Technical Realisation of Digital TV Transmitter Systems

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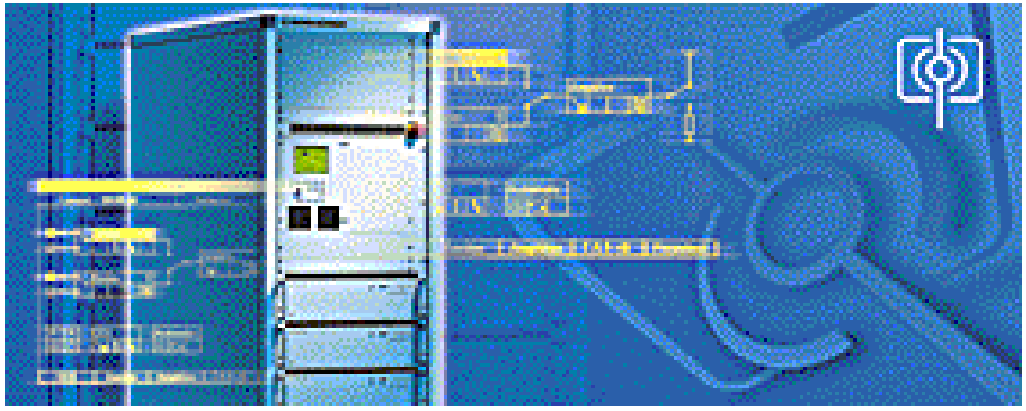
Rohde & Schwarz

Technical Realisation of Digital TV Transmitter Systems

- MFN / SFN networks
- Transition from analog to digital
- state of the art transmitter family
- redundancy systems

Network layout



MFN
(multi frequency network)

SFN
(single frequency network)

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Advantages of the SFN:

*** Frequency efficiency**

- the DVB-T system use the SFN: one frequency for several programs

(current situation: each program has another frequency
==> MFN: Multi Frequency Network)

- the SFN is with the factor of 3 better than the MFN's

*** Power efficiency**

- lower transmitter power in the SFN is required because

- addition of all signal components from different transmitters and reflection at the receiving antenna

- with the lower transmitter output power: lower distortions in neighbor areas

- if gaps exists in the coverage (deep valley, tunnels, etc.): these gaps can be filled

Disadvantages of the SFN:

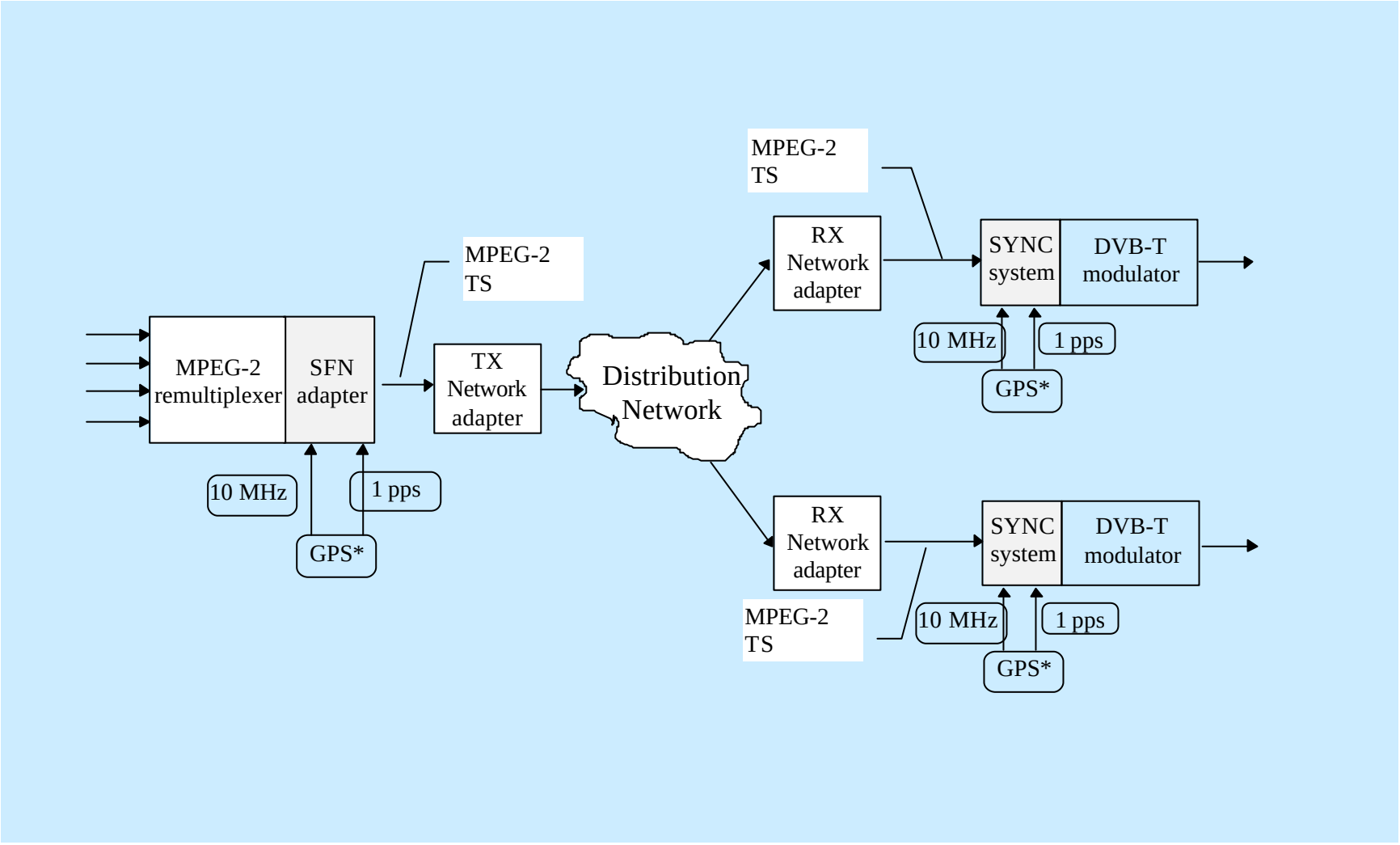
*** the TS is equal at all transmitter sites (no local program can be introduced)**

*** a transmitter which violates the SFN rules is a jammer in the coverage**

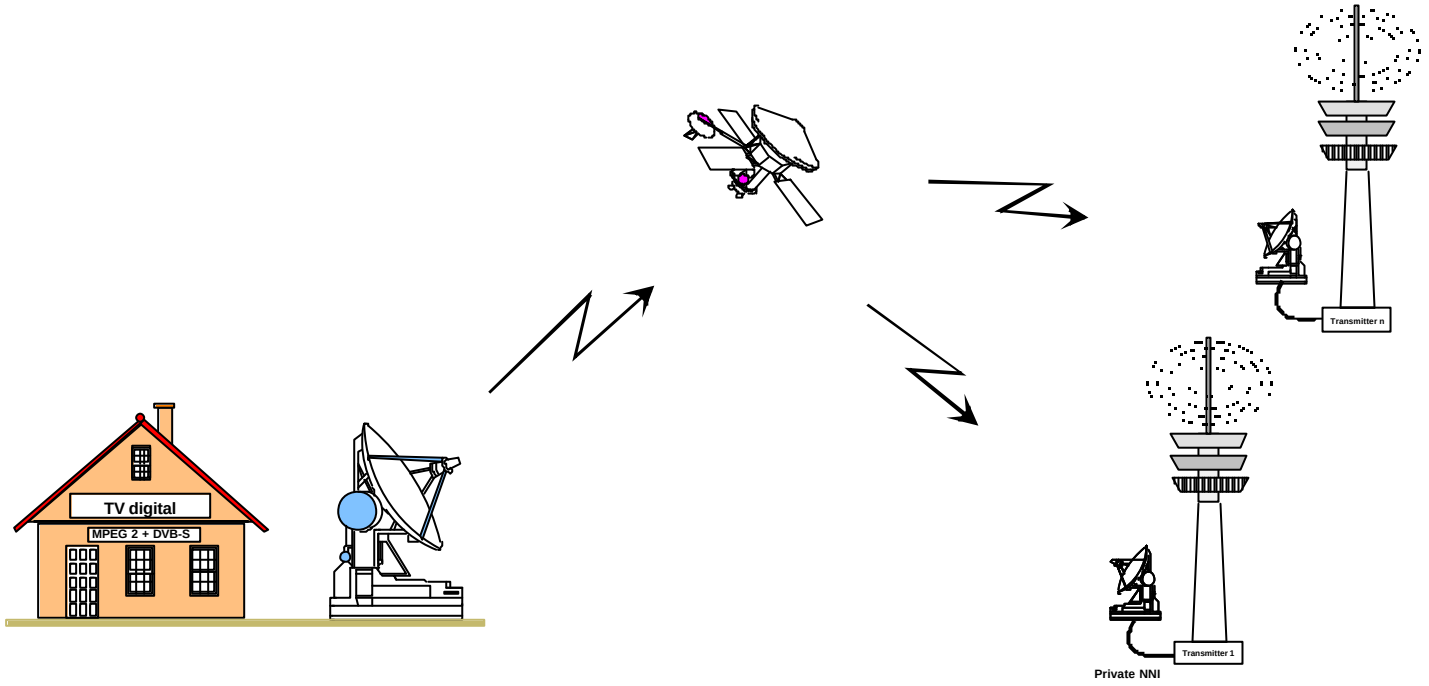
*** synchronization (time, frequency, information) is necessary**

*** network monitoring is necessary to control the SFN features**

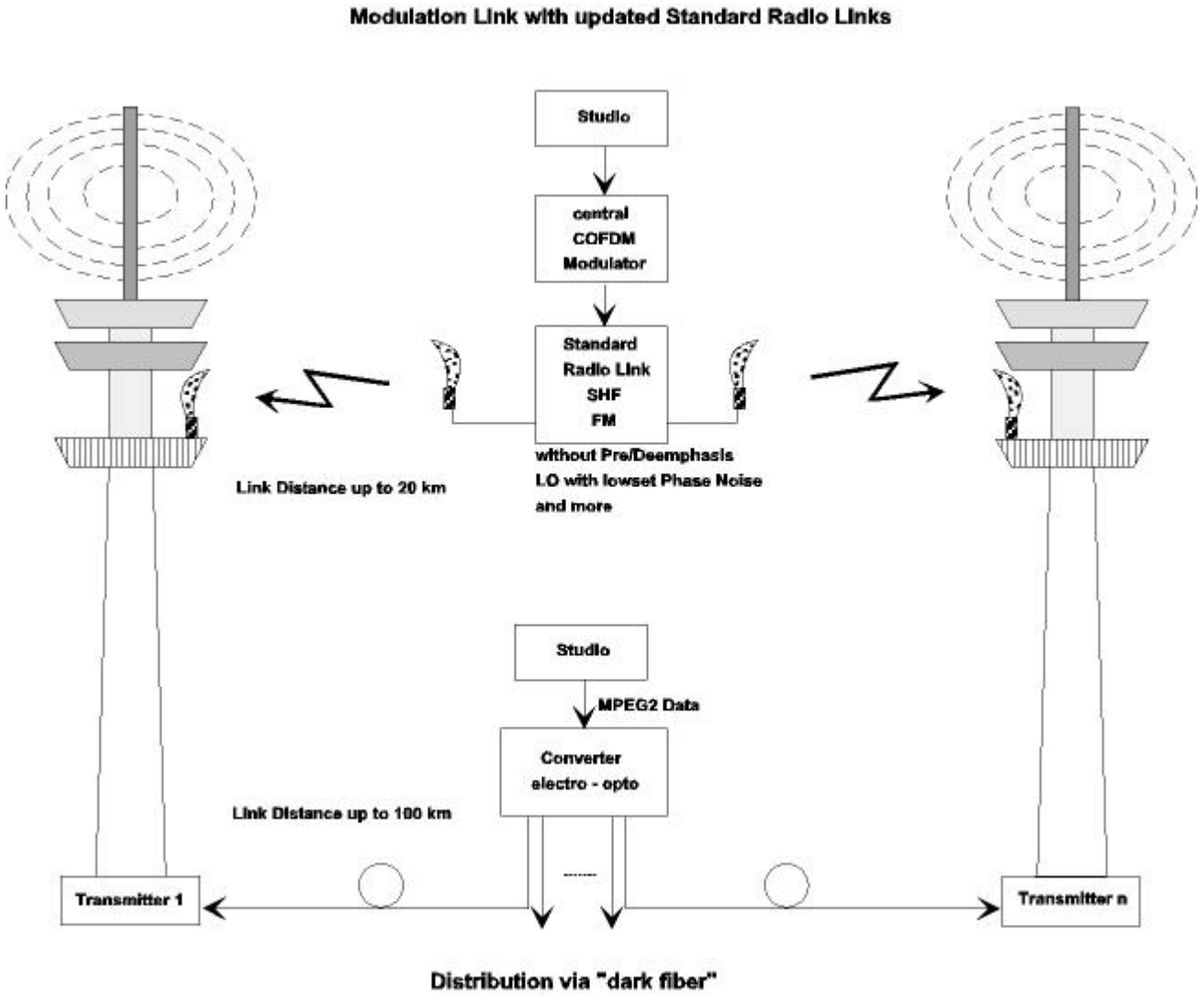
DVB-T transmitter chain SFN



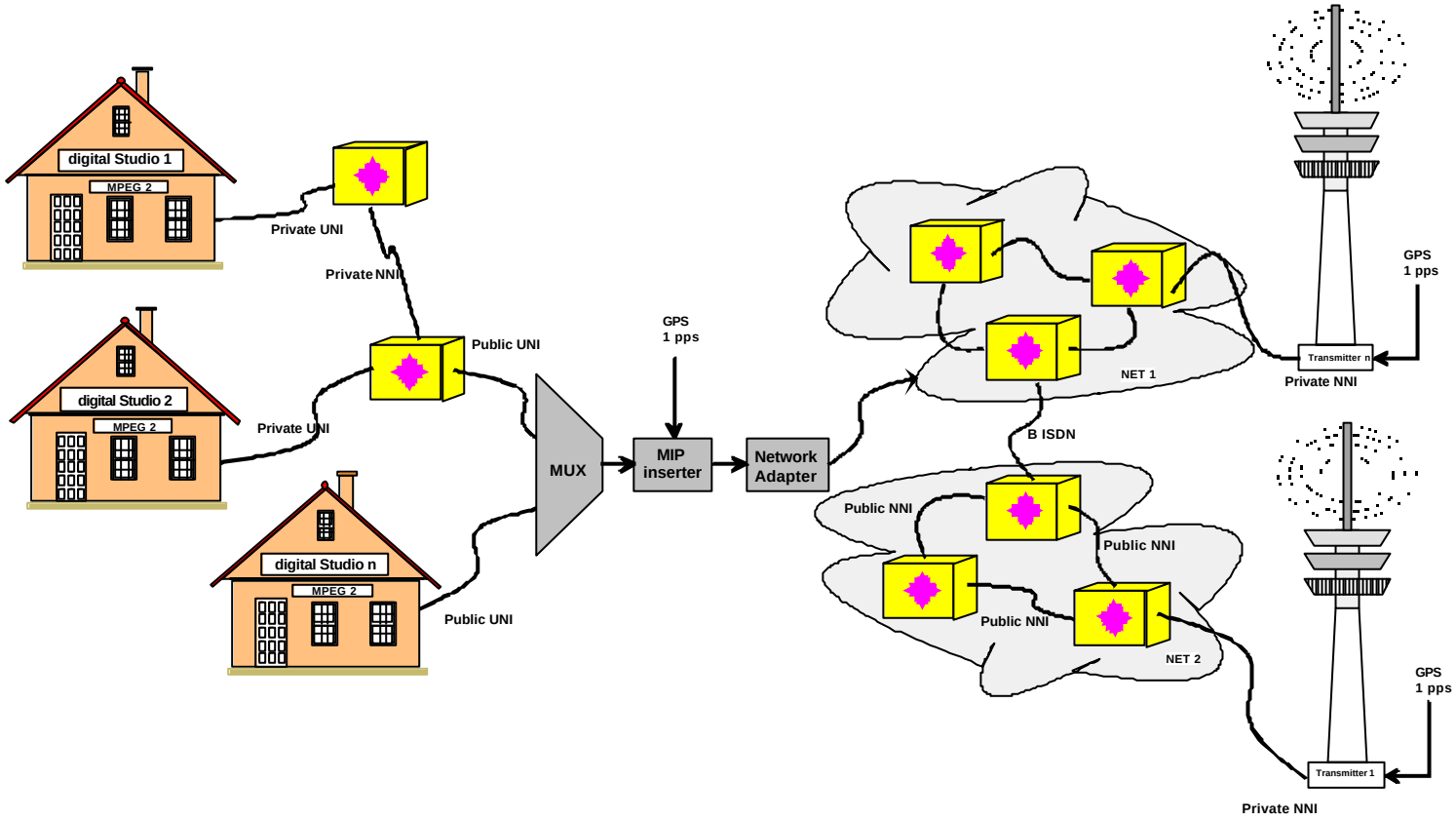
DVB-T transmission network (via Satellite)



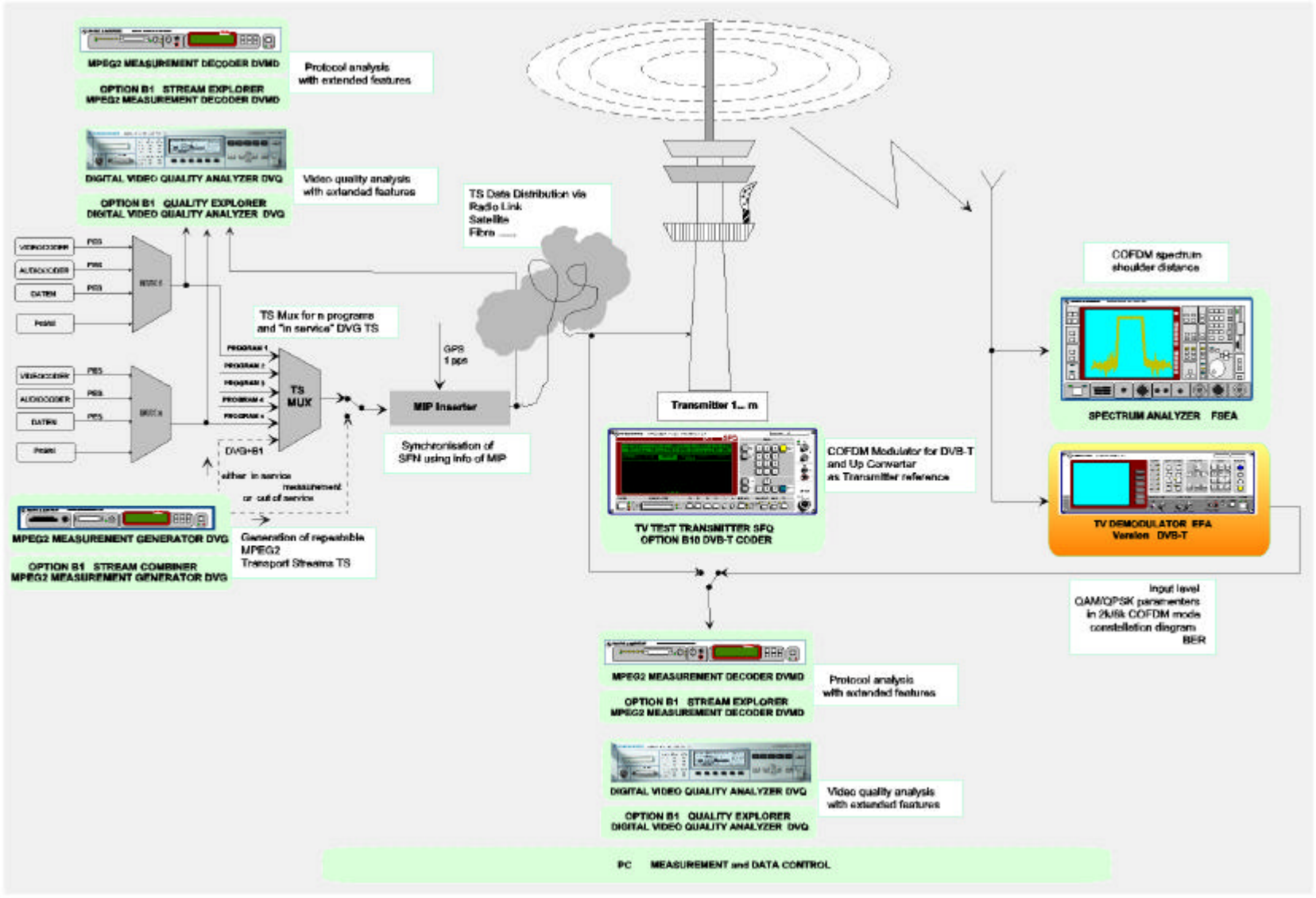
DVB-T transmission network (via Radio Link/dark fiber)



DVB-T transmission network (via ATM/SDH)



DVB-T network monitoring



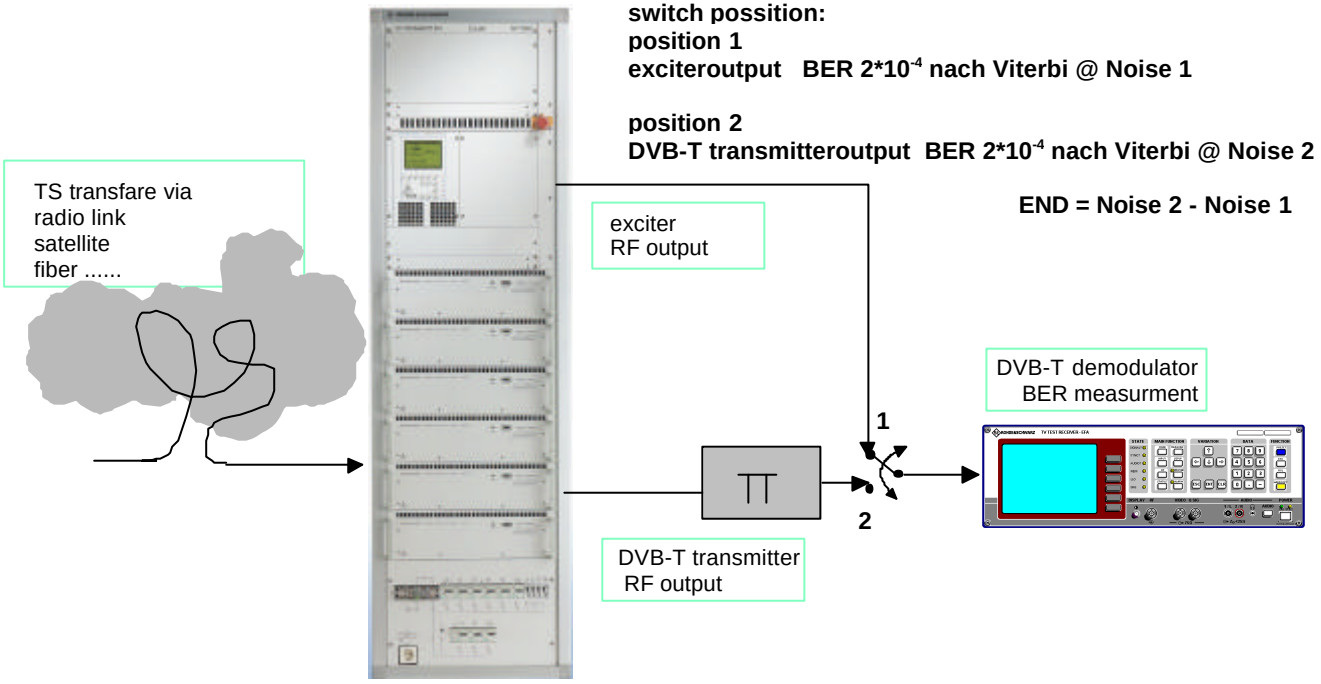
DVB-T networks monitoring

program source program - TS	data rate	entire TS single programs elementary streams
	protocol-parameter	parameters of 1. priority 2. priority 3. priority
	tables	presence repetition rate
	picture quality	DVQL - W DVQL - U TA SA
	event protocol	all unusual events summed up in REPORT
program source measurement-TS		repeatable measurement sequences for comparable measurements
MIP insertion		monitoring of PID, synchronisation info, GPS 1pps
modulation links	modes	radio link (HDB3, QPSK) satellite (QPSK) dark fibre ATM over SDH/PDH

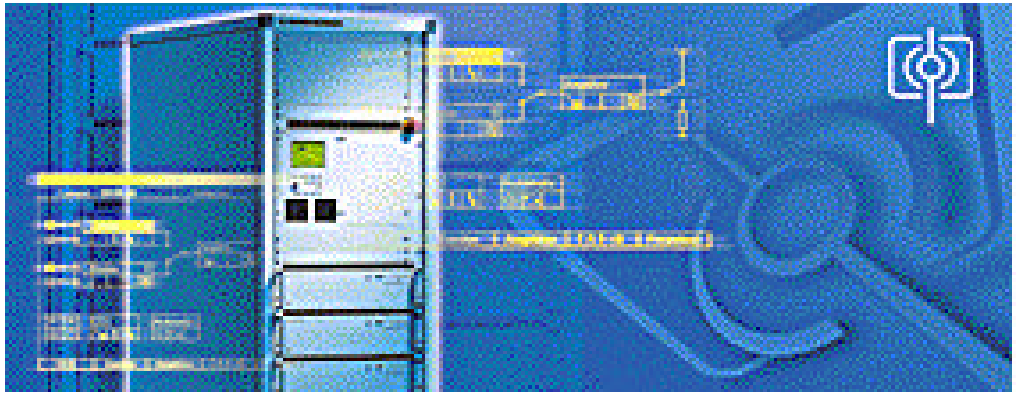
DVB-T transmitter monitoring

transmitter output	**RF parameters**	**accuracy of frequency** **phase noise of LO** **average level and max. peak level in RF and IF** **amplitude vs frequency** **phase vs frequency** **C/N and intermodulation** **shoulder distance** **power efficiency**
parameters after demodulation		**QPSK/QAM parameters in 2k/8k mode** **constellation diagram** **BER, MER, END** **TPS** **signal delay from TS @ transmitter input to antenna**

DVB-T Transmitter



Transition from analog to digital



Requirements for the engineering work

Definition of the intended coverage area in relation to the existing analog TV Service (area , population, channel, power).

Investigation of possible limitation by interference of other services in this area

Result: Selection of "free channels" to choose for licensing in terms of frequency and radiated power.

Technical planning of the station

- **Investigation of the existing antenna**

  Result: dependent on the desired coverage area (omnidirectional, sectional, beam) and mechanical (static) situation define modification and antenna gain.

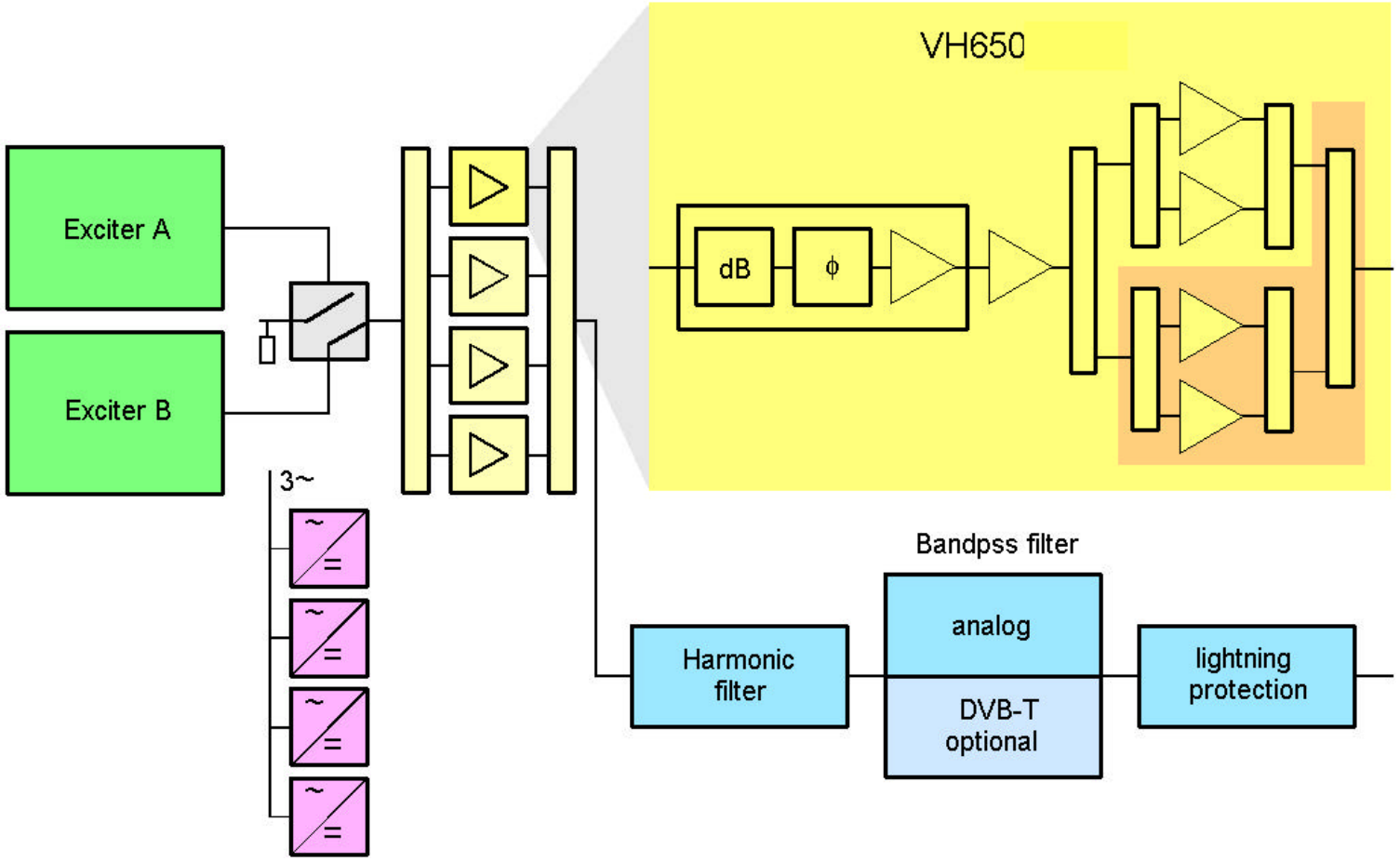
- **Calculate necessary transmitter power**

- **Space requirement for transmitters**

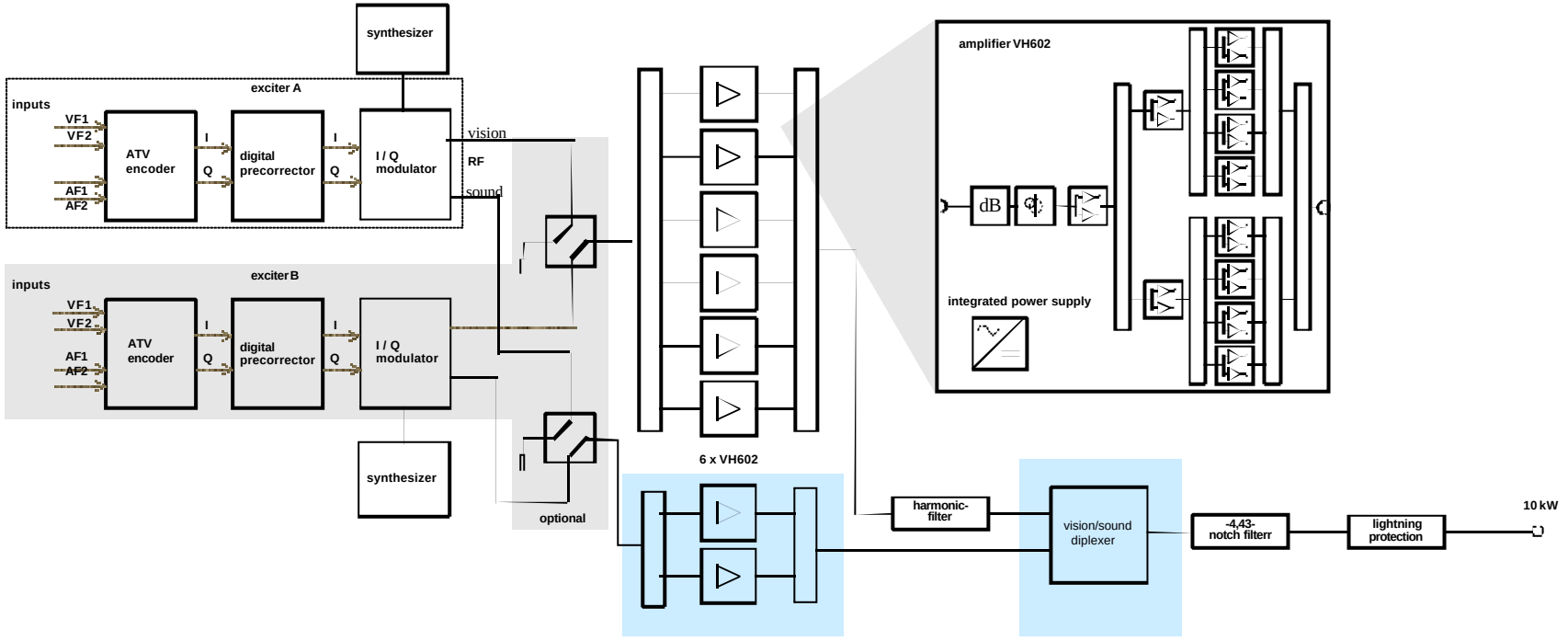
Alternativ: transition of the excisting analog transmitter into digital service

- **Change of encoder module in exciter**
- **bypassing of the sound part (amplifier and v/s diplexer)**
- **introducing of DVB-T band - filter**
- **new equalizing of transmitter**

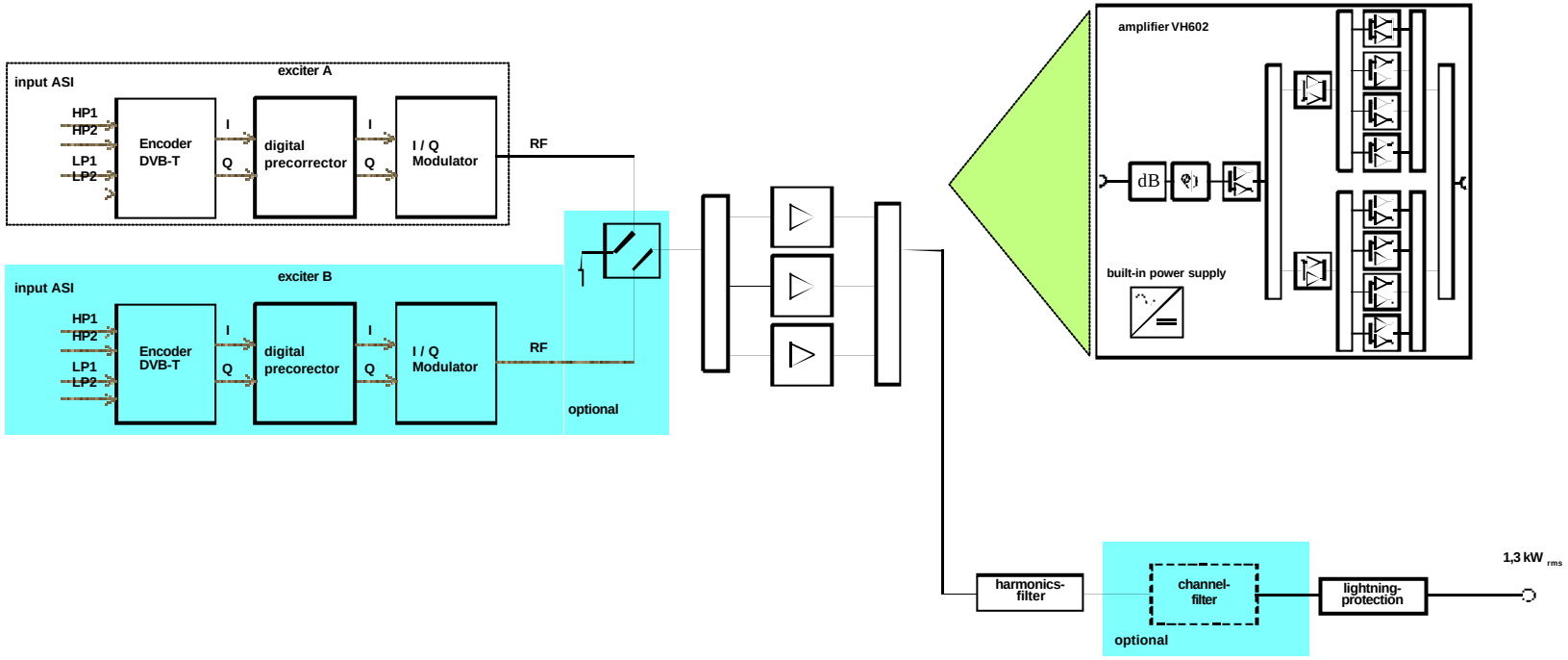
Block Diagram NH/NV7000



Transmitter analog(split)



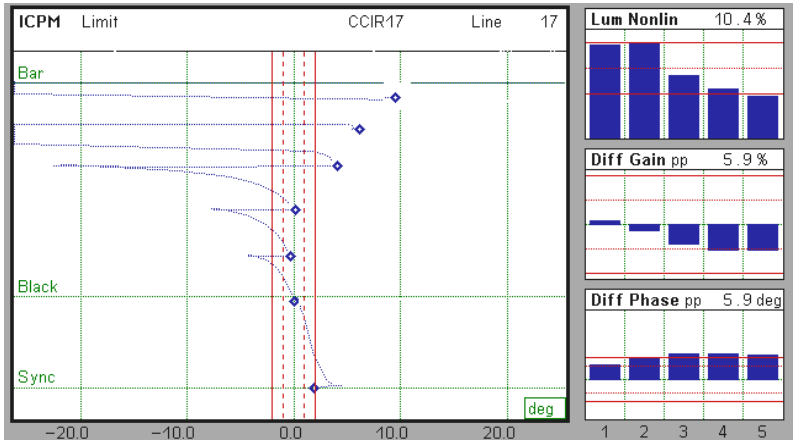
Block Diagram 1,3 kW DVB-T Transmitter



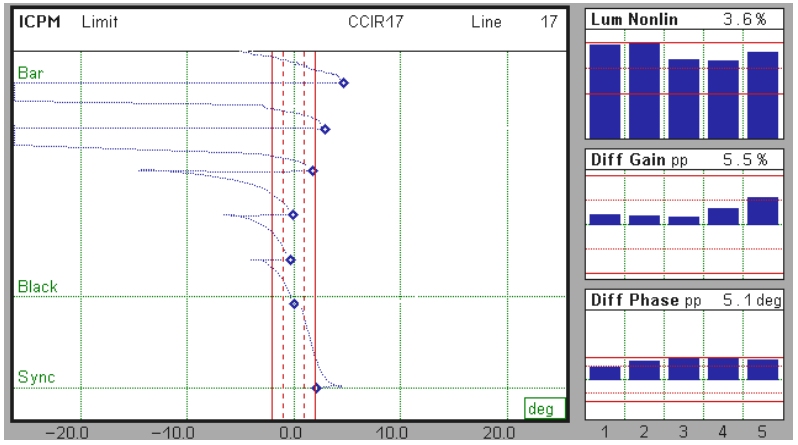
DVB-T Transmitter NV7130 1,3kW$_{rms}$

PAL-nonlinearity

Black picture

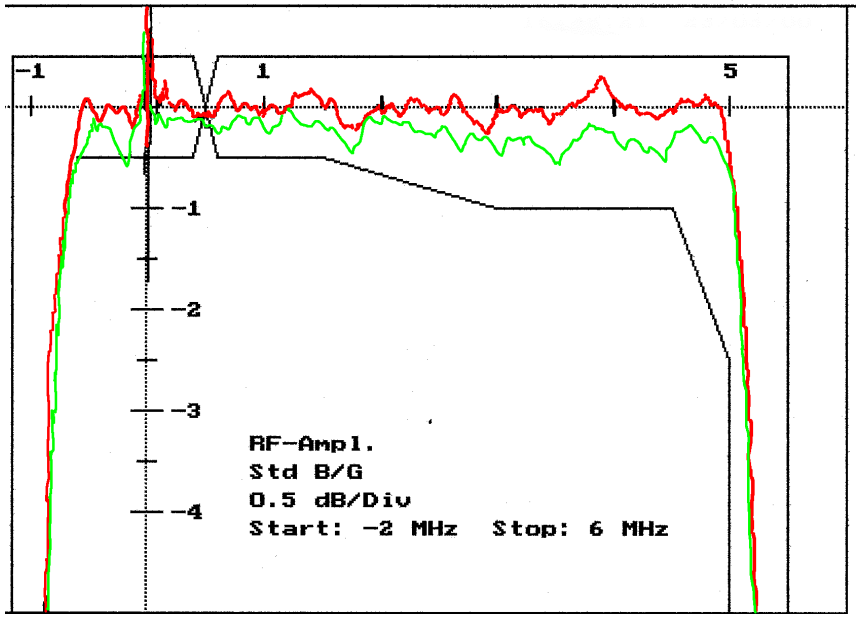


Black picture



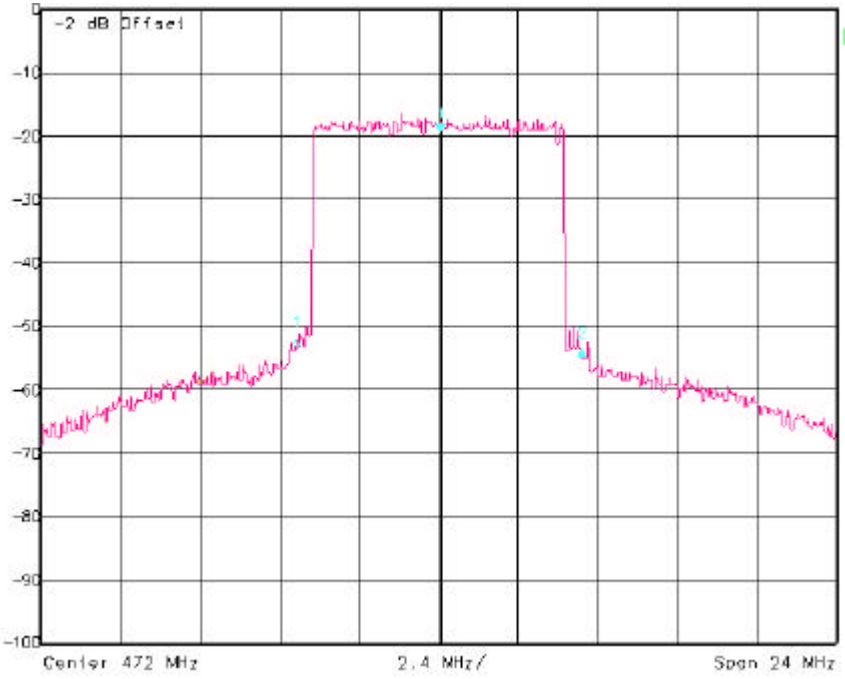
Frequency response in channel

bl/wi-amplification

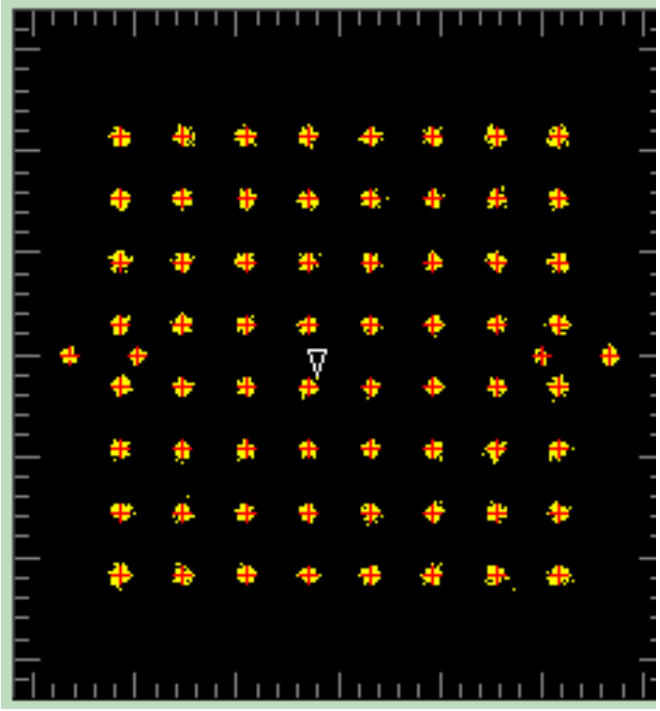


DVB- Transmitter nonlinearity

frequencyresponse

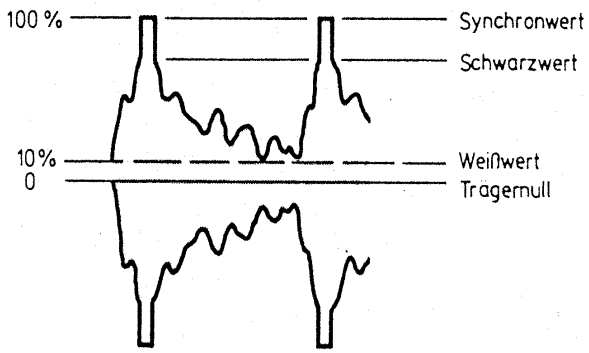


Constellation Diagramm 64QAM

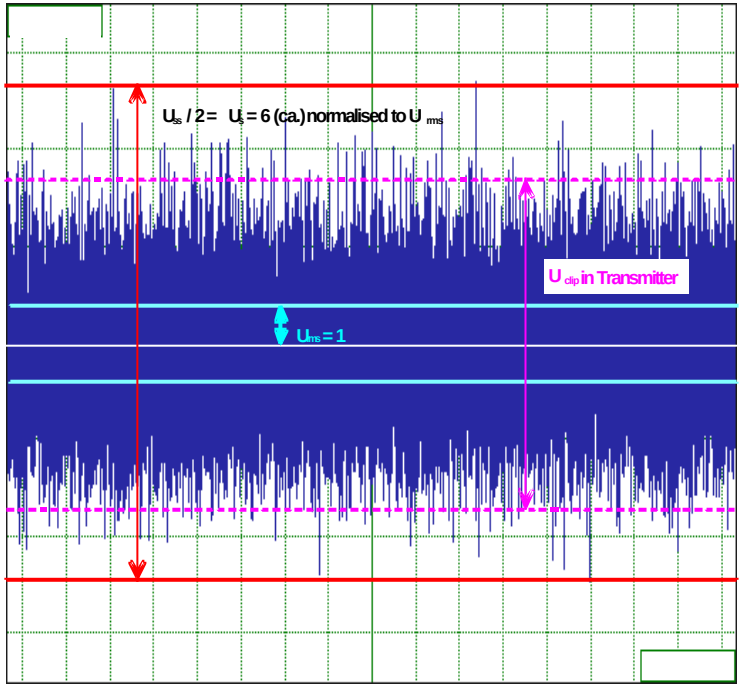


DVB-T Crest Faktor

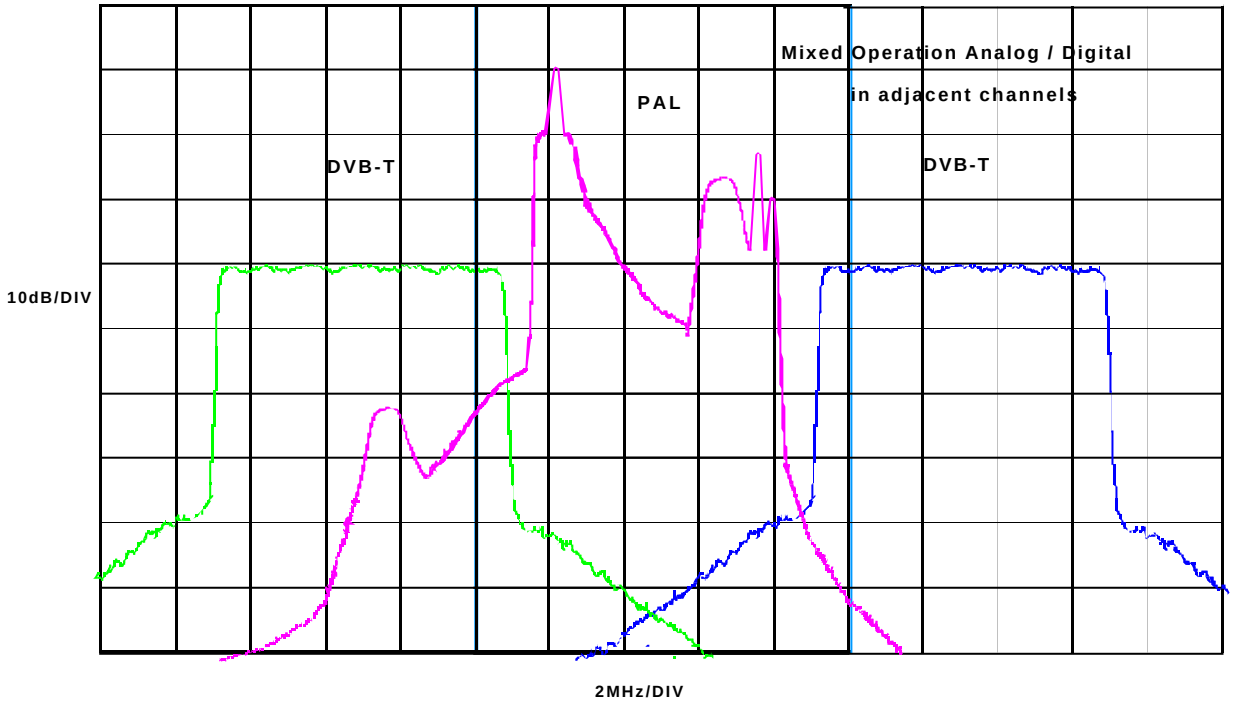
analog



digital

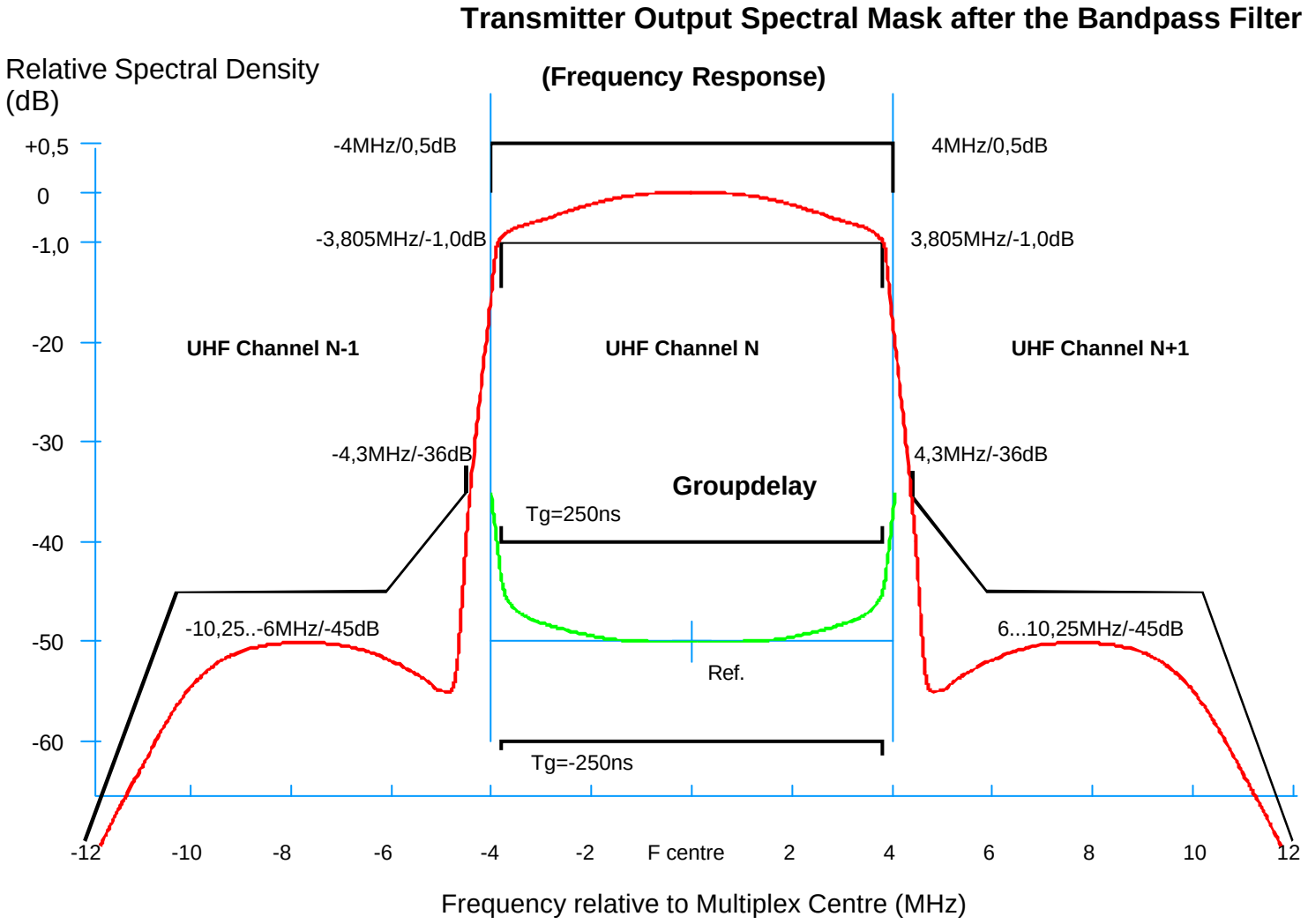


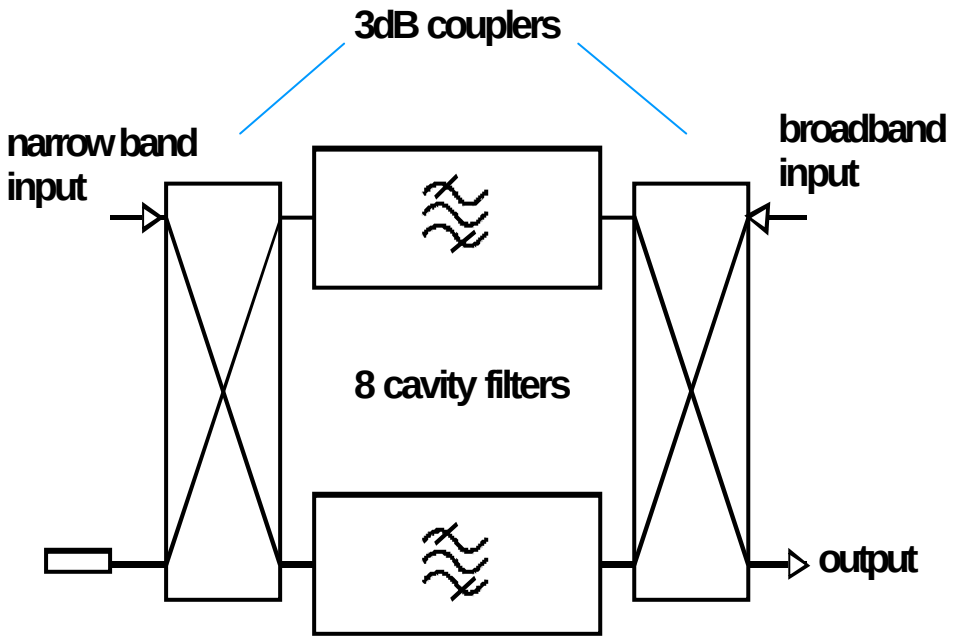
Example of a radiated signal from a TV station

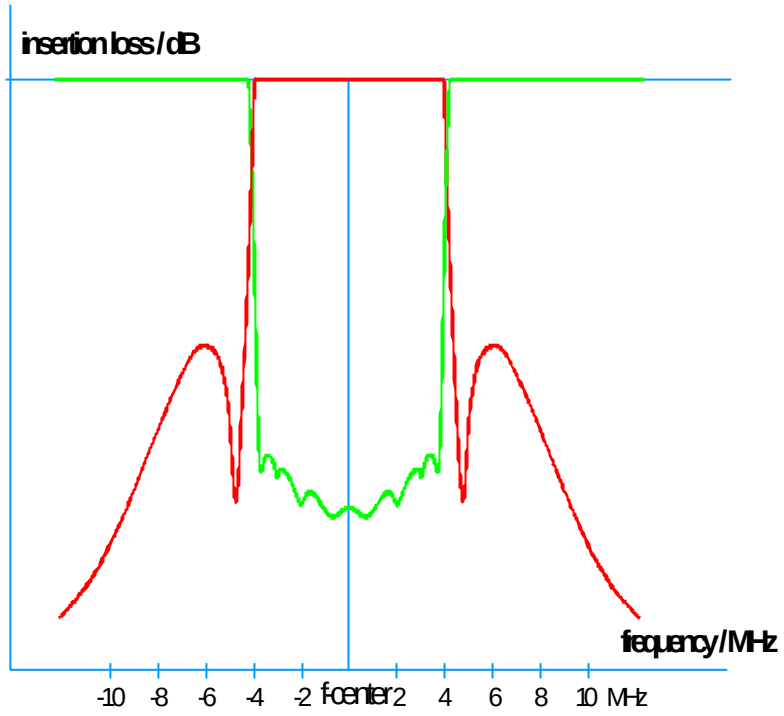


Interference from analog to digital service

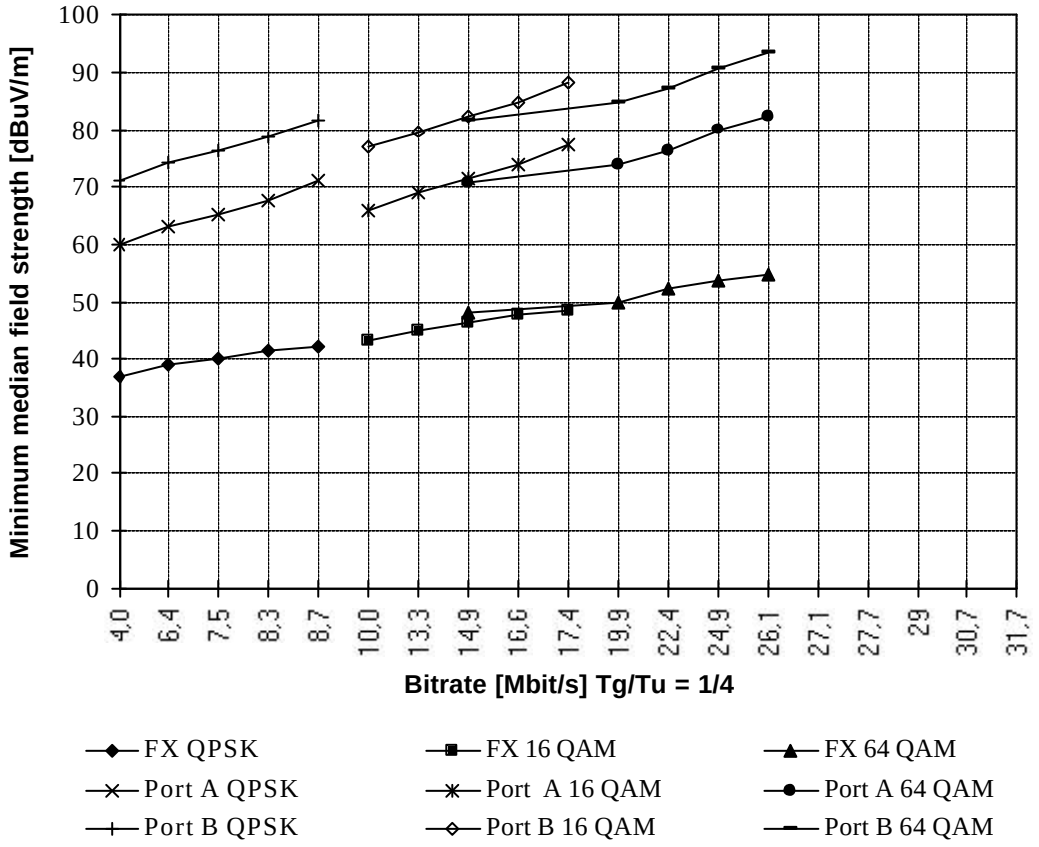
Interference from digital to analog service


Transmitter Output Spectral Mask after the Bandpass Filter
(Frequency Response)
Relative Spectral Density (dB)
+0,5
0
-1,0
-20
-30
-40
-50
-60
-4MHz/0,5dB
4MHz/0,5dB
-3,805MHz/-1,0dB
3,805MHz/-1,0dB
UHF Channel N-1
UHF Channel N
UHF Channel N+1
-4,3MHz/-36dB
4,3MHz/-36dB
Groupdelay
Tg=250ns
-10,25..-6MHz/-45dB
6...10,25MHz/-45dB
Ref.
Tg=-250ns
-12
-10
-8
-6
-4
-2
F centre
2
4
6
8
10
12
Frequency relative to Multiplex Centre (MHz)

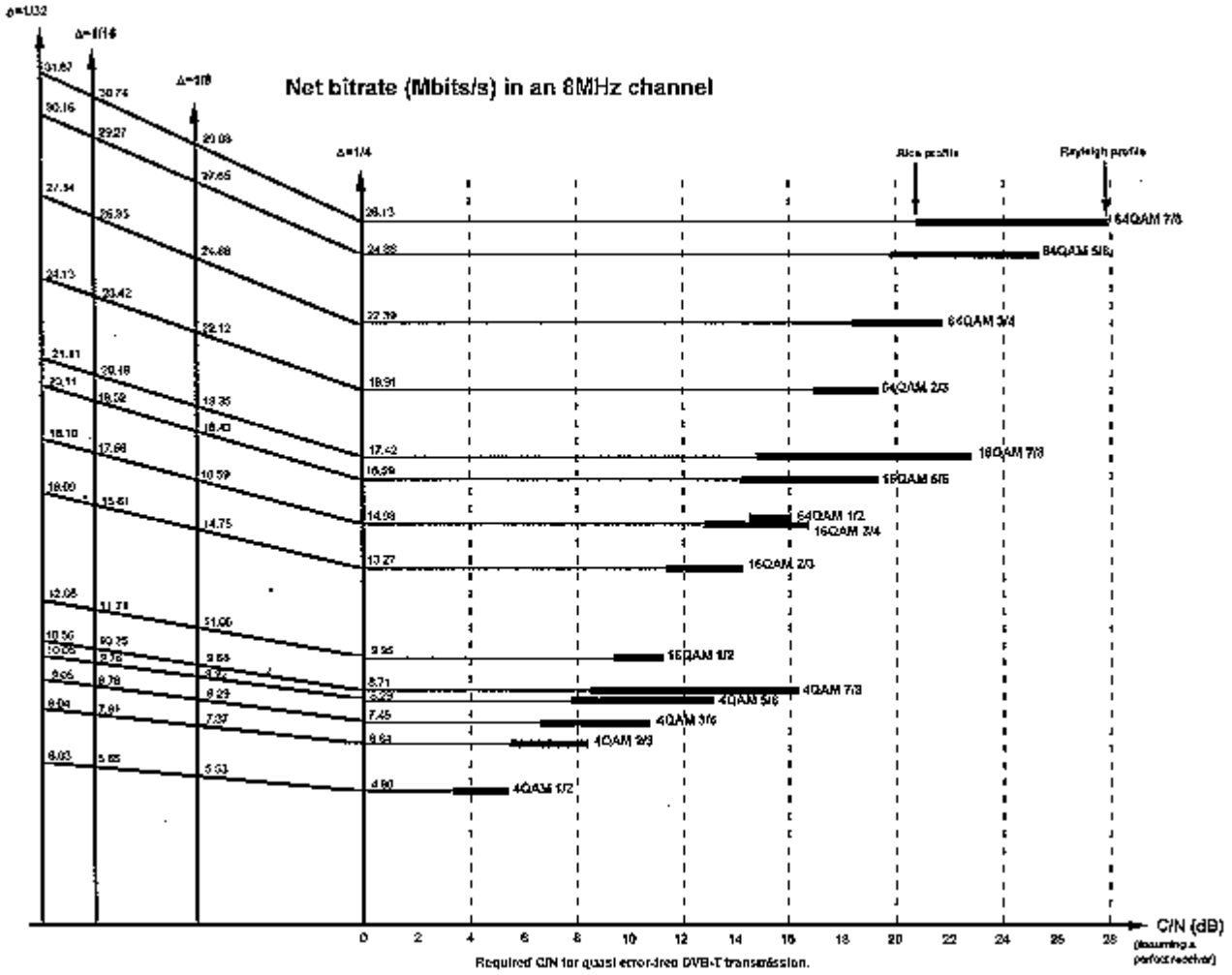

3dB couplers
narrow band input
broadband input
8 cavity filters
output


insertion loss/dB
frequency/MHz
-10
-8
-6
-4
-2
f-center
2
4
6
8
10 MHz

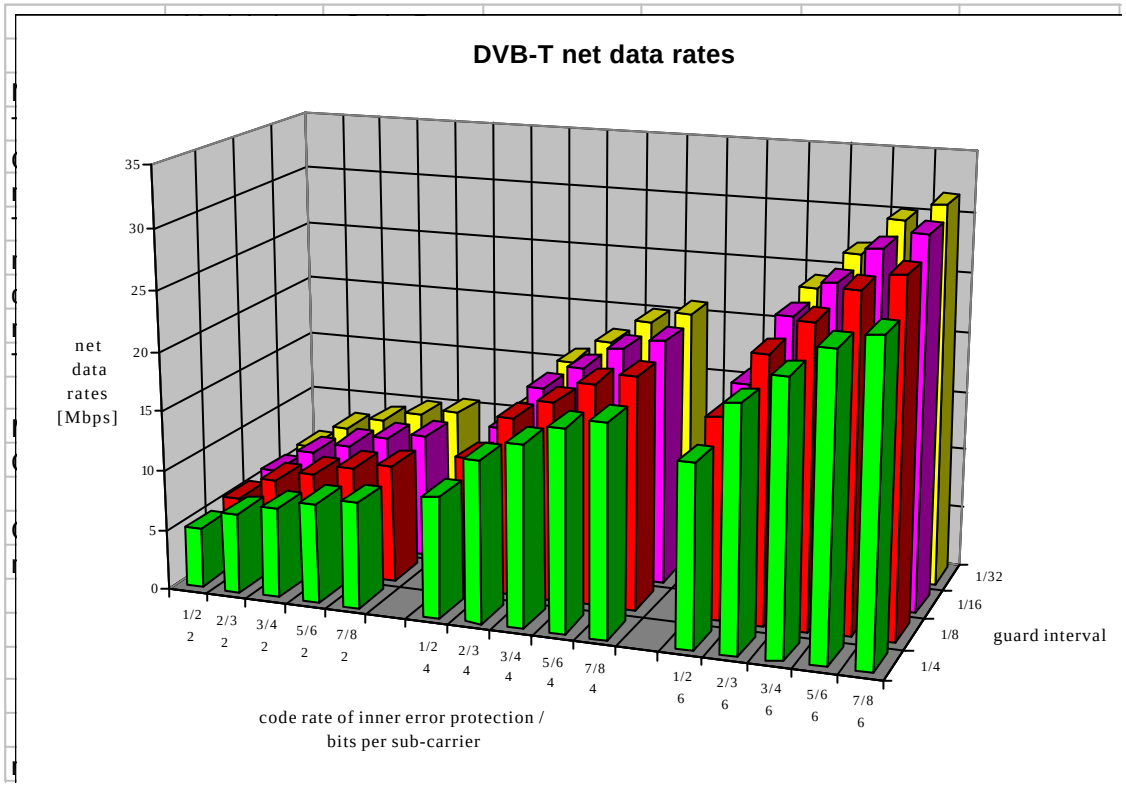
DVB-T realisation of digital transmitter stations



DVB-T realisation of digital transmitter stations



DVB-T realisation of digital transmitter stations



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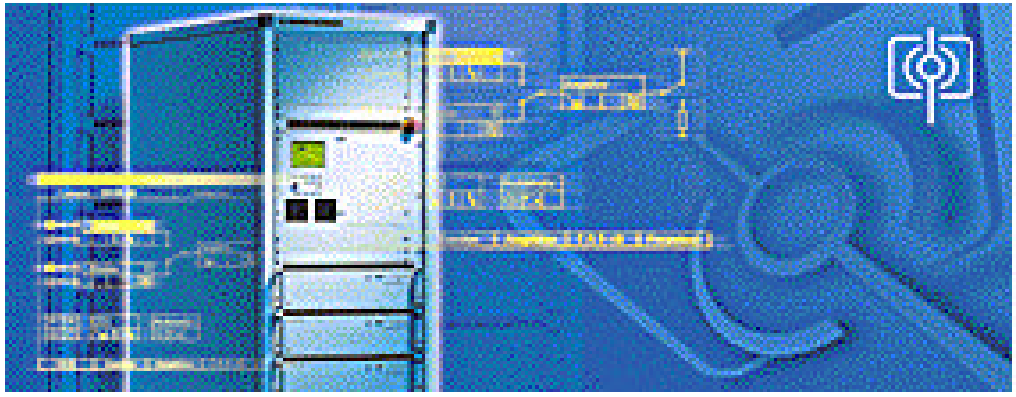
The new UHF transmitter family NH/NV7000

for analog and digital TV transmitters

- High Power -



Innovation and experience

for the benefit of the broadcaster

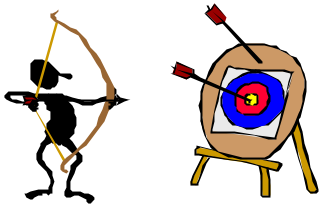
NH/NV7000 Component Structure and System Family

Modulator / Exciter **SH700 ATV Splitt Ampl. / SC700 ATV Combined Ampl. / SV700 DVB-T**	
Control and Monitoring	
LDMOS Amplifier Modules ***470 - 860 MHz***	
VH602 2kW/400W	**VH650** 500W/200W
Power Supply integrated in VH602	**Power Supply**
Liquid Cooling System	**Air Cooling System**

High Power Tx
ATV: 3,5kW ... 40kW
DVB-T: 800W ... 10kW

Medium Power Tx
ATV: 250W ... 2kW
DVB-T: 100W ... 800W

DVB-T transmitter system



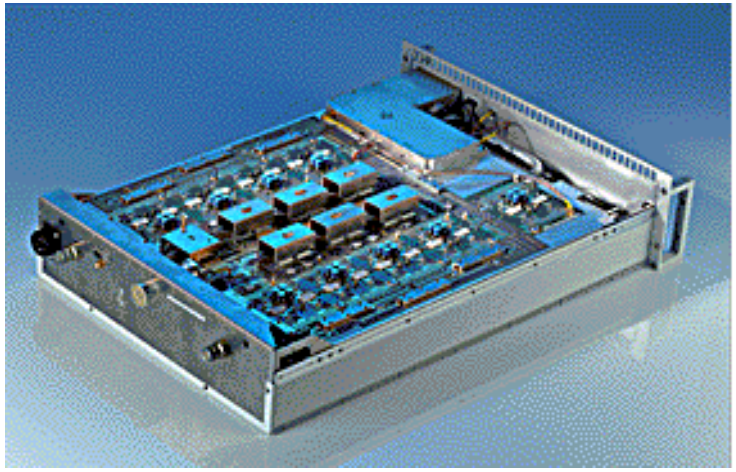
TARGETS for NH/NV7000

Transmitter: Medium Power air cooled

Transmitter: High Power liquid cooled

- **Economical**
- **Compact**
- **State of the art**
- **Modular design**
- **Expandable**
- **Easy to handle**

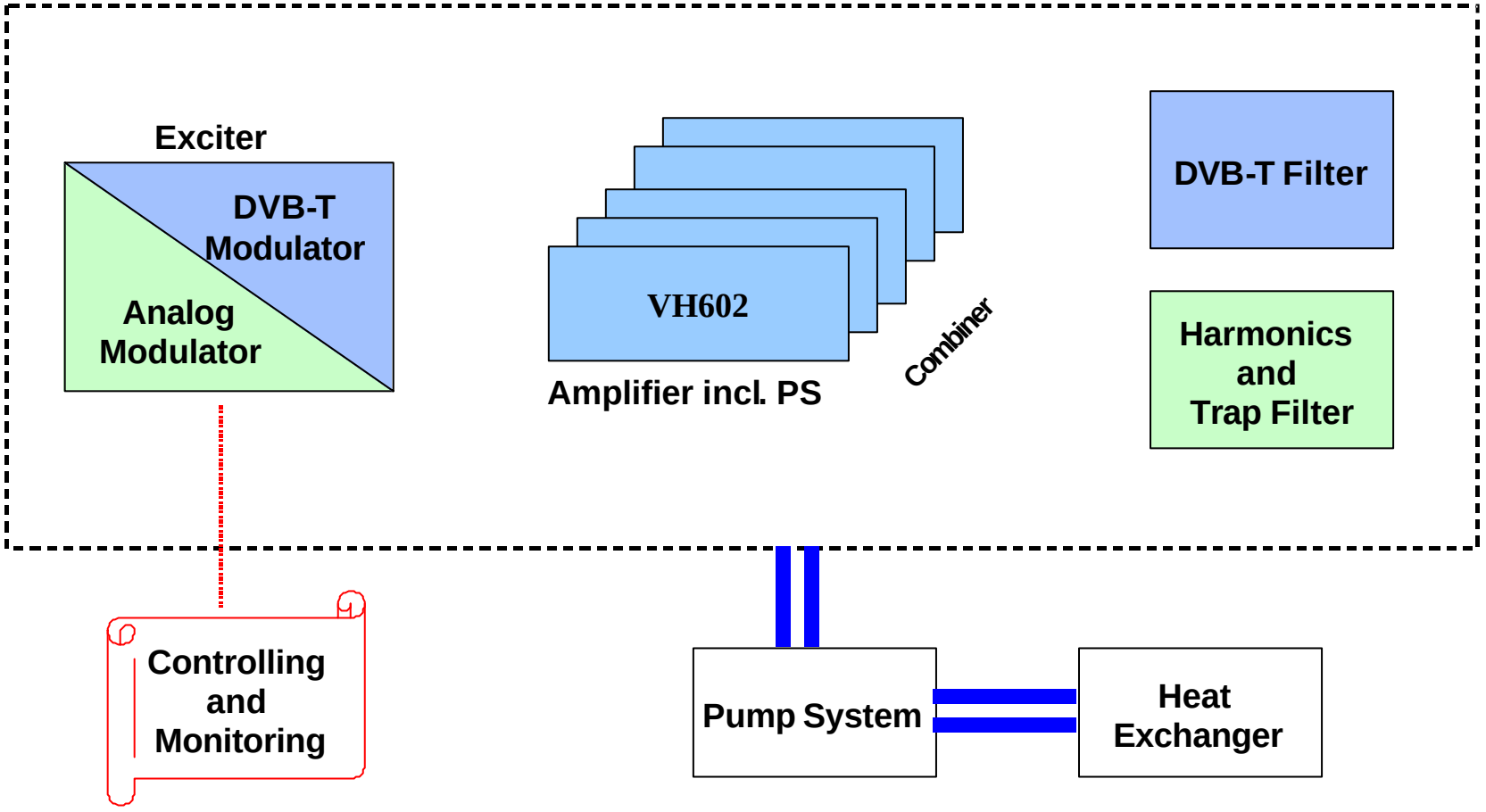
Liquid Cooled Transmitter / Amplifier



VH602 LDMOS amplifier

← 10kW ATV / 2,5 kW DVB-T transmitter into one rack

System configuration for liquid cooling



NH/NV Power Classes

Number of Amplifier Module (+ Sound Amp. Module for ATV)	ATV P_{sync}	DVB-T P_{eff} (36dB shoulder)
2 (+1*)	3,5 kW	**800 W**
3 (+1*)	5 kW	**1,3 kW**
4 (+2)	7 kW	**1,7 kW**
6 (+2)	10 kW	**2,5 kW**
8 (+2)	13 kW	**3,4 kW**
12 (+2)	20 kW	**5 kW**

* optional 2

Further combination: 2*13kW and 2*20kW in active reserve 3*10kW

Redundancy in power

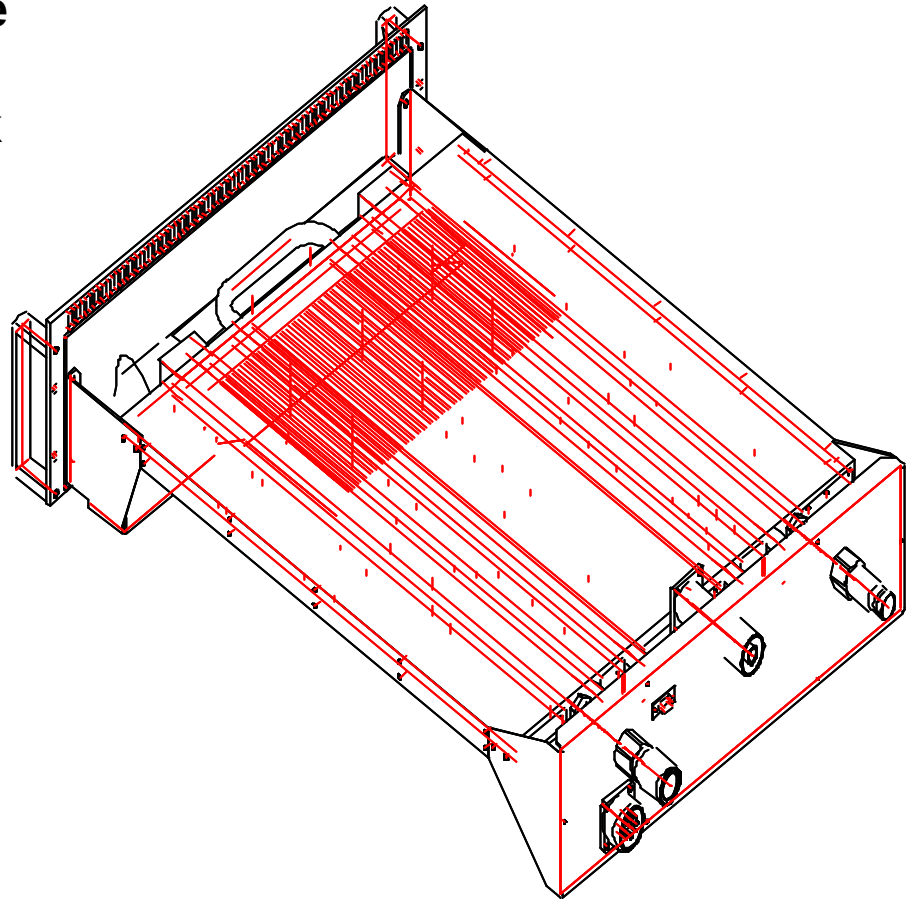
Output Power with Breakdown of Amplifiers:

$$P_{out} = P_{rated} * \left(\frac{m-n}{m}\right)^2$$

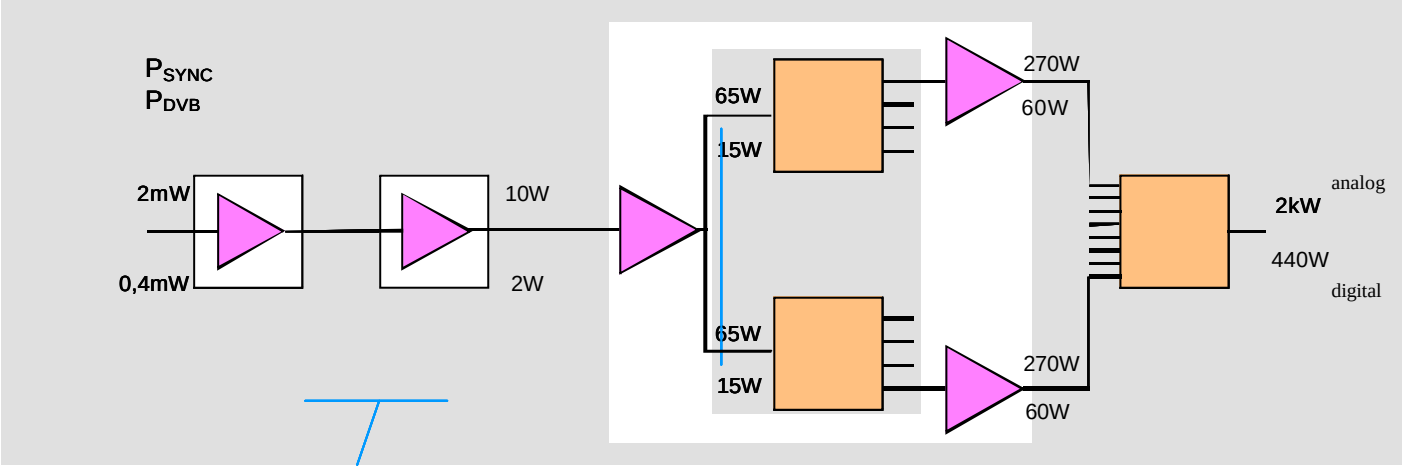
P_{out} = real output power
P_{rated} = nominal output power
m = number of amplifiers
n = number of defect amplifiers
for example: m=8, n=1 Þ P_{out} = 0.766 x P_{rated}

Cooling Concept Amplifier

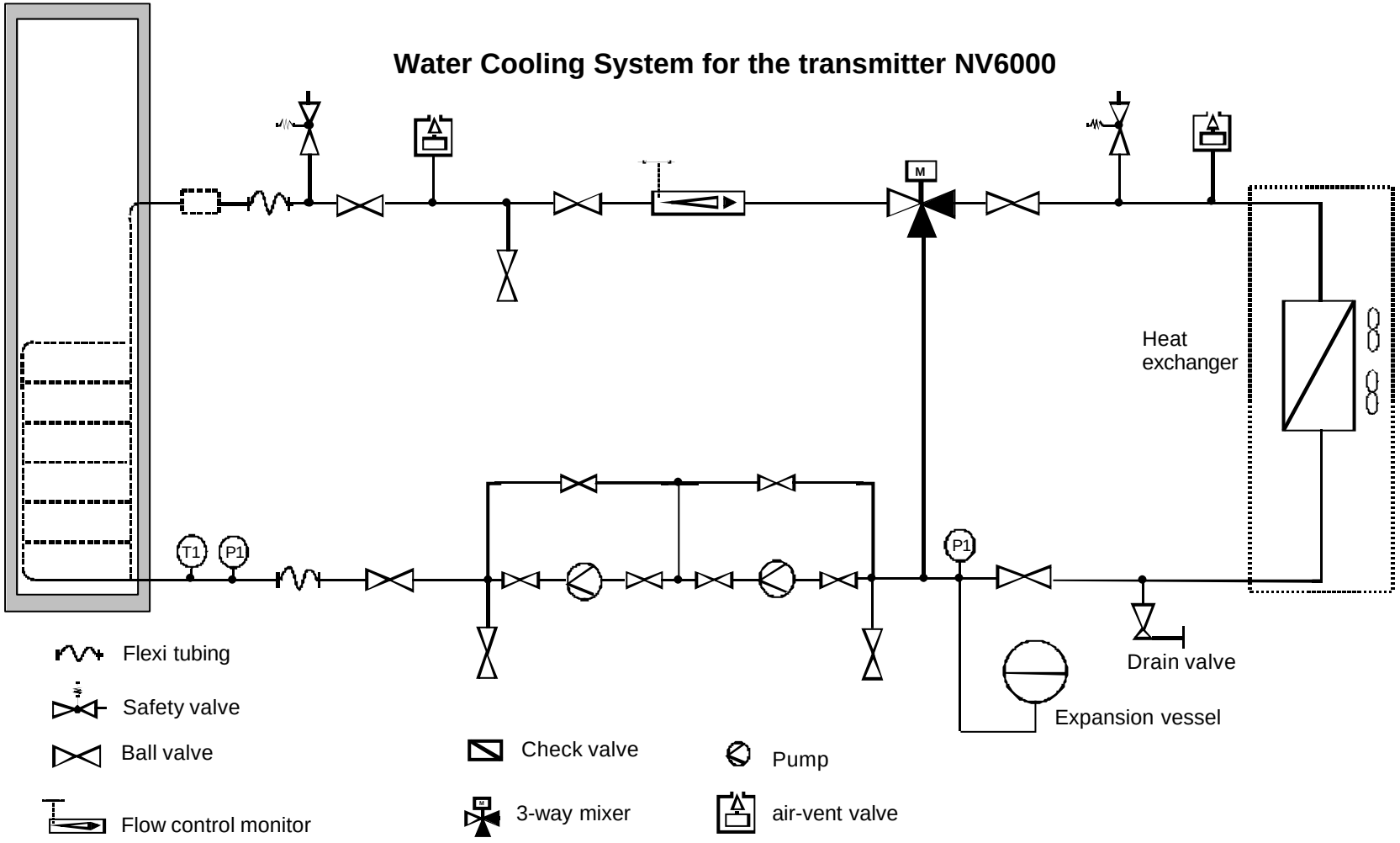
- **Closed loop of liquid through one pipe** with continuous identical diameter into the amplifier heat sink (corrosion-less material in stainless steel and aluminium)
- **Internal blower** for transfer of remainder heat to watercooler, thus preventing any hot spot
- **Transistors mounted directly on top of cooling pipe**
- **ΔT input / output amplifier < 3°C**
- **Junction temperature < 120°C** at 24°C ambient temperature



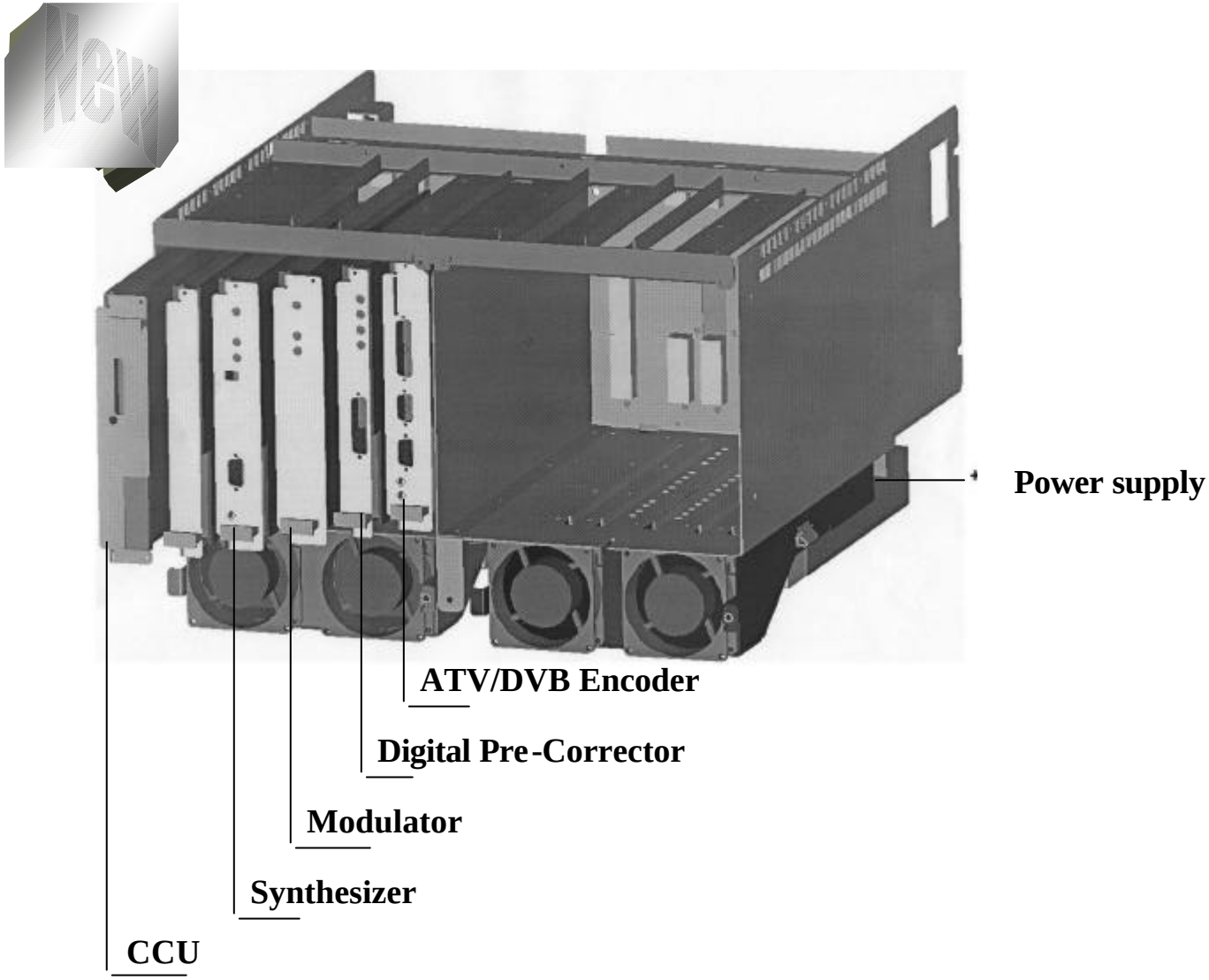
VH602 Block Diagram



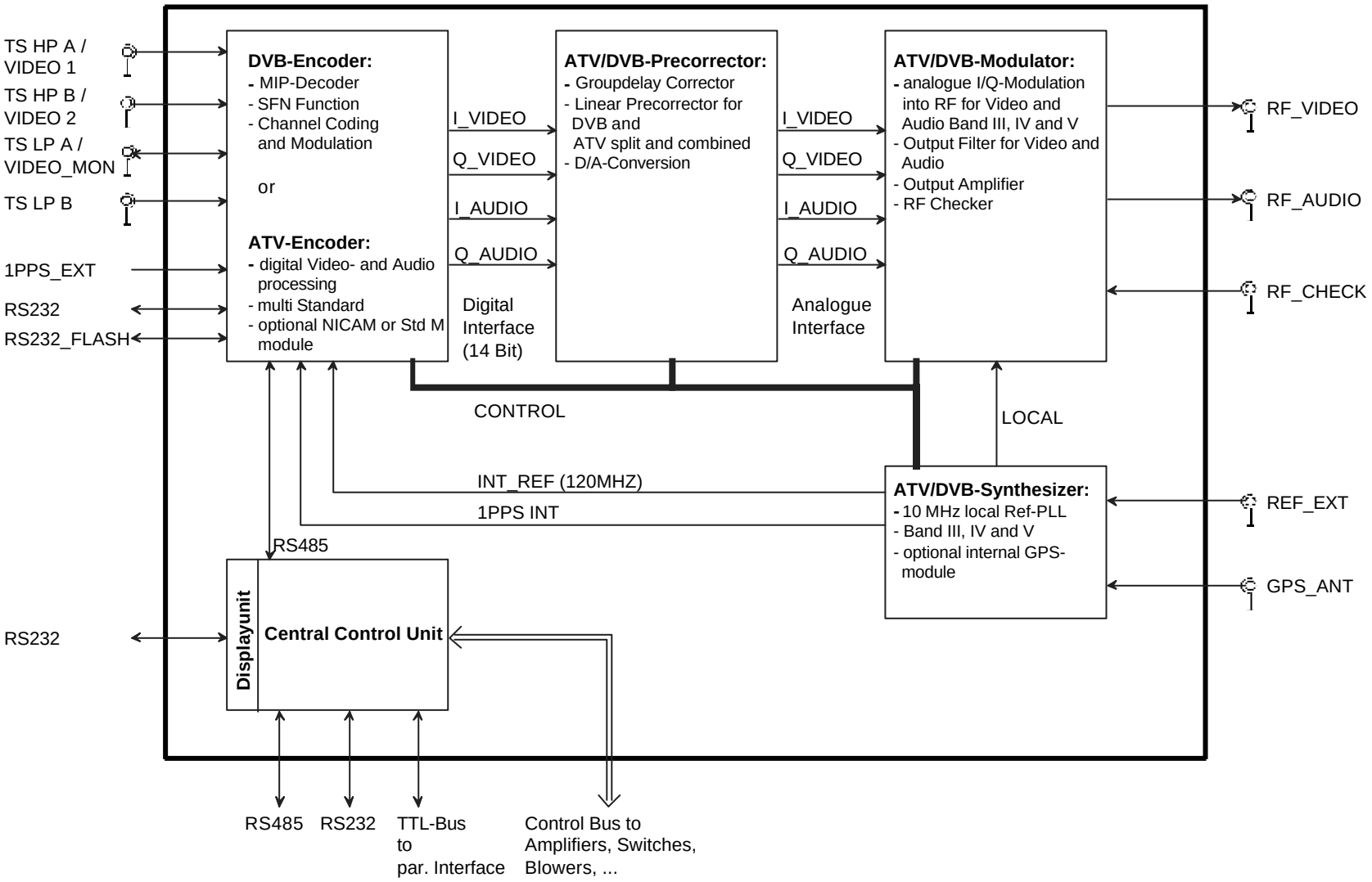
Liquid Cooling System



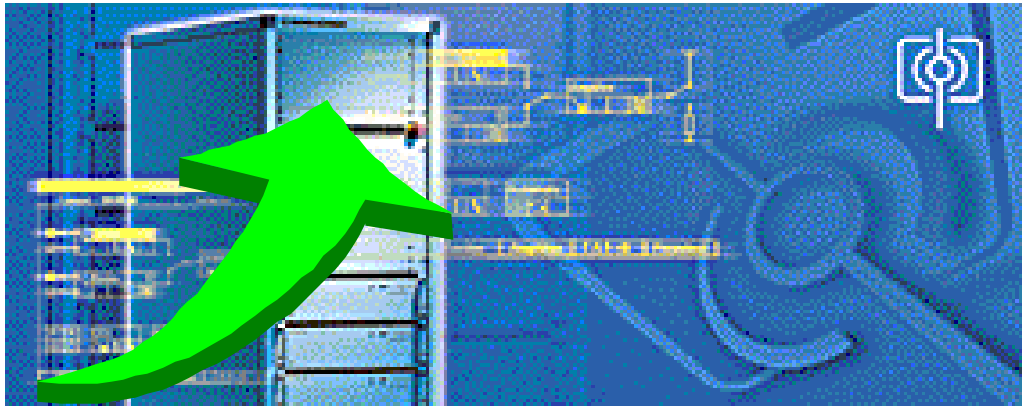
Multistandard Exciter SX700



Block Diagram

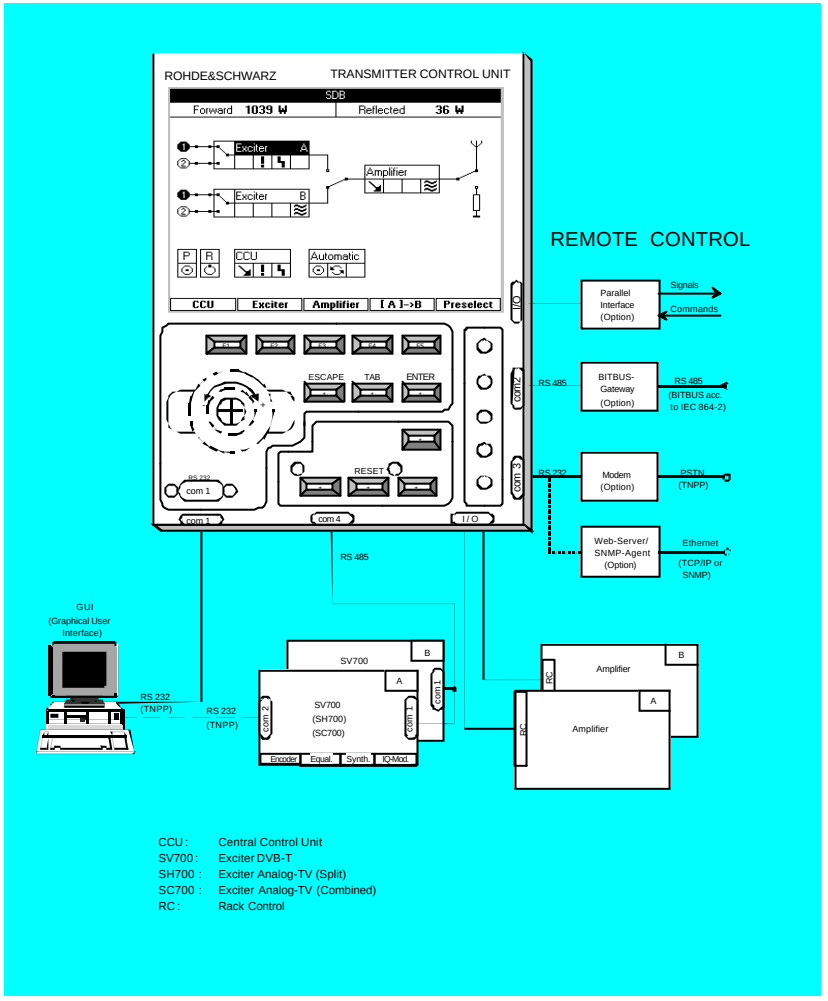


NetLink

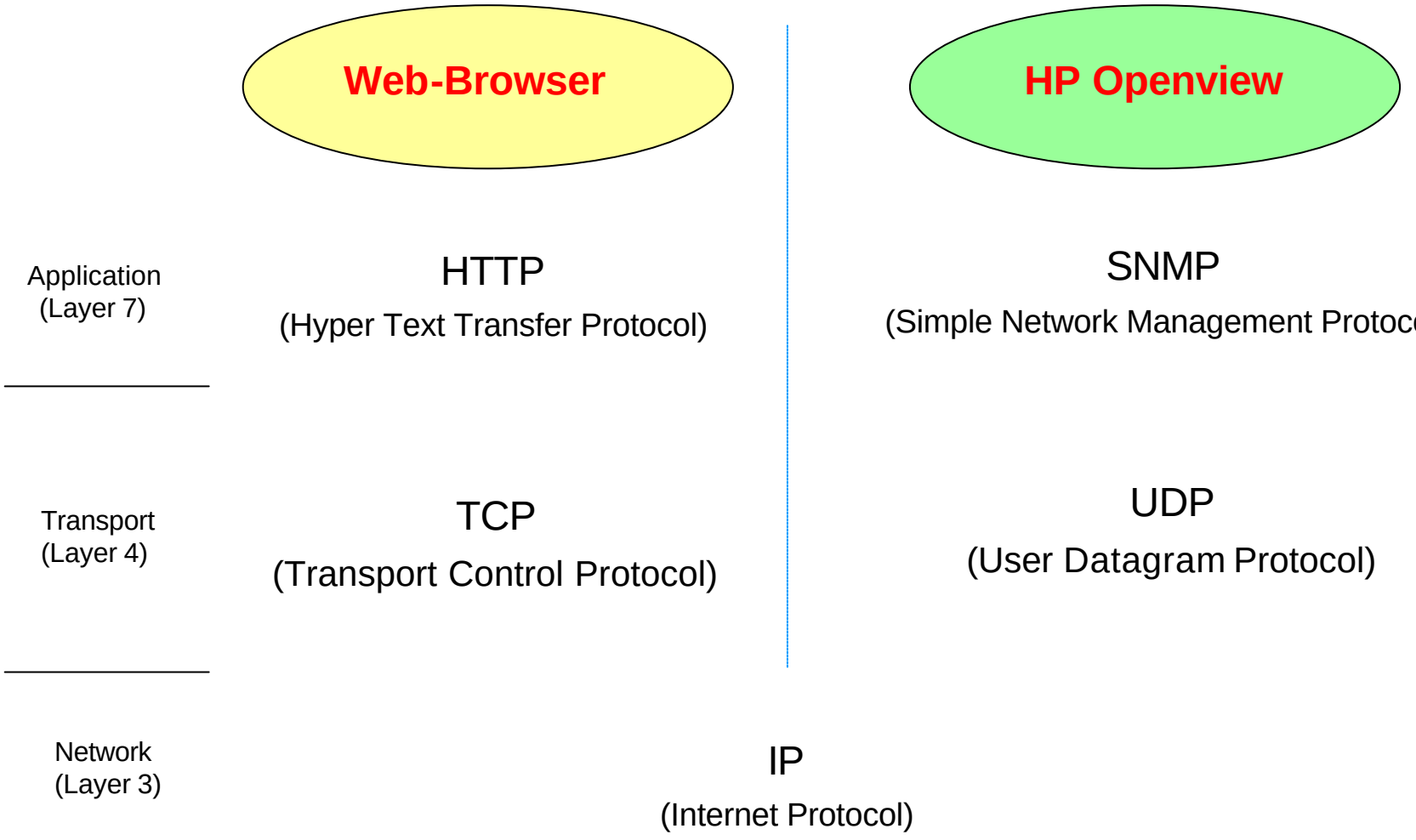


Monitoring and Controlling System

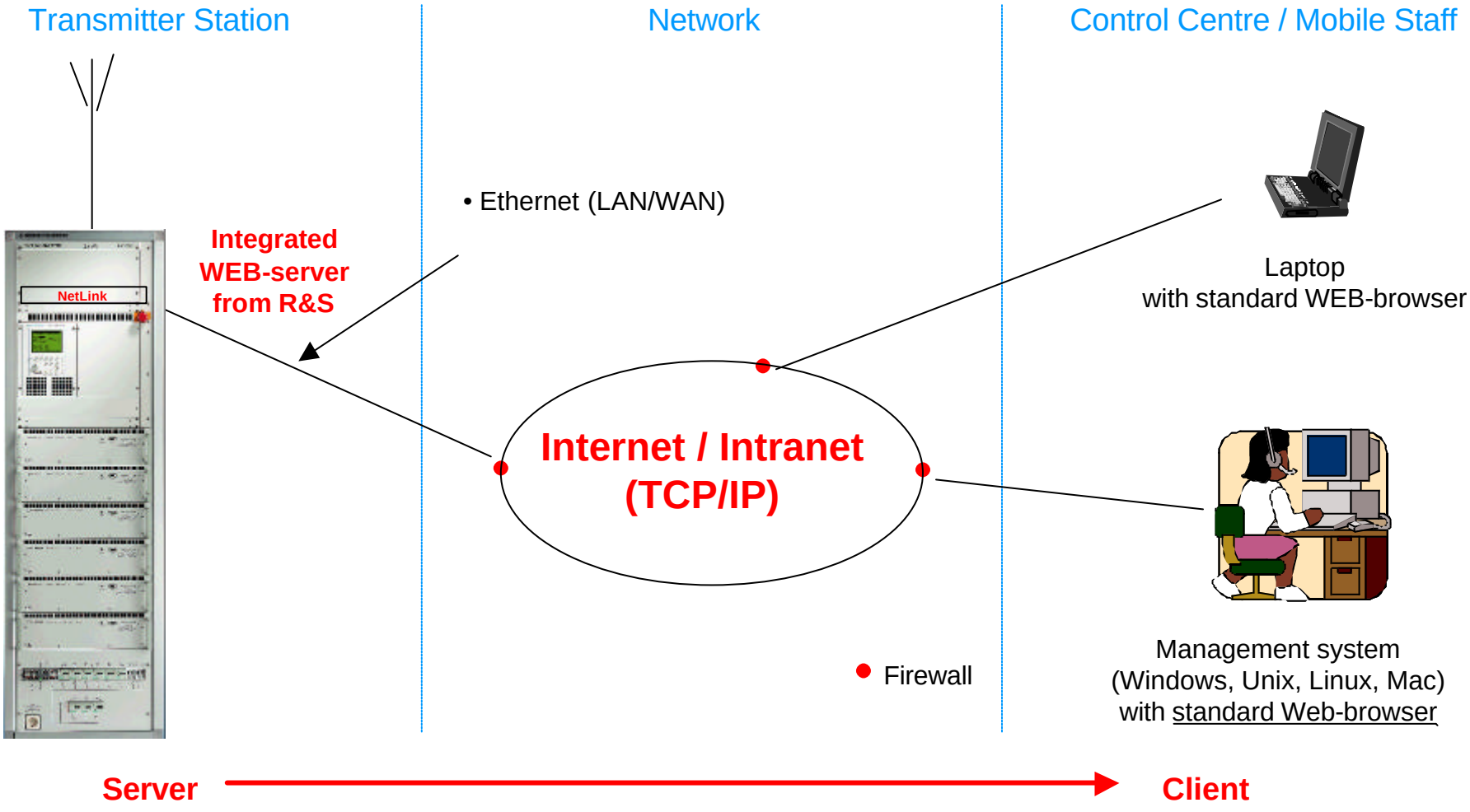
- **User-friendly monitoring software on one large display**
- **Additional PC software (GUI)** with very comfortable graphical presentation and high level of information
- **One interface for the all parameters** of the exciter (incl. encoder and GPS-receiver in case of DVB-T)
- **Multiple possibilities of remote control**
  - Bitbus (RS485)
  - RS232 with TNPP protocol -> modem option
  - NetLink for SNMP interface or WEB-based supervision system
  - Parallel interface



Overview on Protocol Types and Layers

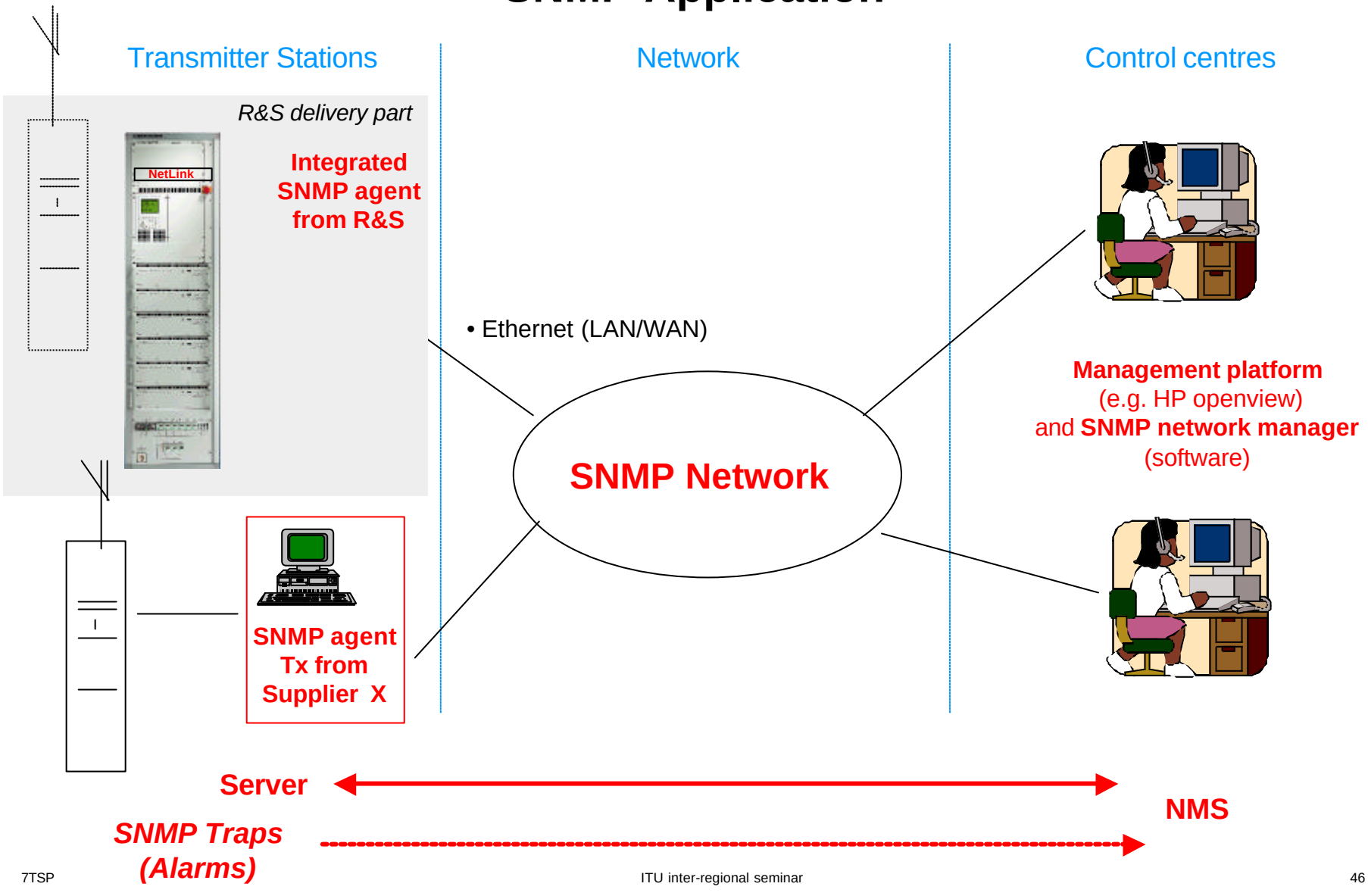


WEB-Server Application (Supervision System over TCP/IP)

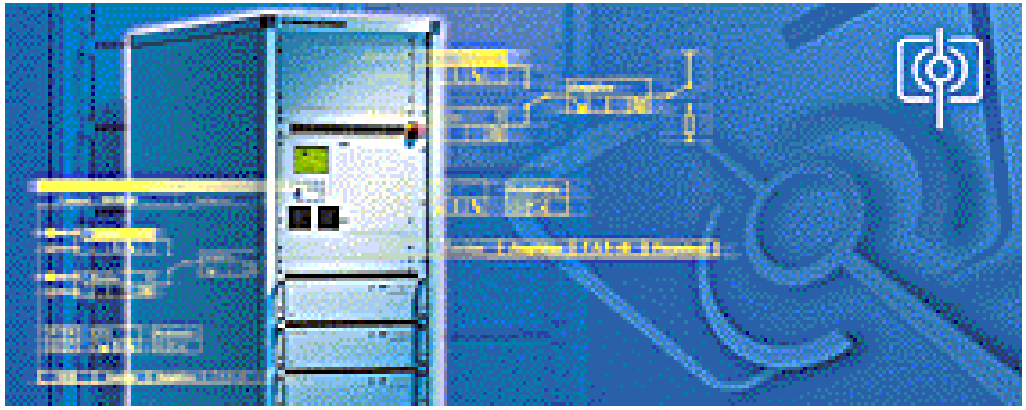


5. NetLink SNMP-Agent

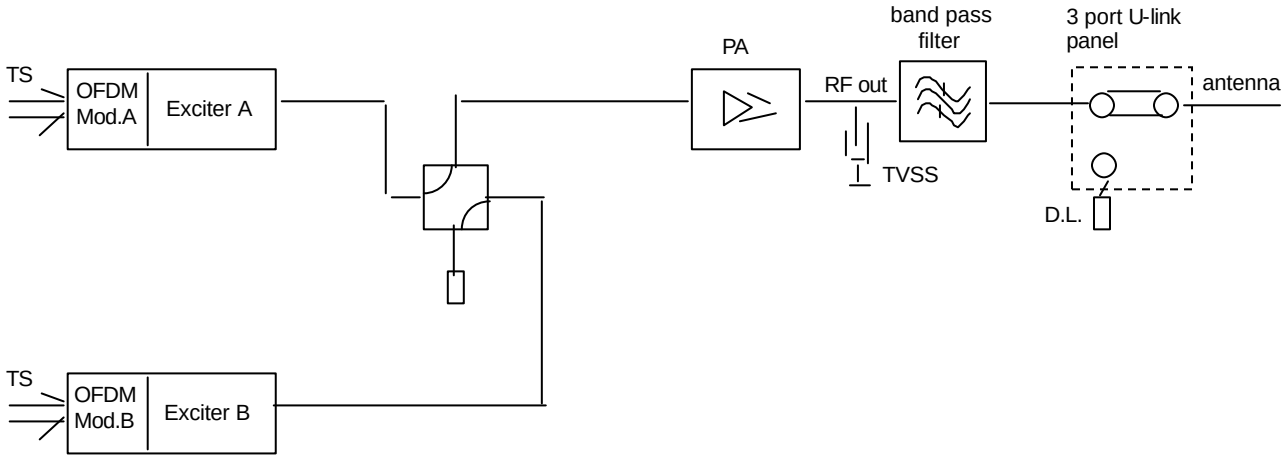
SNMP Application



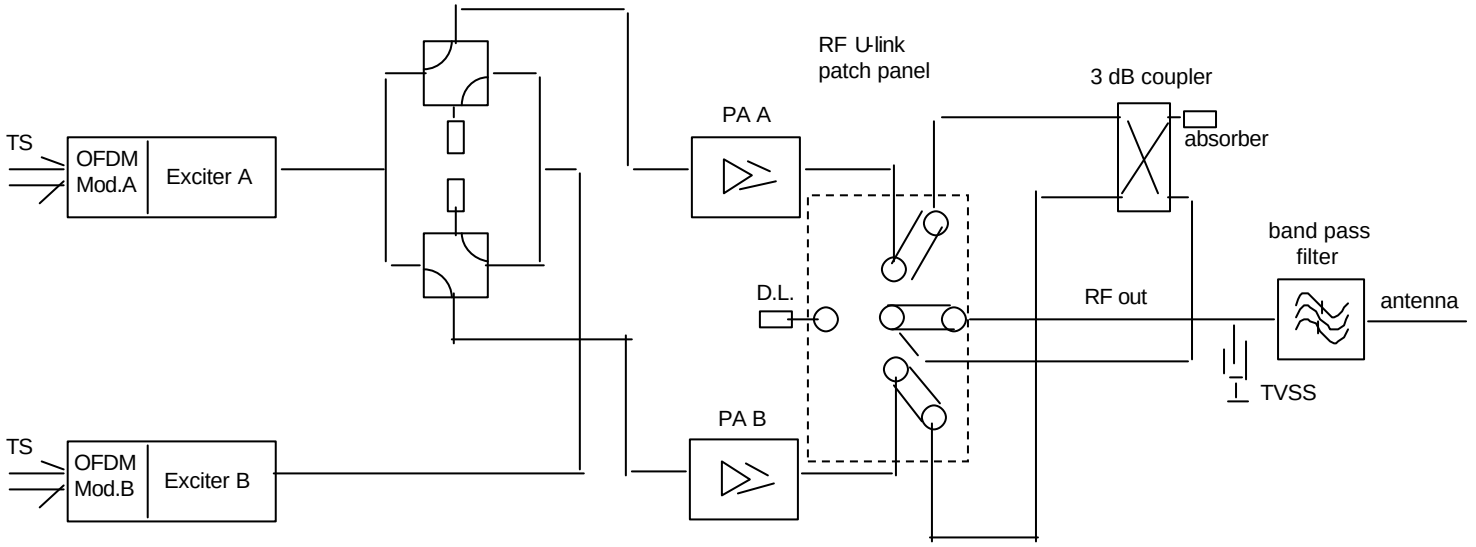
Transmitter Redundency Systems



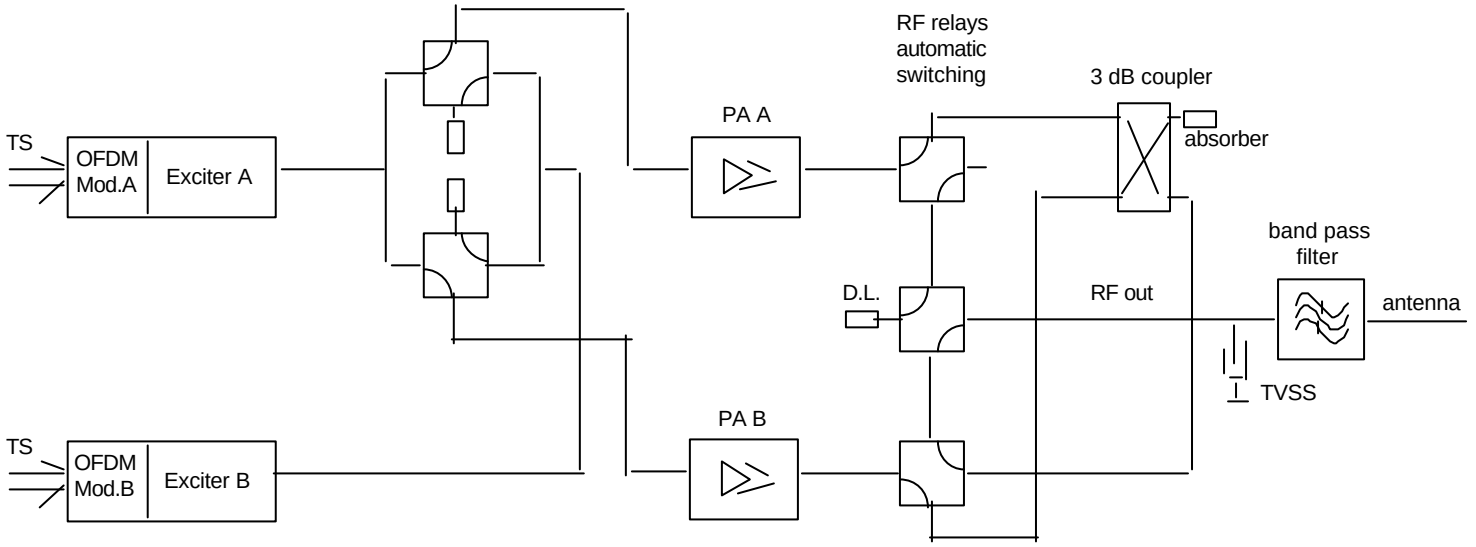
Dual drive, single PA stage



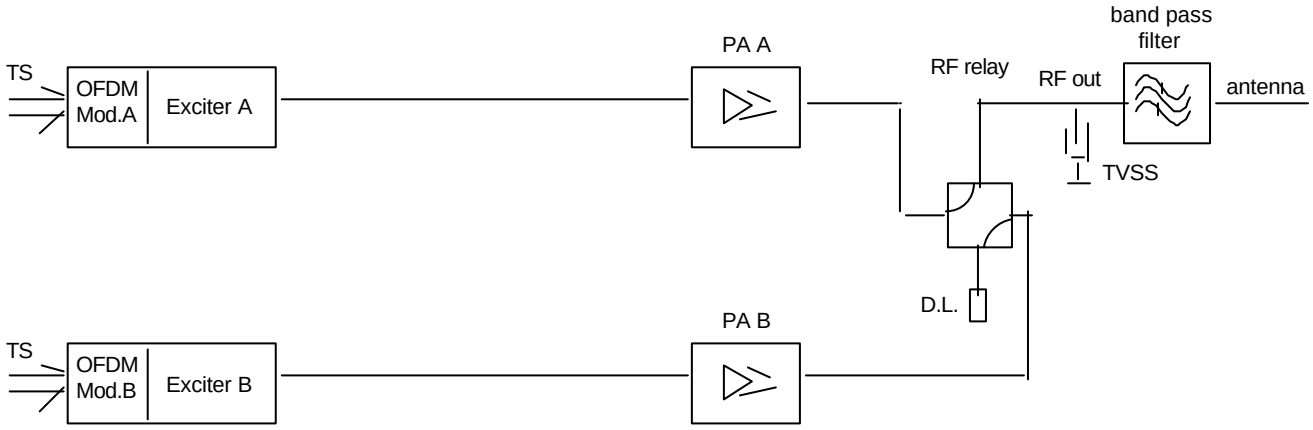
Dual drive, double PA stage, U-link patching



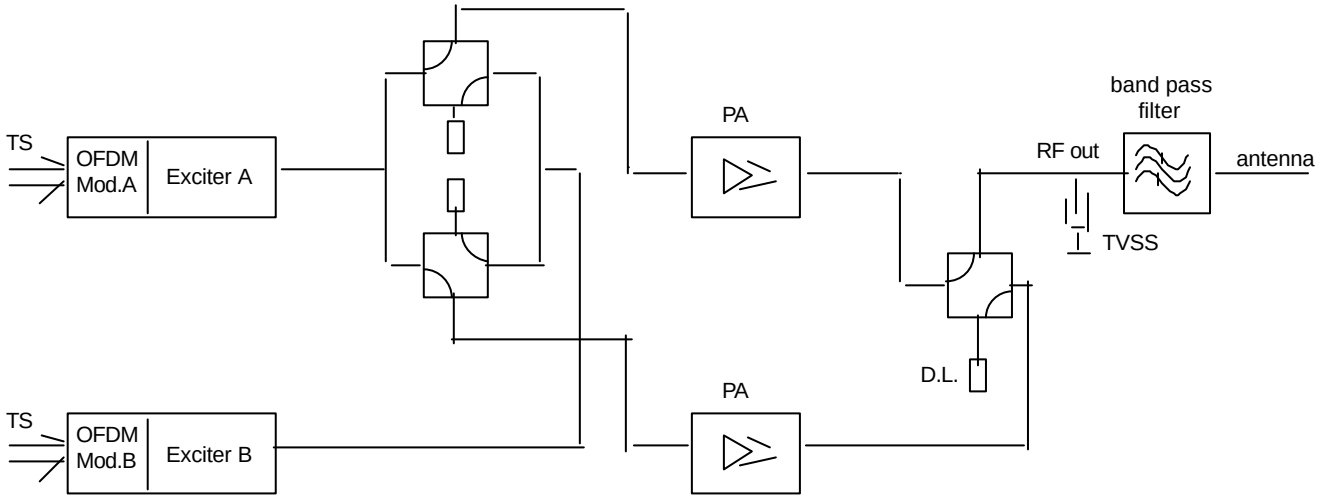
Dual drive, double PA stage, RF relay switch



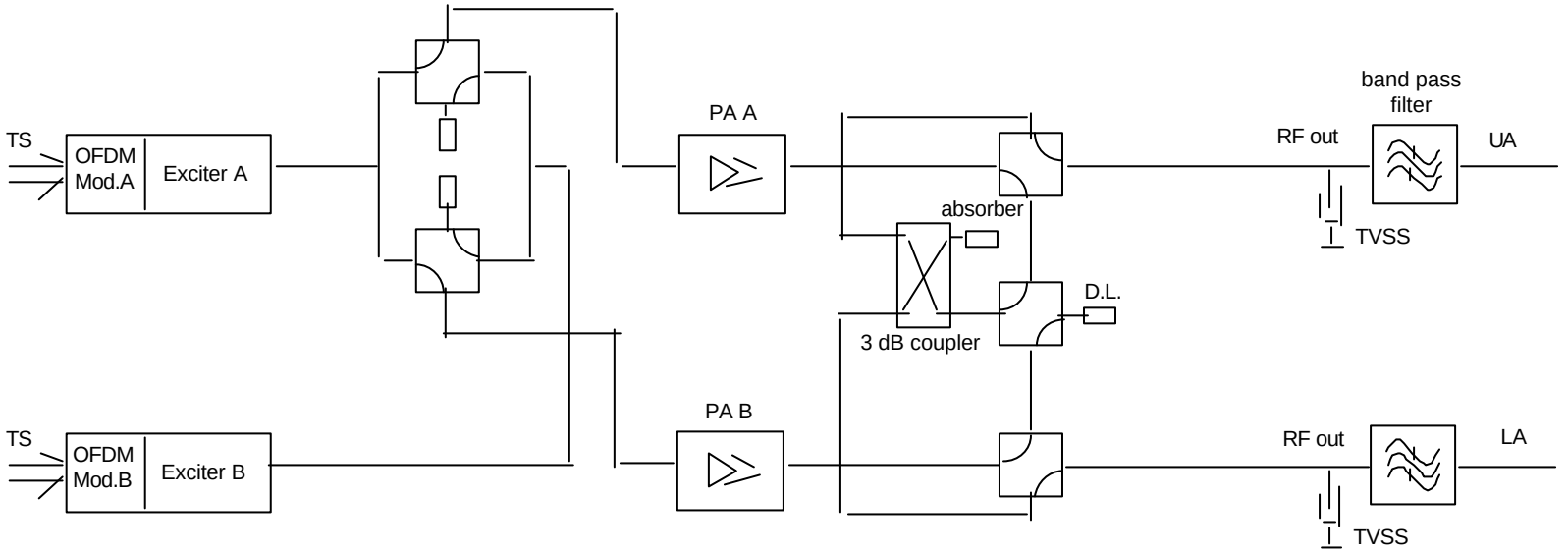
Passive stand-by



Passive stand-by with dual drive

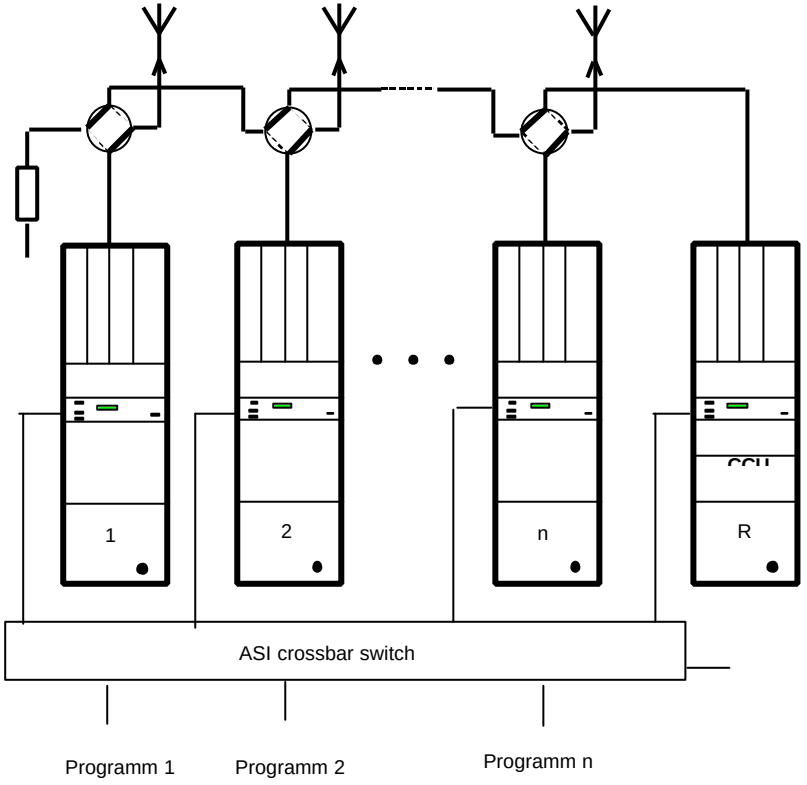


Passive-/active stand-by for half antenna



Reserve concepts

N+1 Reserve System



DVB-T transmitter n+1

Conclusion

Benefits for the broadcaster

- ☑ **Extremely compact design**
- ☑ **Improved technology for exciter, amplifier and cooling system**
- ☑ **Low operational cost**
- ☑ **More flexibility for installation**
- ☑ **More flexibility for remote control**
- ☑ **High commonality of sub-modules for reduced spares inventories**
- ☑ **Easy transition from analogue to digital secures investment**

References:

ETS 300 744 Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital Terrestrial television (DVB-T).

ETR 290 Digital Video Broadcasting (DVB); Measurement guidelines for DVB systems.

TR 101 190 Digital Video Broadcasting (DVB); Implementation guidelines for DVB terrestrial services; Transmission aspects. (TR 101 190).

TM 1925 Digital TV Transmitter Performance Specification.
(AC106 VALIDATE Del.14)