

User manual for MERUS™ MA12070 musical instrument bass amplifier

DEMO_BASSAMP_60W_MA12070



About this document

Scope and purpose

This document describes the functional setup and user guide for the MA12070 musical instrument bass amplifier. It includes a description of features, performance specification, schematics, PCB layout and bill of materials (BOM) of the amplifier.

Intended audience

This user manual is for audio amplifier design engineers, audio system engineers, audio software engineers and musicians interested in technology.

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Board overview

1 Board overview

The MA12070 musical instrument bass amplifier is a wall-adapter or battery-powered, 60 W, professionally featured and ultraefficient pocket-sized bass instrument amplifier. It is modeled after classic vacuum-tube bass amplifier topology. It utilizes the exceptional audio quality and best-in-class efficiency of Infineon’s MERUS™ amplifier technology ([Infineon class D audio amplifier solutions](#)) to amplify every nuance of a real vacuum-tube pre-amplifier.

It incorporates a 12AU7/ECC82 vacuum tube for real-tube class-A amplification, which is run at low plate-voltage, excluding high-voltage generation circuitry, and the ultrahigh fidelity **MA12070** multilevel switching audio power amplifier.

The design is made for direct use as a self-contained amplifier head or as a combo including a speaker. It only requires an external +24 V regulated power supply.

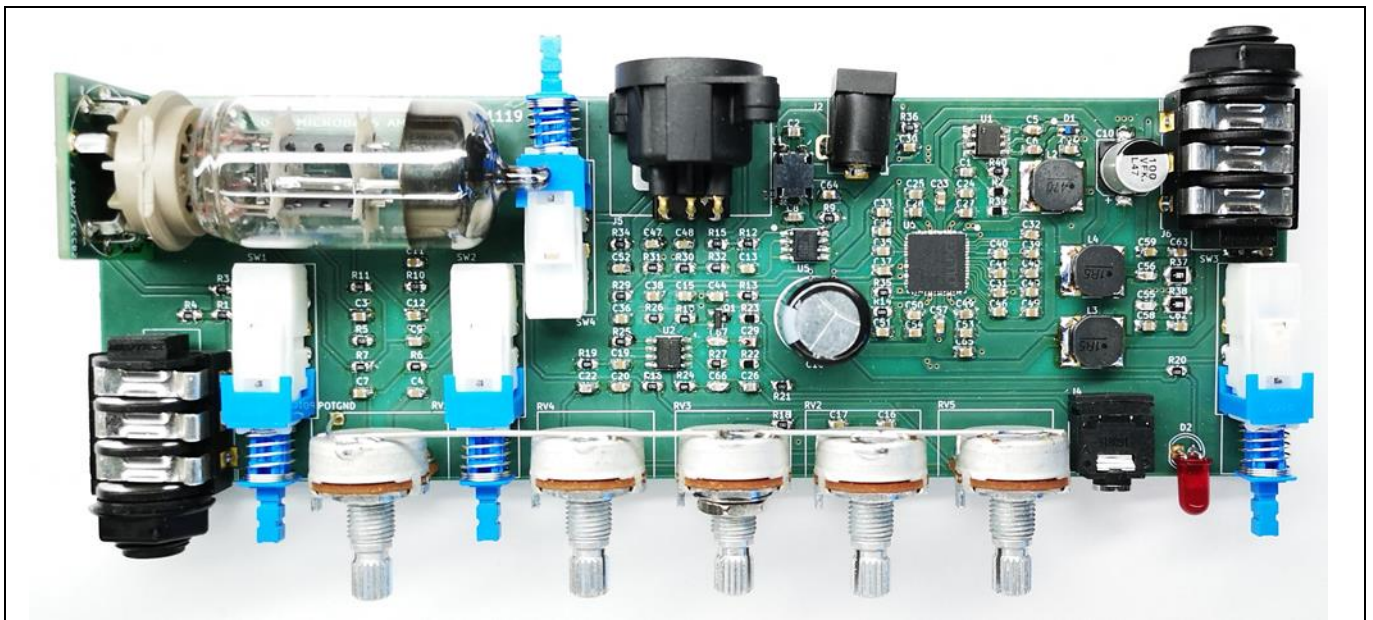


Figure 1 MA12070 musical instrument bass amplifier

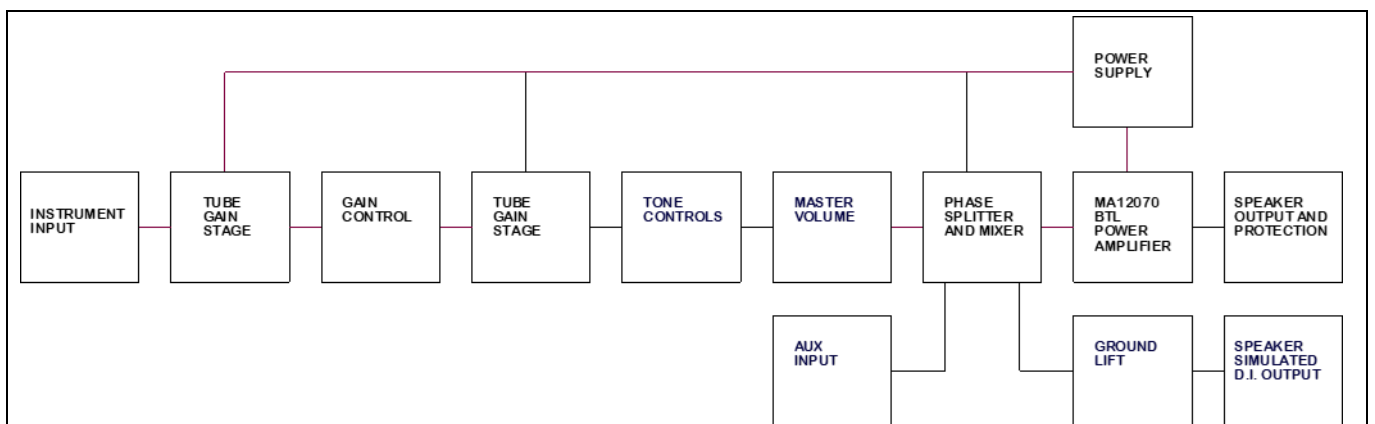


Figure 2 Block diagram

Please see the Infineon application note [MA12070 musical instrument bass amplifier](#) for further details.

Board overview

1.1 Features and performance

The key features and performance of the MA12070 musical instrument bass amplifier are as follows:

- One “classic tube sound” bass instrument channel
- 1 x 60 W at 4 Ω speaker output.
- Powered by off-the-shelf regulated wall adapter (+24 V DC/3 A)
- Unparalleled power efficiency – with very low power losses and cool operation
- No external heatsink (full volume, bass instrument playing)
- Dual 12AU7 triode class A pre-amp run directly on adapter voltage for genuine tube sound
- Passive instrument input jack with -12 dB input pad switch for active instruments
- Gain and volume controls for tube overdrive
- Bright switch for “slap-bass” sound
- Dynamic “breathe and feel” when fully dimmed
- Classic three-band passive Baxandall tone control: treble, middle, bass
- Stereo 3.5 mm AUX input for practicing/street accompaniment
- XLR DI: frequency-compensated, true balanced output for live PA/mixing desk (phantom power safe)
- XLR DI ground switch
- Protection: power supply reverse polarity and hot-plug, thermal, DC and speaker short-circuit
- Speaker jack output with low-cost LC-filter
- DC barrel input jack
- Low idle power consumption even with vacuum tube
- Small dimensions: 185 mm x 60 mm x 30 mm

Table 1 Electrical specifications

| | |
|---|---|
| Power input | +18 V to +24 V, 3 A regulated, positive tip 2.1 mm, DC barrel |
| Idle power consumption | 2.7 W at 24 V input |
| Power input at 10 W _{rms} output | 15.3 W at 24 V input |
| Output power | 60 W _{rms} at 5 percent THD, 4 Ω 24 V input |
| Output load impedance | 4 Ω to 16 Ω, 6.35 mm jack |
| Instrument input sensitivity/impedance | 25 mV/1 MΩ, 90 mV/65 kΩ, 6.35 mm mono |
| AUX input sensitivity/impedance | 400 mV _{rms} /200 mV _{rms} , mono/stereo, 4.7 kΩ, 3.5 mm jack |
| Bass control range | ±12 dB at 40 Hz |
| Treble control range | ±14 dB at 4 kHz |
| Middle control range | 11 dB at 380 Hz |
| DI output level | True balanced: -6 dBm, true ground lift |
| DI output frequency response (-3 dB) | 55 Hz to 8 kHz, 6 dB/oct |

2 User interface

2.1 User controls

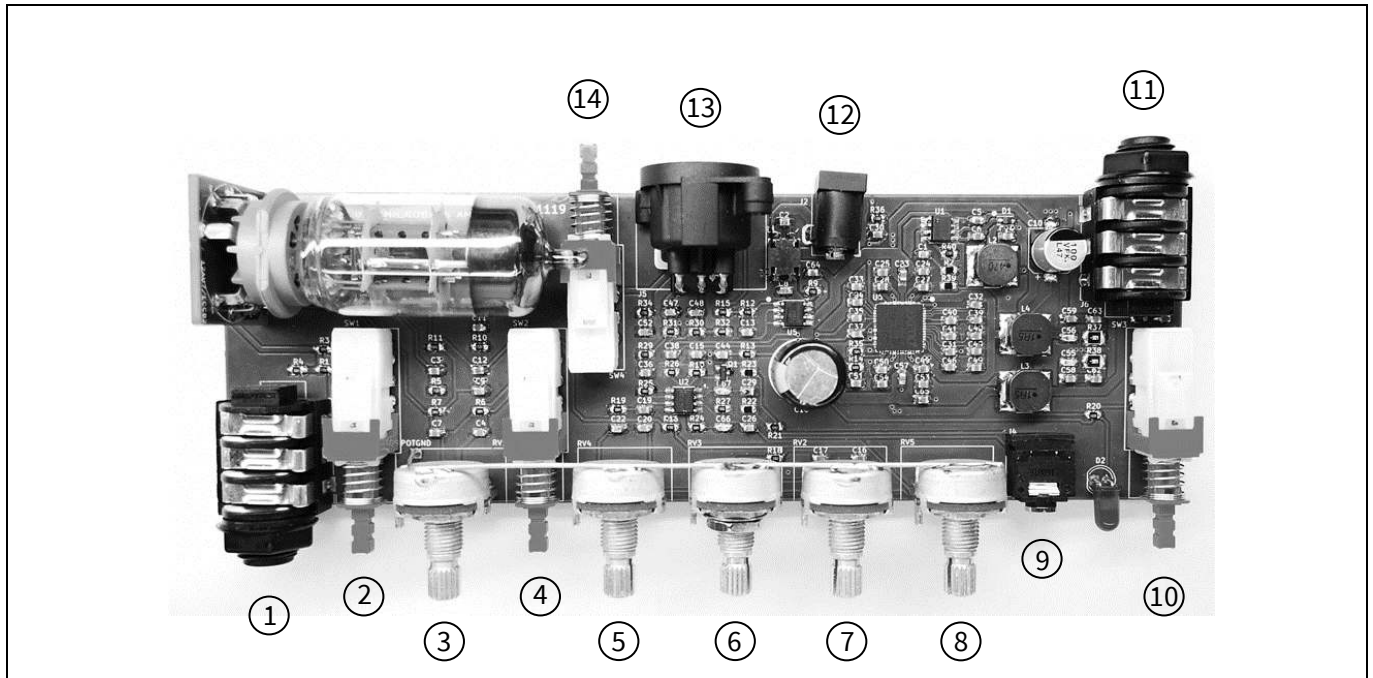


Figure 3 User controls overview

Table 2 User controls description

| Front of PCB (left to right): | |
|---------------------------------|--|
| 1. INPUT: Instrument input jack | Connect a shielded ¼ in. mono jack cable from the instrument to this jack. 1 MΩ/65 kΩ input impedance. |
| 2. PAD: -12 dB input pad switch | When using active instruments or instruments with a high output level, use this switch for matching the input sensitivity of the amplifier for a clean sound. 65 kΩ input impedance when engaged. |
| 3. GAIN: Gain control | Adjusts the signal amplitude from the first tube gain stage into the second tube gain stage. Combined with the master volume control (8) it is possible to overdrive the tube for genuine tube distortion. |
| 4. BRIGHT: Bright switch | Boosts the higher treble harmonics of the instrument when engaged. Works in conjunction with the gain control (3). Most effective when the gain control is at its lower settings. |
| 5. TREBLE: Treble tone control | Adjusts the treble frequencies of the instrument. Passive Baxandall type with the capability of both boosting and cutting treble frequencies of approximately ±15 dB at 4 kHz. Set to middle position yields a flat treble response. |

User interface

| | |
|---|---|
| 6. MID: Middle tone control | Adjusts the insertion level of the Baxandall tone control. Perceived as boosting or cutting mid-range frequencies compared to treble and bass frequencies. Set to middle position yields ± 14 dB of range of the treble control, and ± 12 dB range for the bass control. |
| 7. BASS: Bass tone control | Adjusts the lower frequencies of the instrument. Passive Baxandall type with the capability of both boosting and cutting bass frequencies with ± 12 dB at 40 Hz. Set to middle position yields a flat bass response. |
| 8. VOLUME: Master volume control | Adjusts the overall output volume of the amplifier. Combined with the gain control (3), one can overdrive the tube for genuine tube distortion while still controlling the output volume of the amplifier. |
| 9. AUX IN: Auxiliary input | 3.5 mm stereo input jack for connecting a phone, MP3 player or other sources for accompaniment or practicing along. Post master volume input. |
| 10. POWER ON/OFF: Power on/off switch and LED | Switches the amplifier on and off, with the red LED indicating on when lit. |
| Back of PCB (left to right): | |
| 11. SPEAKER: Speaker output jack | Connect this to a speaker cabinet (4 Ω min.) via a ¼ in. mono jack cable. Do not connect to ground. |
| 12. POWER INPUT: DC power input barrel | Connect +24 V DC/3 A wall adapter with positive tip into this socket. |
| 13. DIOUT: Balanced XLR speaker simulated DI output | In a live situation, connect this frequency-compensated output to the front-of-house (FOH) mixing desk. In a recording situation, use this output for direct recording. Post master volume, and phantom power safe. The output cuts the extreme highs and lows for more realistic sound when going into live or recording full range systems. |
| 14. GROUND LIFT: Ground lift switch | If experiencing ground-loop hum or noise in a live or recording situation, press this switch to disconnect Pin 1 in the XLR from the amplifier ground. This will in many cases remove hum or noise. Be aware that the amplifier ground is now floating from the rest of the system. |

2.2 Setting up the amplifier for use

1. Put the on/off switch (10) in the depressed position (off).
2. Set all the controls at 12'o clock. Set the volume control (8) to minimum.
3. Put the pad switch (2) in the depressed position (high sensitivity input).
4. Put the bright switch (4) in the depressed position (not bright).
5. Connect a speaker (4 Ω minimum) to the speaker output jack (11) via a 6.35 mm mono jack cable. Make sure the jack cable is a speaker-grade cable.
6. Connect a +24 V DC/3 A regulated power supply to the DC power input barrel (12). Make sure it has a positive-tip scheme (inner tip is positive, outer ring is negative).
7. Connect a bass instrument via a shielded 6.53 mm mono jack cable to the input jack (1).
8. Turn-on the amplifier by pressing the on/off switch (10). The red LED (10) should light up.
9. Turn up the volume control (8) to the desired level.
10. Turn the controls until the desired response and sound is achieved (see Table 2 for a detailed explanation of functions).
11. Connect a mono or stereo AUX signal (e.g., from the telephone headphone output) via the AUX IN 3.5 mm stereo jack (9) for playing along with or for rehearsing song material (this input is placed after the volume control (8) so the AUX signal volume can be controlled from the AUX source).
12. In a live or direct recording situation, connect a three-pin shielded XLR cable from the DI OUT XLR connector (13) to a mixing desk or sound card. This injects the amplifier's pre-amp signal with frequency compensation. Press the ground lift switch (14) if ground-loop/noise problems occur.
13. Play!

3 Hardware documentation

3.1 Schematic

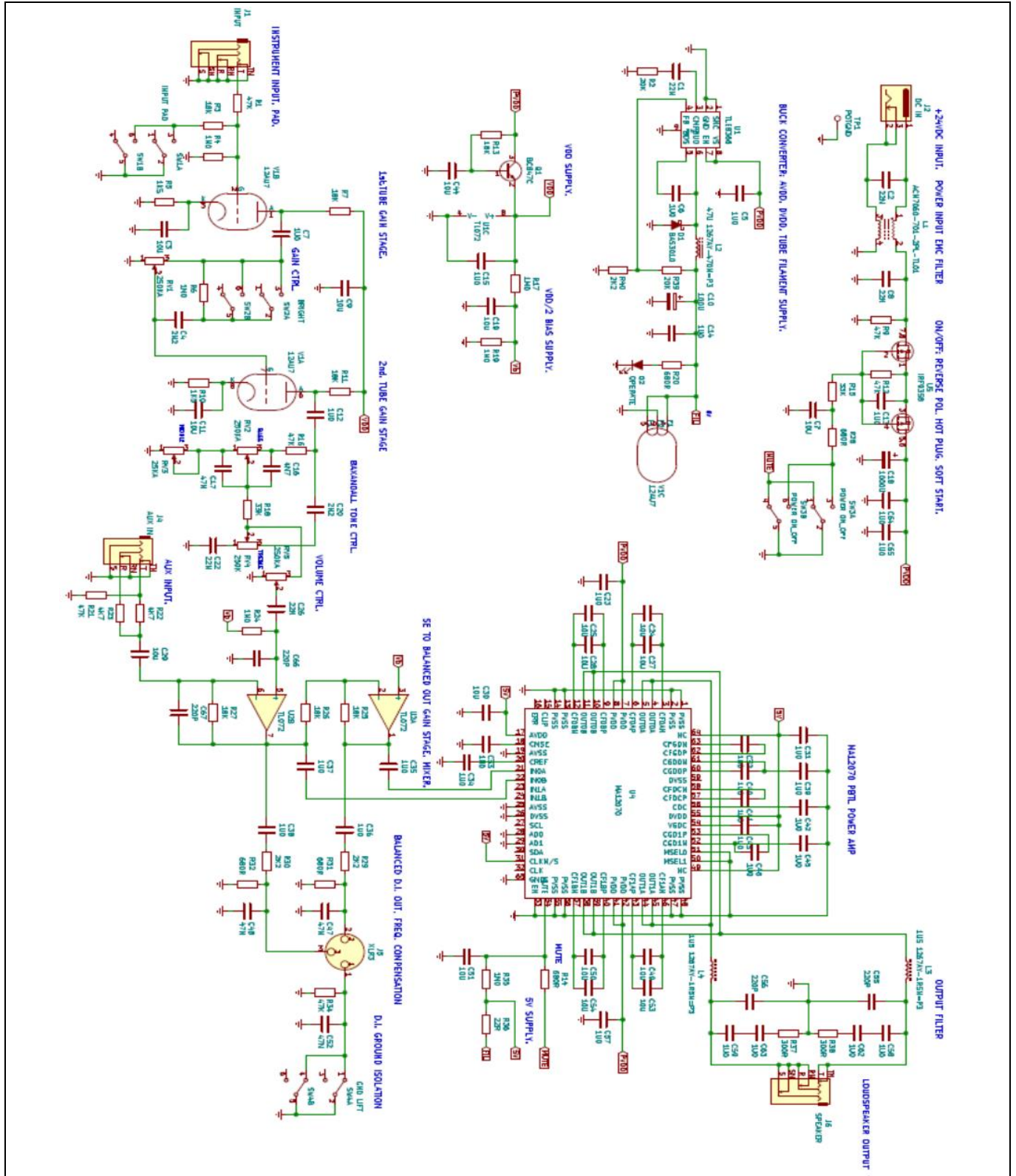


Figure 4 Schematic

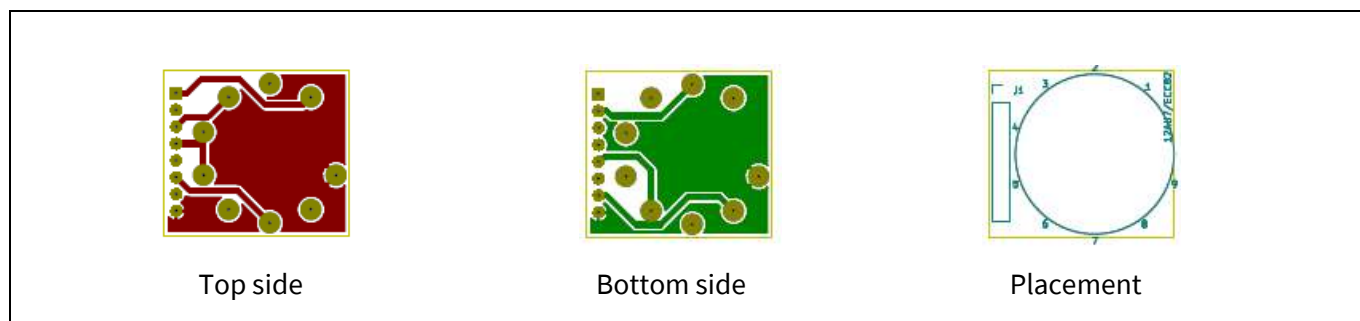


Figure 6 Tube PCB layout

BOM

4 BOM

Table 3 MA12070 musical instrument bass amplifier BOM

| Designator | Description | Manufacturer | Part number | Qty |
|--|---|--------------|----------------------|-----|
| C10 | Electrolytic capacitor, FK series, 100 μ F, 35 V, 8 x 10 mm | Panasonic | EEEFK1V101P | 1 |
| C18 | Electrolytic capacitor, FK series, 1000 μ F, 35 V, 12.5 x 20 mm | Panasonic | EEUFR1V102B | 1 |
| C3,C9,C11,C19,C24,C25,C27,C28,C29,C30,C44,C49,C50,C51,C53,C54,C60 | Ceramic capacitor, 10 μ F, \pm 10 percent, X5R, 25 V, 0805 | Samsung | CL21A106KAYNNNE | 17 |
| C5,C6,C7,C12,C13,C14,C15,C23,C31,C32,C33,C34,C35,C36,C37,C38,C39,C40,C41,C42,C43,C45,C46,C57,C58,C59,C62,C63,C64,C65 | Ceramic capacitor, 1 μ F, \pm 10 percent, X7R, 50 V, 0805 | Samsung | CL21B105KBFNNNE | 30 |
| C1,C2,C8,C22,C26 | Ceramic capacitor, 22 nF, \pm 5 percent, NP0, 50 V, 0805 | TDK | C2012C0G1H223J125AA | 5 |
| C17,C47,C48,C52 | Ceramic capacitor, 47 nF, \pm 10 percent, NP0, 50 V, 0805 | Murata | GRM21BR71H473KA01L | 4 |
| C16 | Ceramic capacitor, 4.7 nF, \pm 5 percent, NP0, 200 V, 0805 | Kemet | C0805C472J2GECTU | 1 |
| C4,C20 | Ceramic capacitor, 2.2 nF, \pm 5 percent, NP0, 100 V, 0805 | Kemet | C0805C222J1GACTU | 2 |
| C55,C56,C66,C67 | Ceramic capacitor, 220 pF, \pm 5 percent, NP0, 50 V, 0805 | Vishay | VJ0805A221JXACW1BC | 4 |
| R4,R6,R17,R19,R24,R35 | Resistor, 1 M Ω , 125 mW, 1 percent, 0805 | Vishay | CRCW08051M00FKEA | 6 |
| R1,R9,R12,R16,R21,R34 | Resistor, 47 k Ω , 125 mW, 1 percent, 0805 | Vishay | CRCW080547K0FKEA | 6 |
| R15,R18 | Resistor, 33 k Ω , 125 mW, 1 percent, 0805 | Vishay | CRCW080533K0FKEA | 2 |
| R2,R39 | Resistor, 20 k Ω , 125 mW, 1 percent, 0805 | Vishay | CRCW080520K0FKEA | 2 |
| R3,R7,R11,R13,R25,R26,R27 | Resistor, 18 k Ω , 125 mW, 1 percent, 0805 | Vishay | CRCW080518K0FKEA | 7 |
| R22,R23 | Resistor, 4.7 k Ω , 125 mW, 1 percent, 0805 | Vishay | CRCW08054K70FKEA | 2 |
| R29,R30,R40 | Resistor, 2.2 k Ω , 125 mW, 1 percent, 0805 | Vishay | CRCW08052K20FKEA | 3 |
| R5,R10 | Resistor, 1.5 k Ω , 125 mW, 1 percent, 0805 | Vishay | CRCW08051K50FKEA | 2 |
| R14,R20,R28,R31,R32 | Resistor, 680 Ω , 125 mW, 1 percent, 0805 | Vishay | CRCW0805680RFKEA | 5 |
| R37,R38 | Resistor, 300 Ω , 500 mW, 5 percent, 1210 | Panasonic | ERJT14J301U | 2 |
| R36 | Resistor, 22 Ω , 125 mW, 1 percent, 0805 | Vishay | CRCW080522R0FKEA | 1 |
| L1 | Common-mode filter, 700 Ω , 4 A, 7 x 6 mm | TDK | ACM7060-701-2PL-TL01 | 1 |

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BOM

| | | | | |
|-----------------|---|------------------|-----------------------|---|
| L2 | Power inductor, 47 μ H, 1.9 A, 8 x 8 mm | Murata | 1267AY-470M=P3 | 1 |
| L3,L4 | Power inductor, 1.5 μ H, 7.3 A, 8 x 8 mm | Murata | 1267AY-1R5N=P3 | 2 |
| D1 | Schottky diode, BAS3010, 30 V, 1 A, SOD-323 | Infineon | BAS3010A03WE6327HTSA1 | 1 |
| D2 | LED, red, 5 mm, TH, T1-3/4 | Broadcom | HLMP-3301 | 1 |
| Q1 | BJT, NPN, BC847C, 45 V, 100 mA, SOT-23 | Infineon | BC847CE6327HTSA1 | 1 |
| U1 | Buck controller, adjustable, 45 V, 1.8 A, SOIC-8 | Infineon | TLE8366EVXUMA1 | 1 |
| U2 | Dual audio op-amp, TL072A, \pm 18 V | ST | TL072ACDT | 1 |
| U4 | Multilevel class D amplifier, MA12070, 2 x 80 W | Infineon | MA12070XUMA1 | 1 |
| U5 | Dual P-channel MOSFET, IRF9358, -30 V, -9.2 A | Infineon | IRF9358TRPBF | 1 |
| RV1,RV2,RV4,RV5 | Rotary potentiometer, TH, 250 k Ω logarithmic, 16 mm | TT Electronics | P160KN-0QC15A250K | 4 |
| RV3 | Rotary potentiometer, TH, 25 k Ω logarithmic, 16 mm | TT Electronics | P160KNP-0QC20A25K | 1 |
| SW1,SW2,SW3,SW4 | Push-button switch, TH, DPDT, 30 V, 0.1 A | Alps Alpine | SPUN191600 | 4 |
| J4 | Phone jack, stereo, switched, TH, 3.5 mm | Cliff | FC68133 | 1 |
| J1,J6 | Phone jack, stereo, switched, TH, 6.35 mm | Neutrik | NMJ6HFD2 | 2 |
| J5 | XLR connector, three contacts, male, TH | Neutrik | NC3MAAH | 1 |
| J2 | DC power connector, jack, 5 A, TH, 2.5 mm | Multicomp | SPC21365 | 1 |
| J3 | Header, eight contacts, one row, right angle, 2.54 mm | Würth | 61300811021 | 1 |
| N1 | Tube socket, TH, PCB, ceramic, NOVAL | Belton | VT9-PT | 1 |
| V1 | Electron tube, dual triode, 12AU7/ECC82, NOVAL | Electro Harmonix | 12AU7 / ECC82 | 1 |

5 Revision history

| Document version | Date of release | Description of changes |
|------------------|-----------------|------------------------|
| V 1.0 | 28-05-2020 | First release |
| | | |
| | | |

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