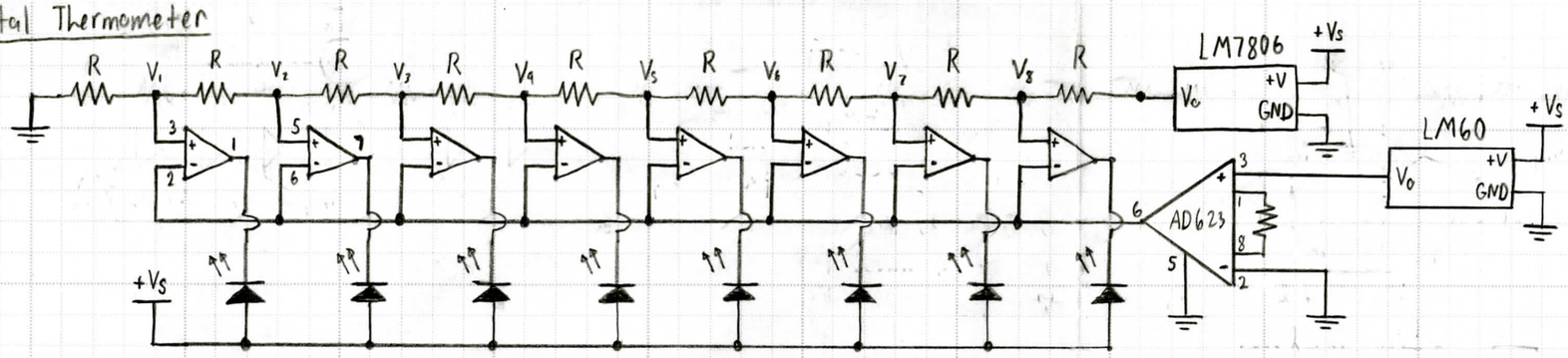
FREESE AND NICHOLS

SUBJECT Digital Thermometer SHT NO. _____ OF _____

PROJECT NO. _____ CHK BY _____ DATE _____ BY _____ DATE _____

Digital Thermometer



Reference Voltages

$V_{drop} = 0.\overline{66}$ V

$V_1 = 0.\overline{66}$ V
$V_2 = 1.\overline{33}$ V
$V_3 = 2$ V
$V_4 = 2.\overline{66}$ V
$V_5 = 3.\overline{33}$ V
$V_6 = 4$ V
$V_7 = 4.\overline{66}$ V
$V_8 = 5.\overline{33}$ V

Parts List

- LM393 Dual Comparators x4
- 1kΩ Resistors x9
- AD623 Instrumentation Amp
- LM60 Temperature Sensor
- LEDs x8
- LM7806 Voltage Regulator

AD623 Gain Formula

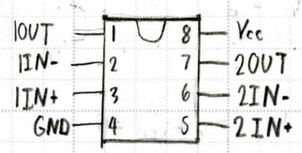
- $G = \frac{100k\Omega}{R_G} + 1$
- $R_G = \frac{100k\Omega}{G-1}$

LM60 Info

- Temperature range (°C): -40°C to 125°C
- Voltage Output Range: 0.174 V to 1.205 V
- $V_o = [6.25\ mV/°C \times T(°C)] + 424\ mV$
- $T(°C) = \frac{V_o - 424\ mV}{6.25\ mV/°C}$
- DC Offset = 424 mV
- I_o (max) = 10 mA

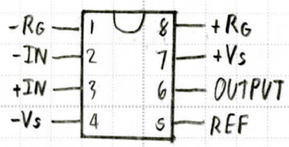
IC Pinouts

* LM393



- $V_{cc} = 9V$

* AD623



- $+V_S = 9V$
- REF → GND
- $-V_S$ → GND

To Do List

- Use PIC 24 to display the temperature on an SSD.
- Replace LM60 with a microphone and the AD623 with the LM386.
- Create ECAD model with LED arrays and resister arrays.
- Extend circuit to 30 LEDs and tune it for the senior design project.

Project Description

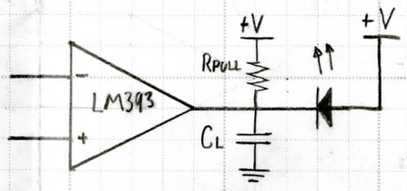
The project is simply a device that mimics a mercury thermometer. This is done by setting reference voltages (V_1 through V_8) by creating a voltage divider circuit. These voltages are connected to the non-inverting node of the comparaters (LM393). The temperature reading is taken from the LM60; it outputs a voltage based on the ambient air temperature. This voltage is amplified by an instrumentation amplifier — the output of this amplifier is connected to the inverting nodes of all the comparators. The output of each comparator is connected to the cathode of an LED.

* Voltage Divider Circuit

A simple series connection of 9 resistors of equal values. The LM7806 is a 6V regulator that ensures that the reference voltages remain constant. The 9th resistor between ground and V_1 allows for all LEDs to be off Should V_o(AD623) < V_1; likewise, the 1st resistor between the regulator output and V_8 establishes a reference below 6V so that all LEDs are capable of being turned on.

* Comparator Portion

The way this component works is simple — if the inverting node is greater than the non-inverting node the component will behave as a current sink. Conversely, if the opposite is true, the output will be a high impedance and current will not flow through the LED.



* Transducer Element

The overall circuit doesn't necessarily require the LM60 temperature sensor — any transducer capable of producing a voltage output relative to a measured physical quantity. This means that a microphone or a pressure-sensitive component can replace the LM60 and the gain of AD623 can be adjusted to suite the component.

* AD623 Amplifier

A simple instrumentation amplifier; as the circuit implies, the

LM60 - 926-LM60BIZ/NOPB

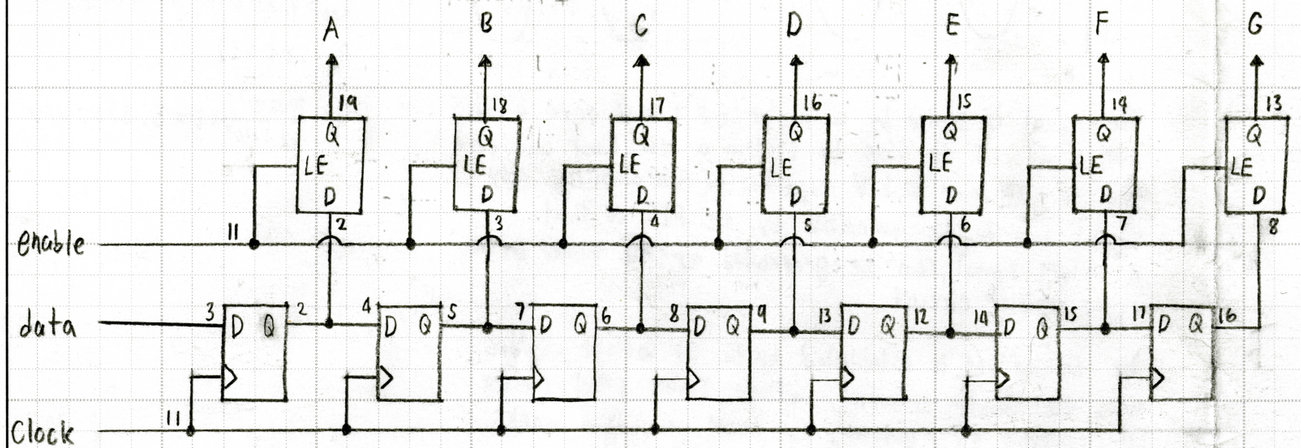
AD623 - 584-AD623BNZ

FREESE AND NICHOLS

SUBJECT Shift Register & Motor Driver SHT NO. _____ OF _____

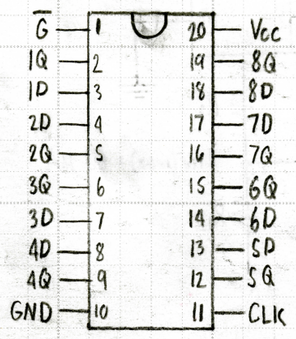
PROJECT NO. _____ CHK BY _____ DATE _____ BY _____ DATE _____

7-Bit SR w/ Latches



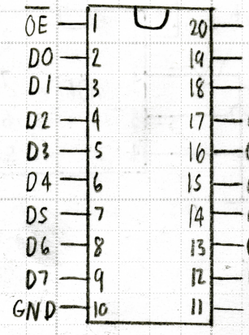
IC Pinouts

* SN74LS377N



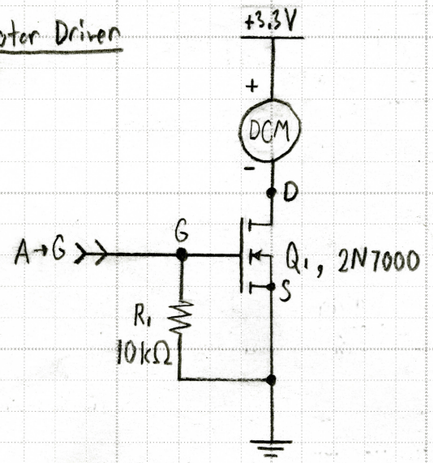
- V_{CC} = 5V
- SIPO Config.
- Active Low
- RE Trigger
- V_{IH} = ~3.15V
  V_{IL} = ~1.35 V
- V_{OH} = ~4.5V
  V_{OL} = ~0V

* TC74ACT573P



- V_{CC} = 5V
- DX → QX
- Active Low
- RE Trigger
- V_{IH} = ~2.0V
  V_{IL} = ~0V
- V_{OH} = ~4.5V
  V_{IH} = ~0V

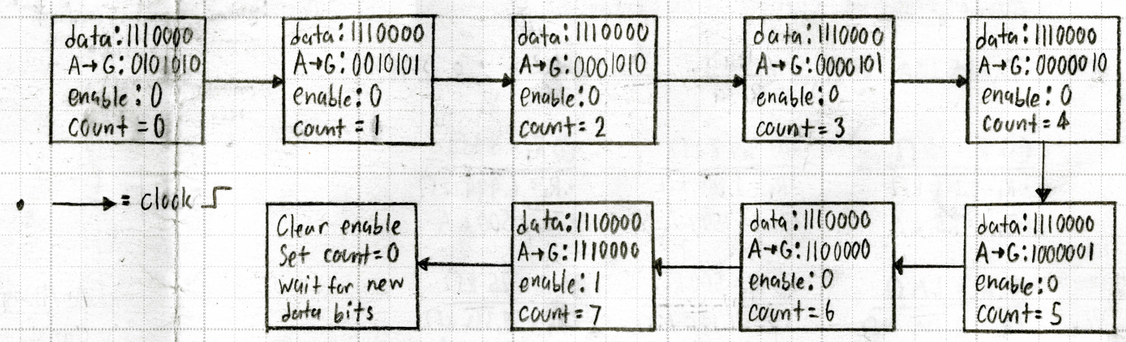
Motor Driver



Parts List

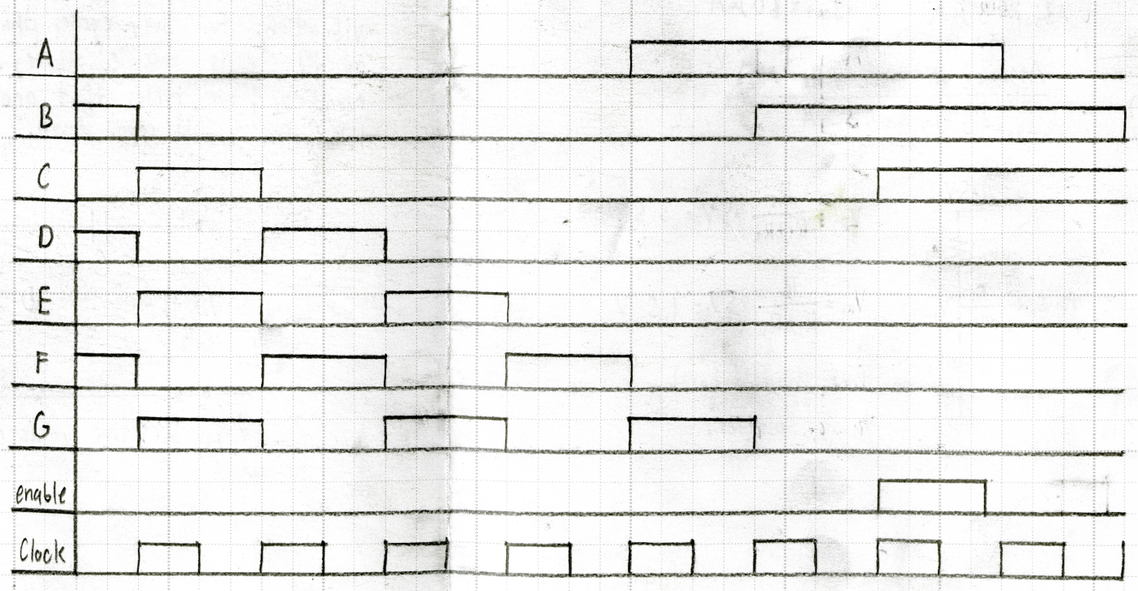
* 7-bit SIPO SR w/ latches
  - SN74LS377N D-type flip-flop
  - TC74ACT573P D-type latch
* Motor Driver
  - 2N7000 NMOS Transistor x7
  - 10kΩ Resistor x7
  - Vibrating DC Motor x7

Flowchart



Timing Diagram

data: 1110000
A→G: 0101010



2N7000 Info.

- $r_{DS(on)}$ = 5.0Ω
- $V_{GS(th)}$ = 3.0 VDC
- t_{on} = 10 ns
- t_{off} = 10 ns

In the 7-bit SIPO SR latch, the components on the top row are the TC74ACT573P D latches and the bottom row of components are the SN74LS377N D flip-flops. The numbers seen on the schematic directly correspond to the pinout diagrams seen to the right. The latches ensure that the can only be seen when the "enable" input is at logic high. With a suitable microcontroller (PIC24, MSP, etc.) the output can be enabled every 7 clock pulses.