Texas Instruments Electronic Online Challenge 2018

Signet 4 channel Digital Video Recorder Disassembly and Analysis

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Full Report
Signet 4 Channel Digital Video Recorder

Introduction

This device was used for the CCTV system, however in years time became out of date. Device was chosen, because it is just right complexity for it to be analysed within the limits of this challenge.

Photo #1

Photo #2

Insides

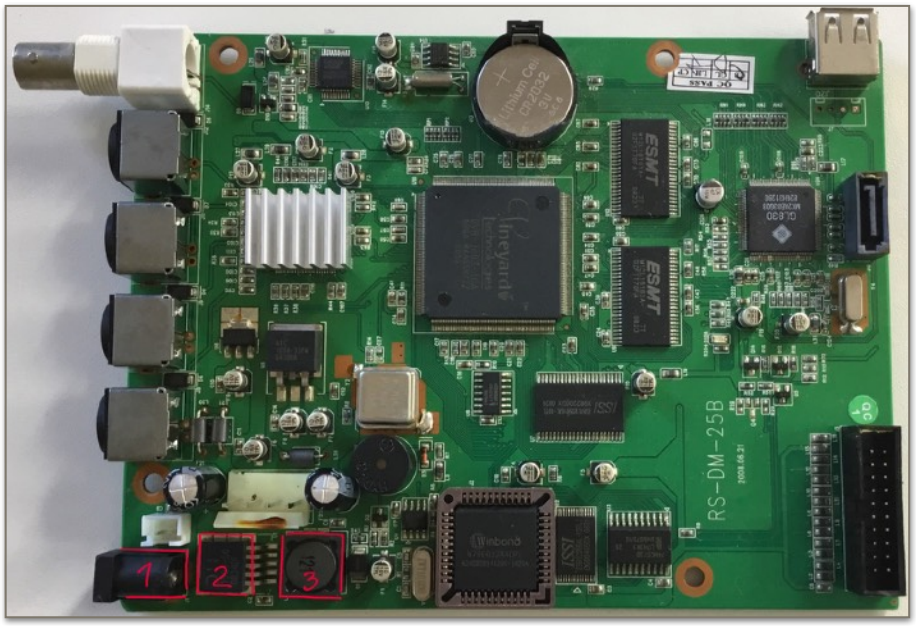
Recorder consists of 4 major components: HDD(1), Circuitboard(2), Control-Panel (3) and Remote-control

(Caption for photo #2 to the left)

CircuitBoard

Circuitboard, represents sheet of fibreglass, with traces of aluminium foil printed on it, to form circuits between components attached to the circuitboard.

Photo #3



1.1 Power

The recorder is powered with DC of 12V(1), which then is converted to 3.3V(2). DC/DC converter is followed by an inductor(3). This allows to change voltage and current to a specific value.

1.2 DVR[1] chip

The main component of the circuitboard is a DVR chip(1) made by Vineyard Technologies, which is an analogue to Samsung MultiMedia Card, widely used in communication media. Here DVR chip plays a role of CPU, by managing most of the processes on device, yet has limited functionality. Circuitboard doesn't have a ROM module, hence it can be assumed that BIOS is stored within the DVR.

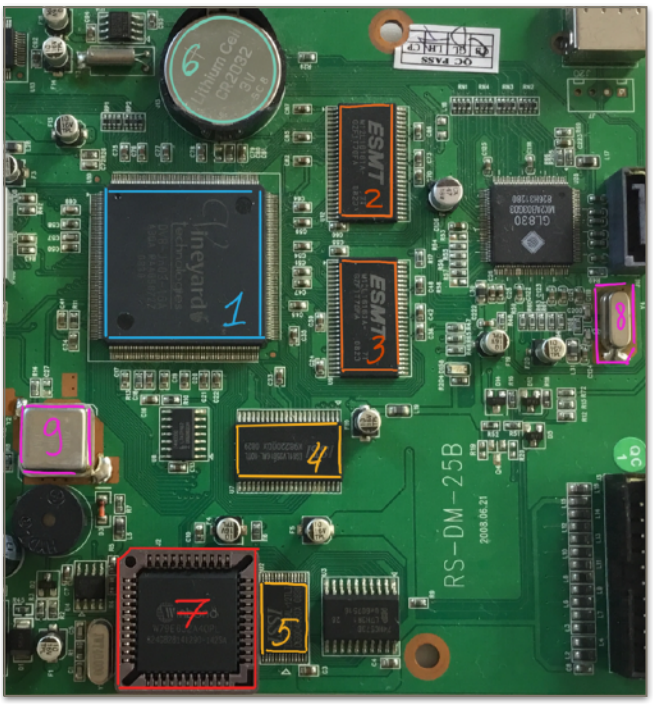


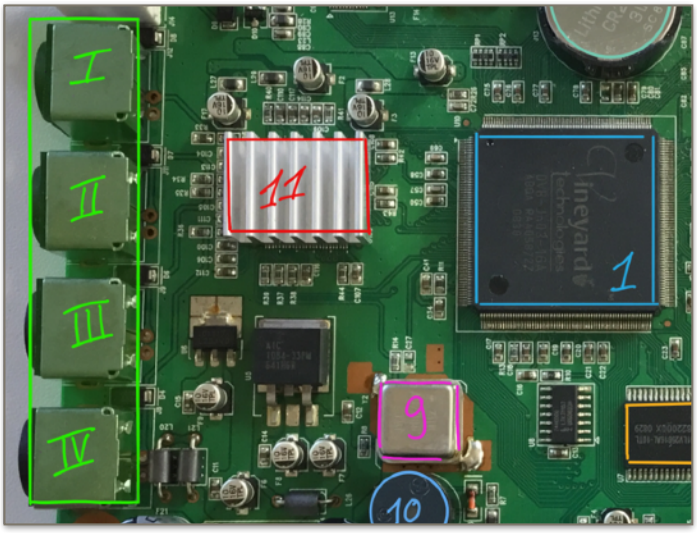
Photo #4

1.3 Memory

On the circuitboard there are four integrated RAM modules — two SynchronousDynamicRAM(2,3) and two AsynchronousStaticRAM(4,5). SDRAM(2) is volatile, however it is powered by battery, which prevents recorder from reconfiguration, when powered-off. SDRAMs(2,3) are used by DVR chip(1) main memory when device is powered on. They require synchronisation, which is done with aid of crystal oscillator(8 or 9).

ASRAM(4) is used by DVR chip(1) as cache memory, at it is faster then SDRAM and doesn't have to be refreshed. ASRAM(5) is used by micro-controller(7).

Photo #5



1.4 Video Input

Video input comes from 4 ports(i,ii,iii,iv), which is then transferred to the microprocessor(this could also be bridge-controller, performing the same tasks) with a heat-sink(11), where data is formatted to be managed by DVR chip(1).

1.5 User Input

User can input information in 2 ways: using buttons(red) on remote-control or control-panel.

1.5.1 Remote Controller

Photo #6

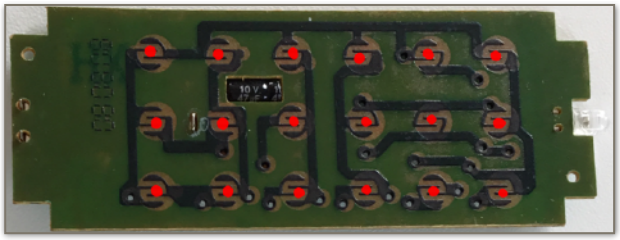
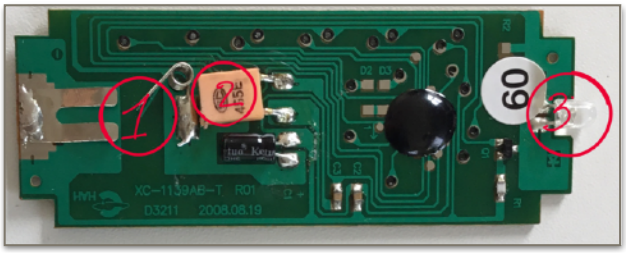


Photo #7



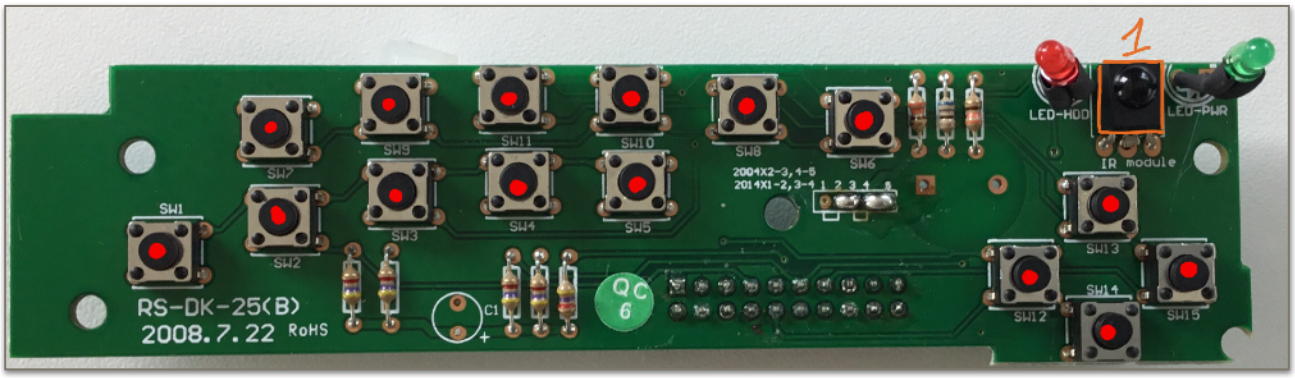
[1] Digital Video Recorder (DVR)

(Captions for Photos #6 and #7 above right and left) K-Force 2919-C

If button pressed on remote-control, the current from battery(1), passes to a ceramic-resonator(2), which resonates in specific frequency (corresponding to pre-defined commands), then signal is passed to bulb(3), which lights up and transmits an encoded IR ray to control-board.

1.5.2 Control-panel

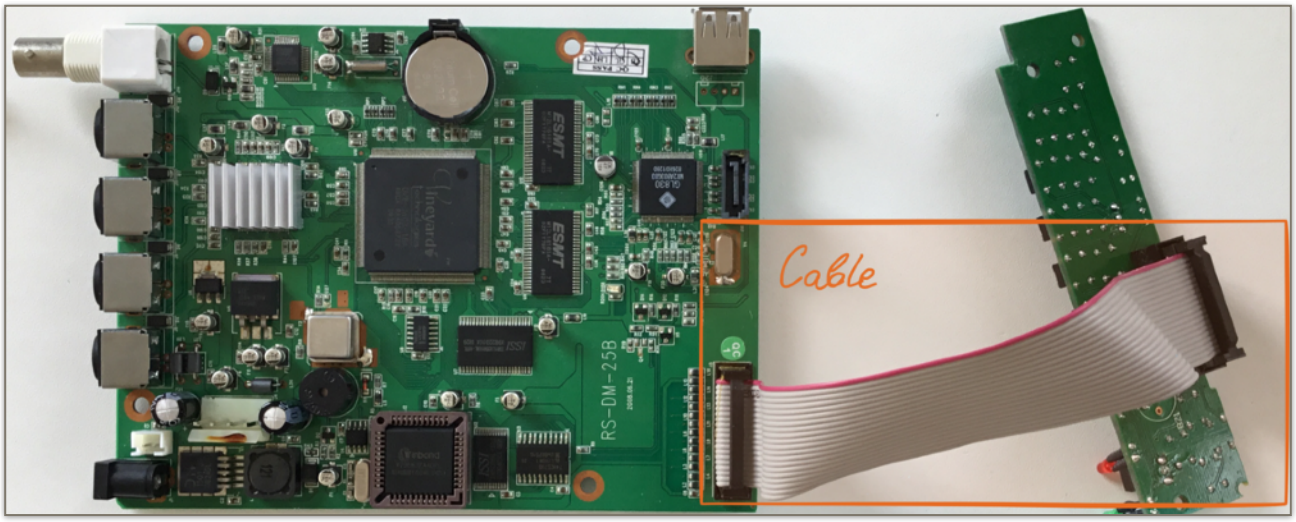
Photo #8



Signal received by either IRModule(1) or switches(red) *(Caption for photo #8 above)* Is transferred to main-circuit via 21-pin cable(Cable) *(Caption for photo #9 below)*

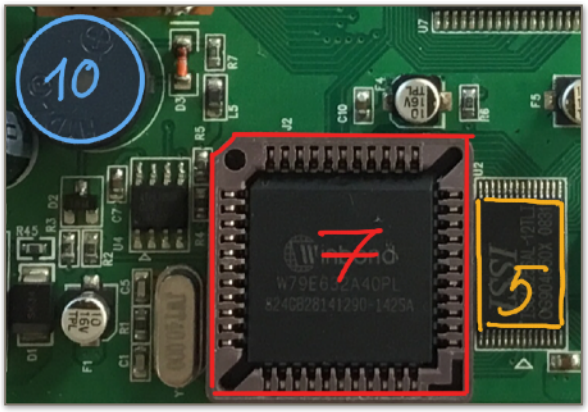
1.6 Microcontroller

Photo #9



The signal is received and transferred to microprocessor(7),essentially an 8bit CPU, to perform functions. ASRAM(5) is used as instruction register. To notify user of system status — buzzer(10) or LEDs(Control-board) are used.

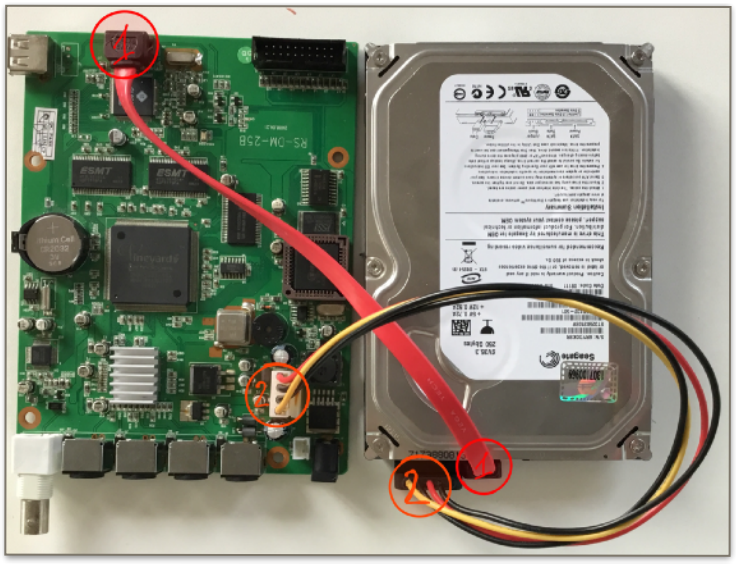
Photo #10



1.7 HDD

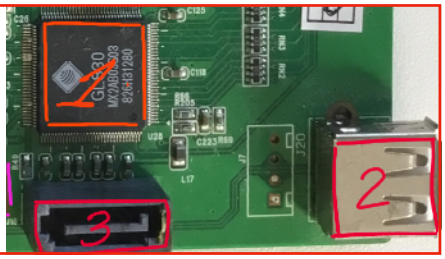
HDD is connected to main-board via 2 wires: SATA(data transfer(1)) and power wire(2).
(Caption for photo #11 below)

Photo #11



The data from HDD is transferred to a bridge controller(1), which acts as a transceiver/receiver for the data from USB2.0(2) and SATA(3) ports
(Caption for photo #12to the right)

Photo #12



1.8 Output

When data needs to be outputted it passes through DigitalVideoEncoder(1) and then transfers through VideoOutput(2)
(Caption for photo #13 below)

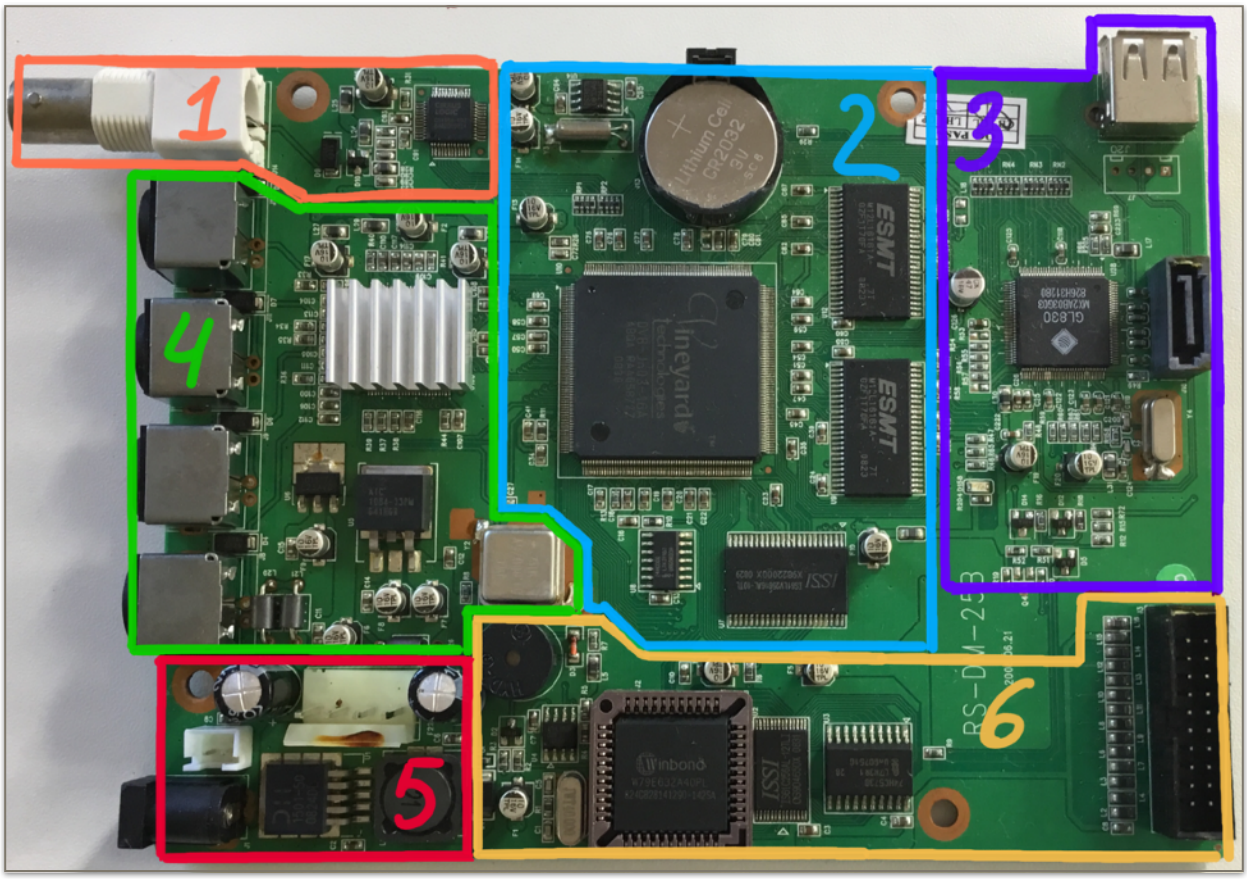
Photo #13

1.9 Circuit Blocks

Although, all of the components on the circuit are interconnected, they can be divided into “sub-circuits”, where each contains components to perform specific tasks.

(Caption for the photo #14 below)
1. Video output circuit-block
2. Main processing circuit-block
3. Data transfer/encoder circuit-block
4. Data input/decoder circuit-block
5. Power circuit-block
6. User Interaction circuit-block

Photo #14



Conclusion

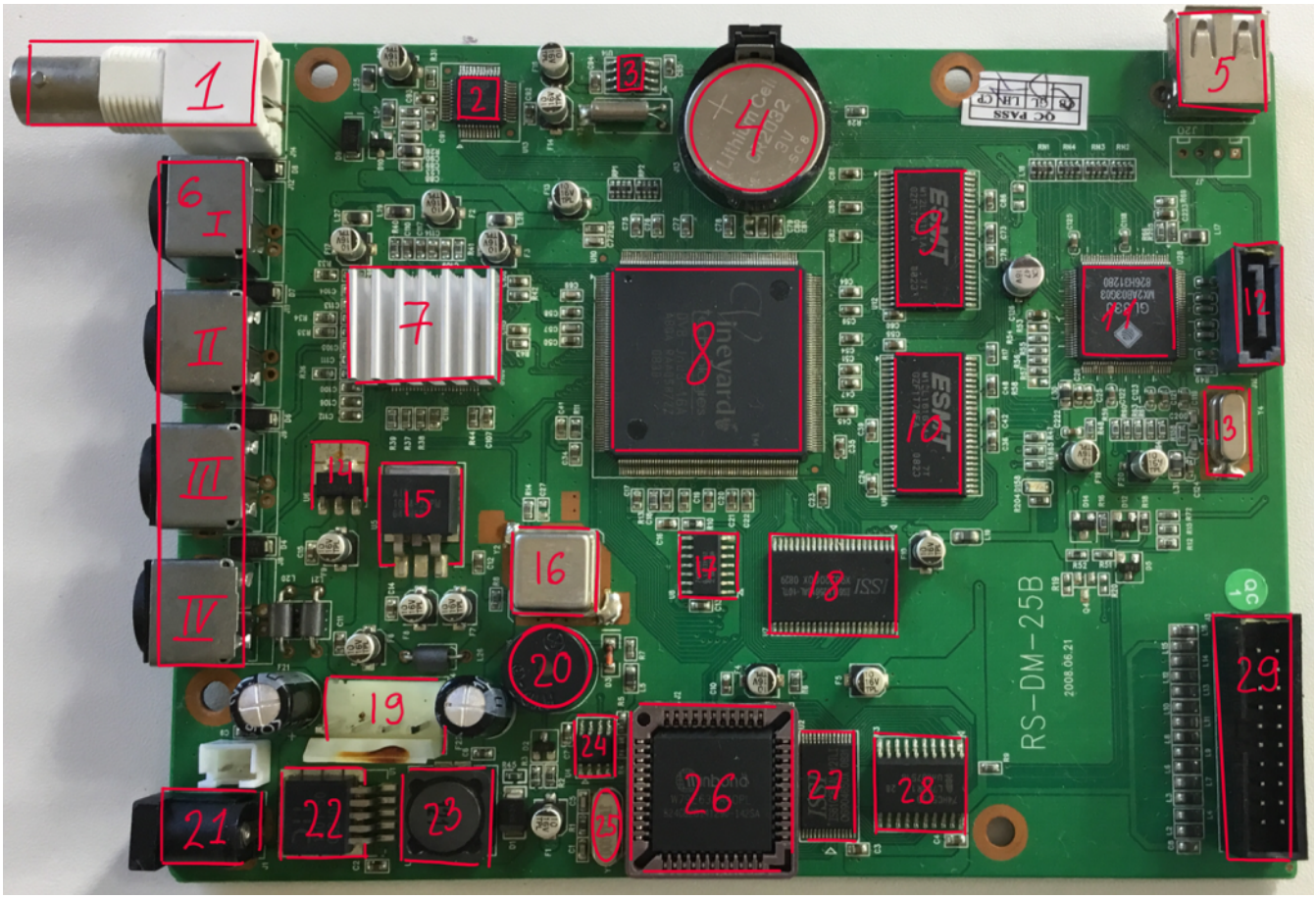
This was the first time I have analysed a circuitboard in so much detail. Even thought DVR is relatively simple product with limited functionality, I still learned many lessons from it. For example, before my knowledge was limited to RAM and ROM, whereas now I know about AS and SD RAMs, their uses and differences. I won’t ever thought that outdated product like this, carries such beauty and complexity in its detail. I was amazed by it and definitely enjoyed the pleasure to understand the full mechanism of it.

Report word count = 495 Words

Appendix

Component List:

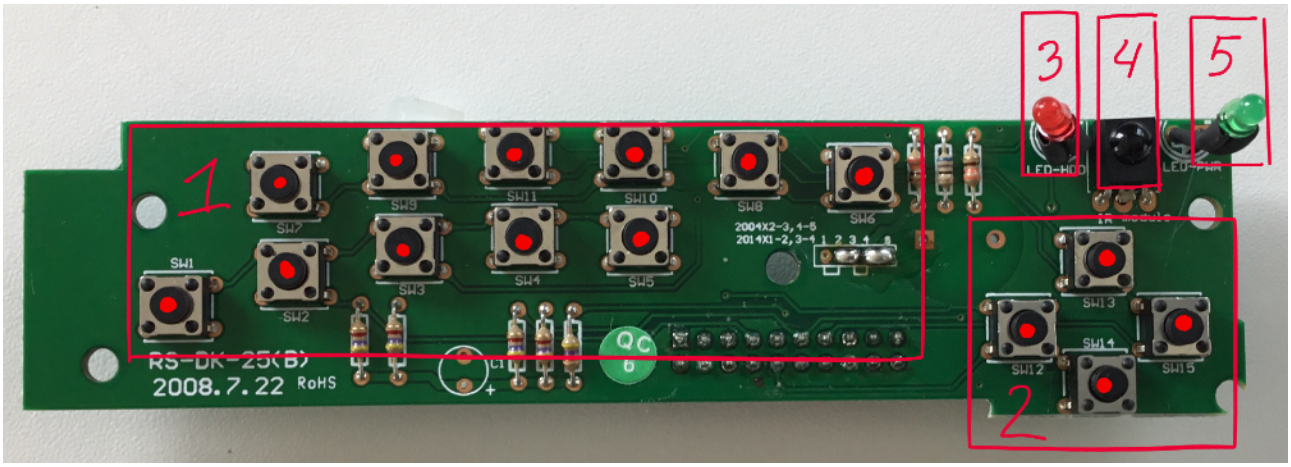
Main Circuitboard



1. Video Output Channel
2. Cirrus Logic NTSC/PAL Digital Video Encoder
3. DS1307 Real-Time Clock
4. Lithium cell battery 3.3V
5. USB 2.0 Port
6. Female Sockets for DMX 5 pin cables
7. Microprocessor with heat sink (model cannot be identified due to glued heat sink)
8. Vineyard Technolodies DVR chip (DVB-Jn03-16A)
9. ESMT 512K x 16Bit x 2Banks Synchronous DRAM
10. ESMT 512K x 16Bit x 2Banks Synchronous DRAM
11. GL830 USB 2.0 / PATA to SATA bridge controller
12. SATA cable port

13.JWT25000C12 crystal oscillator
14. Transistor
15. 5A Low Dropout Positive Regulator, for changing Voltage
16. JWT 54.000/5V MHz crystal oscillator
17. NXP 74HC00D Quad 2-Input NAND Gate
18. ISSI 256K x 16 Asynchronous CMOS StaticRAM
19. HDD power supply cable
20. HYDZ magnetic buzzer
21. DC power supply port for 12V
22. 150kHz, 3A PWM Buck DC/DC Converter
23. Inductor
24. ATMLH806 IC chip
25. JWT 40.000 crystal oscillator.
26. Winbond 8-bit Microcontroller
27. ISSI 32K x 8 High-Speed CMOS Static RAM
28. NXP Octal D-Type Latch with 3-State Outputs
29. Female socket for 20 Pin cable

Controller Panel



1. Set of 11 switches with pre-defined functions
2. Set of 4 switches with pre-defined functions
3. Red LED for indicating HDD status
4. Infra-Red module for receiving signals from remote control.
5. Greed LED for indicating power supply status

Remote Control

Photo Front

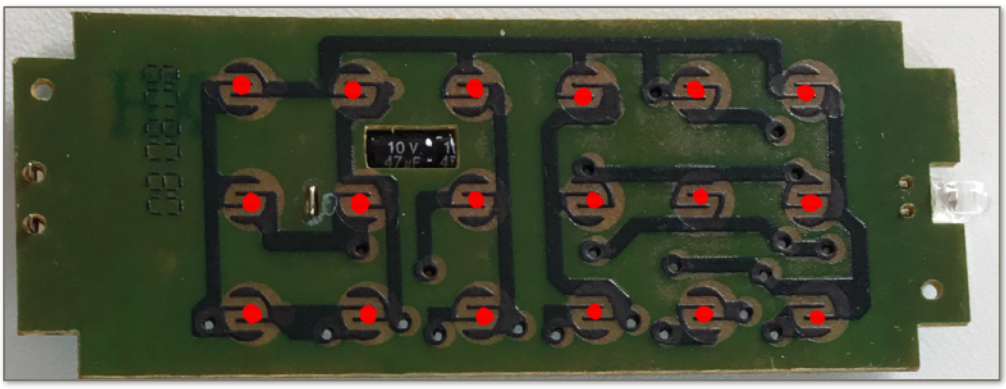
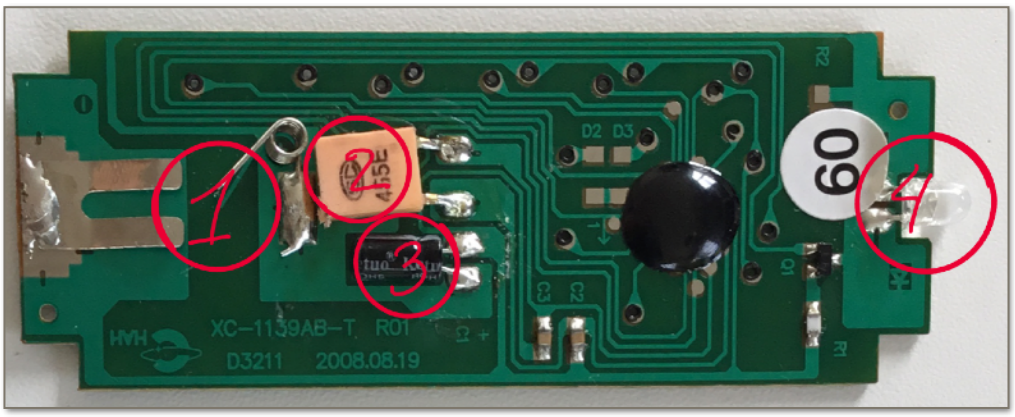


Photo Back



Shown in RED — Spots for rubber switch contacts, i.e. analog of button switch

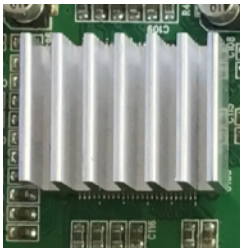
1. Slot for 3V lithium cell battery
2. Ceramic Resonator 455E
3. Ketuo Rohs capacitor 10V

Tables of Components:

Table 1 Board Components		
Resistors (R)		
Main Circuitboard	205	Function: An essential circuit component, which allows to reduce current flow or divide voltages.
Control Panel	8	
Remote control	2	
Capacitors (C)		
Main Circuitboard	223	Function: A component that stores potential energy of an electric field. Can discharge quickly, which allows to stabilise voltage supply
Control Panel	0	
Remote control	2	
Inductors (L)		
Main Circuitboard	17	Function: Is used to change the current within the circuit, by using Faraday's law of induction
Control Panel	0	
Remote control	0	
Diodes (D)		
Main Circuitboard	12	Function:

Table 1 Board Components		
Control Panel	0	A semiconductor that allows current to travel only in one direction. And gives infinite resistance in another.
Remote control	3	
Integrated Circuit (U)		
Main Circuitboard	12	Function: A semi-autonomous “circuit-board”, which can serve different purposes
Control Panel	0	
Remote control	3	
Oscillators (Y)		
Main Circuitboard	4	Function: This component oscillates, producing signals of different frequencies. It converts DC to AC signal.
Control Panel	0	
Remote control	0	
Connection Points (J)		
Main Circuitboard	20	Function: Specific holes in the circuitboard, which allow to attach additional components.
Control Panel	0	
Remote control	0	
Transistor (Q)		
Main Circuitboard	4	Function: A semiconductor, main use of which is amplification of the electronic signals and power.
Control Panel	0	
Remote control	1	
Fuse (F)		
Main Circuitboard	20	Function: Device which melts down and breaks the circuit in care of current overdraw.
Control Panel	0	
Remote control	0	

Table 2 Processor Components

Component Name	Purpose	Count	Image
Vineyard Technolodies DVR chip (DVB-Jn03-16A)	Chip, analog of CPU, used to perform different functions and operations pre-defined in manufacturer's software. Is limited to the defined functions	1	
Winbond 8-bit Microcontroller	This micro-controller is essentially an 8-bit CPU. In DVR it receives the user commands, performs a fetch-decode-execute cycle and shows the user status of HDD and power thought the LED lights	1	
Microprocessor with heat sink (model cannot be identified due to glued heat sink)	This Microprocessor receives data stream from the input channels and encodes it into a readable for DVR chip format (Although, this could also be a bridge controller module, performing the same task)	1	

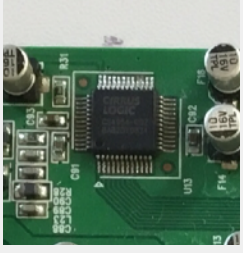
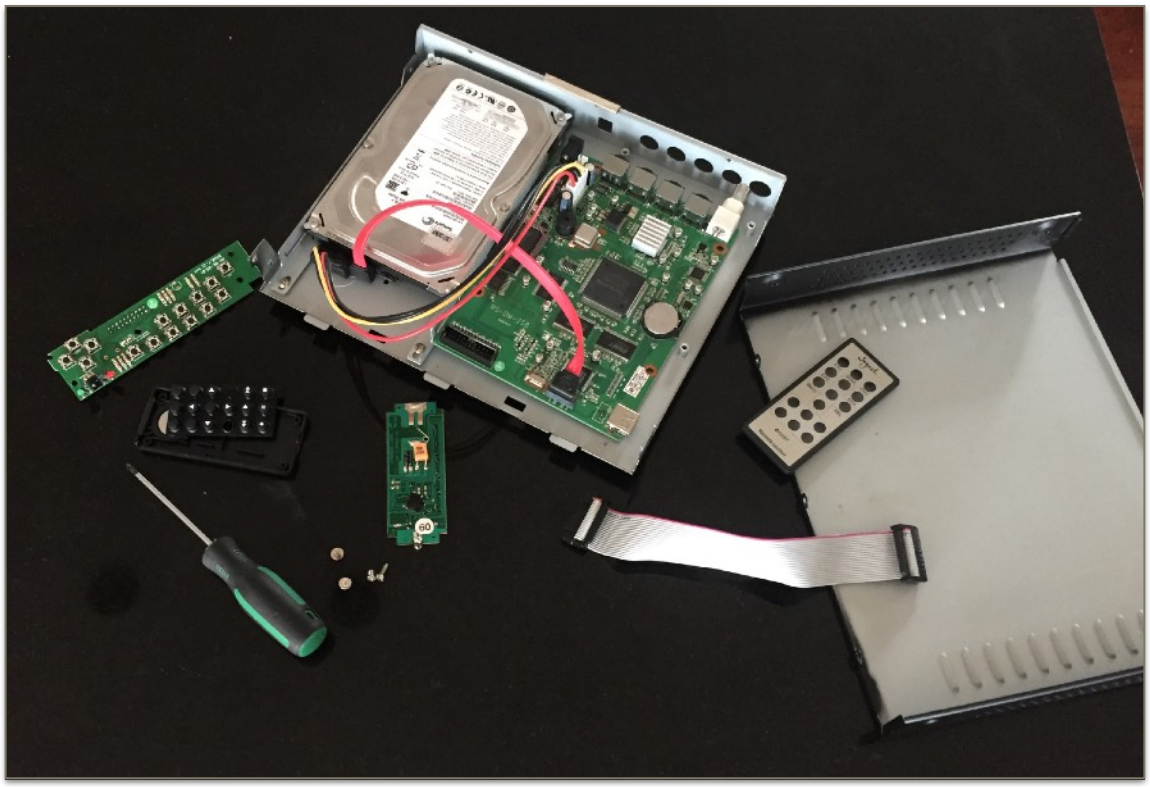
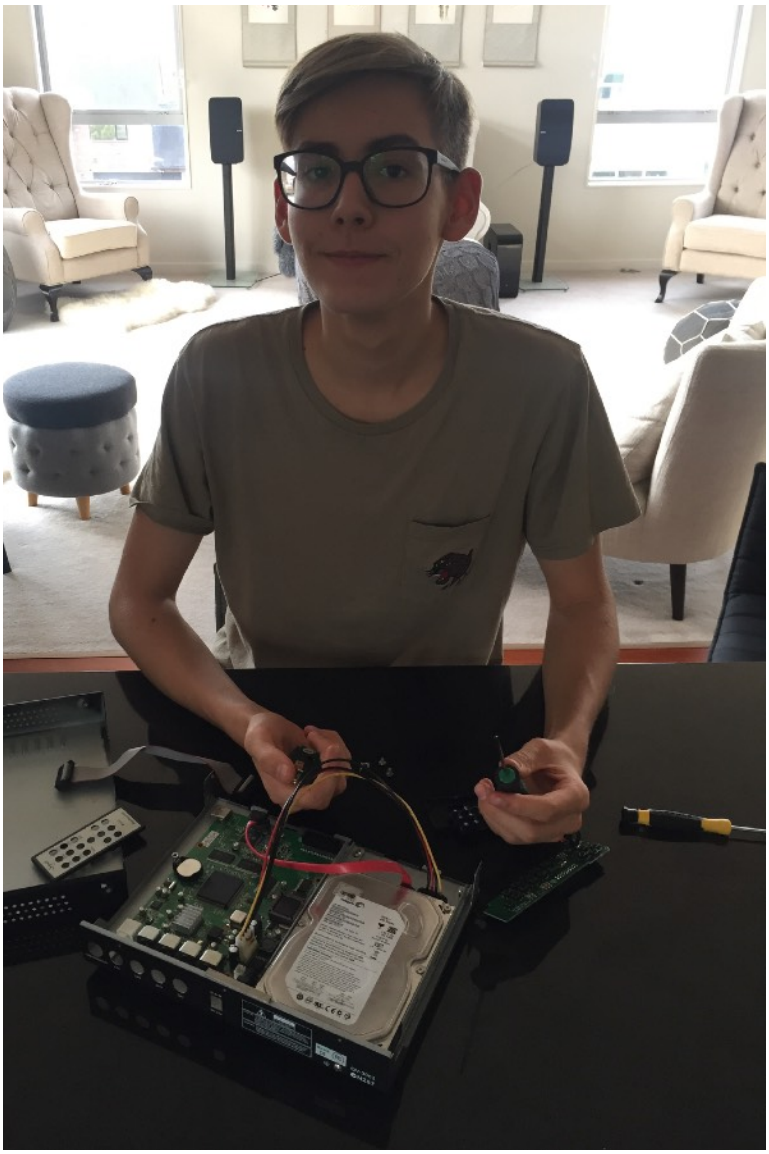
Component Name	Purpose	Count	Image
GL830 USB 2.0 / PATA to SATA bridge controller	This bridge controller, is made to encode the data from and to SATA and USB 2.0 formats, hence allowing to transfer data to and from HDD	1	
Cirrus Logic NTSC/ PAL Digital Video Encoder	This is a Digital Video encoder it encodes the data stream from the circuitboard into a format used in Video Output cables.	1	

Table 3 Data Encoders

Table 4 Memory Slots

Component Name	Purpose	Count	Image
ESMT 512K x 16Bit x 2Banks Synchronous DRAM	This is a synchronous Dynamic Random-access memory module. It has to be synchronised in order for it to work, as it performs 1 action per period. Even thought it is a volatile memory on this circuitboard it is directly powered by a battery, which allows SDRAM to store memory even thought the device is powered-off. It is used as main memory slot for the DVR chip	2	
ISSI 256K x 16 Asynchronous CMOS StaticRAM	This is an asynchronous Static Random-access memory module. It is faster then SDRAM because it is independent of synchronisation. In this circuit it is used by the DVR chip as cache memory slot	1	
ISSI 32K x 8 High-Speed CMOS Static RAM	This is an asynchronous Static Random-access memory module. It is faster then SDRAM because it is independent of synchronisation. Here it is used by microcontroller as its own memory slot.	1	





On the Photo (Above):
Disassembled digital video recorder

On the Photo (to the left):
Me working on the project

On the Photo Below:
K-Force at Asia-Pacific Robotics Competition