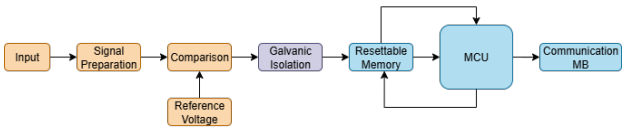
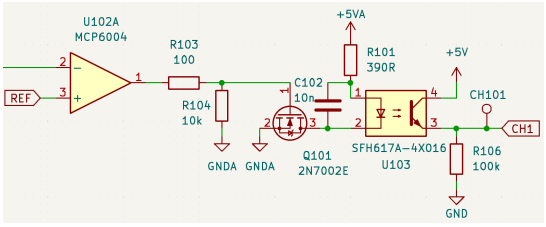
Hacking into Doorbell Systems

Many residential buildings still rely on conventional analog doorbell systems, which cannot be directly integrated into modern smart-home platforms. This creates a demand for solutions that enable simple and cost-efficient upgrades without extensive reconstruction.



Block schematic of VITA PCB



Galvanic isolation circuitry

Signal detection

Signal detection is carried out in two parts. First, the signal is scaled down using a bridge rectifier followed by a voltage divider, so that it can be compared with a reference voltage, using an operational amplifier in comparator configuration and then be galvanically isolated. Finally, the detected button press is stored using D-Flip Flops to ensure no button press is missed. In this way, the required input voltage range can be fully covered, and the circuit, as well as the installed system are independent of each other.

System composition

Since a maximum of 4 apartments can be covered per VITA, these can be stacked and interconnected. The data, as well as the respective board ID, can be configured and forwarded via CAN to the MB (mainboard). There, an interface conversion to SPI is performed and the wireless communication board CM5 (Compute module 5) is informed. The incoming data is then displayed accordingly on the CM5 console. From the CM5, the door opener circuit can be activated via the MB.

Future work

Since the CM5 is currently used with the corresponding I/O board, integrating it into the MB provides both space and cost advantages. With a product-specific power supply, the system can be further expanded in a modular way, offering more flexibility for installation. Peripherals such as microphone, speaker, and camera can be easily implemented with the CM5. To have a product ready for installation, an application is also required through which the end user can interact with the system. This enables an upgrade solution for existing doorbell systems without major reconstruction work.

Infobox

Console log with according VITA ID and data to know what button from which board was pressed. Detected button press shown with timestamp.

```
luca@raspberrypi:~/SNB $ python3 spi_v2.py
/dev/spidev0.0 | mode=3 | speed=250000 Hz | bpw=8 | lsbfirst=False
TX: FF FF  RX: FF FF
TX: FF FF  RX: FF FF
TX: FF FF  RX: 01 02
[13:30:16] ID=0x01 DATA=0x02
TX: FF FF  RX: FF FF
TX: FF FF  RX: FF FF
TX: FF FF  RX: FF FF
TX: FF FF  RX: 01 01
[13:30:20] ID=0x01 DATA=0x01
TX: FF FF  RX: FF FF
TX: FF FF  RX: FF FF
TX: FF FF  RX: 01 08
[13:30:23] ID=0x01 DATA=0x08
TX: FF FF  RX: FF FF
TX: FF FF  RX: 01 04
[13:30:25] ID=0x01 DATA=0x04
TX: FF FF  RX: FF FF
TX: FF FF  RX: FF FF
TX: FF FF  RX: FF FF
TX: FF FF  RX: FF FF
TX: FF FF  RX: FF FF
TX: FF FF  RX: FF FF
TX: FF FF  RX: FF FF
TX: FF FF  RX: FF FF
```

Project Team:
Luca Andrea Wüthrich

Client:
Swiss neu Bell GmbH, Alpnach

Coaches:
Prof. Dr. Hanspeter Schmid,
Prof. Dominique Kunz