

ELECTRONIC BASICS #1: THE MULTIMETER

- **Ohm's Law:** The relationship between voltage, current, and resistance.
- **Measuring Resistance:** Selecting the correct setting, using probes, and understanding circuit resistance.
- **Continuity Testing:** Checking for cable breaks using the meter's beep function.
- **Voltage Measurement:** Distinguishing between AC and DC voltage and safely measuring battery or power supply voltage.
- **Current Measurement:** Using the correct probe socket and avoiding fuse damage.

ELECTRONIC BASICS #2: DIMMING ALL KINDS OF LEDs!?

Different methods for dimming LEDs are explored, including voltage reduction, potentiometer use, and Pulse Width Modulation (PWM). PWM rapidly switches LEDs on and off to create a dimming effect without wasting power. Techniques using an Arduino, a 555 timer, and MOSFETs are demonstrated, showing efficient ways to control LED brightness in various applications..

ELECTRONIC BASICS #3: PROGRAMMING AN ATTINY + HOMEMADE ARDUINO SHIELD

Programming an ATtiny 85 using an Arduino Uno is demonstrated, covering software setup and board data installation. A custom shield is designed to streamline the process. SPI communication challenges with the WS 2801 LED strip are addressed using a bit-bang approach. The test confirms functionality, with future improvements planned.

ELECTRONIC BASICS #4: ARDUINO + BLUETOOTH + ANDROID = AWESOME

A Bluetooth module is connected to an Arduino Nano to control LEDs using an Android app. Voltage differences between the module and the Arduino are addressed with a voltage divider. An app is recommended for communication, and code is provided for LED control. The importance of disconnecting TX and RX connections before uploading code is emphasized.

ELECTRONIC BASICS #5: HOW TO MULTIPLEX

Multiplexing is used to control many LEDs with fewer microcontroller I/O pins. LEDs are arranged in a matrix, with cathodes connected per column and anodes per row. Power is supplied to specific rows and columns to activate individual LEDs. Rapid switching creates a stable visual effect. P-channel MOSFETs manage row power, while a TLC5940 LED driver controls column brightness. A programming library simplifies coding, enabling animations like a sine wave display. This technique is applicable to LED matrices and RGB LED cubes.

ELECTRONIC BASICS #6: STANDALONE ARDUINO CIRCUIT

Building a standalone Arduino circuit using an ATmega328P microcontroller is demonstrated. Essential components include a 16 MHz clock crystal, capacitors, and a resistor for stability. Different methods for programming the microcontroller are outlined, including using an FTDI chip for USB-to-serial conversion. Advantages and limitations of standalone circuits compared to standard Arduino boards are discussed. A final build is completed in a gadget box with female headers for reprogramming. to create a stable visual effect. P-channel MOSFETs manage row power, while a TLC5940 LED driver controls column brightness. A programming library simplifies coding, demonstrating animations like a sine wave display. The technique is useful for LED matrices and is later applied to an RGB LED cube.

ELECTRONIC BASICS #7: 7 SEGMENT DISPLAY

The use of 7-segment displays is explored, both with and without an Arduino microcontroller. Different types of displays are introduced, highlighting their pin configurations and required voltage levels. Methods for displaying numbers without a microcontroller are demonstrated using a BCD to 7-segment display driver and a 4-bit binary counter. Multiplexing is used to control multiple digits efficiently. The SAA1064 IC is introduced as a dedicated solution for handling 7-segment displays with the I²C communication protocol, reducing the processing load on the microcontroller. A schematic and example code are provided to simplify

integration with an Arduino.MHz clock crystal, capacitors, and a resistor for stability. Different methods for programming the microcontroller are outlined, including using an FTDI chip for USB-to-serial conversion. Advantages and limitations of standalone circuits compared to standard Arduino boards are discussed. A final build is completed in a gadget box with female headers for reprogramming.

ELECTRONIC BASICS #8: EVERYTHING ABOUT LEDs AND CURRENT LIMITING RESISTORS

Key principles of LED operation are explained, including forward voltage, ideal current, and resistor calculations using Kirchhoff's Voltage Law and Ohm's Law. Series and parallel LED connections are compared, highlighting efficiency differences. The risks of voltage variations in LEDs are addressed, emphasizing the importance of current regulation. Simple constant current sources, such as the LM317 and the TLC5940 LED driver, are introduced for improved LED longevity and stability.

ELECTRONIC BASICS #9: DIODES & BRIDGE RECTIFIERS

Diodes are widely used in electronics, particularly in power supplies and circuit protection. Their function in preventing damage from reversed polarity is explained, along with their voltage drop characteristics. The conversion of AC to DC using diodes is demonstrated, highlighting the role of rectifiers in power supply designs. A bridge rectifier circuit is introduced, showing how it efficiently converts both halves of an AC waveform into a continuous DC output.

ELECTRONIC BASICS #10: DIGITAL TO ANALOG CONVERTER (DAC)

Different methods for converting digital signals into analog waveforms are explored. The R-2R resistor ladder technique is introduced, demonstrating its ability to generate varying voltage levels. An experiment is conducted using an Arduino Nano to output different digital values, resulting in a corresponding analog signal. Triangle and sine waves are generated through gradual voltage adjustments. The importance of buffering the output using an operational amplifier is highlighted to maintain signal integrity. Alternative DAC solutions, including integrated circuits like the DAC0800 and MCP4725, are mentioned for more precise applications.

ELECTRONIC BASICS #11: SENDING SMS WITH ARDUINO | | TC 35 GSM MODULE

The process of using a TC 35 GSM module to send SMS messages with an Arduino Uno is demonstrated. The setup begins with inserting a prepaid SIM card into the module and removing the SIM lock using a smartphone. Powering the module correctly is explained, with a recommendation to use 5V to avoid voltage regulation issues. The login process for connecting the module to a mobile network is automated using a jumper wire linked to an Arduino pin.

Communication between the GSM module and Arduino is established via AT commands, with an FTDI breakout used for

initial testing. The process of sending an SMS is outlined, requiring a specific command format and ending with a dot for proper execution. A simple schematic and example code are provided for integration into various projects, including an alarm system that sends SMS notifications.

ELECTRONIC BASICS #12: COILS / INDUCTORS (PART 1)

Inductors, also known as coils, play a fundamental role in electronics. Current flowing through a wire generates a magnetic field, which can be intensified by winding the wire into coils and using a ferromagnetic core. Lenz's Law explains how inductors resist changes in current flow by inducing opposing voltage. Applications include electromagnetic switches, motor control, and DC-DC converters. Energy stored in inductors is utilized in boost converters to raise voltage, while flyback diodes protect circuits from voltage spikes caused by inductive loads. The behavior of inductors in AC circuits is explored in the next part of the series.

ELECTRONIC BASICS #13: COILS / INDUCTORS (PART 2) | | REACTANCE

The concept of reactance is explored, demonstrating how inductors create a form of resistance that differs from conventional resistors. A small LED circuit powered by a transformer is tested with and without an inductor, showing how inductance affects current flow. Changes in inductance influence reactive power, impacting efficiency in power systems. Increasing frequency is shown to raise reactance, reducing current flow. Applications such as noise filters, phase

shifts in AC circuits, and inductive loads in motors are discussed. An affordable transistor tester is introduced for measuring inductance, resistance, and capacitance.

ELECTRONIC BASICS #14: CAPACITORS

Capacitors are explained through a demonstration, beginning with the construction of a basic capacitor. Capacitance, voltage rating, and the role of dielectric materials in increasing charge storage are discussed. Behavior in DC and AC circuits is analyzed, showing how capacitors stabilize voltage, create signal filters, and compensate for inductive loads. The importance of selecting appropriate capacitance values for specific applications is highlighted, along with practical examples in electronic circuits.

ELECTRONIC BASICS #15: TEMPERATURE MEASUREMENT (PART 1) | | NTC, PT100, WHEATSTONE BRIDGE

Various methods for measuring temperature are explored, including NTC thermistors, PT100 sensors, and the Wheatstone bridge circuit. NTC thermistors decrease resistance with increasing temperature, while PT100 sensors offer a more linear response. Accurate measurement techniques using voltage dividers and operational amplifiers are demonstrated. A pre-made transmitter is introduced to simplify the process, reducing errors and improving precision. The advantages of integrated circuits such as the LM35 and DS18B20, which provide direct temperature readings, are highlighted. Thermal inertia and response speed limitations of resistance-based

sensors are discussed, with alternative solutions mentioned for faster measurements.

ELECTRONIC BASICS #16: RESISTORS

Resistors are essential components in electronic circuits, used for limiting current, dividing voltage, and acting as pull-up or pull-down resistors in logic circuits. Their resistance value is calculated using Ohm's Law. Power ratings are important, as excessive power dissipation requires high-wattage resistors. Voltage dividers are formed by connecting resistors in series, allowing signal level adjustments. Potentiometers serve as adjustable resistors for fine-tuning voltage outputs. Low-value resistors, known as shunt resistors, enable current measurement through voltage drop analysis. Additional applications include circuit protection, light detection using photoresistors, and temperature sensing with PT100 sensors. While resistors behave predictably in DC circuits, parasitic inductance and capacitance affect performance in high-frequency AC circuits. Considering these effects is crucial in circuit design.

ELECTRONIC BASICS #17: OSCILLATORS | | RC, LC, CRYSTAL

Oscillators generate periodic signals used in timing circuits, clock generation, and radio communication. RC oscillators create waveforms through capacitor charging and discharging, demonstrated with an astable multivibrator and a 555 timer circuit. LC tank circuits utilize inductors and capacitors to form resonant oscillations, maintaining frequency stability. Crystal

oscillators rely on piezoelectric vibrations to achieve precise clock signals, commonly found in microcontrollers and communication systems. Frequency adjustments are achieved by modifying resistance, capacitance, or inductance, influencing circuit behavior for different applications.

ELECTRONIC BASICS #18: DC & BRUSHLESS DC MOTOR + ESC

Brushless DC motors and electronic speed controllers (ESCs) are examined, comparing them to conventional DC motors. The internal structure of both motor types is explored, showing how electromagnetism generates rotational motion. ESCs regulate motor speed using pulse width modulation, ensuring efficient power delivery. Differences between outrunner and inrunner motors are highlighted, explaining how magnet placement affects torque and speed. The KV rating is introduced, indicating the number of revolutions per volt applied. Practical tests are conducted to measure speed and torque variations under different voltage conditions.

ELECTRONIC BASICS #19: I2C AND HOW TO USE IT

The I²C communication protocol is explained, highlighting its ability to connect multiple master and slave devices. A small breakout board is built to interface an FM radio module with an Arduino Nano. Proper wiring is established, including pull-up resistors to stabilize data lines. Data transmission principles are outlined, covering start conditions, address selection, and bit formatting. Practical implementation is demonstrated by tuning an FM frequency through hexadecimal calculations. An

oscilloscope is used to analyze data transmission, confirming the expected output. Reading data from I²C devices follows a similar process, storing received bits in a buffer for evaluation. The importance of understanding datasheets is emphasized for successful integration. Other communication protocols like SPI and One-Wire are mentioned as alternatives.

ELECTRONIC BASICS #20: THYRISTOR, TRIAC | | PHASE ANGLE CONTROL

The thyristor, a controllable diode, is introduced with a focus on its function in AC power regulation. Its four-layer structure is explained, along with the addition of a gate terminal to control current flow. A practical example is demonstrated using an LED, highlighting the latching and holding current requirements for maintaining conduction. Methods for turning off the thyristor, including interrupting current flow with a MOSFET, are outlined.

The triac is then introduced, combining two thyristors in an inverse parallel configuration to enable full-wave AC control. A zero-crossing detection circuit is built using an optocoupler and a full-bridge rectifier, ensuring precise switching at the correct phase angle. A microcontroller-based delay system is implemented using an Arduino Nano and a potentiometer, adjusting the activation timing of the triac. The final circuit allows efficient power regulation for AC appliances, including heating elements and motor speed adjustments. While practical applications are explored, challenges such as reduced power factor due to waveform distortion are acknowledged.

ELECTRONIC BASICS #21: OPERATIONAL AMPLIFIERS (OP-AMPS)

Operational amplifiers (op-amps) are widely used in both analog and digital electronics. Their function is explained through three fundamental principles: maintaining zero voltage difference between inputs, drawing no input current, and amplifying signals based on feedback circuits.

A basic op-amp setup is demonstrated using the LM358 IC, powered by a single 12V supply. A non-inverting amplifier circuit is introduced, where a voltage divider determines the amplification factor. Applications of this setup include signal amplification for sensors such as PT100 temperature sensors and electret microphones.

The limitations of op-amps are highlighted, including voltage output constraints and imperfections in input impedance. Rail-to-rail op-amps are briefly mentioned as alternatives for better performance. An inverting amplifier circuit is explored to improve AC signal amplification, preventing distortion caused by DC voltage levels.

The final section introduces op-amps used as comparators, where outputs shift between high and low states based on input voltage differences. This principle is applicable in circuits such as Schmitt triggers and integrators. The versatility of op-amps is emphasized, making them essential in constant current sources, voltage followers, and summing amplifiers.

ELECTRONIC BASICS #22: TRANSISTOR (BJT) AS A SWITCH

Bipolar junction transistors (BJTs) are introduced as switching elements in electronic circuits. NPN and PNP transistor types

are explained, with their terminals—emitter, collector, and base—described. The necessity of base current for transistor operation is highlighted, alongside calculations for proper resistor selection to limit current and prevent damage.

The concept of saturation mode is discussed, where the transistor is fully switched on, allowing maximum current flow. Voltage drop across the collector-emitter junction is observed, affecting circuit efficiency. Differences in control methods for NPN and PNP transistors are explained, focusing on circuit polarity and switching behavior.

Higher-power applications require transistors with increased current ratings. The BD535 transistor is demonstrated for handling larger loads, with considerations for heat dissipation and efficiency. Darlington transistors are introduced to reduce base current requirements, making direct microcontroller control possible.

Power loss in BJTs is analyzed, revealing the limitations of bipolar transistors in high-current switching applications. Alternative solutions, including MOSFETs, are suggested for better efficiency. The fundamental principles of transistor switching are summarized, enabling practical application in various electronic projects.

ELECTRONIC BASICS #23: TRANSISTOR (MOSFET) AS A SWITCH

MOSFETs are introduced as efficient alternatives to bipolar junction transistors (BJTs) for switching applications. Unlike BJTs, MOSFETs rely on voltage at the gate rather than current, reducing power loss and improving efficiency. The video

demonstrates an N-channel MOSFET controlled by an Arduino, showing how a pull-down resistor stabilizes gate voltage.

Challenges arise when switching larger loads due to parasitic capacitances and oscillations, causing voltage spikes. Solutions involve adding a gate resistor to manage current flow, increasing rise and fall times to reduce unwanted oscillations. The importance of gate charge and switching losses at higher frequencies is highlighted, emphasizing the role of MOSFET driver ICs for optimized performance. Practical applications include LED dimming and motor control, demonstrating the versatility of MOSFETs in electronics.

ELECTRONIC BASICS #24: STEPPER MOTORS AND HOW TO USE THEM

Stepper motors are commonly used for precise positioning, such as in 3D printers. Their structure is explained, focusing on hybrid synchronous stepper motors with rotor magnets and stator coils. The motor moves in discrete steps, controlled by alternating magnetic fields.

Different driving methods are demonstrated:

- **Wave Driving:** Activates one coil at a time, offering basic functionality.
- **Full-Step Driving:** Uses both coils simultaneously, increasing torque.
- **Half-Step Driving:** Combines the previous methods, doubling the resolution.
- **Micro-Stepping:** Adjusts current flow smoothly, reducing vibration and noise.

A homemade driver circuit using MOSFETs and an Arduino is tested, showing the mechanics of stepper motor control. The A4988 stepper motor driver is introduced, improving efficiency by providing variable current regulation. A 555 timer generates step pulses to drive the motor. The advantages of stepper motors, including their holding torque and precision, make them suitable for robotics and automation.

ELECTRONIC BASICS #25: SERVOS AND HOW TO USE THEM

Servos are compact motor systems that integrate a motor, control electronics, and a feedback mechanism, making them easy to use for precise motion control. The video explains their basic operation, highlighting the three-wire configuration: ground (brown), power (red, typically 4.8V–7.2V), and control (orange, requiring a PWM signal). The PWM signal's pulse width determines the shaft position, allowing rotation within a 180-degree range.

Inside a typical servo, gears reduce motor speed while increasing torque. A built-in potentiometer provides position feedback, enabling the control circuit to adjust movement accurately. A simple Arduino setup is demonstrated to generate the necessary control signals, showing how a potentiometer can be used to fine-tune positioning.

Alternative control methods without a microcontroller are explored, including a 555 timer circuit for generating a PWM signal. The video also explains modifying a servo for continuous rotation by removing internal position constraints and adjusting the feedback mechanism. Finally, stronger servo models with metal gears and enhanced torque capabilities are

introduced, highlighting their advantages in high-power applications.

ELECTRONIC BASICS #26: 555 TIMER IC

The 555 timer IC is one of the most widely used integrated circuits in electronics. Its internal structure consists of voltage dividers, comparators, a flip-flop, and a discharge transistor. Three main configurations are explained:

- **Monostable Mode:** A push-button triggers a temporary high output. A capacitor charges through a resistor, and once it reaches $2/3$ of the supply voltage, the output resets. This setup is useful for delays and timing applications.
- **Bistable Mode:** Two stable states are created using the trigger and reset pins. Pressing one button sets the output high, while pressing another resets it low, making it suitable for toggle switches.
- **Astable Mode:** Continuous oscillation is generated, creating a square wave. The charging and discharging cycles are controlled by resistors and a capacitor. By adding diodes and a potentiometer, the duty cycle can be adjusted for PWM applications.

The limitations of the NE555 timer are discussed, particularly its inability to produce a precise 50% duty cycle due to transistor voltage drops. The CMOS-based TLC555 is introduced as a better alternative, offering lower power consumption and improved frequency performance.

ELECTRONIC BASICS #27: ADC (ANALOG TO DIGITAL CONVERTER)

Analog to Digital Converters (ADCs) are essential for transforming analog signals into digital values. The video explains key specifications such as sampling rate and resolution, demonstrating their effects on accuracy. The Nyquist-Shannon theorem is introduced to optimize sampling frequency, ensuring correct signal reconstruction. Successive approximation ADCs, commonly used in microcontrollers, are explored through practical examples. The process involves sampling a voltage, comparing it against a reference, and refining the digital output step by step.

An alternative ADC type, the flash ADC, is explained for DIY applications. It operates using multiple comparators to generate a quick digital output. Though extremely fast, its resolution is limited due to the large number of required components. The final section discusses integrating a dedicated ADC chip with Arduino, following datasheet guidelines for proper configuration. These concepts provide a foundation for understanding ADC principles and their importance in electronics.

ELECTRONIC BASICS #28: IGBT AND WHEN TO USE THEM

Insulated Gate Bipolar Transistors (IGBTs) are compared to MOSFETs, focusing on their switching speed, efficiency, and power handling capabilities. IGBTs combine characteristics of bipolar junction transistors and MOSFETs, offering high voltage tolerance but slower switching times. Their structure and operation are examined through practical demonstrations, including a test circuit controlling a lamp.

IGBTs are shown to maintain conduction due to gate charge retention, requiring a pulldown resistor or driver IC to manage switching. A comparison of energy losses highlights that MOSFETs dissipate significantly less power at lower currents, while IGBTs become advantageous at high voltage and current levels. Applications in power electronics, including Tesla coil drivers, are discussed, emphasizing the importance of selecting the appropriate transistor based on frequency and efficiency requirements.

ELECTRONIC BASICS #29: SOLAR PANEL & CHARGE CONTROLLER

The operation of solar panels and methods for optimizing their power output are explored. Solar cells generate voltage when exposed to light, with multiple cells connected in series to increase the total voltage. The impact of shading is demonstrated, showing how partial blockage significantly reduces power efficiency. Bypass diodes are introduced to mitigate this issue by allowing current to bypass shaded cells, improving performance in larger panels.

Charge controllers are explained as essential components for battery charging. Maximum Power Point Tracking (MPPT) controllers adjust load resistance to maintain optimal efficiency, while Pulse Width Modulation (PWM) controllers offer a simpler but less effective approach. The importance of considering real-world conditions, such as temperature and sunlight intensity, is highlighted. Practical tests measure voltage, current, and power output under different loads, emphasizing the necessity of proper panel placement and electrical optimization.

ELECTRONIC BASICS #30: MICROCONTROLLER (ARDUINO) TIMERS

Timers on microcontrollers like the Arduino Uno enable precise event timing and PWM signal generation. The video explains the basics of timer operation, demonstrating how to create accurately timed events for applications like clocks, LED matrices, and frequency generation.

Interrupts are introduced as an efficient method for handling multiple timed events without blocking the main loop. The functionality of an Arduino timer is explored, showing how prescalers modify timing intervals to achieve specific delays. Comparisons between normal, CTC, and fast PWM modes illustrate different approaches to timing control.

A practical implementation generates PWM signals with adjustable duty cycles and frequencies up to 8 MHz. The importance of understanding timer registers and configurations is emphasized, enabling precise timing adjustments for various electronic projects.

Electronic Basics #31: Schottky Diode & Zener Diode

Two specialized diodes, Schottky and Zener, are explained along with their unique characteristics. Schottky diodes offer lower forward voltage drop, reducing energy losses and improving efficiency in high-frequency applications like boost converters. Their fast switching speed makes them ideal for circuits operating at elevated frequencies, though they exhibit higher reverse leakage current.

Zener diodes function as voltage regulators by maintaining a stable voltage when connected in reverse bias. Their ability to protect circuits from excessive voltage fluctuations is demonstrated through practical applications, including MOSFET gate protection and AC waveform clipping. Considerations for selecting appropriate Zener voltage and power ratings are outlined, emphasizing their role in circuit stability.

ELECTRONIC BASICS #32: RELAYS & OPTOCOUPERS

Relays and optocouplers are examined, highlighting their roles in electrical isolation and switching applications. A relay operates as an electromechanical switch, controlling high-power loads while providing galvanic isolation. Its internal structure consists of a coil, movable contact, and terminals for normally open (NO) and normally closed (NC) connections. A diode is added to protect circuits from voltage spikes caused by coil deactivation.

Optocouplers use an infrared LED and a photosensitive transistor to transmit signals while maintaining electrical isolation. This allows safe interfacing between low-voltage control circuits and high-voltage loads. Their faster switching speeds make them ideal for phase-angle control in AC circuits where relays are too slow. Practical implementations are demonstrated, showing how optocouplers can drive transistors, which then activate relay coils for improved circuit protection and performance.

ELECTRONIC BASICS #33: STRAIN GAUGE/LOAD CELL AND HOW TO USE THEM

Strain gauges and load cells are introduced as tools for measuring weight and force electronically. A strain gauge consists of a zig-zag resistance wire pattern that changes resistance when stretched or compressed. This change is too small to measure directly, so a Wheatstone bridge circuit is used to convert resistance variations into a proportional voltage.

To improve accuracy, a differential amplifier boosts the signal before it is processed by a microcontroller's ADC.

Temperature sensitivity is addressed by using a half-bridge or full-bridge configuration with multiple strain gauges, ensuring stable readings.

Load cells are presented as a simpler alternative, integrating a pre-built Wheatstone bridge into an aluminum structure. The HX711 breakout board is introduced as a high-resolution ADC with an integrated amplifier, allowing precise weight measurements without additional circuitry. Practical applications include building a digital scale and integrating weight sensing into projects like an electric longboard.

ELECTRONIC BASICS #34: TWO-POSITION CONTROLLER & PID CONTROLLER

The video explains control systems used in automation and electronics. A two-position (on/off) controller is demonstrated,

where a temperature sensor activates a heating element when the measured value drops below a set threshold. While simple, this method leads to temperature fluctuations due to continuous switching.

The PID controller is introduced as an improvement, incorporating proportional, integral, and derivative terms to stabilize the system. The proportional component adjusts output based on error magnitude, the integral term corrects accumulated error over time, and the derivative term prevents overshooting by responding to rapid changes. A practical demonstration shows how tuning PID parameters enhances stability, reducing oscillations and improving performance in temperature regulation and motor speed control applications.

ELECTRONIC BASICS #35: SCHMITT TRIGGER AND WHEN TO USE THEM

Schmitt triggers are explored as a solution to eliminate unwanted signal oscillations caused by noise. The video begins by demonstrating a simple comparator circuit using an operational amplifier, which converts an input triangle wave into a square wave. The limitations of standard comparators are highlighted, showing inconsistent transitions due to noise interference.

To address this, Schmitt triggers are introduced. These circuits establish two voltage thresholds: an upper threshold (V_{T+}) and a lower threshold (V_{T-}). The output switches states only when the input crosses these defined levels, preventing signal instability within the hysteresis range.

Two configurations are discussed:

- **Non-inverting Schmitt Trigger:** Maintains output logic levels directly.
- **Inverting Schmitt Trigger:** Reverses the output state based on threshold crossings.

A practical implementation using a 74HC14 inverter IC is shown. Threshold voltages are measured and validated against datasheet specifications. Common applications include debouncing mechanical switches to eliminate unintended triggering caused by switch contact noise. Additionally, Schmitt triggers improve signal integrity in noisy data transmissions.

A final demonstration features a relaxation oscillator circuit. By incorporating a resistor-capacitor network, a Schmitt trigger generates a stable square wave output with adjustable frequency. These principles establish Schmitt triggers as essential components for signal conditioning and circuit stability.

ELECTRONIC BASICS #36: SPI AND HOW TO USE IT

The SPI communication protocol is explained, demonstrating how a master device interacts with multiple slaves. An Arduino is wired to the DS3234 real-time clock IC, and SPI functions are introduced using the Arduino library.

Chip select (CS) is used to initiate data transmission. The video explains SPI data formats, including MSB-first transmission and different SPI modes that affect clock signal behavior. Mode selection is outlined based on rising and falling edges.

A practical test modifies the RTC's square wave output frequency by writing to register addresses. Data transmission

is verified using an oscilloscope, confirming correct operation. Reading and writing functions are explored, showcasing bit manipulation techniques for formatting values.

The video concludes by comparing SPI to I2C, highlighting SPI's higher speed but requiring dedicated chip select lines for each slave device. Applications like SD card communication are mentioned as examples where SPI excels.

ELECTRONIC BASICS #37: WHAT IS IMPEDANCE? (AC RESISTANCE?)

Impedance is introduced as an extension of resistance in AC circuits, incorporating inductors and capacitors alongside traditional resistors. The concept is demonstrated by examining the behavior of inductors and capacitors when exposed to AC signals.

Inductive reactance is explained through a test circuit, where a sine wave is applied to an inductor. The opposition to current flow increases with frequency, creating a phase shift between voltage and current. Capacitive reactance follows a similar principle but with opposite characteristics, where higher frequencies lead to increased current flow.

The video highlights how simple resistance calculations are insufficient for AC circuits. Complex impedance is introduced as a mathematical approach, using real and imaginary components to determine phase shifts and voltage relationships. Practical measurements confirm theoretical calculations, illustrating how impedance impacts circuit design and signal behavior.

ELECTRONIC BASICS #38: TRUE, REACTIVE, APPARENT & DEFORMED POWER

Power measurement techniques are explored using an energy multimeter. Transformers and motors are examined to highlight how reactive power affects power grids. A transformer draws current even without a load due to inductive properties, resulting in apparent power.

Reactive power is analyzed through phase shifts between voltage and current. An inductor's power waveform alternates between consuming and supplying energy, illustrating how oscillations occur instead of useful power consumption. The impact of reactive power on wiring and grid efficiency is discussed, emphasizing the need for compensation methods.

A small synchronous motor is tested to demonstrate inductive reactive power. Capacitors are introduced as a solution, effectively balancing phase shifts and improving efficiency. The relationship between true power, reactive power, and apparent power is summarized using a power triangle.

A laptop power supply is analyzed, showing how non-sinusoidal current introduces deformed power, reducing efficiency. The Fourier series is briefly introduced to explain harmonic distortions in modern switch-mode power supplies. Power factor correction (PFC) is mentioned as a mitigation technique.

ELECTRONIC BASICS #39: CONTROLLING A BIG LED MATRIX AND SHIFT REGISTERS

The video explores a custom-built LED matrix containing 384 LEDs, arranged in a 32×12 grid. Reverse engineering the

matrix reveals the use of STP16C596 constant current LED driver ICs, which control the cathode connections of the LEDs through multiplexing. The anode connections are managed in grouped segments, activating three rows at a time to cycle through the matrix quickly, producing a stable image.

Shift registers play a key role in handling the data flow efficiently. The STP16C596 ICs function as serial-in, parallel-out shift registers, storing incoming data and shifting bits across 16 outputs with each clock pulse. The video demonstrates how an Arduino Nano is programmed to manage the shift registers and cycle through the matrix rows using p-channel MOSFETs for supply voltage switching.

A basic scrolling text display is created using a boolean matrix. Interrupt-driven timing sequences control the serial data, latch, and clock signals to update the shift registers properly. The video concludes by emphasizing the complexity of programming large LED matrices and the importance of efficient multiplexing techniques.

ELECTRONIC BASICS #40: HOW SAFE IS CONTACTLESS PAYMENT?

The video explores RFID and NFC technologies, which enable contactless payments. RFID relies on wireless energy transfer, where a reader generates a magnetic field that powers the RFID tag. This tag contains a coil and chip that stores identification data, which is transmitted by modulating the carrier wave's amplitude.

Near Field Communication (NFC) is introduced as an advanced form of RFID with standardized protocols. Unlike RFID, NFC

allows bidirectional data exchange between readers and tags, requiring close proximity for security. Various Arduino-compatible RFID reader modules, including RC522 and PN532, are tested, showing how stored data can be accessed and manipulated.

Security concerns are addressed by demonstrating how modern smartphones with NFC capabilities can read tag data. Contactless payment cards are tested but found to be inaccessible due to encryption and authentication mechanisms. To enhance security, anti-skimming cards are suggested to block unauthorized RFID scanning.

ELECTRONIC BASICS #41: DOES A DIY AUDIO CROSSOVER MAKE SENSE?

The video examines audio crossovers, explaining how they separate frequency ranges for different speakers. A bookshelf speaker setup is analyzed, highlighting how the woofer handles low frequencies while the tweeter manages higher ones.

Basic filter components such as resistors, capacitors, and inductors are tested to demonstrate their frequency-dependent behavior. A resistor damps signals across all frequencies, while an inductor increases resistance with frequency, making it suitable for low-pass filtering. Capacitors allow high frequencies to pass while blocking lower ones, functioning as high-pass filters.

RC and RL filters are introduced, explaining their cutoff frequencies and signal attenuation behavior. The advantages and limitations of passive filters are discussed, with inductors being less ideal due to their higher dissipation factor and cost.

The original crossover is reverse-engineered, revealing a more complex filter design tailored to the speaker's characteristics. A software tool is used to simulate the crossover performance, showing differences between the original and replacement crossovers. The conclusion emphasizes that replacing a well-designed crossover with a generic one can negatively impact sound quality, reinforcing the importance of customized filter designs.

ELECTRONIC BASICS #42: IS IT EASY TO CREATE YOUR OWN TRANSFORMER?

The video explores the principles behind transformers, explaining how they convert high-voltage AC mains power into lower, usable voltages for electronic devices. A practical example demonstrates a 230V to 13.5V AC transformer, outlining its core structure, primary and secondary coils, and the role of electromagnetic induction.

Key topics include the impact of resistance and inductance on primary coil impedance, which self-regulates current flow. Energy losses due to eddy currents and hysteresis effects in the core material are discussed, with laminated steel sheets used to reduce inefficiencies. Load tests examine voltage drop and efficiency, showing how saturation limits power output.

Methods for improving transformer performance are explained, such as increasing the core cross-section for higher power handling or raising frequency in switch-mode designs. Challenges in DIY transformer construction are highlighted, including difficulty sourcing well-documented core materials.

A follow-up video is mentioned for deeper exploration of custom transformer designs.

CONTROLLING MECHANICAL 7-SEGMENT DISPLAYS AND UNDERSTANDING RS-485 & UART WORKS #43

The video explores mechanical seven-segment displays, which use electromagnetic actuators to flip plastic segments rather than LEDs. These displays are commonly used in commercial applications due to their reliability and visibility. The internal structure and control mechanisms are examined, highlighting how segments are activated using transistor-driven circuits.

RS-485 and UART communication protocols are introduced for controlling these displays efficiently. RS-485 is demonstrated as a robust solution for long-distance, multi-device communication, providing differential signaling to reduce noise interference. UART, which operates over simple serial connections, is explained alongside data transmission techniques. A practical example shows how an Arduino communicates with the display through RS-485, ensuring stable data exchange.

The importance of correct wiring and signal integrity is emphasized, with tests verifying proper display functionality. The video concludes by discussing the advantages of RS-485 in industrial environments and comparing it to other serial communication methods.

IMPROVING MY ELECTRIC LONGBOARD WITH A CAN BUS! WHAT CAN THE CAN BUS DO? EB#44

The video explains how a CAN Bus system enhances the performance of an electric longboard by improving motor synchronization. Initially, a slight difference in motor rotation is observed when applying small acceleration, despite both motor controllers receiving identical PPM signals. To address this, the CAN Bus feature of the FS-ESC controllers is activated, allowing direct communication between them.

The basics of the CAN Bus protocol are covered, including how it enables communication between microcontrollers and sensors using two data lines (CANH and CANL). Its advantages, such as collision handling through prioritized message transmission and error correction mechanisms, are explained. A practical demonstration shows the effect of enabling CAN Bus on the longboard, ensuring both motors respond uniformly.

Additional improvements include implementing traction control, which balances power consumption with RPM, improving performance in uneven terrain. The video concludes by highlighting the widespread use of CAN Bus in automotive applications and suggesting ways to integrate it into other projects.

BUILDING A DIGITAL MUSIC PLAYER WITH I2S #45

The video explores how the I2S (Inter-IC Sound) protocol facilitates digital audio transmission between microcontrollers and peripherals. An ESP32 microcontroller reads audio data from an SD card via SPI and outputs it using an I2S amplifier.

Basic principles of audio sampling are explained, including bit resolution and sampling rate. A 16-bit resolution preserves sound details, while a 44.1 kHz sampling rate ensures accurate signal reproduction. The limitations of ESP32's built-in DAC are highlighted, leading to the use of an external I2S amplifier for better quality.

The wiring setup includes an I2S microphone breakout board for audio input. The video demonstrates how word selection, serial clock, and data lines work within the protocol. The relationship between bit depth, sampling rate, and clock frequency is examined, showing how adjustments impact signal accuracy.

Code implementation for ESP32 is outlined, utilizing an audio library to handle file reading and I2S data transmission. A demonstration plays a recorded sound file, validating the system's functionality.

DOES THIS OLD INDUCTION MOTOR STILL WORK? | | How Do ASYNCHRONOUS MOTORS WORK? #46

The video begins by introducing an old asynchronous induction motor, explaining that it had been stored for years without knowing if it still functioned. The process of testing and understanding its operation is outlined, starting with an inspection of its terminal box, which contains six connector wires corresponding to separate coils. The motor's wiring configurations—delta and star—are discussed, showing how connections influence voltage handling.

Disassembly attempts provide a look inside the motor's construction, revealing its rotor and stator. The rotor consists of a squirrel cage design, while the stator contains copper coil

windings. The video explains how the rotor is induced into motion without permanent magnets by utilizing a rotating magnetic field generated from three-phase AC voltage. The working principle is demonstrated through an experiment where the motor is powered with the correct voltage configuration, showing smooth operation.

The concept of slip is introduced, explaining why the rotor turns slightly slower than the stator's rotating field. A comparison is made with brushless DC motors, which maintain synchronous rotation due to permanent magnets. Methods for adjusting an induction motor's RPM are discussed, including adding more pole pairs or using frequency converters.

The video concludes with practical insights on wiring single-phase motors, highlighting how capacitors create artificial phase shifts for operation. The durability and simplicity of asynchronous motors are emphasized, reinforcing their widespread use in industrial applications.

BUILDING A TUBE AMP: EXAMINING AUDIO QUALITY#47

The video explores the use of vacuum tube amplifiers, comparing their performance to modern transistor-based amplifiers. Vacuum tubes operate by heating a cathode to release electrons, controlled by a grid to regulate current flow. This principle allows small signals to be amplified using higher voltage.

A purchased tube amplifier is inspected, revealing that vacuum tubes are only used for pre-amplification while power amplification relies on operational and class D amplifiers. Tests show that tube amps introduce distortion, described as "warm"

or "natural," making them preferable for some audio enthusiasts despite efficiency drawbacks.

A DIY circuit replicates tube amplification using a high-voltage DC supply. Waveform analysis highlights unintended interference caused by power supply switching frequencies. A comparison with a bipolar junction transistor-based amplifier confirms similar functionality, but vacuum tubes exhibit more distortion due to nonlinear characteristics.

THE BEST PROTECTION FOR YOUR CIRCUITS? eFUSE! HERE IS WHY THEY ARE AWESOME! EB#48

The video explains how eFuse ICs protect circuits from common electrical faults such as overcurrent, overvoltage, and reverse voltage. Unlike traditional fuses, which permanently break the connection during a fault, eFuse ICs automatically limit current and voltage while resetting once conditions return to normal.

A practical example demonstrates the use of the TPS25961 eFuse in a LiPo battery charger. Key features include adjustable current limits, voltage clamping, and thermal shutdown protection. The circuit is assembled with an Arduino Nano to showcase operation under different conditions.

Passive components such as resistors and capacitors fine-tune protection thresholds. The importance of reverse voltage protection is discussed, with a p-channel MOSFET circuit presented as a simple solution. The video concludes by

comparing different eFuse ICs and highlighting factors to consider when selecting one for a project.

ELECTRONIC BASICS #49: EVERYTHING YOU NEED TO KNOW WHEN BUYING/USING AN OSCILLOSCOPE

The video covers oscilloscope selection and usage, emphasizing common mistakes that could damage equipment. It explains bandwidth, sampling rate, and channel count considerations when choosing an oscilloscope. Passive probes are introduced, highlighting impedance effects and scaling factors for accurate measurements.

Trigger settings are demonstrated to stabilize waveforms, with examples of frequency analysis, rise-time detection, and voltage ripple assessment. Safe mains voltage measurements are discussed, warning against improper grounding techniques that could harm the oscilloscope. Differential probes are recommended for high-voltage applications.

Current measurement methods are compared, examining the use of current clamps and shunts. The importance of FFT analysis for signal processing is briefly mentioned, along with advanced waveform evaluation techniques.

ELECTRONIC BASICS #50: PROBABLY THE MOST USED COMPONENT NOBODY KNOWS OF! TL431 GUIDE

The video explores the TL431, a precise programmable reference IC widely used in power supplies and regulation circuits. It begins by examining a switch-mode power supply,

highlighting its efficiency and voltage conversion capabilities. The TL431 is introduced through its functional block diagram, showing its internal comparator, transistor, and voltage reference.

A breadboard demonstration illustrates the IC's open-loop operation, where the output remains high until the reference voltage threshold is reached. The closed-loop configuration is tested, revealing how it acts as a stable adjustable zener diode, maintaining a constant voltage regardless of input fluctuations.

Further experiments demonstrate voltage divider applications that allow custom reference voltages. Practical circuits, including battery undervoltage protection and precision current sinks, showcase its versatility. The role of TL431 in feedback systems for switch-mode power supplies is explained, detailing how it stabilizes output voltage using an optocoupler and PWM control.

A test setup with an Arduino-generated PWM signal verifies the effectiveness of the feedback system. The video concludes by emphasizing the importance of TL431 in various applications and encouraging experimentation with its capabilities.

ELECTRONIC BASICS #51: DIGITAL POTENTIOMETER GUIDE

The video introduces digital potentiometers as a solution for adjusting circuit parameters electronically instead of manually turning a mechanical potentiometer. Various applications are demonstrated, including setting output voltages, dimming LEDs, and controlling sensor thresholds.

Basic digital potentiometer models such as X9C103 and X9C104 are tested, explaining their internal structure. These

ICs use a series of resistors with electronically controlled switches to adjust the resistance in discrete steps. The process of setting values through three digital pins is shown, along with the limitations caused by resolution constraints.

A practical example attempts to replace a mechanical potentiometer in a high-power LED driver circuit. Stress tests reveal voltage and current limits, leading to the use of an alternative high-voltage digital potentiometer, the MCP41HV51, which handles up to 36V. The video demonstrates SPI-based control for adjusting brightness dynamically through microcontroller commands.

The conclusion highlights the versatility of digital potentiometers, showing their effectiveness in automation projects while emphasizing the importance of selecting the correct model based on voltage and current requirements.

ELECTRONIC BASICS #52: NEGATIVE VOLTAGES ARE MORE IMPORTANT THAN YOU THINK!

The video explains the significance of negative voltages in electronics and demonstrates various methods to generate them. It begins by highlighting applications where dual rail power supplies are essential, such as waveform generators, audio amplifiers, operational amplifiers, ADCs, DACs, and LCDs.

Several approaches for creating negative voltages are explored:

- **Charge Pump Circuit:** A simple method using a boost converter and diodes to invert voltage, though it has limitations in current output and noise levels.

- **Center Tap Transformer:** A more robust solution that provides stable dual rail voltages but requires AC mains power.
- **Resistive Voltage Divider with an Op-Amp Buffer:** A method for splitting a single voltage into positive and negative rails, stabilized using an operational amplifier.

The advantages and drawbacks of each method are discussed, with practical demonstrations showing their effectiveness in different scenarios. The video concludes by emphasizing the importance of selecting the right approach based on current requirements and noise sensitivity.

ELECTRONIC BASICS #53: MECHANICAL SWITCHES ARE OBSOLETE?! SWITCH TO A LATCH CIRCUIT!

The video explains latch circuits, which maintain an on or off state using brief pulses instead of continuous activation. These circuits are used in applications such as overcurrent protection, self-deactivating microcontrollers, and efficient power switching.

A basic latch circuit is demonstrated using the 74LS279 SR latch IC. The circuit responds to set and reset pulses, holding the output until changed by another signal. The logic behind NOR gates is explored, showing how fundamental digital circuits mimic latch behavior.

A MOSFET-based latch circuit is built, allowing a single push button to toggle power to a load. The advantages over mechanical toggle switches are highlighted, including cost-effectiveness and simplified wiring. A set-reset variation is

tested, demonstrating its use in microcontrollers that can fully power down when not in use.

Different latch circuit designs are examined, showcasing their applications in real-world electronics. The video concludes by reinforcing the versatility of latch circuits and encouraging their use in automation projects.

ELECTRONIC BASICS #54: THE BEST PROTECTION FOR YOUR CIRCUIT IS NOT A FUSE! BUT A RESETTABLE FUSE?

The video explores resettable fuses, also known as PPTC (Polymeric Positive Temperature Coefficient) devices, as an alternative to traditional glass fuses. Unlike conventional fuses that require replacement after activation, resettable fuses increase resistance when excessive current flows, limiting damage while remaining reusable.

Key characteristics such as hold current, trip current, and maximum voltage ratings are explained. A practical demonstration shows how a resettable fuse responds to overcurrent conditions, gradually increasing resistance until the circuit is protected. Comparisons with standard glass fuses highlight differences in activation speed and effectiveness.

Limitations of resettable fuses are discussed, including leakage current after tripping and slower response times compared to electronic fuses. Their applications in battery packs, LED circuits, and consumer electronics are examined, emphasizing their role in preventing damage from accidental shorts or overheating.

The video concludes by comparing different fuse types, explaining when each is most suitable based on circuit requirements.

ELECTRONIC BASICS #55: THE MOST IMPORTANT CIRCUIT FOR OUR ELECTRICAL FUTURE?! (PFC)

The video explains power factor correction (PFC) and its role in improving electrical efficiency. It begins by comparing two devices: a heat gun, which draws current in phase with mains voltage, and an LED strip, which consumes current in short bursts near voltage peaks. This behavior leads to increased apparent power usage, making power grids less efficient.

The problem with reactive power is illustrated using a foam-to-liquid analogy, where reactive power represents energy that oscillates without contributing to actual work. The importance of maintaining a power factor close to one is emphasized, ensuring that apparent power closely matches real power.

Two types of PFC circuits are discussed:

- **Passive PFC**, which corrects phase shifts by adding capacitance or inductance to reduce reactive power.
- **Active PFC**, which eliminates current waveform distortions using a boost converter to stabilize voltage, reducing harmonics and improving power factor.

A practical demonstration modifies an AC-to-DC power supply by integrating an active PFC circuit. The input current waveform is analyzed, showing improvements in power factor and reduced harmonic distortion. The video concludes by highlighting regulatory trends toward mandatory PFC circuits in modern appliances to improve electrical efficiency.

ELECTRONIC BASICS #56: THESE 3 CENT COMPONENTS ARE ACTUALLY USEFUL?! (COLOR RING INDUCTOR)

The video explores color ring inductors, which resemble resistors but function as inductors. Their affordability and labeled values make them appealing for beginners, though their electrical specifications are often undocumented.

A teardown reveals their internal structure—copper wire wrapped around a ferromagnetic core. Practical tests compare their performance to standard inductors in a boost converter circuit. While they function, their saturation current is significantly lower, limiting their effectiveness in high-power applications.

A custom test circuit measures saturation current, showing that color ring inductors reach saturation much earlier than conventional inductors. Their limitations are discussed, particularly their unsuitability for power-intensive circuits. However, they remain useful for low-power applications, signal filtering, and experimentation.

The video concludes by emphasizing their value for beginners while cautioning against their use in demanding circuits.

ELECTRONIC BASICS #57: GROUND IS MORE IMPORTANT THAN YOU THINK!

The video explores the role of ground in electrical and electronic circuits, demonstrating its importance through practical experiments. A simple setup shows how soil can conduct electricity, illustrating why grounding is essential in electrical systems.

The function of protective earth wiring is explained using a toaster as an example. When a fault occurs, such as a live wire touching the metal chassis, the ground wire prevents dangerous electrical shocks by creating a short circuit. Circuit breakers and residual current devices trip to cut off power, ensuring safety.

The concept of static electricity is discussed, highlighting how excess charge builds up on surfaces. Grounding helps dissipate static electricity, protecting sensitive components and preventing accidental shocks. The connection between grounding in electrical grids and PCB designs is also explored, reinforcing the idea of using a common reference potential for stability.

The video concludes by emphasizing the widespread use of grounding in household wiring, industrial systems, and electronics, ensuring reliability and safety in electrical applications.

ELECTRONIC BASICS #58: THIS COMPONENT SOLVES "ALL" MOTOR PROBLEMS?! (MOTOR ENCODER)

The video explores motor encoders and their role in precise motor control. Traditional rotary encoders are examined, highlighting their limitations in resolution and mechanical design. Magnetic encoders are introduced as an alternative, offering higher precision by detecting changes in a magnet's position relative to internal sensors.

An example setup demonstrates a magnetic encoder attached to a motor shaft. The encoder provides detailed position feedback, significantly improving accuracy compared to mechanical encoders. The benefits of using motor encoders in

robotics and high-speed BLDC motors are discussed, showing how they enable smooth and efficient control.

A practical test features a BLDC motor controlled via a SOLO motor driver. Encoder feedback ensures stable operation in speed and torque modes while allowing precise positioning adjustments. The advantages of motor encoders over stepper motors are highlighted, particularly in applications requiring high torque and speed consistency.

ELECTRONIC BASICS #59: THIS \$0.70 COMPONENT SAVES YOUR CIRCUIT?! (SURGE PROTECTION)

The video explores various overvoltage protection components, demonstrating their effectiveness in safeguarding circuits from sudden voltage spikes.

Three primary protection components are examined:

- **TVS Diodes (Transient Voltage Suppressors):** These components clamp excessive voltage by becoming conductive when a threshold is exceeded, dissipating energy as heat. A practical test shows how a TVS diode prevents damage to a microcontroller circuit subjected to high-voltage pulses.
- **MOVs (Metal Oxide Varistors):** These components function similarly to TVS diodes but handle larger energy bursts. Their resistance decreases sharply when voltage exceeds a certain level, allowing excess energy to be absorbed. Tests confirm their effectiveness in protecting circuits from repeated voltage surges.
- **GDTs (Gas Discharge Tubes):** These components ionize gas inside a sealed enclosure when voltage surpasses a

critical level, creating a conductive path to dissipate energy. While useful for high-voltage applications, they are less effective for low-voltage circuits.

ELECTRONIC BASICS #60: IS THIS THE NEW GOLDEN STANDARD FOR COMMUNICATION? (I3C)

The video explores the I3C communication protocol, which serves as the successor to I2C. A breakout board is designed for the BOS1921 piezo haptic driver IC, which supports both I2C and I3C.

Key differences between I2C and I3C are examined:

- **Speed Improvement:** I3C operates at up to 12.5 MHz, significantly faster than I2C's 1 MHz limit.
- **Push-Pull Drivers:** Unlike I2C's open-collector design with pull-up resistors, I3C uses push-pull drivers for efficient switching and reduced power consumption.
- **Dynamic Addressing:** Devices receive addresses during initialization, eliminating hardware-defined addresses and potential conflicts.
- **Common Command Codes (CCC):** Standardized commands simplify communication between devices.
- **Hot-Join Feature:** Devices can connect to the bus without requiring a system reset.
- **In-Band Interrupts:** Interrupt signals are transmitted within the data stream, reducing the need for extra pins.

ELECTRONIC BASICS #61: THE WORLD'S SIMPLEST AUDIO AMP JUST GOT BETTER?! (MOSFET AMP)

The video revisits a simple audio amplifier design and explores ways to improve its performance. Initially, a basic Class A amplifier using a bipolar junction transistor (BJT) is tested, but its low power output limits its ability to drive a loudspeaker effectively.

To increase current flow and improve efficiency, a Darlington transistor is introduced. While it provides higher gain, it also introduces voltage drop issues, requiring adjustments to the circuit's supply voltage and resistor values. Heat dissipation challenges arise, necessitating the use of a heatsink.

A MOSFET-based amplifier is then tested as an alternative. Unlike BJTs, MOSFETs rely on voltage control rather than current, allowing for lower resistance and improved efficiency. A potentiometer is used to fine-tune biasing, ensuring optimal signal amplification.

Comparisons between the Darlington and MOSFET amplifiers reveal differences in harmonic distortion and signal fidelity. While the MOSFET circuit provides higher output volume, BJTs generally offer better linearity in amplification. The video concludes by discussing trade-offs between efficiency, complexity, and audio quality in amplifier design.

ELECTRONIC BASICS #62: NOT A MICROCONTROLLER!...THIS IS BETTER?! (PLC)

The video explores programmable logic controllers (PLCs) and their advantages compared to microcontrollers in industrial automation. A conveyor belt system is used as an example,

featuring input buttons, sensors, output LEDs, and a motor controlled by an Arduino Opta PLC.

PLCs are designed for industrial environments, offering standardized voltage ranges and relay outputs that can switch high-power AC loads. Microcontrollers, while more flexible, operate at lower voltages and require additional circuitry for driving motors or high-power applications. The video demonstrates programming in a function block diagram format, where pre-made logic blocks simplify automation tasks compared to traditional text-based coding.

A conveyor belt automation project is implemented using proximity sensors. The system monitors transported objects, reversing the belt if metal is detected. Live debugging is highlighted as a key advantage of PLCs, making troubleshooting efficient. The comparison concludes by discussing the distinct roles of PLCs in industrial automation versus microcontrollers in high-speed signal processing applications.