

THE ART OF SUCCESS IN ELECTRONIC SERVICING



By Jestine Yong
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DEDICATION

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I would like to thank God for giving me the skills, knowledge, patience, and desire needed to write this e-book. My wife, Michelle Tan, shared both my ideas and complaints patiently and has given me invaluable support and encouragement. I would not have completed the work without her presence and advice. I would also like to thank my partner William Hor and all my colleagues for their endless assistance.

Preface

What you want to do in life is often related to an early interest. My first interest in electronics developed at the age of eight or nine – there's where I began to dismantle toys and torch lights. I wondered how and why, with the use of batteries, a motor can rotate and a bulb lights up. Quite often, I will dismantle a working toy into many pieces to find out what is really 'inside' the toy, causing it to move and make noises.

After thorough research, I will usually end-up being unable to put back the parts that I have dismantled. I'll just keep the parts; motor, speaker, gear, electronic board, screw or whatever I can salvage to place it into my cabinet. Whenever I have the time, I will build my own circuit using the parts that I have salvaged. Although I was too young to understand the math's and science of electronics at that time, I found that making things work and a little bit of troubleshooting was indeed very fun.

Due to this investigative instinct, I decided to choose the electronics repair industry for my career. In the years that followed, I've learned a lot about electronics and troubleshooting. The purpose for me to write this book is to help other electronic enthusiasts, technicians and engineers who want to troubleshoot any kind of electronic equipment as quickly as possible. Although you may already be using some of the information in this book, still I am sure that some information may be new to you. The troubleshooting procedure and repairing business strategies explained in this book are simple, but very effective, and result-orientated. Whether you are an amateur or a professional in electronic repairing, this book will be useful as a successful guide to electronic servicing.

CONTENT

PART 1

1.1	Introduction to Electronic Servicing	6
1.2	Safety first.....	7
1.3	Tools and Test Equipment.....	12
1.4	Workshop.....	22
1.5	Understanding the Equipment.....	23
1.6	Steps in Troubleshooting.....	24
1.7	Documentation.....	27
1.8	Electronic Books and Magazine	28
1.9	Sight, Sound, Smell and Touch	29
1.10	State of mind	30

PART 2

2.1	Good management	31
2.2	Time is money.....	33
2.3	Estimate and quotation	35
2.4	Keeping spare parts	36
2.5	Sharing knowledge and togetherness	38

PART 3

3.1	Setting up as an Authorized Service Centre (ASC).....	39
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PART 4

4.1 Promoting your business 41

PART 5

Conclusion 43

Suggested Technical Reference Books 44

Appendix

About the author 47

Subscribe to my newsletter 48

Contact Us..... 49

Copyright/Disclaimer..... 50

PART 1

1.1 Introduction to Electronic Servicing

With countless new electronic products or equipment reaching the market, there is a large demand for electronic repair technicians and engineers. As a result, you may be interested in moving into the electronics repair field. The electronic servicing field is considered a prestigious job. If you are really good in your work, there is almost no competition and you can acquire skills that allow you to earn enough money. Servicing is an ideal combination of your intelligence, efficiency and easy mechanical work. By gaining more experiences the efficiency and skills automatically becomes instinctive.

Many electronic equipment servicing operations are simpler than you may think. You will be surprised to learn that most servicing problems have simple causes – worn cables, dirty connectors, a loose screw in the works, and so on. Almost any end-user can check for this kind of problem. However, there may be other problems caused by component failure. You may give up and say “I’m not an expert in electronics”. You may be surprised to learn that many “troubleshooting” jobs do not require much detailed knowledge of electronics. Even in a “professional” troubleshooting operation, the technician or engineer may not have a detailed knowledge of the circuitry. Electronic servicing is not mysterious or difficult; it only requires your patience and some basic knowledge in electronics.

If you are thinking of becoming an electronics repair technician or engineer, you need proper qualifications. Get at least a certificate in basic electronics or its equivalent through electronic courses. You can go far beyond this by continuing up to a diploma level. As you progress, you will discover your weakness. It’s then up to you to find out more by attending professional courses or reading up related books. Of course, the higher the level you desire, the better. Every second, electronic equipment breaks down and we will need good technicians and engineers to ensure a good repairing job is done. So, if you are thinking of joining us – go for it!!!

1.2 Safety First

Whenever you're working on any electronic equipment, your own safety has to come first. Every electronic technician must always take safety precautions before he or she starts work. Electricity must be handled properly, or else it can injure or cause fatalities. Here are some basic steps that show you how to avoid accidents from occurring.

1. *Electrical Shock*

Once you open up a set cover, you're actually exposing yourself to the threat of electric shock. Always keep in mind that safety has to come first.

A serious shock may stop your heart and if large electric current flows through your body, you will receive serious burns. Here are some rules, which should help you to avoid electricity hazards.

- a) Always turn off the equipment and unplug it before you begin to work.
- b) If you have to run tests while the equipment is operating, turn the equipment on, make your test carefully, and then turn the equipment off again.
- c) Wear rubber bottom shoes or sneakers.
- d) Try to do the work with one hand, while keeping the other in your pocket. That keeps the possible current paths away from the heart.
- e) Don't attempt repair work when you are tired or rushed.
- f) Always assume that all the parts in the power supply are "**HOT**".
- g) Use only plastic screwdriver for shock protection during service operation.

2. *Discharging Switch Mode Power Supply (SMPS) Capacitors*

Most SMPS have a resistor to drain the charge in the main filter capacitor. But some resistors may fail and the capacitor can hold this charge even after you have turned off the equipment. This capacitor has a range of about 150uf to 330uf at 400 working voltage.

Before you start to work on a power supply, always turn off the power and discharge the capacitor. You can do this by placing a resistor across the two legs of the capacitor. The resistor value can be around 2.2 to 4.7 kilo ohms 10watt. It takes only a few seconds to fully discharge a capacitor. Double-check the capacitor with a voltmeter after every discharge.

NOTE / WARNING:

Do not discharge capacitor with screwdriver because: -

- i. It may melt the tip of the screwdriver.
- ii. It will damage the capacitor and its terminal.
- iii. If we are too near to the point of discharge, the heavy spark generated may cause injury to our eyes.

3. ***Hot Ground Problem***

Modern equipment consists of two grounds, one of which is a “hot” ground while the other is a “cold” ground. Hot ground is in the primary side of a switch mode power supply while the cold ground is the equipment ground.

Be careful when taking voltage measurements around these grounds. For example, if you want to check the primary circuit of a power supply with power on, always ground your meter or scope to the hot ground, while check the secondary side using the cold ground.

If the “Hot” ground is not used and you use only the cold ground, the voltage measurement might not be correct and it may destroy your meter. One way to prevent this is to use an “isolation transformer”.

4. ***Isolation Transformer***

When servicing any electronic equipment, always use an isolation transformer to protect yourself from an electrical shock. During servicing, the isolation transformer is connected between the equipment and ac power line. An isolation transformer is a transformer that has a 1:1 turn ratio to provide the standard line voltage at the secondary outlet. This means that it does not change the voltage. The transformer still produces 240V AC at its outputs, but both sides of this AC lines are independent of ground. If you were to accidentally touch one of these outputs, you would be protected. The isolation transformer must be rated to handle the power of any equipment connected to it. Typical ratings are 250 to 500W.

Note: A variable transformer or variacs is not an isolation transformer.

5. *Discharging the Cathode Ray Tube (CRT) Anode*

The CRT of a Monitor and TV can hold a dangerous charge, even if the Monitor and TV have not been used several days. All CRT have graphite coating on the internal and external surfaces of the glass bell. This conductive graphite coating are commonly known as aquadag coating and it forms the two plates of a high voltage filter capacitor using the glass in between as dielectric. The external coating is always connected to the Monitor and TV chassis ground by a spring arrangement around the CRT.

This high voltage filter capacitor has very low leakage. Before removing a CRT, ensure that you discharge this capacitor in order to prevent shocks or serious injuries.

6. *High Voltage*

Monitors and TV have sections that use very high DC voltages. The high voltage is needed to be applied to the CRT to attract the electron beam to the phosphor. This high voltage could be as low as 12,000 volt in a monochrome Monitor or as high as 30,000 volt in large color monitor. Flyback Transformer is the part that is used to generate the high voltage.

The high voltage circuit inside a Monitor or TV can give you a dangerous electric shock and causes you to jerk violently. You could cut yourself by accidentally knocking on sharp chassis edges. Be familiar with the high voltage circuits before you work on any high voltage equipment.

7. *X-Radiation*

An X-ray is a form of radiation produced when a beam of electrons strikes some material at a relatively high speed. The only source of X-ray in a modern Monitor or TV is from the CRT. Prolong exposure to X-ray can be harmful. However, the CRT does not emit measurable X-ray if the high voltage is at the high voltage adjustment value only. When high voltage is excessive, then only X-ray is capable of penetrating the shell of the CRT, including the lead in glass material.

Test the brightness and use a high voltage probe to monitor the high voltage each time a Monitor or TV comes in for repair. When the brightness is raised, usually the high voltage will go-down, and when brightness is reduced the high voltage will go-up. When troubleshooting a Monitor or TV with excessively high voltage, avoid being unnecessarily close to the set. Do not operate the Monitor or TV for longer than it is necessary to locate the cause of excessive voltage. To ensure continuous X-ray protection, replace the CRT with one that is of same or equivalent type as the original.

8. *Wearing Goggles*

The CRT has a complete vacuum inside. It must be handled carefully and safely. Always wear goggles, to protect the eyes from flying glass, in the event of an implosion when removing and old tube from the set and installing a replacement. Do not lift the CRT by the neck, instead hold the CRT with both hands on the heavy glass front of the tube. Also be sure to place the CRT facing downwards on a soft surface.

9. *Electrostatically Sensitive Devices (ESD)*

Integrated circuits (IC) & some field-effect transistors are examples of ESD devices. These components can be easily damaged by static electricity. There are several techniques which can reduce the incidence of component damage, caused by static electricity.

- a) Immediately, before handling any ESD devices drain the electrostatic charge from your body by touching a known earth ground.
- b) Store ESD devices in conductive foam pad until installation in circuit.
- c) Wear a grounding strap, attached to your wrist.
- d) Use only a grounded tip soldering iron to solder or desolder ESD devices. (Some suggest using a battery powered soldering iron when working on ESD circuits).

10. *Fire*

Before returning the equipment to the user, every reasonable precaution is taken to avoid fire hazards. Be sure to use only direct replacements and not one that defeats some safety measure. For example, the fuses in your equipment are carefully designed. Fuses must be replaced only with the same size, type and ratings. Should you install a fuse that is too large than the original rating, chances are that the equipment will be flammable.

11. *Lifting*

Some equipment like TV, Hi-fi or Monitor can easily weight around 15 to 30 kilogram. Many problems arise when lifting this equipment from the floor. Wrong posture when lifting equipment may cause acute back pain. The right way to lift is keep your back straight and upright, and use your legs to supply the lifting power.

12. *Ventilation*

Be sure that your work place has good ventilation. Prolong exposure or excessive inhalation of vapors from chemical spray and fumes from lead may cause damage to your nervous system or body.

13. *Laser Warning Labels*

If you are troubleshooting DVD, VCD, laser printer and other laser-related products, you will notice a laser warning label on or near the laser head assembly. Do not stare at the laser beam at any time. Always avoid directly exposing your eyes to the beam. Prolong exposure of laser beam to the eyes may cause eye injury or loss of sight. Do not attempt to adjust the laser gain controls by any methods, other than those described in the service manual. Incorrect adjustment can increase the laser radiation beyond acceptable limits. You have to use a laser power meter to confirm the existence of a laser beam.

1.3 Tools and Test Equipment

This chapter introduces you to the tools and test equipment needed for electronic troubleshooting. You will need an assortment of tools and test equipment ranging from simple tool such as the screwdriver to sophisticated equipment like the Digital oscilloscope. Some simple fault of electronic equipment can be repaired by using only basic tools and test equipment. But if you are repairing electronic equipment for a living or you want to be ready to repair all kinds of electronic problems that come your way, you will need to invest in some specialized equipment. You can then be ready to move quickly when trouble strikes!!

Tools

Tools are the basic requirement of a service technician or engineer. Without tools, one cannot even open the cabinet and have access to the circuits.

Soldering Irons

Transistor and ICs can easily be destroyed by overheating. For this reason, you must choose carefully when you select a soldering iron for use with digital circuit like CMOS IC. Use a low-powered iron, with a rating of about 30 watts. Do not use a high-powered iron, because it can easily overheat an IC or other parts. If you overheat a trace on a circuit board, the heat can cause the trace to lift from the board. Soldering tips can be manufactured in a wide range of shapes and sizes. Before you select the best tip for the job, you must understand the ideal soldering conditions. Remember to turn off the equipment before you make any solder repairs.

Sponges

Always keep a damp sponge near your soldering station, and wipe the tip of the hot iron frequently while you're soldering. This will keep the tip clean and shiny for maximum heat transfer.

Soldering Iron Holders

If you have a soldering iron with no switch, (some soldering irons have a switch, where each press will increase the power from 30w to 120w), it will remain hot all the time when it is plugged in. Sometimes the solder iron becomes too hot and it melts the plastic case of the soldering iron. The holder is often formed into a spiral, with lots of air space to radiate the heat from the iron and also to prevent the soldering tip from touching other parts which can sometimes cause fire.

Solder

Solder is related by the proportion of lead to tin. For example, “60/40” solder is 60% tin and 40% lead. The diameter of the solder that I usually use is 0.8mm. Most solders are manufactured with a hollow center which contains “flux”. As a solder melts, the flux cleans the parts and prevents oxidation to ensure a good connection. Always use resin-core solder and under no circumstances should you use paste flux containing acids or solvents or use solder containing acid flux. Harsh solvents destroy delicate components leads and circuit traces.

Heat guns

You can often use temperature as a diagnostic tool. Many intermittent are thermal. That is, they appear at one extreme temperature or another. If the problem shows up only at a high temperature, it may be very difficult to find with the cover removed. With the cover removed, the circuits usually run much cooler, and a thermal intermittent will not show. In this case, it may be necessary to use a little heat to identify the problem. A home hair dryer works well if you use the lowest possible heat setting. Be careful not to overheat the circuits. Certain plastic materials can be easily damaged.

Freeze Sprays

Freeze sprays or spray coolers are available for tracing thermal intermittent. They use chemicals such as Freon to rapidly cool circuit components. A spray tube is included to control the application closely. Thus, it is easy to confine the spray to a specific component at one time. Be very careful not to use just any spray coolant. Some can generate static charges in the thousands of volts when they are used. Sensitive devices can be damaged by static discharges, so buy a brand that is specified as “anti-static”.

Dental Mirrors

A small, adjustable dental mirror is helpful when you need to look into out-of-the-way places especially if the components are located under the belly of the CRT.

Screwdrivers

Screws are made in different sizes, and they’re designed to be turned by screwdrivers of the corresponding sizes. You will need a good set of screwdrivers with both Philips and flat slotted heads. Many people have the habit of trying to turn a screw with whichever screwdriver they have. Most screws can be turned easily if you use a screwdriver of the right size.

A power screwdriver is also useful in electronic servicing because some equipment have numerous screws, that your hand will get tired unscrewing them.

Long-Nose Pliers

A long-nose pliers is needed to remove components once they are desoldered from the PCB board. They are very useful for reaching into tight spaces inside the equipment. For example, components located under the belly of the CRT are very difficult to remove without pliers.

Wire Cutters

Wire cutters are useful for cutting wires, wire ties, and lead on large parts, such as resistors and capacitors.

Wire Strippers

Before you can make connections with a piece of wire, you must “strip” away the plastic insulation on a wire. Resist the temptation to strip insulation using wire cutters. Even if insulation should be removed successfully, wire cutters often leave a nick or pinch in the conductor, which later might fatigue and break.

Magnifying Lamp

A magnifying lamp not only provides light, but also makes it easier to read component marking especially the surface mounted components (SMD) and small resistor color code. A magnifying lamp also can be use to check for cracks, broken solder joints or burnt components in a PCB board.

Spray Cleaner

The wiper at a variable resistor might accumulate dust after operating for a certain amount of time. This can result in all types of erratic or intermittent circuit problem. A spray cleaner can be used to solve this kind of problem. However if symptom persists, replace the variable resistor.

Toothbrush

You may use a toothbrush to look for intermittent or bad connection in a PCB board. Simply run the toothbrush over the PCB board until you push the bad connection into working. Most of the time you can locate the fault using this way.

In addition to the above listed tools, some tools like table vice, hammer with nail extractor and drill machine are also used in workshops especially for installation and dismantling work.

General Test Equipment

In this section, we highlighted general equipment for electronic servicing. Some equipment, such as a multimeter, is an absolute necessity for the test bench. Other equipment, such as a transistor tester, is useful but not imperative to have. In any case, the more equipment you have, the more prepared you will be to troubleshoot all kinds of electronic equipment problems.

Multimeters

There are two types of multimeters in the market, one is the analog while the other is digital. Some people call them multimeters or just meters, while other might refer to them as volt ohm meters (VOMs) or multitesters. Regardless of which name you choose to call them multimeters are the handiest and most versatile piece of test equipment that you will ever use.

The analog meter can measure ac and dc voltage, current, and resistance, and uses a meter to read out the test results. A digital multimeter (DMM) performs the same functions, but it produces a digital display. DMM are ranked by the number of digits they display. A “3½ digit” DMM will indicate three numbers for each reading. The “half digit” is reserved for character like “+1” or “-1”. The more sophisticated meters automatically choose the correct voltage or resistance range. This feature is called “auto-ranging”. DMM are easier to read, more tolerant of operator error, and more precise than their analog multimeters.

A good DMM also include features like a capacitance checker, frequency meter, continuity checker and transistor checker. The diode setting is used for checking all solid state devices such as ICs, diodes, transistors, SCRs and so forth.

Oscilloscope

Oscilloscopes offer a tremendous advantage over multimeters. An oscilloscope or “scope” can give you a “picture” of a changing electronic signal. Instead of reading signals in numbers or lighted indicators, an oscilloscope will show voltage versus time on a graphical display. Not only can you observe ac and dc voltages, but are also very helpful for checking the “shape” of an electronic signal. If you know what kind of signal to expect, and the scope shows you a different signal, you know something is wrong. The scope may be used to check the operating characteristics of parts like transistors and capacitors. Oscilloscopes have been used for many years to troubleshoot power supply, amplifiers, and other analog devices.

Don't get the idea that you will need an oscilloscope for every repair. For example, you need to check the presence of horizontal and vertical signal in the input and output of a microprocessor IC. It is also useful in checking the proper Red, Green and Blue (RGB) signal in the video circuit. Without an oscilloscope, it is difficult or almost impossible to trace the problem. The better the scope, the higher the frequency of the signals that it can display and much more expensive. Analog scope with 40 to 60 megahertz (MHz) bandwidth will serve you well. Some "dual trace" scopes can display two signals at once. This allows to you check the timing relationship of two related signal. If you have used an oscilloscope, then you probably know just how useful they can be.

Transistors Tester

You can make some simple tests on transistors using just a DMM. However, you can test transistors much more easily using a special "transistor tester". A transistor tester does a more thorough job at checking transistors than you can do with just a DMM. Many different types are available in the market. Transistor tester allows you to make an in-circuit test, without removing the transistor from the circuit board. The tester indicates whether the transistor is working, and it also allows you to measure the "gain" or output of the part. Most transistor tester can also measure diodes.

Frequency Counter

Some DMM is equipped with a built in frequency counter that can read frequency directly. The ranges available is dependent on your particular meter. Simple handheld meters can often read up to 100KHz, and bench top multimeters can handle 10MHz or more.

A frequency counter is useful for checking the frequency of, for example, the horizontal and vertical sync signals coming from the computer and the clock signal of the Monitors microprocessor.

DC Power Supply

In your servicing work, you will sometimes need to provide power to parts of a circuit board, without using the equipment output supply for troubleshooting purposes. The output of the power supply should be regulated so that the output voltage doesn't change as the power supply is loaded. I use a digital type of DC power supply which is a regulated power supply. It has a voltage range of between 0 and 30 volts and current range from 0 to 5A. The adjustable current which limits of up to 5A amps, protects both the power supply and the device under test from damage.

A power supply is useful in troubleshooting; for example, when you suspect that the microprocessor causes the Monitor cannot be turned on. You can always place +5 volts to its VCC input pin of the microprocessor and check if the outputs are producing any signals. The power supply can be used with other circuits, such as circuit in power section, video drivers, oscillators and etc.

Capacitance Meter

Without a capacitance meter, it is sometimes difficult to determine a capacitor's value. Choose a capacitance meter that accurately measures the value of any capacitor between 0.1PF to 20,000UF. Capacitance meter will usually display capacitance in microfarad (uf), Nano farad (nf) or Pico farad (pf). As long as your reading is within the tolerance of the capacitor's marked value, you know the part is good. It is best used to check fixed capacitor (ceramic, Mylar, etc). For electrolytic type of capacitor, an ESR meter is preferred. Some DMM is also equipped with a built-in capacitor checker. Always discharge a capacitor before testing.

Inductance Meter

Most inductance meter comes together with the resistance and capacitance measurement/range. It is also called the LCR meter. Inductance meter is required to determine a coil or a winding value. Winding's value in Flyback, power transformer, horizontal and vertical yoke coil can be checked with the inductance meter. An inductance meter will usually display inductance value directly in Henry (H), milihenry (MH) or microhenry (UH).

ESR Meter

Almost all electrolytic capacitor failures are due to high ESR (Equivalent Series Resistance). The high internal resistance reduces the capacitor's rate of charge and discharge, effectively making it an "open" capacitor. High ESR is usually as a result of dehydration of the electrolyte due to equipment heat, old age, corrosion, defective rubber seal and high ripple current.

High ESR in electrolytic causes various problems. In a monitor vertical section, they can cause over/under scan problems. In power section, they cause no power and power blink. In the color or video circuits, they cause intermittent or missing colors. In high voltage section, they cause horizontal output transistor (HOT) to blow several minutes after it is replaced.

The job of finding any high ESR in electrolytic capacitor is done by the ESR meters. Note that ESR cannot be measured by a digital capacitance meter or a multimeter. It has to be measured by the ESR meter. ESR meters come in all shapes, sizes and brand. We found that a unit called cap analyzer 88A ESR meter manufactured by EDS in USA to be the best value

for our repair shop. Cap analyzer 88A is a powerful ESR meter, user friendly, robust, versatile and capable in locating bad or shorted electrolytic capacitor while still in the circuit.

This unique meter uses a test frequency higher than most others (>100KHz), automatically discharges the capacitor under test, checks for DCR (DC Resistance) leakage, then checks and display ESR on a 20 segment LED bar scale. It includes a low capacitance one handed tweezers test probe, and even beeps from one to five times depending on the ESR reading of the capacitor. Because it is microprocessor controlled, it has more features and is much more accurate than other meters. Possibly, its best attribute is a three-colored chart on the front panel that shows typical ESR readings of good, fair and bad capacitors depending on their capacitance.

The cap analyzer 88A checks capacitors in-circuit accurately because the frequency is high enough to magnify the capacitor's actual capacity, and measures only the ESR. Both DCR and ESR measurement are under 50 milivolts so that no active devices are turned on. Because it checks DCR first, it will alert the technician immediately if the capacitor or anything else in that circuit is shorted or leaky, before it checks ESR. Portability and battery-operated, this makes it ideal for repairs at the site, eliminating a double service call and valuable technical travel time.

Specialized Test Equipment

In this section we highlight specialized equipment for repairing certain types of electronic equipment. These test equipments are specially designed to tackle only on certain type of circuit or component. Some repairs cannot be attempted without the help from the equipments. The required specialized test equipment depends upon which part of the electronic repairing field the technician or engineer wants to specialize in.

Troubleshooting Monitor and TV

1. Flyback Tester (Besides checking if the Flyback Transformer winding is shorted, it also can be used to check the winding of switch mode power supply, B+ coil and Horizontal yoke coil).
2. High voltage probe (To measure the high voltage at the anode of the CRT).
3. Pattern generator (It allows you to test and align the Monitor/TV using standard visual patterns).
4. CRT Tester/Regenerator (A CRT tester/regenerator enables you to test and regenerate the cathode ray tube (CRT) of a Monitor or TV).

5. Monitor/TV Analyzer (It is an all-in-one piece of equipment designed especially to test Monitor or TVs).
6. Universal Horizontal Analyzer (Localize Horizontal and B+ supply defects in Monitor and TV).

Troubleshooting audio equipment

1. Function Generator (Provides several different waveforms at a variable frequency in making audio tests of the amplifier).
2. Distortion meter (It is designed to measure total distortion at any frequency between 20Hz and 20 KHz).
3. Wow and flutter meter (The wow and flutter meter is ideal when servicing any record/playback equipment such as cassette players, VCRs' and etc).
4. Laser power meter (To determine if the laser diode of CD players, CD Rom drives, VCD and DVD are working properly).
5. Noise generator (You can quickly locate the defective stage at both audio and RF (radio frequency) circuits of the AM/FM table and car radio).
6. Tone generator (It can be used like the noise generator to quickly locate a dead or weak stage within the audio circuits).
7. Audio signal tracer (The audio signal tracer troubleshoots audio circuits from input to the speaker).

Troubleshooting transmitter equipment

1. Spectrum analyzer (for measuring harmonics in the output).
2. Field strength meter (for measuring transmitted power at a distance from the antenna).
3. RF Impedance Bridge (for transmitters and antennas).
4. RF power meter (for measuring RF output power).
5. SWR meter (for finding standing wave ratio on feeders).

Troubleshooting digital circuit

1. Signature analyzer (A tool which gives a technician or engineer a convenient way of comparing complicated “streams” of data).
2. Logic probe (Provides a fast and easy means to indicate whether the test point is “high”, “low”, or “pulsing”).
3. Logic pulser (To inject signals either a constant “high” or a “low”, or a series of pulses at the inputs of a device, and then, read the resulting pulses and the outputs with the logic probe).
4. Logic clip (Similar in appearances to the IC test clip. The lower end of the logic clip fits over the pins of the IC being tested. A series of LED’s along the top of the logic clip indicates the logic state of each pin. By feeding known signals into an IC, watching the output on the logic clip, and comparing the results with a truth table, a technician can indicate if the IC is working properly).
5. Current tracers (To detect short circuit in a board to a specific point).
6. Logic state analyzer (To display the logic states of many different signals at the same time).
7. Logic comparator (This device provides a convenient way of checking a faulty IC against an IC which is known to be good).
8. IC tester (This tester is different from the logic comparator because it does not require the technician to have known-good spare of IC being tested. This tester is supervised by an on-board microprocessor).
9. Analog signature analysis (It works by applying a current-limited AC signal across two points of a component. The current flow causes a vertical deflection of the trace, while the applied voltage causes a horizontal deflection. Together they form a unique V/I signature that represents the overall health of the device under test. Analyzing the signature can quickly determine whether the component is good, bad or marginal).
10. Digital oscilloscope (This equipment digitizes each sample and stores it in memory).

Thus, if you are looking at a spurious event (i.e. a glitch), you can capture the event and view it as long as you want. You can also save the waveform to disk so that you can recall it later. Compared to analog oscilloscope, the glitch would just be a flash on the screen and then it disappears. Digital oscilloscope is also essential for critical timing measurements).

1.4 Workshop

Before you begin to repair any electronic equipment, you need a conducive work area where you can perform your repairs. The requisites of a good workshop are as follows:

- ❑ The workshop should have 3 pronged (grounded) electrical outlets, good lighting and well-ventilated. Your work area needs a very good lighting system. Some electronic equipment uses Surface Mount Devices (SMD) which is very small, thus making it difficult to identify the value or part number. Without good lightings, you will have trouble identifying its components.
- ❑ It should be well-equipped with test instruments and tools, and should have sufficient storage space for spare parts and related accessories.
- ❑ Floor material should be anti-static, non-sticky, easily cleaned and non-slippery. It should be kept clean of dust, dirt, webs, insects, etc.
- ❑ The workshop should have fire extinguishers and a first-aid kit box.
- ❑ The workbench should be equipped with a complete power strip with surge protectors, fluorescent lighting and a magnifying lamp. A magnifying lamp does not only provide light, but also makes it easier to read component markings.
- ❑ The workbench also should have sufficient space for keeping test instrument, tools, soldering iron and the set under test.
- ❑ There are many other accessories that makes electronic repairing easier, which includes jumper cables, power cords and chemicals just to name a few.

Good planning of a workshop will make people enjoy working there!!!

1.5 Understanding the Equipment

Before you start troubleshooting any kind of electronic equipment, you have to first understand how it works. As a technician, you must develop the right level of understanding required to repair the equipment efficiently. Most beginners assume that this means you must understand every parts or function of a circuit. This kind of detailed knowledge is helpful, of course, but it is not necessary.

As a technician, you normally won't have to deal with all the details of a circuits functioning. You don't have to design the equipment, but all you need to do is to ensure that it is functioning. Any piece of faulty equipment was once working; as such you can assume that all of the complex design problems have been taken care of by the engineers. All you must do is to bring the equipment back to life. Once you fully understand the circuit function, it is easy for you to breakdown each and every section of a circuit and use the right tools and test equipment to pinpoint the faulty components within a very short period of time. For example, if a customer tells you the Monitor color is out i.e. yellow display, your knowledge will prompt to you that the power supply (vertical and horizontal section) is working fine. The problem may lie somewhere within the signal cable, CRT board or even CRT. This can narrow down the problem and save your troubleshooting time.

1.6 Steps in Troubleshooting

Knowledge of the right troubleshooting procedure and its intelligent application is essential for correct and quick diagnosis of the fault. Fault diagnosis is the acquired skill in being able to locate a fault quickly within any circuit or system. Regardless of how complex your particular circuit or system may be, a reliable troubleshooting procedure can be broken down into four basic steps.

- Step 1: Determining failure symptoms.
- Step 2: Identify and isolate the location of the problem.
- Step 3: Repair and replace the suspected component.
- Step 4: Test the equipment thoroughly after repair in order to make sure you have solved the problem and that no other problem shall arise.

If the problem is not solved, you may try again starting from step 1. This is a universal troubleshooting procedure and you can use this procedure to troubleshoot any kind of electronic equipment.

Determining failure symptoms

The determination symptoms of failure systems does not mean that you go straight to the toolbox and soldering tool, nor does the steps mean that test equipment should be used extensively. Instead, the steps mean that you must know what the equipment is supposed to do when operating normally and, more important, you must be able to recognize when the normal job is not being done. Regardless, before you open your toolbox, you must have a firm understanding of the symptoms. Think about the symptoms carefully.

Many faults are identified through display on video screen or sound from speaker. For example, in a TV receiver, if the picture is normal, but there is no sound, the common sections up to video detector stage are normal and the fault lies in the sound section. In a stereo amplifier, one channel is working normally, but the other is not, the defect is obviously in the other channel. Ask yourself what is happening. If the stereo amplifier is a new installation, perhaps the audio cable in the speaker box was not fixed. If you have not been using your stereo for a while, do you remember the last time you switched on the stereo? Does the sound slowly fades away or completely does not have sound? By recognizing and understanding the symptoms, you definitely know that something is wrong and have a fair idea of what is faulty, but you probably do not know just which area or location of the equipment is faulty. This is established in the next step of troubleshooting.

Identifying and isolate the location of the problem

Before you try to isolate a problem within the equipment, be sure that the equipment is, in fact, causing the problem. For example, if a Monitor has a missing red color, do not charge into the set with the screwdriver and soldering tool. Be sure that the Monitor is the cause of the problem by comparing a known good Monitor or testing the faulty Monitor in another PC. Sometimes a defective video card in your PC also can cause the missing-red-color symptom. When you are confident that the equipment is faulty, you can begin to identify possible problem areas.

Most electronic equipment can be subdivided into sections that have a definite purpose or function. The term function is used here to denote an operation in a specific section of the equipment. For example, in a color Monitor, the function can be divided into video, picture tube, horizontal, vertical, high voltage, monitor controls, microprocessor and power supply circuits. Say, if the problem is the missing red color, the only section you need to check is the video circuit, signal cable and picture tube.

Identification of the faulty section eliminates the need of checking all the stages or circuits. This expedites troubleshooting. Once you have identified the faulty section, concentrate on the circuits and ignore the remaining sections. You can begin the actual repairing process and, hopefully, track the fault to the component level.

Repair and replace the suspected component(s)

Now you can begin the actual repairing procedure with the help of tools, test equipment and schematic diagram. Inspection using the senses – sight, smell, sound, and touch – is very useful in trying to locate the problem. More details on using the senses to troubleshoot electronic problem is covered in a later chapter.

Once a faulty component is located, it is necessary to reason out the cause. For example, if the fuse was found open, there might be a cause (say, a shorted rectifier in power supply section) which made it blow. The cause should first be removed. If there is no short, fuse might go off due to some momentary surge of current (transient) and in that case it can be replaced without further investigations.

After the fault is located, it is to be rectified. The process of rectifying the fault is called ‘repair’ or ‘corrective maintenance’. The next step is to remove the cause first and then to replace the defective component with a new one. The new component for replacement should be of the same value, ratings, tolerance, size and any other specifications as per the manufacturer of the original component.

Test the equipment thoroughly after repair

After the equipment has been repaired, the equipment must be carefully re-assembled and tested. Run a thorough test to check the equipment and determine if the problem is solved. Thorough checking of the equipment is called ‘servicing’.

Do not be discouraged if the equipment still does not work. Simply walk away, clear your mind, and start again by defining your symptoms.

1.7 Documentation

It is difficult to repair any piece of complicated equipment without some service literature. It is possible to repair electronic equipment without the service manual, but it can be very time-consuming. You can lose a lot of valuable servicing time if you are without a good service manual. The service manual is a set of documents prepared by the manufacturer to help the service engineers to repair or service that set of equipment. A well-written manual is the best servicing aid. It contains the following information:

- ❑ Describe how a circuit works
- ❑ Block diagram of the equipment
- ❑ Circuit diagrams
- ❑ Signal and voltage test points
- ❑ Adjustment procedure
- ❑ List of accessories
- ❑ List of spare parts with the part numbers, values, tolerances and ratings
- ❑ Fault diagnosis steps, generally in the form of flow charts
- ❑ Preventive maintenance layout
- ❑ Safety precautions to be observed while handling the equipment
- ❑ And much, much more

A service manual can be very expensive, but it is worth the investment. With the help of a service manual, a service technician or engineer can:

- ❑ Align, calibrate and test the equipment correctly to get the optimum output
- ❑ Locate a fault quickly
- ❑ Use the correct replacement part
- ❑ Conduct preventive maintenance correctly

By using the right service manual, as well as with the assistance of good tools, testing equipment and your own experience, you are set to multiply your troubleshooting power!!!

1.8 ELECTRONIC Books and Magazine

With the ever-changing electronic servicing and continuous development of the industry, electronic technicians have to constantly update themselves with the latest developments. Besides attending the manufacturer's service meetings, they must read books and magazine on electronic servicing. Books and magazine can be your most cost-effective servicing "tools". Most of the books and magazine are written by people who have been in the trade for some years, and they are able to pass on their invaluable experience to the readers. New repairing techniques, the latest troubleshooting tools and test equipment, problems and solutions on certain electronic equipment will be revealed to you through the books and magazine. Always be on the look out for good books and magazines!!!

There is another type of book which is essential for any repair technician. It is called "data book" or "data manual". A service technician can find out the equivalent transistor through this book if the original one is not available. Make, dimensions, pin outlines, input and output voltages and switching characteristic are also provided. It contains data not only of the transistor, but also of diodes, thyristors, IC, etc.

Data book is a valuable aid for the service technician, and it is an essential item for any electronic workshop library.

Here are some websites that links to related information on Electronic Books and Magazines.

Electronic Books

www.newnespress.com

www.samswebsite.com

www.delmar.com

www.wiley.com

Electronic Magazine

www.elektor.com

www.siliconchip.com.au

1.9 Sight, sound, smell and touch

Sight, sound, smell and touch can solve a lot of electronic problems. They are the most important tools and can give you a strong clue as to the source of the problem. When the unit is opened, it must be inspected closely with the four senses; otherwise you may spend countless hours trying to find the culprit which is caused by a leaky electrolytic capacitor (oil leak) which you've missed out during troubleshooting.

- Sight - You can see a cracked printed circuit board, a burnt resistor, blown electrolytic capacitor, arcing from Flyback transformer, lightning damage, cracked diode, oil leak from capacitors, poor board connection, melted plastic of the Flyback transformer, cracked CRT neck and many more.
- Sound - You can hear a tic-tic and high pitch sound from the Flyback Transformer, arc over in the neck of CRT, capacitor bursting while the unit is operating, high voltage shutdown and arcing at the Flyback Transformer.
- Smell - The oil from a leaky electrolytic capacitor can generate a powerful smell, a burnt resistor also produces a smell and ozone smell from the Flyback Transformer.
- Touch - You can use your finger to make a quick "touch test" of components in a suspected faulty circuit. Overheated components in the printed circuit board are always a source of trouble. Always turn off the equipment before you begin to touch on the suspected components like IC's, transistor and diode. Before you touch any components, be careful to ground yourself by touching the case of the equipment for a moment. If you don't do this, you can accumulate a static charge, which can damage delicate CMOS ICs. Some components are hot even when they're operating normally. If a transistor is attached to a large metal plate (a heat sink), you can expect the plate to be quite hot. A transistor with a smaller heat sink should be proportionally cooler.

Use of the sight, sound, smell and touch senses will reveal the untold story of the faulty circuit and may provide helpful clues.

1.10 State of mind

As a repair technician, you must start to develop the right state of mind for repairing work. An electronic repairing problem requires mental discipline as well as technical knowledge. Repair work can be very frustrating. You may work for many hours trying to find a particular problem and make a repair, only to have the problem return a week later.

Do not be discouraged if the equipment still malfunctions. You'll have to try different approaches until you really find the causes of the problem. If one idea doesn't work, try something else; try yet another idea, and keep this up until you're successful. Try not to work when you are tired, upset or frustrated. Try to avoid working under the pressure of deadlines, although this isn't always possible. Always set the equipment aside after working on it for long hours. Time is lost if you keep working on it. Simply walk away, clear your head, and start again by defining your symptoms. You may also try tackling it first thing in the morning when your mind is clear. You should also realize that there may be more than one bad component to deal with. Be prepared to make several repair attempts before the equipment is repaired completely.

As you gain more experience with repairing work, you'll begin to recognize the **state of mind** that brings good results. The experienced technician is cool and rational and this gives them a huge advantage over the amateur, who tends to work without a plan.

PART 2

2.1 Good Management

If you start a servicing centre, good management together with honest nature, your behavior and efficient servicing will earn you regular flow of job and credible reputation and of course, money. The amount of money that you earn in servicing is entirely up to you. It requires only one thing – sincere involvement. All jobs coming in the workshop must be cared well against any accident. They should be well-attended and after the servicing they must be kept with care until it is returned to the owner. There are some suggestions that lead to good management.

- ❑ Customer's complaint is a vital piece of information. The person who is attending to the customer must be very efficient and well-trained to get a precise description of the faulty equipment. The details of the fault should be accurate, which is very much essential, before you start servicing the faulty equipment.
- ❑ Keep the record of all jobs and their progress until the set is repaired and returned to the customer.
- ❑ As soon as you repair a set, write the description of the fault, how you repaired the set and the components replaced. When you encounter similar problems, you can refer back to your record and find out what the solution was the last time. This will definitely help you in the long-run to cut down on time needed to solve future repairing problems.
- ❑ In order to speed up the job, you may need a service centre software management packages that automate almost every part of your business. It serves as a databank of faults, their remedies and can also provide an instant reference to a particular customer, generates invoices and progress reports. The software management packages may also offer a method for tracking and scheduling tasks. Within the tracking information, the system will show the job information; the current status of the job; a listing of parts ordered for the particular job; and a schedule of service performed by all technicians.
- ❑ Uncollected repair tie up space and money. Sent notice to customer that states that if an item is uncollected by a certain amount of time, the item will be sold or dispose of.
- ❑ Do not cheat any customer and remember, once a customer feels that he is being cheated by you, he will definitely not come again and will also warn others.

- Charge reasonably so that you earn reasonably and the customer is also satisfied. A happy customer is the most cost effective form of advertising, often bringing new businesses through referrals.

2.2 Time Is Money

In the field of servicing, time is money. You can waste it, or you can make money out of it. The less the time you take on one job, the more number of jobs you can do and hence, the more you can earn. Anytime the technician or engineer spends over one hour on a given electronics problem without locating the faulty component, time is lost. Time can be lost due to:

- ❑ Intermittent problem - Sometimes a fault might be intermittent. Dry solder joints, heating, loose connectors, etc may cause intermittent faults. Such faults are the most difficult to locate.
- ❑ Non-availability of - Spare parts After spending countless hours of repair, you've been told by your supplier that the defective part that you need is no longer available in the market.
- ❑ Callbacks or repeated - Repairs This will usually cost the electronic technician extra money. The technician has to repair the problem without additional charge unless it is a different problem. It is advised that doing a good repair job at the beginning eliminates repeated callbacks.
- ❑ Equipment that had - been badly repaired by someone An inexperienced technician will usually cause more trouble than solving the original problem. Many sets come in with missing components, cables connected to the wrong location, components installed in the opposite direction, unsolder tracks, wrong part numbers as substitute for the original components and etc. The technician might take extra time to locate the faults and time is loss during the repairing process. A half an hour job might take him three or more hours to solve it and at times, the equipment is beyond repair.
- ❑ Understanding new - Understanding the new design of electronic circuit may take

design of electronic circuit

you time. For example, a technician who is good in repairing Analog Television may have difficulty in repairing Digital Television. He will takes a longer time to analyze the new circuit, to learn new ways of troubleshooting digital circuit problem and learn how to replace surface mount components (SMD). All these will consume his time. What about the latest technology of PLASMA TV? It may be even more time consuming to understand the new design and circuit.

- New symptom which - you have not seen before

I believe you will agreed with me that even though you have been in the repairing field for more than 10 years, some symptoms you might have not seen before whether you are servicing TV, Monitor, VCR, DVD and etc. Due to the new symptom, it will take you a long time in finding the exact location of the fault.

In order to speed up your repairing job and make additional money, you must master the correct techniques of servicing and learn the logical approach to identifying fault quickly. You must equip yourself with knowledge of the right kind of tools and test equipment in servicing field and do your best to repair it.

2.3 Estimates and Quotation

Repair pricing is different from one service centre to another. It all depends on your competitors, location, overheads and the value of the item to be repaired. If you make your estimates too low, you will have plenty of work but marginal profit, and if you make them too high your customers will most probably switch to other competitors. Charge reasonably so that you earn enough and the customers are also happy. Apart from the ethical consideration, reputation soon spreads and a dissatisfied customer will not come back and will also warn others. On the other hand, a good job, reasonable charges undoubtedly bring referral business. Here are some guidelines that will help you give a reasonable price quotation.

- ❑ Inform customer at the start. If it would cost them more, you will inform them. If it costs less, you will go ahead with the repairs.
- ❑ Flat rates charges for dealers. Except if it involves changing expensive components such as a Cathode Ray Tube (CRT) or Flyback Transformer in Monitor or TV repairing. The flat rate charges are inclusive of labor charge, replacing passive and active components, changing switch, repair cable and etc. This is an easy way for dealers to quote their customers.
- ❑ Explain to customers in detail as to why an item is beyond economical repair or not worth repairing. Anyhow, some customers may ask for a second opinion.
- ❑ Always charge a minimum bench fee if a customer decides to take back the equipment, which has already been repaired. The fees include the time you have spent troubleshooting the equipment and putting back the bad components which you have initially replaced.
- ❑ Always charge for repeated service, when the original repair had nothing to do with the present problem.
- ❑ Do not work for nothing – make a fair charge.

You may have different ideas about this, but in my opinion the system outline above is effective.

2.4 Keeping Spare Parts

A good and successful repairing technician must be equipped with numerous components and spare parts commonly used in electronic servicing. Time is saved by speedy diagnosis but wasted during actual repairs. You have diagnosed the cause of a fault in record time, then spend twice as long searching in your spare parts box for a suitable replacement, or order it and find some day later that one was there all the time, hiding in the corner. Time and money are wasted if you do not set up a proper parts management. If it took you more than few minutes finding a spare part, you probably wasted many hours a month and several days a year.

A wide range of electronic components is required even at the initial stage of starting the servicing job. A day spent on introducing a new setup or parts management will pay for itself many times over. A parts management system can be inexpensive to setup and easy to maintain. Once it is properly setup what you need to do is just monitor the stock level before it falls to a minimum level.

It is not possible for you to run to the market every time you need a component. This can take away your precious time, moreover it is not economical. It destroys the efficiency and presence of mind. Do not make it a practice; otherwise this practice will cause you financial loss. Sometimes you can get spare parts from the many dead appliances, as well as consumer electronic and computer equipment, for your electronic repair.

Below is a list of components frequently used in servicing:

Resistors ($\frac{1}{4}w$, $\frac{1}{2}w$, 1w and 2w) – Preferred values 0.1 Ω to 10m Ω

Variable Resistors (potentiometer) - 1k Ω , 5k Ω , 10k Ω , 50k Ω and 100k Ω

Capacitors – Preferred values 10pF to 4700UF

Fuses (fast and slow blow) – Ratings 0.5A to 6.3A and also include 13A fuse

Zener Diodes – Preferred values 2.4V to 30V

Diodes – 1N4001 to 1N4007, 1N5401 to 1N5048 and include some ultra-fast recovery diode

Bridge Rectifiers – KBL04, KBL06, KBL08

Voltage Regulator IC – 7805 to 7812 and 7905 to 7912

IC/Transistor/FET – Depends on what type of equipment you repair

Solder spares – Elements, tips

Led's – Mixed

On/off switch –Mixed

Once you are fully equipped with the essential tools, test equipment and components, the servicing are easy and the actual efficiency of repair can be well-judged.

2.5 Sharing Knowledge and Togetherness

With today's service technology, going it alone will likely lead you to frustration due to the numerous complicated new designs of the circuits. Much faster servicing can be obtained by continuously consulting or keeping in touch with fellow servicemen and discussions. Remember that a discussion with the right man on the appropriate subject is always fruitful. Nowadays, there are many technical websites found in the Internet. Be a member and gain much from its facilities like repairing tips, schematics, latest news from manufacturers and more. Some technical sites even provide a "chat room" where you can chat via your keyboard with others "in the room".

Whatever the problems you're facing, there's a good chance that one of the electronic repair forum members has dealt with it before. An electronic repair forum is a great source of "inside" information. This is where you discover the things that nobody can or will talk about it publicly, such as:

Did you know that you can rewind the Monitor B+ coil?

Brand X Television keeps breaking down due to a capacitor leakage at location C124

There are 3 ways to rejuvenate a dim Cathode Ray Tube (CRT) even without using a CRT Rejuvenator testing equipment?

Here are several electronic repair forum which you can check:

www.repairworld.com (general electronic equipment repair forum)

<http://groups.yahoo.com> (you can choose from the list of repairing forums that suits your field by typing the word 'repair' in the search box)

<http://groups.google.com> (if you like electronic repair then select the 'sci-electronic' forum group)

PART 3

3.1 Setting Up As an Authorized Service Centre (ASC)

The following are some guidance you need to know in order to successfully become an Authorized Service Centre (ASC). Setting up from scratch as an ASC is not an easy job. Your workshop needs to meet the manufacturers' requirement first, before they can appoint your company as an ASC.

- Good track - record Manufacturers expect a company to have a good track record in the trade and have been around in the business for a long time. Experience in running a repairing business counts. If your company is new, your chances of being appointed as an ASC would be low.
- Accessibility - Usually, a manufacturer would prefer a company that is located not too far from them. This makes it easy for a manufacturer to deliver products to you for repair, besides saving time.
- Location - Another factor is whether or not there is another ASC in the locality. Normally, manufacturers are not keen to have more than one ASC within a specific radius.
- Space - A company must provide enough space to cater for their products. Manufacturers would not prefer to appoint a company to become ASC if the working space is too small or cramped. A light industrial unit would be fine for them.
- Security - A decent alarm system is essential to prevent easy break-ins. You must have the responsibility to take care or protect your manufacturers' products. Any break-in will cause you to lose business and tarnish your company's name.

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- ❑ Reception Area - If a manufacturer is interested in appointing your company as an ASC, you will almost certainly be paid a visit. A proper reception area, neat, tidy and well-managed workshop will reflect on them as well. First impression counts a lot.
- ❑ Service Centre - Management Software - Using a good computer system and service center management software will boost the manufacturers' confidence in your company because it can speed up the job by providing daily business Operations such as status of repair, parts inventory control and etc.
- ❑ Tools and Test - Equipment - The variety of tools and test equipment available will be taken into consideration. An oscilloscope, frequency counter, SMD rework Station, ESR meter are some initial requirements. The workbench should be of decent size and comes with fluorescent lightings.
- ❑ Employee - There must be enough well-trained technicians or engineers to cope up with the repairing work. Prolonged or continuous delay of repairing work will make them to reconsider another service center.

To run an Authorized Service Centre, there must be total commitment and dedication, but it will guarantee plenty of satisfaction and a secured future. It can also broaden the product range that comes your way.

PART 4

4.1 Promoting Your Business

If you recently set-up a business, you may need to advertise your business. If your repairing shop isn't getting any customers, no matter how good or skillful you are, you may be out of business in a very short time. There are many ways in which you can promote your business.

Advertising

- Local Newspapers - Advertise your repairing shop in the service section of your local newspaper. Although it is a bit expensive, the results are tremendously good.
- Magazines - If you provide a specialist service such as the repair of TV Tuner or the supply of schematic diagrams, consider an advertisement in the electronics or hobby magazine.
- Leaflet Drops - Flyers can be delivered to nearby households. You can do it on your own or engage a leaflet distributor service. Sometimes you can slot in your leaflets into the newspaper and ask the newspaper deliveryman to deliver it for you for a certain amount of fee.
- Yellow Pages - Place your advertisement in the category that suits your business. For example, if you repair TV then put it under the category of Electronics Equipment repair and servicing or just TV repair.
- Local Trade - Directories Advertise only to the trade directories that are related to your repairing business. If you repair computer monitor and printer, then select the computer trade directory for advertisement.

- Website - If you have additional budget, you could invest it on developing a website for your company. Your website need not to be complicated, but you should at least include in necessary information like your nature of business, your services or products and contact details (e.g. email address) in order for customer to make enquiries to you.

Use letter, fax and telemarketing

A letter or fax to your targeted customers and telephone calls, followed by a personal visit will usually yield good results. This proofs to your customers that you are serious about the business.

Hiring a salesman

If you can afford to hire a salesman, then go ahead. With the help of a salesman you can concentrate on repairing work and manage your company at the same time. A salesman might bring you big contracts with hospitals, schools, hotels and factories. This will guarantee a stable source of work and a secured future.

Once you've have got hold of a new customer, give them the best service because in return, your customer will promote your business through word-of-mouth referrals. A happy customer is the most cost-effective form of advertising, often bringing much new business through recommendations. No costs involve, and this usually means that the new customer has a positive attitude towards you before you even have to do any work for them.

PART 5

Conclusions

With the information you have acquired, you should have a basic understanding of how to repair equipment, run a technical department, set-up your own repairing business, promote your repairing business and even the requirements to become a competent Authorized Service Center. If you begin a servicing center, remember that good management, honest nature, your attitude and efficient servicing will make you a successful business person.

Quote:

Success is a ladder that cannot be climbed with your hands in your pockets!!!

Suggested Technical Reference Books

1. Basic Electronics – Eight Editions By: Bernard Grob
MCGrawhill Publication
2. Electronics-Principles and Applications
– Fifth Edition By: Schuler
MCGrawhill Publication
3. Electronic Troubleshooting Handbook By: John D. Lenk
MCGrawhill Publication
4. The Art of Electronics By: Paul Horowitz and
Winfield Hill
5. The Illustrated Dictionary of Electronics
- Eight Edition By: Stan Gibilisco
MCGrawhill Publication
6. ECG Semiconductor and Replacement Guide By: ECG Philips
7. UP-To-Date World’s Transistor-Diodes-
Thyristors & IC’s Comparison Tables
Volume I and II By: Tech Publication
8. RS Components Catalogue By: RS Components
(Get a free copy from your local distributor) www.rswwww.com
9. Farnell Components Catalogue By: Farnell
(Get a free copy from your local distributor) www.farnell.com
10. Basic Television and Video Systems
- Sixth Edition By: Bernard Grob
MCGrawhill Publication
11. Troubleshooting & Repairing Solid-State TVs
- Third Edition By: Homer L. Davidson
MCGrawhill Publication
12. Troubleshooting & Repairing Color Television
Systems By: Robert L. Goodman
MCGrawhill Publication

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|--|---|
| 13. Television Electronics – Theory and Servicing – Eight Edition | By: Milton Kiver and Milton Kaufman
CBS Publisher & Distributors |
| 14. Practical TV & Video System Repair | By: John Ross
Delmar Thompson Learning |
| 15. Digital HDTV Systems | By: Robert L. Goodman
Prompt Publication |
| 16. Troubleshooting and Repair Guide to TV – Second Edition | By: Engineering Staff of Sams
Prompt Publication |
| 17. TV Troubleshooting and Repair | By: Engineering Staff of Sams
Prompt Publication |
| 18. Troubleshooting and Repairing Computer Monitors - Second Edition | By: Stephen J. Bigelow
MCGrawhill Publication |
| 19. Computer Monitor Troubleshooting and Repair | By: Joe Desposito and Kevin Garabedian
Prompt Publication |
| 20. Power Supply Troubleshooting & Repair | By: Lanny L. Logan
Prompt Publication |
| 21. Troubleshooting & Repairing Computer Printers - Second Edition | By: Stephen J. Bigelow
MCGrawhill Publication |
| 22. Practical VCR Repair | By: David T. Ronan
Delmar Thompson Learning |
| 23. Maintaining and Repairing VCRs | By: Robert L. Goodman
MCGrawhill Publication |
| 24. Troubleshooting & Repairing Audio Equipment - Third Edition | By: Homer L. Davidson
MCGrawhill Publication |
| 25. Troubleshooting & Repairing Compact Disc Players - Third Edition | By: Homer L. Davidson
MCGrawhill Publication |

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| 26. | Troubleshooting & Repairing Camcorders | By: Homer L. Davidson
MCGrawhill Publication |
| 27. | DVD Player Fundamentals | By: John A Ross
Prompt Publication |
| 28. | Consumer Electronics Component Homebook:
How to Identify, Locate, and Test Consumer
Electronic Components | By: Homer L. Davidson
MCGrawhill Publication |
| 29. | Complete Microwave Oven Service Handbook:
Operation, Maintenance, Troubleshooting,
and Repair | By: Carlton Gallawa |
| 30. | Build Your Own Test Equipment | By: Carl J. Bergquist
Prompt Publication |
| 31. | Test Equipment Guide | By: Engineering Staff of Sams
Prompt Publication |
| 32. | Oscilloscope Guide | By: Dr. Arnold Banks
Prompt Publication |

About The Author



Jestine Yong is Co-Founder of Noahtech Computer Repairing and Services, which has entered its 11 years in operation. He has vast experience in repairing monitors, power supplies, computer peripherals and related electronics troubleshooting.

A graduate from the Robert Gordon University, Aberdeen, UK, with a Bachelor of Science in Electrical and Electronic Engineering, Jestine takes pride in active contributions to the field through the sharing of electronics repairing knowledge and expertise.

Within Noahtech, Jestine also serves as a lecturer in conducting technical workshops such as “Introduction to Testing Basic Electronic Components”, Basic/Advanced Practical Monitor Troubleshooting and Repairing and LCD Monitor Repair. Jestine is the author of the e-book “[How to Find Burnt Resistor Value](#)” and “[Testing Electronic Components](#)” and he is currently working on his third e-book. You can be sure that he will share his knowledge with all enthusiasts out there!

Residing in Kuala Lumpur, Malaysia with his wife, Michelle Tan, Jestine is blessed with two lovely children – Noah and Hannah. He enjoys writing, internet marketing, reading, fishing and traveling during his past times.

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If you want updates on the latest electronic repairing news, then I personally recommend you to log on to my website regularly or sign up for my free **monthly** Newsletter. Things that you can expect to receive with the free subscription include:

- Repairing tips, tricks, gadgets and strategies to skyrocket your repairs!
- Tips and articles on running and promoting an electronic repairing business.
- News and notes on the electronics industry and manufacturers.
- Review of the hottest and latest repairing tools, test equipment and technical books.
- How electronic components function and the right equipment to measure them.
- Hot links to other electronics repairing websites.
- Updates on the arrival of the latest technical e-books.
- And much, much more!

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