Silicon Complexity

A Hardware Perspective:

from simple, functionally overloaded
to complex and specialised components

Tom Pfeifer – TSSG, Waterford IT, Ireland

Telefunken 1939: Einheits-Fernsehempfänger E 1
15 tubes

Flyback transformers /
Horizontal deflexion unit

Functional overload:
oscillator used for
high voltage also

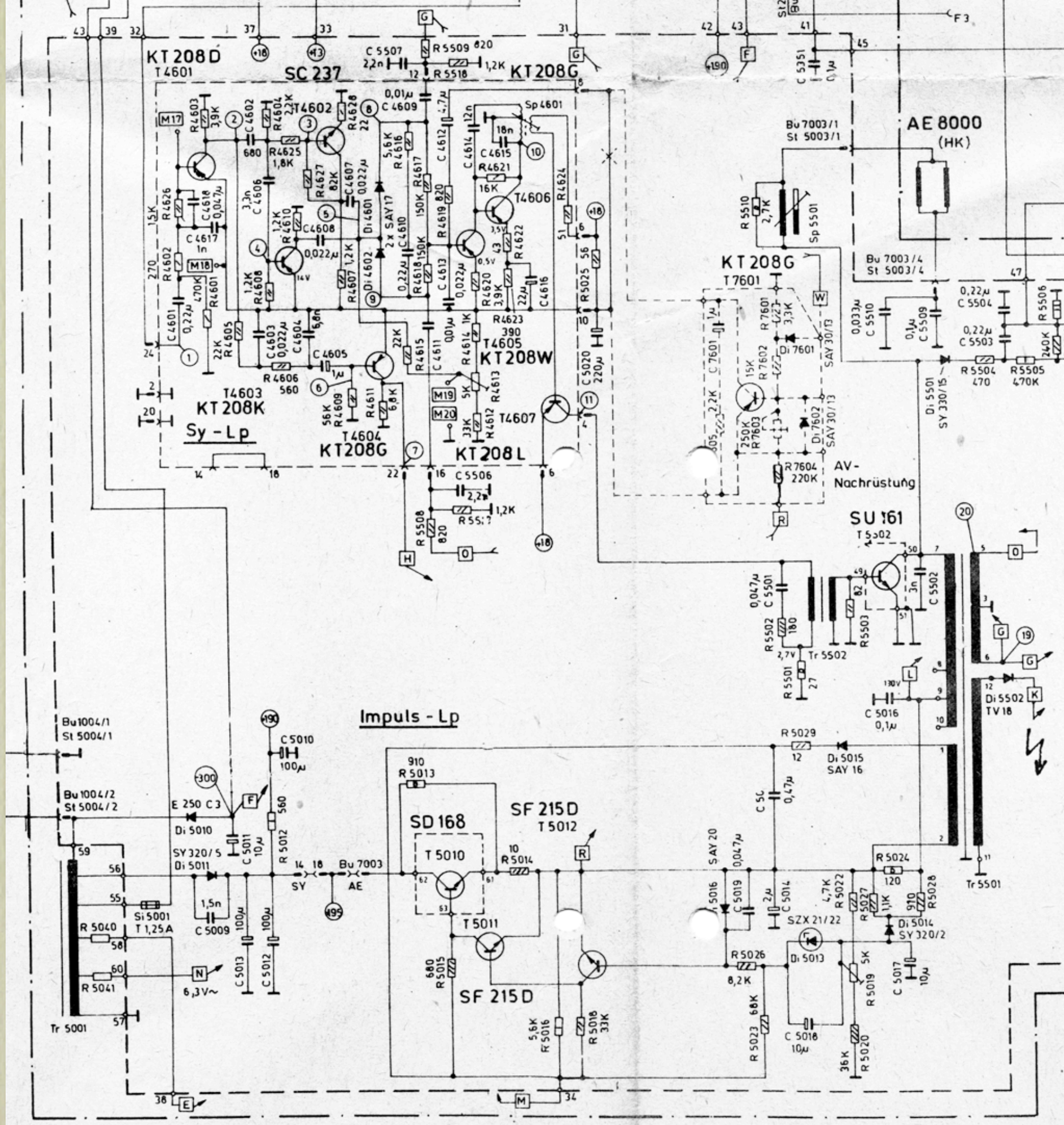
"For the first time the high voltage for the picture tube was generated by the flyback impulse of the horizontal (line) output transformer and was rectified in a special high tension rectifier tube (RFG 5). This solution was much better than a separate expensive high voltage rectifier with a high voltage transformer."

Gemeinschafts-Empfänger

Einheits-Fernseh-Empfänger

1970s

- Transistors: cheaper than tubes
- slight increase in active elements
- functional overload remains



1980s

- ICs
- black box
- system designer needs external parameters only

NTE ELECTRONICS, INC.
44 FARRAND STREET
BLOOMFIELD, NJ 07003
(973) 748–5089

NTE1683
Integrated Circuit
Horizontal/Vertical Processing Circuit

Description:
The NTE1683 is an integrated circuit in an 18–Lead DIP type package designed for color TV deflection signal processing circuits.

Features:
- An auto–synchronized circuit, composed of a phase comparator circuit and a frequency–discriminator circuit
- Vertical and horizontal oscillator circuit operations which are highly stable against changes in supply voltage and temperature
- Built–in high tension protector circuit

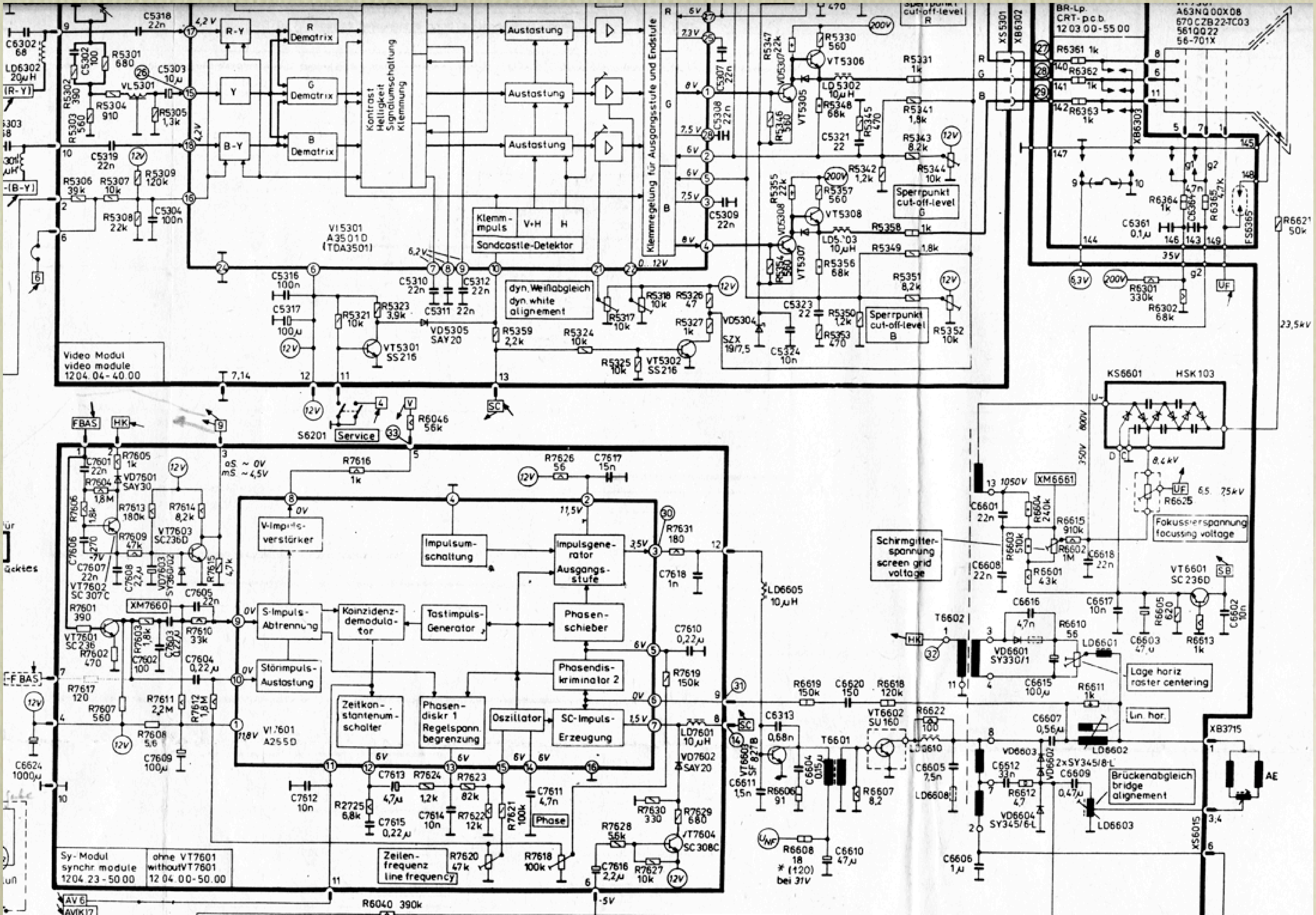
Absolute Maximum Ratings: (T_A = +25°C unles otherwise specified)

Supply Voltage
- $V_{7–5, 10}$ 13.8V
- $V_{15–5, 10}$ 13.8V

Circuit Voltage
- $V_{1–5, 10}$ 6V
- $V_{3–5, 10}$ 13.8V
- $V_{4–5, 10}$ 13.8V
- $V_{6–5, 10}$ 13.8V
- $V_{9–5, 10}$ 9V
- $V_{12–5, 10}$ 4.5V
- $V_{13–5, 10}$ 13.8V
- $V_{18–5, 10}$ 13.8V

Circuit Current
- I_1 . . . . . –1/1mA
- I_2 . . . . . –10/10mA
- I_3 . . . . . –3/50mA
- I_4 . . . . . –1/1mA
- I_6 . . . . . 0/500mA
- I_8 . . . . . –2/0mA
- I_9 . . . . . –1/0mA
- I_{11} . . . . . –40/2mA
- I_{12} . . . . . –1/3mA
- I_{13} 0/40mA
- I_{16} . . . . . –3/3mA
- I_{18} 0/1mA

Power Dissipation, P_D 940mW
Operating Temperature Range, T_{opr} . . . . . –20° to +70°C
Storage Temperature Range, T_{stg} . . . . . –55° to +150°C


R Dematrix
G Dematrix
B Dematrix
R-Y
Y
B-Y
Austastung
Kontrast Helligkeit Signalumschaltung Klemmung
Klemmregelung für Ausgangsstufe und Endstufe
Klemm-impuls
V+H
H
Sandcastle-Detektor
VI 5301 A3501D (TDA3501)
dyn. Weißabgleich dyn. white alignement
Sperrpunkt cut-off-level R
Sperrpunkt cut-off-level G
Sperrpunkt cut-off-level B
BR-Lp. CRT-p.c.b. 1203.00-55.00
A63NQ00X08 670CZB22-TC03 5610022 56-701X
Video Modul video module 1204.04-40.00
KS6601
HSK103
Service
S6201
FBAS
HK
V-Impuls-verstärker
Impulsum-schaltung
Impulsgene-rator Ausgangs-stufe
S-Impuls-Abtrennung
Koinzidenz-demodulator
Tastimpuls-Generator
Phasen-schieber
Störimpuls-Austastung
Phasendis-kriminator 2
Zeitkon-stantenum-schalter
Phasen-diskr 1 Regelspann. begrenzung
Oszillator
SC-Impuls-Erzeugung
VI 7601 A255D
Sy-Modul synchr. module 1204.23-50.00
ohne VT7601 without VT7601 1204.00-50.00
Zeilen-frequenz line frequency
Phase
Schirmgitter-spannung screen grid voltage
Fokussierspannung focussing voltage
Lage horiz raster centering
Lin. hor.
Brückenabgleich bridge alignement
T6602
T6601
VT6602 SU160
VT6601 SC236D
VT7604 SC308C
VD7602 SAY20
LD6602
LD6603
LD6605 10µH
XB3715
XS6015
AE
23,5kV
8,4kV
1050V
XM6661
XM7660
R6040 390k
AV6
AV(K)7

- Complexity increases – but is encapsulated
- Well-defined interfaces
- Task for system designer becomes easier – Reliability goes up
- Functional overload remains as tradition for all fixed-synced TVs and computer screens
- Multisync monitors ***require*** separation of horizontal frequency and high tension transformation

DATA SHEET

TDA4857PS
I²C-bus autosync deflection controller for PC monitors

Product specification
Supersedes data of 2000 Jan 31
File under Integrated Circuits, IC02

2001 Apr 11

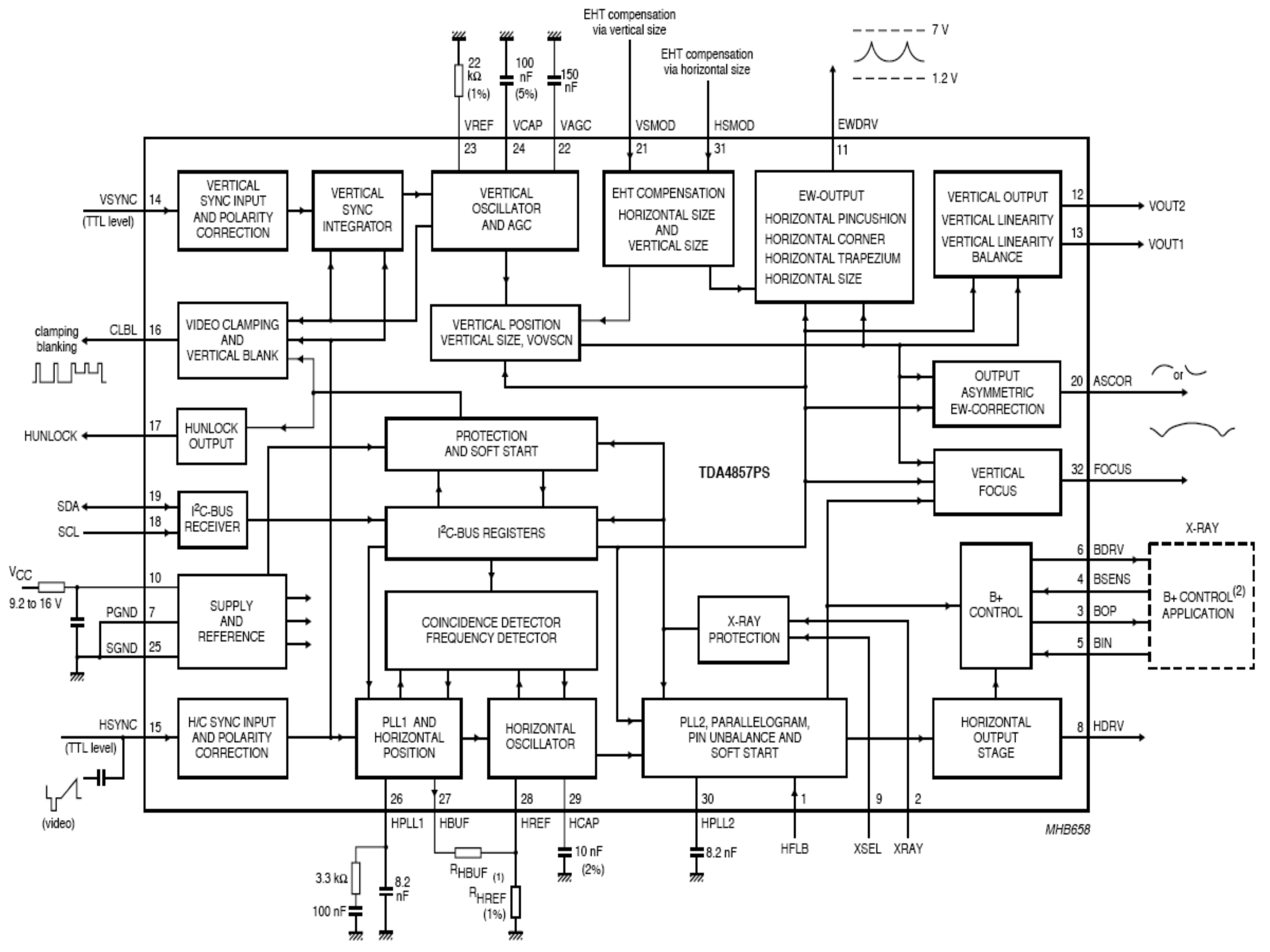
Philips Semiconductors

PHILIPS

2000:

- Highly complex multi-sync deflection controller:

- but system design easier than ever!


EHT compensation via vertical size
EHT compensation via horizontal size
7 V
1.2 V
22 kΩ (1%)
100 nF (5%)
150 nF
VREF
VCAP
VAGC
VSMOD
HSMOD
EWDRV
23
24
22
21
31
11
VSYNC (TTL level)
14
VERTICAL SYNC INPUT AND POLARITY CORRECTION
VERTICAL SYNC INTEGRATOR
VERTICAL OSCILLATOR AND AGC
EHT COMPENSATION HORIZONTAL SIZE AND VERTICAL SIZE
EW-OUTPUT HORIZONTAL PINCUSHION HORIZONTAL CORNER HORIZONTAL TRAPEZIUM HORIZONTAL SIZE
VERTICAL OUTPUT VERTICAL LINEARITY VERTICAL LINEARITY BALANCE
12
VOUT2
13
VOUT1
clamping blanking
CLBL
16
VIDEO CLAMPING AND VERTICAL BLANK
VERTICAL POSITION VERTICAL SIZE, VOVSCN
OUTPUT ASYMMETRIC EW-CORRECTION
20
ASCOR
or
HUNLOCK
17
HUNLOCK OUTPUT
PROTECTION AND SOFT START
TDA4857PS
VERTICAL FOCUS
32
FOCUS
19
SDA
18
SCL
I²C-BUS RECEIVER
I²C-BUS REGISTERS
X-RAY
6
BDRV
4
BSENS
3
BOP
5
BIN
B+ CONTROL
B+ CONTROL(2) APPLICATION
VCC
9.2 to 16 V
10
PGND
7
SGND
25
SUPPLY AND REFERENCE
COINCIDENCE DETECTOR FREQUENCY DETECTOR
X-RAY PROTECTION
HSYNC (TTL level)
15
H/C SYNC INPUT AND POLARITY CORRECTION
PLL1 AND HORIZONTAL POSITION
HORIZONTAL OSCILLATOR
PLL2, PARALLELOGRAM, PIN UNBALANCE AND SOFT START
HORIZONTAL OUTPUT STAGE
8
HDRV
(video)
26
27
28
29
30
1
9
2
HPLL1
HBUF
HREF
HCAP
HPLL2
HFLB
XSEL
XRAY
3.3 kΩ
100 nF
8.2 nF
RHBUF (1)
RHREF (1%)
10 nF (2%)
8.2 nF
MHB658

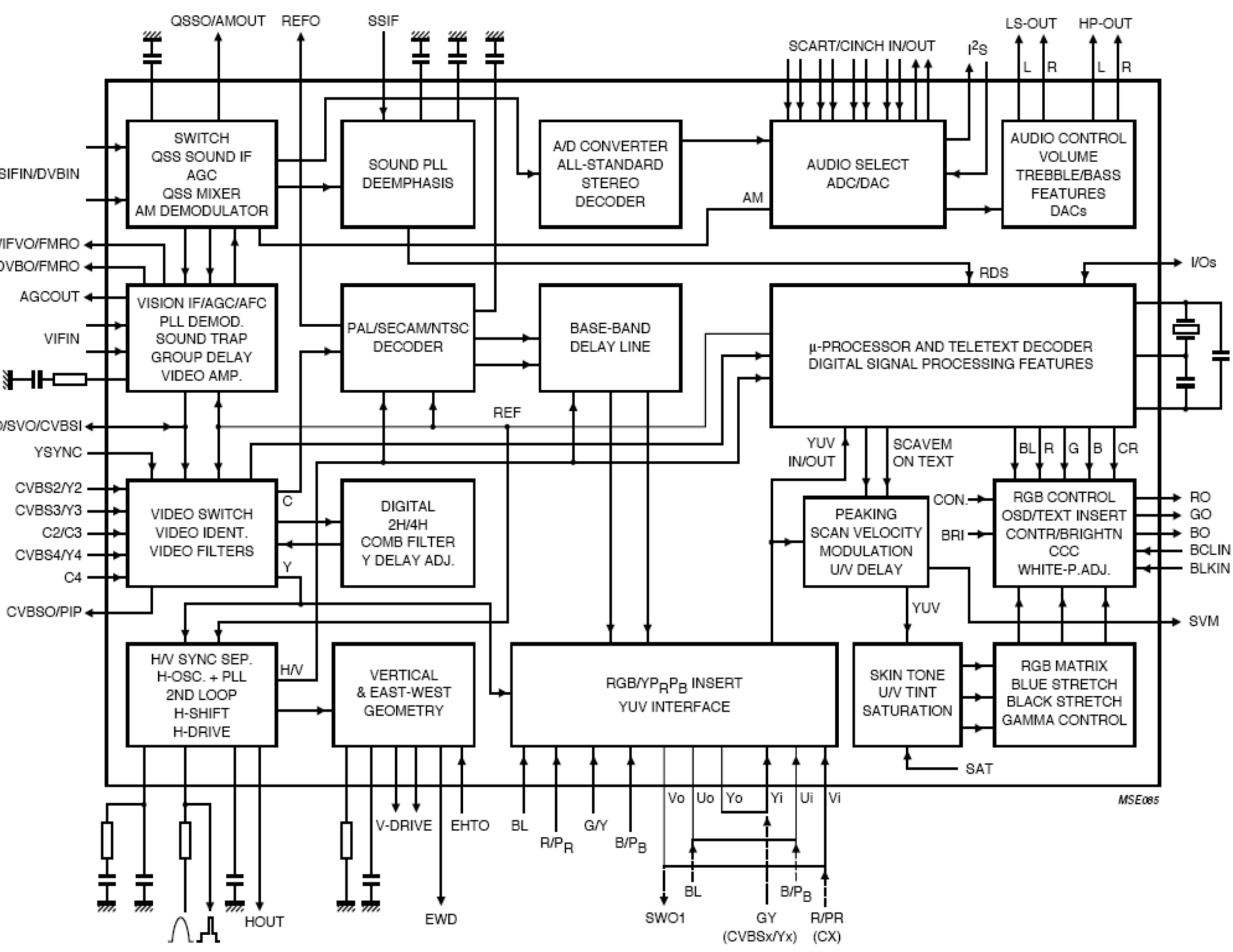
2005:

- One-chip TV
- Most complex so far
- Number of active elements not even advertised anymore
- but system design easier than ever!

All in one: superb picture quality, digital stereo sound, flash memory

UOC[III]: 3rd generation Ultimate One Chip TV solution

PHILIPS


QSSO/AMOUT
REFO
SSIF
SCART/CINCH IN/OUT
I²S
LS-OUT
HP-OUT
L
R
L
R
SWITCH
QSS SOUND IF
AGC
QSS MIXER
AM DEMODULATOR
SOUND PLL
DEEMPHASIS
A/D CONVERTER
ALL-STANDARD
STEREO
DECODER
AUDIO SELECT
ADC/DAC
AUDIO CONTROL
VOLUME
TREBBLE/BASS
FEATURES
DACs
SIFIN/DVBIN
AM
DVBO/IFVO/FMRO
DVBO/FMRO
AGCOUT
VIFIN
RDS
I/Os
VISION IF/AGC/AFC
PLL DEMOD.
SOUND TRAP
GROUP DELAY
VIDEO AMP.
PAL/SECAM/NTSC
DECODER
BASE-BAND
DELAY LINE
µ-PROCESSOR AND TELETEXT DECODER
DIGITAL SIGNAL PROCESSING FEATURES
REF
IFVO/SVO/CVBSI
YSYNC
CVBS2/Y2
YUV
IN/OUT
SCAVEM
ON TEXT
BL
R
G
B
CR
CVBS2/Y2
CVBS3/Y3
C2/C3
CVBS4/Y4
C4
VIDEO SWITCH
VIDEO IDENT.
VIDEO FILTERS
C
Y
DIGITAL
2H/4H
COMB FILTER
Y DELAY ADJ.
CON.
BRI
PEAKING
SCAN VELOCITY
MODULATION
U/V DELAY
RGB CONTROL
OSD/TEXT INSERT
CONTR/BRIGHTN
CCC
WHITE-P.ADJ.
RO
GO
BO
BCLIN
BLKIN
CVBSO/PIP
YUV
SVM
H/V SYNC SEP.
H-OSC. + PLL
2ND LOOP
H-SHIFT
H-DRIVE
H/V
VERTICAL
& EAST-WEST
GEOMETRY
RGB/YPRPB INSERT
YUV INTERFACE
SKIN TONE
U/V TINT
SATURATION
RGB MATRIX
BLUE STRETCH
BLACK STRETCH
GAMMA CONTROL
SAT
MSE085
V-DRIVE
EHTO
BL
R/PR
G/Y
B/PB
Vo
Uo
Yo
Yi
Ui
Vi
HOUT
EWD
BL
B/PB
SWO1
GY
(CVBSx/Yx)
R/PR
(CX)

We haven’t even discussed digital transmission yet!

DVB-S/C/T MPEG-x Timeshift TV

And it works reliably!

Hardware vs. Software

- Are there different approaches to reliability hardware vs. software?
- Software quality?
- We need standards – but not too many?
- Self healing hardware:
  simple: capacitors (foil vaporizes at shortcut)
  complex: Harddisk reassigns defective sectors
  experimental: FPGAs (redundant logic arrays)

Biological autonomicity

- Nature is complex from quantums to the universe:
  Difference in man-made vs. natural complexity?

- Replication of information in every living cell:
  do we need abundance of stored information?

- Ants: often quoted as example for simple components forming a complex system:
  Pervasive systems –
  providing redundancy & abundance?

- Plastic foil: simple but vulnurable
  Human skin: self-healing due to complexity

- Adding complexity to complexity (in the design) to achieve simplicity (for the end-user) – nothing wrong if well treated:
- Structure and Encapsulation
- Well-defined interfaces (APIs) hiding complexity
- **No paradoxon:** complexity is unavoidable

Everything is simpler than you think
and at the same time
more complex than you imagine.

Johann Wolfgang von Goethe

cited on wikipedia.org