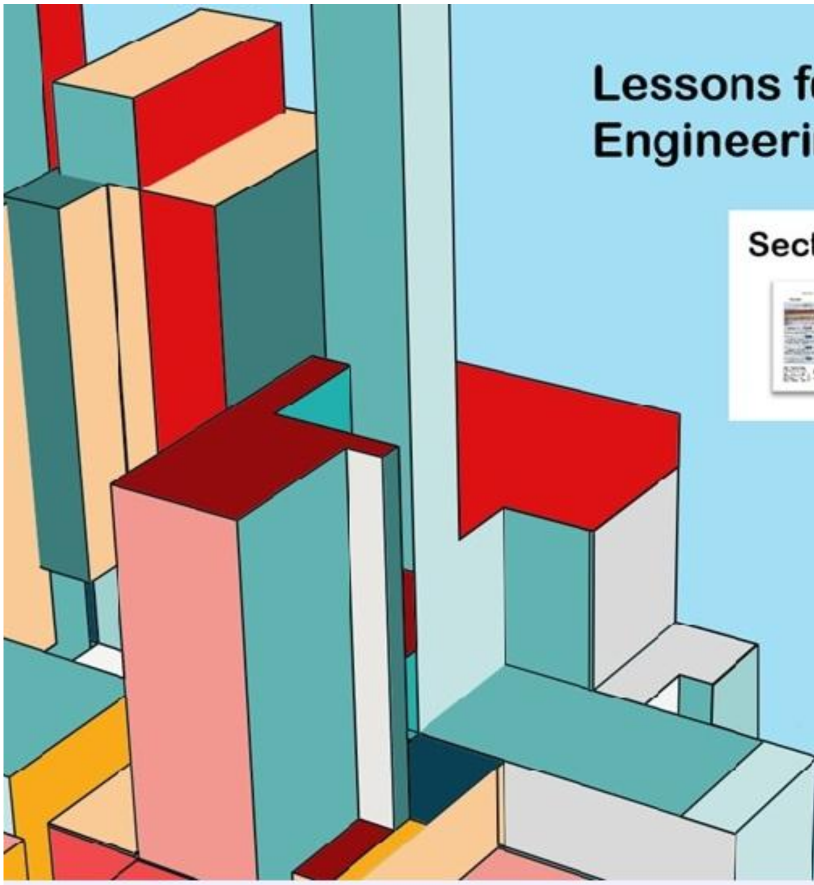


Lessons for Beginning Digital Electronic Engineering

Rev. 003 (MLK Day/2026)

Section 01 – The Electronic Transistor

Covers the fundamentals of electricity, the electronic transistor and solid-state electronic systems to include integrated circuits. Also, we begin training and using the breadboard testing and development kit to demonstrate the basics of electronic logic including building and testing actual digital logic circuits.

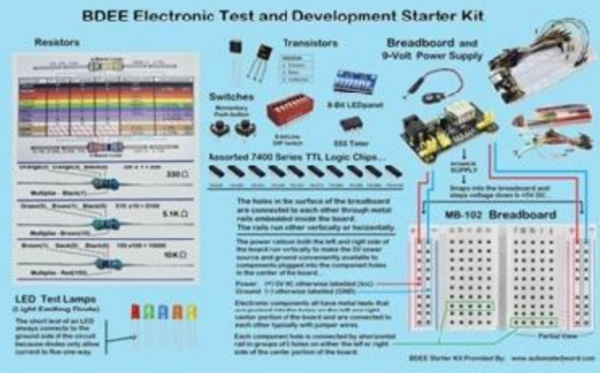
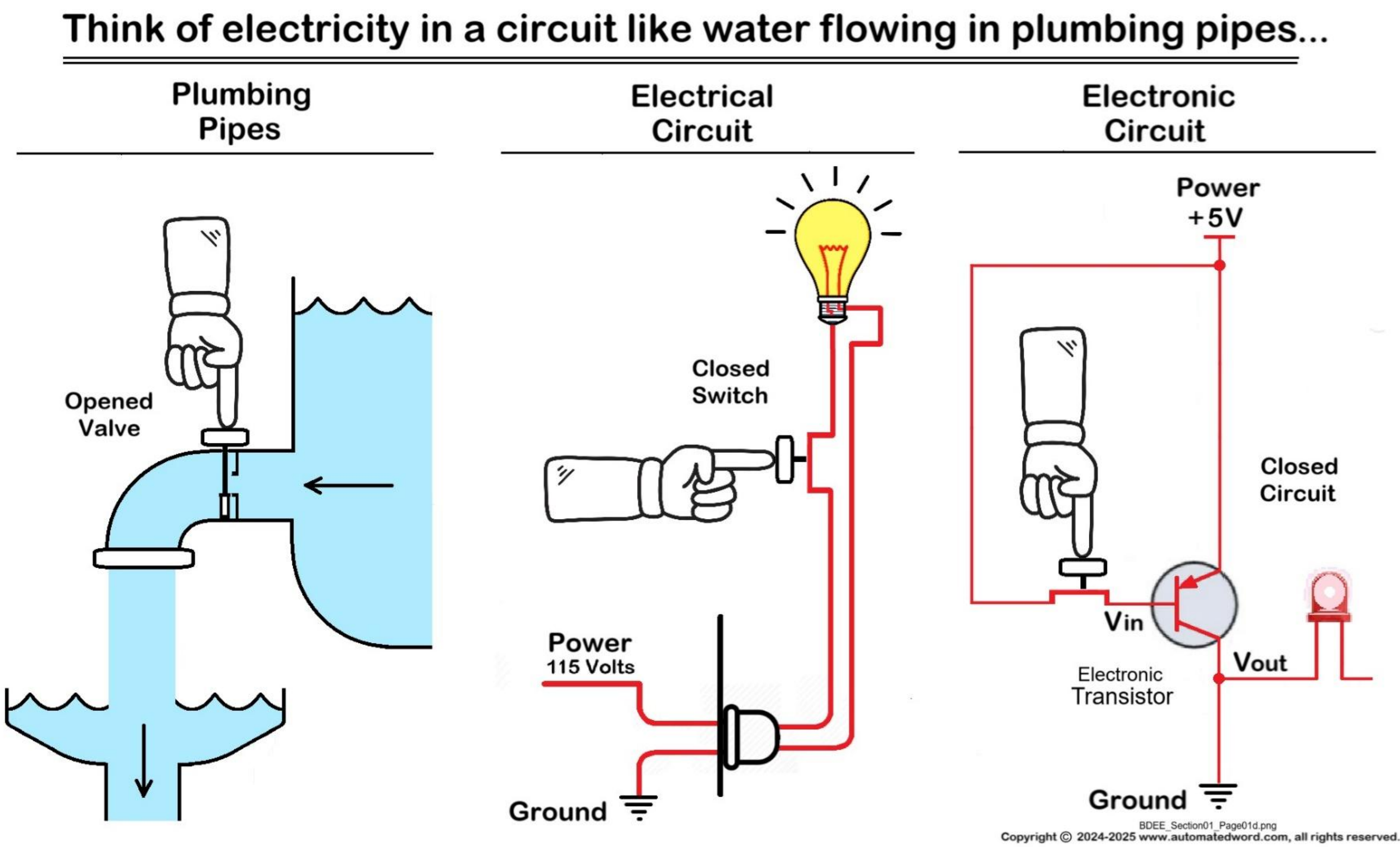


Table of Contents

“You should at least, be knowledgeable about the things that impact your life!”

Introduction to Electronics



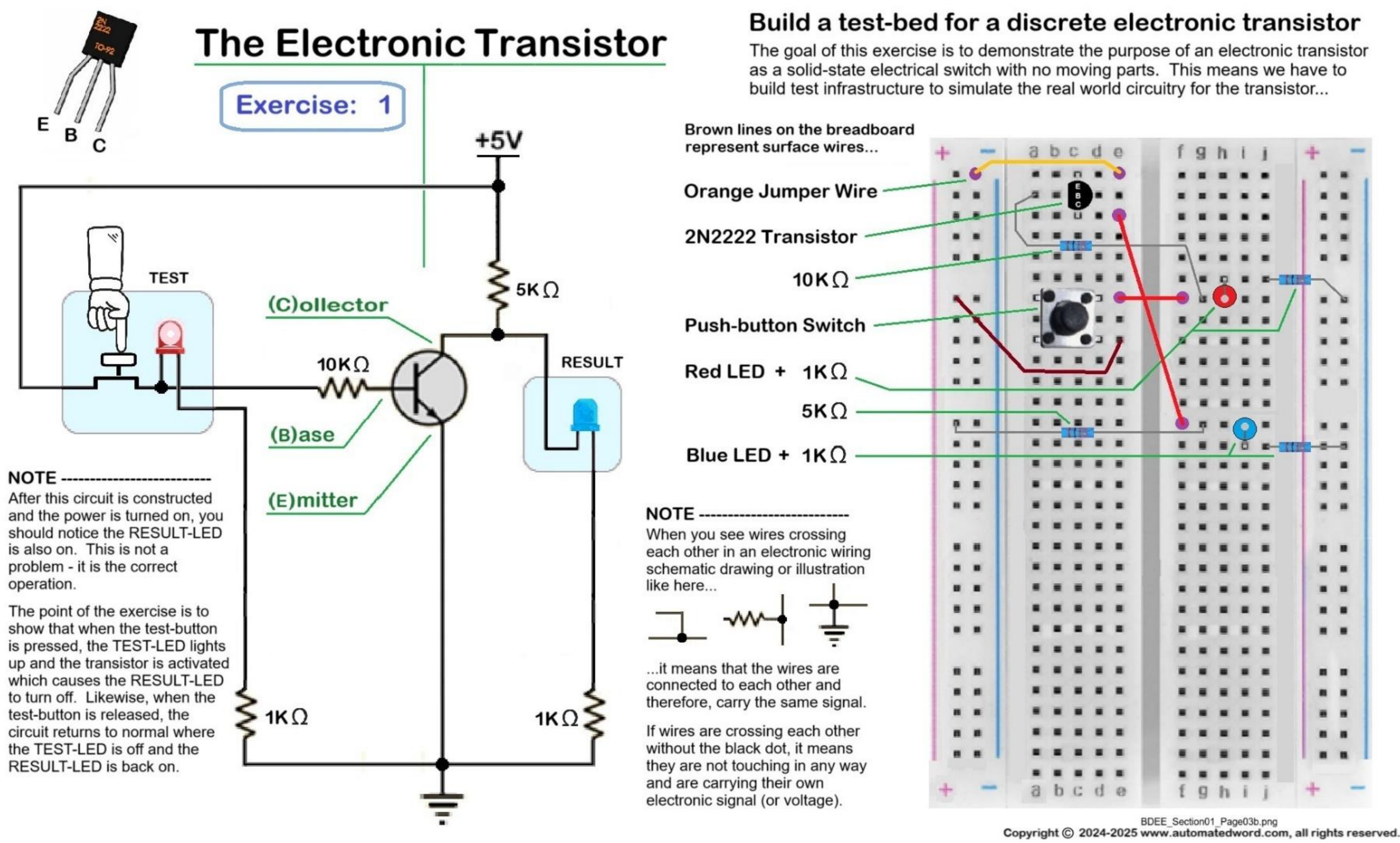
Electricity flowing in an electrical circuit, in some ways, is like water flowing through pipes…
In plumbing systems there is, of course, a source of water supply and usually, a drain in which water that is not used has a place to go. While it is not always the case that a plumbing situation has a drain, for example, a water faucet at a camp site may not have a drain. But, electrical circuits always have their equivalent (a drain) - called the ground wire.

Everything wired in your home has actually two wires involved – one which supplies the power and the grounding wire which you can think of as the "drain". In fact, whether that light in your ceiling has a switch on the wall or you have a lamp with a cord to plug into a wall outlet, they all involve two wires (Power Supply and Ground). That's why we refer to a lamp's wires as a "cord" – a cord has more than one wire in it. If a cord has more than two wires, we usually refer to it as a "cable".

One thing that is different between plumbing and electrical circuits is terminology about the state of flow. While, in plumbing, we refer to a valve, in electric circuitry we usually call this a switch but, they both do essentially the same thing – the valve lets the water flow or not while an electric switch lets the current of electrons flow in a circuit or not. However they may be similar in their function, we use the exact opposite terminology in electrical systems. In plumbing, we typically say to "open" a valve to let the water flow or to "close" the valve to shut the water flow off. In an electric circuit though, we say to "close" the switch to turn the circuit on and "open" the switch to turn the circuit off.

The important thing to remember is that a "transistor" is the switch in an electronic circuit and the term "electronic" is a circuit which is completely solid-state meaning, it has no moving parts. We build a test-bed to fool the transistor into thinking it is emersed in a circuit of at least several other transistors because, normally, that would be the case – one transistor's output would be connected to another's input and so on. So, with that, we shall leave water and plumbing behind and focus on the electronic.

  (Back to TOC)



In exercise 1 & 2 we will demonstrate the purpose of a transistor in the context of digital electronics. Before beginning this exercise, you can refer to the notes about your Test Kit starting on page 13. In order to save time, I have placed all the necessary components into a zip-lock bag labeled – "Exercise 1-5". In the bag you should find…

- (2) 2N2222 Transistors
- (2) Push-Button Momentary Switches
- (2) Red LEDs
- (2) Blue LEDs
- (6) 1KΩ Resistors
- (1) 5KΩ Resistor
- (2) 10KΩ Resistors
- (4) Blue/Green Jumper Wires (4-short, 1-long)
- (4) Black Jumper Wires
- (3) Red Jumper Wires
- (2) Orange/Yellow Jumper Wires
- (5) Brown Surface Wires (3-short, 2-longer)
- (1) 74LS00 Chip (Quad 2-Input NAND Gate)

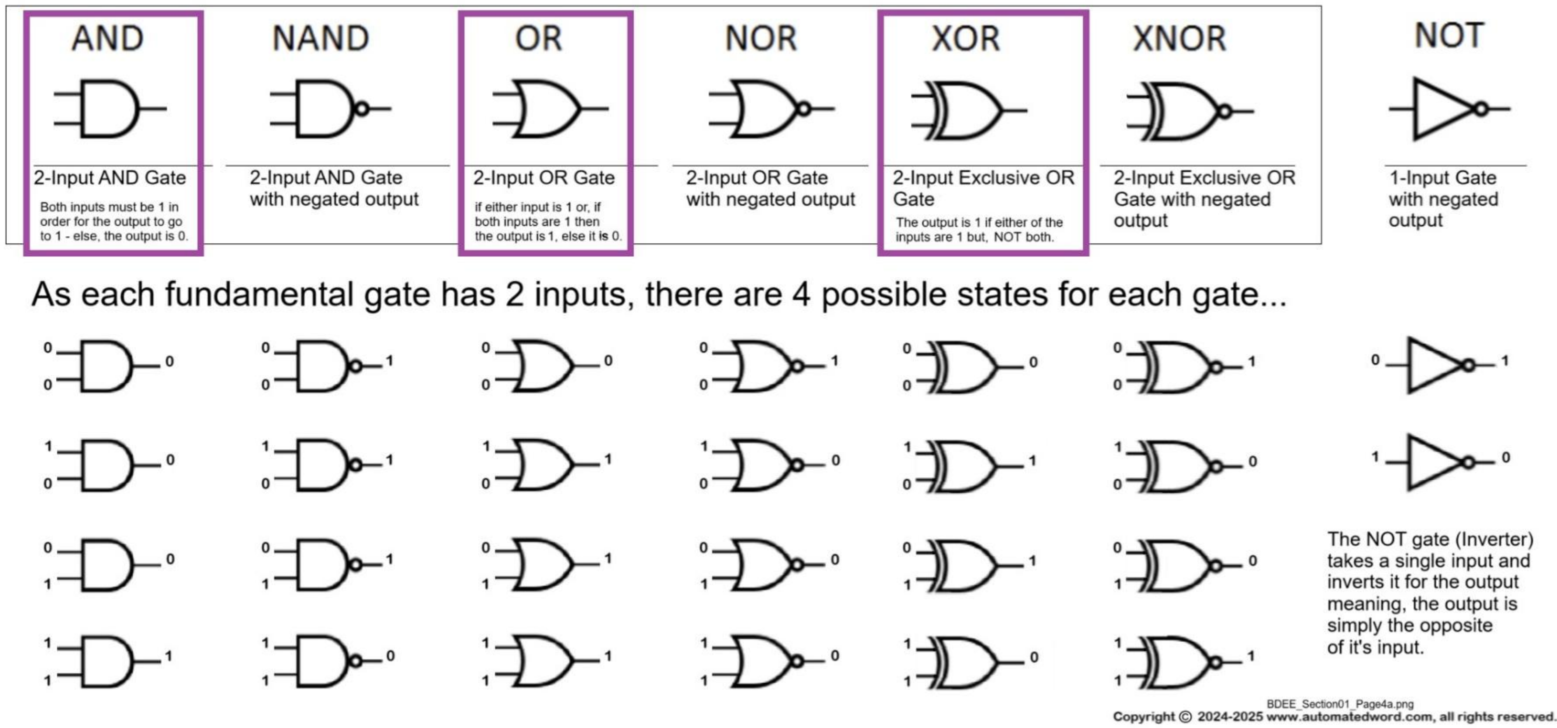
Make sure to turn off the power supply module before you begin – sometimes it is better to remove the power supply module from the breadboard which can make it easier to handle the breadboard while manipulating the components into place.

Simply assemble the experiment according to the schematic and illustration above. Make sure the power supply module is properly inserted into the breadboard and turned on. Test the circuit by pressing the little black momentary push-button (called the "TEST-BUTTON"). See if the resulting operation matches the description (also in the notes of the above image). Check out these links…

From transistors to micro-processors - 101 Computing   YouTube - How do Transistors Work?

Digital Electronic Logic is made of "Logic Gates"

The building-blocks of electronic logic are formed from the following 2-Input comparator components where each component compares 2 binary inputs and issues a single binary outcome (output)…



Digital electronics, unlike analog electronics, is primarily concerned with performing logical functions. The actual electronic circuitry and its components are, in many ways, much simpler than the circuitry and components of analog electronics. This is due to the fact that digital electronics only deals with a fixed voltage level. Basically, this means that throughout its circuitry, any given wire (or "Lead", as we call them), there exists either the full system voltage or zero voltage – there is no variance of voltage level in between. This simplifies things in the sense that we can then refer to the two possible levels in non-electronic terminology and this is most typically as the terms "One" and "Zero" where we use 1 to represent the presence of voltage and 0 to represent the absence of voltage (or 0-Volts). One of the reasons we turn to this terminology is because, ultimately, the final goal of working in digital electronics is to build logical, arithmetic and computational systems and this terminology, you will see, is more conducive to those ends.

A digital system is constructed of components that we call "Logic Gates" which perform logical functions. All logic gates have input and output leads. They read their input voltage levels and, depending upon the gate's design, they issue an output voltage level according to the design of the gate's internal circuitry. In shorthand this means they read 1's and 0's and issue a 1 or 0 according to logical function at hand.

There are three fundamental logic gates shown on this page as: the "AND" gate, the "OR" gate and the "XOR" gate (Exclusive-OR gate). Each gate has a simple permutation called a negated output – this simply means that whatever the gate would normally issue according to its function the negated permutation of the gate will issue the opposite value. As non-sensical as this may seem at first, these permutated gates have their function both in the logical sense as well as in electronic circuit efficiency.

Don't worry, this will all make more sense as we begin to put it into the context of digital circuitry. For now, it is important to understand what each component does and you will see its purpose later.

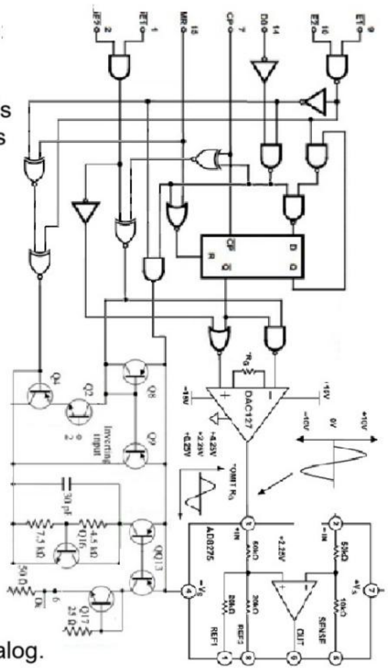
Electronic Logic By Its Nature is Based on Boolean Logic

Boolean logic (Boolean Algebra) is a mathematical system that underpins computer science and digital electronics. At its core, Boolean logic deals with binary values of true or false, which can be represented as 1 and 0 respectively. This fundamental concept allows Boolean logic to model the on/off states in circuits and the logic gates that direct computational operations. Invented by George Bool, a mathematician in the 1800's.

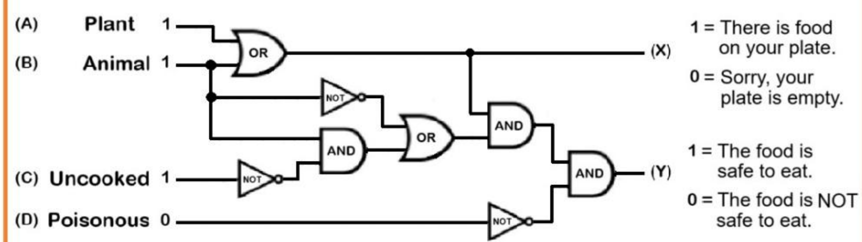
When you are looking at an electrical schematic drawing and you see several logic gate symbols as in the upper half of this drawing, you know you are looking at digital electronic logic.

When you see things like transistors, resistors and capacitors, you can pretty much bet that it is analog electronics as seen in the lower half. Especially, if you see sine-waves...

If the digital is pointing toward the analog, it is likely controlling or feeding data to it. Otherwise, it is likely reading data from the analog.



Here is a rough analogy for a structure of logic that could be implemented with digital electronic components. This structure has a specific purpose which is to determine if there is food on a plate to be eaten and, if so, is the food safe to eat. There are four inputs to the structure (A, B, C and D). A and B are indicators of what type of food exists and C and D are properties of the food (if it exists). The structure will produce two resulting outcomes (X and Y) or, "results" of the analysis that is performed by the logic structure. In the example given: input A indicates that vegetables are present because the input value is "1". Likewise, input B indicates the presence of meat...



Input C indicates that the food is raw with an input value of "1" and the other property, input D indicates that the food is not poisonous with the value "0". The rule of the logic structure is to determine whether or not food of any type is present which will be indicated by result X and, if meat is present, it must be cooked. Finally, neither type of food can be poisonous and the result of overall food safety will be indicated by Y. See if you can, by following the logic structure, determine what the resulting values of X and Y will be given the input values of A, B, C and D...

BDEE_Section01_Page4d.png

This page is, for the most part, self-explanatory. However, you should have a fairly good understanding of how the example "Logic Structure" works. This is explained on the next page.

One thing that everyone should understand is this…

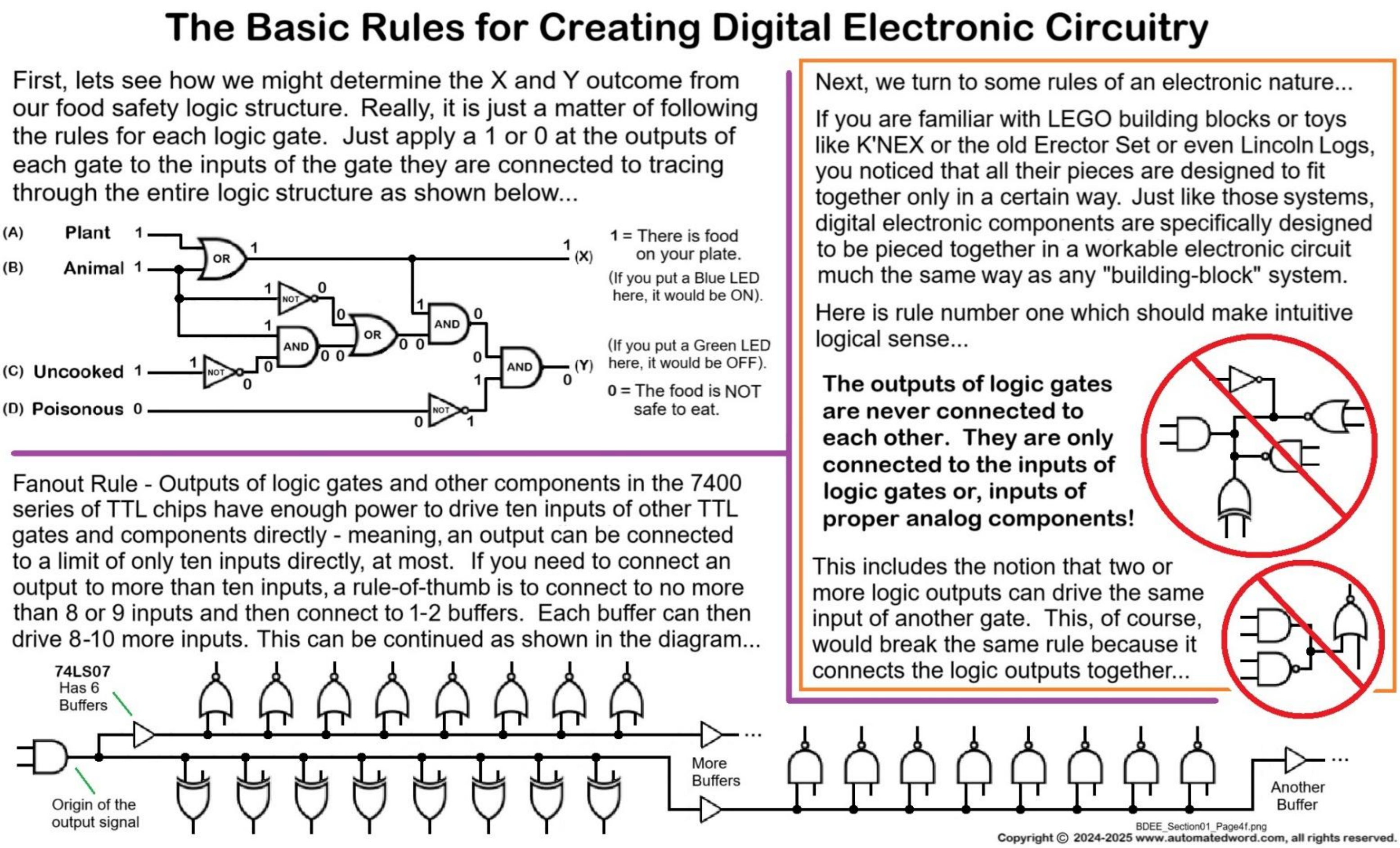
Since the Internet (the World Wide Web) was created by computer scientists, electronic engineers and mathematicians, you should know that the very first body of knowledge that appeared on the internet and is stored there is, in fact, computer science and math and electronics. The internet first came about because of an effort by these people to communicate and collaborate, first in the United States and then, the rest of the world. So, the long and short of this story is that, everything you want to know about these subjects is available at your fingertips or voice command. These engines very quickly know what you are talking about because these subjects are the deepest and most thoroughly saved.

You are encouraged to take advantage of the world's instantaneous encyclopedic knowledge through search engines like Google, Bing and many other engines as well as AI systems such as ChatGPT. I went to Bing and put in the phrase: "electronic logic structures"… I tend to disregard sites that are overly packed with intrusive ads that block your view of the subject matter - some sites are ok as long as their ads are sidelined and out of the way. Here are some sites I found…

Difference Between Digital And Analog Systems
Digital Logic Gate Tutorial - Basic Logic Gates
Digital Electronics Basics: Understanding Logic Circuits
Electronics - Wisc-Online
Basic Electronics Tutorials and Revision
Electronics | Open Library

YouTube - An Introduction to Logic Gates
YouTube – Super YouTubers digital electronics
Video Tutorials on Electrical Engineering & Electronics
YouTube – Digital Electronics Classroom

  (Back to TOC)



This page is, for the most part, self-explanatory. However, you should have a fairly good understanding of the basic rule of how logic gates are connected to each other.

Also, it should be noted that we have not introduced the 7400 series of integrated circuit logic chips yet but, the same rules of connecting logic gates apply no matter what the electronic components are.

The 7400 series of logic chips will start to be introduced in a couple of slides but, for now, here are some great websites I found with google and the simple phrase: “what is the fanout rule”…

Fan-out - Wikipedia
Fan-out explained
Fan Out in Digital Logic: A Beginner's Guide
What is fan-out in digital circuitry?

Fan Out of Logic Gates | Electrical4U
Electrical4U: Learn Electrical & Electronics Engineering (For Free)

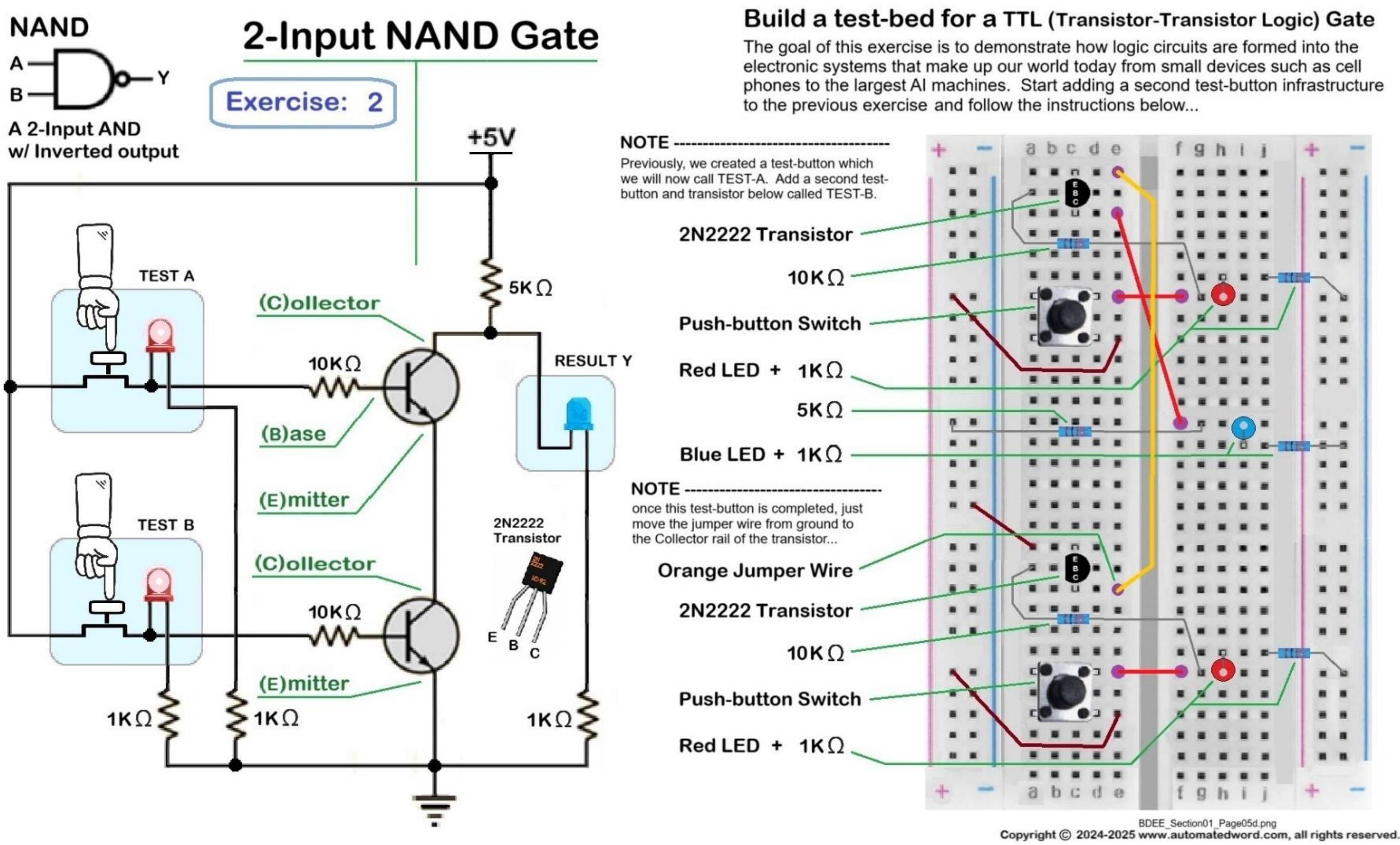
Introduction to Basic Electronics | Free Online Course | Alison
Combining Gates & Solving Problems - KnowItAll Ninja

Basic Logic gates in details | Tutorials Link
How do logic gates work? - Explain that Stuff
Digital Logic Gates | Electronics Tutorial
cs.cornell.edu - 06-gates.pdf

I asked ChatGPT about: “TTL chip families” and got a range of links between the following…

Transistor–transistor logic - Wikipedia
Microscope Solutions for Semiconductor Manufacturing

  (Back to TOC)



Now, it is time to build an actual digital logic gate – the NAND gate is the simplest one…

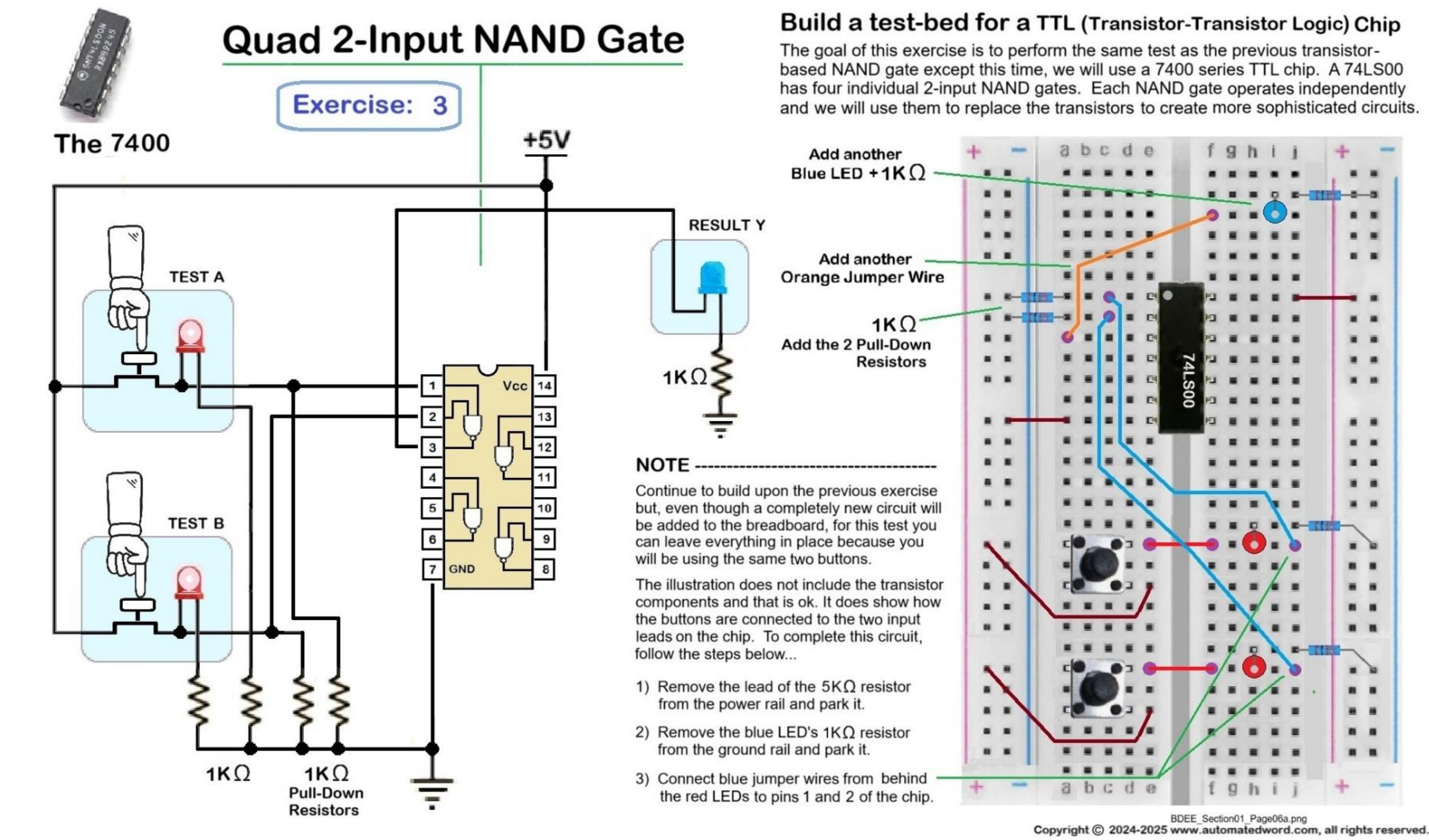
It is just a matter of adding another segment of test-bed infrastructure (to your previous exercise 1) to accommodate the second transistor. This involves following the schematic diagram and illustration of the breadboard as to where to add another momentary push-button, another red LED and 1K ohm resistor and, of course, another 2N2222 transistor.

The only difference is that here you add another little brown wire to the emitter of the second transistor and make the connection to ground. Then, move the orange jumper wire from its connection to ground to the collector of the second transistor.

With that constructed and the power module connected and turned on, you should see the behavior Of a 2-input NAND gate – where the only thing that turns the resulting blue LED off is by pressing both test-buttons at the same time.

Even though we don't have to understand what a transistor is or how it works in order to learn effective digital electronic engineering principals, it is still important to have access to this type of information in general as a matter of my teaching a thorough and effective course. So, I went to a Bing and searched the phrase: "what is an electronic transistor"… The results include usage in analog electronics…

YouTube - Transistors Explained - How transistors work
Transistors - Learn all about transistors
Working Principle of Transistor | Electrical4U
Basic Electronics - Transistors
Transistors 101 : A Beginner's Guide to Transistors
Principles of Transistor Circuits. Introduction to the Design of Amplifiers, Receivers and Digital Circuits



There is a little change in the infrastructure that is required when dealing with integrated circuit chips. This has to do with the third rule of building logic circuits which we have not discussed yet, like this...

If you are expecting to get a valid output from a logic gate, all of its inputs must be connected otherwise, they are left in an indeterminate state which leads to an unreliable output from the gate.

In the case where we are trying to feed a gate's inputs manually through momentary push-button switches, the problem is that when we are not pressing the button, there is no connection to either power or ground leading to the input of the gate. By adding a 1K ohm "pull-down" resistor, the gate is satisfied that it has a proper 0-voltage level when the button is left open.

In the case where a gate's input is normally connected to the outputs of other gates or components, this type of pull-down resistor infrastructure is already built into each chip. You will notice that the second NAND gate does not need pull-down resistors because it is receiving input directly from another gate.

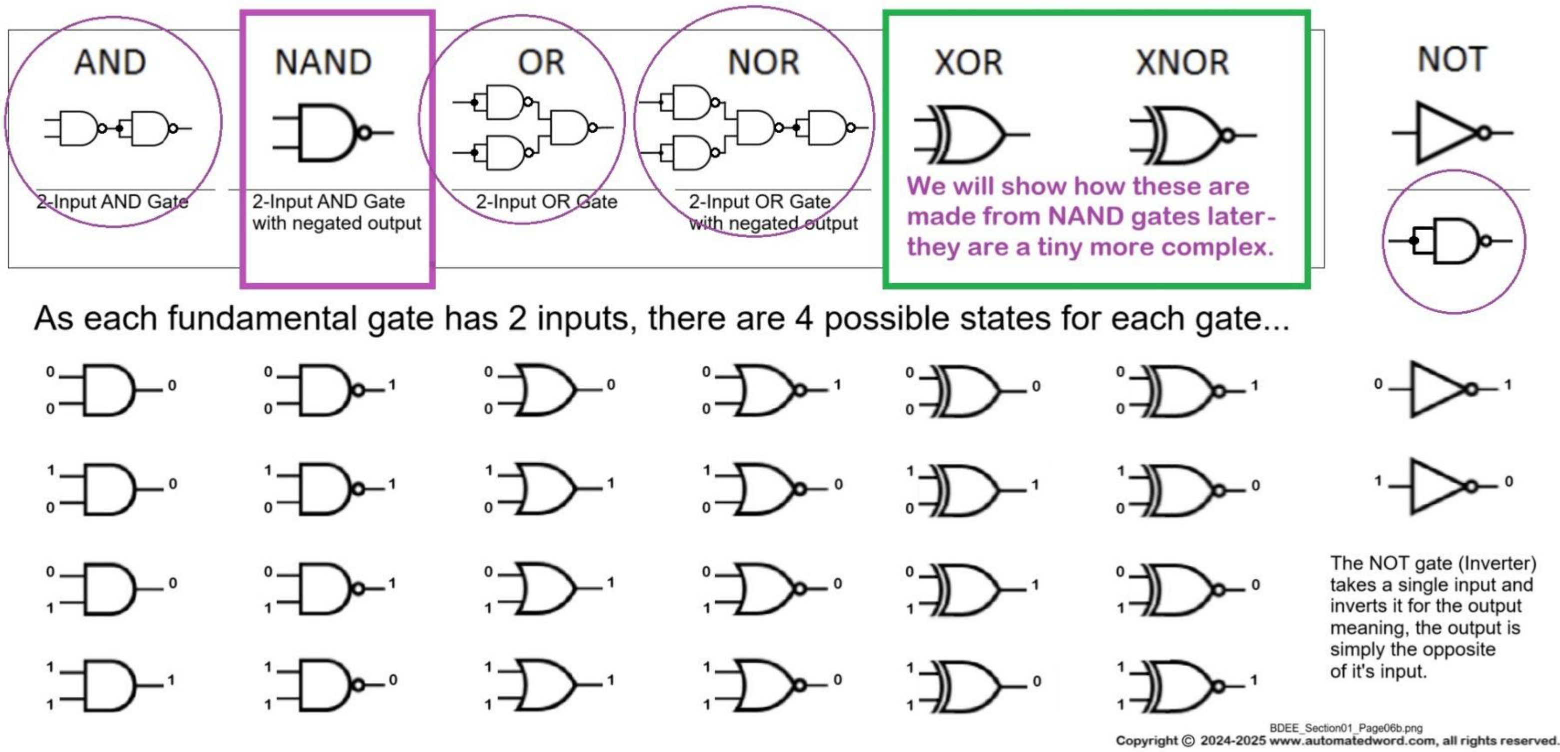
BDEE Quick PDF Viewer Datasheet for the 74LS00

Here I did a Google search for: "what is an IC chip?"…

Integrated circuit - Wikipedia
What is Integrated Circuit (IC)? – How it Works | Synopsys
YouTube - What is an Integrated Circuit (IC)
How integrated circuit is made
YouTube - Understanding Logic Gates
Integrated Circuits - SparkFun Learn
Different Types of Integrated Circuits (ICs) & Their Applications & Limitation
What is an Integrated Circuit (IC) and its Types?
The Ultimate Guide to: Integrated Circuit (IC)
What is an IC Chip? - bomzon
Semiconductor device fabrication - Wikipedia

The NAND Gate is Considered to be The "Universal" Logic Gate

The NAND is considered to be universal because you can build every single piece of electronic logic with it from the simplest of devices to super-computers. However, this is really more a point of interest than it is of practical value. Current electronic technology is far more sophisticated than building everything with NAND gates...



Well, maybe a super-computer built with nothing but NAND gates is a little bit of a stretch – it would probably run noticeably slower than it would if built properly using all of the fundamental gates.

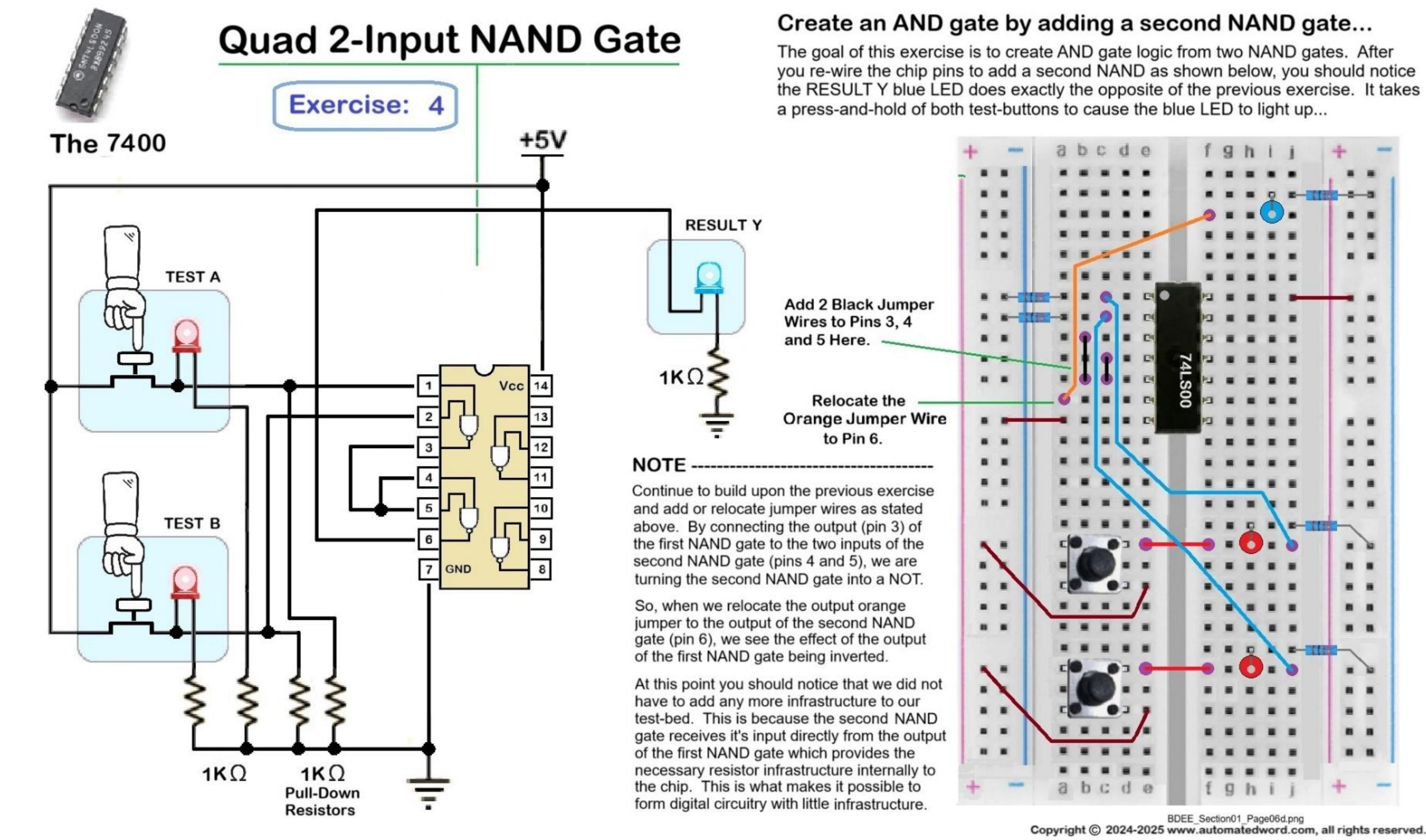
But yes, it is true! If electronic manufacturers were only able to produce NAND gates, that’s exactly what we would be using today to create the same world of electronic products because ultimately, no matter how sophisticated electronic technology becomes, the logic structure remains exactly the same at every scale. That part hasn’t changed one iota since the beginning of electrical field theory.

Don’t misunderstand this notion of the NAND gate being universal though. It doesn’t mean that we should replace all other gates and logic structure with NAND gates. That would be very inefficient – the other gates may require more transistors, diodes and resistors in their circuitry to accomplish their functions but, they are highly optimized for their tasks and ultimately, building everything with NAND gates would require even more circuitry and would yield much slower performance and much higher power consumption.

The point I am trying to make here is that, while the state of digital electronic technology will, of course, advance in performance, scale and innovation to newer and, as of yet, unheard-of contraptions, the part that you are learning now has little to do with electrical circuits but everything to do with logical circuitry and, that part is forever – it will be exactly the same when you are 99 years old – like anything else in the realm of mathematics.

All of digital electronics is based on electronic gates and those gates are all based on, you guessed it – the transistor. In fact, a very large number of transistors. Check out this video about scaling down to scale up! …

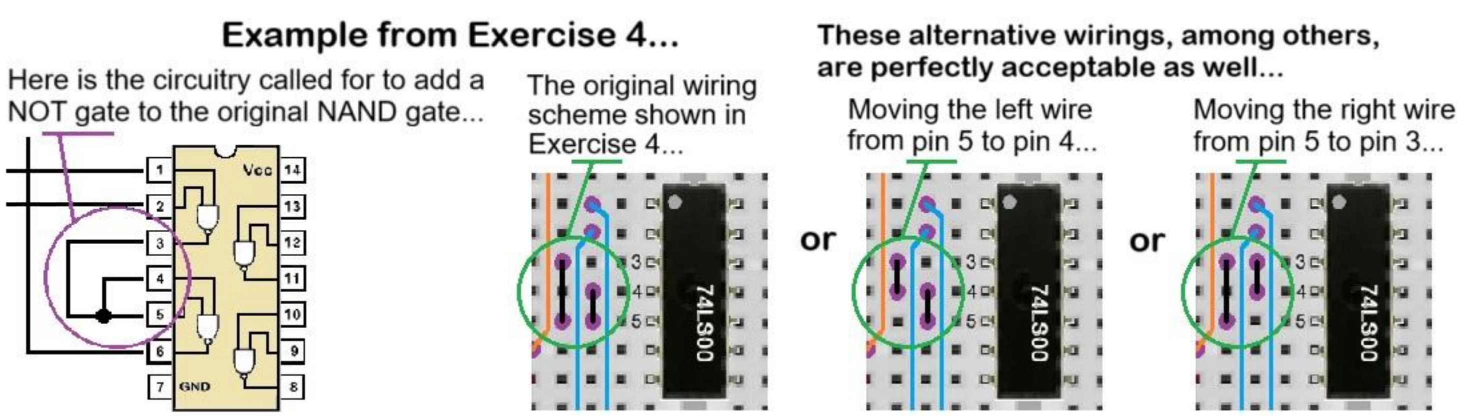
[YouTube – How do Transistors Build into a CPU?]



When you have finished re-wiring the chip in this exercise and turn on the power supply, you should see it operate like an AND gate as you test the four possible states of the gate – the first state, of course, is when no buttons are pressed...

Remember, it doesn't matter which wiring scheme is chosen to make the connection of the output of the first NAND gate (pin 3) to the two inputs of the second NAND gate (pins 4 and 5). We are not concerned with which wires are connected to each other, we are ultimately trying to connect pins of the chip together.

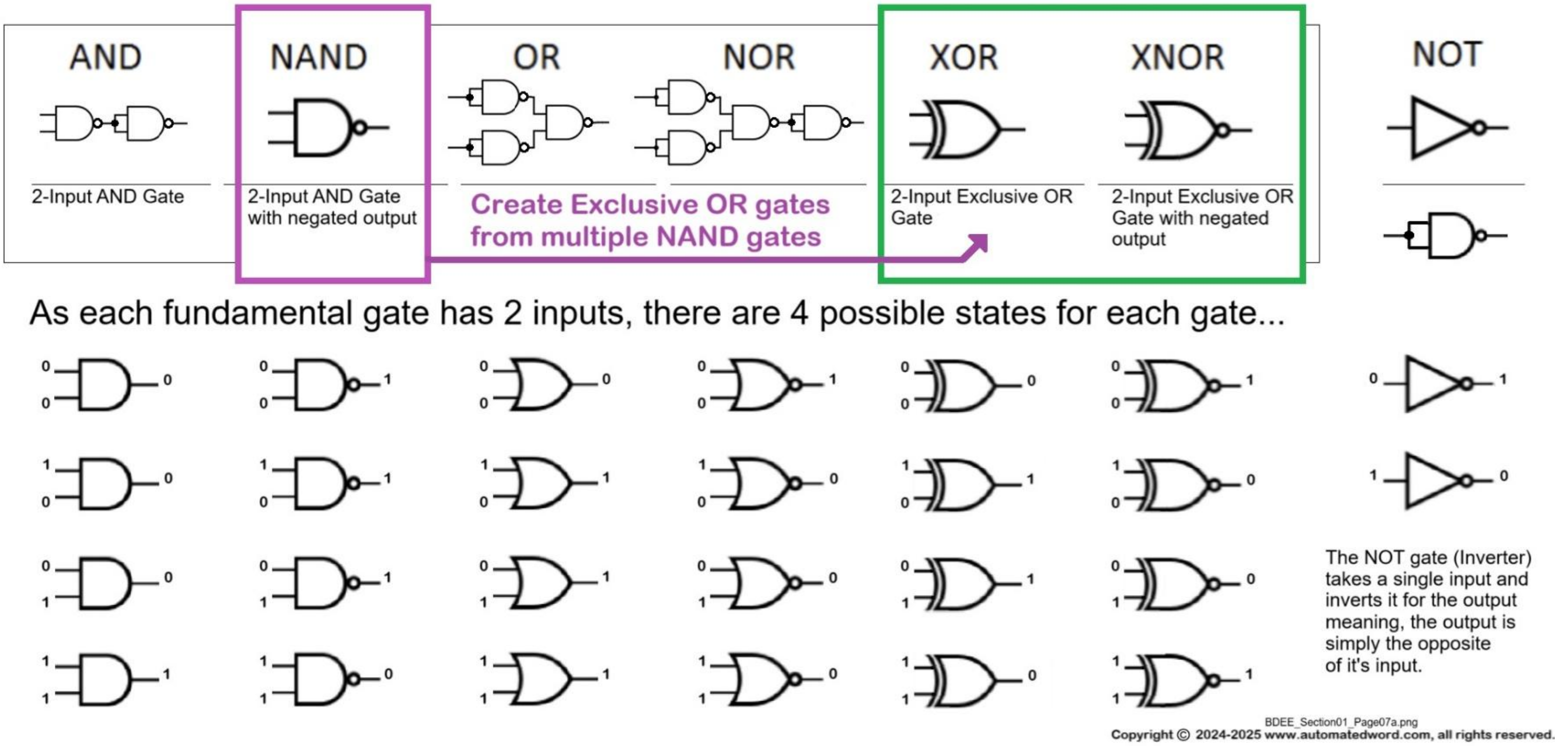
The following wiring schemes accomplish the same thing – meaning the circuitry (or jumper wire placement) in each scheme all conform to what the schematic diagram is calling for – and that is, that pins 3, 4 and 5 all must be connected to each other...

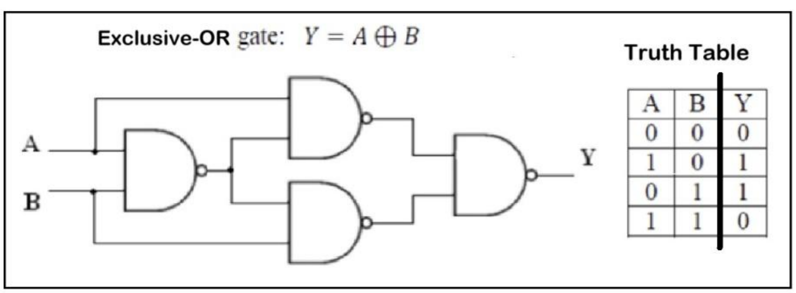


  (Back to TOC)

The NAND Gate is Considered to be The "Universal" Logic Gate

The NAND is considered to be universal because you can build every single piece of electronic logic with it from the simplest of devices to super-computers. However, this is really more a point of interest than it is of practical value. Current electronic technology is far more sophisticated than building everything with NAND gates...



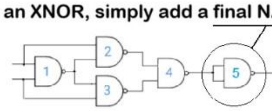


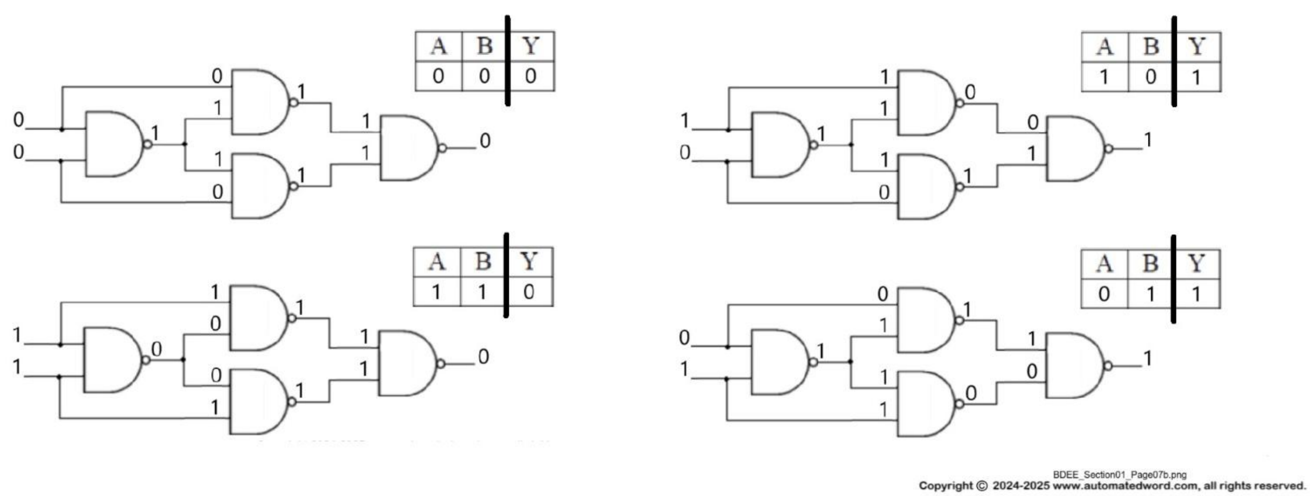
A	B	Y
0	0	0
1	0	1
0	1	1
1	1	0

XOR/XNOR with NAND gates...

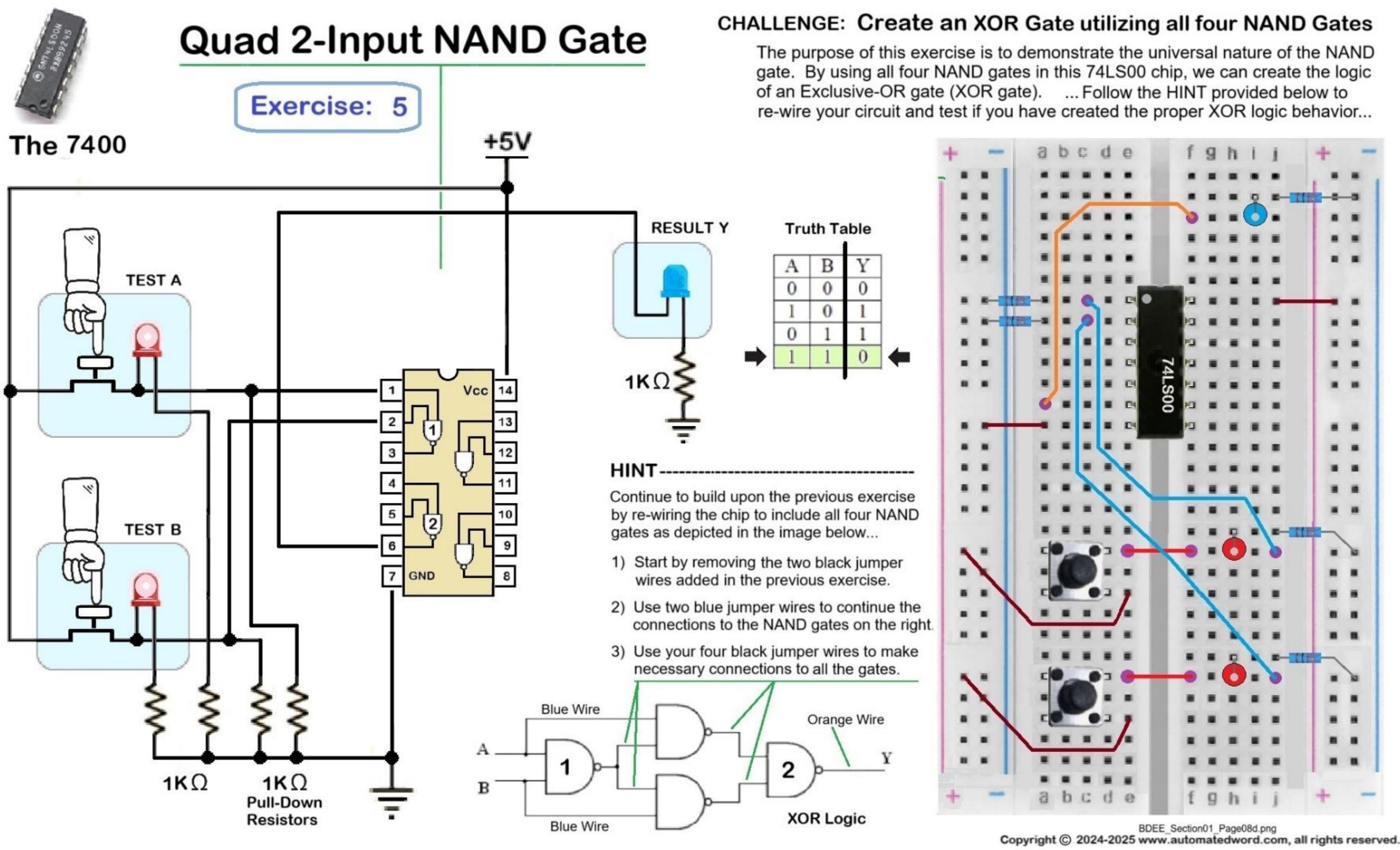
This is an example of how to form a 2-Input Exclusive-OR gate (XOR) and an Exclusive-OR with negated output (XNOR) using multiple 2-Input NAND gates.

To make an XNOR, simply add a final NAND gate...





"You should, at least, be knowledgeable about the rudiments of a skill."



This is called a CHALLENGE Exercise because the complete circuit is not filled out for you to follow. The Point of the exercise is for you to figure out a possible wiring scheme utilizing all four discrete NAND gates in this single 74LS00 chip. There is a HINT provided for you in the above slide as well as the schematic of the implementation of an XOR gate made of four NAND gates including the color-coding of the wires used.

Remember, the explanation given in Exercise 4 about how it is not important which holes you plug jumper wires into – what is important, is which pins of the chip you are connecting together by plugging into the rails that extend from the chip's pins. Ultimately, this means the following...

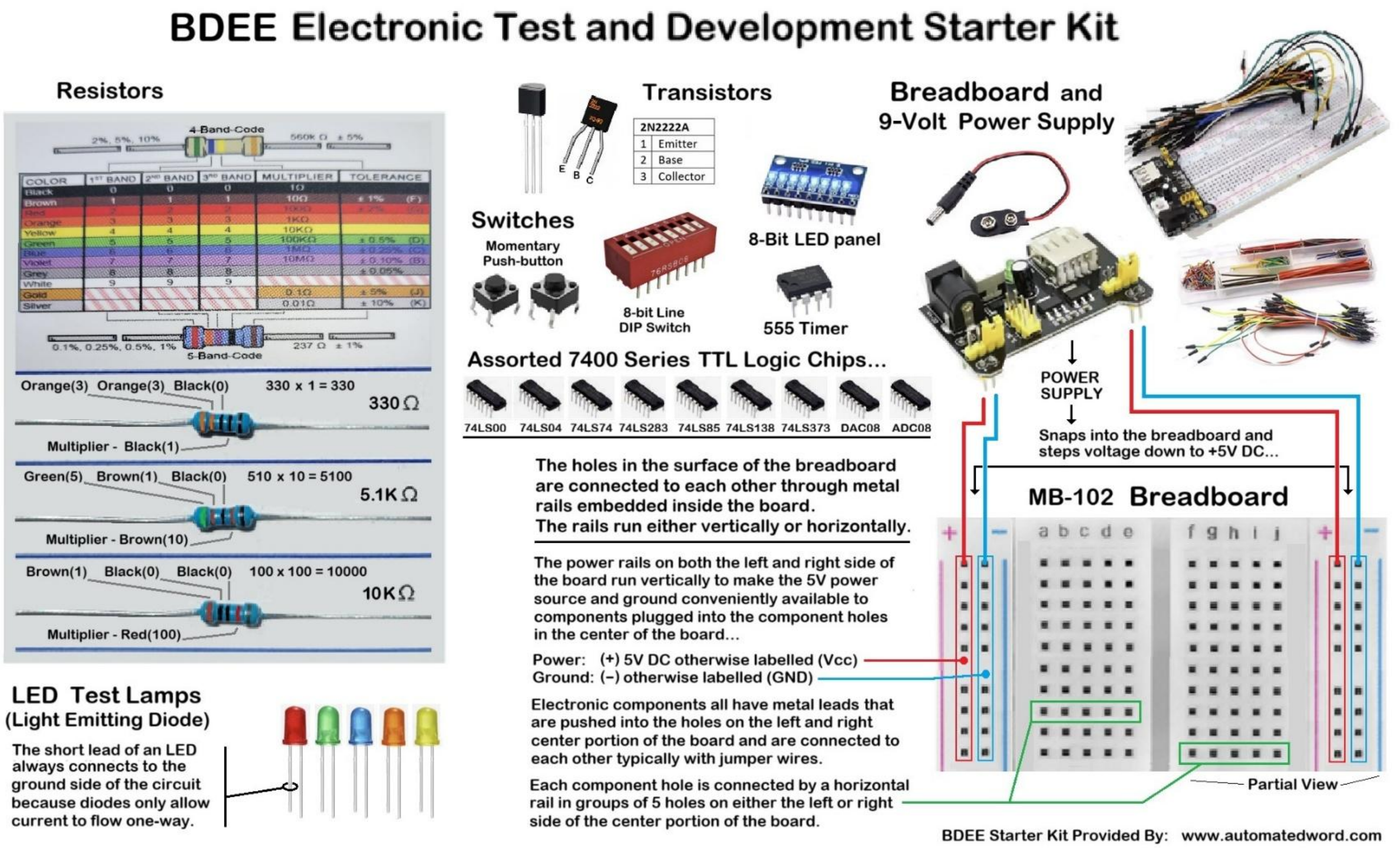
There are almost always several different ways to make the proper logical connection to a given pin on the chip but, no matter which way you decide, the important thing is that your connections match the logic of the schematic's design. If you have doubts, simply look at the two different rails you have connected to each other with a jumper wire and just make sure that it matches a connection between the pins that you see in the schematic drawing. You can review a similar circumstance in the previous: Exercise 4 Example.

Here I did a Google search for: "what is a universal logic gate?"...

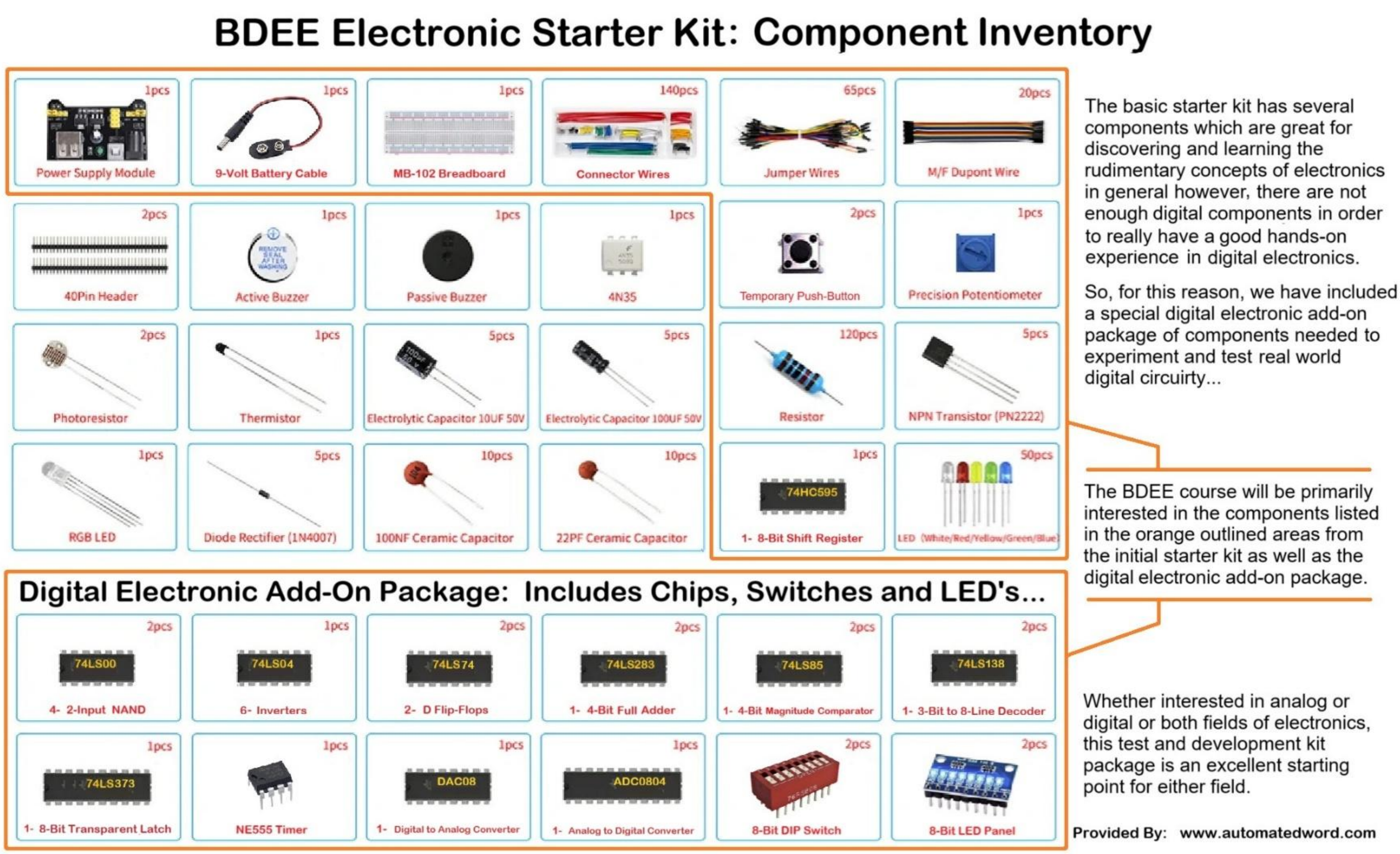
Universal Logic Gates - Technical Articles XOR gate - Wikipedia XOR Gate - GeeksforGeeks
Universal Logic Gates | Tutorials on Electronics | Next Electronics

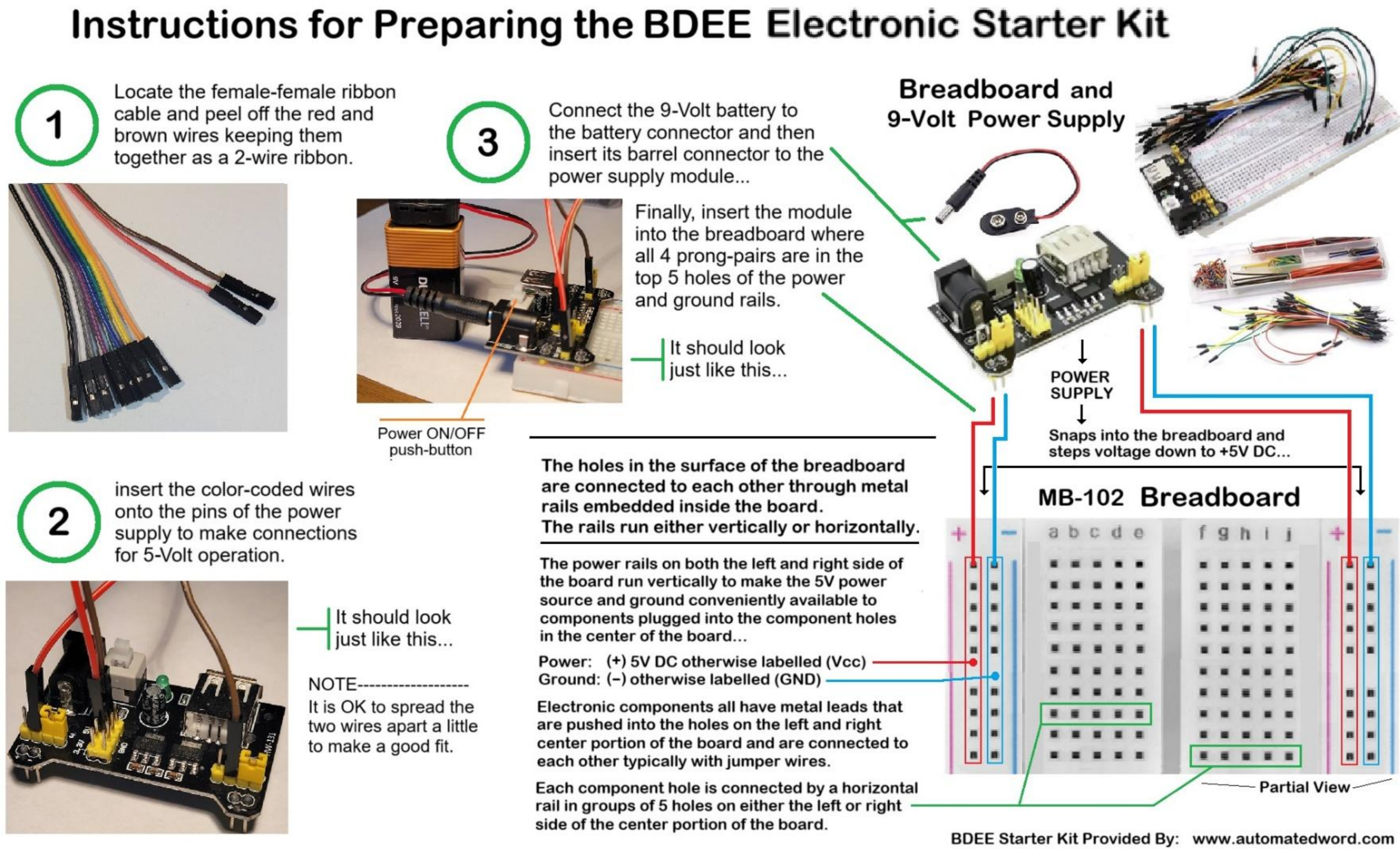
Here I did a Bing search for: "what is an XOR gate used for"... and the same for Google ...

what is the XOR gate used for? – Bing Search what is the XOR gate used for - Google Search



Watch this video for a complete explanation of your breadboard: [YouTube - How to Use a Breadboard]





Watch this video for a complete explanation of your breadboard: [YouTube - How to Use a Breadboard]

IMPORTANT NOTES! ---

The BDEE Test and Development Starter Kit is safe to work with without any bodily protection like eye goggles or gloves.

As is, out of the box and assembled, you can handle any part or wire on the breadboard even when the power module is turned on. This is due to the fact that it is powered by no more than 10 volts DC and is actually stepped down to 5 volts DC through the power supply module. These voltage levels are completely safe for handling without protection.

The same precautions would apply as any common battery operated retail device – it should be kept dry at all times and it is recommended that the battery be disconnected when not in use for a period of time.

If you grow tired of operating from actual 9-Volt batteries, you can purchase a common retail 9-Volt wall plug-in device with the same barrel connector or USB cable and use that as a more permanent power supply – there is no difference in operating the starter kit from a battery or a wall plug-in power supply.

It should be noted that lots of electronic components like transistors, diodes, integrated circuit chips and many other micro-electronic devices are susceptible to damage from static electricity shocks – it is recommended to be aware if you have accumulated static electricity or if you are not sure, you can easily remove a static charge by touching some grounded metal – a good example is a water faucet at a sink or other plumbing pipes. This should be done before handling any electronic components.

Finally, many components are very delicate by nature – try not to handle them roughly or bend their wire leads too much or too often – they break off easily making the component unusable.

Troubleshooting Digital Electronics

This page is all about solving problems in digital electronic circuitry and there are three major types of concerns involved with a little overlap between them. When troubleshooting a problem there is generally a hierarchy of steps that you go through in order to most efficiently arrive at determining what the problem is. It is important to follow these steps because it can be a time consuming process if you have miss-determined which type your difficulty lies in so the best way to tackle a problem is by an efficient process of elimination. So, here is how it works…

First, try to determine what type of problem exists – the first type of problem is "Electrical/Mechanical". This is where you might see fluttering or flickering in the LED lights and usually, it might seem that it is so intermittent and delicate that it looks like the circuit is so sensitive that a butterfly would upset it. In general, you need to determine whether the power supply module has well fitted wiring (including the battery components/wires) and that it is properly seated into the breadboard. Sometimes there might simply be mechanical problems like loose connections of jumper wires or even surface wires not seated well into the breadboard rail holes. Are the pins or leads of all components, switches, chips, transistors, LEDs and so on properly seated into breadboard rail holes. Do you see flickering lights when brushing your hands against groups of jumper wires or, when you handle the breadboard a certain way?

The next type of problem is typically when the circuit seems to be fairly stable but a particular LED or set of LEDs are not lit when they should be – or, they should be OFF but they are ON. Or, is any component in your circuit not behaving as expected. These types of problems are generally categorized as "Power Distribution/Configuration" problems. Make sure that each component or wire is seated in the correct breadboard rail hole. Sometimes this means you might have plugged a wire into the rail next door instead of the intended rail. Does each component in your circuit that requires power and ground wires are actually wired to power and ground (or, they might be reversed). A very common mistake is to mis-configure components that have a specific polarity – like an LED or other diode is accidently reversed.

Finally, the circuit looks very stable – there is no flickering/fluttering but the circuit is just not behaving as it is expected to – for example, the wrong lights are reacting to your switch settings – or not reacting. Well, you have finally (hopefully) arrived at the third category which we call simply "Logic/Connection" problems. If there is any fun at all in troubleshooting, it is in this last layer of problems – for example…

You change a switch from OFF to ON and the wrong LED light comes on or goes off. At least you're getting some indication that something is getting through the circuitry – that's good so far. But now, you might think to yourself that: "I must have connected a wire from the output of the chip to the wrong light". Well, not so fast. Remember the old adage about computer programs: "Garbage In – Garbage out"? That applies to the hardware side of things also. So, the first rule about troubleshooting this layer of problems is to make sure that you first check the input side of chips before the outputs. It is very common to have switched a wire to correct something on the output side only to run across the error again in further testing. And then you will find yourself wasting time undoing your work on the output side when the problem was a miss-connection on the input side. Follow steps below for all problem types…

Using the Multimeter as your Primary Test and Measurement Tool…

When using the multimeter for any testing or measuring, make sure that the Black test-lead is connected to the "COM" socket on the multimeter and the Red test-lead is connected to the "VΩmA" socket. To save battery power, make sure you turn off your multimeter when not in use. Leaving it on overnight will kill the battery for sure.

When testing / measuring voltage… Make sure your circuit is turned on. Make sure your Black test-lead is connected to a ground rail on the breadboard – this way you should see something close to either 0 volts or 5 volts wherever you touch the Red test-lead to. Keep in mind that there is a fairly wide voltage tolerance range for TTL chips. This means that, at its input pins, the typical 7400 series chip will consider as much as a single volt to be zero voltage (or, the value 0) and 4-volts could be considered a 1 (meaning: 5-volts or, even higher). It should be extremely rare that you would see a voltage between 1 and 4 volts of higher than 6 volts – If you do, it usually means there is still some sort of electrical problem. And, this could happen if you have chip outputs connected together by mistake – this sort of miss connection can also cause that flickering/fluttering in a circuit – so check it.

When testing / measuring continuity or resistance, you don't have to worry about polarity however, if you are measuring resistance across a resistor or a diode (LED) that is actually in a circuit or testing for continuity in the circuit, make sure your circuit is turned OFF. Remember a diode should show continuity in only one direction.

  (Back to TOC)

ANENG®

SZ308 Digital multimeter

High precision | Electrician maintenance

Video Instructions:

[Aneng SZ308 Multimeter - YouTube](#)

[Basics: Voltage, Resistance and Continuity](#)

[How To Use a Multimeter (For Beginners)](#)

Basic Usage (BDEE Course)…

When measuring resistance, set the dial to 20KΩ (see image below) - unless you are expecting to measure more than 20KΩ or less than 2KΩ. If you are measuring simple **continuity from point A to point B** in a circuit, you should set the dial to 2KΩ.

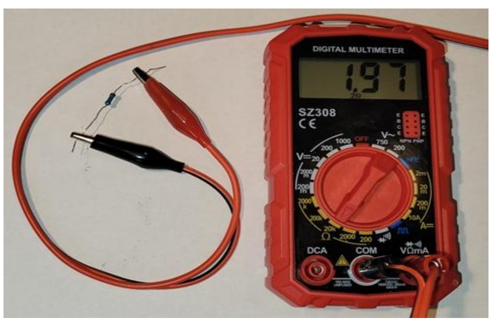


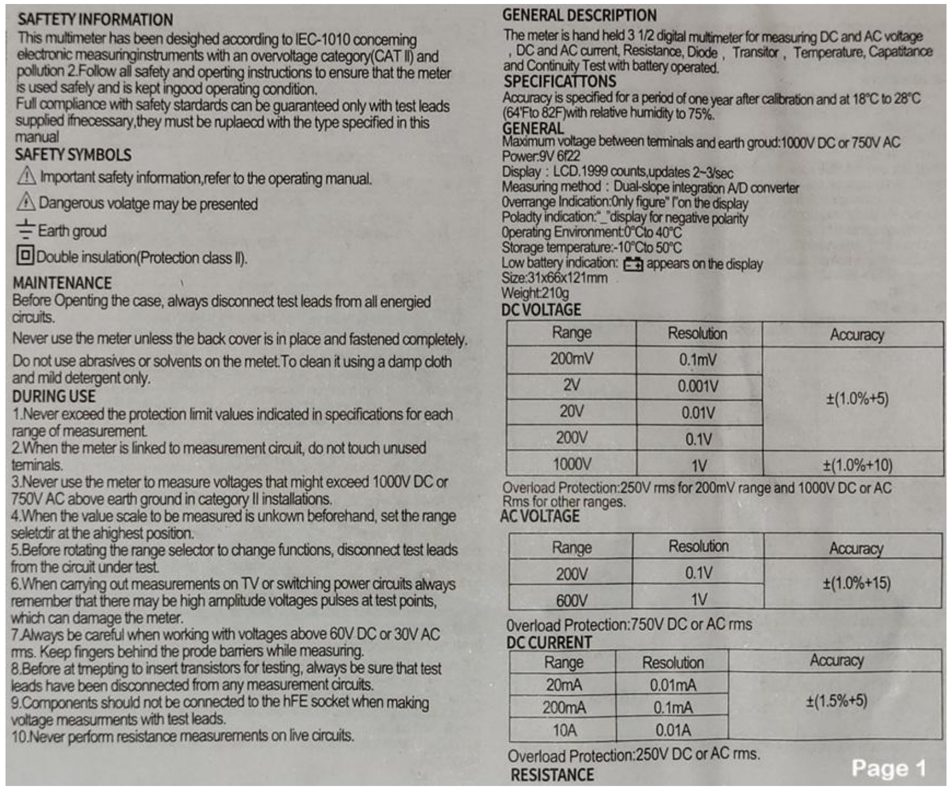
Image – Measuring a 2KΩ resistor

When measuring voltage, set the dial to 20V DC (see image below) - unless you are expecting to measure in the milli-volt range.

IMPORTANT NOTE: We will never measure anything more than 20-volts (DC). It can be dangerous to measure more than 50-volts DC or AC without proper training.

Image – Measuring the 5-Volt Power

Package Information:



SAFTETY INFORMATION

This multimeter has been desighed according to IEC-1010 concerning electronic measuringinstruments with an overvoltage category(CAT II) and pollution 2.Follow all safety and operting instructions to ensure that the meter is used safely and is kept ingood operating condition.

Full compliance with safety standards can be guaranteed only with test leads supplied ifnecessary,they must be ruplaecd with the type specified in this manual

SAFETY SYMBOLS

⚠ Important safety information,refer to the operating manual.

⚠ Dangerous volatge may be presented

⏚ Earth groud

▣ Double insulation(Protection class II).

MAINTENANCE

Before Openting the case, always disconnect test leads from all energied circuits.

Never use the meter unless the back cover is in place and fastened completely.

Do not use abrasives or solvents on the metet.To clean it using a damp cloth and mild detergent only.

DURING USE

1.Never exceed the protection limit values indicated in specifications for each range of measurement.

2.When the meter is linked to measurement circuit, do not touch unused terminals.

3.Never use the meter to measure voltages that might exceed 1000V DC or 750V AC above earth ground in category II installations.

4.When the value scale to be measured is unkown beforehand, set the range seletctir at the ahighest position.

5.Before rotating the range selector to change functions, disconnect test leads from the circuit under test.

6.When carrying out measurements on TV or switching power circuits always remember that there may be high amplitude voltages pulses at test points, which can damage the meter.

7.Always be careful when working with voltages above 60V DC or 30V AC rms. Keep fingers behind the prode barriers while measuring.

8.Before at tmepting to insert transistors for testing, always be sure that test leads have been disconnected from any measurement circuits.

9.Components should not be connected to the hFE socket when making voltage measurments with test leads.

10.Never perform resistance measurements on live circuits.

GENERAL DESCRIPTION

The meter is hand held 3 1/2 digital multimeter for measuring DC and AC voltage , DC and AC current, Resistance, Diode , Transitor , Temperature, Capatitance and Continuity Test with battery operated.

SPECIFICATTONS

Accuracy is specified for a period of one year after calibration and at 18°C to 28°C (64°Fto 82F)with relative humidity to 75%.

GENERAL

Maximum voltage between terminals and earth groud:1000V DC or 750V AC

Power:9V 6f22

Display : LCD.1999 counts,updates 2~3/sec

Measuring method : Dual-slope integration A/D converter

Overrange Indication:Only figure" I"on the display

Poladty indication:"_"display for negative polarity

Operating Environment:0°Cto 40°C

Storage temperature:-10°Cto 50°C

Low battery indication: 🔋 appears on the display

Size:31x66x121mm

Weight:210g

DC VOLTAGE

Range	Resolution	Accuracy
200mV	0.1mV	±(1.0%+5)
2V	0.001V	
20V	0.01V	
200V	0.1V	
1000V	1V	±(1.0%+10)

Overload Protection:250V rms for 200mV range and 1000V DC or AC Rms for other ranges.

AC VOLTAGE

Range	Resolution	Accuracy
200V	0.1V	±(1.0%+15)
600V	1V	

Overload Protection:750V DC or AC rms

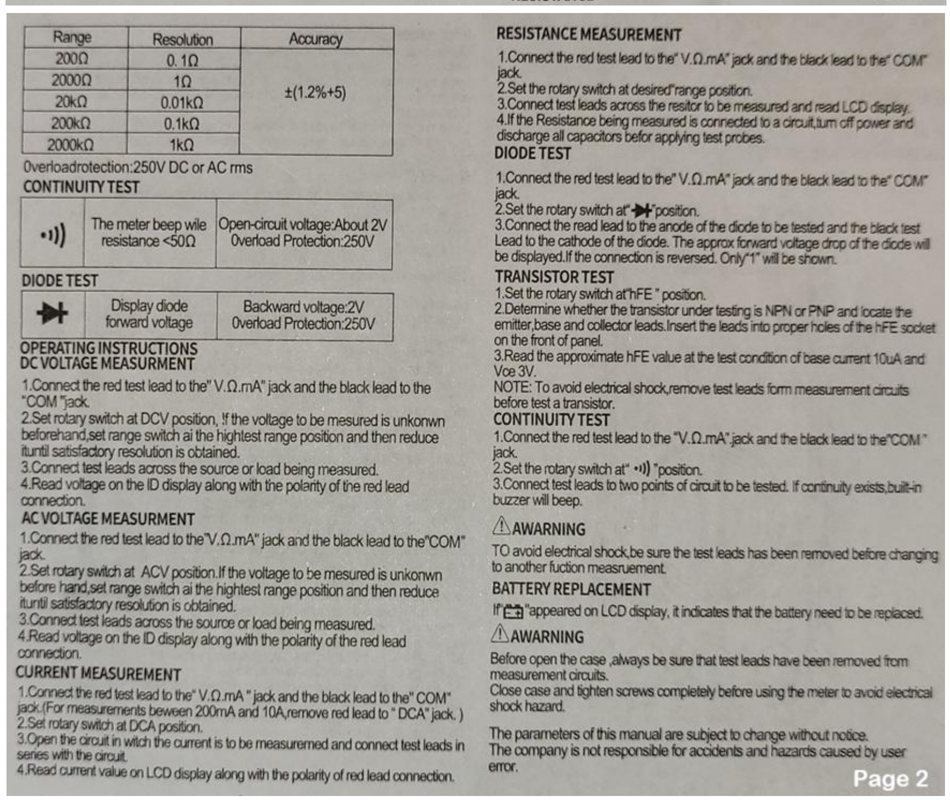
DC CURRENT

Range	Resolution	Accuracy
20mA	0.01mA	±(1.5%+5)
200mA	0.1mA	
10A	0.01A	

Overload Protection:250V DC or AC rms.

RESISTANCE

Page 1



Range	Resolution	Accuracy
200Ω	0. 1Ω	±(1.2%+5)
2000Ω	1Ω	
20kΩ	0.01kΩ	
200kΩ	0.1kΩ	
2000kΩ	1kΩ	

Overloadrotection:250V DC or AC rms

CONTINUITY TEST

•)))	The meter beep wile resistance <50Ω	Open-circuit voltage:About 2V Overload Protection:250V

DIODE TEST

➔⊢	Display diode forward voltage	Backward voltage:2V Overload Protection:250V

OPERATING INSTRUCTIONS

DC VOLTAGE MEASURMENT

1.Connect the red test lead to the" V.Ω.mA" jack and the black lead to the "COM "jack.

2.Set rotary switch at DCV position, If the voltage to be mesured is unkonwn beforehand,set range switch ai the hightest range position and then reduce ituntil satisfactory resolution is obtained.

3.Connect test leads across the source or load being measured.

4.Read voltage on the ID display along with the polarity of the red lead connection.

AC VOLTAGE MEASURMENT

1.Connect the red test lead to the"V.Ω.mA" jack and the black lead to the"COM" jack.

2.Set rotary switch at ACV position.If the voltage to be mesured is unkonwn before hand,set range switch ai the hightest range position and then reduce ituntil satisfactory resolution is obtained.

3.Connect test leads across the source or load being measured.

4.Read voltage on the ID display along with the polarity of the red lead connection.

CURRENT MEASUREMENT

1.Connect the red test lead to the" V.Ω.mA " jack and the black lead to the" COM" jack.(For measurements beween 200mA and 10A,remove red lead to " DCA" jack.)

2.Set rotary switch at DCA position.

3.Open the circuit in witch the current is to be measuremed and connect test leads in series with the circuit.

4.Read current value on LCD display along with the polarity of red lead connection.

RESISTANCE MEASUREMENT

1.Connect the red test lead to the" V.Ω.mA" jack and the black lead to the" COM" jack.

2.Set the rotary switch at desired range position.

3.Connect test leads across the resitor to be measured and read LCD display.

4.If the Resistance being measured is connected to a circuit,turn off power and discharge all capacitors befor applying test probes.

DIODE TEST

1.Connect the red test lead to the" V.Ω.mA" jack and the black lead to the" COM" jack.

2.Set the rotary switch at"➔⊢"position.

3.Connect the read lead to the anode of the diode to be tested and the black test Lead to the cathode of the diode. The approx forward voltage drop of the diode will be displayed.If the connection is reversed. Only"1" will be shown.

TRANSISTOR TEST

1.Set the rotary switch at"hFE " position.

2.Determine whether the transistor under testing is NPN or PNP and locate the emitter,base and collector leads.Insert the leads into proper holes of the hFE socket on the front of panel.

3.Read the approximate hFE value at the test condition of base current 10uA and Vce 3V.

NOTE: To avoid electrical shock,remove test leads form measurement circuits before test a transistor.

CONTINUITY TEST

1.Connect the red test lead to the "V.Ω.mA" jack and the black lead to the"COM " jack.

2.Set the rotary switch at" •))) "position.

3.Connect test leads to two points of circuit to be tested. If continuity exists,built-in buzzer will beep.

⚠AWARNING

TO avoid electrical shock,be sure the test leads has been removed before changing to another fuction measruement.

BATTERY REPLACEMENT

If"🔋"appeared on LCD display, it indicates that the battery need to be replaced.

⚠AWARNING

Before open the case ,always be sure that test leads have been removed from measurement circuits.

Close case and tighten screws completely before using the meter to avoid electrical shock hazard.

The parameters of this manual are subject to change without notice.

The company is not responsible for accidents and hazards caused by user error.

Page 2

  ([Back to TOC](#))