-1 Critical video signals

For the 2carrier analog system some critical video signals for the B/G standard are listed in the following table.

f_{SC1} = 5.5MHz, f_{SC2}= 5.7421875 MHz, f_p = 54.6875 kHz, $f_{id\text{-}st}$ = 117.5 Hz , $f_{id\text{-}d}$= 274.1 Hz

$f_{SC2} + f_p - f_{SC1}$	=	296.875 kHz
$f_{SC2} - f_p - f_{SC1}$	=	187.500 kHz
$f_{SC2} + f_p + f_{id\text{-}st} - f_{SC1}$	=	296.992 kHz
$f_{SC2} + f_p - f_{id\text{-}st} - f_{SC1}$	=	296.758 kHz
$f_{SC2} - f_p + f_{id\text{-}st} - f_{SC1}$	=	187.617 kHz
$f_{SCSC2} - f_p - f_{id\text{-}st} - f_{SC1}$	=	187.383 kHz
$f_{SC2} + f_p + f_{id\text{-}d} - f_{SC1}$	=	297.149. kHz
$f_{SC2} + f_p - f_{id\text{-}d} - f_{SC1}$	=	296.601. kHz
$f_{SC2} - f_p + f_{id\text{-}d} - f_{SC1}$	=	187.774 kHz
$f_{SC2} - f_p - f_{id\text{-}d} - f_{SC1}$	=	187.226. kHz
$f_p + f_{id\text{-}st}$	=	54.805 kHz
$f_p - f_{id\text{-}st}$	=	54.570 kHz
$f_p + f_{id\text{-}d}$	=	54.962 kHz
$f_p - f_{id\text{-}d}$	=	54.413 kHz
$1/2(f_{SC2} + f_p)$	=	2.898437 MHz
$1/2(f_{SC2} - f_p)$	=	2.843750 MHz
$1/2(f_{SC2} + f_p + f_{id\text{-}st})$	=	2.898496 MHz
$1/2(f_{SC2} - f_p + f_{id\text{-}d})$	=	2.843887 MHz
$1/3(f_{SC2} + f_p + f_{ST})$	=	1.932331 MHz
$1/3(f_{SC2} + f_p + f_{id\text{-}st})$	=	1.895927 MHz

fp = pilot
$_{id\text{-}st}$ = ident for stereo
id-d = ident for dual
SC1 = sound carrier 1
SC2 = sound carrier 2

Table 2.2-2 critical video signals for analog 2 sound carrier system

ICPM (incidental phase modulation, NYQUIST SLOPE INDUCED AM/PM conversion)

Whereas the crossmodulation effect can be cured by the quasi split sound concept which uses different pathes for vision and sound IF reference picture carrier regeneration the ICPM can not be removed by QSS-SR when using the single reference concept where the Nyquist slope remains in the carrier generation path. Classical QSS concepts which used two separate chips for vision and sound demodulation with two separate references and a specific SAW filter without a Nyquist slope for the first sound IFpath did not have this kind of distortion. Of course these older concepts needed a lot more components than the actual single reference concepts.

The phenomenon of ICPM is caused by the Nyquist slope. Together with the wanted AM modulation the picture carrier is also phase modulated. Within the loop bandwidth of the PLL the VCO will follow the PM modulated picture carrier and so the PM is transferred to the VCO. The PM depends on the video amplitude so a great amplitude jump from white to black will cause also a large delta Phi.

The PC carrier out of the VCO with its unwanted PM now is used for the generation of the intercarrier frequency so also the intercarrier frequency is phase modulated with the video content. The differentiation of the PM gives a FM and this FM can lead to an audible disturbance or can cause ident problems and BER degradation.

Figure 2.2-3 shows the PM which comes from the NYQUIST slope.

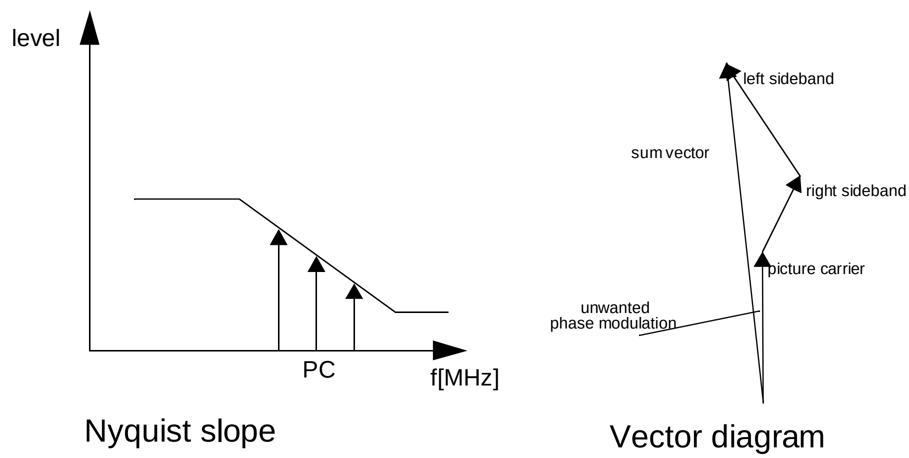


Fig. 2.2-3 Phase modulation generation at the Nyquist slope

Supposing that the picture carrier is AM modulated only with one frequency of below 750 kHz we see in figure 2.2-3 that the vectors of the two sidebands nearby the picture carrier are not of the same length. (In contras

t to that a purely AM modulated signal has 2 sidebands of equal length which build a sum vector which is also in the same direction like the picture carrier). Constructing the sum vector here we see that the sum vector has also a PM.

A critical signal for this error mechanism is the 54.6875 kHz pilot frequency +/- the ident modulations which cause sidebands as shown in figure 2.2-2. A 54.6875 kHz signal is converted to a PM and can disturb the pilot carrier directly (the pilot may lock to a false frequency) or it may disturb the ident signals and there might be misidentification.

AGC or PLL takes a disturbing signal as reference

Another error mechanism may occur if an AGC circuit is looking to a disturbing signal instead of the wanted signal which should be controlled.

Figure 2.2-4 shows a disturbing signal which falls for example in the NICAM wanted bandwidth. The AGC now looks to the disturbing signal and detects a strong signal which it controls. For a strong error signal the AGC might decrease the gain and so also the (weak) wanted signal decreases and the bit error rate increases. Another problem may occur if the PLL takes the disturbing signal as reference and trys to lock to it.

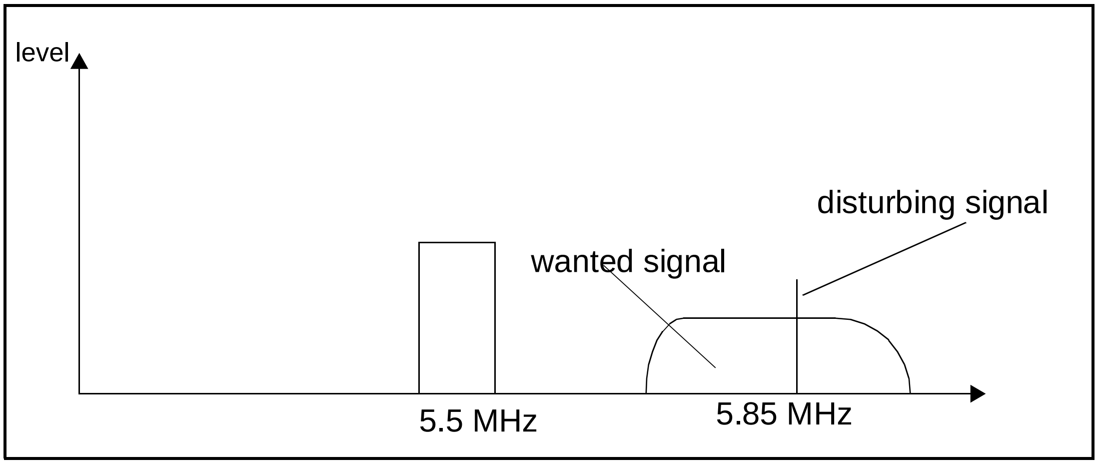


Fig. 2.2-4 Disturbing signal gives wrong information to the AGC

Critical signals are those which produce spectral components in the range of the wanted signal.

Another critical signal for NICAM which has to be regarded is the color carrier and combination frequencies which may fall into the NICAM band.

2.3 Normal and worst case signal conditions

The nominal values of the picture carrier to the sound carriers are given in figure 2.3-1 for different standards and sound processing systems. These values can be measured under nominal conditions at the antenna input.

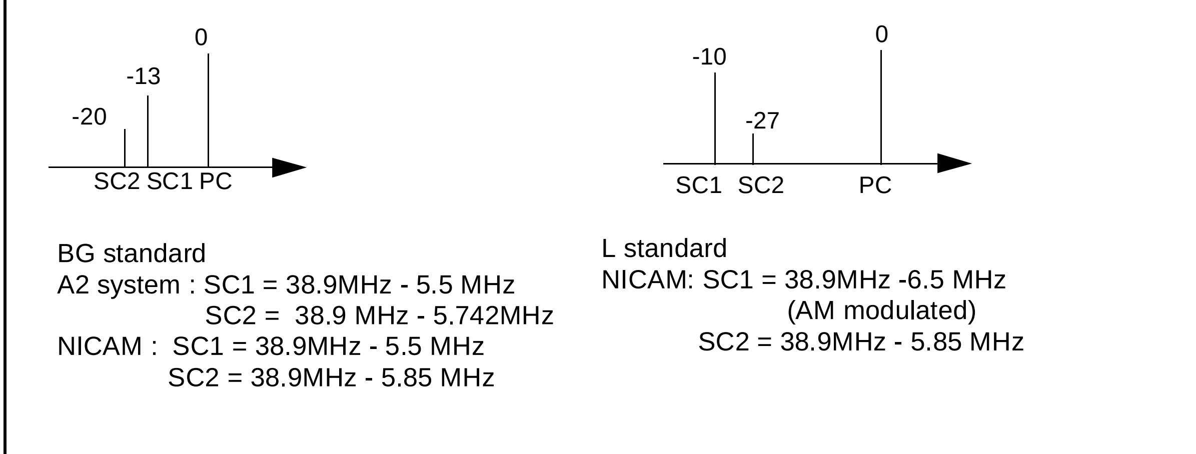


Fig. 2.3-1 Nominal picture to sound carrier ratios from transmitter

For private cable systems according to FTZ 1R8 -15 the SC1 can vary between -10dB and -19dB, the SC2 can vary between - 20 dB +/- 6 dB in relation to the picture carrier. A standard tuner may have a tilt of +/- 4 dB, a SAW filter may have a spread over picture carrier to sound carriers of +/- 3 dB. Other countries have different field conditions.

Making these assumptions for standard B/G for example we would get a PC/SC2 ratio before the(ideal) SAW filter of:

PC/SC2 from transmitter		= 20 dB
private cable system	(+6dB)	+6 dB
tuner tilt	(+4 dB)	+4 dB
SAW filter spread	(+3 dB)	+3 dB

worst case PC/SC2 before SAW = 33 dB -> 13 dB more than the nominal case !!

When using the intercarrier system with an intercarrier SAW filter with for example 14 dB the sound carrier is reduced by 14 dB and the picture carrier is reduced by 6 dB caused by the Nyquist slope. So the decreasing of the PC/SC2 ratio is -6dB/-14dB -> -8dB. So with an 14 dB intercarrier filter compared to an QSS-SR system the PC/SC2 ratio at the IC is decreased at further 8 dB.

From the worst case assumption even for QSS-SR we see from the example above that the PC/SC2 ratio can be worse by around 13 dB. That means that the disturbing video signals which may have an influence on the intercarrier are 13dB stronger than assumed under nominal conditions.

2.4 The compared applications

2.4.1 General setup

All measurements were taken with a UV916M Tuner and a TDA9815 frontend for QSS mode and a TDA9812 for intercarrier mode as shown exemplary in figure 2.4.2 -1 and 2.4.2-2. This frontend combination delivers the intercarrier signal which goes either into the TDSD3 for NICAM demodulation and decoding or into the internal FM demodulators of the TDA9815 which deliver the audio signals for the TDA9840. The tilt of the tuner was measured and is less than 0.5 dB.

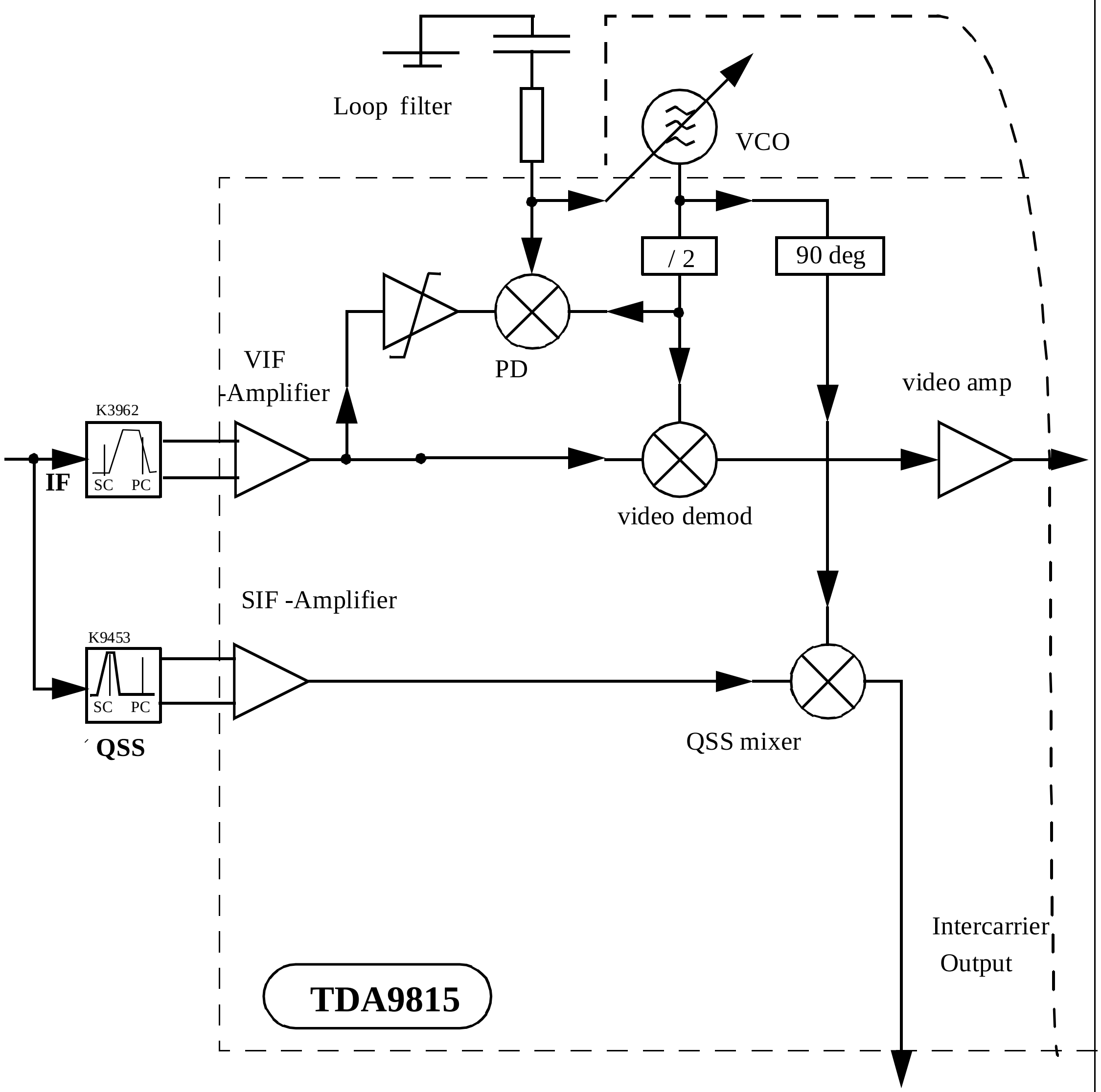


Figure 2.4.1-1 The TDA9815 in QSS-SR mode

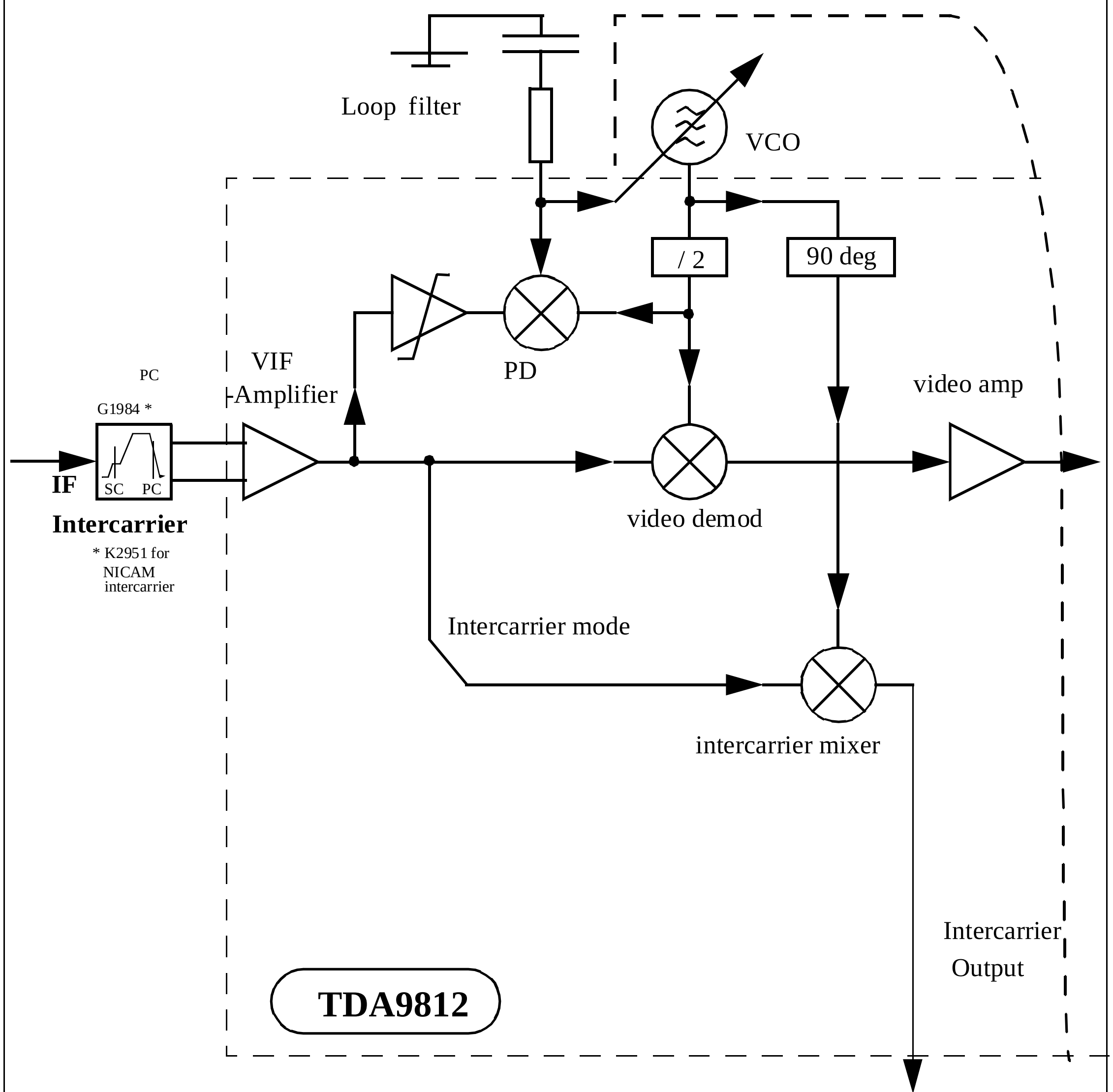


Figure 2.4.1-2 The TDA9812 in Intercarrier mode

2.4.2 Digital sound processing: NICAM with the SAA7284 -Standard BG

The following figures show the application setups for intercarrier(fig. 2.4.2-1) and QSS-SR (figure 2.4.2-2)

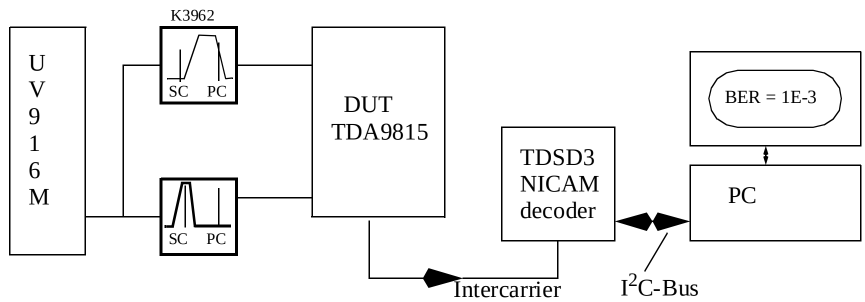


Figure 2.4.2-1 NICAM - TDSD3 with SAA7284 - QSS-SR mode application

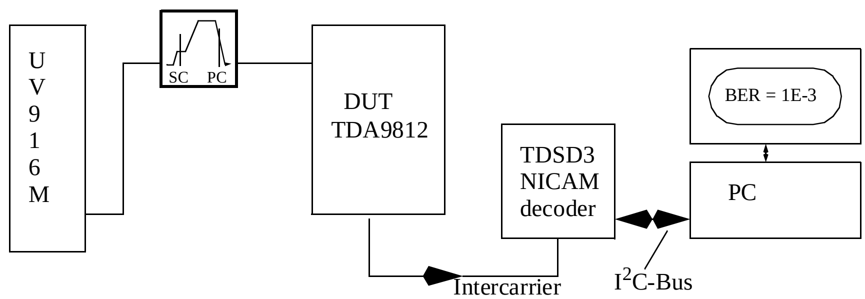


Figure 2.4.2-2 NICAM - TDSD3 with SAA7284 - Intercarrier mode application

2.4.3 Digital sound processing: NICAM with the SAA7284 -Standard L

The second sound carrier is reduced to 27 dB below the PC to prevent the AM modulated sound carrier1 (6.5MHz) from beeing disturbed by the NICAM QPSK modulated sound carrier1 (5.85MHz).

2.4.4 Two sound carrier analog concept with TDA9840 in standard BG

To get an idea of the performance concerning the analog two sound carrier system the concepts with the TDA9840 were investigated for standard BG. The measurements will show also for this concept different critical video signals which are related to the sound processing concept. For example the 250 kHz signal is expected to be critical for this concept whereas the 350 kHz is not due to the different distances of sound carrier 1 to sound carrier 2.

Figure 2.4.4 - 1 and figure 2.4.4 -2 show the application setup. The internal FM demodulators of the TDA9815 were used for the two sound carriers. The TDA9840 is the stereo decoder. Whereas for the NICAM demodulator a BER of 1E-3 was the criterion for the measurements here the misident criterion is used. Misident means that the ident does not indicate correctly the transmitted mode.

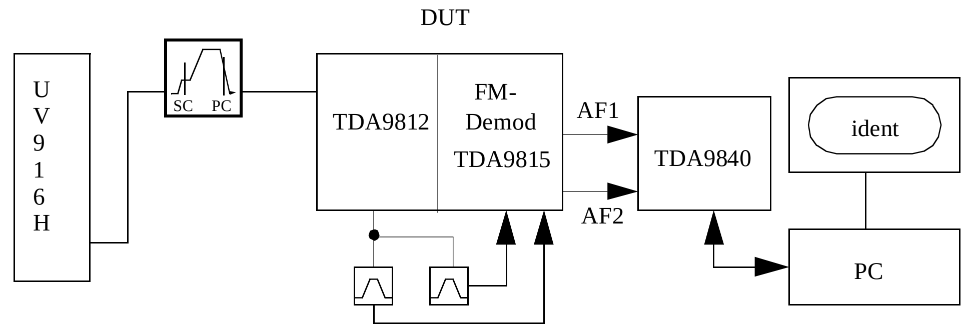


Figure 2.4.4-2 two soundcarrier application with TDA9812 - Intercarrier mode

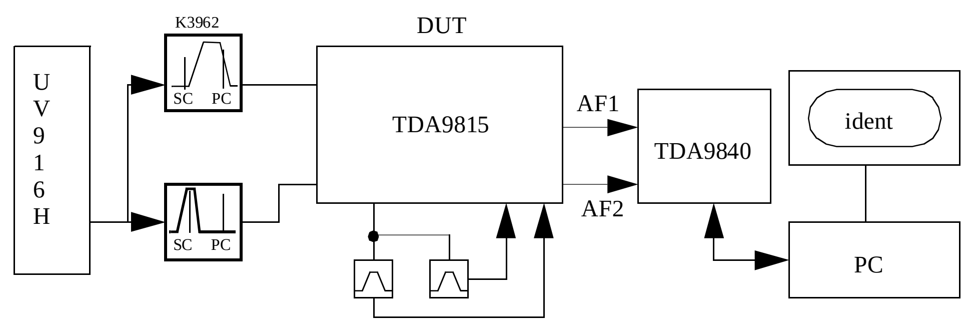


Figure 2.4.4-3 two soundcarrier application with TDA9815 - QSS-SR mode

3. Measurements, results and interpretation

3.1 Genaral measurement setup

Figure 3.1 - 1 shows the standard measurement setup .

Depending on the applications which were described in chapter 2 either the BER or the misident is the measurement criterion.The tuner tilt was measured and is below 0.5 dB at the highest sound carrier distance.

The RF input level is determined at which the reading of the control software corresponds to an error count of 39(hex). This error count fluctuates from hex 30 up to hex 45 .As described in the Application Note of the SAA7283 this hex value corresponds to a BER of 1E-3.

For these measurements the values were taken where the correct ident was lost. Normally the value is measured where the ident comes back again. The hysteresis was measured to be around 2 dB.

3.2 Sensitivity for holding a given BER(or getting ident) versus antenna input level

When the BER for NICAM shown by the PC control software is equal or better than a BER of 1E-3 we will define that the given BER is hold.

Figure 3.1 - 1 on the next page shows the measurement setup ,chapter 2 gives the application diagram for the different measured applications . The following applications were compared:

a) NICAM - BG- QSS-SR concept (Nic-QSS-BG)

b) NICAM - BG - Intercarrier concept (Nic-Int-BG)

c) NICAM - L- QSS-SR concept (Nic-QSS-L)

d) NICAM - L - Intercarrier concept(Nic-Int-L)

e) analog modulated 2 sound carrier concept (A2-QSS-BG)

f) analog modulated 2 sound carrier concept (A2-Int-BG)

3.2.1 Results

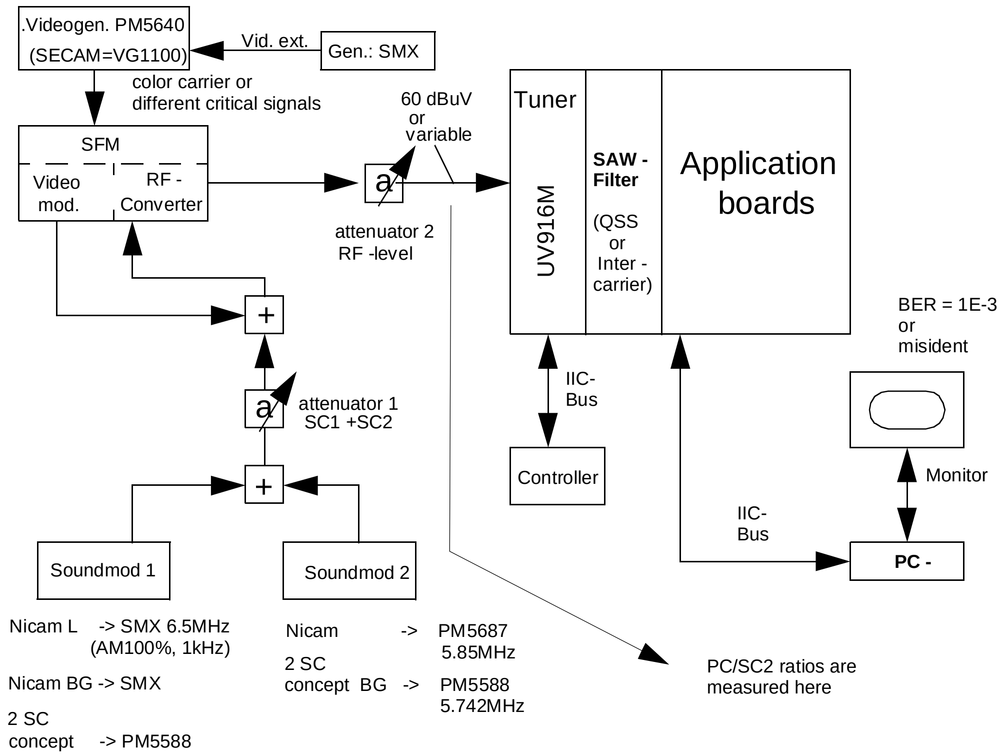
Table 3.2 - 1 shows the results.

The values in the table show the RF input level at which the BER = 1E-3 or where a misidentification occurs. The lower value indicates the better performance.

	NICAM	NICAM	Analog 2 SC	Analog 2 SC
	Intercar.	QSS	Intercar.	QSS
Standard	RF(BER=10-3)	RF(BER10E-3)	RF(misident)	RF(misident)
BG	27 dBuV	25dBuV	22dBuV	21dBuV
L	33 dBuV *	25 dBuV		

* when using a 14 dB sound shelf filter for NICAM-L-Intercarrier the value is 27dBuV instead of 33 dBuV

table 3.2 -1 sensitivity for holding ident or BER=1E-3



3.1 General settings

* RF converter at channel 4 (62.25MHz) ..
* SC1 and SC2 were attenuated by one common attenuator
* The PC/SC2 ratio can be regulated by attenuator 1
* PC/SC2 ratio depends on application -> see chapter 2

3.2 Sensitivity of BER=1E-3 (misident) versus RF-input level

* video signal: color bar

3.3 Allowable PC/SC2 ratio for BER=1E-3 (misident) versus RF-input level

* video signal color bar

3.4 Allowable PC/SC2 ratio for BER=1E-3 (misident) versus disturbing video signals

* RF level = 60 dBuV at the tuner input

Figure 3.1 - 1 General measurement setup of the different applications

3.2.2 Interpretation

The loss in sensitivity due to intercarrier demodulation is low in standard B/G. At standard L the loss is 8 dB with a 20 dB sound shelf. 33 dBuV corresponds to a reduced picture quality. The picture is very noisy but shapes still can be recognized. The color carrier is not yet activated and the vertical sync is O.K. With 14 dB sound shelf the sensitivity for NICAM - L is like that for NICAM - BG.The QSS-SR system shows better values because the sound and vision paths are separated.

3.3 Allowable PC/SC2 ratio to get a given BER (or ident) versus RF input level

Figure 3.1 - 1 shows the measurement setup,chapter 2 gives the application diagram for the different measurements. The applications listed in table 3.3.1-1 were compared.

Two parameters are important for the performance of a TV set:

- the PC/SC2 ratio at which the stereo decoders loose identification or drop below a given BER.
- the RF level for these limits.

For a specific application and a given video signal a diagram can be drawn with PC/SC2 at one axis and the RF input level at the second one. The line for BER = 1E-3 or loss of identification gives the limit for the different concept/standard combination.

3.3.1 Results

Table 3.3.1 - 1 shows the results.

the values in the table show the allowable PC/SC2 at the tuner input to get a BER of 1E-3 or where misidents occur. So the higher value is the better one

					K2951		G1984
					20 dB		14 dB
	NICAM	**NICAM**	**Analog 2C**	**Analog 2C**	**NICAM**	**NICAM**	**NICAM**
	Intercarrier	**QSS-SR**	**Intercarrier**	**QSS-SR**	**Intercarrier**	**QSS-SR**	**Intercarrier**
RF(dBuV)	**Nic-Int-BG**	**Nic-QSS-BG**	**A2-Int-BG**	**A2-QSS-BG**	**Nic-Int-L20**	**Nic-QSS-L**	**Nic-Int-L14**
33	21	28	29	31	21	25	21
36	24	30	32	34	22	27	24
39	27	33	35	36	23	31	27
42	30	36	37	38	25	34	30
45	33	39	39	41	27	37	33
48	35	42	40	44	29	40	35
51	37	44	40	47	31	43	36
54	40	47	40	50	32	46	38
57	41	50	40	53	34	49	40
60	41	52	40	56	34	52	40
63	41	54	40	58	34	54	40
66	41	57	40	59	34	57	41

table 3.3.1 -1 Allowable PC/SC2 ratio to get a given BER(or ident) versus RF input level

The curves in figure 3.3.1-1 show the comparison.

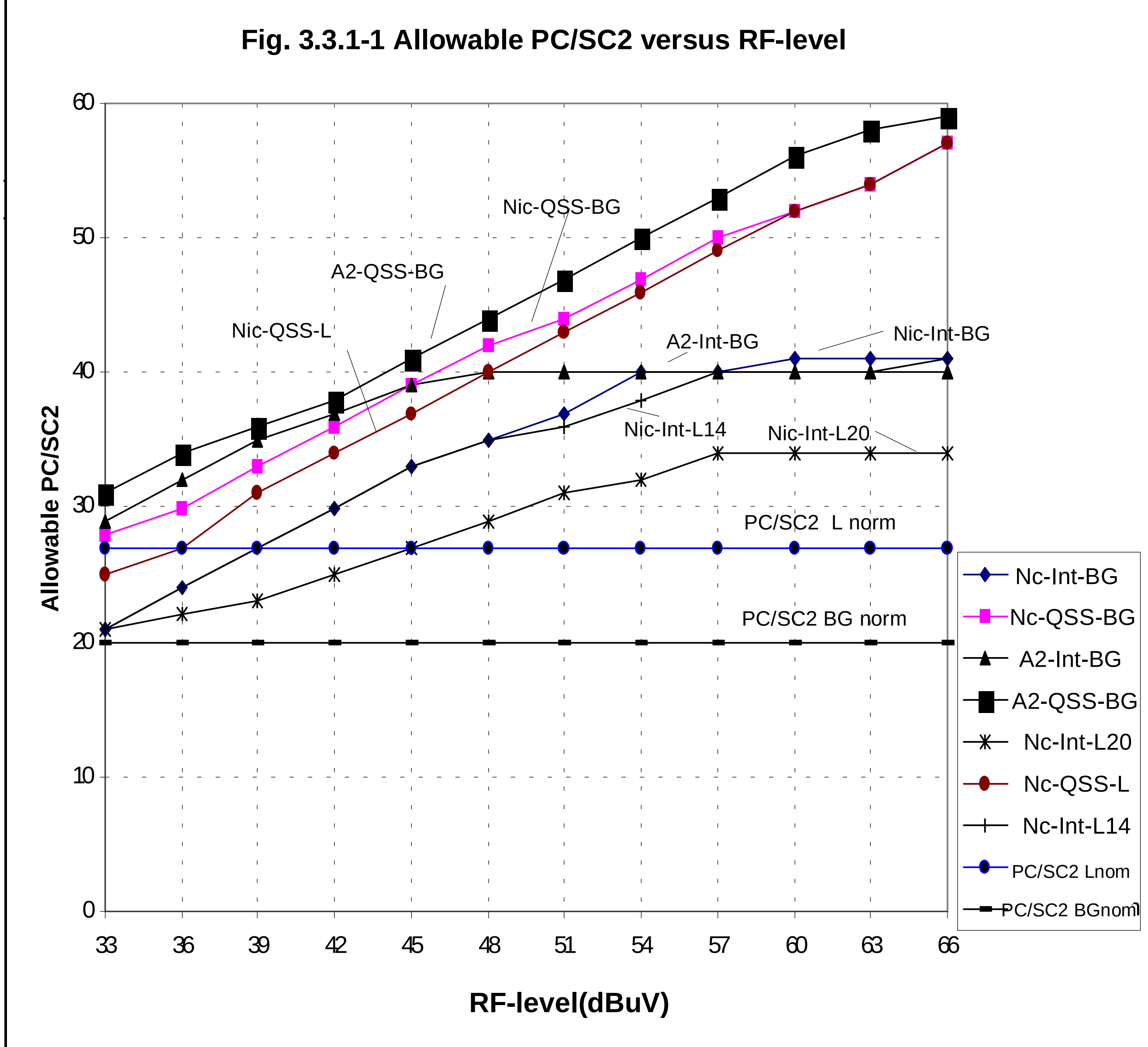


Figure 3.3.1-1Allowable PC/SC2 versus RF level

3.3.2 Interpretation

A setmaker can use this diagram for the decision about a concept to be used: He can fix the requirements for the PC/SC2 ratio at a certain RF input level.When the point of intersection is below the curve for intercarrier these concepts can be used but if it is above (like PC/SC2 = 45 dB at V_{RFin} = 60 dBuV) only QSS-SR concepts can meet this requirement.

From chapter 2.3 we can see that the standard L intercarrier mode is the worst case. The intercarrier concept is hardly acceptable for standard L NICAM .Only stronger signals can make the system running sufficiently.

Especially when using an 20dB sound shelf filter the situation for standard L NICAM is critical because the margin to the nominal PC/SC2 of 27dB is only 7 dB at 60 dBuV. Already at 45 dBuV the RF input signal BER goes below 1E-3 for the nominal PC/SC2. Taking the worst case spread of 13dB for PC/SC2 the NICAM sound will not be acceptable. NICAM will even go out of operation. The 14 dB soundshelf improves the situation but for worst case PC/SC2 the concept can just reach a BER of 1E-3.

NICAM BG is no problem above 45 dBuV. A2 intercarrier has no problem and the QSS concepts work very well.

3.4 Allowable PC/SC2 ratio to get a BER 1E-3 (ident) versus disturbing video signals

Figure 3.1 - 1 shows the measurement setup,chapter 2 gives the application diagram for the different measurements.

3.4.1 Results

Table 3.4.1 - 1 shows the results, figure 3.4.1 - 1 shows these values in a diagram.

The RF input is 60dBuV, sinewave signals are 100% modulated around a middle video level corresponding to “grey” with a VG1100 for standard L. When using the PM5580 a setup of 350 mV was tuned by the variable output setup poti.

The values in the table show the allowable PC/SC2 ratios to get a BER of 1E-3(or where misidents occur) versus disturbing video signals. So the higher value is the better one.

	NICAM Intercarrier		NICAM QSS mode		Analog 2 Sound carr. (A2)	
					Intercarrier	QSS
Video signal	Nic-Int-BG	Nic-Int-L	Nic-QSS-BG	Nic-QSS-L	A2-Int-BG	A2-QSS-BG
color bar	42	33	52	52	40	57
black	42	33	52	52	43	57
white	42	33	52	52	43	56
650/350/250k	41	32	52	52	42	56
fsc1/2 *	42	33	52	52	42	57
fsc1/3 *	42	34	52	52	42	57

table 3.4.1 -1 Allowable PC/SC2 ratio to get a BER 10E-3(ident) versus disturbing video signals

* NICAM : fsc1/2 = 5.85/2 MHz = 2.925 ; fc1/3 = 5.85/3 = 1.95MHz

* A2 : fsc1/2 = 5.5/2 MHz = 2.75 ; fc1/3 = 5.5/3 = 1.83MHz

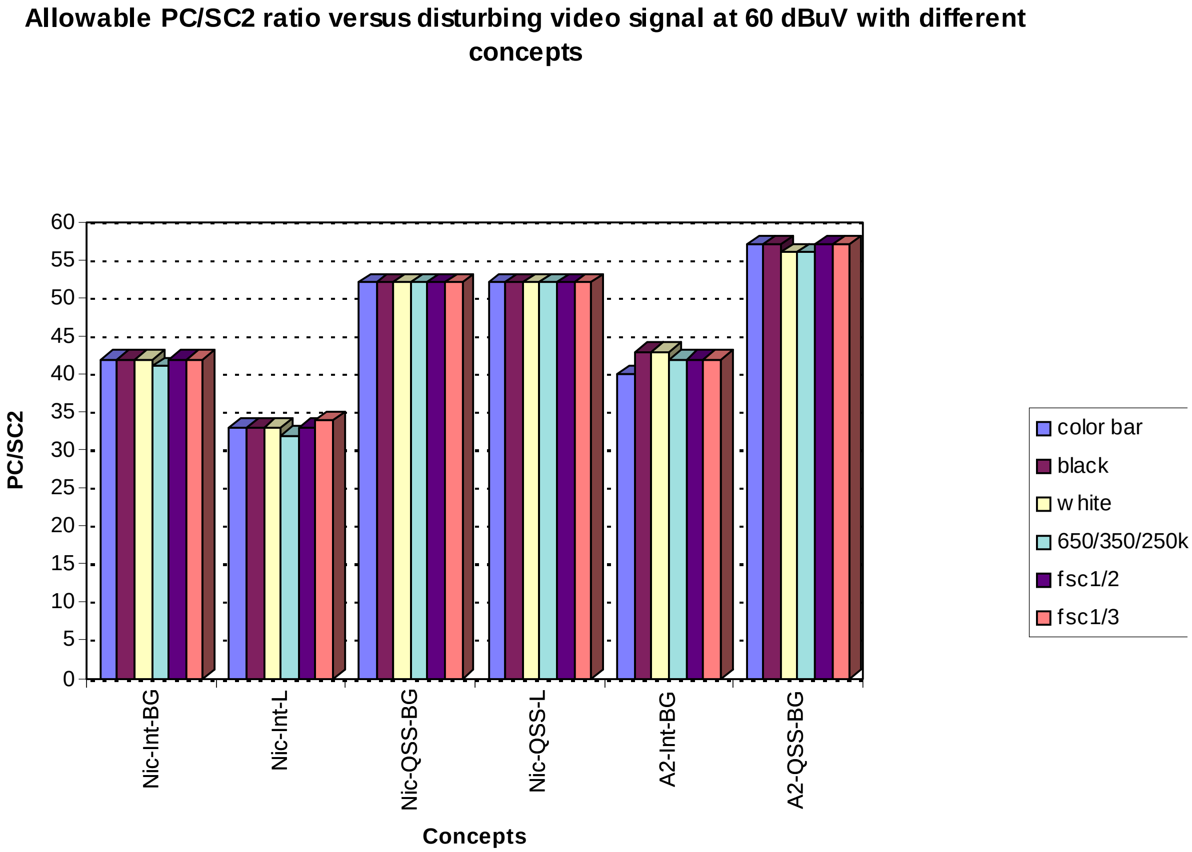


Figure 3.4.1-1 Allowable PC/SC2 ratio versus disturbing video signals at 60dBuV with different concepts with 14 dB sound shelf filter for intercarrier mode.

Critical signals

Some critical video signal frequencies were investigated. An overview of possible critical signals for the 2 carrier concept is given in chapter 2 in the table 2.2 -2. As example for each of the groups the following frequencies were taken. They represent one frequency of the corresponding group .

f_p = pilot frequency = 54,6875

$f_{id\text{-}st}$ = 117,5 Hz

a) A2 system : $f_{SC2} + f_p - f_{SC1}$ = 296,875

Misidentification: Stereo is transmitted but mono is detected. -> misident

b) A2 system : $f_{SC2} + f_p + f_{id\text{-}st} - f_{SC1}$ = 296,992

In spite of sending a stereo signal mono is detected.By changing the frequency by around 10 Hz the ident is correct again. -> misident

c) A2 system : $f_p + f_{id\text{-}st}$ = 54.805 kHz

In spite of sending a mono signal stereo is detected. By changing the frequency by around 2 Hz the ident is correct again

-> misident

d) A2 system : 2.898437MHz

BER is OK under normal PC/SC2 conditions. By making the PC/SC2 7 dB worse misidents occur.

->BER of 1E-3 O.K. when using a 14 dB soundshelf SAW filter .

e) NICAM: f_{vid} =

350 kHz/650 kHz

BER is OK under normal PC/SC2 conditions. By making the PC/SC2 2 to 3 dB worse especially for standard L the BER increases dramaticaly.

->no misident when using or simulating a 14 dB soundshelf SAW filter .

table 3.4.1-1 gives an overview over the results:

	QSS-SR	Intercarrier
a) A2 concept: $f_{SC2} + f_p - f_{SC1}$ = 296,875	O.K.	misident
b) A2 concept: $f_{SC2} + f_p + f_{id\text{-}st} - f_{SC1}$ = 296,992	O.K.	misident
c) A2 concept: $f_p + f_{id\text{-}st}$ = 54.805 kHz	misident	misident
d) A2 concept: $(f_{SC2} + f_p)/2$ = 2.898437MHz	O.K.	O.K.
e) NICAM: f_{vid} =350 kHz/650 kHz	O.K.	O.K.

Table 3.4.1-1 disturbing video signals with discrete critical frequencies

3.4.2 Interpretation

For the NICAM /BG and L and for the for the A2 concepts we did not see a big influence of the video signal in QSS-SR systems. We can explain this with the separated paths of the video and sound IF. Also in QSS-SR we see no big influence of a critical video signal.

For standard L a standard L video generator has to be used because the color carriers are different from the BG standard.As seen in the measurements taken before intercarrier concepts are more sensible against disturbances than the more robust QSS-SR systems. The following signals will be discussed in detail:

a) A2 system: $f_{SC2} + f_p - f_{SC1} = 296{,}875$

caused by nonliner effects of the common IF amplifier and mixer for the intercarrier mode the disturbing signal is crossmodulated to the second sound carrier and falls in the pilot carrier frequency range. This effect is not shown in QSS-SR mode because the paths for the video IF and the sound IF are separated.

b) A2 system: $f_{SC2} + f_p + f_{id\text{-}st} - f_{SC1} = 296{,}992$

The effect is similar to case a) but here the AM modulated ident signal which has spectra at around 117 Hz apart from the pilot frequency is disturbed.Also here the disturbance is only present in the Intercarrier mode concept. The disturbing signal has to be very exact on the ident spectrum(10Hz) and to generate a misident in practice it has to stay for around 1 second. This disturbance is not very likely to happen in practice.

c) A2 system: $f_p + f_{id\text{-}st} = 54.805$ kHz

This error is present either in QSS-SR or in Intercarrier mode concepts because the error mechanism is different from that of case a) and b). Here the disturbing video signal components which fall inside the loop filter bandwidth of the PLL are converted as PM to the VCO. The AM modulated videosignal introduced the PM due to the nyquist slope as explained in chapter 2.2. As long as the FM caused by this PM falls within the loop filter bandwidth of the PLL it will succed in following the picture carrier. Unfortunately now also the VCO is modulated and so also the intercarrier will have this disturbance. This effect is also present in QSS-SR systems when using the single reference concept.

Also in this case by changing the disturbance by about 2Hz the ident is O.K. In practice the disturbing videosignal has to stay for more than around 1 sec before a misident will occur. Also this is not very likely in practice .

d) A2 system $(f_{SC2} + f_{p)/2}$:2.898437MHz

With a 14 dB sound shelf filter no misident occurs. With a 20 dB sound shelf filter also here a misident occurs The PC/SC2 increases by 7 dB. With the worst case spread of PC/SC2 = 13 dB this would cause problems. The concept with the 14 dB sound shelf is just at the limit..

e) NICAM: f_{vid} =350 kHz,650 kHz

Also here the Intercarrier mode is the critical case.Video frequencies which cause spectral components in the spectrum of the NICAM signal will not disturb the BER for nominal PC/SC2 ratios. Both sound carriers are present at the intercarrier also for standard L.By making the picture carrier just 2 to 3 dB greater than the normal ratio we see at standard L an increasing of the BER. So we can conclude that there is not a great margin.

The error mechanism is described in chapter 2. Here the disturbing (strong) signal falls within the NICAM wanted signal spectrum. The AGC detects a strong(disturbing) signal and reduces the gain which will make the wanted signal even weaker. All frequencies which fall into the wanted NICAM signal bandwidth will have this effect.Another problem may occur if the PLL of the DQPSK demodulator trys to lock to the disturbing frequency.

4. Conclusion

The advantage that led to the introduction and widespread use of the Quasi Split Sound concept can be found back also in this investigation. QSS-SR performs better in all cases altough sometimes with a marginal improvement.

Concerning **sensitivity** the Intercarrier concept is really worse only for NICAM-L with 20 dB sound shelf. A limit of 33 dBuV will not be a problem even in private cable systems as long as they meet specifications like in Germany with a minimum RF signal level of 60 dBuV. Terrestrial antenna signals will have much lower levels. The setmaker has to jugde whether the picture quality of his chassis at 33 dBuV is such that he still wants to have NICAM sound or that he can accept a switching to AM sound. A 14 dB sound shelf filter improves the sensitivity to 27 dBuV. This is acceptable as it is for standard B/G.

The **PC/SC2 ratio** is more critical.In the field it can deviate + 13dB from the nominal value as explained in chapter 2.3. For NICAM-L with 20 dB sound shelf the margin between the nominal PC/SC2 and the limit for a BER of 1E-3 is too low even for RF levels above 60 dBuV. Terrestrial reception leads to RF levels below 60 dBuV. Here the margin get smaller due to the slope of the curve. Although a sound shelf of 14 dB gives some improvement problems may occur at RF levels of around 50dBuV due to PC/SC2 spreads,echoes and airplane flutter. At the worst case the PC/SC2 for private cable systems of 40 dB QSS-SR allows 9 dB less RF level to reach a BER of 1E-3. This is a good performance.

NICAM BG with 14 dB sound shelf is no problem down to 45 dBuV because the worst case PC/SC2 is 33 dB due to the stronger second sound carrier . The margin is quite big.

Here the spreads have been taken from the German regulation on private cable systems (FTZ 1R8-15) and datasheets of tuners and SAW filters. A setmaker has to decide which spreads he will take into account and at which intersection point of RF level and PC/SC2 he wants to reach a BER of 1E-3 or correct ident.

Tuner noise figure, SAW filter and IF demodulator influence the PC/SC2 versus RF level characteristic. Thus it has to be measured for each specific chassis.

Crosstalk of video content is in case of NICAM only critical for system L with a 20dB sound shelf. There a video content of 650kHz +/- 180 kHz may corrupt NICAM if both sound carriers are present at the IF input of the VIF demodulator. If the spreads of PC/SC2 are taken into account it is even more dangerous. A 14 dB sound shelf gives sufficient improvement.

For the A2 system some rather narrow frequency windows exist where misidentification occurs. Their width are some Hz or tens of Hz. When ICPM (NYQUIST induced AM/AP conversion) is the cause it affects also QSS-SR concepts.

APPENDIX 1

Distribution list :

U.Buhse	SLH
T.Hafemeister	CIC-PD
B.Heinke	SLH
W. Hentschel	PS-SCC
H.Kühn	SLH
M.Meyer	SLH
J.Matull	SLH
V. Pham	SLS
R.Ribback	PS-SCC
L. Valkestijn	PS-SLE
O. Zander	PS-SCC