



# **AON-Robotics**



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## I. Introduction

The selected item by AON-R Team was a Yamaha CRX-E300 desktop radio from 2005. The reason the radio was chosen, besides its availability for disassembly, was because of its diverse components ranging from simple passive components to more complex chips utilized for signal amplification or data conversion. This will provide us with some good insight on how a radio works, as in, how it takes signals and plays them.

## **II. Parts List of Radio**

- a. Passive Components/Modules: Passive components are those which are incapable of controlling current by means of another electrical signal. The ones found in the radio are the following.
  - Resistors (R)- Component that reduces the flow of current
  - Inductors (L)– Stores energy in the form of magnetic field
  - Capacitors (C)- Stores and releases electrical charge
  - Diodes Component that conducts only in one direction
  - Potentiometers Changes resistance by varying the amount of contact between two conductors. Generally used as an interface between user and radio to control volume and other aspects of audio output.
  - Passive Crystal Oscillator Can be used to provide a stable clock signal for integrated circuits or to stabilize frequencies for radio transmitters and receivers
  - Relays Electromechanical switches
  - Switch Mechanical switches. Pushbuttons and a rotary switch was found.
  - Fuse Conductor that melts when current that exceeds its capacity has been drawn to its path.
  - Voltage Regulators Used to drop voltage level to the designed value.

**Note:** When RLC are used together, they can be used to create a bias for active components or to filter out unwanted elements within electrical signals.

- **b.** Active Components/Modules: They are capable of electrically control current. The active components found in the radio are the following:
  - Integrated Circuits Set of electronic circuits in a chip that can perform a single or several functions. The ones found in the radio can be found with the images in the appendix section.
  - Crystal Oscillators Used to aid in the tuning of radio frequencies because of its reliability.
  - Optical Reader Scans disk information by reflecting light emitted by a laser diode onto the reading lens.
  - LCD Used to display various messages relating radio status and other essential information.
  - Inductive Proximity Sensors Generates an electrical signal when a metal approaches the sensor.
  - Bridge Rectifier Converts AC to DC.
- **c. Electrical Machines:** They operate using electromagnetic forces, the following that were found in the radio:
  - Transformers Uses windings to induce an increased or decreased voltage and current output while keeping a high-power efficiency percentage.
  - Brush Motors DC powered motors utilized for the disk drive operation.
- **III. TI Components-** A total of 16 diverse kinds of integrated circuits where found and researched. Even though the IC were not TI brand, we were able to find that half of them had an equivalent model within the Texas Instruments catalog. These components are listed below:
  - 1. Frequency Synthesizer (LC72131K)
  - 2. Dual General-Purpose JFET-input Operational Amplifier (NJM2068D)
  - 3. Brush DC Motor Controller (LB1641)
  - 4. Small Signal Bipolar Transistor (2SA1037K)
  - 5. Multiplexers/Switches (LC78211)
  - 6. SIPO Based Peripheral Driver (BU2092)
  - 7. High Speed CMOS Logic Quad Buffer (HD74HC125P)

 High Speed CMOS Logic Analog Multiplexers/Demultiplexers (MC74HC4051N)

## **IV.Conclusion**

After taking the desktop radio apart, we concluded that the device works like the diagram shown below. The boxes show the different components that where found within the radio. Their function can be seen in the appendix section of the report. The gray arrows indicate the direction of signal flow, while the yellow arrow indicates that power goes to the Main Board of the radio.

This reverse engineering exercise was an excellent experience for all the students involved. It helped us to further understand the complexity of the design process behind each product before it reaches the customer. It is evident after the disassembly of an electronic device that the integrated circuit design is fundamental and integral of all electronic devices. It also made the team realize the importance of modular design with just a simple desktop radio. After this report, we may end up using similar electronic chips for homemade projects and adventures.



## Radio Disassembly Images



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# Appendix

Most of the boards contain almost all the components previously mentioned in the *Internal Components of the Radio* section. But not all will be marked to avoid cluttering the image of the boards. Only examples of those components will be shown so the reader can have a general idea of what the component looks like.

**Main Board:** Connected to all the other boards in the radio. Used for power conversion and controls the output for speaker output.





**AM/FM Tuner Board:** Used to receive radio signals and decode and play them.

Inductor

Potentiometer

Crystal Oscillator



- IC-LA1837 Automatic radio station selection.
- IC-LC72131 Frequency Synthesizer



Volume Board: Used for volume selection of audio output.

### Potentiometer

- IC-NJM2068D Low Noise Dual Operational Amplifier, which is used to amplify signals
- IC-LB1641 Bidirectional Motor Drive, which is used to change the direction of movement of a motor

**LCD Board:** Used to display important messages, receive IR signals, power on the radio, and perform other functions the radio offers



**Audio Tuning Board:** Used for adjusting audio output characteristics, selecting type of input for radio, and includes an auxiliary jack.





Switch – Rotary switch used for radio input selection

Auxilary Jack

Audio Input Board: This board is used to obtain several types of inputs, like auxiliary jack, tape input through the red plugs scene on the left, etc.



#### Diodes

- Transistor used as an electrical switch or as an amplifier
- IC-LC78211 Function switch for serial data.
- IC-BU2092 12-bit serial input, parallel output drivers
- IC-NJM2068D Low noise dual operational amplifier
- IC-HD74HC125P Quad bus buffer (amplifier with unity gain)

IC-MC74HC4051N – 8 channel analog multiplexer/demultiplexer for data input selector/data output selector

**CD Drive Board:** Used to control the motors that rotate the disk, moves the optical reader, opens and closes the tray, and processes the data read to the board.



Active Crystal Oscillator

## Optical Reader

- Brush Motors Used for opening and closing tray, spinning disk, and moving the position of optical reader
- IC-AN8785SB Linear driver for CD/CD ROM
- IC-NJM2068MD Low noise dual operational amplifier

IC-7C74HC125AF – Quad bus buffer

- IC-MN35511AL 20-bit digital signal to analog signal converter (DAC)
- IC-AN8399SA Current sense amplifier. Used for outputting a voltage proportional to the current flowing in