

Multilevel Class D BT Speaker

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Techfest Munich 2019 Workshop

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- 3 Multilevel Class D technology
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- 5 ESP32 BT Sink
- 6 MA12070P amplifier
- 7 Infineon @Techfest

What we offer for Techfest

Modular hardware boards compatible with Arduino, ESP32, Raspberry Pi

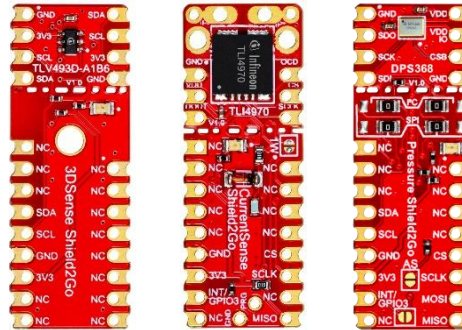
Motor Controllers

DC, BLDC, Steppers - up to 700W



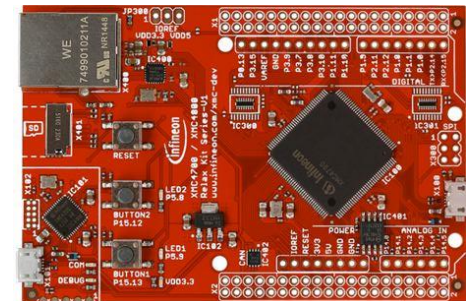
Sensors

Pressure, Magnetic, Microphone, more



Microcontroller Kits

Arduino compatible



Radar & 3D Imager

24 & 77 GHz Radar, Pico Flexx 3D cam



FLEXX

Digital Audio

Silicon Stereo Microphone & Class D Amps



[Infineon.com/makers](https://www.infineon.com/makers)

Audio Class D and Infineon

- › International Rectifiers acquired 5 years ago
 - >100 W analog power amplifier module design
 - Professional and industrial audio amplification
 - Marked insight and demand
- › MERUS™ Audio acquired 2 years ago
 - <100 W analog and digital input monolithic ICs
 - 20 people startup from Denmark
 - Design team with multidisciplinary skills
 - Patterned Multi level technology



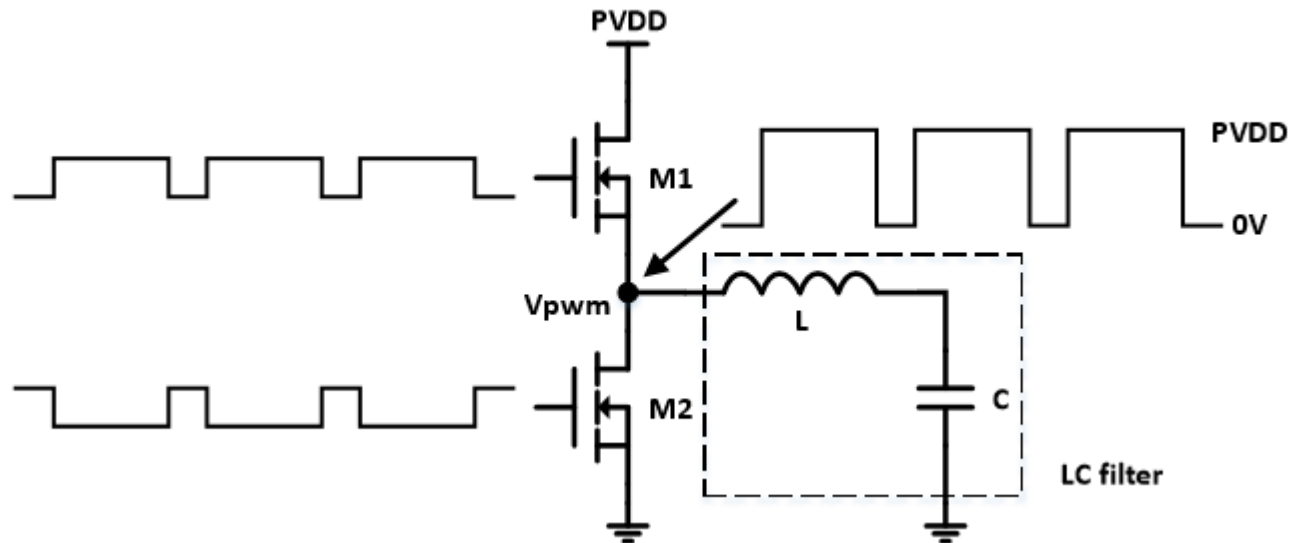
Soundboks – 5 year old startup

- › Born at Roskilde Festival
 - DIY build - Returned with 200 request to build
- › Today sold more then 50K Soundboks 2
- › Released Soundboks 3 last month



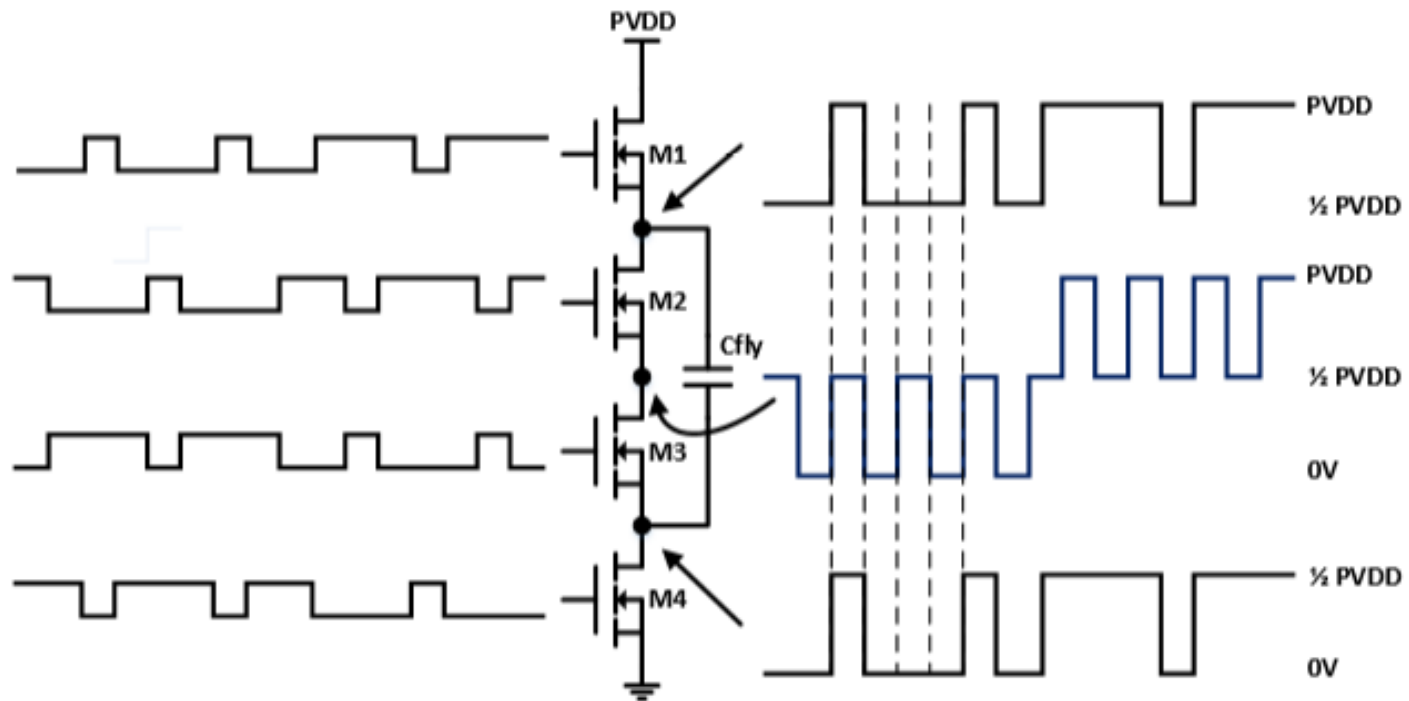
Multilevel Class D

- › Traditional class D (20 year old tech)
 - Large Idle loss – even at moderate volume
 - Effective only at max power
 - EMC issues
 - Complex discrete rail tracking



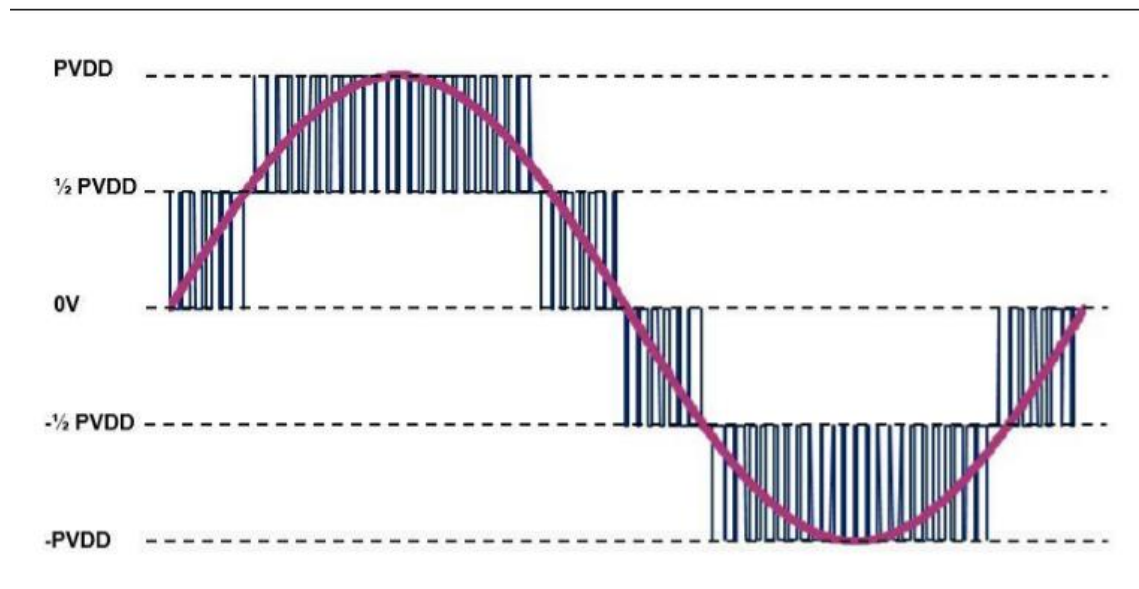
Multilevel Class D

- › New tech in audio amplification
 - Low idle power loss
 - Low EMC noise
 - Requires and enables advanced modulation



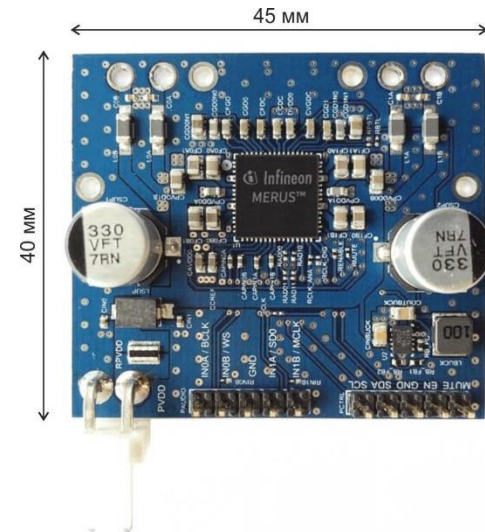
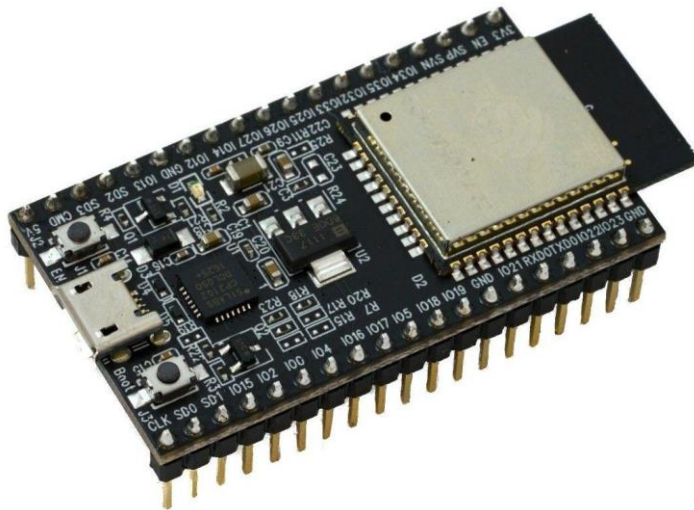
Multilevel Class D

- › 3 or 5-level modulation in BTL configuration
- › Dynamic modulation and modulation frequency
- › Design for low power consumption, EMC or audio performance.
- › [Multilevel class D white paper](#)
- › [IEEE paper on IC design from 2016](#)



Workshop - Work to be done

- › ESP32 classic Bluetooth audio sink
 - Simple demo implementation of BT A2DP protocol
 - Audio streaming / start/stop / trackinfo / bitrates / volume
 - I2S 16 bit output internal or external DAC
 - Add a MerusAudio ESP-IDF component
 - ESP32 driver for MA120x0
 - Device setup and register access
 - Change from 16 to 32 bits audio samples



Lets do some work

› Run the ESP32 a2dp_sink demo

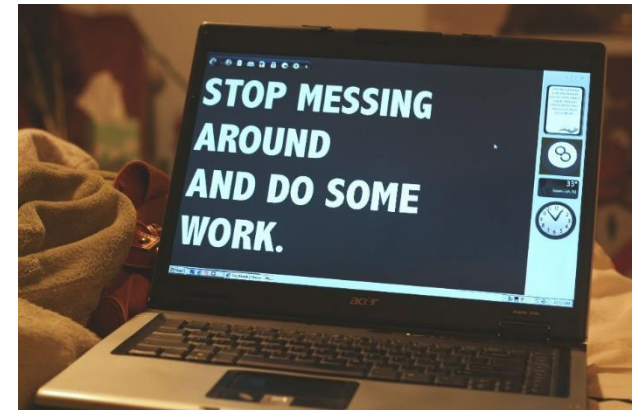
- `cd ~/esp`
- `cp -r esp-idf/examples/bluetooth/bluedroid/classic_bt/a2dp_sink .`
- `make menuconfig` // change serial port and link speed 230kb
- `make flash monitor -j6`

› Tips!

- Change bluetooth name
- Connect you phone, stream audio

› Challenge

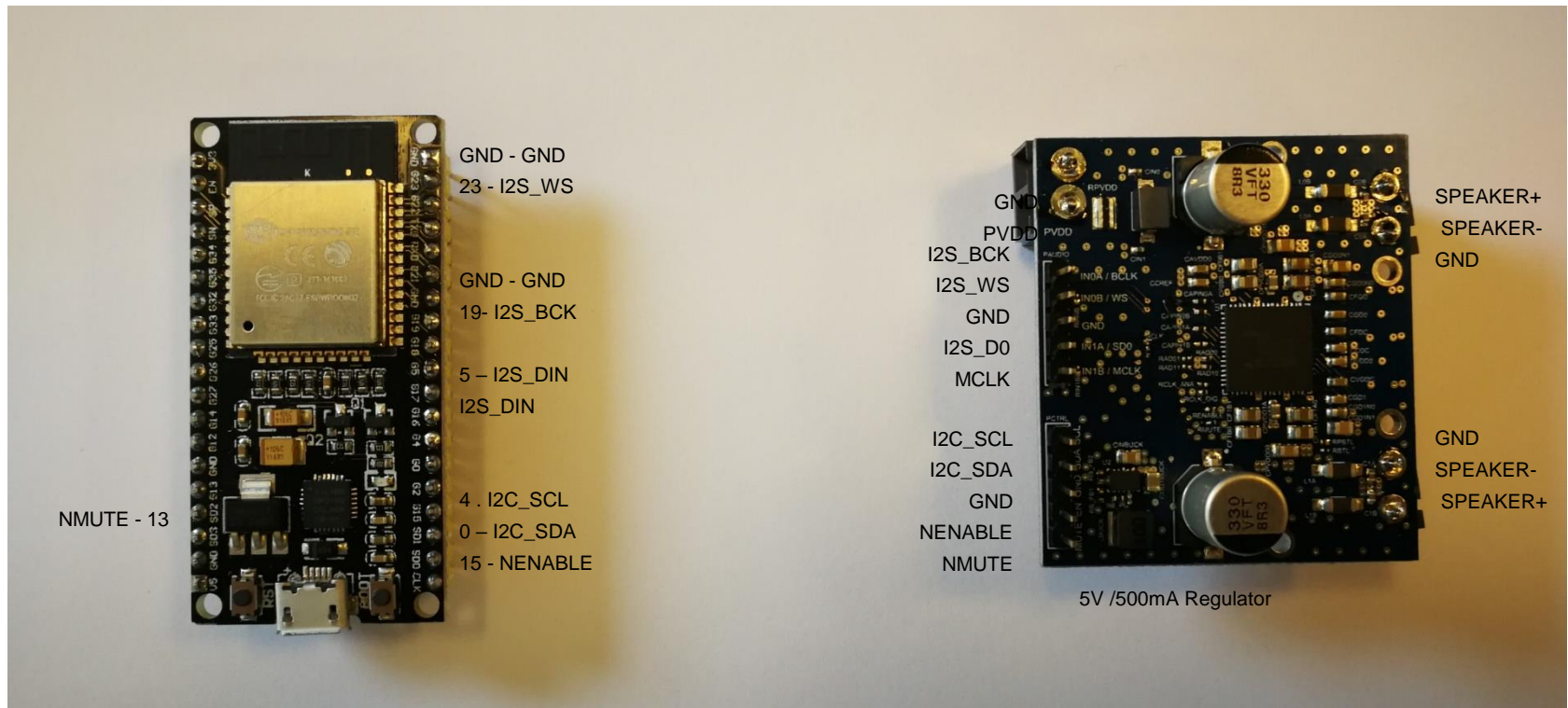
- Find the BT audio sample callback
- Find and modify track number event
 - Add some stuf "i like AC/DC" if play AC/DC



Wire up ESP32 and MA120x0P

ESP32	Driver	Signal	Dir	MA120x0P
G15	GPIO	Enable amplifier (NC)	I PD	nENABLE
G13	GPIO	Mute amplifier (NC)	I PU	nMUTE
G19	I2S DMA	I2S_BCK – bit clock 3.072 MHz	I	I2S_BCK + MCLK
G23	I2S DMA	I2S_WS – L/R frame 48KHz	I	I2S_WS
G5	I2S DMA	I2S_Dout	I	I2S_D0
G4	I2C DMA	I2C_SCL – Clock (100kbps)	B	I2C_SCL
G0	I2C DMA	I2C_SDA – Data	B	I2C_SDA
GND	Power	2 x GROUND	P	GND

ESP32 MA12070P connections



Close Look at MA120x0P

- > I2S audio input
- > I2C control interface
 - volume
 - input format
 - power modes
- > Control lines
 - nenable, nmute
- > Status
 - nerr and nclip



- [MA120x0P Datasheet](#)

Add the MerusAudio esp-idf component

- › https://github.com/jorgenkraghjakobsen/a2dp_sink_techfest
- › `cd ~/esp`
- › `git clone https://github.com/jorgenkraghjakobsen/a2dp_sink_techfest.git`
- › `make menuconfig // setup serial interface and speed (230kbps)`
- › `make flash monitor -j6`

- › What is added to code
 - MA120x0 setup called from main
 - Change audio bits pr sample from 16->32
 - Repack sample data from BT to I2S buffer

Audio AE team at Techfest

- › Raspberry pi HAT
- › Raspberry drivers
- › More ESP32 processing pipeline
- › More amplifier boards

- › Ariel Muszkat
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- › Acoustics
- › Audio Hardware
- › Application Engineering at IFX

- › Jørgen Kragh Jakobsen
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- › ESP32
- › Raspberry pi
- › Digital audio streaming
- › IC design analog / digital



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