Scopen

Capstone Project Presentation
Byron Aguilar
Team Leader
AFE Design
Board Layout
Firmware
Android App

Boning Dong
System Design
Board Layout
Firmware
Desktop Software
Board Assembly

Cesar Gonzalez
AFE Design
Power Management
DAC Interface
Firmware
Project objective

For students and hobbyists, do we really need a huge and expensive oscilloscope?
The power of an oscilloscope in a pen
Project Structure

Hardware Design
- Analog Front End
- MCU System
- WiFi System
- Battery Management

Firmware Design
- Waveform Sampler
- Thread Manager
- TCP Communication
- Inter-Chip Communication

Software Design
- Pen Discovery
- Manage Connections
- Commands transmission
- User Interface Design

Industrial Design
- Body shell
- Aesthetic Design
- User Interaction
- 3D Modeling
Hardware Design

- Analog Front End (AFE)
- Microcontroller System (MCU)
Analog Front End

Input

20 mVpp to 50 Vpp
5 MHz Bandwidth

1M Ohm input impedance

Attenuation

VGA

Single to Differential Converter

Differential Signal: Centered at 1.7V
.375V amplitude

To ADCs

AttenCTR

STM32 DAC

Buffer

Buffer

3.3V

3.3V
Challenges

Impedance Consideration
- Isolate Stages
- Buffers

Gain Stage
- Varying Gain (VGA)
- Gain Controlled by STM32 DAC
MCU System
Challenges

Microcontroller selection
Needed a small controller with fast ADCs

Memory selection
Needed non-BGA package small memory.
Firmware Design

STM32G474QE

ESP32 Pico Kit
Architecture

- Input Handler: Handles user input through touchpad.
- Command Executor: Executes commands received from the app.
- Command Receiver: Receives commands sent by the app.
- Command Transmitter: Transmits the user triggered events to the app.
- Data Transmitter: Transmits the sampled data to the app.

Task Threads

- Down Stream Task
- Up Stream Task

FreeRTOS

- Touch Sensor
- Analog Front End
- Battery Management

ARM Cortex M4 Architecture

- SRAM Memory
- ADC
- SPI
- High Resolution Timer
- General Timer
- GPIO
- DAC
- OPAMP

STM32 HAL Drivers Library

Self Developed Drivers

STM32 LL Drivers Library

Arduino ESP32 Pico Library
ADC Sampling Control

Sampling Code

8-Bit Resolution

Compare Unit 1
ADC 1
DMA 1 Channel 1
External Memory

Compare Unit 2
ADC 2
DMA 2 Channel 1
External Memory

Compare Unit 3
ADC 3
DMA 1 Channel 2
External Memory

ADC 4
DMA 2 Channel 2
External Memory

HRTIM
High Resolution Timer
Thread Management

**Input Handler Thread**
- **loop:**
  1. wait for USER_INPUT_SIG
  2. fetch the event
  3. append to cmd queue

**Command Executing Thread**
- **loop:**
  1. wait for the recy_cmd_queue
  2. fetch command
  3. run command

**Data Sending Thread**
- **loop:**
  1. wait for DATA_SAMPLED_SIG
  2. send data

**Command Sending Thread**
- **loop:**
  1. wait for send_cmd_queue
  2. fetch command
  3. send command

**Command Receiving Thread**
- **loop:**
  1. listen the uart port
  2. receive parse command

**Occupied Semaphore**

**Slots Semaphore**

**SPI**

**UART**
Communication System

- SPI
- UART
- Data size
- Data Type
- WiFi Module
- TCP
- UDP
- TCP
- User Interface
Software Design

Client Desktop Software
Architecture

View Layer

Model Layer

Controller Layer
Industrial Design

Fusion 360 Case Model
Design Principle
- Robust
- Durable
- Elegant

Challenges
- 3D modelling
- Filament Material
- 3D printing tolerance
Scopen Summary
20 Vpp Measuring Capabilities
Total Length: 5.9 inches
Micro-USB Charging
5 MHz Bandwidth
Touch Pad
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**Scopen**
$299

**IkaScope WS2000**
$299

**Digilent Analog Discovery 2**
$279
Acknowledgement

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