

Service Service Service



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Service Manual

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1. Technical Specifications, Connections, and Chassis Overview

Index of this chapter:

- 1.1 Technical Specifications
- 1.2 Connection Overview
- 1.3 Chassis Overview

Notes:

- Figures can deviate due to the different set executions.
- Specifications are indicative (subject to change).

1.1 Technical Specifications

1.1.1 Vision

Display type	: LCD
Screen size	: 19" (48 cm), 16:9 : 20" (51 cm), 4:3 : 22" (56 cm), 16:9 : 26" (66 cm), 16:9
Resolution (H × V pixels)	: 640×480 (20") : 1366×768 (26") : 1440×900 (19") : 1680×1050 (22")
Light output (cd/m ²)	: 300 (19", 20", 22") : 500 (26")
Contrast ratio	: 800:1 (20", 26") : 1000:1 (19", 22")
Typ. response time (ms)	: 12 (20") : 8 (26") : 5 (19", 22")
Viewing angle (H × V degrees)	: 178×178 (20") : 170×160 (19", 22") : 160×160 (26")
Tuning system	: PLL
Colour systems	: PAL, SECAM
Video playback	: PAL, SECAM, NTSC
Tuner bands	: UHF, VHF, S, Hyper
Supported Computer Formats	
60 Hz	: 640×480(max.for 20")
60 Hz	: 800×600 (all exc.20")
60 Hz	: 1024×768(all exc.20")
60 Hz	: 1280×768 (26" only)
60 Hz	: 1280×1024 (26" only)
60 Hz	: 1366×768 (26" only)
50 Hz, 75 Hz	: 1440×900 (26", only)
Supported Video Formats	
60 Hz	: 480i
60 Hz	: 480p
50 Hz	: 576i
50 Hz	: 576p
50 Hz, 60 Hz	: 720p
50 Hz, 60 Hz	: 1080i
50 Hz, 60 Hz	: 1080p (19", 22" only)

1.1.2 Sound

Sound systems	: Mono : Stereo
Maximum power (W)	: 2 × 3 (19", 20") : 2 × 5 (22", 26")

1.1.3 Miscellaneous

Power supply	
- Mains voltage (V _{AC})	: 100 to 240
- Mains frequency (Hz)	: 50, 60
Power consumption (W)	: ~50 (19") : ~58 (20") : ~53 (22") : ~120 (26")
Stand-by (W)	: < 0.3
Dimensions (W × H × D in mm)	: 475 × 334 × 71 (19") : 470 × 406 × 71 (20") : 538 × 375 × 71 (22") : 671 × 458 × 90 (26")
Weight (kg)	: ? (19") : 5.8 (20") : ? (22") : 7.7 (26")

1.2 Connection Overview

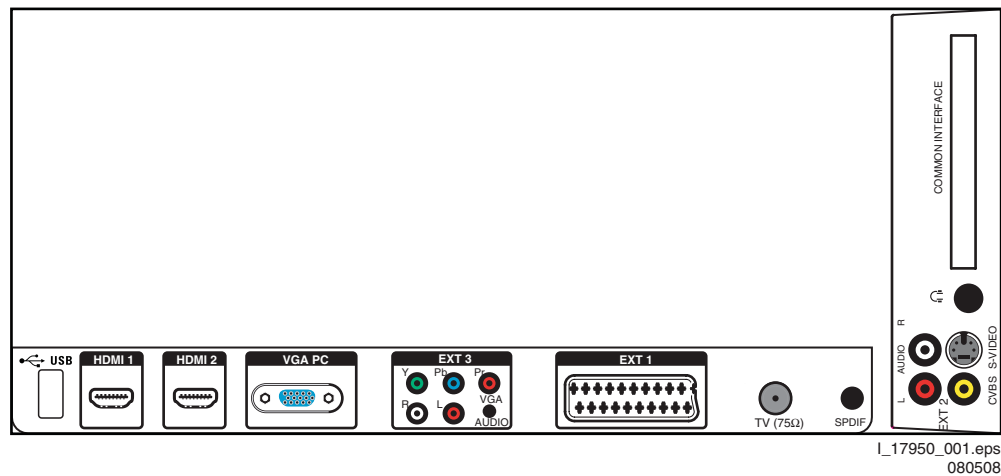


Figure 1-1 Rear and side I/O connections

Note: The following connector colour abbreviations are used (acc. to DIN/IEC 757): Bk= Black, Bu= Blue, Gn= Green, Gy= Grey, Rd= Red, Wh= White, and Ye= Yellow.

1.2.1 Side connections

EXT 2: Cinch: Video CVBS - In, Audio - In

Ye - Video CVBS 1 V_{PP} / 75 ohm
Wh - Audio L 0.5 V_{RMS} / 10 kohm
Rd - Audio R 0.5 V_{RMS} / 10 kohm



EXT 2: S-Video (Hosiden): Video Y/C - In

1 - Ground Y Gnd
2 - Ground C Gnd
3 - Video Y 1 V_{PP} / 75 ohm
4 - Video C 0.3 V_{PP} / 75 ohm



EXT 2: Mini Jack: Audio Head phone - Out

Bk - Head phone 32 - 600 ohm / 10 mW



EXT 2: Common Interface

68p - See diagram B05



1.2.2 Rear Connections

USB2.0

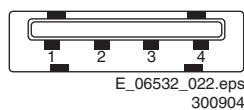
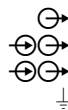


Figure 1-2 USB (type A)

1 - +5V
2 - Data (-)
3 - Data (+)
4 - Ground

Gnd



HDMI 1 & 2: Digital Video, Digital Audio - In

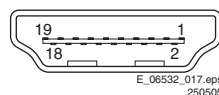
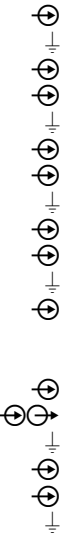


Figure 1-3 HDMI (type A) connector

1	- D2+	Data channel
2	- Shield	Gnd
3	- D2-	Data channel
4	- D1+	Data channel
5	- Shield	Gnd
6	- D1-	Data channel
7	- D0+	Data channel
8	- Shield	Gnd
9	- D0-	Data channel
10	- CLK+	Data channel
11	- Shield	Gnd
12	- CLK-	Data channel
13	- n.c.	
14	- n.c.	
15	- DDC_SCL	DDC clock
16	- DDC_SDA	DDC data
17	- Ground	Gnd
18	- +5V	
19	- HPD	Hot Plug Detect
20	- Ground	Gnd



VGA PC: Video RGB - In and Service UART

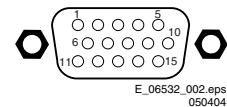
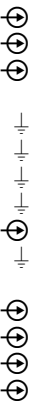


Figure 1-4 VGA Connector

1	- Video Red	0.7 V _{PP} / 75 ohm
2	- Video Green	0.7 V _{PP} / 75 ohm
3	- Video Blue	0.7 V _{PP} / 75 ohm
4	- n.c.	
5	- Ground	Gnd
6	- Ground Red	Gnd
7	- Ground Green	Gnd
8	- Ground Blue	Gnd
9	- +5V_dc	+5 V
10	- Ground Sync	Gnd
11	- n.c.	
12	- DDC_SDA	DDC data
13	- H-sync	0 - 5 V
14	- V-sync	0 - 5 V
15	- DDC_SCL	DDC clock

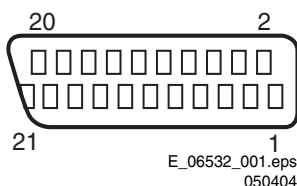


EXT 3: Cinch: Video YPbPr - In, Audio - In

Gn - Video Y	1 V _{PP} / 75 ohm	⊕⊕
Bu - Video Pb	0.7 V _{PP} / 75 ohm	⊕⊕
Rd - Video Pr	0.7 V _{PP} / 75 ohm	⊕⊕
Wh - Audio L	0.5 V _{RMS} / 10 kohm	⊕⊕
Rd - Audio R	0.5 V _{RMS} / 10 kohm	⊕⊕

EXT 3: Mini Jack: VGA Audio - In

Bk - Audio L/R	0.5 V _{RMS} / 10 kohm	⊕⊕
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EXT 1: Video RGB/YC - In, CVBS - In/Out, Audio - In/Out**Figure 1-5 SCART connector**

1 - Audio R	0.5 V _{RMS} / 1 kohm	⊕
2 - Audio R	0.5 V _{RMS} / 10 kohm	⊕
3 - Audio L	0.5 V _{RMS} / 1 kohm	⊕
4 - Ground Audio	Gnd	⊕

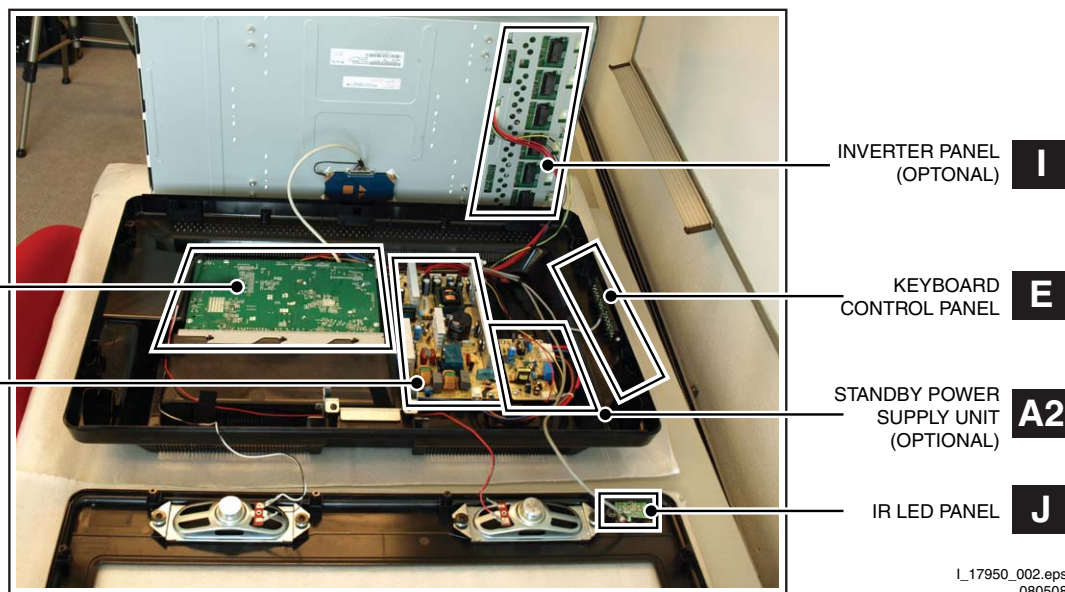
5 - Ground Blue	Gnd	⊕
6 - Audio L	0.5 V _{RMS} / 10 kohm	⊕
7 - Video Blue/C-out	0.7 V _{PP} / 75 ohm	⊕
8 - Function Select	0 - 2 V: INT 4.5 - 7 V: EXT 16:9 9.5 - 12 V: EXT 4:3	⊕
9 - Ground Green	Gnd	⊕
10 - Easylink P50	0 - 5 V / 4.7 kohm	⊕
11 - Video Green	0.7 V _{PP} / 75 ohm	⊕
12 - n.c.		⊕
13 - Ground Red	Gnd	⊕
14 - Ground P50	Gnd	⊕
15 - Video Red/C	0.7 V _{PP} / 75 ohm	⊕
16 - Status/FBL	0 - 0.4 V: INT 1 - 3 V: EXT / 75 ohm	⊕
17 - Ground Video	Gnd	⊕
18 - Ground FBL	Gnd	⊕
19 - Video CVBS	1 V _{PP} / 75 ohm	⊕
20 - Video CVBS/Y	1 V _{PP} / 75 ohm	⊕
21 - Shield	Gnd	⊕

Aerial - In

- IEC-type (EU)	Coax, 75 ohm	⊕
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Cinch: S/PDIF - Out

Bk - Coaxial	0.4 - 0.6V _{PP} / 75 ohm	⊕
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1.3 Chassis Overview**Figure 1-6 PWB/CBA locations (26" model)**

2. Safety Instructions, Warnings, and Notes

Index of this chapter:

- 2.1 Safety Instructions
- 2.2 Warnings
- 2.3 Notes

2.1 Safety Instructions

Safety regulations require the following **during** a repair:

- Connect the set to the Mains/AC Power via an isolation transformer (> 800 VA).
- Replace safety components, indicated by the symbol , only by components identical to the original ones. Any other component substitution (other than original type) may increase risk of fire or electrical shock hazard.

Safety regulations require that **after** a repair, the set must be returned in its original condition. Pay in particular attention to the following points:

- Route the wire trees correctly and fix them with the mounted cable clamps.
- Check the insulation of the Mains/AC Power lead for external damage.
- Check the strain relief of the Mains/AC Power cord for proper function.
- Check the electrical DC resistance between the Mains/AC Power plug and the secondary side (only for sets that have a Mains/AC Power isolated power supply):
 1. Unplug the Mains/AC Power cord and connect a wire between the two pins of the Mains/AC Power plug.
 2. Set the Mains/AC Power switch to the "on" position (keep the Mains/AC Power cord unplugged!).
 3. Measure the resistance value between the pins of the Mains/AC Power plug and the metal shielding of the tuner or the aerial connection on the set. The reading should be between 4.5 MΩ and 12 MΩ.
 4. Switch "off" the set, and remove the wire between the two pins of the Mains/AC Power plug.
- Check the cabinet for defects, to prevent touching of any inner parts by the customer.

2.2 Warnings

- All ICs and many other semiconductors are susceptible to electrostatic discharges (ESD ). Careless handling during repair can reduce life drastically. Make sure that, during repair, you are connected with the same potential as the mass of the set by a wristband with resistance. Keep components and tools also at this same potential.
- Be careful during measurements in the high voltage section.
- Never replace modules or other components while the unit is switched "on".
- When you align the set, use plastic rather than metal tools. This will prevent any short circuits and the danger of a circuit becoming unstable.

2.3 Notes

2.3.1 General

- Measure the voltages and waveforms with regard to the chassis (= tuner) ground ($\perp$), or hot ground ($\downarrow$), depending on the tested area of circuitry. The voltages and waveforms shown in the diagrams are indicative. Measure them in the Service Default Mode (see chapter 5) with a colour bar signal and stereo sound (L: 3 kHz, R: 1 kHz unless stated otherwise) and picture carrier at 475.25 MHz for PAL, or 61.25 MHz for NTSC (channel 3).

- Where necessary, measure the waveforms and voltages with ($\perp$) and without ($\downarrow$) aerial signal. Measure the voltages in the power supply section both in normal operation ($\textcircled{I}$) and in stand-by ($\textcircled{b}$). These values are indicated by means of the appropriate symbols.

2.3.2 Schematic Notes

- All resistor values are in ohms, and the value multiplier is often used to indicate the decimal point location (e.g. 2K2 indicates 2.2 kΩ).
- Resistor values with no multiplier may be indicated with either an "E" or an "R" (e.g. 220E or 220R indicates 220 Ω).
- All capacitor values are given in micro-farads ($\mu = \times 10^{-6}$), nano-farads ($n = \times 10^{-9}$), or pico-farads ($p = \times 10^{-12}$).
- Capacitor values may also use the value multiplier as the decimal point indication (e.g. 2p2 indicates 2.2 pF).
- An "asterisk" (*) indicates component usage varies. Refer to the diversity tables for the correct values.
- The correct component values are listed in the Spare Parts List. Therefore, always check this list when there is any doubt.

2.3.3 BGA (Ball Grid Array) ICs

Introduction

For more information on how to handle BGA devices, visit this URL: www.atyourservice.ce.philips.com (needs subscription, not available for all regions). After login, select "Magazine", then go to "Repair downloads". Here you will find Information on how to deal with BGA-ICs.

BGA Temperature Profiles

For BGA-ICs, you **must** use the correct temperature-profile, which is coupled to the 12NC. For an overview of these profiles, visit the website www.atyourservice.ce.philips.com (needs subscription, but is not available for all regions)

You will find this and more technical information within the "Magazine", chapter "Repair downloads".

For additional questions please contact your local repair help desk.

2.3.4 Lead-free Soldering

Due to lead-free technology some rules have to be respected by the workshop during a repair:

- Use only lead-free soldering tin Philips SAC305 with order code 0622 149 00106. If lead-free solder paste is required, please contact the manufacturer of your soldering equipment. In general, use of solder paste within workshops should be avoided because paste is not easy to store and to handle.
- Use only adequate solder tools applicable for lead-free soldering tin. The solder tool must be able:
 - To reach a solder-tip temperature of at least 400°C.
 - To stabilize the adjusted temperature at the solder-tip.
 - To exchange solder-tips for different applications.
- Adjust your solder tool so that a temperature of around 360°C - 380°C is reached and stabilized at the solder joint. Heating time of the solder-joint should not exceed ~ 4 sec. Avoid temperatures above 400°C, otherwise wear-out of tips will increase drastically and flux-fluid will be destroyed. To avoid wear-out of tips, switch "off" unused equipment or reduce heat.
- Mix of lead-free soldering tin/parts with leaded soldering tin/parts is possible but PHILIPS recommends strongly to **avoid** mixed regimes. If this cannot be avoided, carefully clear the solder-joint from old tin and re-solder with new tin.

2.3.5 Alternative BOM identification

It should be noted that on the European Service website, "Alternative BOM" is referred to as "Design variant".

The **third digit** in the serial number (example: AG2B0335000001) indicates the number of the alternative B.O.M. (Bill Of Materials) that has been used for producing the specific TV set. In general, it is possible that the same TV model on the market is produced with e.g. two different types of displays, coming from two different suppliers. This will then result in sets which have the same CTN (Commercial Type Number; e.g. 28PW9515/12) but which have a different B.O.M. number.

By looking at the third digit of the serial number, one can identify which B.O.M. is used for the TV set he is working with. If the third digit of the serial number contains the number "1" (example: AG1B0335000001), then the TV set has been manufactured according to B.O.M. number 1. If the third digit is a "2" (example: AG2B0335000001), then the set has been produced according to B.O.M. no. 2. ***This is important for ordering the correct spare parts!***

For the third digit, the numbers 1...9 and the characters A...Z can be used, so in total: 9 plus 26 = 35 different B.O.M.s can be indicated by the third digit of the serial number.

Identification: The bottom line of a type plate gives a 14-digit serial number. Digits 1 and 2 refer to the production centre (e.g. AG is Bruges), digit 3 refers to the B.O.M. code, digit 4 refers to the Service version change code, digits 5 and 6 refer to the production year, and digits 7 and 8 refer to production week (in example below it is 2006 week 17). The 6 last digits contain the serial number.



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Figure 2-1 Serial number (example)

2.3.6 Board Level Repair (BLR) or Component Level Repair (CLR)

If a board is defective, consult your repair procedure to decide if the board has to be exchanged or if it should be repaired on component level.

If your repair procedure says the board should be exchanged completely, do not solder on the defective board. Otherwise, it cannot be returned to the O.E.M. supplier for back charging!

2.3.7 Practical Service Precautions

- **It makes sense to avoid exposure to electrical shock.** While some sources are expected to have a possible dangerous impact, others of quite high potential are of limited current and are sometimes held in less regard.
- **Always respect voltages.** While some may not be dangerous in themselves, they can cause unexpected reactions that are best avoided. Before reaching into a powered TV set, it is best to test the high voltage insulation. It is easy to do, and is a good service precaution.

3. Directions for Use

You can download this information from the following websites:

<http://www.philips.com/support>

<http://www.p4c.philips.com>

4. Mechanical Instructions

Index of this chapter:

- 4.1 Cable Dressing
- 4.2 Service Positions
- 4.3 Assy/Panel Removal
- 4.4 Set Re-assembly

Notes:

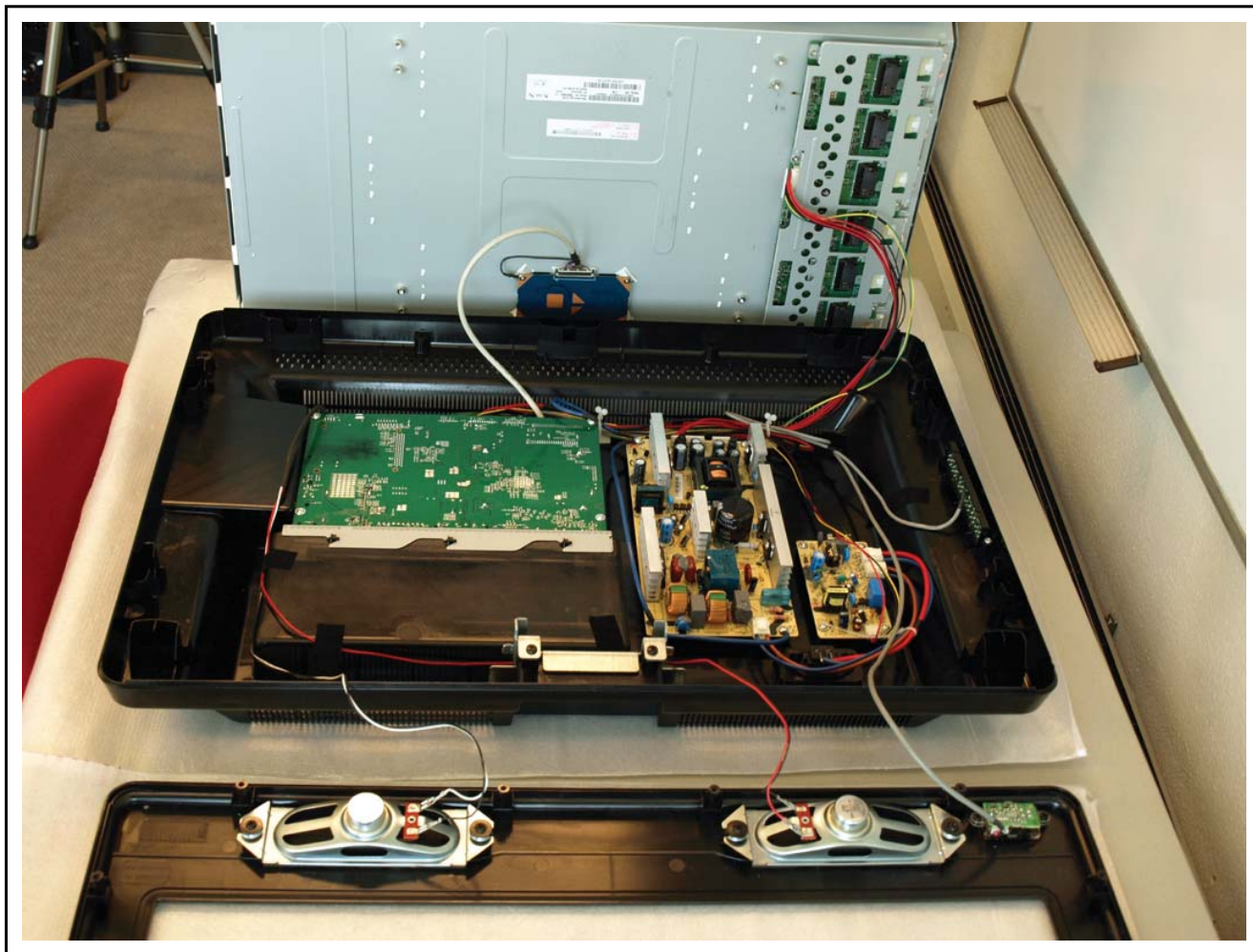
- Figures below can deviate slightly from the actual situation, due to the different set executions.
- Follow the disassemble instructions in described order. They apply mostly to the 26" model unless otherwise specified, but the described method is comparable for the other screen sizes.

4.1 Cable Dressing



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Figure 4-1 Cable dressing (20" model)



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Figure 4-2 Cable dressing (26" model)

4.2 Service Positions

For easy servicing of this set, there are a few possibilities created:

- The buffers from the packaging.
- Foam bars (created for Service).

4.2.1 Foam Bars

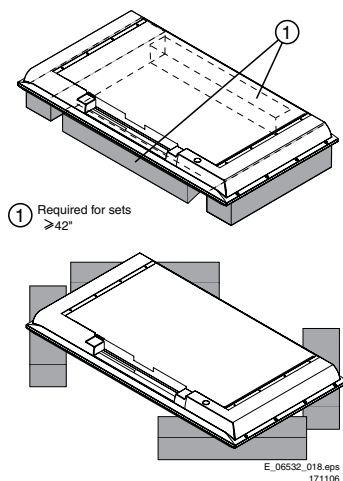


Figure 4-3 Foam bars

The foam bars (order code 3122 785 90580 for two pieces) can be used for all types and sizes of Flat TVs. See figure "Foam bars" for details. Sets with a display of 42" and larger, require **four** foam bars [1]. Ensure that the foam bars are always supporting the cabinet and **never** only the display.

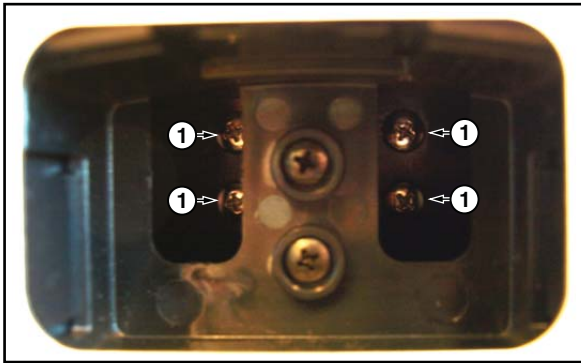
Caution: Failure to follow these guidelines can seriously damage the display!

By laying the TV face down on the (ESD protective) foam bars, a stable situation is created to perform measurements and alignments. By placing a mirror under the TV, you can monitor the screen.

4.3 Assy/Panel Removal

4.3.1 Stand

1. Refer to next figure.
2. Place the TV set upside down on a table top, using the foam bars (see section "Service Position").
3. Remove the screws that secure the stand and remove the stand.



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Figure 4-4 Stand

4.3.2 Rear Cover

Warning: Disconnect the mains power cord before you remove the rear cover.

1. Refer to next figures.
2. Place the TV set upside down on a table top, using the foam bars (see section "Service Positions").
3. Remove the screws that secure the rear cover. The screws are located at the sides.

Be careful: Some models (mainly the smaller screen sizes) use latches for securing the rear and front cover together (see figure "Front cover latch location"). **These must be unlocked first before you can open the TV-set!** To open them, use e.g. a (plastic) putty knife. Insert the tool into the gap between the front and rear cover (be extremely careful not to scratch or dent the cabinet when inserting the tool).

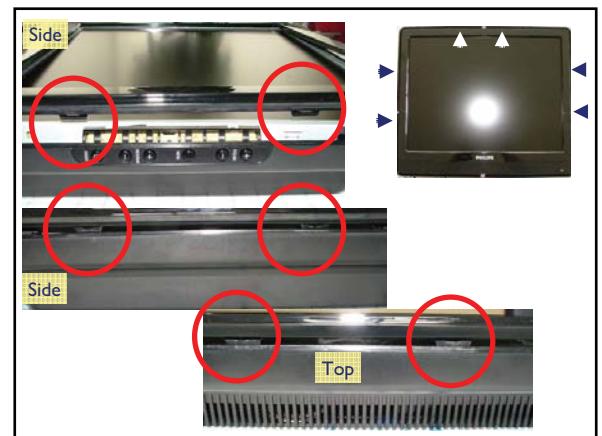
Gently release the internal latches. Note: You will hear little popping sounds as the latches release and the rear cover moves away from the front cover.

4. Now the rear cover could be lifted but the SSB and power supply panel(s) are mounted in the rear cover and still connected to the LCD panel and other boards. **Those cables should be released first!**
5. To release the LVDS cable lift the back cover a few centimetres and move it downwards the set. Now unplug the LVDS connector [2].
- Caution:** be careful, as this is a very fragile connector!
6. Remove the screw [3].
7. Now the rear cover can be lifted to gain access to the speaker cables and the IR/LED panel cable. Release the connectors [4].



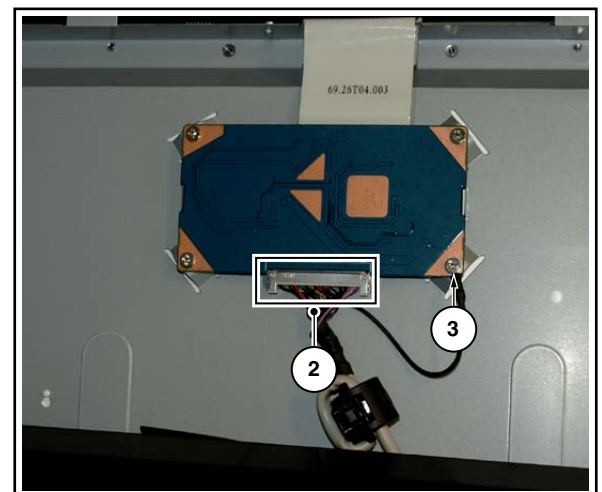
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Figure 4-5 Front cover latch location [1/2]



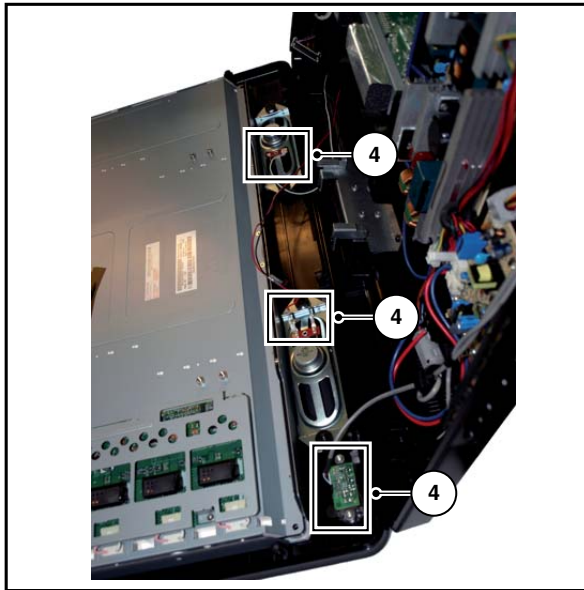
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Figure 4-6 Front cover latch location [2/2]



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Figure 4-7 LVDS release

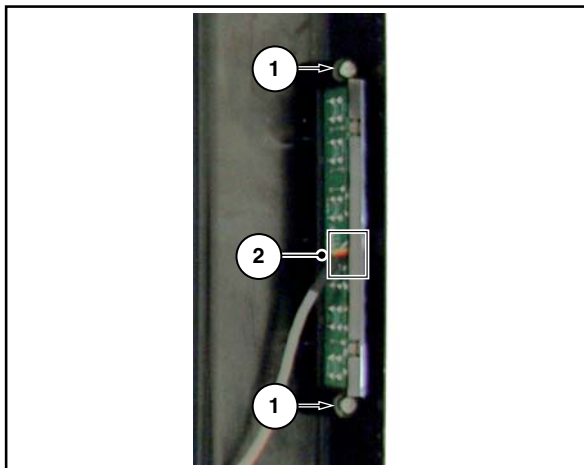


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Figure 4-8 Speaker and IR/LED panel cable release

4.3.3 Keyboard Control Board

1. Refer to next figure.
 2. Unscrew two screws [1]
 3. Unplug connector [2] and remove the board.
- When defective, replace the whole unit

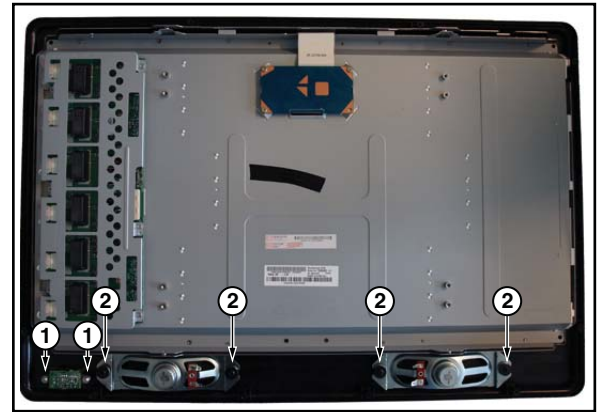


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Figure 4-9 Keyboard control board

4.3.4 IR/LED Board and Speakers

1. Refer to next figure.
 2. Remove the screws [1] and remove the IR/LED board.
 3. Remove the screws [2] and remove the speakers.
- When defective, replace the whole unit.



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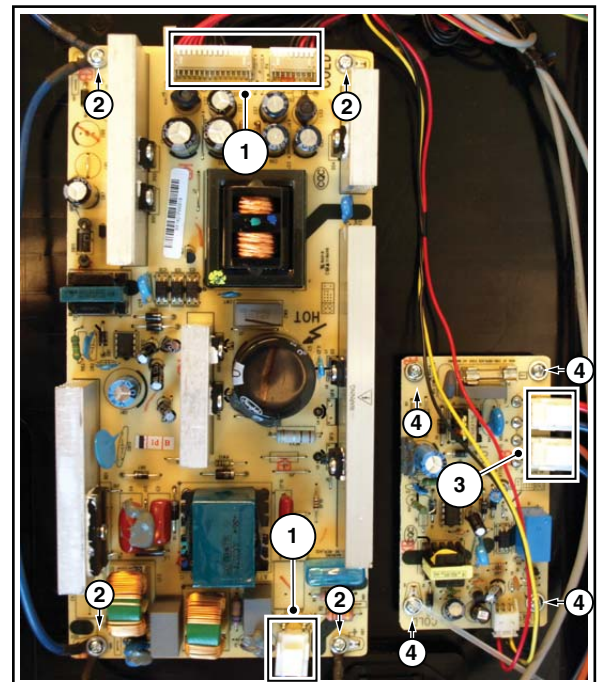
Figure 4-10 IR/LED Board and Speakers

4.3.5 Power Supply Board

Due to different set executions this chassis is supplied with one or two power supply boards and figures may differ.

Caution: it is absolutely mandatory to remount all different screws and cables at their original position during re-assembly. Failure to do so may result in damaging the power supply.

1. Refer to next figure.
2. Unplug all the connectors [1].
3. Remove the fixation screws [2]
4. Remove the main power supply board.
5. Unplug all the connectors [3].
6. Remove the fixation screws [4]
7. Remove the stand-by power supply board.



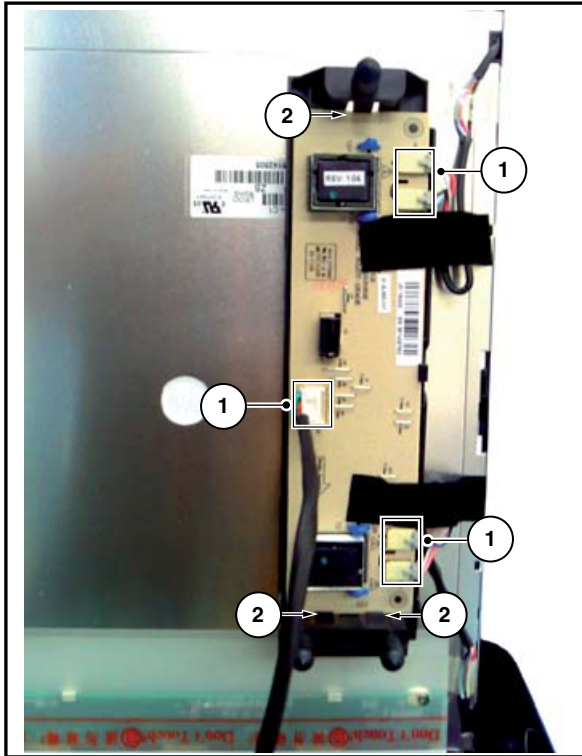
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Figure 4-11 Power Supply Unit(s)

4.3.6 Inverter Board (19", 20", and 22" versions)

Due to different set executions this chassis some versions are supplied with an inverter board. Figures may differ.

1. Refer to next figure.
2. Unplug all connectors [1].
3. Release the clips [2]
4. Take out the inverter board.



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240408

Figure 4-12 Inverter Board

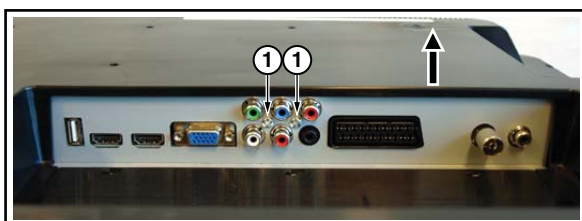
4.3.7 Small Signal Board (SSB)

Caution: it is absolutely mandatory to remount all different screws at their original position during re-assembly. Failure to do so may result in damaging the SSB.

Removing the SSB

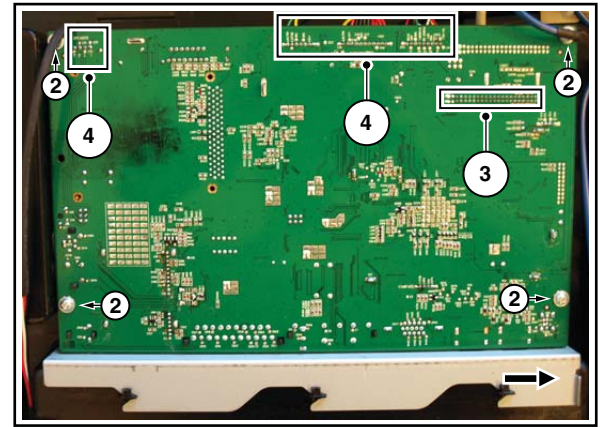
1. See next figures.
2. Remove the screws [1] from the SSB connector plate.
3. Remove the screws [2] from the SSB.
4. On the **outside** of the set, **lift** the rear cover near the tuner connector approximately 3 mm in the indicated direction and keep it lifted, while
5. On the **inside** of the set, **slide** the metal plate in the indicated direction.
6. Gently lift the board from the rear cover.
7. Now unplug the LVDS connector [3].

Caution: be careful, as this is a very fragile connector! Unplug the rest of the cables [4].



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Figure 4-13 SSB connector plate



I_17950_008.eps
080508

Figure 4-14 SSB

4.4 Set Re-assembly

To re-assemble the whole set, execute all processes in reverse order.

Notes:

- While re-assembling, make sure that all cables are placed and connected in their original position. See figure "Cable dressing".
- Pay special attention not to damage the EMC foams at the SB shields. Make sure, that EMC foams are put correctly on their places.

5. Service Modes, Error Codes, and Fault Finding

Index of this chapter:

- 5.1 Test Points
- 5.2 Service Modes
- 5.3 Error Codes
- 5.5 Service Tools

5.1 Test Points

This chassis is NOT equipped with test points in the service printing. No test points are mentioned in the service manual.

5.2 Service Modes

The Service Mode feature is split into different parts:

- Service Alignment Mode (SAM).
- Service Default Mode (SDM).
- Customer Service Mode (CSM).

SDM and SAM offer features, which can be used by the Service engineer to repair/align a TV set. Some features are:

- Activates the blinking LED procedure for error identification when no picture is available (SDM).
- Make alignments (e.g. white tone), (de)select options, enter options codes, reset the error buffer (SAM).
- Display information ("SAM" indication in upper right corner of screen, error buffer, software version, options and option codes, sub menus).

The CSM is a Service Mode that can be enabled by the consumer. The CSM displays diagnosis information, which the customer can forward to the dealer or call centre. In CSM mode, "CSM", is displayed in the top right corner of the screen. The information provided in CSM and the purpose of CSM is to:

- Increase the home repair hit rate.
- Decrease the number of nuisance calls.
- Solved customers' problem without home visit.

5.2.1 Service Alignment Mode (SAM)

How to Enter

To enter SAM, use the following method:

- Press on the remote control the code "062596" directly followed by the "INFO" key.

After entering SAM, the following screen is visible, the values can be adjusted according to the requested (see Chapter 8).

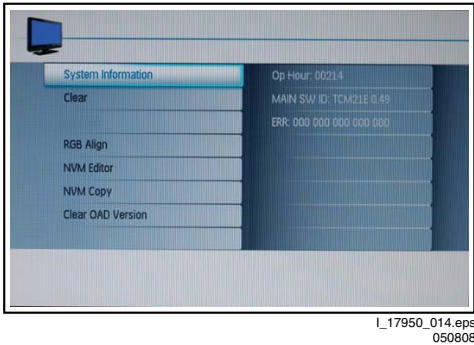


Figure 5-1 SAM menu, System Information

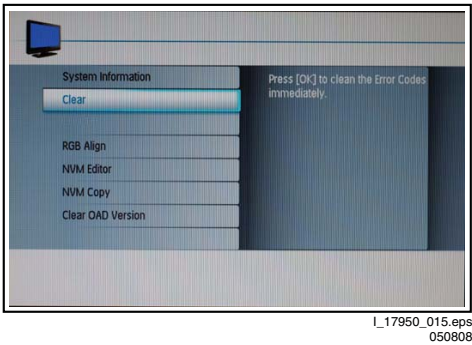


Figure 5-2 SAM menu, Clear

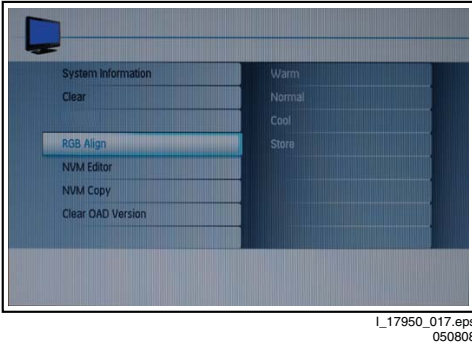


Figure 5-3 SAM menu, RGB Align

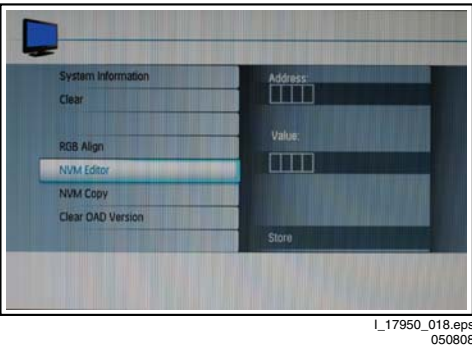


Figure 5-4 SAM menu, NVM Editor

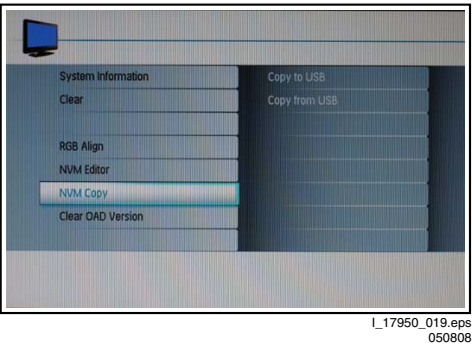


Figure 5-5 SAM menu, NVM Update

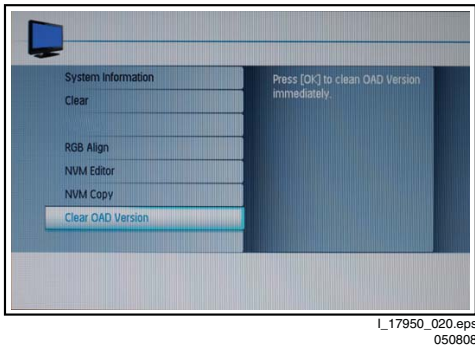


Figure 5-6 SAM menu, Clear OAD

How to EXIT

Put set in <stand-by> by using the remote control.

5.2.2 Service Default Mode (SDM)**Purpose**

- To create a pre-defined setting, to get the same measurements as given in this manual.
- To override SW protections.
- To start the blinking LED procedure.

How to enter

To enter SAM, use the following method:

- Press on the remote control the code “062596” directly followed by the “MENU” key.

After entering SDM, the following screen is visible.

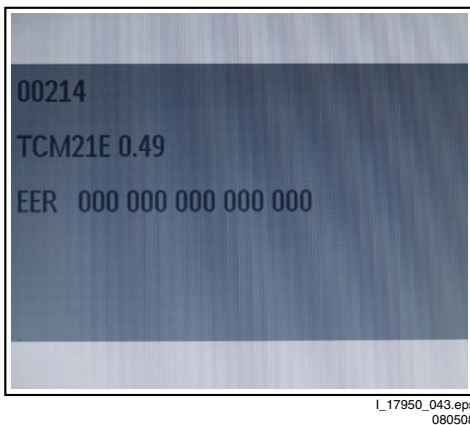


Figure 5-7 SDM menu

From top to bottom, it gives the following information:

- Operation hours
- Software version
- Error buffer display.

5.2.3 Customer Service Mode (CSM)**Purpose**

When a customer is having problems with his TV-set, he can call his dealer or the Customer Help desk. The service technician can then ask the customer to activate the CSM, in order to identify the status of the set. Now, the service technician can judge the severity of the complaint. In many cases, he can advise the customer how to solve the problem, or he can decide if it is necessary to visit the customer. The CSM is a read only mode; therefore, modifications in this mode are not possible.

How to Activate CSM

Key in the code “123654” via the standard RC transmitter.

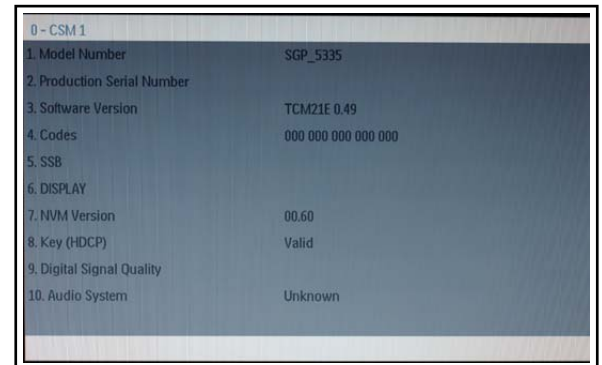
Contents of CSM

Figure 5-8 CSM Menu -1-



Figure 5-9 CSM Menu -2-

Menu Explanation

1. **Model Number.** Type number and region.
2. **Production Serial Number.** Product serial no.
3. **SW Version.** Software cluster and version is displayed (TC = TCL, M2 = MTK2, E = Europe, 0.49 = software version).
4. **Codes.** Error buffer contents.
5. **SSB.** SSB serial number.
6. **DISPLAY.** Display type.
7. **NVM Version.** NVM version.
8. **Key (HDCP) HDMI.** Shows valid or invalid HDCP key when HDMI connected. Else blank.
9. **Digital Signal Quality.** Quality of antenna signal in %.
10. **Audio System.** Audio system (Mono/Stereo/NICAM)
11. n.a.
12. **Video Format.** Video format.
13. **Stand-by μ P SW ID.** SW version Stand-by microprocessor.

How to exit

Press “MENU” on the RC-transmitter.

5.2.4 Blinking LED Procedure

The software is capable of identifying different kinds of errors. Because it is possible that more than one error can occur over time, an error buffer is available which is capable of storing the last five errors that occurred. This is useful if the OSD is not working properly.

Errors can also be displayed by the blinking LED procedure. The method is to repeatedly let the front LED pulse with as many pulses as the error code number, followed by a period of 1.5 seconds in which the LED is "off". Then this sequence is repeated.

Any RC command terminates the sequence. Error code LED blinking is in white colour.

Example: the contents of the error buffer is "013 007 000 000 000".

After entering SDM, the following occurs:

- 1 long blink of 5 seconds to start the sequence
- 1 medium blink of 3 seconds and then 3 short blinks followed by a pause of 1.5 seconds
- 7 short blinks followed by a pause of 1.5 seconds
- 1 long blink of 1.5 seconds to finish the sequence.

The sequence starts again with 12 short blinks.

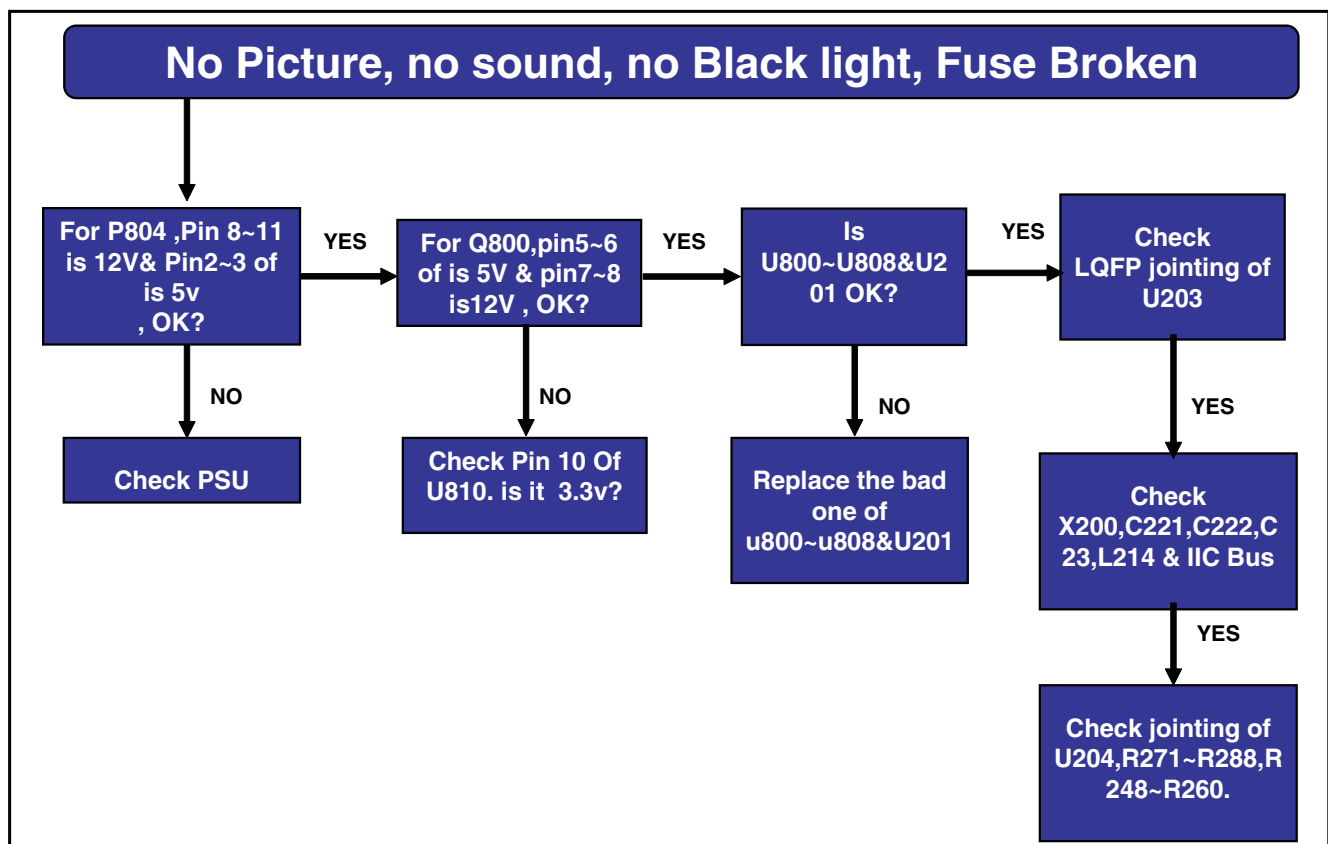
5.3 Error Codes

The error code buffer contains all errors detected since the last time the buffer was erased. The buffer is written from left to right. When an error occurs that is not yet in the error code buffer, it is displayed at the left side and all other errors shift one position to the right.

Basically there are six kind of errors:

Code	Description	Detection method	Type
0	no error		
3	μP Control	I ² C-bus	Error log + blinking in SDM
4	General I ² C bus Error	I ² C-bus	Protection + spontaneous
7	Tuner	I ² C-bus	Error log + blinking in SDM
8	Demodulator	I ² C-bus	Error log + blinking in SDM
10	MT8295	I ² C-bus	Error log + blinking in SDM
13	HDMI switch	I ² C-bus	Error log + blinking in SDM

5.4 Fault Finding



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Figure 5-10 No picture, no sound, no backlight, fuse broken (19", 20", and 22" sets)

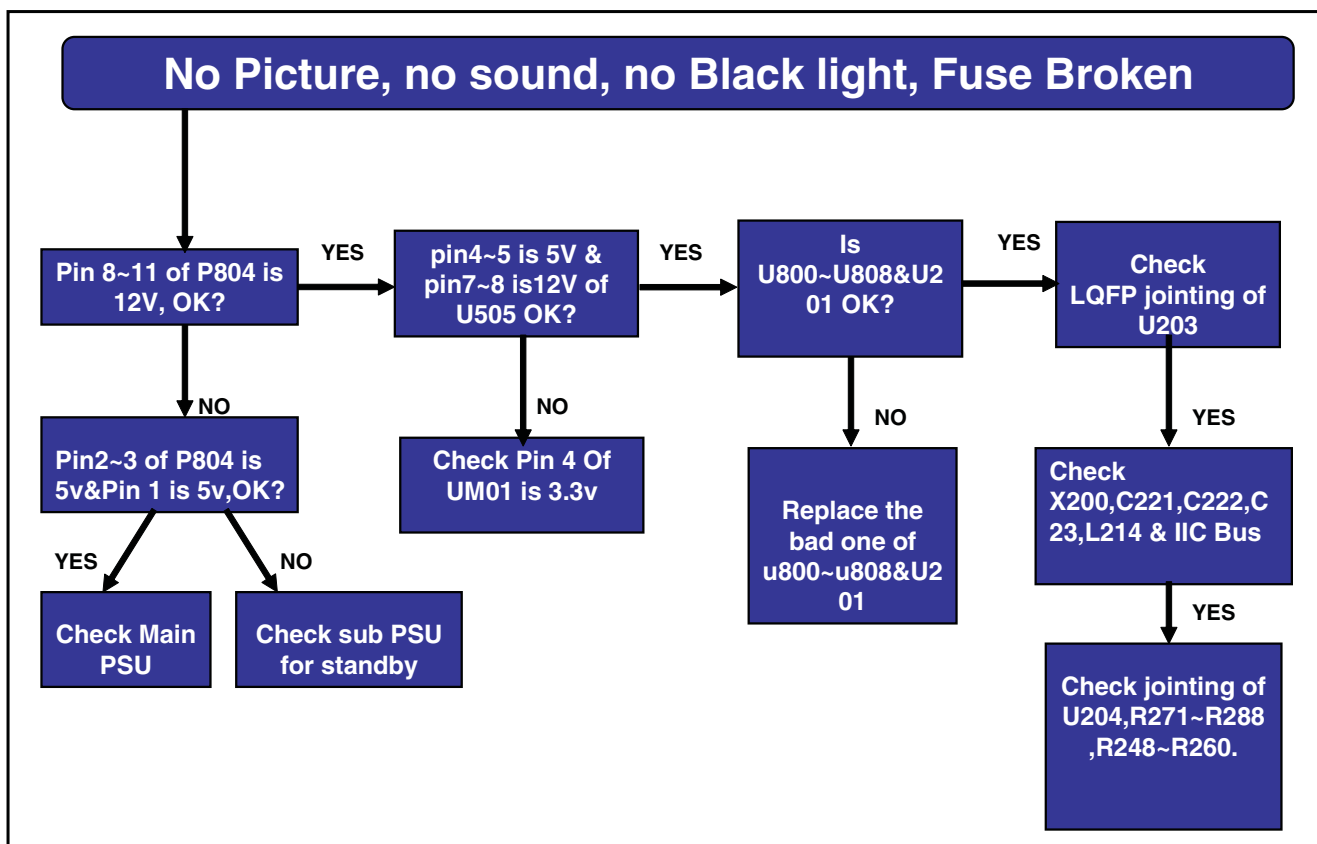
I_17950_010.eps
080508

Figure 5-11 No Picture, no sound, no backlight, fuse broken (26" sets)

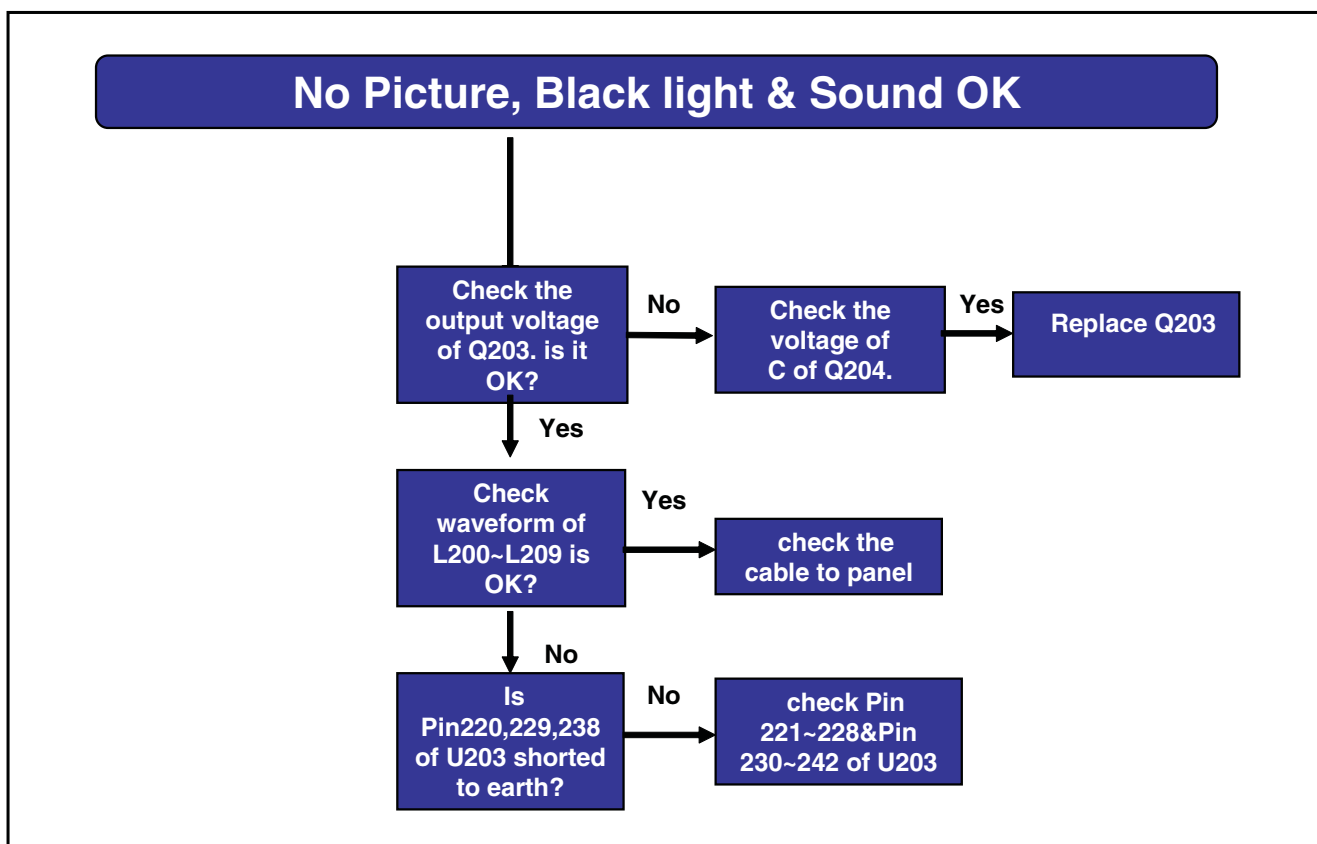
I_17950_011.eps
080508

Figure 5-12 No Picture, Backlight & Sound OK

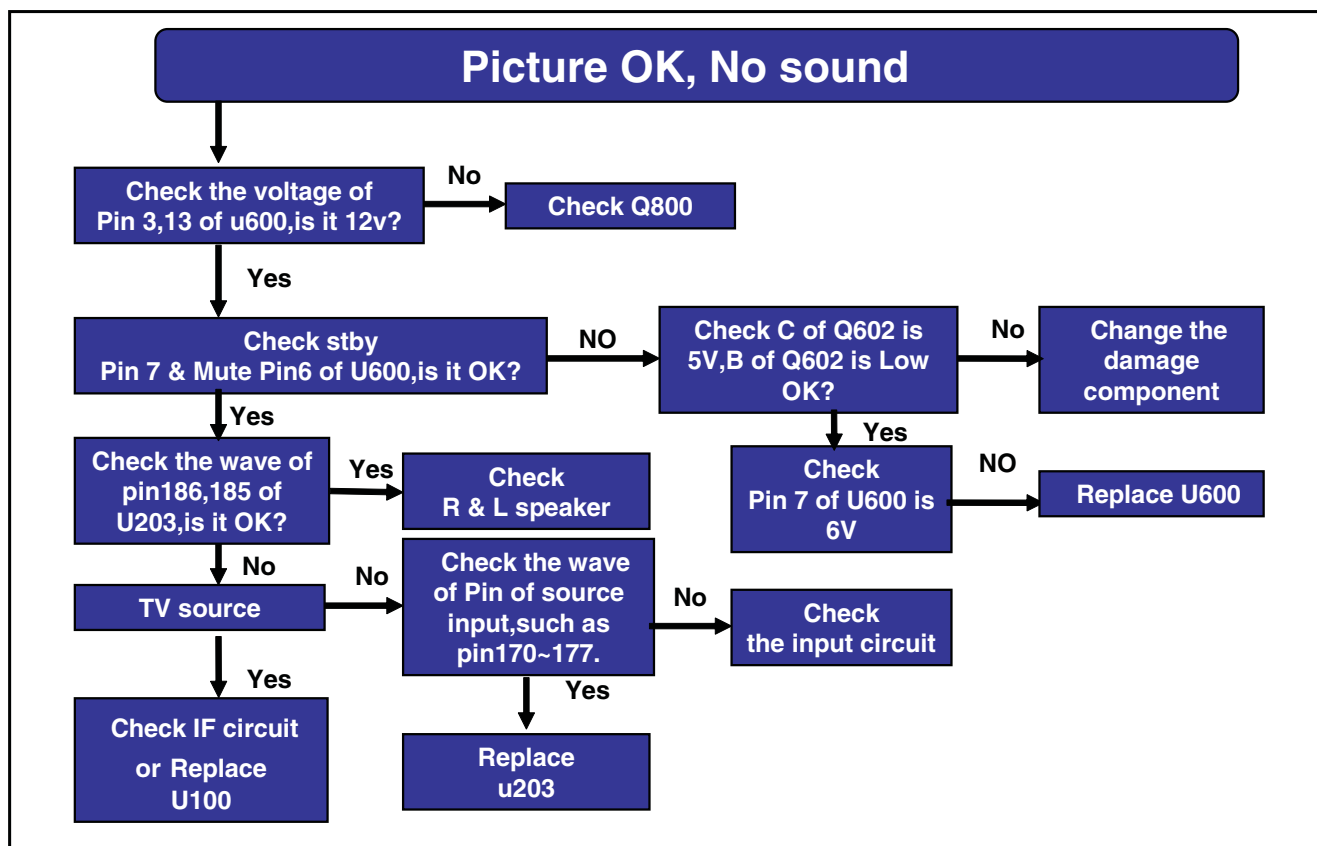
I_17950_012.eps
080508

Figure 5-13 Picture OK, No sound

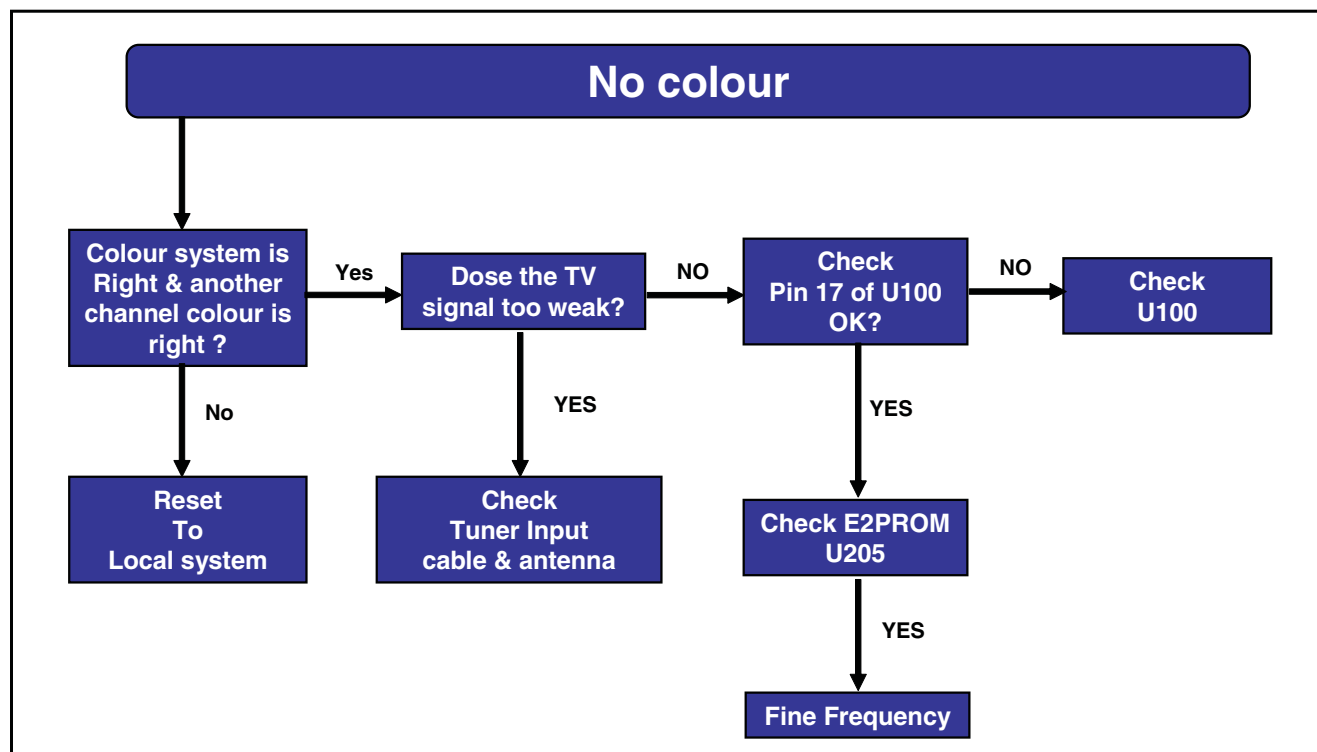
I_17950_013.eps
080508

Figure 5-14 No colour

5.5 Service Tools

5.5.1 ComPair

Introduction

ComPair (Computer Aided Repair) is a Service tool for Philips Consumer Electronics products, and offers the following:

1. ComPair helps you to quickly get an understanding on how to repair the chassis in a short and effective way.
2. ComPair allows very detailed diagnostics and is therefore capable of accurately indicating problem areas. You do not have to know anything about I²C or UART commands yourself, because ComPair takes care of this.
3. ComPair speeds up the repair time since it can automatically communicate with the chassis (when the uP is working) and all repair information is directly available.
4. ComPair features TV software upgrade possibilities.

Specifications

ComPair consists of a Windows based fault finding program and an interface box between PC and the (defective) product. The (new) ComPair II interface box is connected **to the PC** via an USB cable. For the TV chassis, the ComPair interface box and the TV communicate via a bi-directional cable via the service connector(s).

How to Connect

This is described in the ComPair chassis fault finding database.

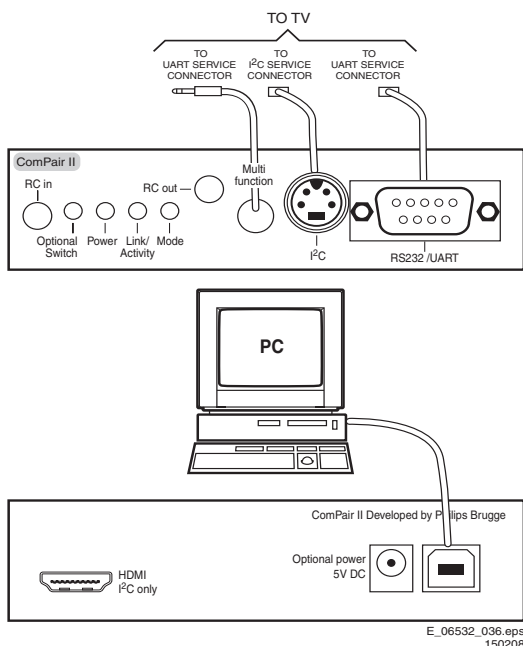


Figure 5-15 ComPair II interface connection

Caution: It is compulsory to connect the TV to the PC as shown in the picture above (with the ComPair interface in between), as the ComPair interface acts as a level shifter. If one connects the TV directly to the PC (via UART), ICs will be blown!

How to Order

ComPair II order codes:

- ComPair II interface: 312278591020.
- For latest software see Philips Service website.
- ComPair UART interface cable: 312278591070.

Note: If you encounter any problems, contact your local support desk.

5.6 Software Upgrading

5.6.1 Introduction

Software upgrading can be done by ComPair, but also via the USB port. This allows to replacement of a software image in a stand alone set.

5.6.2 Main Software Upgrade

In “normal” conditions, so when there is no major problem with the TV, the main software and the default software upgrade

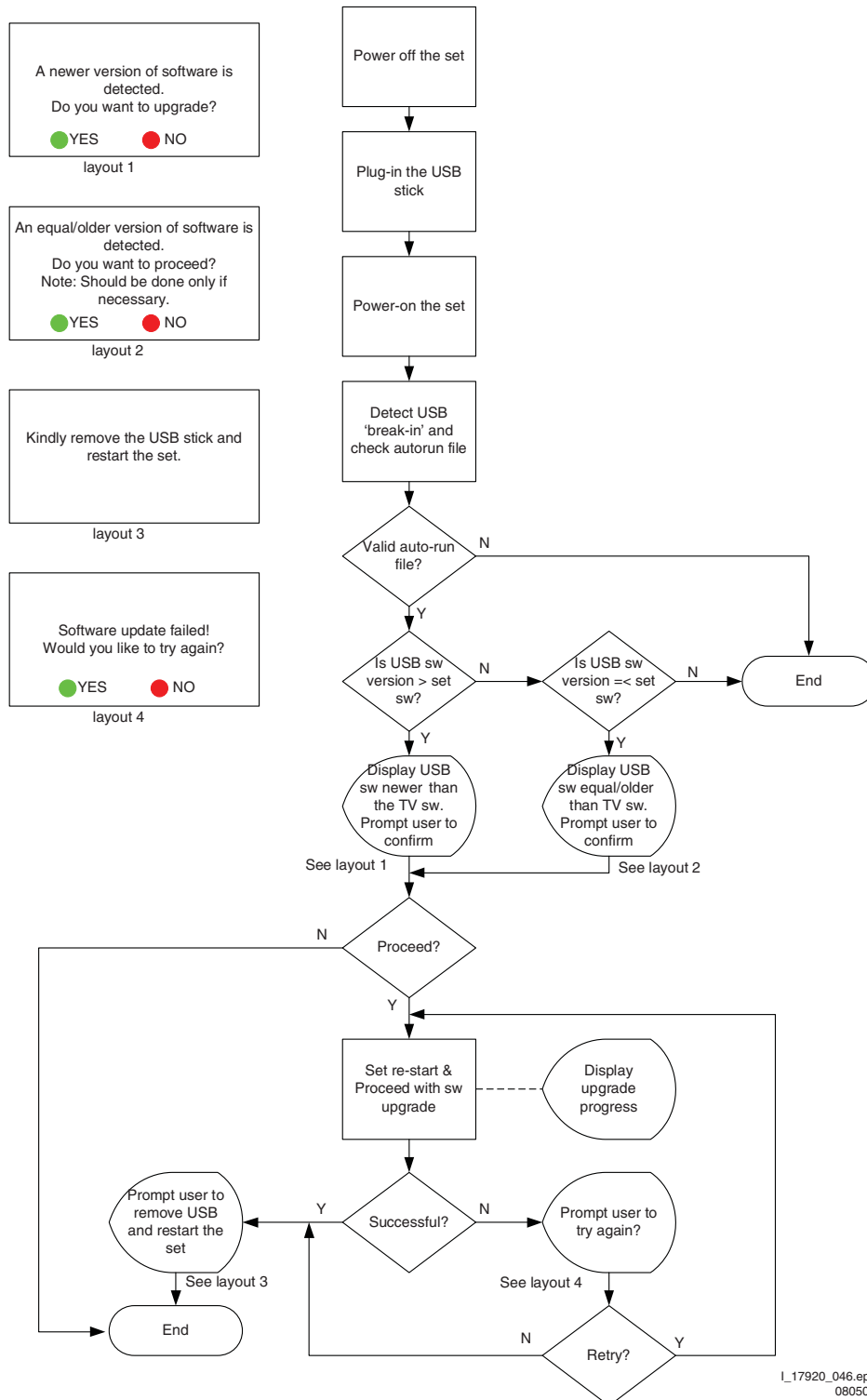
application can be upgraded with the “upgrade.upg”. The software can be downloaded from the CCR website.

The “autorun.upg” file must be placed in the root of your USB stick.

How to upgrade:

1. Copy “upgrade.upg” to the root of your USB stick.
2. Insert USB stick in the side I/O while the set is in “On” mode. The set will restart and the upgrading will start automatically. As soon as the programming is finished, you will get the message that you can remove your USB stick and restart the set.

User software upgrade flow chart

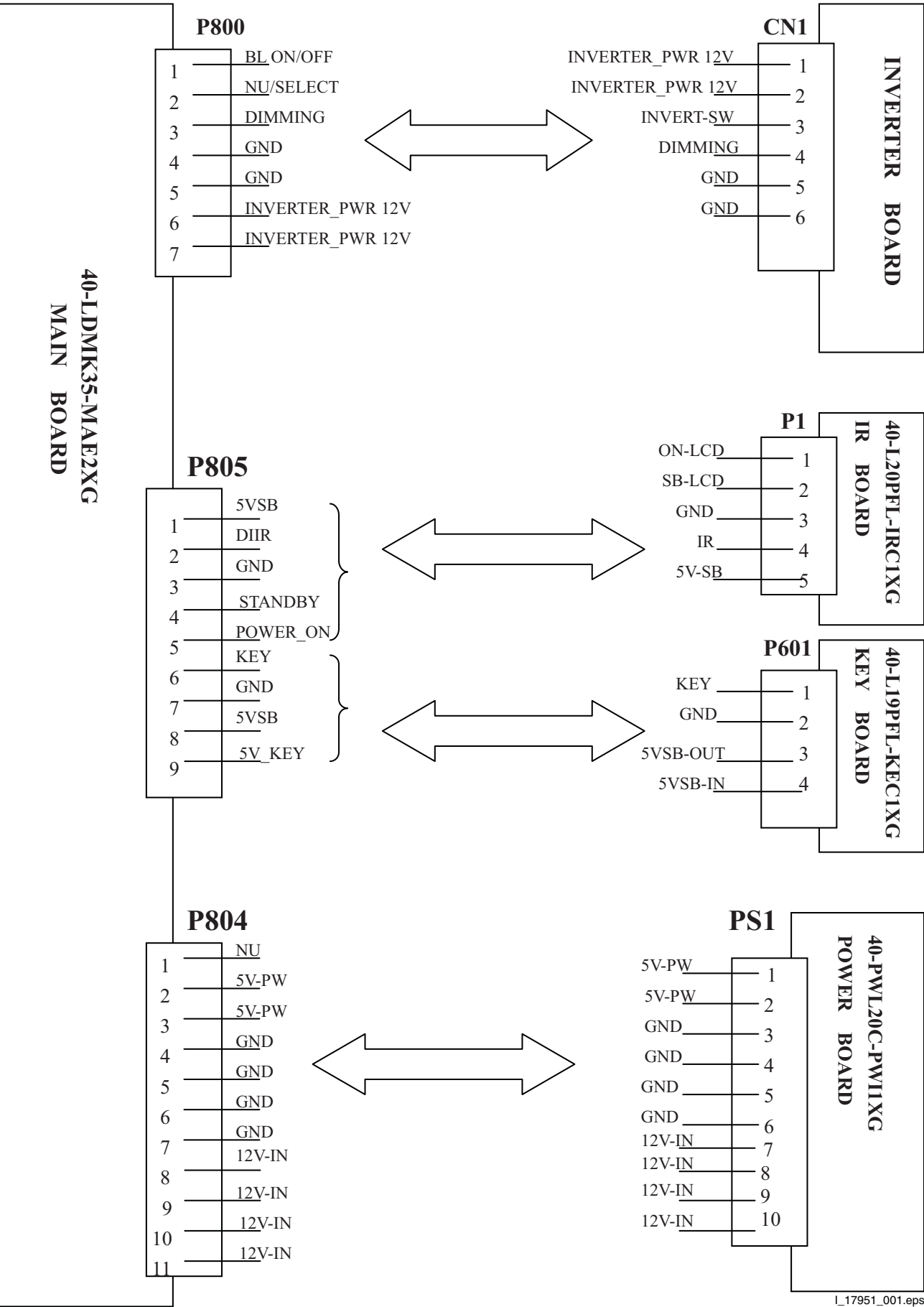


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Figure 5-16 SW upgrade flowchart

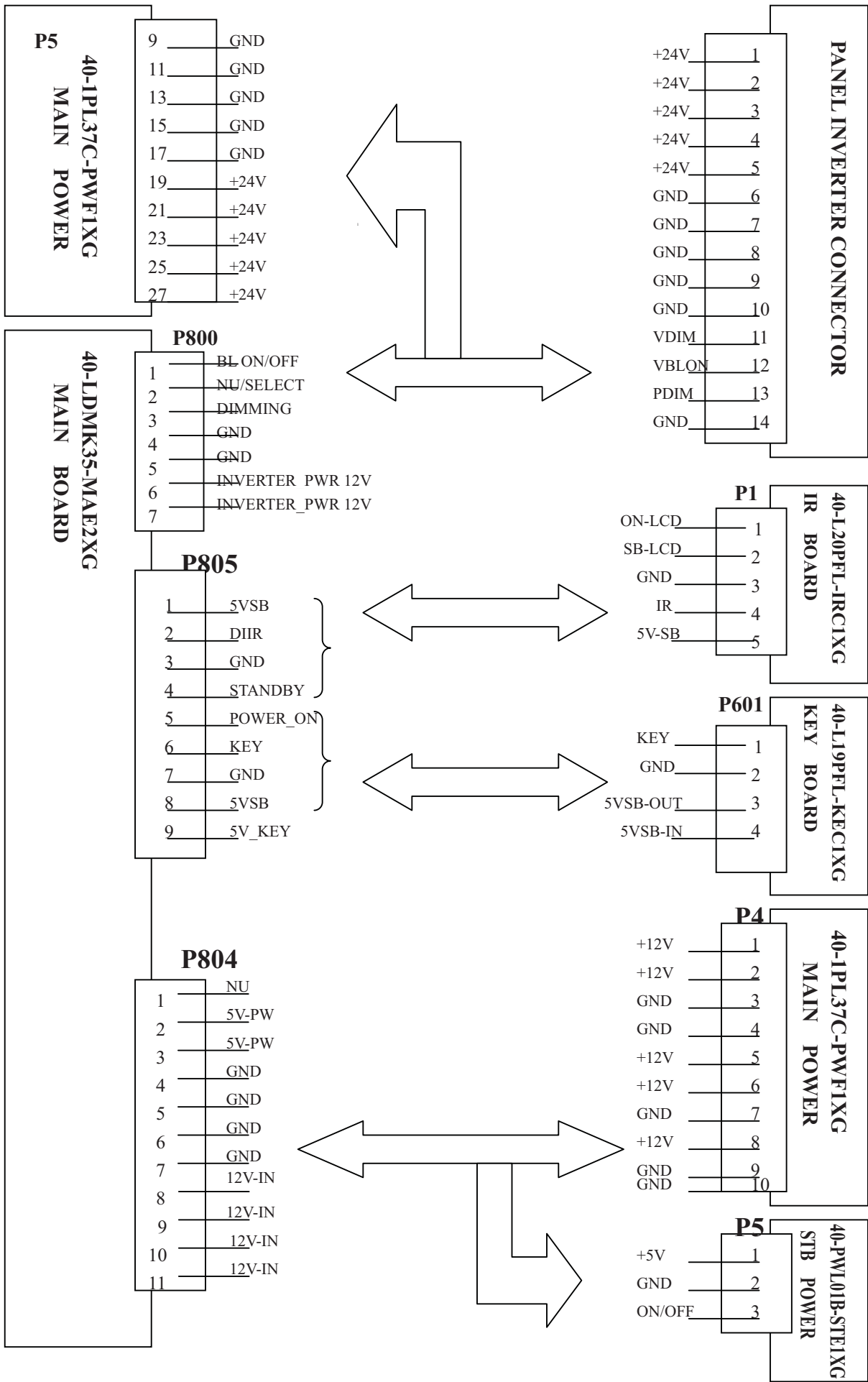
6. Block Diagrams, Test Point Overview, and Waveforms

Wiring Diagram Of Connector 19", 20", and 22"



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050808

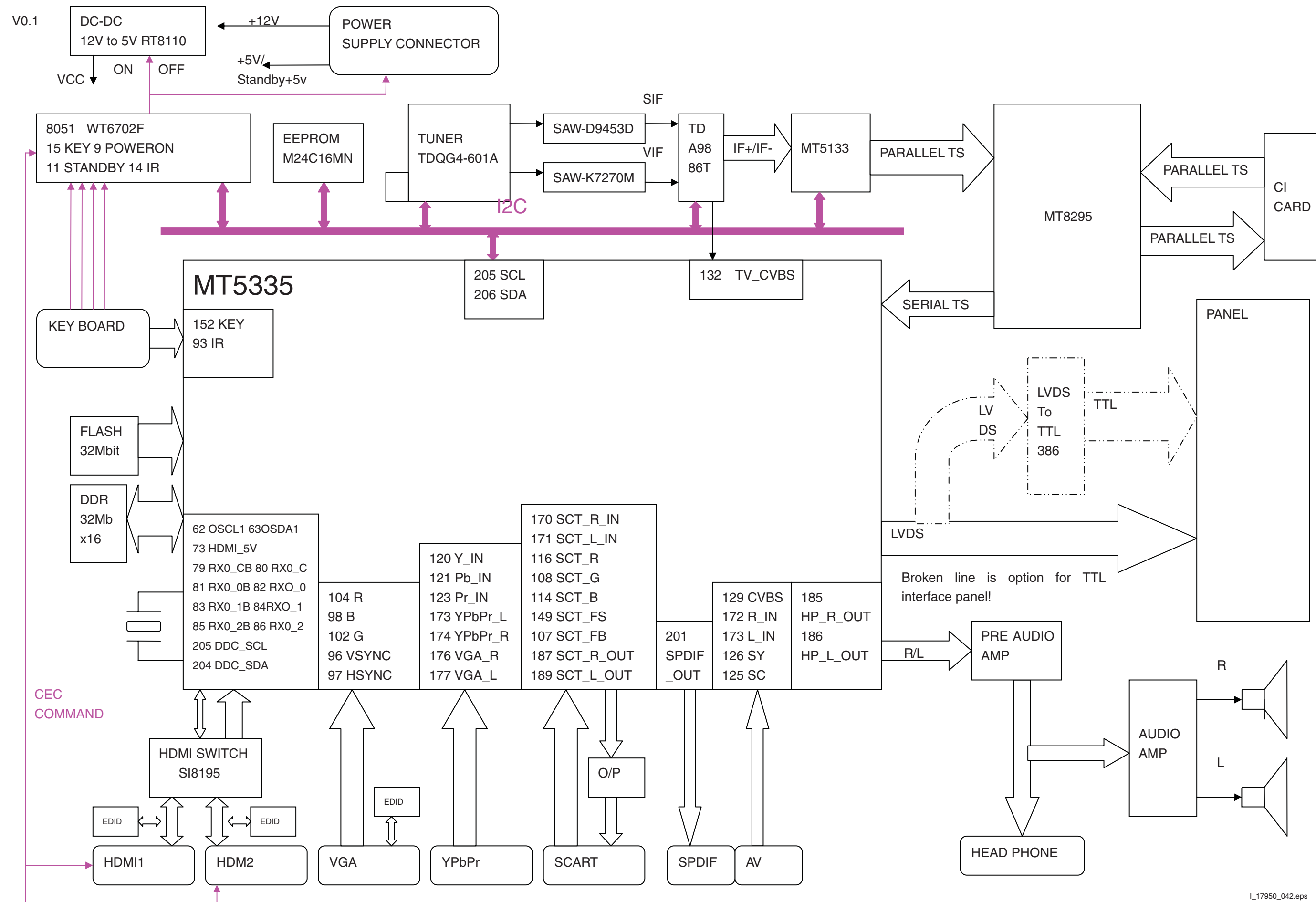
Wiring Diagram Of Connector 26"



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050808

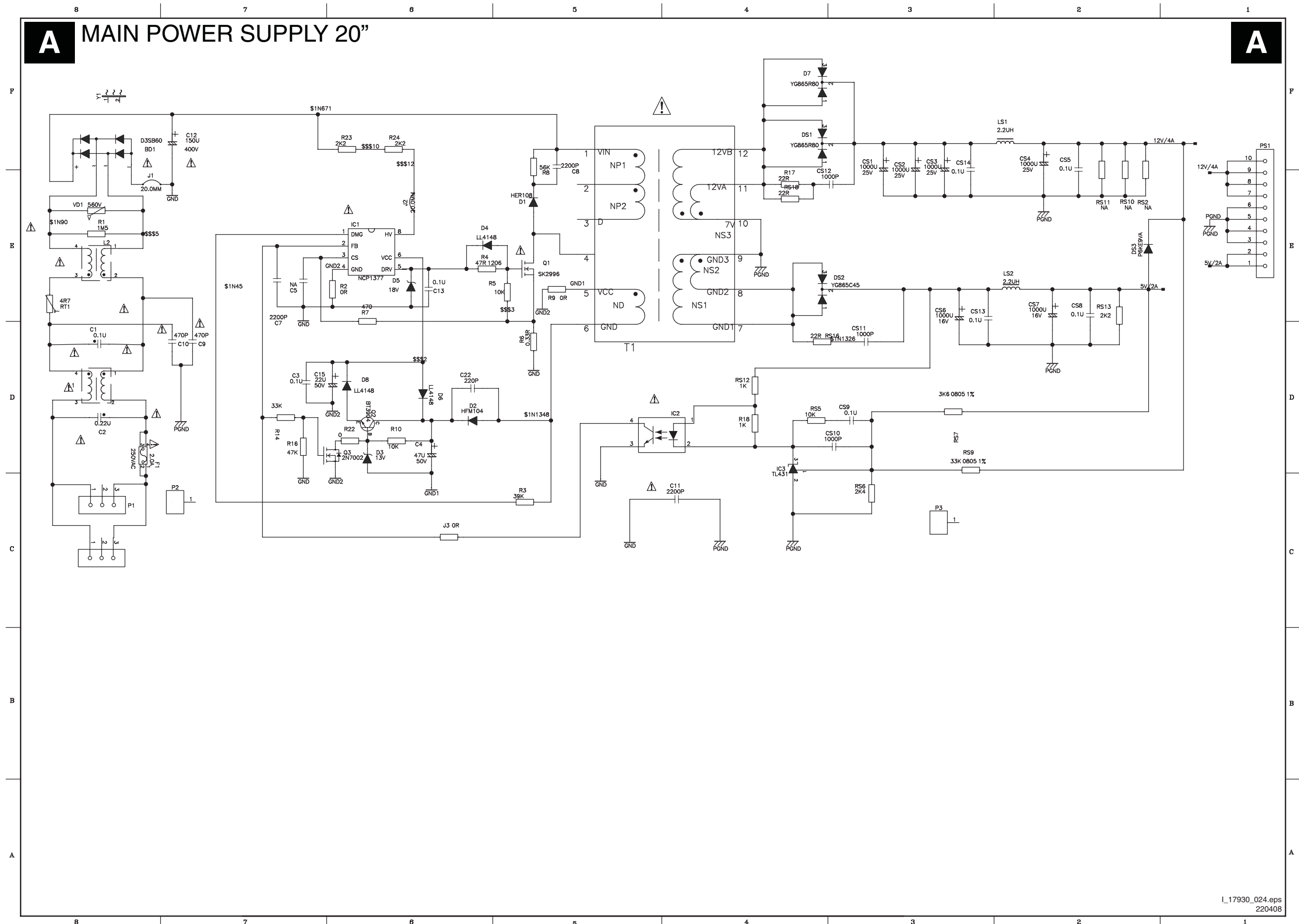
Block Diagram MT5335

MT5335

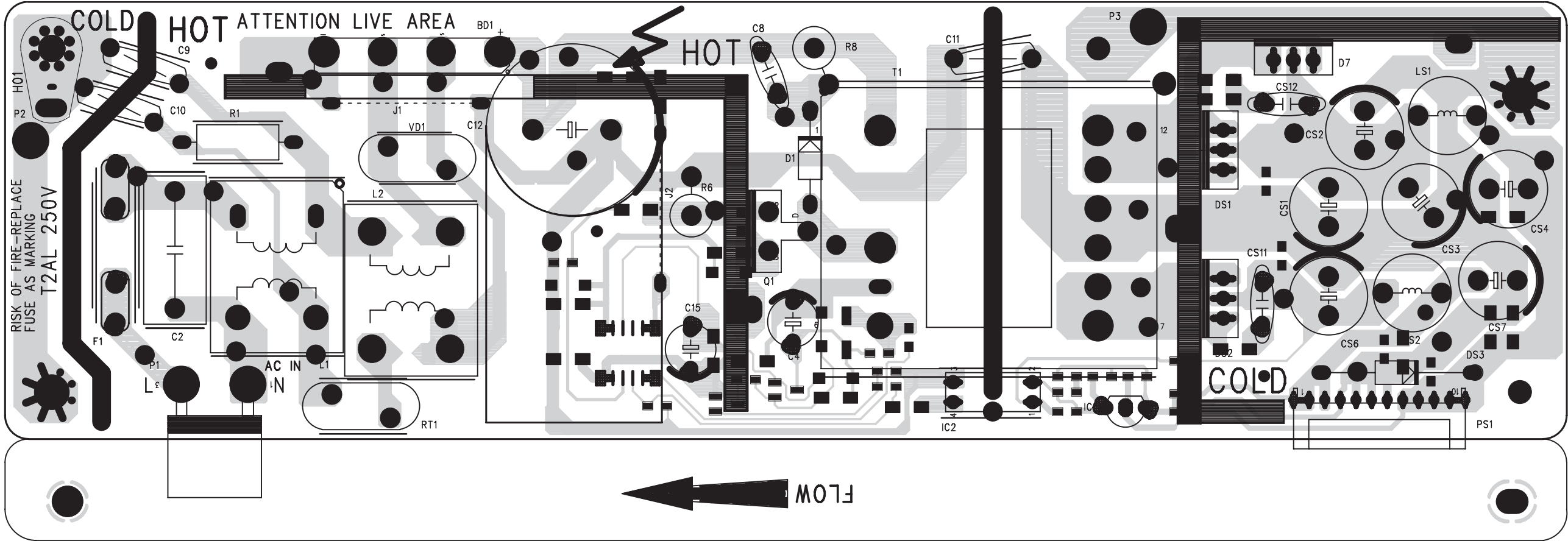


7. Circuit Diagrams and PWB Layouts

Main Power Supply (20")

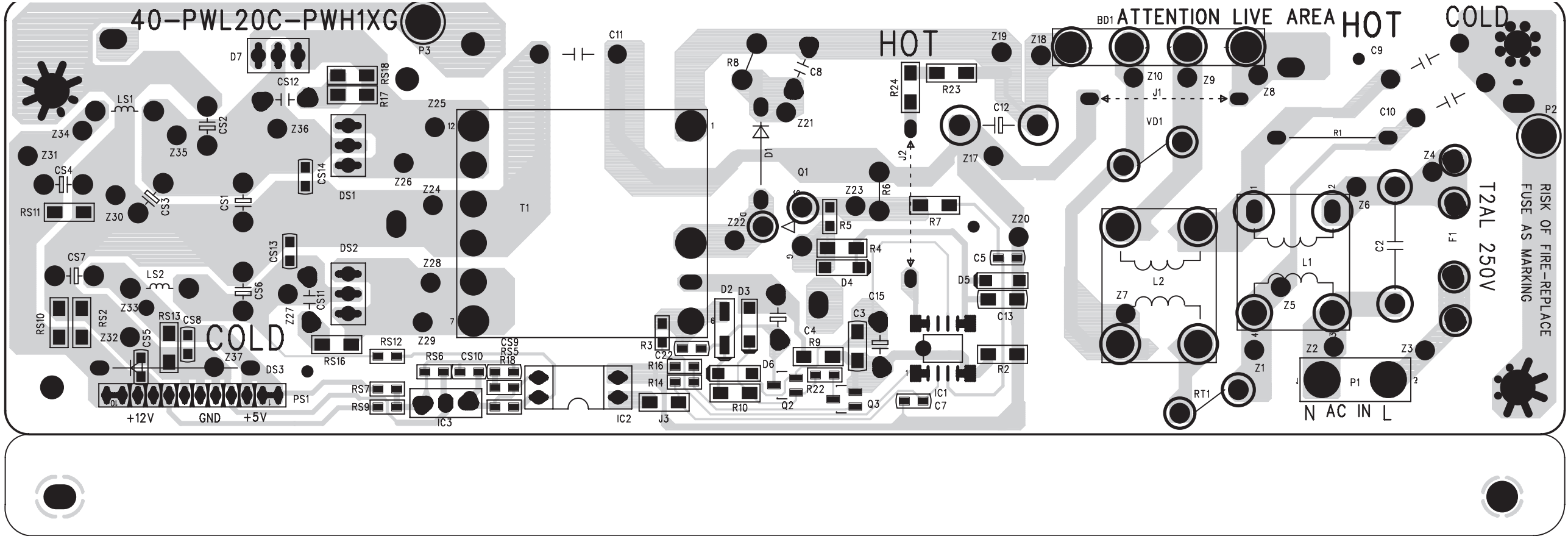


Layout Main Power Supply (20") (Top Side)



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220408

Layout Main Power Supply (20") (Bottom Side)

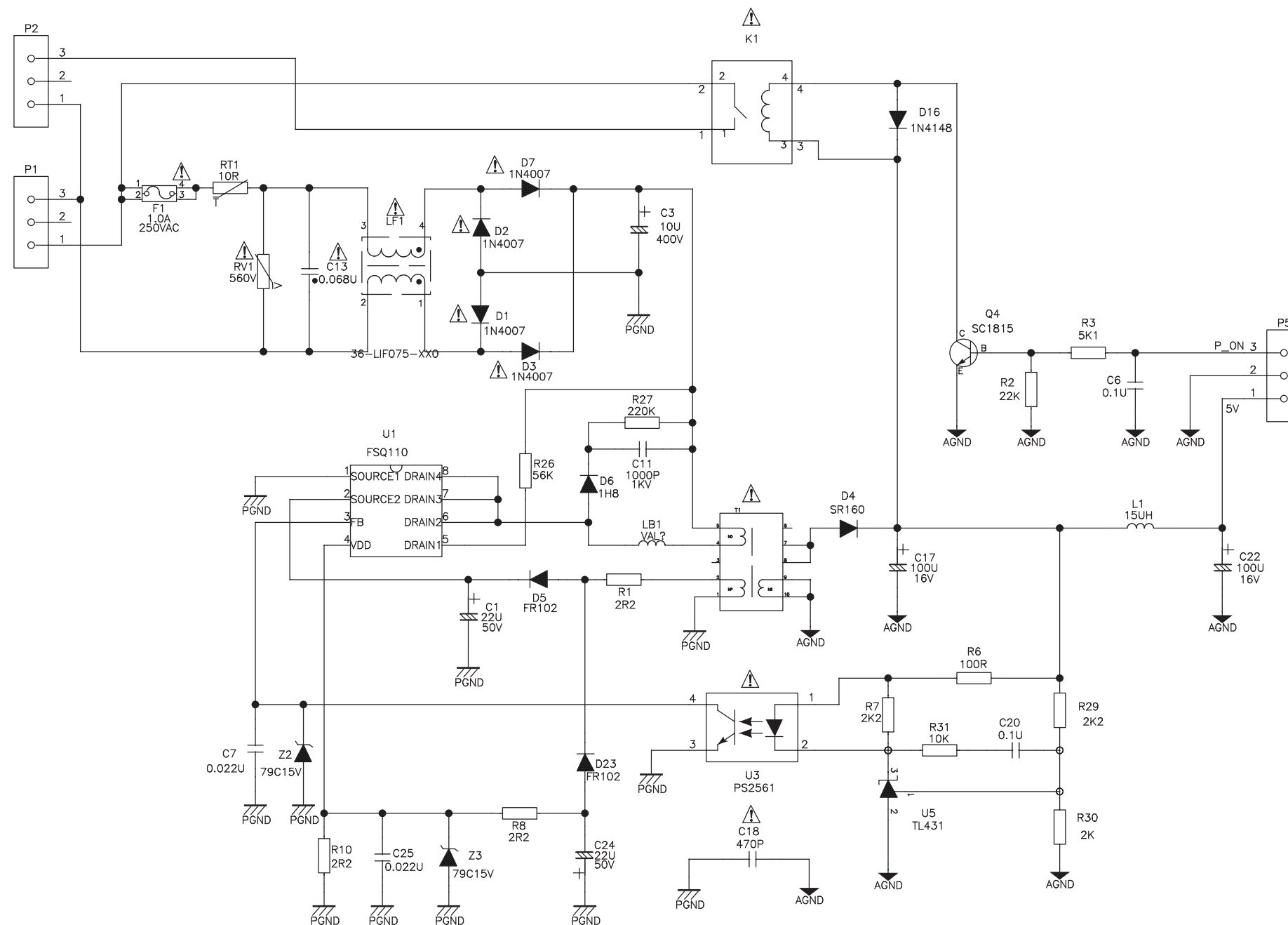


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220408

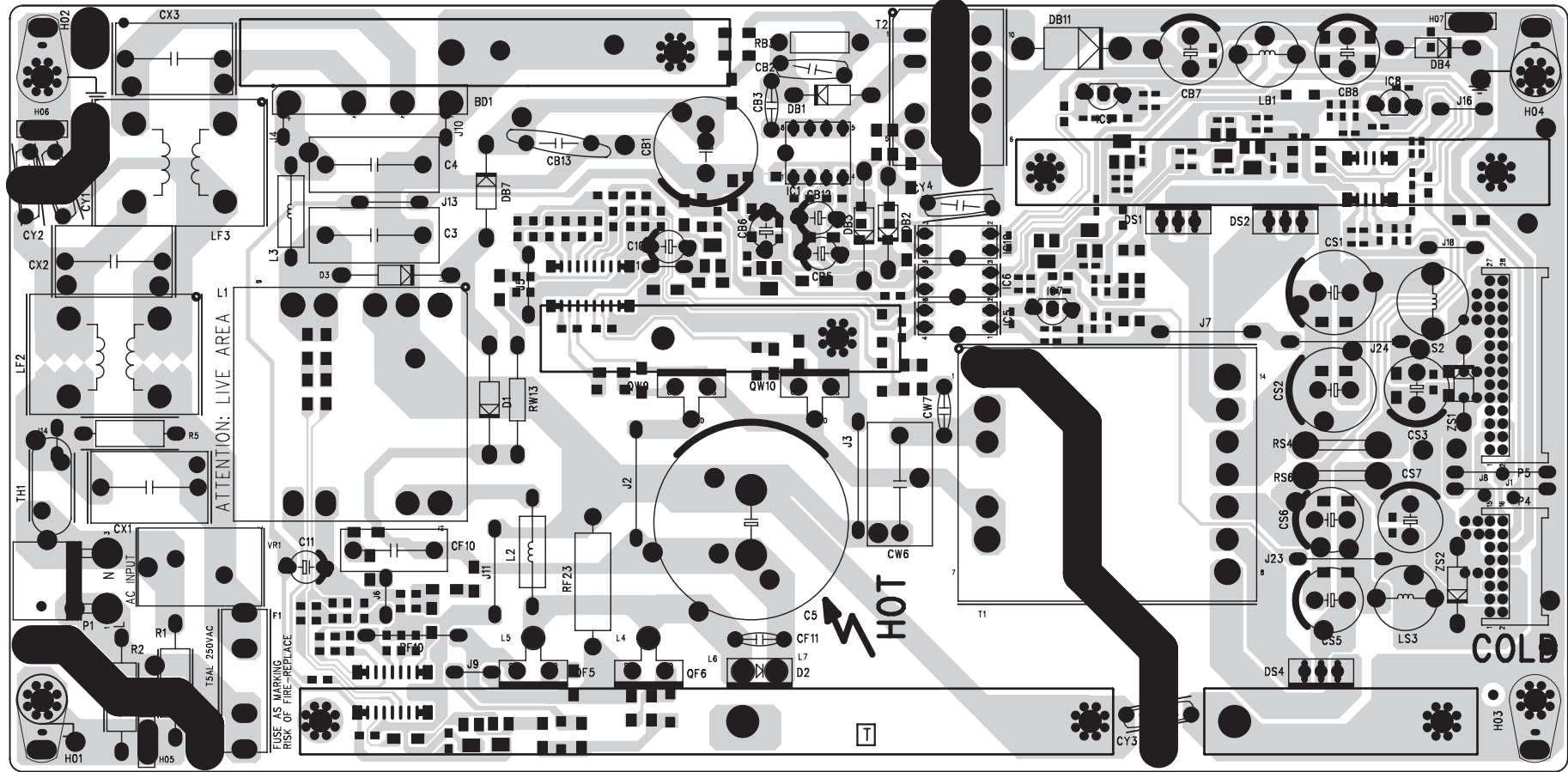
A1 MAIN POWER SUPPLY 26"



Standby Power Supply (26")

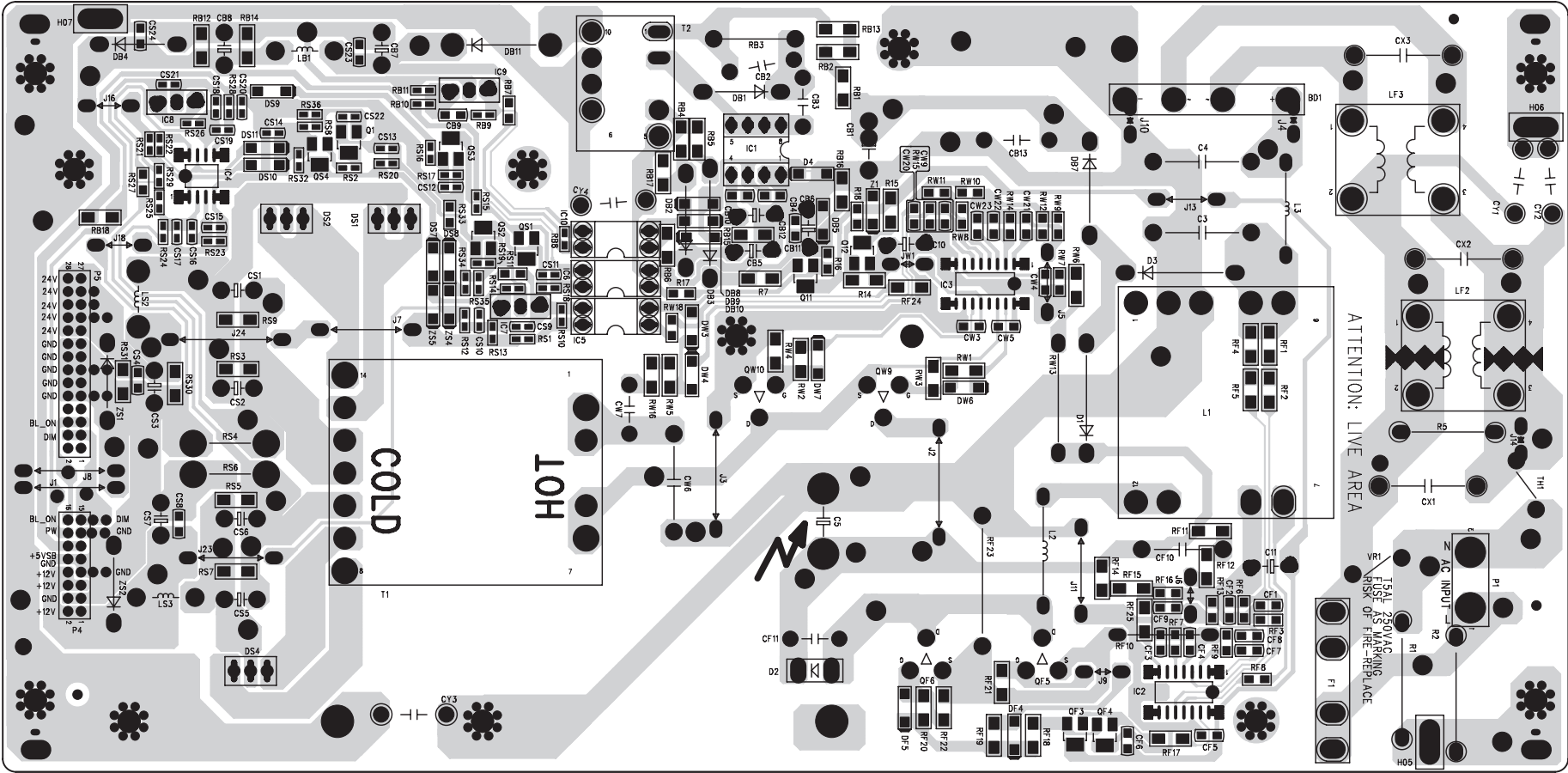
A2 STANDBY POWER SUPPLY 26"**A2**

Layout Main Power Supply (26") (Top Side)



L_17930_029.eps
220408

Layout Main Power Supply (26") (Bottom Side)

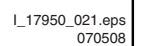


L_17930_030.eps
220408

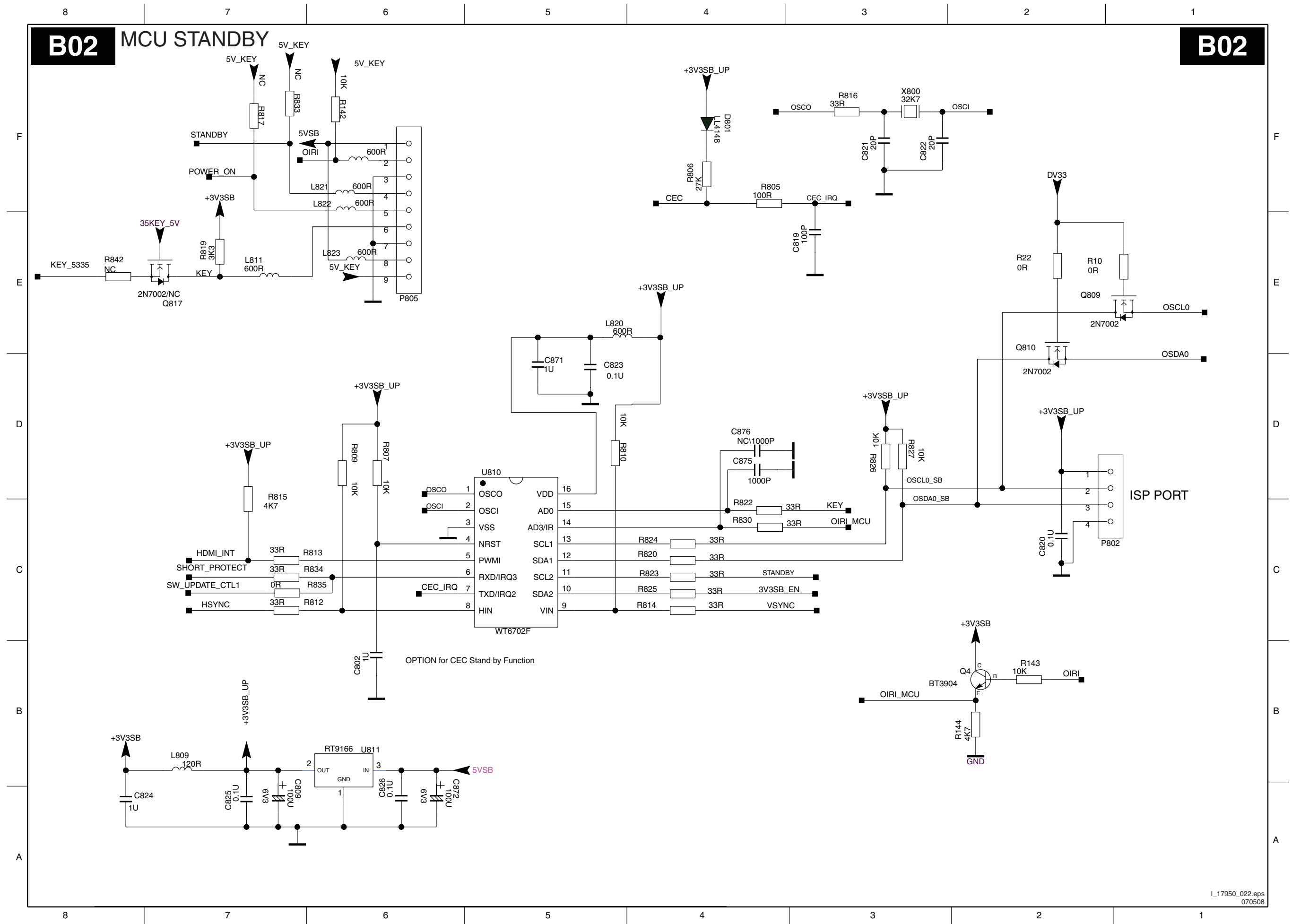
Personal Notes:

B01 TUNER

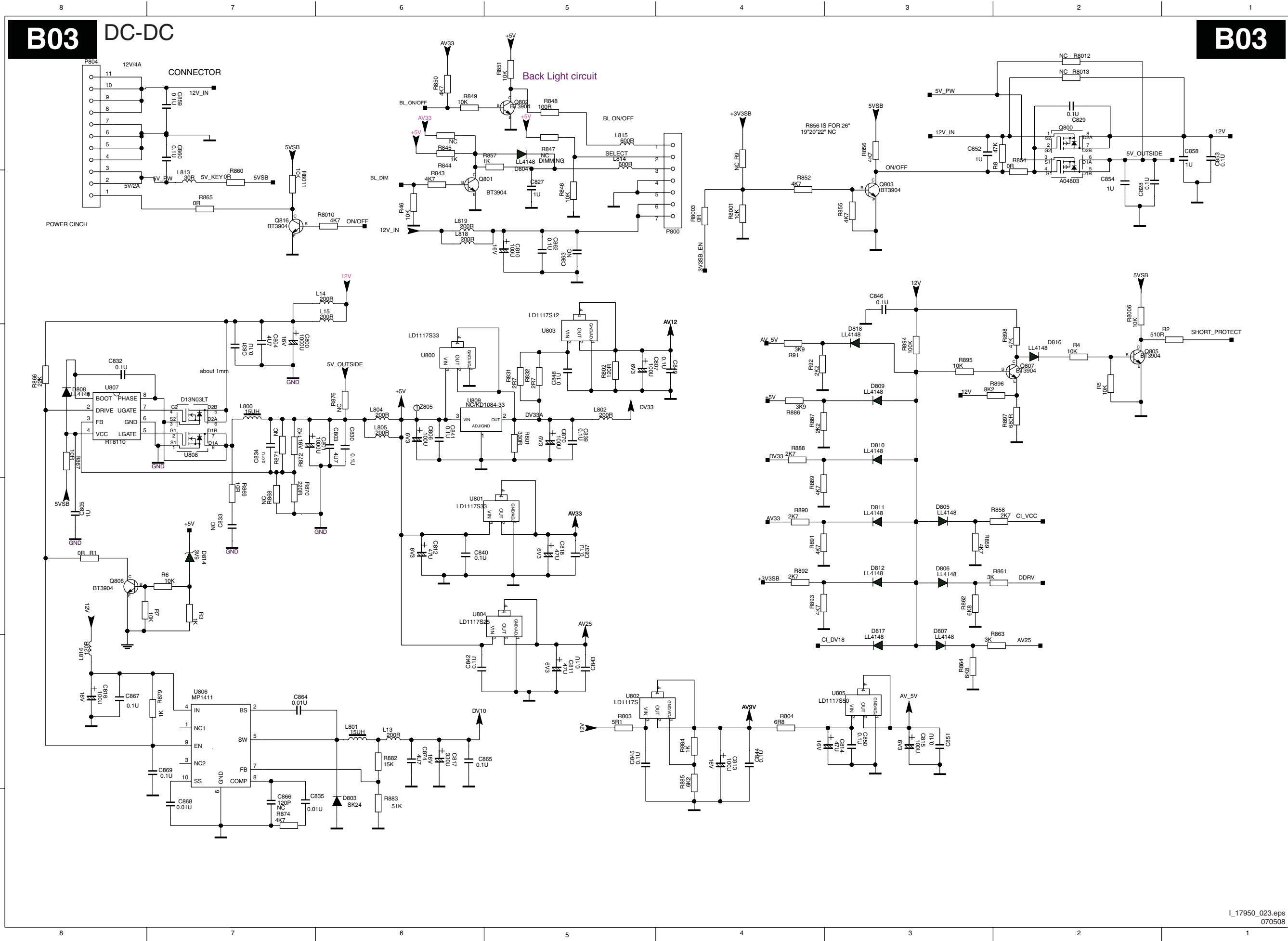
B01



SSB: MCU Standby



SSB: DC / DC

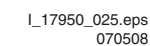


B04 DIGITAL CHANNEL DECODER



DVBT-CI-DECODER

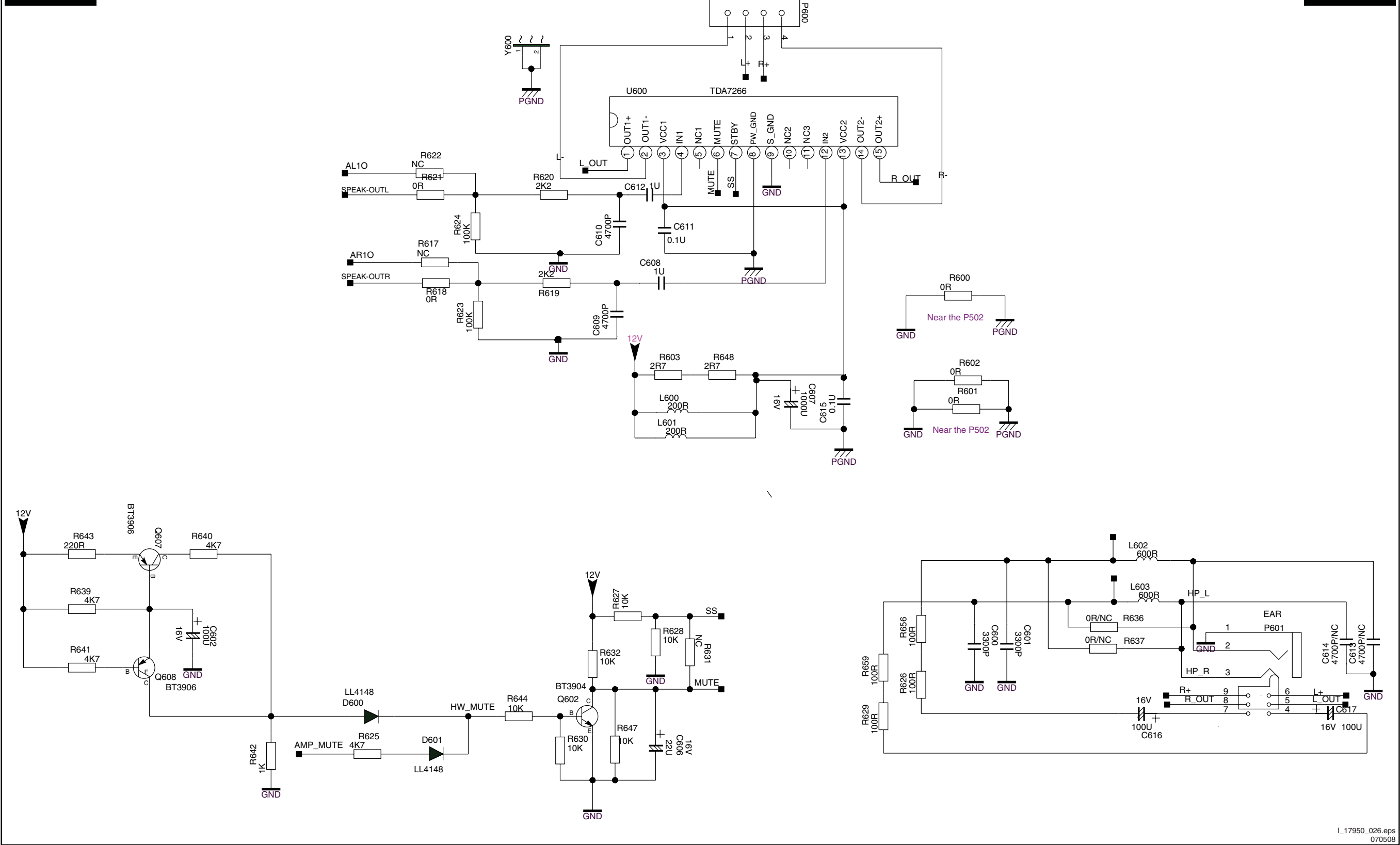
B05



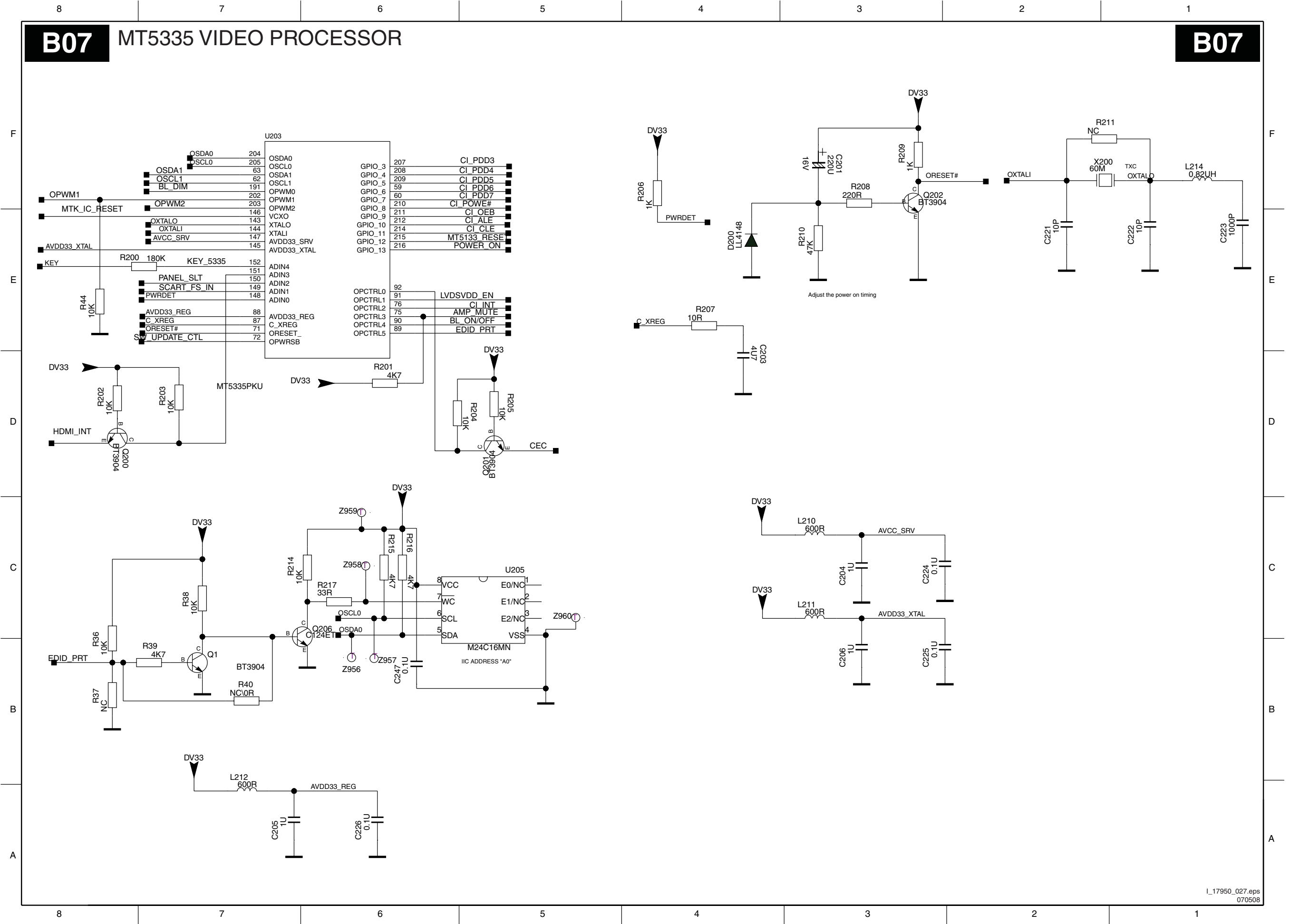
SSB: Audio Amplifier

B06 AUDIO AMPLIFIER

B06



SSB: MT5335 Video Processor

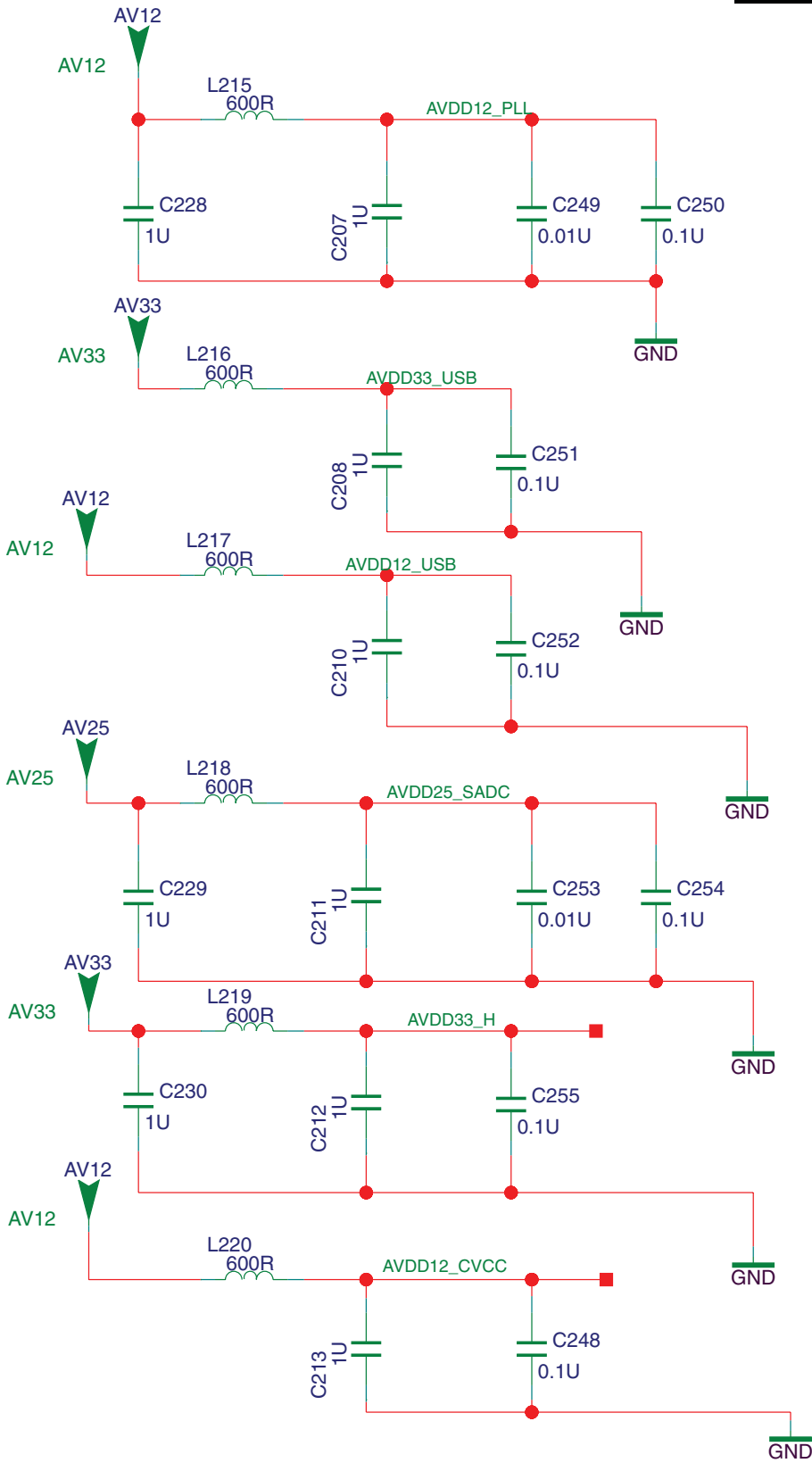
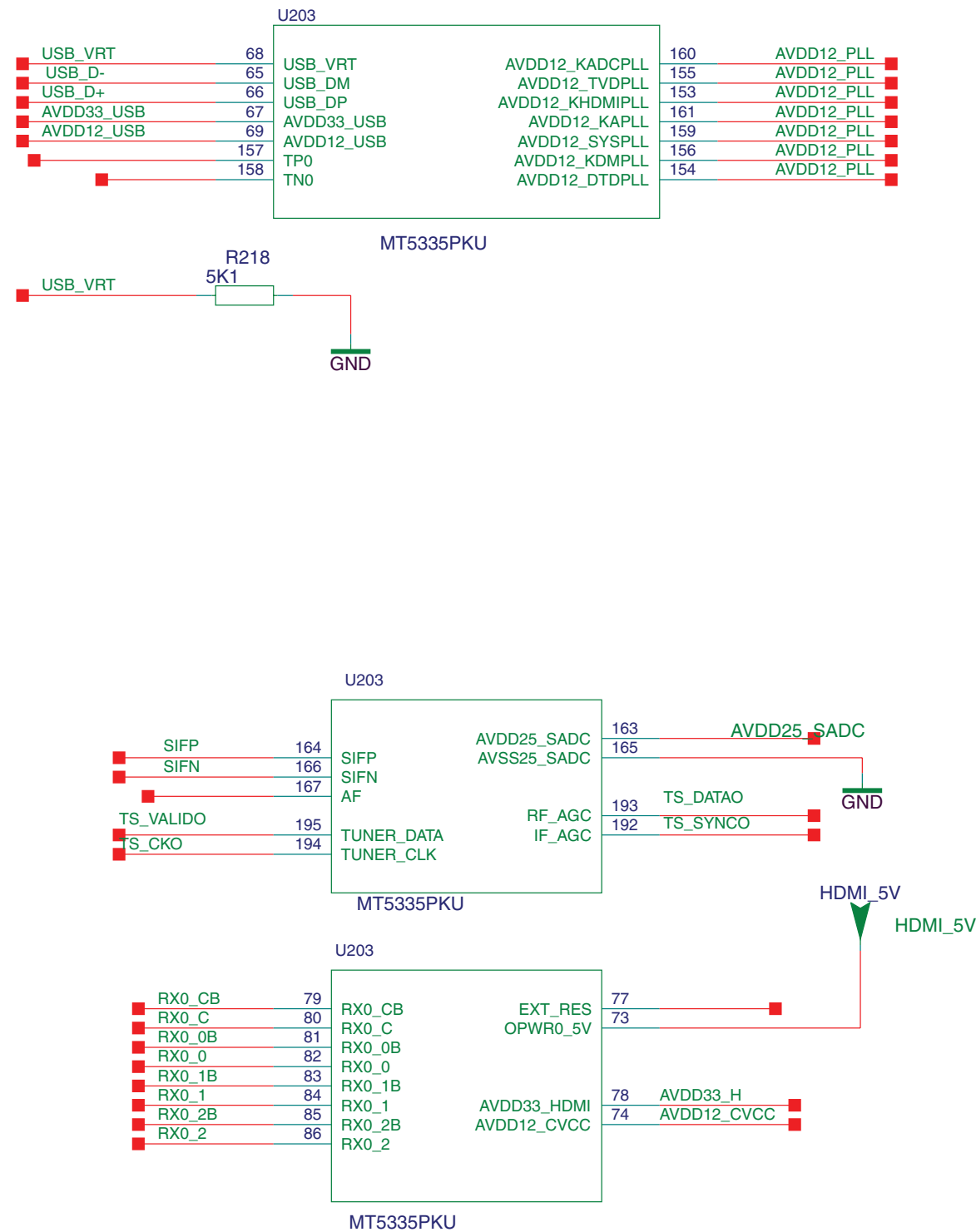


SSB: MT5335 Interface USB/HDMI

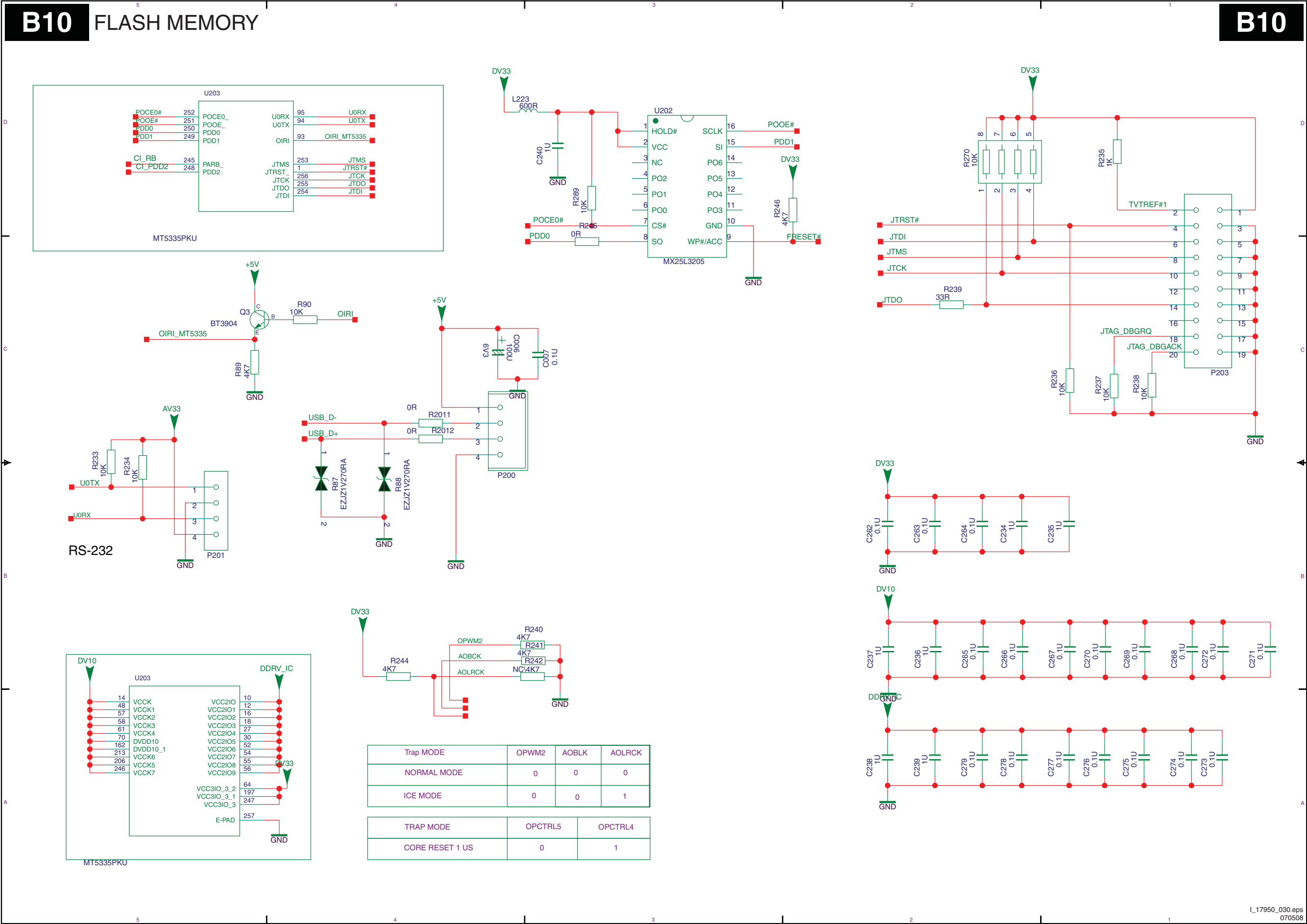
B08

MT5335 INTERFACE - USB, HDMI

B08



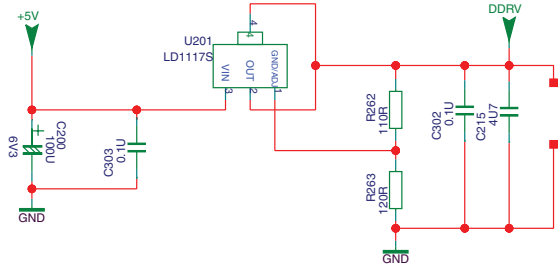
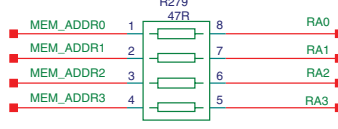
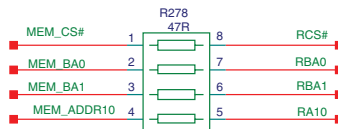
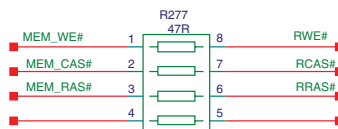
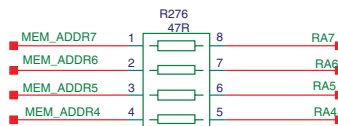
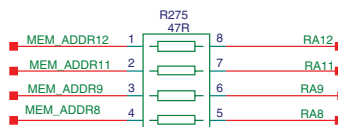
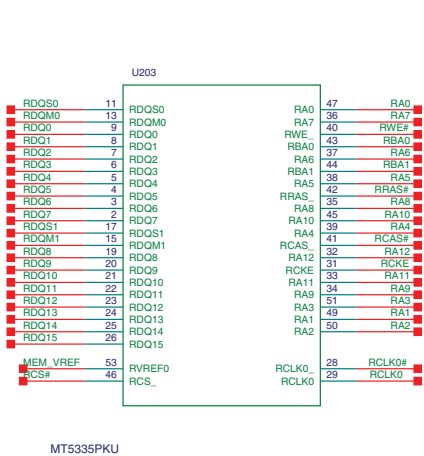
SSB: Flash Memory

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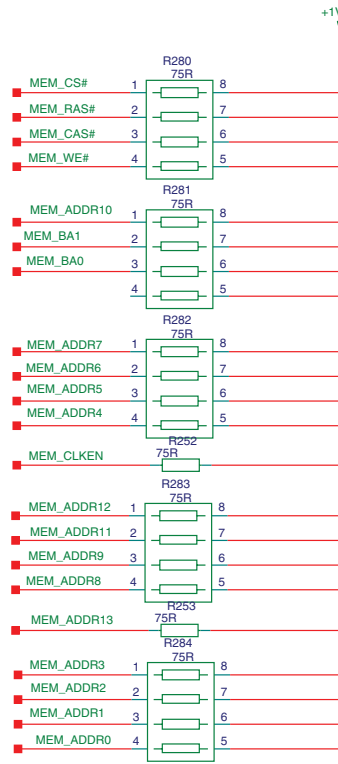
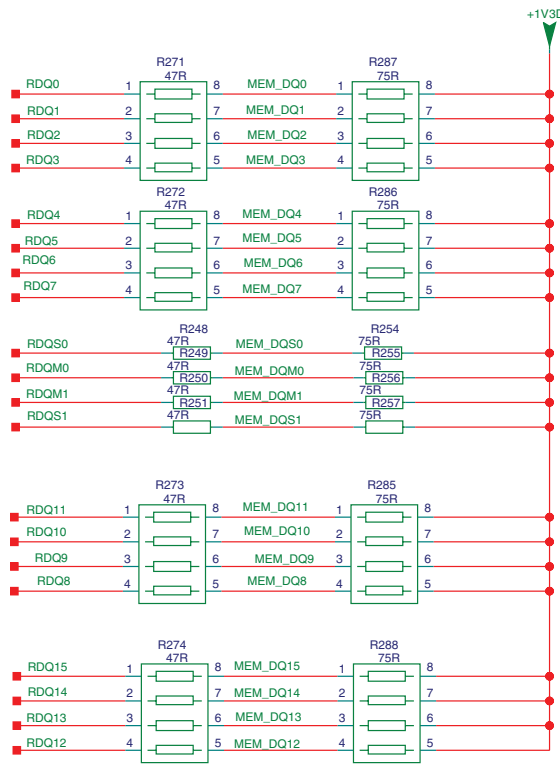
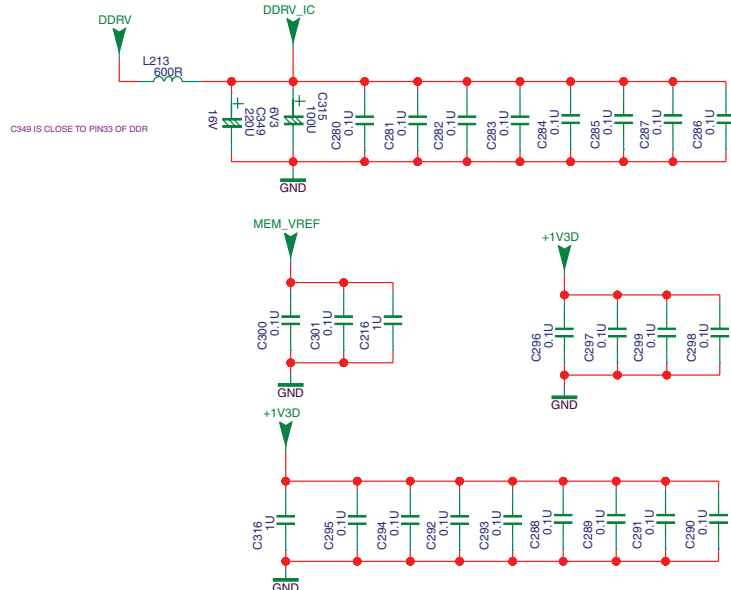
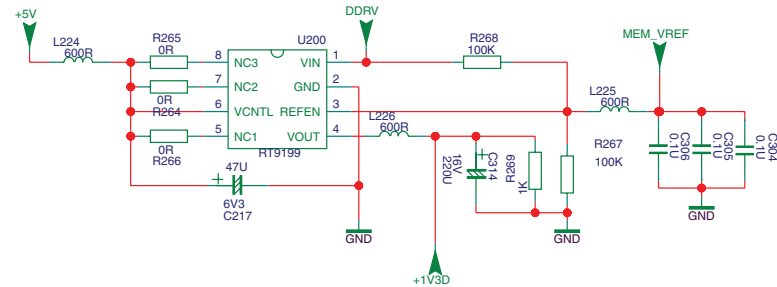
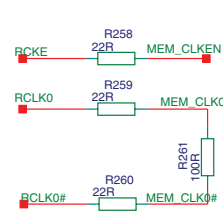
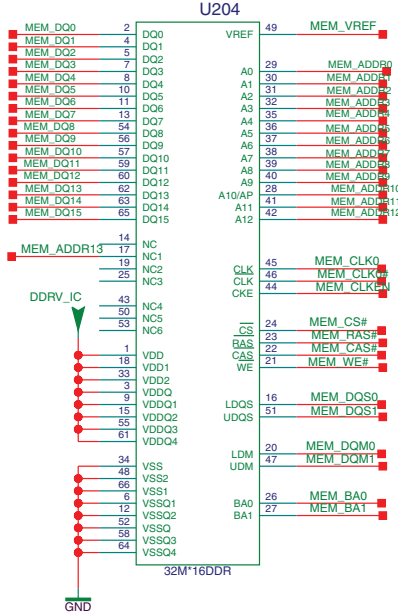
SSB: SDRAM

B11 SDRAM

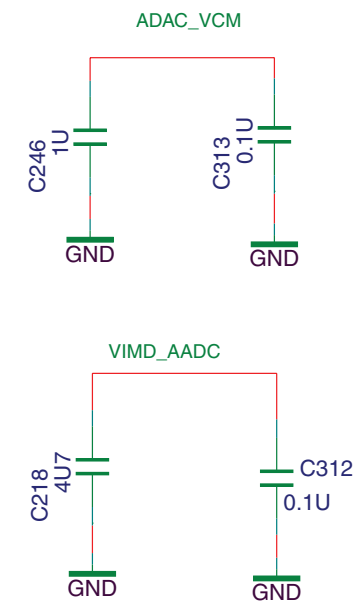
B11



$1.25 \times (1 + 120/110) = 2.6V$



B12



B13 DIGITAL-ANALOG-CONVERTER

B13

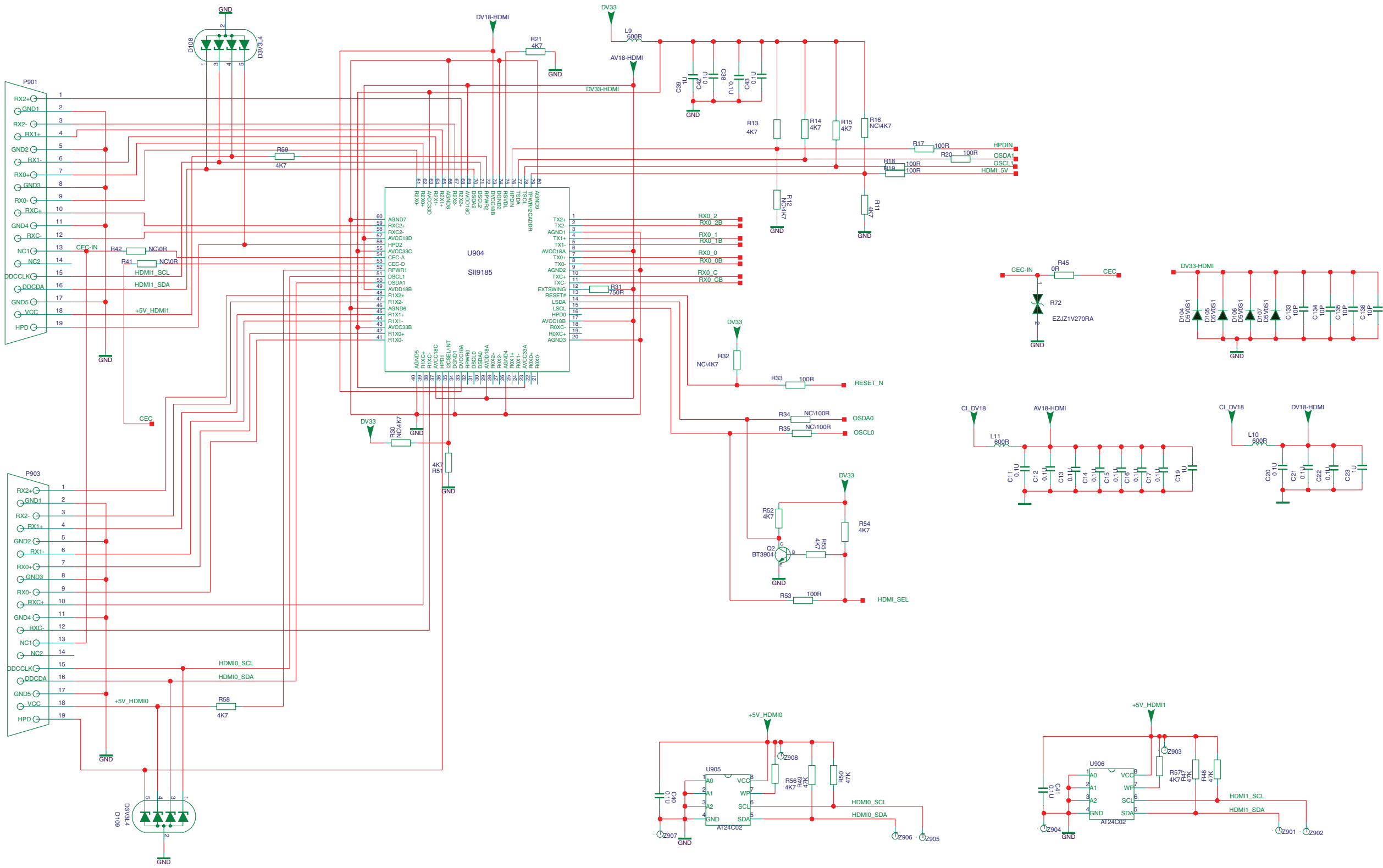


SSB: HDMI Switch

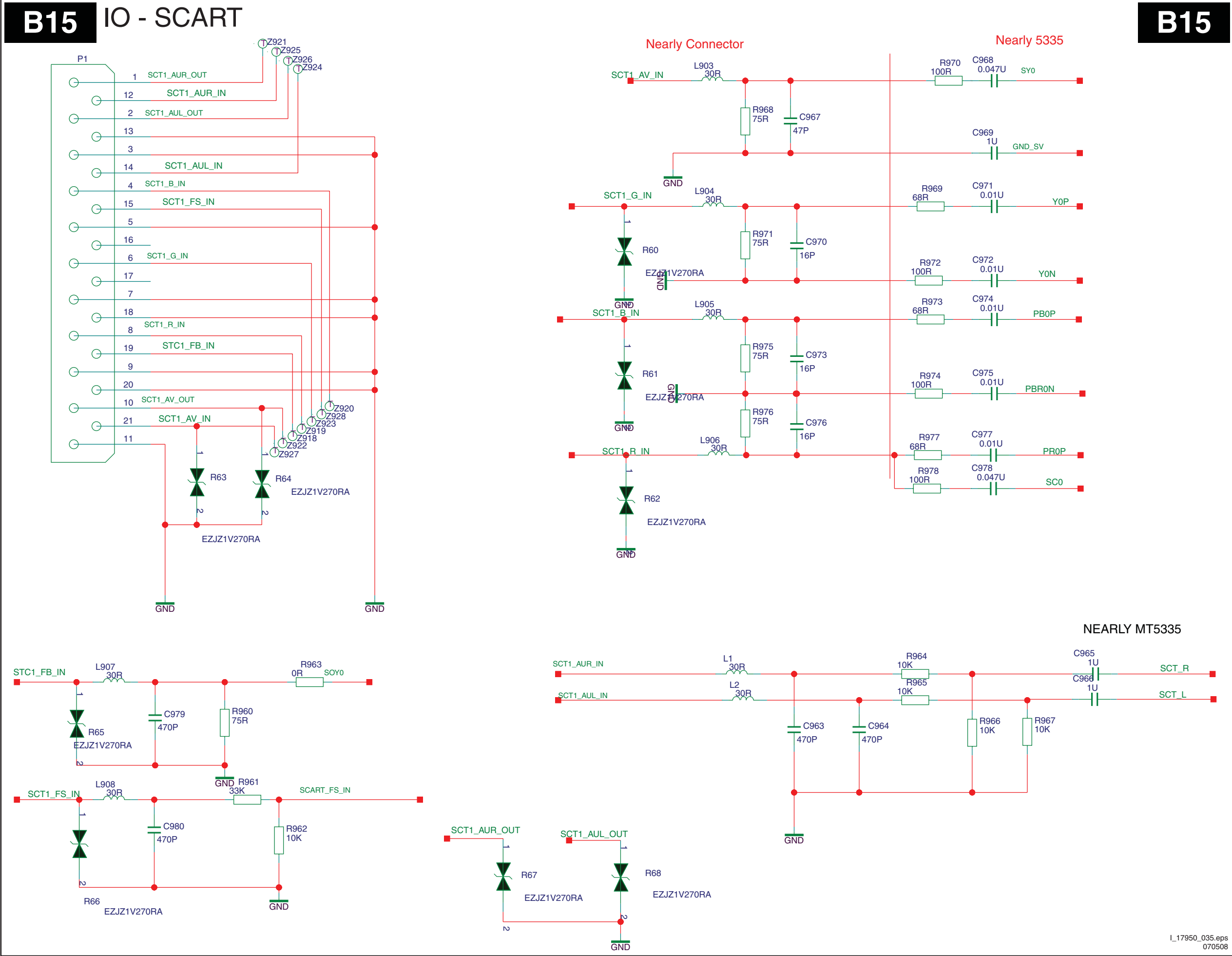
B14

HDMI SWITCH

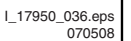
B14



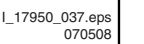
SSB: I/O Scart



B16 IO - SIDE AV, SVIDEO, AUDIO AV_5V



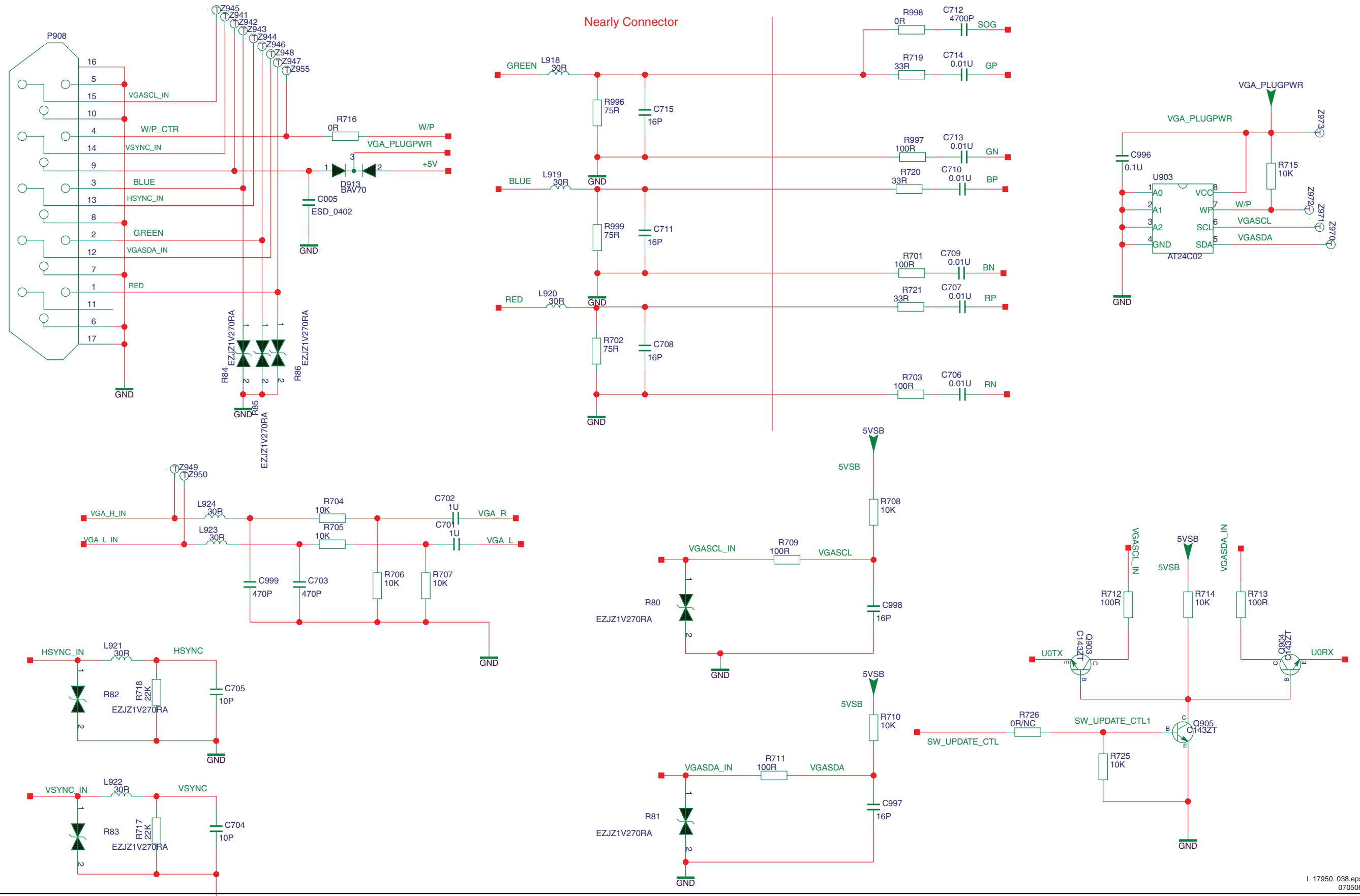
B17 MT5335 INTERFACE - YPBPR, VGA



SSB: I/O VGA

B18 IO - VGA

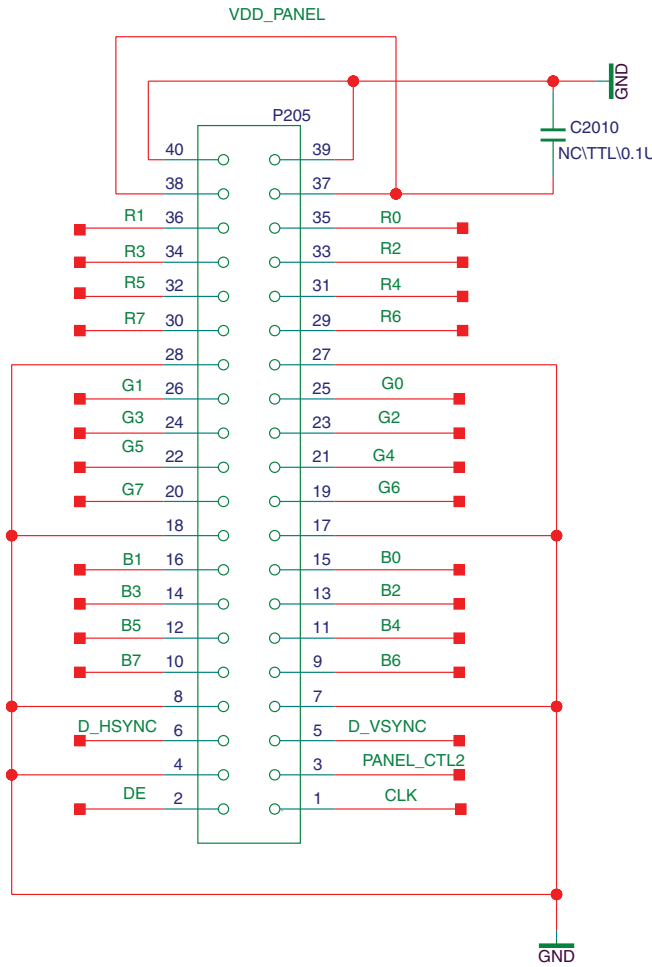
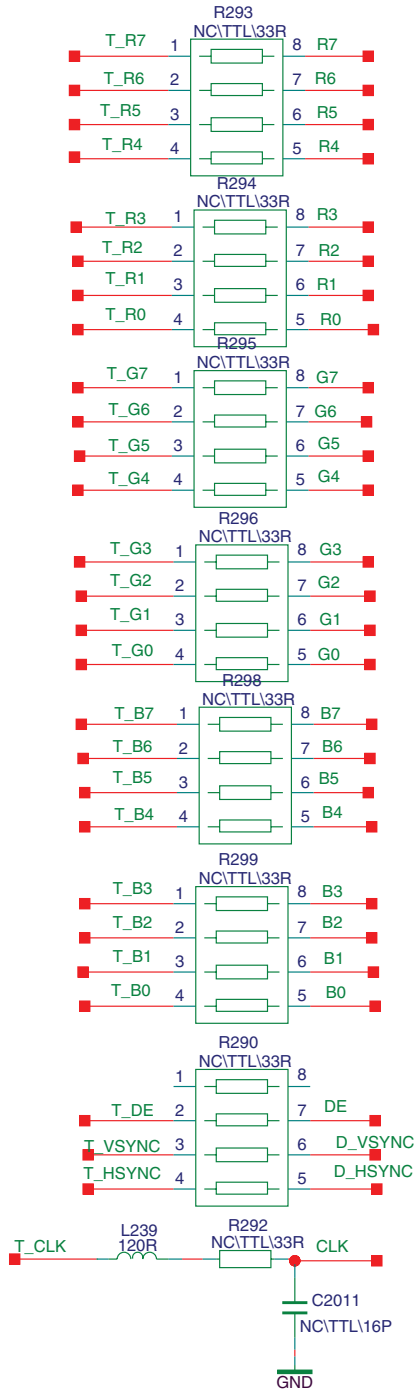
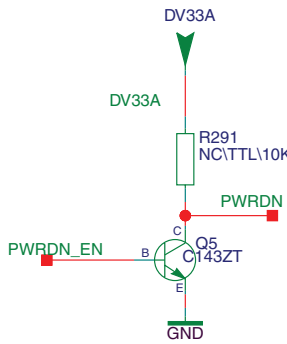
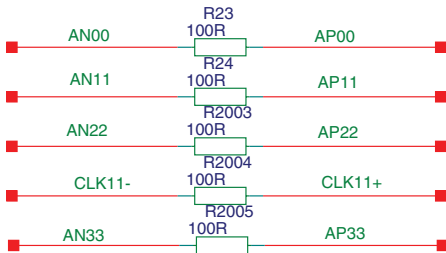
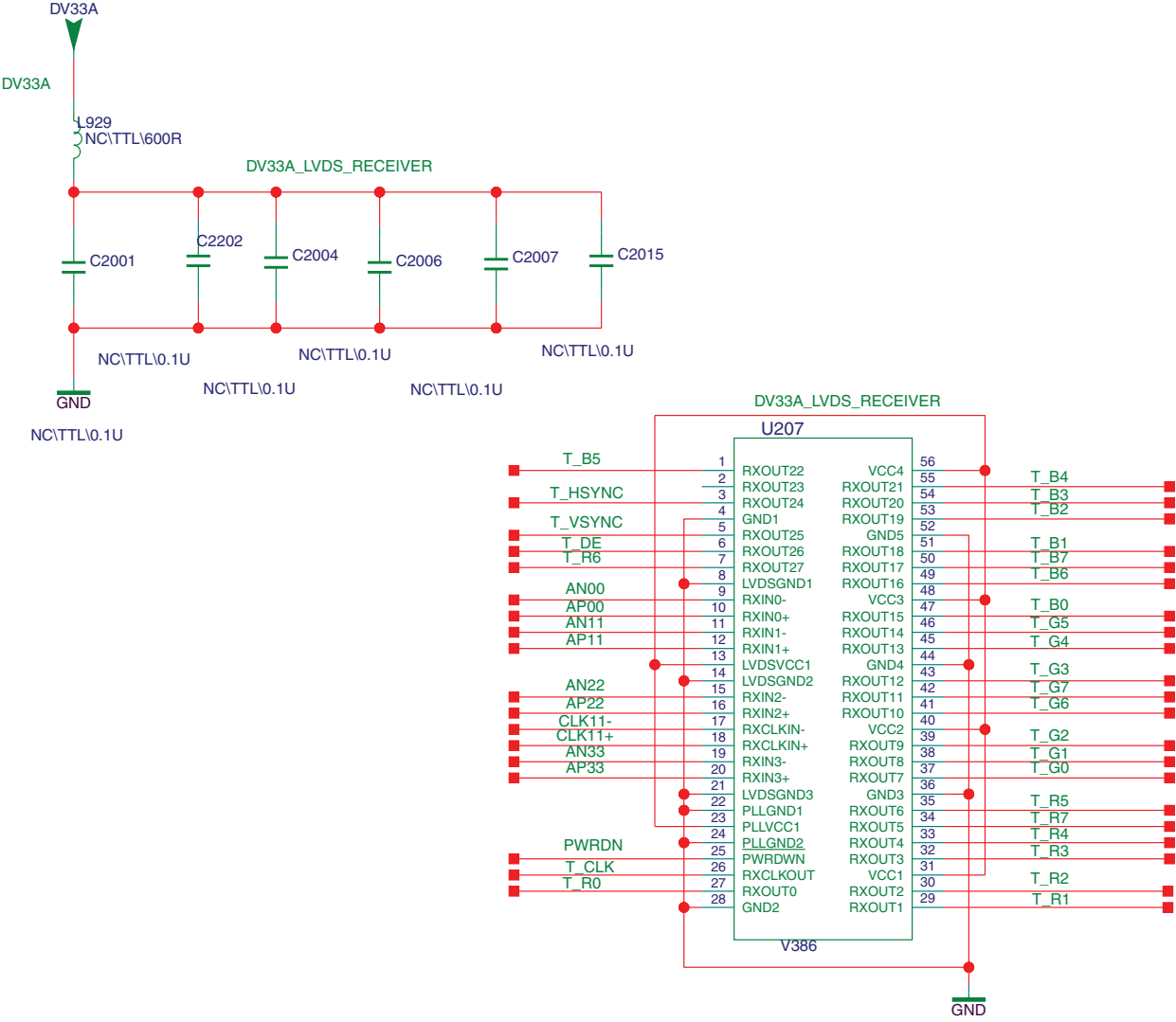
B18



SSB: LVDS Receiver

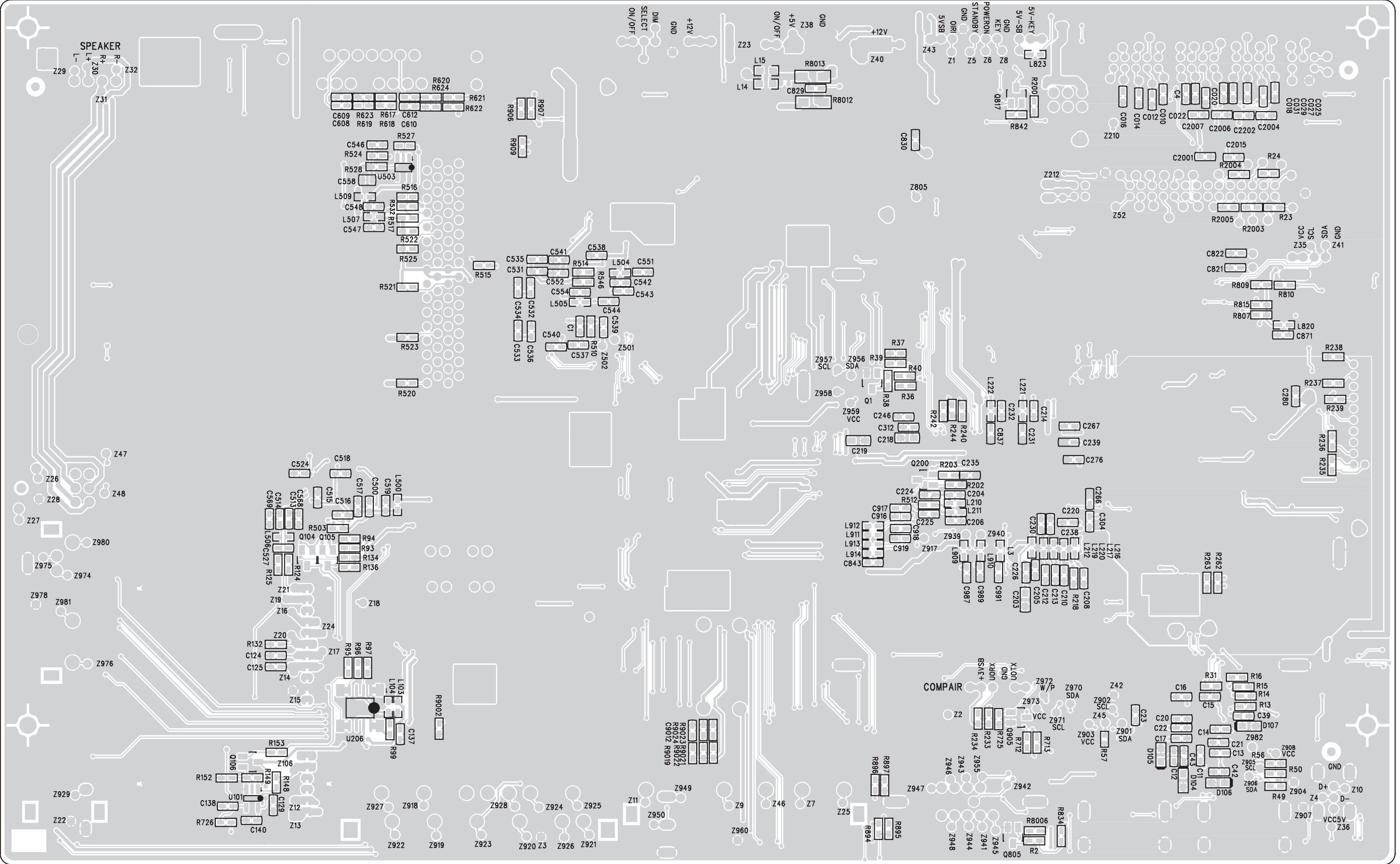
B19 LVDS RECEIVER

B19

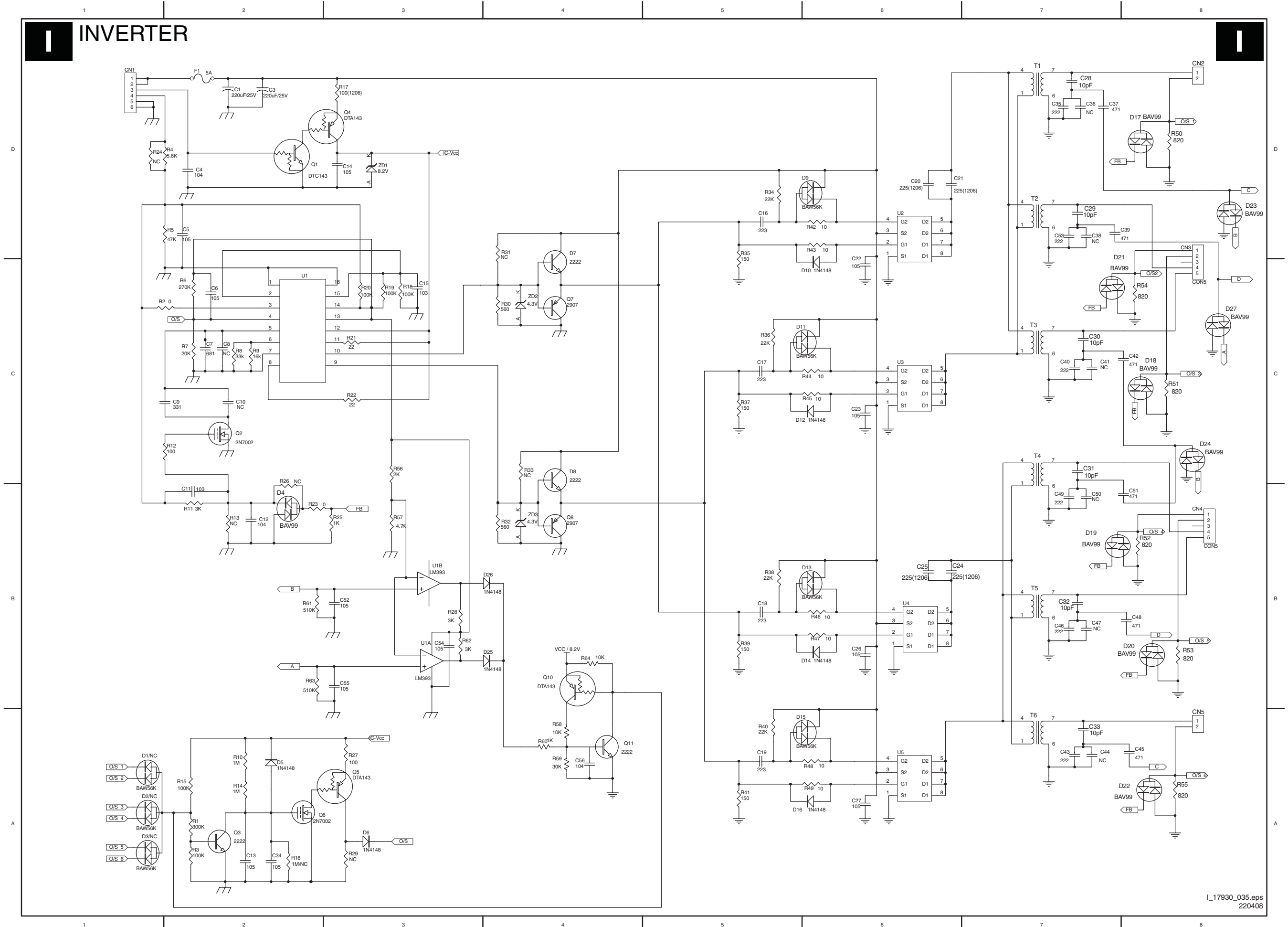


I_17950_040.eps
070508

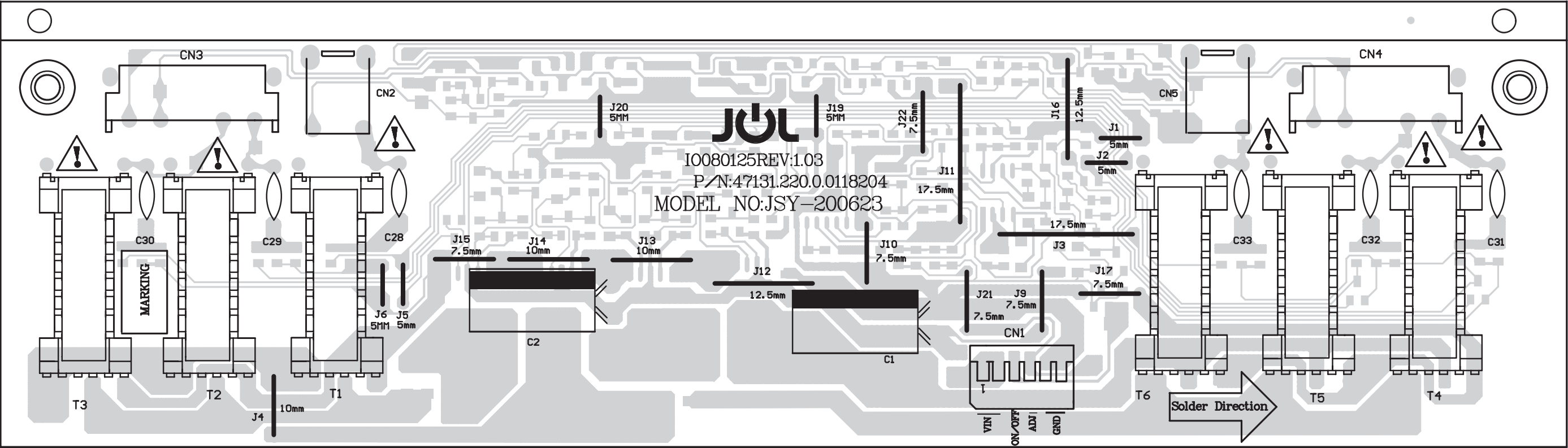
Layout Small Signal Board (Bottom Side)



Inverter Panel

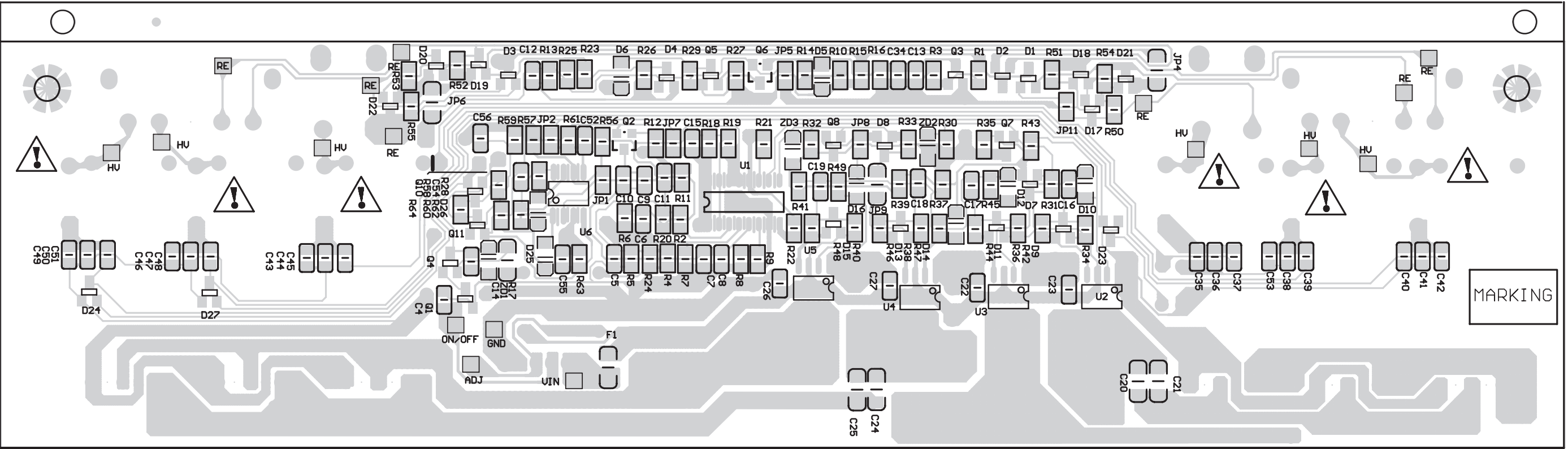


Layout Inverter Panel (Top Side)



I_17930_036.eps
220408

Layout Inverter Panel (Bottom Side)



I_17930_037.eps
220408

[illegible]

8. Alignments

Index of this chapter:

- 8.1 Electrical Alignments
- 8.2 Hardware Alignments
- 8.3 Software Alignments

Note:

The Service Modes are described in chapter 5. Menu navigation is done with the CURSOR UP, DOWN, LEFT or RIGHT keys of the remote control transmitter.

8.1 Electrical Alignments

Perform all electrical adjustments under the following conditions:

- Power supply voltage (depends on region):
 - AP-NTSC: 120 VAC or 230 VAC / 50 Hz ($\pm 10\%$).
 - AP-PAL-multi: 120 - 230 VAC / 50 Hz ($\pm 10\%$).
 - EU: 230 VAC / 50 Hz ($\pm 10\%$).
 - LATAM-NTSC: 120 - 230 VAC / 50 Hz ($\pm 10\%$).
 - US: 120 VAC / 60 Hz ($\pm 10\%$).
- Connect the set to the mains via an isolation transformer with low internal resistance.
- Allow the set to warm up for approximately 60 minutes.
- Measure voltages and waveforms in relation to correct ground (e.g. measure audio signals in relation to AUDIO_GND).
- **Caution:** It is not allowed to use heatsinks as ground.
- Test probe: $R_i > 10\text{ M}\Omega$, $C_i < 20\text{ pF}$.
- Use an isolated trimmer/screwdriver to perform alignments.

8.2 Hardware Alignments

Not applicable.

8.3 Software Alignments

8.3.1 White Balance Adjustment (VGA Mode)

Only VGA input requires colour temperature adjustment as all other inputs or relative ones. Both WARM and COOL colour coordinates are also relatives to NORMAL colour temperature mode ones.

Equipment requirements: Colour analyser (e.g. Minolta CA-210).

Pre conditions:

- Picture Preset: Standard.
- Black Expand: Off.
- Tone: Normal.
- Dynamic Contrast: Off.

Colour Temp Alignment

Apply a 1366×768@50Hz signal with white pattern, set "brightness" at 100%, and "contrast" at 50%. Adjust the R, G, and B sub-gain for the screen centre.

The 1931 CIE chromaticity (x, y) co-ordinates shall be:

Table 8-1 Alignment for 19", 20", and 22" with colour analyser

	Cool (9000K)	Normal (8000K)	Warm (6500K)
x (70 IRE)	0.289 +/- 0.003	0.296 +/- 0.003	0.314 +/- 0.003
y (70 IRE)	0.291 +/- 0.003	0.299 +/- 0.003	0.319 +/- 0.003

Table 8-2 Alignment for 26" with a colour analyser

	Cool (11000K)	Normal (9000K)	Warm (6500K)
x (70 IRE)	0.278 +/- 0.003	0.289 +/- 0.003	0.314 +/- 0.003
y (70 IRE)	0.278 +/- 0.003	0.291 +/- 0.003	0.319 +/- 0.003

8.3.2 Display Code

When after an SSB or display exchange, the display option code is not set properly; it will result in a TV with "no display" or strange resolution.

Therefore, it is required to set this display option code after such a repair.

To do so, press (slowly) the following key sequence on a standard RC transmitter: "**062598**" directly followed by "**MENU**" and "**xxx**", where "xxx" is a 3 digit decimal value of the panel type: see column "Display code" in table below.

When ready, the set will go to stand-by.

After this, perform a cold start.

LCD Panel:	Display Code:
AUO 19"	096
CMO 19" - M190Z1-L01	094
LG 20" - LC201V02-SDD1	093
AUO 22"	097
CMO 22" - M220Z1-L03	022
AUO 26" - T260XW03 V3	030
AUO 26" VM	098
CMO 26"	095

9. Circuit Descriptions, Abbreviation List, and IC Data Sheets

Index of this chapter:

- 9.1 Introduction
9.3 Abbreviation List
9.4 IC Data Sheets

Notes:

- Only **new** circuits (circuits that are not published recently) are described.
- Figures can deviate slightly from the actual situation, due to different set executions.

9.1 Introduction

This chassis is a digital derivative from the TCM1.0E LA chassis and supports DVB-T reception. It uses the Mediatek MT5335 main chip. It processes the following input/output signals:

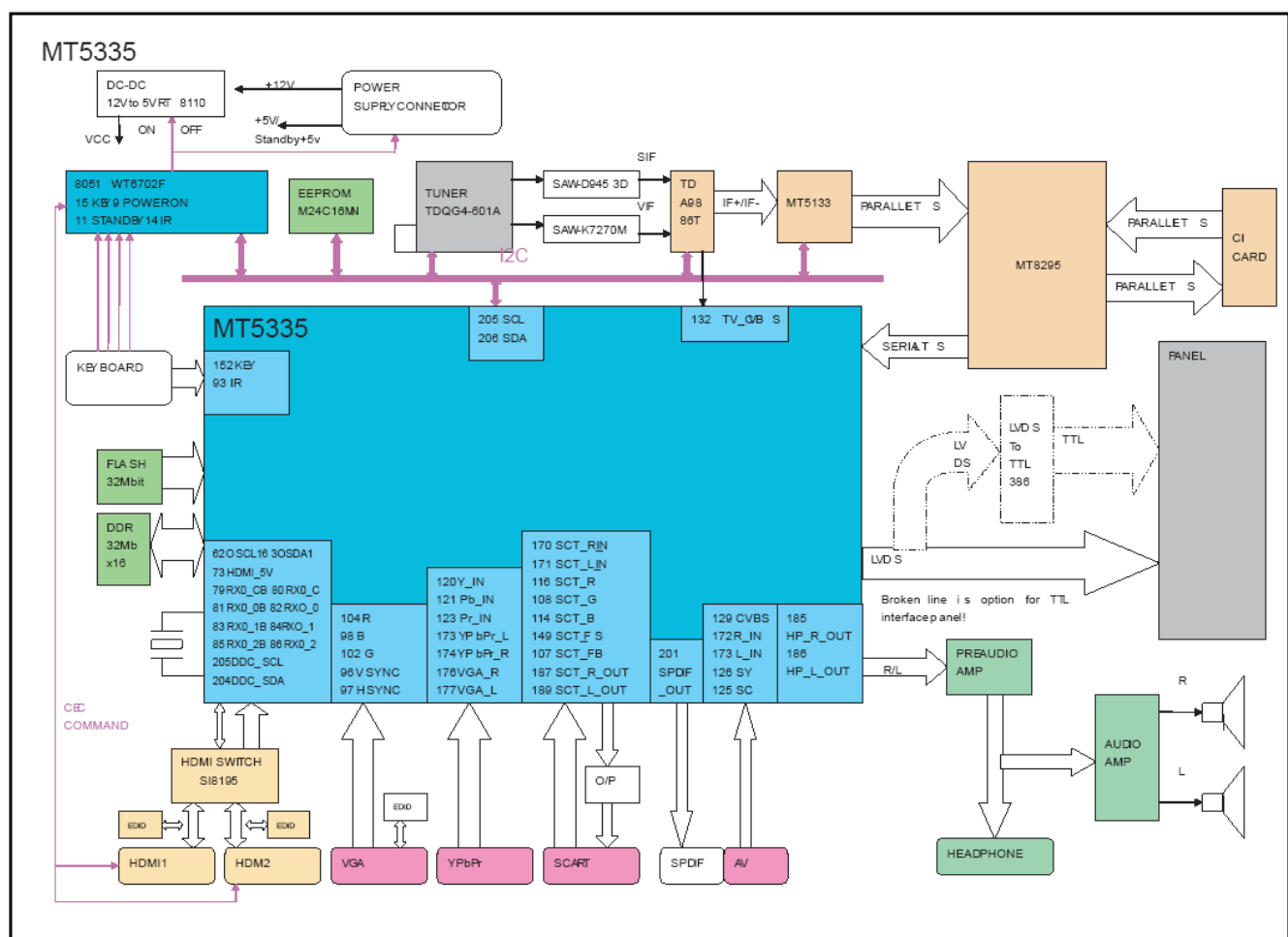
- Analog and digital RF signals (PAL B/G, D/K, I, SECAM B/G, D/K, L/L', DVB-T)
- SCART input signals (CVBS & RGB)
- CMP input signals (YPbPr)
- VGA input signals
- HDMI input signals, v1.2 compliant, with HDCP, audio included as EIA-861B standard
- S-Video input
- Headphone output
- SPDIF output.

The platform is also designed for the lowest power consumption in off/stand-by mode (<0.3W) to fulfil new Philips CE environment policy requirement.

The MT5335 is surrounded by a tuner, a video demodulator, a HDMI interface, SDR and flash memory, an audio amplifier, and optionally a stand-by microprocessor (26"). For the smaller set versions also the inverter board is serviceable.

For the block diagram, refer also to chapter 6 “Block diagrams, Test Point Overviews, and Waveforms”.

9.2 Block Diagram



I_17951_012.eps
060808

Figure 9-1 Block diagram

9.3 Abbreviation List

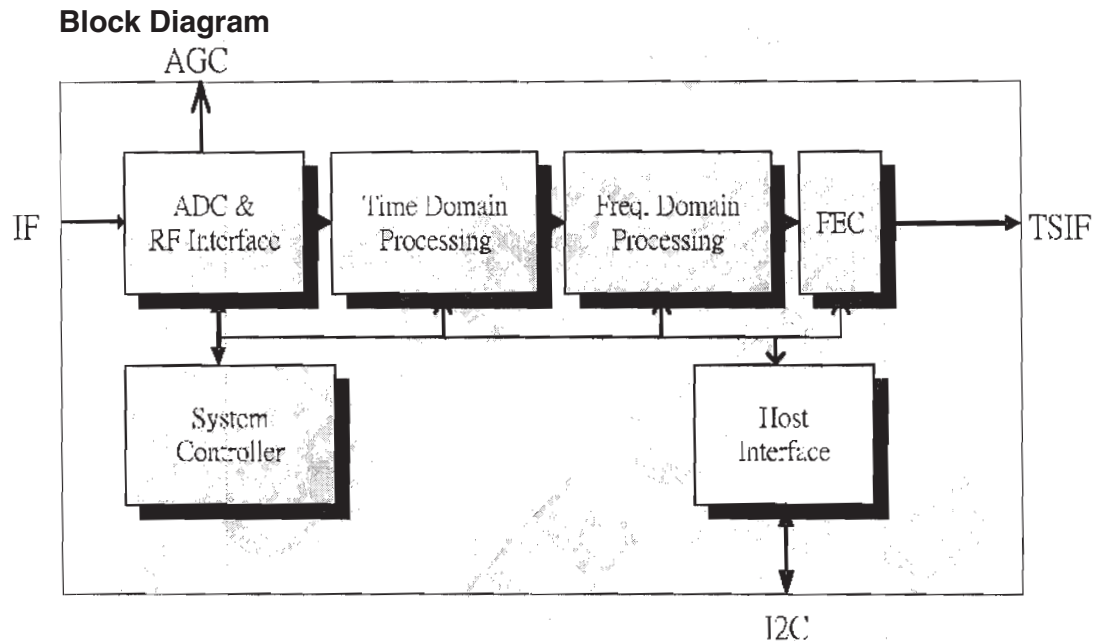
1080i	1080 visible lines, interlaced	FBL-SC2-IN	Fast blanking signal for SCART2 in
1080p	1080 visible lines, progressive scan	FBL-TXT	Fast Blanking Teletext
2CS	2 Carrier Sound	FLASH	FLASH memory
2DNR	Spatial (2D) Noise Reduction	FM	Field Memory / Frequency Modulation
3DNR	Temporal (3D) Noise Reduction	FMR	FM Radio
480i	480 visible lines, interlaced	FRC	Frame Rate Converter
480p	480 visible lines, progressive scan	FRONT-C	Front input chrominance (SVHS)
AARA	Automatic Aspect Ratio Adaptation: algorithm that adapts aspect ratio to remove horizontal black bars; keeping up the original aspect ratio	FRONT-DETECT	Front input detection
ACI	Automatic Channel Installation: algorithm that installs TV channels directly from a cable network by means of a predefined TXT page	FRONT-Y_CVBS	Front input luminance or CVBS (SVHS)
ADC	Analogue to Digital Converter	FTV	Flat TeleVision
AFC	Automatic Frequency Control: control signal used to tune to the correct frequency	G-SC1-IN	Green SCART1 in
AGC	Automatic Gain Control: algorithm that controls the video input of the feature box	G-SC2-IN	Green SCART2 in
AM	Amplitude Modulation	G-TXT	Green teletext
AUO	Acer Unipack Optonics	H	H_sync to the module
AP	Asia Pacific	HD	High Definition: 720p, 1080i, 1080p
AR	Aspect Ratio: 4 by 3 or 16 by 9	HDMI	High Definition Multimedia Interface, digital audio and video interface
ASD	Automatic Standard Detection	HP	Head Phone
AV	Audio Video	I	Monochrome TV system. Sound carrier distance is 6.0 MHz
B-SC1-IN	Blue SCART1 in	I2C	Integrated IC bus
B-SC2-IN	Blue SCART2 in	I2S	Integrated IC Sound bus
B-TXT	Blue teletext	IC	Integrated Circuit
B/G	Monochrome TV system. Sound carrier distance is 5.5 MHz	IF	Intermediate Frequency
BTSC	Broadcast Television System Committee	Interlaced	Scan mode where two fields are used to form one frame. Each field contains half the number of the total amount of lines. The fields are written in "pairs", causing line flicker.
C-FRONT	Chrominance front input	IR	Infra Red
CBA	Circuit Board Assembly (or PWB)	IRQ	Interrupt ReQuest
CL	Constant Level: audio output to connect with an external amplifier	Last Status	The settings last chosen by the customer and read and stored in RAM or in the NVM. They are called at start-up of the set to configure it according to the customers wishes
CLUT	Colour Look Up Table	LATAM	LATIn America
ComPair	Computer aided rePair	LC04	Philips chassis name for LCD TV 2004 project
CSM	Customer Service Mode	LCD	Liquid Crystal Display
CVBS	Composite Video Blanking and Synchronisation	LED	Light Emitting Diode
CVBS-EXT	CVBS signal from external source (VCR, VCD, etc.)	L/L'	Monochrome TV system. Sound carrier distance is 6.5 MHz. L' is Band I, L is all bands except for Band I
CVBS-INT	CVBS signal from Tuner	LPL	LG Philips LCD
CVBS-MON	CVBS monitor signal	LS	Loud Speaker
CVBS-TER-OUT	CVBS terrestrial out	LVDS	Low Voltage Differential Signalling, data transmission system for high speed and low EMI communication.
DAC	Digital to Analogue Converter	M/N	Monochrome TV system. Sound carrier distance is 4.5 MHz
DBE	Dynamic Bass Enhancement: extra low frequency amplification	MOSFET	Metal Oxide Semiconductor Field Effect Transistor
DFU	Directions For Use: owner's manual	MPEG	Motion Pictures Experts Group
DNR	Dynamic Noise Reduction	MSP	Multi-standard Sound Processor: ITT sound decoder
DRAM	Dynamic RAM	MUTE	MUTE Line
DSP	Digital Signal Processing	NAFTA	North American Free Trade Association: Trade agreement between Canada, USA and Mexico
DST	Dealer Service Tool: special (European) remote control designed for service technicians	NC	Not Connected
DTS	Digital Theatre Sound	NICAM	Near Instantaneous Compounded Audio Multiplexing. This is a digital sound system, used mainly in Europe.
DVD	Digital Versatile Disc	NTSC	National Television Standard Committee. Colour system used mainly in North America and Japan. Colour carrier NTSC M/N = 3.579545 MHz, NTSC 4.43 = 4.433619 MHz (this is a VCR norm, it is not transmitted off-air)
DVI	Digital Visual Interface	NVM	Non Volatile Memory: IC containing TV related data (for example, options)
DW	Double Window	O/C	Open Circuit
ED	Enhanced Definition: 480p, 576p		
EEPROM	Electrically Erasable and Programmable Read Only Memory		
EU	EUrope		
EXT	EXternal (source), entering the set by SCART or by cinches (jacks)		
FBL	Fast Blanking: DC signal accompanying RGB signals		
FBL-SC1-IN	Fast blanking signal for SCART1 in		

ON/OFF LED	On/Off control signal for the LED	VCR	Video Cassette Recorder
OSD	On Screen Display	VGA	Video Graphics Array
PAL	Phase Alternating Line. Colour system used mainly in Western Europe (colour carrier = 4.433619 MHz) and South America (colour carrier PAL M = 3.575612 MHz and PAL N = 3.582056 MHz)	WD	Watch Dog
		WYSIWYR	What You See Is What You Record: record selection that follows main picture and sound
PC	Personal Computer	XTAL	Quartz crystal
PCB	Printed Circuit Board (or PWB)	YPbPr	Component video (Y= Luminance, Pb/Pr= Colour difference signals B-Y and R-Y, other amplitudes w.r.t. to YUV)
PDP	Plasma Display Panel	Y/C	Video related signals: Y consists of luminance signal, blanking level and sync; C consists of colour signal.
PIG	Picture In Graphic		Luminance-signal
PIP	Picture In Picture	Y-OUT	Baseband component video (Y= Luminance, U/V= Colour difference signals)
PLL	Phase Locked Loop. Used, for example, in FST tuning systems. The customer can directly provide the desired frequency	YUV	
Progressive Scan	Scan mode where all scan lines are displayed in one frame at the same time, creating a double vertical resolution.		
PWB	Printed Wiring Board (or PCB)		
RAM	Random Access Memory		
RC	Remote Control transmitter		
RC5 (6)	Remote Control system 5 (6), the signal from the remote control receiver		
RGB	Red, Green, and Blue. The primary colour signals for TV. By mixing levels of R, G, and B, all colours (Y/C) are reproduced.		
RGBHV	Red, Green, Blue, Horizontal sync, and Vertical sync		
ROM	Read Only Memory		
SAM	Service Alignment Mode		
SC	SandCastle: two-level pulse derived from sync signals		
SC1-OUT	SCART output of the MSP audio IC		
SC2-B-IN	SCART2 Blue in		
SC2-C-IN	SCART2 chrominance in		
SC2-OUT	SCART output of the MSP audio IC		
S/C	Short Circuit		
SCL	Clock signal on I2C bus		
SD	Standard Definition: 480i, 576i		
SDA	Data signal on I2C bus		
SDI	Samsung Display Industry		
SDM	Service Default Mode		
SDRAM	Synchronous DRAM		
SECAM	SEequence Couleur Avec Memoire. Colour system used mainly in France and Eastern Europe. Colour carriers = 4.406250 MHz and 4.250000 MHz		
SIF	Sound Intermediate Frequency		
SMPS	Switch Mode Power Supply		
SND	SouND		
SNDL-SC1-IN	Sound left SCART1 in		
SNDL-SC1-OUT	Sound left SCART1 out		
SNDL-SC2-IN	Sound left SCART2 in		
SNDL-SC2-OUT	Sound left SCART2 out		
SNDR-SC1-IN	Sound right SCART1 in		
SNDR-SC1-OUT	Sound right SCART1 out		
SNDR-SC2-IN	Sound right SCART2 in		
SNDR-SC2-OUT	Sound right SCART2 out		
SNDS-VL-OUT	Surround sound left variable level out		
SNDS-VR-OUT	Surround sound right variable level out		
SOPS	Self Oscillating Power Supply		
S/PDIF	Sony Philips Digital InterFace		
SRAM	Static RAM		
STBY	Stand-by		
SVHS	Super Video Home System		
SW	Sub Woofer / SoftWare		
THD	Total Harmonic Distortion		
TXT	TeleteXT		
uP	Microprocessor		
VL	Variable Level out: processed audio output toward external amplifier		

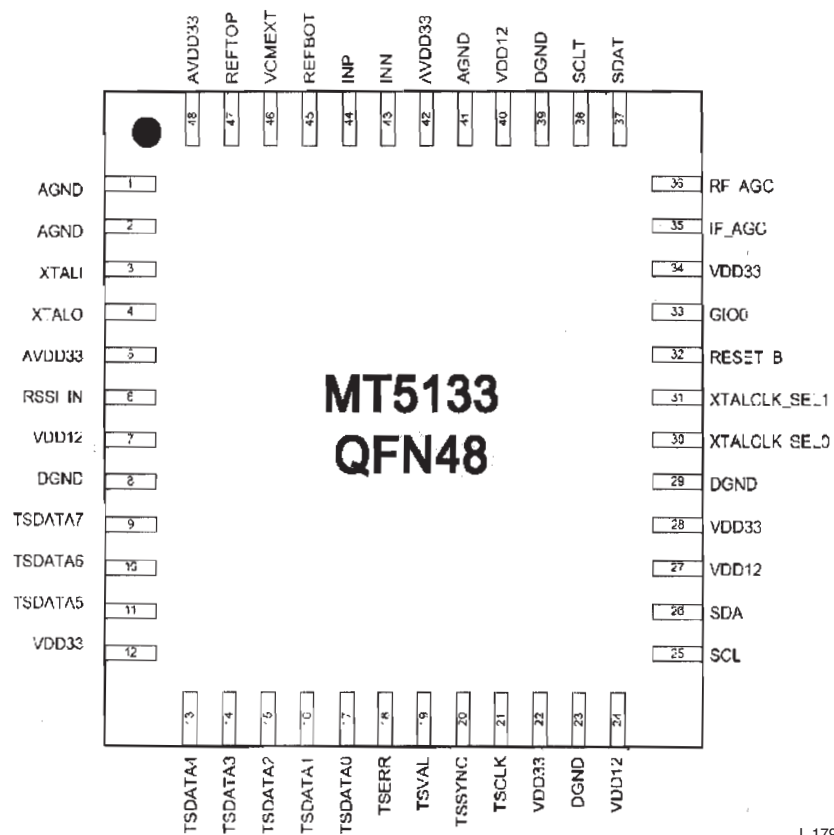
9.4 IC Data Sheets

This section shows the internal block diagrams and pin layouts of ICs that are drawn as "black boxes" in the electrical diagrams (with the exception of "memory" and "logic" ICs).

9.4.1 Diagram B, MT5133



Pin Configuration



L_17950_048.eps
080808

Figure 9-2 Block diagram & pin configuration

9.4.2 Diagram B, MT5335

Block Diagram

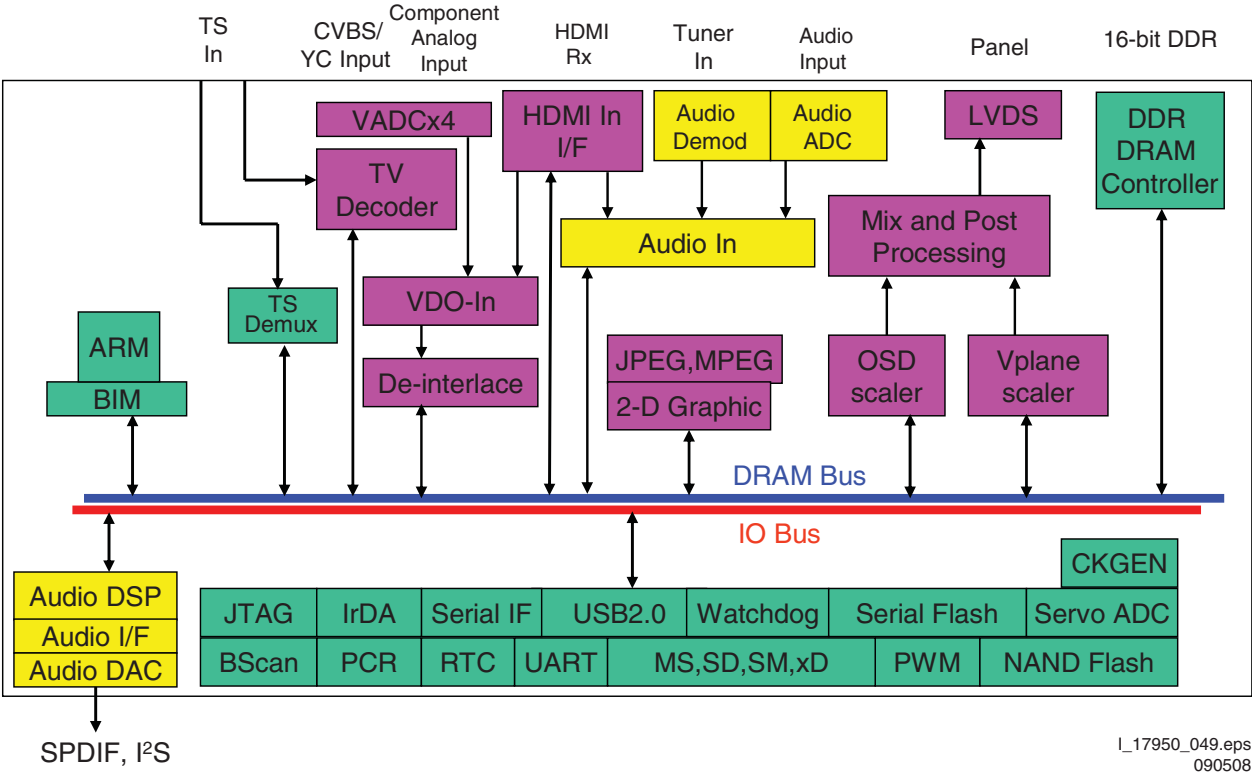


Figure 9-3 Block diagram

9.4.3 Diagram B, MT8295

Block Diagram

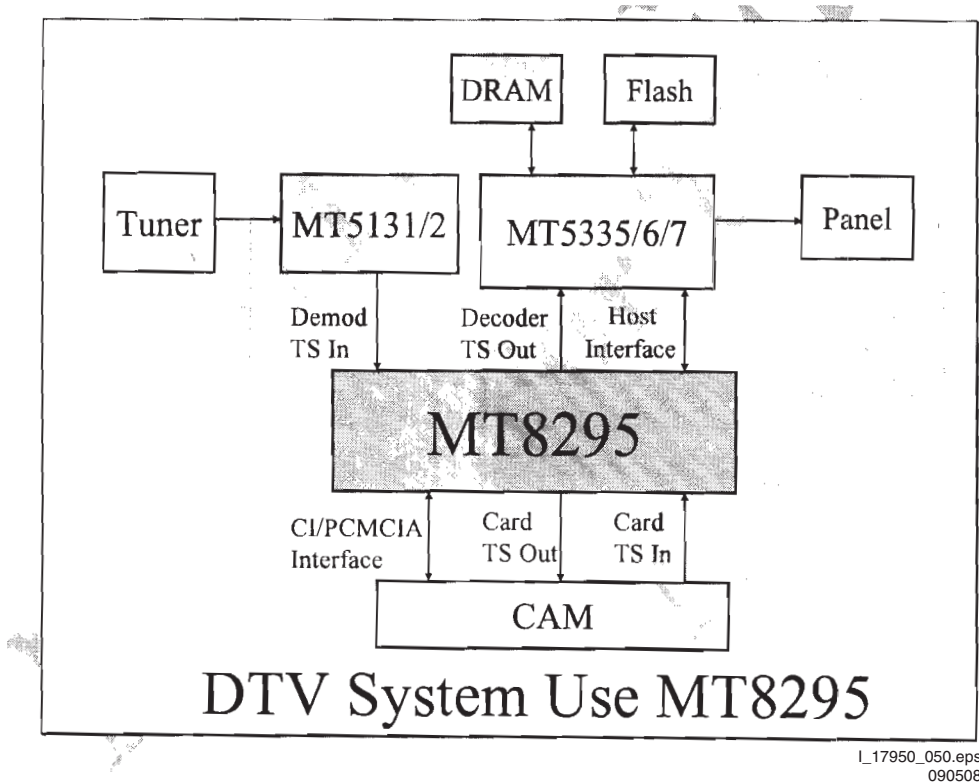


Figure 9-4 Block diagram

9.4.4 Diagram B, SIL9185

Block Diagram

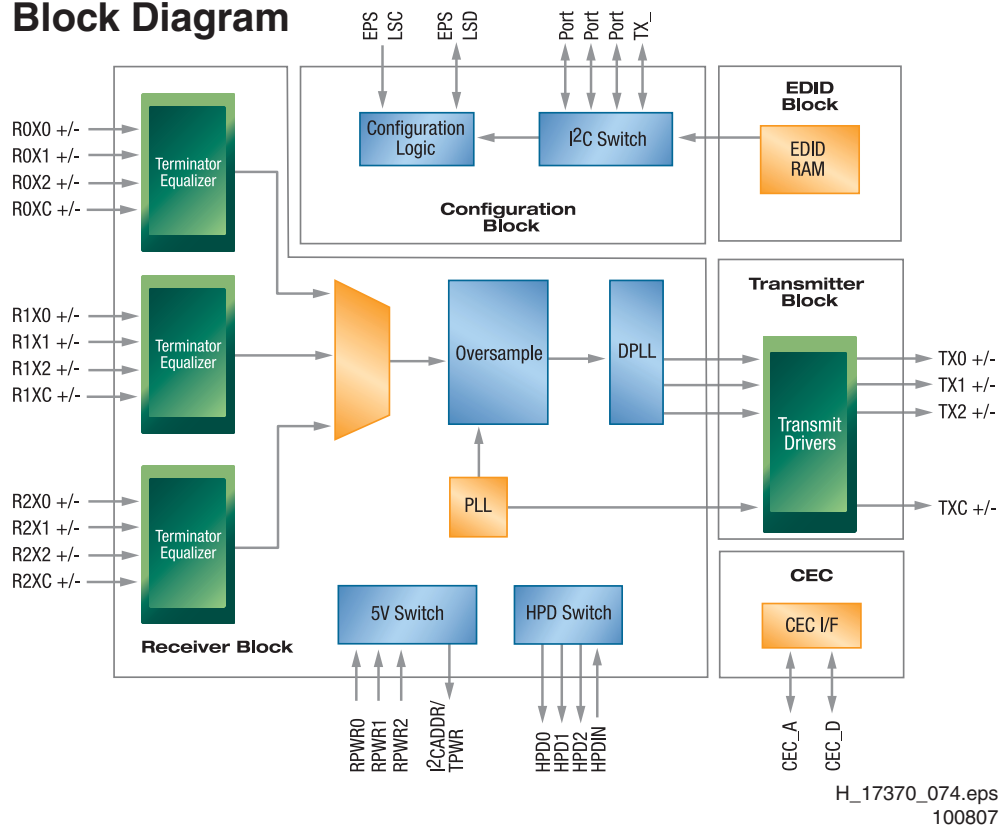


Figure 9-5 Block diagram

9.4.5 Diagram B, TDA9886

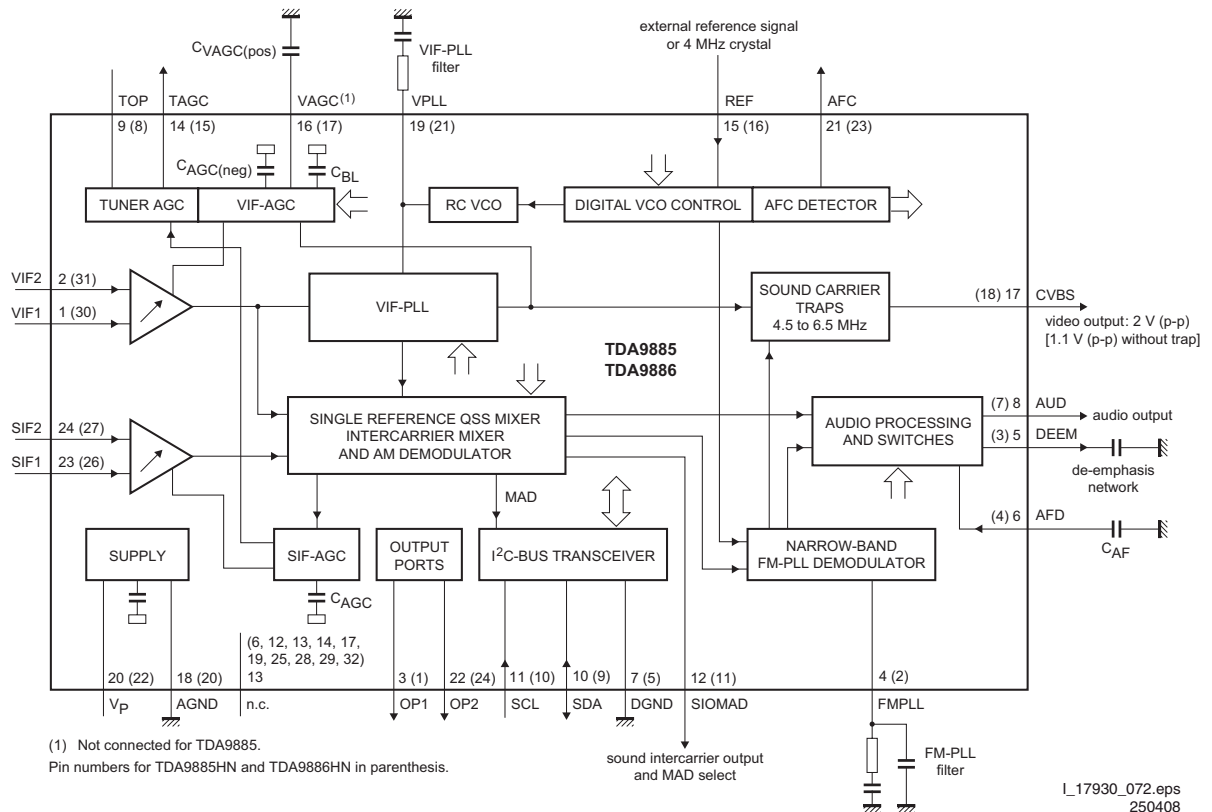
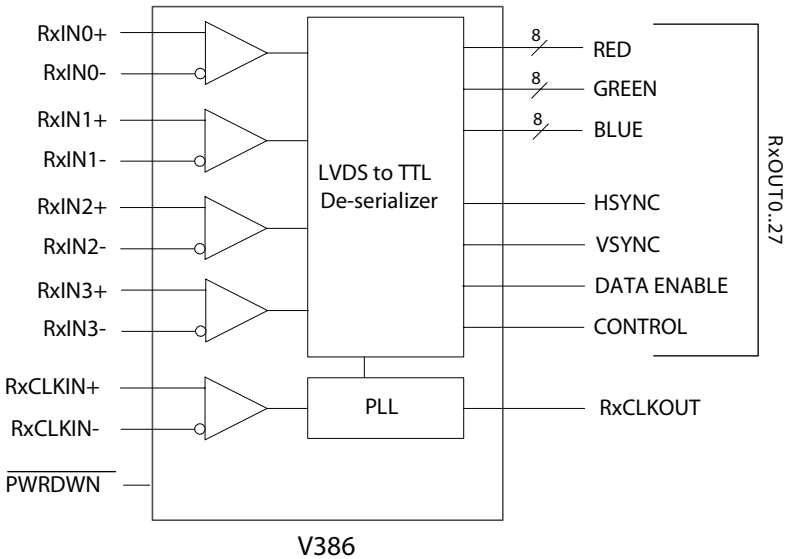


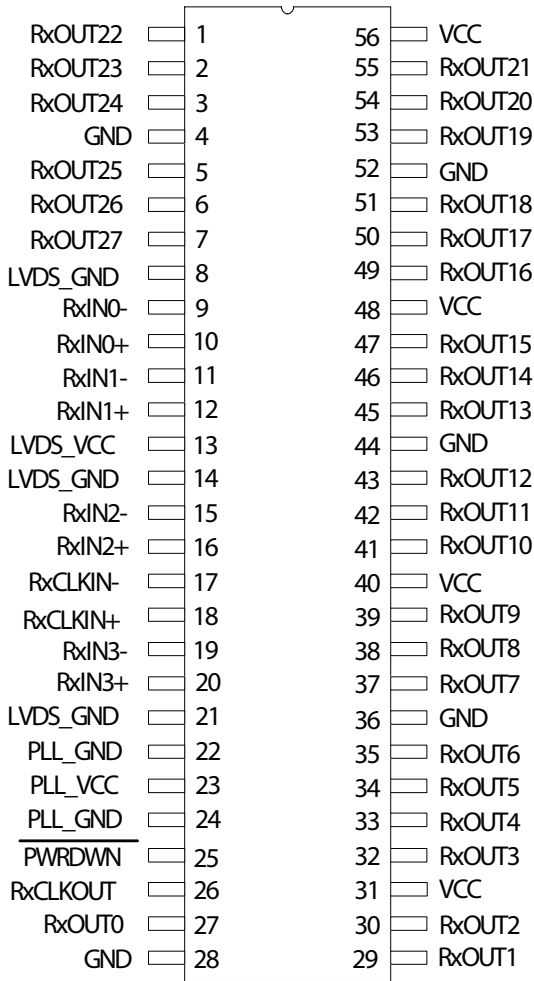
Figure 9-6 Block diagram

9.4.6 Diagram B, V386

Block Diagram



Pin Configuration



56-pin TSSOP
V386

I_17950_051.eps
090508

Figure 9-7 Block diagram & pin configuration

9.4.7 Diagram B, WM8501

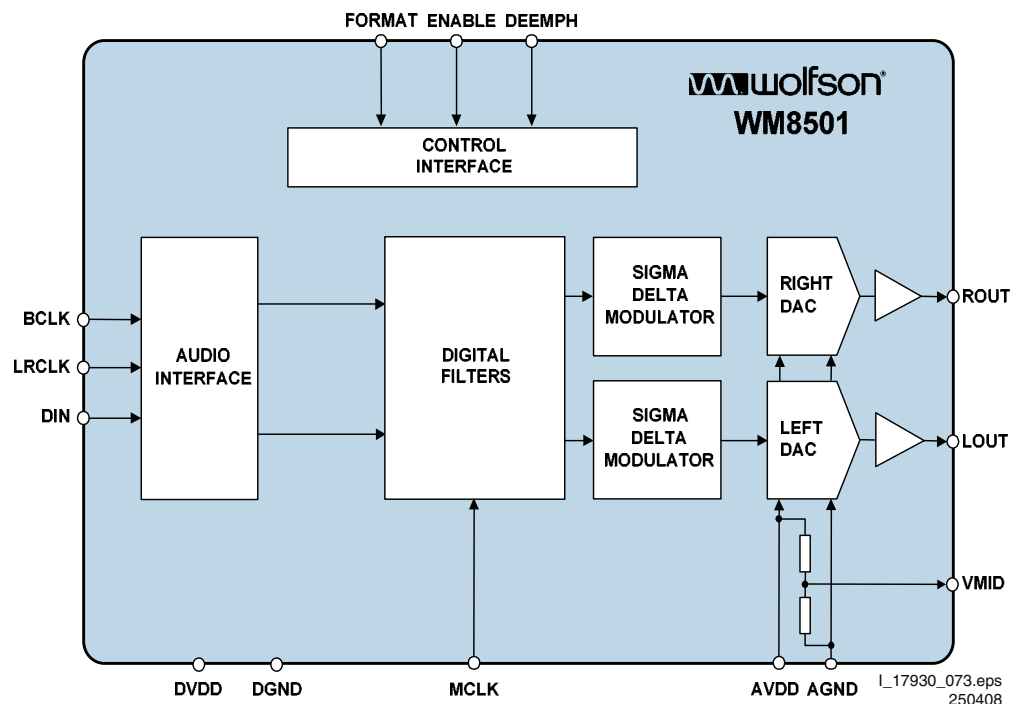
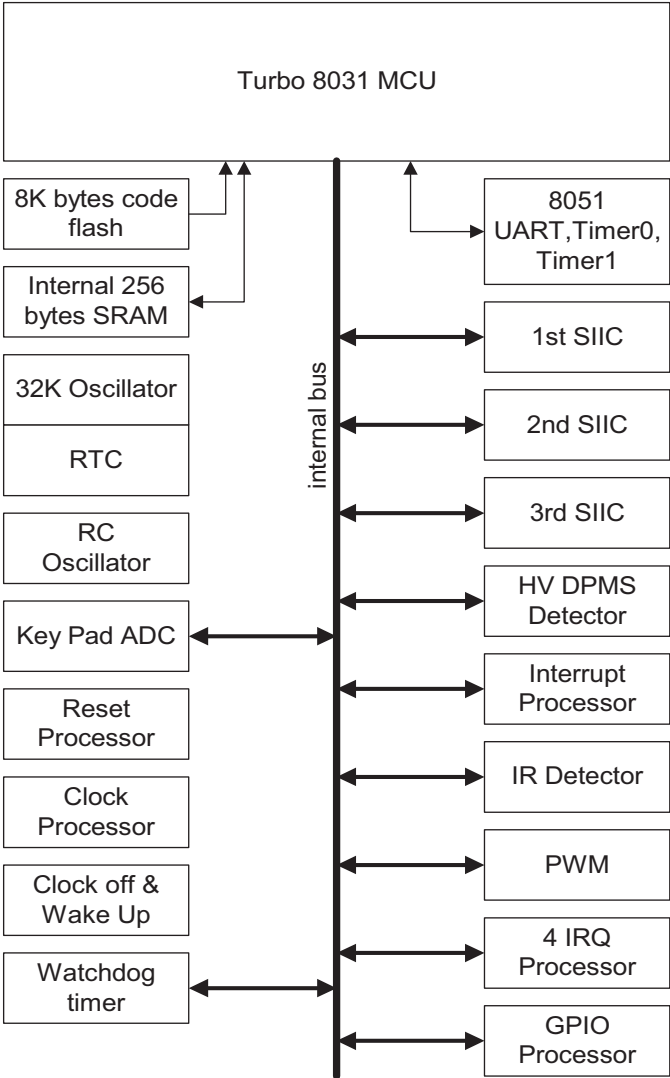


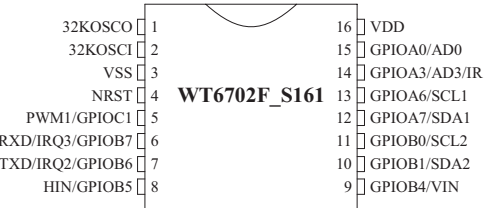
Figure 9-8 Block diagram

9.4.8 Diagram B, WT6702

Block Diagram



Pin Configuration



Package Type	Package Outline
SOP 16 pin	150mil
SOP 20 pin	300mil
SSOP 20 pin	150mil
SOP 24 pin	300mil

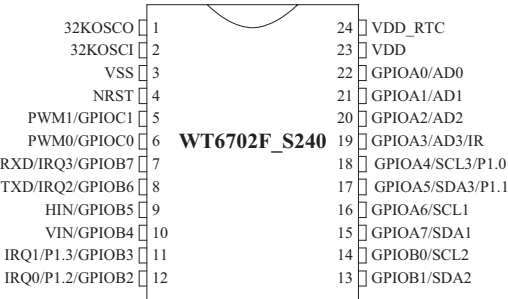
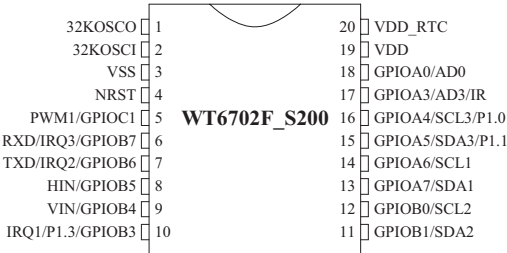
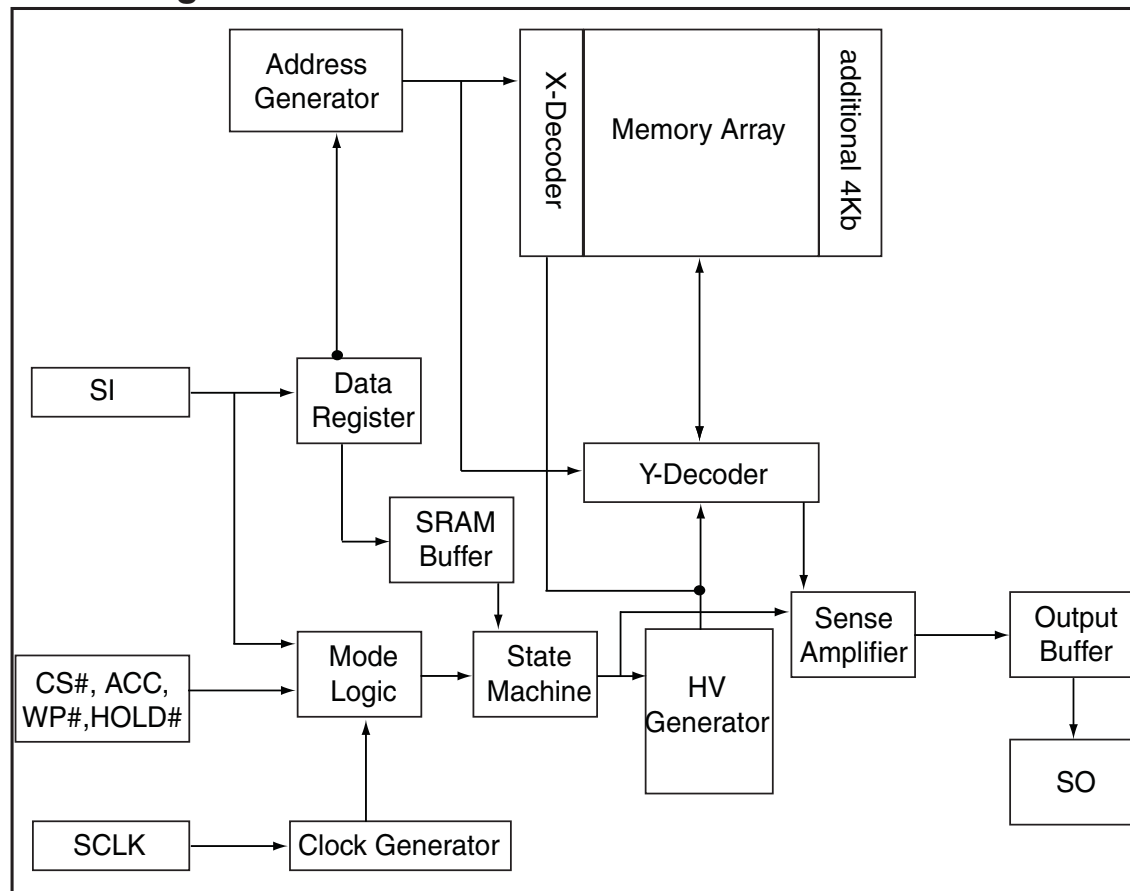


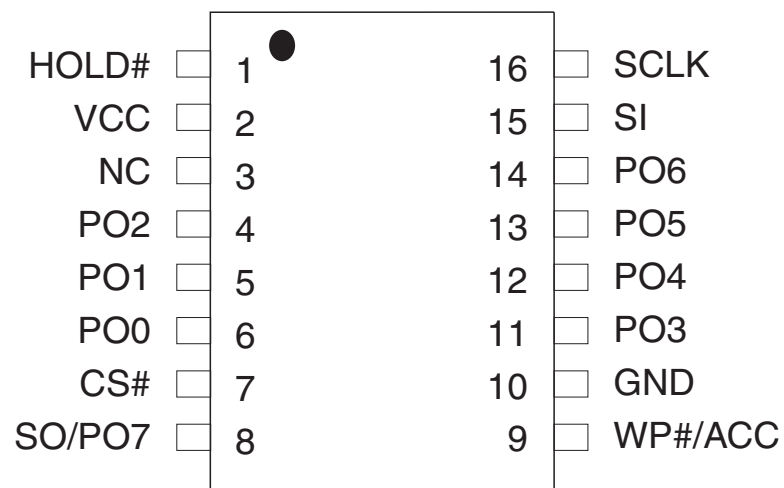
Figure 9-9 Block diagram & pin configuration

9.4.9 Diagram B, MX25L3205

Block Diagram



Pin Configuration



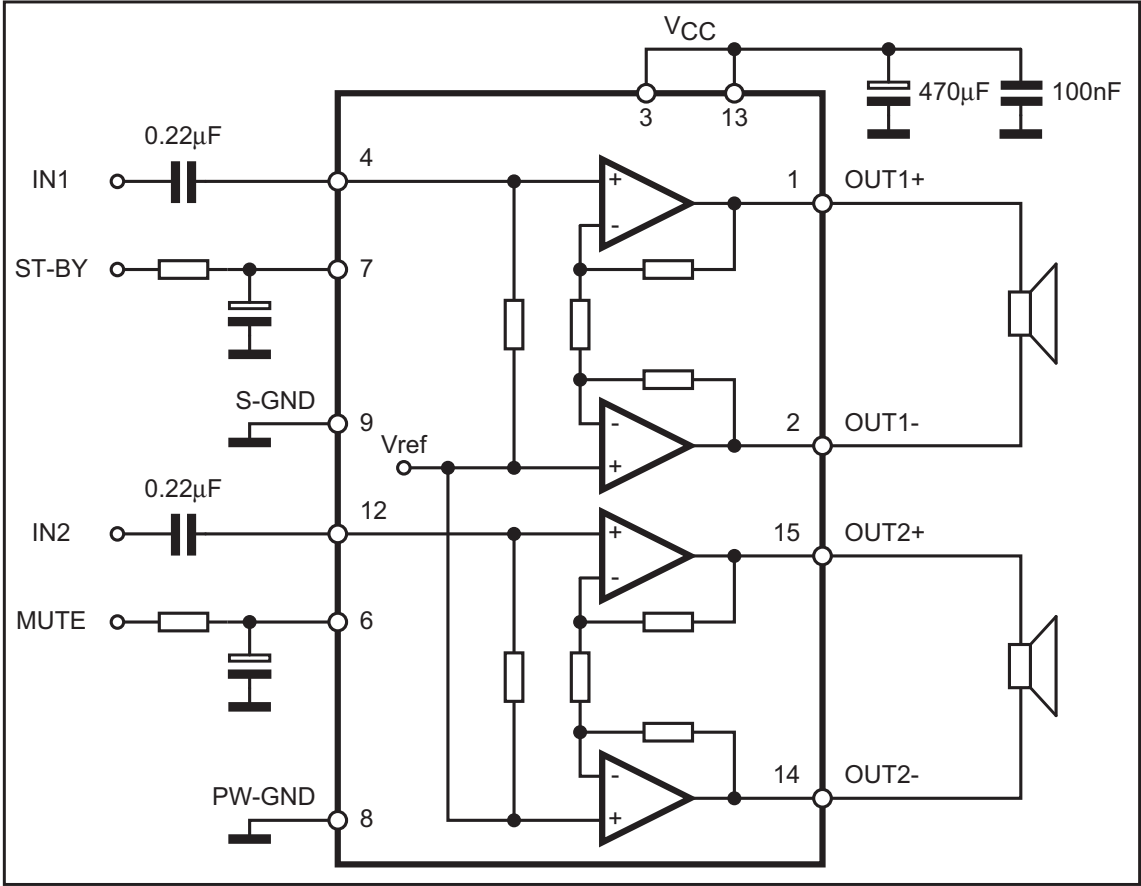
16-PIN SOP (300 mil)

I_17950_053.eps
090508

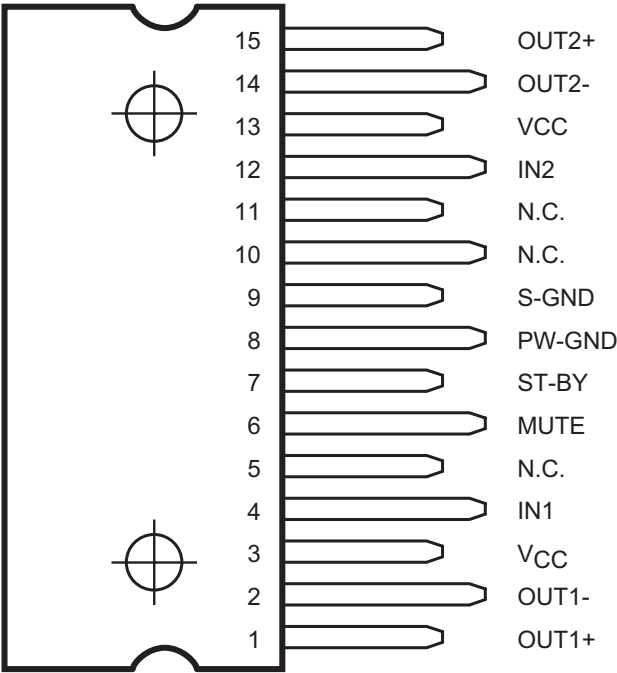
Figure 9-10 Block diagram & pin configuration

9.4.10 Diagram B, TDA7266

Block Diagram



Pin Configuration



I_17950_054.eps
090508

Figure 9-11 Block diagram & pin configuration

10. Spare Parts List & CTN Overview

For the latest spare part overview, please consult the Philips Service website.

Table 10-1 Sets described in this manual:

CTN	Styling	Published in:
19PFL5403D/10	ME8	3122 785 17951
19PFL5403S/60	ME8	3122 785 17951
20HFL3330D/10	MG8	3122 785 17951
20PFL3403D/10	MG8	3122 785 17950
22PFL5403D/10	ME8	3122 785 17951
26PFL3403D/10	MG8	3122 785 17951
26PFL5403D/10	ME8	3122 785 17950

11. Revision List

Manual xxxx xxx xxxx.0

- First release.

Manual xxxx xxx xxxx.1

- **All Chapters:** Sets added (see table chapter 10).
- **Frontpage:** Styling ME8 added.
- **Chapter 5:** In SAM mode, item "Options" removed.
- **Chapter 5:** Error 11 removed from error code overview.
- **Chapter 6:** Wiring diagrams added.
- **Chapter 8:** Display option codes added.
- **Chapter 9:** Block diagram added.
- **Chapter 10:** CTN overview added.