Digital Interfacing

EE 264

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Why do microprocessors need interface circuits?

- Drive strength
  - Single microprocessor pin can generally only drive a small number of outputs
  - Example: Not strong enough to drive a single LED!
- Voltage differences
  - Different digital devices run at different voltage levels
  - Examples: 5V, 3.3V, 2.5V, ±12V, etc.
- Safety issues
  - Lightning
  - Other extremely high voltages

Drive-Strength: Drivers

- Special buffers that have high output current
- Example: Clock driver – Has built-in circuits to synchronize the output to the input (0 delay)
- LED: 10's of mA
- Relay: 100's of mA

Voltage-Level Change

- One-way: Open-drain drivers
  - These also increase drive strength
  - Only drive to ground (0V) which is a nearly "universal" voltage level
- Two-way: Pass transistor circuits
  - Lets either side drive to ground (bidirectional)
- RS-232 driver circuit
  - Special case: Drives ±12V outputs off of a single +5V supply

Isolation / Safety Circuits

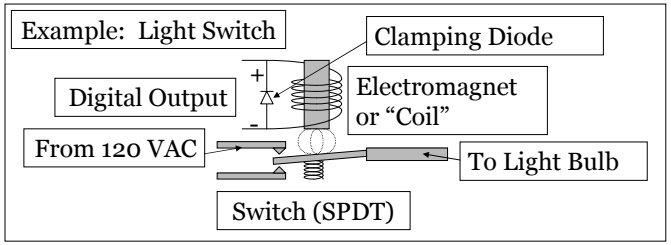
- Isolation: Provide voltage isolation between input and output
- Protection: Two forms
  - Disconnects power when current draw is too large
  - Shorts out and dissipates when voltage rises above a certain level

Specific Examples of Driver Circuits

- Highlights choices available to digital-system designers
- Consult datasheets – and feel free to find your own solutions!

Common Example: Electromechanical Relay

- Digital output drives an electromagnet
- The magnet moves a switch back and forth between contacts

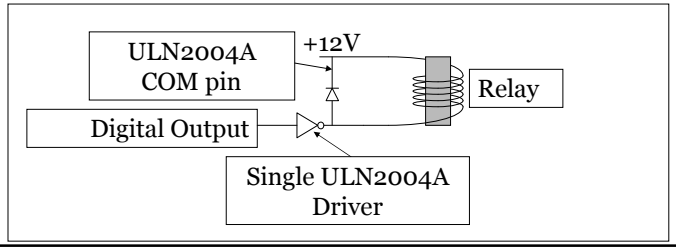


Relays, ctd.

- The switch is a simple short-circuit
  - Can be AC, DC, radio-frequency, etc.
- Switch is completely isolated from the digital driver – no DC connection
- The coil produces an inductive "kick" when it is open-circuited
  - Attach a diode from – to + to absorb the energy
- Coil voltages: +5V, +12V
- Coil currents: 10's to 100's of mA

High Drive Strength: ULN2004A

- Array of 7 Darlington-Pair Open-Collector drivers
- Each output can sink 350 mA
- Built-in diodes to drive relays

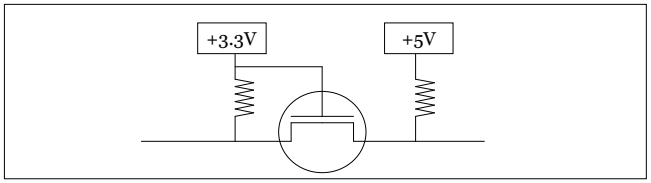


High Drive Strength: TI TPIC Logic

- Each output can drive 100's of mA
- Example: TPIC6595 is a shift register
  - Three-bit input, 8 output drivers
  - Cascadable to dozens of output drivers
- Combines low pin count with high drive strength

Voltage-Level Conversion: Pass-Transistor Isolation

- Use N-channel MOSFET: Lets either side drive to ground
  - Bi-directional interface
  - Need pull-up resistors to drive high
- Example: 3.3V and 5V



Voltage-Level Conversion: RS-232 Driver

- Maxim MAX232 is designed to drive RS-232 ±12V using a single +5V supply
  - Has built in voltage drivers to create +12V and -12V given only +5V
  - Other variations of the part do similar things
  - Go get the datasheets!

Voltage Isolation: Opto-Isolators

- Opto-isolators are combinations of LED's (or IRED's) and photocells
- No DC connection from input to output – only photons!
- Typical isolation is 3,500 volts
- Output can be DC or AC
  - DC type: Darlington-pair output
  - AC type: Triac output

Other Safety Devices

- One type is the simplest: The Fuse!
  - Numerous variations, such as slow-blow
  - Provides a current limit on the system
- Several devices turn into short circuits
  - Telephony: Sidactors
  - Power strips (etc.): Metal-Oxide Varistors (MOV's)
- I don't like MOV's: They can burst into flame!!
  - Adding current limits makes this more likely!
- Needless to say, READ THE DATASHEET when designing for safety!