

Video 1

Practical intro to using a multimeter for voltage, current, and resistance

1. Resistance measurement
2. Continuity test with beeps (If it beeps, our wire is fine)
3. Measuring current
4. Fuse replacement guide

Video 2

LED Brightness Control Using PWM

Traditional Voltage Control

- Inefficient: Reducing voltage or using resistors/potentiometers wastes power as heat.
- Unstable: Brightness control can be nonlinear and unpredictable.
- Component Stress: Continuous voltage drops can damage high-power LEDs.
- Not Scalable: Not suitable for large LED arrays or high-current loads.

PWM (Pulse Width Modulation)

PWM controls the brightness of an LED by rapidly switching the LED ON and OFF at a high frequency.

- The average voltage delivered to the LED is proportional to the duty cycle.
- The human eye perceives a continuous dimming effect due to persistence of vision.

Video 3

In the video, the creator dives into how to harness the power of an ATtiny85 microcontroller to control WS2801 LED strips and create a variety of LED animations with just a push of a button. The main aim of this project is to find a smaller, more affordable alternative to the well-known ATmega328 (the chip found in Arduino Uno) for handling simple tasks. The ATtiny85 is a budget-friendly microcontroller, costing around a dollar, and it comes with 5 input/output pins and 8 KB of flash memory. Despite its compact size, it can produce some pretty impressive LED effects! However, programming it can be a bit more challenging compared to standard Arduino boards. To get the ATtiny85 up and running, the video guides you through the following steps: • Using an Arduino Uno as an ISP (In-System Programmer) • Downloading Arduino IDE v1.0.5 and installing the necessary board files from highlowtech.org • Connecting the pins correctly, including adding a capacitor to the reset pin of the Uno The creator also designed a custom programming shield—a small board that makes it easy to plug in and program the ATtiny85 without the hassle of rewiring every time. One hurdle to overcome is that the ATtiny85 lacks hardware SPI, which is essential for communicating with the WS2801 LED strip. To tackle this, the video demonstrates bit-banging, a technique that emulates SPI

through software using a library from Sparkfun. Even though this is just a prototype, the project clearly shows that the ATtiny85 can effectively control LED animations with a button, all while using the Arduino IDE.

Video 4

Bluetooth-Based RGB LED Control Using Arduino Nano

This project showcases how you can harness Bluetooth technology to control an RGB LED using an Arduino Nano and your smartphone. By connecting a Bluetooth module (HC-05) to the Arduino, you enable wireless communication between the microcontroller and an Android device. The smartphone sends straightforward ASCII commands through the "s2 Terminal" app, which the Arduino then interprets to manage the color and animation of the RGB LED. To make sure everything works smoothly, a voltage divider circuit is employed to reduce the Arduino's 5V TX signal down to the 3.3V level that the Bluetooth module can handle. A common anode RGB LED is utilized, linked to the Arduino's digital pins via current-limiting resistors. Each command sent from the smartphone corresponds to a specific output for the LED, allowing for real-time remote control. Additionally, the project emphasizes the need to disconnect the RX and TX pins of the Bluetooth module while uploading code to prevent any serial interference. All in all, this tutorial serves as a hands-on example of merging wireless communication with basic electronics, inspiring further exploration in DIY and IoT projects..

Video 5

Controlling Large LED Arrays with Limited I/O Pins

The tutorial video walks you through the process of managing the scaling of LEDs in complex setups, like a 4×4×4 RGB LED cube featuring 192 LEDs or a 10×5 LED matrix with 50 LEDs. What's impressive is that it all runs on just a few microcontroller I/O pins, thanks to techniques like multiplexing, TLC5940 LED drivers, and P-channel MOSFETs like the FQP95N06, all orchestrated by an Arduino Nano. For the LED matrix, the cathodes are arranged in columns while the anodes are set up in rows, allowing for control in a multiplexed row-wise fashion. This clever setup helps eliminate ghosting and reduces pin usage. The MOSFETs drive the rows, delivering high current, while the gates are powered by the Arduino's digital pins through 1 kΩ resistors that are pulled up to 5 volts for effective switching. The TLC5940's set-and-reset channels maintain a constant current, controlling the columns with a 2.2kΩ resistor that limits the LED current to 20mA per channel through sinkless shift registers. With the help of the Arduino TLC5940 library, you can create sequential row illumination animations or simulate flowing sine waves by quickly transitioning through the rows. This takes advantage of the persistence of vision, allowing viewers to experience the illusion of smooth lighting. It cleverly masks the actual off-lighting of the LEDs. When you scale this up to more LEDs, the system showcases smart, low-powered control of LEDs and serves as a fantastic starting point for building more advanced three-dimensional cubes

Video 6

In this video, you'll see how to remove the ATmega328P chip from an Arduino Uno and use it in a custom standalone circuit, especially for smaller designs. It highlights the importance of breadboard testing and walks you through the few essential components you'll need, like a 10kΩ resistor, two 22pF capacitors, and a 16MHz crystal. The video covers everything from power and ground connections to clock configuration, and it explains how to map the Arduino pins to the chip's actual pins. You'll find three different methods for programming: using an FTDI programmer (which is the cleanest option), a USB-to-serial bridge, or even another Arduino. It also touches on ICSP. The video suggests adding headers for easy reprogramming but warns you not to lose the built-in protection. It's a fantastic introduction to working with more than just the Arduino board!

Video 7

The video offers a practical and thorough look at seven-segment displays, covering both traditional methods and those that use microcontrollers. It kicks off with the basics of display types—common anode and common cathode—and highlights the crucial role of reading datasheets to get the pin configuration and voltage specs right. If you're not using a microcontroller, you can achieve numeric display with the SN74LS247 BCD to seven-segment driver paired with the SN74290 binary counter, which lets you display numbers sequentially through hardware logic. For those looking to dive into more advanced and scalable designs, the video introduces multiplexing techniques and the SI A1064 IC with I²C communication, which greatly cuts down on pin usage and makes Arduino integration a breeze. By tapping into existing libraries, users can quickly prototype multi-digit displays with just a bit of code. All in all, this tutorial mixes essential digital electronics with modern embedded system techniques,

encouraging hands-on learning and inspiring experimentation in display control projects.

Video 8

The video serves as a comprehensive guide on how to use LEDs efficiently, starting from the basics and gradually diving into more advanced topics. It covers essential concepts like the forward voltage of an LED, which is typically around 3.2V, and the ideal current, usually about 20mA. The video also highlights the crucial role of resistors in managing current to protect the LED. It explains how to calculate resistor values using Ohm's Law and Kirchhoff's Voltage Law, whether you're working with a single LED or multiple ones. While it mentions that LEDs can be connected in parallel, it suggests that a series connection is often a better choice. This setup tends to use less power, provides better current control—regardless of whether it's at 0.532743V or just +2%—and demonstrates greater efficiency when driving current at lower forward voltages. The video points out that LEDs can actually change their forward voltage over time when connected in parallel, just as the forward voltage from a power supply can vary in constant voltage mode. If not managed properly, this can lead to structural defects in the LEDs. Lastly, it emphasizes the importance of balancing efficiency with cost when designing LED circuits, highlighting how each decision impacts the overall performance of the circuit.

Video 9

The video offers a clear and professional look at diodes, showcasing their crucial function in both electrical and electronic circuits. Think of diodes as one-way gates for electricity; they let current flow in just one direction, which helps protect circuits from damage caused by reverse polarity. One important point covered

is the forward voltage drop of a diode—usually around 0.7V for silicon types like the 1N4007. This drop can lead to power loss and heat, particularly in high-current situations. In AC circuits, diodes play a key role in rectification, turning alternating current (AC) into direct current (DC). Single diode rectifiers only allow one half of the waveform to pass through, while bridge rectifiers, which use four diodes, achieve full-wave rectification, making the process more efficient and resulting in a smoother DC output. The video also touches on the connection between RMS and peak voltage in AC systems, which is vital for designing transformer-based power supplies. Additionally, capacitors are introduced as a way to reduce voltage ripple after rectification. The importance of thermal management and choosing the right diode size is highlighted to prevent overheating and ensure everything runs smoothly.

Video 10

This video offers a comprehensive introduction to Digital to Analog Converters (DACs), detailing how they transform digital signals into analog waveforms. It walks you through the practical steps of building a resistor ladder DAC using Arduino and resistors, while also explaining essential concepts like bit resolution and voltage scaling. You'll see various waveforms, including ramp, triangular, and sine waves, to illustrate what DACs can do. The video highlights the crucial role of an operational amplifier as a voltage follower to ensure stable output even under load. Additionally, it compares hardware DACs with Arduino's PWM-based analog Write function, clarifying their differences. To wrap things up, it introduces integrated DAC ICs (DAC0800, PCF8591, MCP4725) for those seeking higher precision and ease of use, making this a fantastic resource for beginners and hobbyists diving into digital signal processing and embedded systems.

Video 11

The video demonstrates how to use the budget-friendly TC35 GSM module with an Arduino Uno to send SMS messages. It emphasizes the importance of safely powering the module at 5V since the MAX232 IC on the board lacks a voltage regulator and could be damaged if powered at a higher voltage. To automate the network login button, a jumper wire is soldered from the button to an Arduino pin, allowing the microcontroller to manage the connection. The module communicates using standard AT commands, which were tested with an FTDI breakout at 9600 baud, enabling checks on network status and signal strength. The Arduino sketch allows you to type your SMS text in the serial monitor and send it by finishing the message with a dot ('.'). This setup is not only beginner-friendly but also versatile, with plans to use the module for SMS-based alarm systems, showcasing its great potential for automated IoT projects.

Video 12

Inductors, often referred to as coils, are essential passive components in the world of electronics. You'll find them in devices like motors, transformers, and relays, where they play a vital role by generating magnetic fields when current flows through them. When you coil a wire, it enhances the magnetic field, and if you add an iron core, it becomes even more powerful, effectively turning it into an electromagnet. The strength of this magnetic field is measured in Henrys, which tells us how well a coil can generate magnetic fields and resist sudden changes in current. This behavior follows Lenz's law, which explains why current lags behind voltage in AC circuits. Inductors are particularly important in boost converters, where they store energy

magnetically to increase voltage. However, they can also create voltage spikes when the current is switched, which is where flyback diodes come into play to protect against those spikes. The video suggests that we'll soon dive into AC behavior, where inductors function as frequency-dependent filters, broadening their impact in electronics. In summary, inductors are crucial for managing current changes smoothly and powering a variety of devices by harnessing magnetic energy.

Video 13

Inductors in AC circuits do more than just resist current like resistors; they actually create something called inductive reactance, which ramps up with frequency. This causes the current to drop, helping to protect sensitive components like LEDs from burning out. Instead of just wasting energy as heat, inductors store energy in a magnetic field, leading to reactive power that oscillates and can put a strain on power grids without doing any useful work. They also create a phase shift, where the current lags behind the voltage by as much as 90 degrees, and you can measure this to determine the inductance. By tweaking the iron core, you can adjust the inductance, which is great for creating tunable circuits. Inductors play a crucial role in frequency filters, such as low-pass and high-pass audio filters. Plus, there are affordable transistor testers available that allow hobbyists to accurately measure inductance, resistance, capacitance, and transistor gain without spending a fortune. This hands-on approach really simplifies the understanding of inductors and makes them incredibly useful for practical electronics!

Video 14

A capacitor is made up of two conductive plates that are separated by an insulating space, and it stores electrical energy by creating an

electrostatic field. The capacitance of a capacitor is influenced by several factors, including the size of the plates, the distance between them, and the type of dielectric material used, which helps enhance its ability to store charge. Electrolytic capacitors come with specific voltage ratings and polarity requirements; if you exceed these voltage limits or reverse the polarity, you could end up damaging the capacitor. In DC circuits, capacitors help prevent sudden voltage changes by charging or discharging gradually, which makes them great for stabilizing voltage and timing applications. In AC circuits, capacitive reactance—essentially the opposite of frequency and capacitance—enables capacitors to function as frequency-selective components in filters, providing a compact and cost-effective alternative to inductors. Plus, capacitors are also used in power factor correction to counteract reactive power from inductive loads, ultimately boosting the efficiency of the entire power system.

Video 15

When it comes to measuring temperature, NTC thermistors and PT100 sensors are the go-to options. NTC thermistors are resistors that decrease in resistance as the temperature rises, making them a budget-friendly choice, though they might not be the most accurate for all applications. On the other hand, PT100 sensors are platinum-based resistance temperature detectors that have a resistance of 100Ω at 0°C . They offer greater accuracy and stability, which is why they're often used in industrial and scientific settings. To get precise readings from sensors like the PT100, a Wheatstone bridge circuit is typically used. This circuit balances two legs to detect tiny voltage changes, which helps improve measurement accuracy. The Wheatstone bridge, often used alongside amplification circuits, plays a vital role in ensuring

precise temperature measurements and is essential for various sensor applications.

Video 16

A resistor is an essential passive electrical component that limits the flow of electric current in a circuit, measured in ohms (Ω). It helps control voltage and current according to Ohm's Law ($V = I \times R$). Resistors come in two main types: fixed, with a constant resistance value, and variable (potentiometers), which allow adjustable resistance. Understanding resistors and their color coding is fundamental for designing and analyzing electrical circuits effectively

Video 17

Oscillators are crucial electronic circuits that create periodic waveforms, and they come in three main types: RC, LC, and crystal oscillators. RC oscillators rely on resistors and capacitors to generate low-frequency signals, making them perfect for audio and timing applications thanks to their straightforward design. On the other hand, LC oscillators use inductors and capacitors to produce higher-frequency oscillations through resonant tank circuits, which are often found in radio frequency applications. Crystal oscillators take advantage of the mechanical resonance of quartz crystals to deliver highly stable and precise frequencies, which is why they're essential in clocks and communication systems. Each type has its own set of trade-offs regarding frequency range, stability, and complexity, with crystal oscillators being the most accurate, though they do need extra circuitry to start up and maintain those oscillations.

Video 18

The video showcases a clever way to transform a regular BLDC PC fan into a working wind generator. By taking out its internal electronics, you can repurpose the fan as a low-speed AC generator. The AC voltage it produces is then converted to DC with a straightforward circuit that includes resistors, a Zener diode, and a capacitor to help regulate the voltage and smooth out the signal. To keep track of the voltage output, an Arduino microcontroller is used, which also allows for monitoring wind speed. This setup is not only budget-friendly but also a practical solution for small-scale wind energy collection and gathering real-time environmental data.

Video 19

I2C, or Inter-Integrated Circuit, is a nifty little 2-wire communication protocol that lets multiple low-speed devices connect with microcontrollers. It operates using two lines: SDA, which stands for Serial Data, and SCL, or Serial Clock. These lines enable data to flow back and forth between a master device and one or more slave devices on the same bus. The SDA line carries important information about I2C, like how easy it is to wire up, the synchronous monitoring provided by the clock, and the ability to support various individual address devices. This makes it super handy for embedded systems that need to interact with sensors, displays, EEPROMs, and other components, all in one neat package. For reliable data transfer, there are also key elements like start and stop conditions, addressing bits, R/W bits, and acknowledgment signals. Most microcontrollers come with built-in support for I2C, along with helpful libraries like Wiring for Arduinos, making it a great choice for devices that require compact and efficient interconnections.

Video 20

Thyristors and Triacs are types of semiconductor devices that play a crucial role in managing power for AC devices, like dimmers and motor speed controllers. One popular method for this is phase angle control, which shifts the timing of when power is triggered on the AC waveform. This allows a specific amount of power, often referred to as “chopped” power, to be delivered to the load. It’s a smart way to control voltage and current while minimizing energy loss. In the realm of electrical engineering, power electronics solutions are essential, especially when it comes to controlling AC power. Utilizing these components requires careful design and customization to ensure they operate at peak efficiency.

Video 21

This video is a clear and practical guide to operational amplifiers, or op amps. It dives into the essential principles, configurations, and real-world applications of these components. Using the LM358 as a reference, it shows how op amps amplify signals through feedback, ensuring that the voltage difference between inputs remains minimal to control gain. The tutorial compares non-inverting and inverting amplifier setups, highlighting their effectiveness for different types of signals, especially small sensor outputs and audio signals. It also addresses common challenges, such as output voltage swing in single-supply designs, and explains how rail-to-rail op amps and DC offset techniques can help solve these problems. Additionally, the video covers the non-ideal characteristics of real op amps, the importance of input impedance, and how op amps can function as comparators without feedback, which opens up a variety of applications from voltage followers to Schmitt triggers. Overall, it provides a solid foundation for understanding and effectively using op amps in the world of analog electronics.

Video 22

This video serves as a thorough introduction to using Bipolar Junction Transistors (BJTs) as electronic switches, with a focus on both NPN and PNP types. It kicks off by identifying the transistor terminals—emitter, base, and collector—and explains their functions in switching circuits. The presenter shares practical examples, like a BC637 NPN transistor controlling a high-power LED, to demonstrate the correct wiring and the essential role of a base resistor in limiting current and protecting the transistor. Key operational concepts are explored, including how the transistor current gain (β or h_{FE}) affects base resistor calculations, ensuring reliable switching without risking damage. The video also clarifies the polarity differences between NPN and PNP transistors, stressing the importance of placing loads correctly in relation to supply voltage or ground. For higher current applications, such as switching a 6V 21W light bulb, the presenter introduces the BD535 transistor, discussing the challenges of heat dissipation and power loss that come with high-current BJTs. To tackle these issues and lessen base drive requirements, Darlington transistor configurations are introduced, which provide a significant boost in current gain, allowing for direct control from microcontroller outputs like Arduino pins. The video wraps up with practical tips on balancing efficiency, power dissipation, and switching performance, encouraging viewers to choose components wisely and think about thermal management. It also highlights the importance of checking datasheets for accurate transistor specifications to ensure a solid circuit design.

Video 23

This video compares MOSFETs and BJTs for switching electronic loads, highlighting MOSFETs' superior efficiency (~97%) due to their low on-resistance and minimal voltage drop, especially under high current loads where BJTs struggle with heat dissipation. N-channel MOSFETs like the IRLZ44N are commonly controlled via gate voltage, easily driven by microcontrollers such as Arduino, with pulldown resistors essential to prevent false triggering by static discharge.

The video discusses the distinct control requirements for N-channel and P-channel MOSFETs, and explores switching challenges with larger loads—specifically voltage spikes and oscillations caused by parasitic capacitances and circuit inductances. Gate resistors help mitigate these effects by limiting peak gate currents and slowing voltage transitions, reducing harmful oscillations.

At high switching frequencies, gate charge and discharge cycles increase power losses (switching losses), necessitating higher peak gate currents for fast transitions. To manage this, dedicated MOSFET driver ICs are recommended, simplifying gate drive complexity and improving reliability in demanding applications.

Key takeaways include MOSFETs' advantages in efficiency and control, the importance of gate resistors and pulldown resistors for protection, understanding parasitic effects in switching circuits, and leveraging driver ICs for high-frequency, high-power scenarios.

Video 24

This video offers a fascinating look at hybrid synchronous stepper motors, which are often used in 3D printers, even though they can be a bit noisy. It kicks off with a teardown that reveals the motor's inner workings, showcasing the hybrid design that merges rotor permanent

magnets with stator teeth and coil pairs to create precise 1.8° discrete steps (that's 200 steps for a full revolution!). The presenter walks us through various driving methods, starting with basic H-bridge circuits controlled by an Arduino. They illustrate wave, full-step, and half-step modes, all of which help balance torque and resolution. As the video progresses to microstepping, it explains how adjusting coil currents can lead to smoother, quieter operation with much finer step resolution. The use of an A4988 driver IC and a 555 timer for generating step pulses highlights how advanced control can be integrated into a compact setup. In the end, the video emphasizes the essential role of stepper motors in applications that need precise positioning, like 3D printing, and encourages viewers to dive into hands-on experimentation with motor control techniques

Video 25

A servo motor is a highly precise device that's often found in robotics and automation, where it plays a key role in controlled angular positioning. It works by using a PWM (Pulse Width Modulation) signal, usually set at 50Hz, with the pulse width (ranging from 1ms to 2ms) determining the angle of the shaft. Inside a servo, you'll find a motor, gears, and a potentiometer that gives feedback for accurate positioning. Unlike regular DC motors, servos are designed to rotate to and maintain specific positions, which makes them perfect for tasks that need precise control, like robotic arms and camera gimbals. If you want to modify a servo for continuous rotation, you can bypass the potentiometer, allowing it to spin freely. For electrical and electronic engineers working on control systems and automation, understanding how servos operate is crucial..

Video 26

A timer in a microcontroller is an essential piece of hardware that counts clock pulses to measure time intervals accurately. It operates by utilizing a clock source along with a prescaler to control the speed of counting, with a counter that increments until it hits its maximum limit. When the counter overflows, timers typically trigger interrupts, enabling the microcontroller to manage time-sensitive tasks efficiently without the need for constant monitoring. For electrical and electronic engineers, understanding how timers work is crucial, as they are integral to real-time applications like creating precise delays, generating PWM signals, controlling motors, and managing communication protocols. The 555 Timer, known for its stability and user-friendliness, is particularly important in applications such as pulse generation, LED flashers, tone generation, and PWM signal production. Mastering this integrated circuit is fundamental for engineers involved in circuit design and automation.

Video 27

An Analog-to-Digital Converter (ADC) is a crucial electronic component that transforms continuous analog signals into distinct digital values for microcontroller processing. The conversion process includes sampling the analog signal, quantizing it according to the ADC's resolution, and encoding it into binary format. Higher resolution ADCs yield more accurate digital representations, with typical resolutions ranging from 8-bit to 10-bit or even higher. ADCs play a key role in connecting sensors and analog devices to digital systems, allowing for precise data acquisition in various applications like temperature measurement, audio processing, and control systems. Understanding the principles of ADCs is essential for electrical and electronic engineers involved in embedded and automation projects.

Video 28

The Insulated-Gate Bipolar Transistor (IGBT) is truly an intriguing semiconductor device that combines the fast switching capabilities of a MOSFET with the strong current handling and low saturation voltage features of a bipolar junction transistor (BJT). By applying a voltage to the gate terminal, the IGBT can effectively switch high voltages and currents, making it an ideal choice for power electronics applications such as motor drives, inverters, and power supplies. For electrical and electronic engineers involved in power electronics and energy conversion systems, understanding how IGBTs work and their unique characteristics is essential.

Video 29

A solar panel works by transforming sunlight into electrical energy through photovoltaic cells, which generate direct current (DC). To keep everything running smoothly, a charge controller regulates the voltage and current coming from the solar panel to the battery. This helps prevent overcharging and deep discharging, ensuring that the battery lasts longer and the system operates efficiently. Together, these components are the backbone of solar power systems, allowing for dependable energy storage and supply, even when the sun isn't shining. For electrical and electronic engineers who are diving into renewable energy and sustainable power solutions, grasping how these devices function is crucial.

Video 30

A timer in a microcontroller is a crucial hardware component that counts clock pulses to accurately measure time intervals. It works by using a clock source along with a prescaler to manage how fast the

counting happens, with a counter that keeps increasing until it reaches its limit. When the counter overflows, timers often trigger interrupts, allowing the microcontroller to handle time-sensitive tasks efficiently without needing to constantly check in. For electrical and electronic engineers, grasping how timers function is vital, as they play a key role in real-time applications like creating precise delays, generating PWM signals, controlling motors, and managing communication protocols.