



2024 REC Foundation Online Challenge

**VRC High School
Reverse Engineering Challenge**

Item: Hisense 58" 4K UHD Roku Smart TV (58R7E3)

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Introduction

For this year's reverse engineering challenge, the team decided to take apart what appeared to be a non-working Hisense 58" Roku Smart TV (58R7E3). The display of this TV recent went out and not picture could be seen, but audio was still coming from the TV. While doing some initial research of this model it was found that it may be repairable and that were 3 main components that might need to be replaced.

These possible replacement components were narrowed down to one of the following.

- Power Board
- Main Board
- Backlight LEDs

Luckily, by using a simple flashlight the team was diagnose the issue as being attributed to bad backlight LEDs.

As part of this reverse engineering endeavor, it was the team's desire to find out if it is possible to replace this component based on information found online in the hopes of being able to turn this non-working TV back into a working one.



Hisense 58" 4K UHD Roku Smart TV (58R7E3)



Smart TV Front



Smart TV Rear



Smart TV Rear Backing Removed Exposing Components


Power Board (RSAG7.820.8349/ROH)





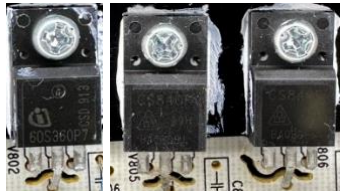

The TV's Power Board is responsible for managing and directing the power supply to different components of the TV. It converts the AC power from the wall outlet into the various DC voltages required by various components of the television.

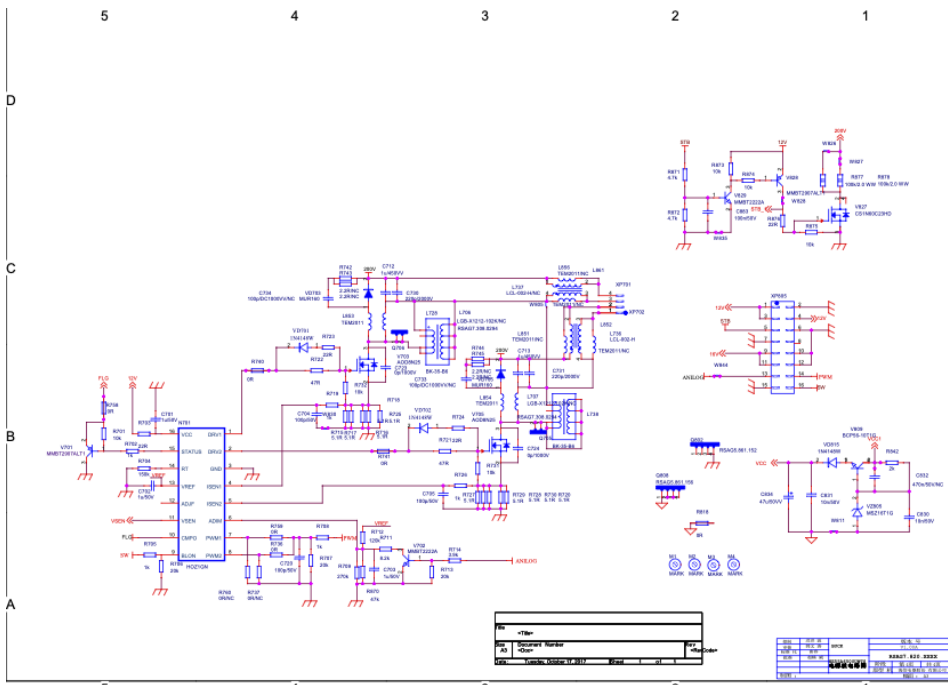
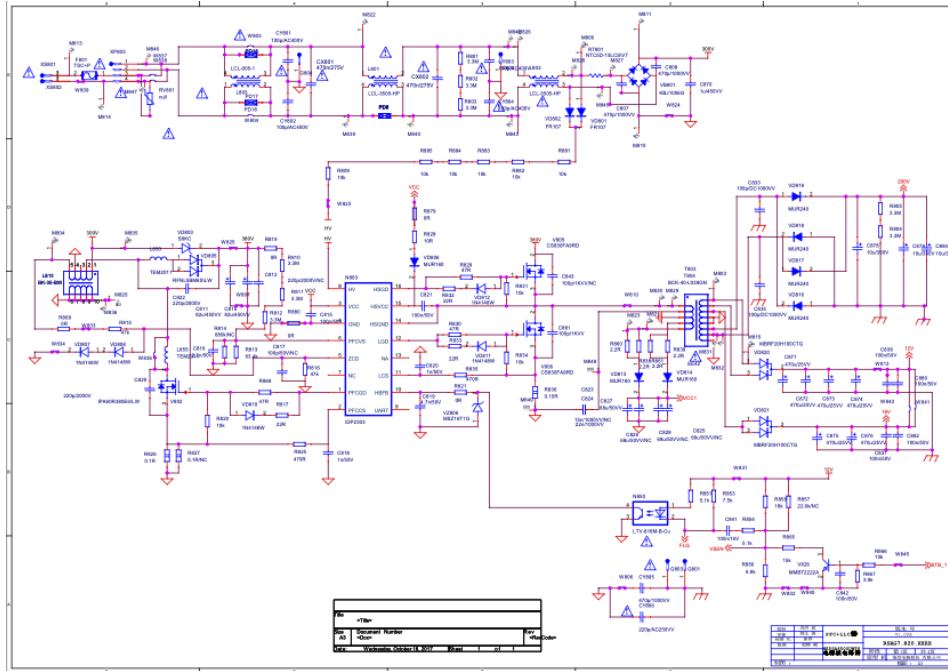


RSAG7.820.8349/ROH Power Board

Power Board Identified Components

<u>Item / Description</u>	<u>Item Image</u>
<p>AC-Capacitors, Suppression Capacitors Suppress interferences which enter the device from the outside and protect the device</p> <p>Datasheet - MKP 275V-X2, MKP 25 450V 105J</p>	
<p>Capacitor Used for storing of electrical energy</p> <p>Datasheets:</p> <ul style="list-style-type: none"> - AISHI RZ - CAPXON GF VENT low ESR Motherboard CAP Capacitor 470uf 35V 105°C - CapXon 82μF450v 	
<p>Ceramic Capacitor</p> <p>R 221K 2KV – Ceramic Capacitor</p>	
<p>Ceramic Fuse</p> <p>250V Ceramic fuse able to withstand high temperature, used to protect against overcurrent in high-current circuits found in AC or DC electronics</p>	
<p>Diodes</p> <p>Semiconductor device that essentially acts as a one-way switch for current</p> <p>Datasheets: MUR160 BAT85</p>	
<p>NTC Power Thermistor</p> <p>The NTC (Negative Temperature Coefficient) thermistor is a ceramic semiconductor in which resistance decreases logarithmically with temperature rise.</p> <p>Datasheets - SCK-055</p>	

<p>LTV-816 Photocoupler Semiconductor device that allows an electrical signal to be transmitted between two isolated circuits Datasheet</p>	
<p>Power Transformers Low frequency current sense transformers designed to monitor current from 0.1 to 30 amperes at frequencies from 50 Hz to 400 Hz.</p>	
<p>Switch-mode Power Rectifiers Primary purpose is to allow current to flow only easily along one specific direction Datasheets – MBR20100</p>	
<p>Resistor Passive electrical component that creates resistance in the flow of electric current 4 Band Resistor ~ 10kΩ ± 5%</p>	
<p>Transistor These devices are well suited for high efficiency switching DC/DC converters and switch mode power supplies Datasheet – IPD60R360P7S, CS840F A9H</p>	
<p>Varistor Used as electronic circuit protectors against power and voltage surges Datasheet - TVR10621</p>	



RSAG7.820.8349/ROH Schematics

Main Board (RSAG7.820.8252/ROH)





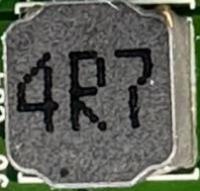



The main board carries a microprocessor and memory to store TV software and settings. This board also contains the input/output connectors that are used to supply video and audio to the system.














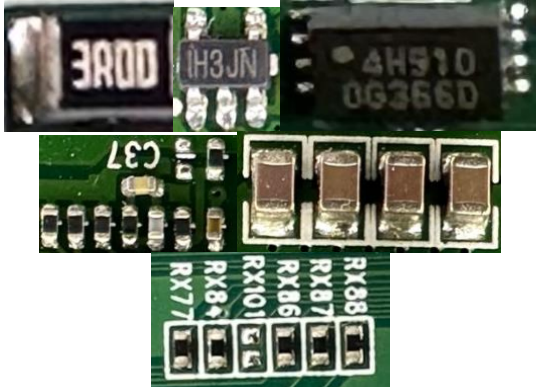
Main Board (RSAG7.820.8252/ROH)

Main Board Identified Components

<u>Item / Description</u>	<u>Item Image</u>
AC-Capacitors, Suppression Capacitors Suppress interferences which enter the device from the outside and protect the device Datasheet - MKP 275V-X2 , MKP 25 450V 105J	
Audio Line Driver With Adjustable Gain Pop-free stereo line driver designed to allow the removal of the output dc-blocking capacitors for reduced component count Datasheet - DRV632-2-VRMS	

<p>S16013 – Integrated Circuits (ICs) SOP16</p> <p>SDRAM IC network isolation transformer</p>	
<p>DRAM Chip DDR3 SDRAM</p> <p>Memory chip to store flash data</p> <p>Datasheet - K4B2G1646F-BCK0</p>	
<p>R90 – SMD Chip Inductor</p> <p>The inductor acts as a choke, which prevents changes in voltage or current.</p>	
<p>100 – SMD Chip Inductor</p>	
<p>4R7 – 4.7 ohms resistor</p> <p>Used as pull-up or pull-down resistors in digital circuits to ensure that the voltage level of a signal is maintained even when the signal is not being actively driven</p>	
<p>2R2 – 2.2 Ohm Resistor</p> <p>Used in circuits for various applications, including voltage regulation and current limiting</p>	
<p>Digital Input Audio Power Amplifier</p> <p>digital-input audio amplifier for driving stereo speakers configured as a bridge tied load (BTL)</p> <p>Datasheet - TI TAS5751M</p>	
<p>Step-Down Converter</p> <p>This device is ideal for load switch and battery protection applications</p> <p>Datasheet - Q4459 LR</p>	

<p>6D9 - IR Color Chip</p>	
<p>Integrated Dual Power Distribution Switch 4.5V to 28V Input, 6A output synchronous buck converter with dual load switches</p> <p>Datasheet – TPS 65286</p>	
<p>W1A – NPN Switching Transistor PMBT3904 SOT-23 40V / 200mA SMD transistor</p>	
<p>RO2 – Digital Transistor</p> <p>Datasheet – DTC623TK</p>	
<p>583 ohms resistor</p>	
<p>2N7002 SMD transistor (N - channel enhancement mode field effect transistor)</p> <p>Datasheet – K72</p>	
<p>TPS65286 – Buck Convertor</p> <p>4.5V to 28V Input, 6A output synchronous buck converter with dual load switches</p> <p>Datasheet – TPS65286</p>	
<p>AWKK 288 – printed heater holder assembly</p>	

<p>PJ9087 SXM54ALF Ultra Low VF Schottky Rectifier</p> <p>Converts alternating current (AC) to direct current (DC) with minimal power loss</p> <p>Datasheet – SXM54ALF</p>	
<p>59C – SMD Chip Resistor</p> <p>Datasheet – 59C</p>	
<p>Zero Ohm Resistor Can be used as a jumper, reserved for debugging, or even</p>	
<p>Various Miscellaneous Components with identified and unidentified markings but unable to find complete information regarding the exact nature of their use.</p>	




T-CON Board (Innolux MV-0S94V-0)




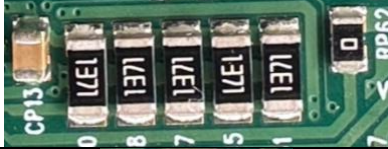



A Timing Control Board (T-CON) is used in LCD TVs to convert the video signal from the main board allowing it to be sent to the LCD Panel to display the signal to the proper location on the screen.



Innolux MV-0S94V-0



T-CON Board Identified Components

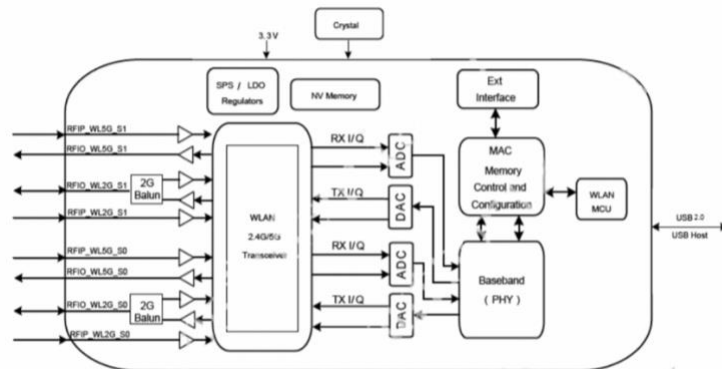
<u>Item / Description</u>	<u>Item Image</u>
<p>6R8 Integrated inductor Power inductor (6.80hm) Suppress interferences which enter the device from the outside and protect the device</p> <p>Datasheet - MKP 275V-X2, MKP 25 450V 105J</p>	
<p>IN8208A-EN1 QFP SMD LCD logic board chip Main Processor used for audio and video signaling to the LCD display boards</p>	
<p>INX IN516 9LGGNT02 Chip Exact use unidentified</p>	

<p>INX IN603C Exact use unidentified</p>	
<p>RT7239 – GSP6BS01 synchronous step-down DC/DC converter Datasheet - RT7239 IC</p>	
<p>MXIC 25V4035F 2.3V-3.6V, 4M-BIT [x 1/x 2/x 4] CMOS MXSMIO® (SERIAL MULTI I/O) FLASH MEMORY Datasheet - MX25V4035F</p>	
<p>1371 SMD Resistor 1.37 kOhms $\pm 0.05\%$ 0.063W, 1/16W Chip Resistor</p>	
<p>Power Transistor Datasheet – 2SA1797G</p>	
<p>Ultra Low VF Schottky Rectifier Ultra-Low forward voltage drop, low power losses Datasheet – SXM54ALF</p>	
<p>ESD Protection Diode Datasheet – VESD15A1-HD1</p>	

Wireless Board

Provides wireless network communication to the television allowing for software firmware updates, control of the device, and access to streaming platform services.


<u>Item / Description</u>	<u>Item Image</u>
<p>Wireless/Wi-Fi Adapter (WC0HR2601) IEEE 802.11 a/b/g/n/ac 2T/2R Band USB2.0 Module based on REALTEK RTL8812BU chipset</p> <p>Provides Wireless / Wi-Fi network access</p> <p>Datasheet</p>	 <p style="text-align: center;"><i>Front</i> <i>Back</i></p>
<p>Wireless/Wi-Fi Adapter Housing Used to hold Wireless Adapter in place.</p>	



WC0HR2601 Functional Block Diagram


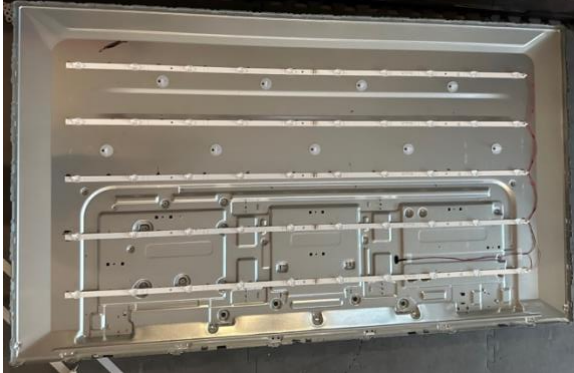
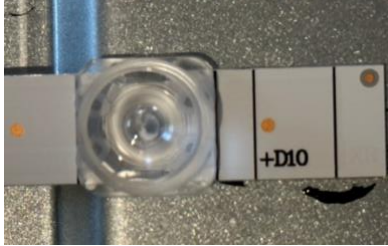
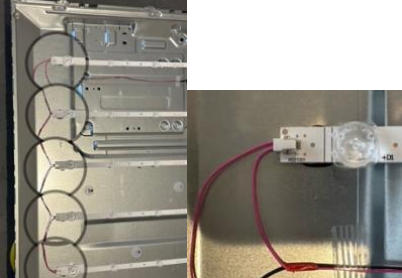
Sound Bar

Provides audio capabilities for the television. The device contains left, right, and center channels for audio output


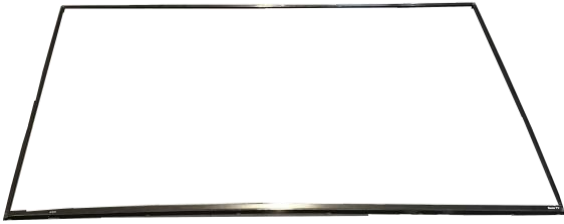

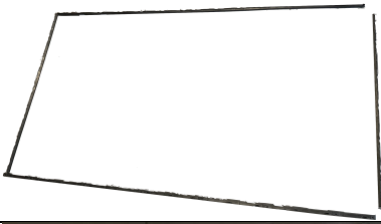


<u>Item / Description</u>	<u>Item Image</u>
<p>Speaker Assembly (VIT81580-12W8Ω-01(ROH)) Provides Stereo Sound Output</p>	

LCD Display

The Liquid-crystal displays (LCDs) Panel leverages LED backlights to illuminate the flat-panel display by using light-modulating properties of liquid crystals combined with polarizers to display images to the end user.

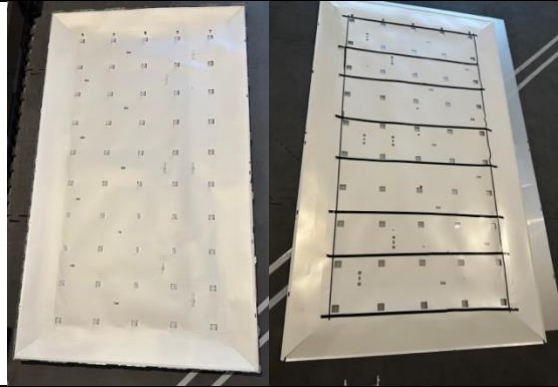
<u>Item / Description</u>	<u>Item Image</u>
<p>LCD Panel (V580DJ4-QE1 Rev. C2) Displays image being produced by main board processor through T-CON board.</p> <p>Datasheet</p>	
<p>LED Backlight Strips (JL.D580A1330-365AS-M LED) Backlight Strips (5) provide a light source behind the LCD Panel to illuminate and display the image being produced.</p>	
<p>LED 3v LED with clear resin housing</p> <p>Individual LED component on the Backlight strip used to illuminate the display</p>	
<p>LED Power Supply Wire Provides 3v power to LED light strip from Power Board</p>	

Non-Electrical Components

<u>Item / Description</u>	<u>Item Image</u>
<p>Screws Used to hold in various components</p>	
<p>Frame / Bezel Used to cover front LCD Panel</p>	
<p>Left and Right Stand / Footings Used to hold TV up</p>	
<p>Rubber Bezel Used to hold in Diffuser panels</p>	
<p>Diffuser Panels Three Layer diffuser panels used to even out LED back light and to distribute light to LCD Panel</p>	
<p>Diffuser Risers Used to hold Diffusers panels above LED back lights</p>	

LED Reflector (Front and Back)

Used to reflect LED light towards panel and to alleviate any dark spots that may be produced by metal frame backing



Summary Report

Findings

After diagnosing the potential issue with the TV, taking it apart, repairing it, and putting it back together the team found that there are many components that are used to produce this device that are both off the shelf and proprietary. While the team was not able to identify all components, even after reaching out to the manufacture, we did learn there are several components that are used in other devices that could give us an idea around the use of their use in this device.

As many LCD TVs have similar designs, we were able to find that parts from other models, and even manufactures, could be used to replaced components in this device. Surprisingly it appears that power and main boards are using in a few other brands leading us to believe that Hisense may be manufacture used for these products. The main difference between this brand and others appears to be the T-CON board which appears to hold several proprietary chips.

Lessons Learned

The main lesson learned is that while the device is not overly expensive and could easily be replaced, a simple LED backlight replacement restored the device to full working order.

By leveraging a simple flashlight pointed at the front of the display we were able to see a faint image that indicated a potential backlight issue.

Researching online we found tutorials to take apart, replace backlight, and put the display back together.

Purchasing a \$30 component allowed us to spend less than 10% of what it would have cost to replace the entire television.

By repairing this device we saved it from going to the landfill and can now leverage it for events that we host as a Pit or Audience display.



Repaired Hisense Smart TV

References

- “Hisense 58" 4K UHD Roku Smart TV (58R7E3).” *Walmart.com*, 2020, www.walmart.com/ip/Hisense-58-4K-UHD-Roku-Smart-TV-58R7E3/458643081. Accessed 12 Dec. 2023.
- RTHD. “How to Tell If TV LED Backlight Is Defective.” *YouTube*, 29 Mar. 2018, www.youtube.com/watch?v=FL9wWOOoRnY8. Accessed 12 Dec. 2023.
- ShopJimmy. “Hisense TV LED Backlight Replacement Tutorial for No Backlights and Bad LEDs.” *YouTube*, 30 Nov. 2016, www.youtube.com/watch?v=mwAnYR08maQ. Accessed 12 Dec. 2023.
- “ShopJimmy.” *Shopjimmy.com*, 2024, www.shopjimmy.com/search.php?search_query=58r6e3. Accessed 12 Dec. 2023.
- BigDog8882. “Hisense 48 Inch Tv, Comes on but No Backlight (Black Screen) Repair.” *YouTube*, 10 Jan. 2020, www.youtube.com/watch?v=n8ugAETrxYc. Accessed 12 Dec. 2023.
- “LED Light and TV Backlight Tester, 0-300V Adaptive Voltage LED Strip Lamp Beads Light Source Testing Tool with Gold Plated Pin & Power Cable Fits for All LED Light Repairs (Orange): Amazon.com: Tools & Home Improvement.” *Amazon.com*, 2024, www.amazon.com/gp/product/B09XGZNC1R/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1. Accessed 12 Jan. 2023.
- Wikipedia Contributors. “Ceramic Capacitor.” *Wikipedia*, Wikimedia Foundation, 13 Jan. 2024, en.wikipedia.org/wiki/Ceramic_capacitor#:~:text=A%20ceramic%20capacitor%20is%20a%20electrical%20behavior%20and%20therefore%20applications. Accessed 20 Dec. 2023.
- Electrical Technology. “Why Is Zero Ohm Resistor Used? 0-Ω Resistor Applications.” *ELECTRICAL TECHNOLOGY*, 28 June 2020, www.electricaltechnology.org/2020/06/why-zero-ohm-resistor-used.html. Accessed 30 Dec. 2023.
- Apogeeweb. “What Is a Chip Fixed Resistor?” *Apogeeweb.net*, Apogeeweb Electronics, 9 Apr. 2019, www.apogeeweb.net/article/232.html. Accessed 30 Dec. 2023.
- PCBWay. “Why Use a Zero-Ohm Resistor? - PCB Basic Information - PCBway.” *Pcbway.com*, 2023, www.pcbway.com/blog/PCB_Basic_Information/Why_Use_a_Zero_ohm_Resistor_816aa28e.html. Accessed 31 Dec. 2023.