***The γ1 modular miniature DAC***

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### Parts list

The table below is a complete parts list for all main configurations of the γ1. See the sections below for specific parts recommendations and options. For parts not offered by [AMB audio shop](https://www.amb.org/shop/), [Mouser](https://www.amb.org/cgi-bin/redir.cgi?t=http://www.mouser.com/), [Digi-Key](https://www.amb.org/cgi-bin/redir.cgi?t=http://www.digikey.com/), [Newark](https://www.amb.org/cgi-bin/redir.cgi?t=http://www.newarkinone.com/), [Farnell](https://www.amb.org/cgi-bin/redir.cgi?t=http://www.farnellinone.com/), [RS Components](https://www.amb.org/cgi-bin/redir.cgi?t=http://www.rs-online.com/) or another vendor's stock numbers for the recommended parts are listed for your convenience.   
  
The A through E columns denote the γ1 configuration. "Y" means the part is required, "N" means that the part should not be populated, and "O" means optional (see corresponding notes below).

* **A:** Full configuration (USB and DAC boards)
* **B:** Lite configuration (USB and DAC boards)
* **C:** USB-to-S/PDIF converter (no DAC board)
* **D:** USB-to-I²S converter (no DAC board)
* **E:** S/PDIF DAC-only configuration (no USB board)
* **F:** Full++ configuration (combination of A and C)

All parts on the DAC board have a "D" suffix, and all those on the USB board have a "U" suffix.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A | B | C | D | E | F | Part ID | Description | Mouser # | Digi-Key # | Farnell # | RS # | Notes |
| Circuit board | | | | | | | | | | | | |
| Y | | | | | | PCB | γ1 PCB set | AMB audio shop | | | | - |
| Resistors | | | | | | | | | | | | |
| Y | N | N | N | Y | Y | R1D | miniature 1% thin film or metal film resistor 75Ω | 270-75-RC | S75CACT-ND | 9343555 | - | - |
| Y | N | N | N | Y | Y | R2D | miniature 1% thin film or metal film resistor 47KΩ | 270-47K-RC | S47KCACT-ND | 9343261 | - | - |
| Y | N | N | N | Y | Y | R3D | miniature 1% thin film or metal film resistor 47KΩ | 270-47K-RC | S47KCACT-ND | 9343261 | - | - |
| Y | N | N | N | Y | Y | R4D | miniature 1% thin film or metal film resistor 3KΩ | 270-3.0K-RC | S3KCACT-ND | 9342990 | - | - |
| Y | N | N | N | Y | Y | R5D | resistor network SIP-6 bussed 47KΩx5 | AMB audio shop | | | | - |
| Y | N | N | N | Y | Y | R6D | resistor network SIP-6 bussed 47KΩx5 | AMB audio shop | | | | - |
| Y | Y | N | N | Y | Y | R7D | resistor network SIP-8 isolated 68Ωx4 | AMB audio shop | | | | - |
| Y | Y | N | N | Y | Y | R8D | miniature 1% thin film or metal film resistor 47KΩ | 270-47K-RC | S47KCACT-ND | 9343261 | - | - |
| Y | Y | N | N | Y | Y | R9D | miniature 1% thin film or metal film resistor 47KΩ | 270-47K-RC | S47KCACT-ND | 9343261 | - | - |
| Y | Y | N | N | Y | Y | R10D | miniature 1% thin film or metal film resistor 47KΩ | 270-47K-RC | S47KCACT-ND | 9343261 | - | - |
| Y | N | N | N | Y | Y | R11D | miniature 1% thin film or metal film resistor 220Ω | 270-220-RC | S220CACT-ND | 9342826 | - | - |
| Y | N | N | N | Y | Y | R12D | miniature 1% thin film or metal film resistor 22KΩ | 270-22K-RC | S22KCACT-ND | 9342842 | - | - |
| Y | N | N | N | Y | Y | R13D | miniature 1% thin film or metal film resistor 22KΩ | 270-22K-RC | S22KCACT-ND | 9342842 | - | - |
| O | O | N | N | O | O | R14D | miniature 1% thin film or metal film resistor 47KΩ | 270-47K-RC | S47KCACT-ND | 9343261 | - | See note 1 |
| O | O | N | N | O | O | R15D | miniature 1% thin film or metal film resistor 47KΩ | 270-47K-RC | S47KCACT-ND | 9343261 | - | See note 1 |
| O | O | N | N | O | O | R16D | miniature 1% thin film or metal film resistor 1.5KΩ | 270-1.5K-RC | S1.5KCACT-ND | 9342621 | - | See note 1 |
| Y | N | N | N | Y | Y | R20D | miniature 1% thin film or metal film resistor 47KΩ | 270-47K-RC | S47KCACT-ND | 9343261 | - | - |
| Y | Y | Y | Y | N | Y | R1U | miniature 1% thin film or metal film resistor 22Ω | 270-22-RC | S22CACT-ND | 9342869 | - | - |
| Y | Y | Y | Y | N | Y | R2U | miniature 1% thin film or metal film resistor 1.5KΩ | 270-1.5K-RC | S1.5KCACT-ND | 9342621 | - | - |
| Y | Y | Y | Y | N | Y | R3U | miniature 1% thin film or metal film resistor 22Ω | 270-22-RC | S22CACT-ND | 9342869 | - | - |
| Y | Y | Y | Y | N | Y | R4U | miniature 1% thin film or metal film resistor 47KΩ | 270-47K-RC | S47KCACT-ND | 9343261 | - | - |
| Y | Y | Y | Y | N | Y | R5U | miniature 1% thin film or metal film resistor 1.5KΩ | 270-1.5K-RC | S1.5KCACT-ND | 9342621 | - | - |
| Y | Y | Y | Y | N | Y | R6U | miniature 1% thin film or metal film resistor 1MΩ | 270-1.0M-RC | S1MCACT-ND | 9342435 | - | - |
| N | Y | Y | Y | N | N | R7U | miniature 1% thin film or metal film resistor 560Ω | 270-560-RC | S560CACT-ND | 9343350 | - | - |
| N | N | Y | N | N | Y | R8U | miniature 1% thin film or metal film resistor 220Ω | 270-220-RC | S220CACT-ND | 9342826 | - | - |
| N | N | Y | N | N | Y | R9U | miniature 1% thin film or metal film resistor 110Ω | 270-110-RC | S110CACT-ND | 9342460 | - | - |
| Capacitors, ferrite beads & inductors | | | | | | | | | | | | |
| Y | Y | N | N | Y | Y | C1D | multilayer ceramic capacitor X7R 1µF 25V | 810-FK24X7R1E105K | 445-2857-ND | 1200404 or 1100398 | 211-5299 | See note 2 |
| Y | Y | N | N | Y | Y | C2D | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | Y | N | N | Y | Y | C3D | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | N | N | N | Y | Y | C4D | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | Y | N | N | Y | Y | C5D | multilayer ceramic capacitor X7R 10nF 50V | 80-C315C103K5R | 399-4148-ND | 1457653 | 538-1196 | - |
| Y | Y | N | N | Y | Y | C6D | conductive polymer electrolytic low-ESR capacitor 47µF 10V | 661-PSA10VB47M | 565-3051-ND | - | - | - |
| Y | Y | N | N | Y | Y | C7D | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | Y | N | N | Y | Y | C8D | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | Y | N | N | Y | Y | C9D | multilayer ceramic capacitor X7R 10nF 50V | 80-C315C103K5R | 399-4148-ND | 1457653 | 538-1196 | - |
| Y | Y | N | N | Y | Y | C10D | conductive polymer electrolytic low-ESR capacitor 47µF 10V | 661-PSA10VB47M | 565-3051-ND | - | - | - |
| Y | Y | N | N | Y | Y | C11D | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | N | N | N | Y | Y | C12D | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | N | N | N | Y | Y | C13D | multilayer ceramic capacitor X7R 10nF 50V | 80-C315C103K5R | 399-4148-ND | 1457653 | 538-1196 | - |
| Y | N | N | N | Y | Y | C14D | multilayer ceramic capacitor X7R 10nF 50V | 80-C315C103K5R | 399-4148-ND | 1457653 | 538-1196 | - |
| Y | N | N | N | Y | Y | C15D | multilayer ceramic capacitor X7R 10nF 50V | 80-C315C103K5R | 399-4148-ND | 1457653 | 538-1196 | - |
| Y | N | N | N | Y | Y | C16D | multilayer ceramic capacitor X7R 10nF 50V | 80-C315C103K5R | 399-4148-ND | 1457653 | 538-1196 | - |
| Y | N | N | N | Y | Y | C17D | multilayer ceramic capacitor X7R 10nF 50V | 80-C315C103K5R | 399-4148-ND | 1457653 | 538-1196 | - |
| Y | N | N | N | Y | Y | C18D | multilayer ceramic capacitor C0G/NP0 1nF 100V | 80-C315C102J1G | 399-4143-ND | 1457635 | 538-1382 | See note 2 |
| Y | N | N | N | Y | Y | C19D | multilayer ceramic capacitor X7R 22nF 50V | 80-C315C223K5R | 399-4169-ND | 1457654 | 538-1326 | - |
| Y | N | N | N | Y | Y | C20D | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | Y | N | N | Y | Y | C21D | multilayer ceramic capacitor X7R 1µF 25V | 810-FK24X7R1E105K | 445-2857-ND | 1200404 or 1100398 | 211-5299 | See note 2 |
| Y | Y | N | N | Y | Y | C22D | audio grade electrolytic capacitor 22µF 6.3V+ | 647-UKW1H220MDD or 647-UES1E220MEM | 604-1051-ND | 8766762 or 8766959 | 215-5691 or 521-1738 | - |
| Y | Y | N | N | Y | Y | C23D | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | Y | N | N | Y | Y | C24D | audio grade electrolytic capacitor 22µF 6.3V+ | 647-UKW1H220MDD or 647-UES1E220MEM | 604-1051-ND | 8766762 or 8766959 | 215-5691 or 521-1738 | - |
| Y | Y | N | N | Y | Y | C25D | audio grade electrolytic capacitor 22µF 6.3V+ | 647-UKW1H220MDD or 647-UES1E220MEM | 604-1051-ND | 8766762 or 8766959 | 215-5691 or 521-1738 | - |
| Y | Y | N | N | Y | Y | C26D | film capacitor MKT or MKS 1µF 63V | AMB audio shop | | | | - |
| Y | Y | N | N | Y | Y | C27D | film capacitor MKT or MKS 1µF 63V | AMB audio shop | | | | - |
| Y | N | N | N | Y | Y | C28D | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | N | N | N | Y | Y | C29D | film capacitor MKT or MKS 1µF 63V | AMB audio shop | | | | - |
| Y | Y | Y | Y | N | Y | C1U | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | Y | Y | Y | N | Y | C2U | multilayer ceramic capacitor X7R 1µF 25V | 810-FK24X7R1E105K | 445-2857-ND | 1200404 or 1100398 | 211-5299 | See note 2 |
| Y | Y | Y | Y | N | Y | C3U | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | Y | Y | Y | N | Y | C4U | multilayer ceramic capacitor C0G/NP0 33pF 100V | 80-C320C330J2G | 399-4172-ND | 1216408 | 538-1253 | See note 2 |
| Y | Y | Y | Y | N | Y | C5U | multilayer ceramic capacitor C0G/NP0 33pF 100V | 80-C320C330J2G | 399-4172-ND | 1216408 | 538-1253 | See note 2 |
| Y | Y | Y | Y | N | Y | C6U | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | Y | Y | Y | N | Y | C7U | multilayer ceramic capacitor X7R 10nF 50V | 80-C315C103K5R | 399-4148-ND | 1457653 | 538-1196 | - |
| Y | Y | Y | Y | N | Y | C8U | conductive polymer electrolytic low-ESR capacitor 47µF 10V | 661-PSA10VB47M | 565-3051-ND | - | - | - |
| N | N | Y | N | N | Y | C9U | multilayer ceramic capacitor X7R 0.1µF 50V | 80-C320C104K5R | 399-4264-ND | 1457655 or 1141775 | 538-1310 | - |
| Y | Y | Y | Y | N | Y | C10U | multilayer ceramic capacitor X7R 1µF 25V | 810-FK24X7R1E105K | 445-2857-ND | 1200404 or 1100398 | 211-5299 | See note 2 |
| N | N | Y | N | N | Y | C11U | film capacitor MKT or MKS 1µF 63V | AMB audio shop | | | | - |
| Y | N | N | N | Y | Y | L1D | miniature inductor 47µH | AMB audio shop | | | | - |
| Y | Y | N | N | Y | Y | L2D | ferrite bead, axial-lead | AMB audio shop | | | | - |
| Y | Y | N | N | Y | Y | L3D | ferrite bead, axial-lead | AMB audio shop | | | | - |
| Y | Y | N | N | Y | Y | L4D | ferrite bead, axial-lead | AMB audio shop | | | | - |
| Y | Y | Y | Y | N | Y | L1U | ferrite bead, axial-lead | AMB audio shop | | | | - |
| Y | Y | Y | Y | N | Y | L2U | ferrite bead, axial-lead | AMB audio shop | | | | - |
| N | N | Y | N | N | Y | L3U | miniature inductor 47µH | AMB audio shop | | | | - |
| Semiconductors | | | | | | | | | | | |  |
| Y | N | N | N | Y | Y | Q1D | 2N3904 NPN transistor TO-92 | 512-2N3904BU | 2N3904FS-ND | 9846743 | 294-312 | - |
| Y | N | N | N | Y | Y | Q2D | 2N3904 NPN transistor TO-92 | 512-2N3904BU | 2N3904FS-ND | 9846743 | 294-312 | - |
| O | O | N | N | O | O | U1D | Texas Instruments TPS2115APW power multiplexer TSSOP-8 | AMB audio shop | | | | See note 1 |
| Y | N | N | N | Y | Y | U2D | Cirrus Logic CS8416-CSZ S/PDIF receiver/multiplexer SOIC-28 | 777-CS8416-CSZ | 598-1123-5-ND | 1023451 | 491-5675 | - |
| Y | Y | N | N | Y | Y | U3D | Wolfson WM8501GED/V stereo DAC SOIC-14 | AMB audio shop | | | | - |
| Y | Y | N | N | Y | Y | U4D | Microchip Technology MCP100 or Maxim/Dallas DS1818 reset manager TO-92 | 579-MCP100-315DI/TO or  579-MCP100-300DI/TO | MCP100-315DI/TO-ND or MCP100-300DI/TO-ND or DS1818-10+CT-ND | 1212673 | 667-4124 | - |
| Y | Y | N | N | Y | Y | U5D | LP2985AIM5-3.3 or TPS79333DBVR LDO voltage regulator SOT23-5 | 926-2985AIM53.3/NOPB or 595-TPS79333DBVR | LP2985AIM5-3.3/NOPBCT-ND or 296-12961-1-ND | 1469134 | 652-0033 | - |
| Y | Y | N | N | Y | Y | U6D | LP2985AIM5-4.5 or TPS793475DBVR LDO voltage regulator SOT23-5 | 926-LP2985AIM545NOPB or 595-TPS793475DBVR | LP2985AIM5-4.5/NOPBCT-ND or 296-12160-1-ND | 1685756 | 761-6488 | - |
| Y | N | N | N | Y | Y | U7D | Toshiba TORX147PL fiber-optic receiver | AMB audio shop | | | | - |
| Y | N | N | N | Y | Y | U8D | Texas Instruments SN74AHC1G02DBVR logic NOR gate SOT23-5 | 595-SN74AHC1G02DBVR | 296-1088-1-ND | 1287441 | - | - |
| Y | Y | N | N | Y | Y | U9D | Microchip Technology MCP101 or MCP101-300DI/TO or Maxim/Dallas DS1817 reset manager TO-92 | 579-MCP101-315DI/TO or 579-MCP101-300DI/TO | MCP101-315DI/TO-ND or MCP101-300DI/TO-ND or DS1817-5+-ND | 1332052 | 667-4143 | - |
| Y | Y | Y | Y | N | Y | U1U | Texas Instruments/Burr-Brown PCM2707PJT or PCM2706PJT stereo USB DAC | 595-PCM2707PJT or 595-PCM2706PJT | 296-15276-5-ND or 296-15275-ND | 1755016 or 1755015 | 662-5510 or 662-5501 | - |
| Y | Y | Y | Y | N | Y | U2U | Texas Instruments SN74AHC1G08DBVR logic AND gate SOT23-5 | 595-SN74AHC1G08DBVR | 296-1091-1-ND | 1105918 | - | - |
| Y | Y | Y | Y | N | Y | U3U | LP2985AIM5-3.3 or TPS79333DBVR LDO voltage regulator SOT23-5 | 926-2985AIM53.3/NOPB or 595-TPS79333DBVR | LP2985AIM5-3.3/NOPBCT-ND or 296-12961-1-ND | 1469134 or 1470478 | 652-0033 or 661-4490 | - |
| N | N | Y | N | N | Y | U4U | Texas Instruments SN74HCU04D logic hex invertor SOIC-14 | 595-SN74HCU04D | 296-9819-5-ND | 9592148 | - | - |
| N | N | Y | N | N | Y | U5U | Toshiba TOTX147PL fiber-optic transmitter | AMB audio shop | | | | - |
| N | Y | Y | Y | N | N | LEDU | T-1 (3mm) red LED | 604-WP7104ID | 754-1243-ND | 1003206 | 826-515 | - |
| Miscellaneous | | | | | | | | | | | |  |
| Y | N | N | N | Y | Y | T1D | pulse transformer 1:1 | 580-DA101C or 673-PE-65612 | 470-1003-ND or 470-1006-ND | 1362398 | - | - |
| Y | N | N | N | Y | Y | SW1D | NKK G13JVCF bicolor illuminated toggle switch | 633-G13JVCF or 633-G13JVCF-RO | 360-1772-ND | - | 453-7893 | Can use G12JVCF (2-pos) for config E |
| Y | Y | N | N | Y | Y | J1D | DC power jack, 1.3mm center pin, PCB-mount | AMB audio shop | | | | - |
| Y | N | N | N | Y | Y | J2D | RCA jack, PCB-mount | AMB audio shop | | | | - |
| Y | Y | N | N | Y | Y | J3D | 3.5mm miniature stereo phone jack, PCB-mount | AMB audio shop | | | | - |
| Y | Y | N | O | O | O | J2U, J3U | 9P long pin header, break-apart | AMB audio shop | | | | See note 7 |
| Y | Y | N | O | O | O | J4D | 3P pin receptacle | AMB audio shop | | | | See note 7 |
| Y | Y | N | O | O | O | J5D | 5P pin receptacle | AMB audio shop | | | | See note 7 |
| N | O | N | N | N | N | JP1D | 2P short pin header | 517-647-01-36 (break apart) | S1011E-02-ND or S1011E-36-ND (break apart) | 1097955 (break apart) | - | See notes 3, 4 and 6 |
| O | O | N | N | O | O | JP2D | 3P short pin header | 517-647-01-36 (break apart) | S1011E-03-ND or S1011E-36-ND (break apart) | 1097955 (break apart) | - | See notes 1 and 3 |
| N | N | Y | N | N | Y | T1U | pulse transformer 1:1 | 580-DA101C or 673-PE-65612 | 470-1003-ND or 470-1006-ND | 1362398 | - | - |
| Y | Y | Y | Y | N | Y | X1U | HC-49USX 12.000MHz crystal 20pF | AMB audio shop | | | | - |
| Y | Y | Y | Y | N | Y | J1U | Mini-B USB connector, PCB-mount | 538-54819-0519 | WM17115-ND | 9786465 | 515-2005 | - |
| N | N | Y | N | N | Y | J4U | RCA jack, PCB-mount | AMB audio shop | | | | - |
| O | O | O | O | N | O | JP1U | 3P short pin header | 517-647-01-36 (break apart) | S1011E-03-ND or S1011E-36-ND (break apart) | 1097955 (break apart) | - | See notes 3, 4 and 5 |
| N | O | N | O | N | N | JP2U-1 | 2P short pin header | 517-647-01-36 (break apart) | S1011E-02-ND or S1011E-36-ND (break apart) | 1097955 (break apart) | - | See notes 3 and 4 |
| N | O | N | O | N | N | JP2U-2 | 2P short pin header | 517-647-01-36 (break apart) | S1011E-02-ND or S1011E-36-ND (break apart) | 1097955 (break apart) | - | See notes 3 and 4 |
| N | O | N | O | N | N | JP2U-3 | 2P short pin header | 517-647-01-36 (break apart) | S1011E-02-ND or S1011E-36-ND (break apart) | 1097955 (break apart) | - | See notes 3 and 4 |
| Y | Y | Y | O | Y | N | Hammond Enclosure | 1455C802 or 1455C802BK or 1455C801 or 1455C801BK or 1455C801BU or 1455C801RD | 546-1455C802 546-1455C802BK 546-1455C801 546-1455C801BK 546-1455C801BU 546-1455C801RD | HM970-ND - HM969-ND 1455C801BK-ND 1455C801BU-ND - | 4272936 9287906 4272810 9287787 2361583 - | 458-0730 773-3047 613-8353 773-2956 - - | - |
| N | N | N | N | N | Y | Box Enclosure | B2-080BK or B2-080BL or B2-080GD or B2-080GR or B2-080RD or B2-080SI | - | - | 1015173 1015174 1418582 1418583 1015176 1015172 or 1549967 | 2508349218 2508349224 2508349230 2508349246 2508349252 2508349202 | [Newark](https://www.amb.org/cgi-bin/redir.cgi?t=http://www.newarkinone.com/) 26K9019 26K9020 26K9021 26K9022 26K9023 26K9024 |
| O | O | N | N | Y | O | Power supply | regulated AC adapter, 5VDC 300mA+, 1.3mm plug, center-positive | See "AC adapter or power supply" section below | | | | - |
| O | O | O | O | O | O | - | 2P jumper shunts | 649-68786-202LF (single) | S9001-ND (10-pack) | 1097979 (10-pack) | - | See note 4 |
| Y | Y | Y | Y | N | Y | - | USB-A to Mini-B cable | 562-3021003-03 or 538-68806-0019 | - | - | - | or buy locally |
| O | O | O | O | O | O | - | imperial #6-32 or metric M3.5 flat-head socket cap screws (for front and rear panel) | - | - | - | - | [McMaster-Carr](http://www.mcmaster.com/) or local hardware store |

#### Notes

See the parts list table above, which refer to specific notes here.

1. This part may be omitted if the USB board will never be attached to the DAC board, or if you want to hardwire for external DC power or USB power only (See jumper settings in the [instructions](https://www.amb.org/audio/gamma1/instructions.shtml) section). Omitting these parts is not recommended. U1D provides controlled voltage ramp-up during turn-on and current limiting protection that would be defeated if it's not used.
2. Straighten formed capacitor leads to fit if necessary.
3. If you use the "break apart" 36P pin headers and receptacles, only one of each type is enough for all positions.
4. If you don't plan to change jumper settings, there is no need to populate the jumper positions with pin headers and jumper shunts. You may leave an "open" jumper completely unpopulated, and you can solder a piece of clipped resistor lead to make a "shorted" jumper. See "Jumper settings" in the [instructions](https://www.amb.org/audio/gamma1/instructions.shtml) section for details.
5. If you plan to mate your γ1 board to a [γ2](https://www.amb.org/audio/gamma2/) board, you should hard-wire JP1U with a clipped resistor lead. Do not use a jumper block and pluggable shunt, because they will not fit when the two boards are mated.
6. If your γ1 is a Full (A), S/PDIF-only (E) or Full++ (F) configuration, and you will be mating it to a γ2 board, then you should install the "leftover" pin from the supplied 9P pin header in JP1D pin 2. This will mate with γ2's J3 receptacle.
7. Also required if mating to a γ2 board.

### Parts selection guide

Due to the tight spacing within the enclosure, and to ensure proper fit when the DAC and USB boards are plugged into each other, please observe the following recommendations. Do not use oversized parts or mount parts in a manner that was not intended. Since the γ1 is mostly a digital circuit, with the exception of the output coupling capacitors, there is no benefit to using "boutique grade" parts. Also, do not substitute parts values unless you know what you're doing. Many of the parts are carefully selected and tuned for optimum operation.

#### Resistors

All discrete resistors (except the resistor networks R5D, R6D and R7D) are miniature through-hole axial-lead types with a body length no longer than about 4mm (the recommended Xicon, Panasonic and Multicomp resistors are 3.5mm or 3.2mm), and no wider than 1.9mm. Metal film or thin film 1% resistors are recommended for their thermal stability.

* Xicon [MF-RC 270 series](https://www.amb.org/cgi-bin/ds.cgi?c=resistors&f=xicon-mf-rc)
* Vishay-Beyschlag [MBA 0204 series](https://www.amb.org/cgi-bin/ds.cgi?c=resistors&f=vishay-beyschlag_thin_film_leaded)
* Vishay-Dale [RN50 series](https://www.amb.org/cgi-bin/ds.cgi?c=resistors&f=vishay_dale_cmf_military)
* Vishay-Dale [CMF50 series](https://www.amb.org/cgi-bin/ds.cgi?c=resistors&f=vishay_dale_cmf_industrial)
* Vishay-BC [SFR16S series](https://www.amb.org/cgi-bin/ds.cgi?c=resistors&f=vishay-sfr16s)
* Stackpole [RN 1/8 or RNM 1/4 series](https://www.amb.org/cgi-bin/ds.cgi?c=resistors&f=stackpole-RNF_RNMF)
* Multicomp [MF12 series](https://www.amb.org/cgi-bin/ds.cgi?c=resistors&f=multicomp-mf)
* Koa-Speer [MFS1/4C series](https://www.amb.org/cgi-bin/ds.cgi?c=resistors&f=koa-speer_MF_MFS_RK)
* other similar

R5D and R6D are SIP-6 "bussed" resistor networks, each with five internal resistors, one pin of each of them are connected to a common bus. R7D is a SIP-8 "isolated" resistor network, with four independent internal resistors. The lead pitch is 0.1" (2.5mm) for all of these.

* Bourns [4600X series](https://www.amb.org/cgi-bin/ds.cgi?c=resistors&f=bourns-4600x_resistor_network)
* Bourns [4300R series](https://www.amb.org/cgi-bin/ds.cgi?c=resistors&f=bourns-4300r_resistor_network)
* other similar

#### Capacitors

There are four types of capacitors used in the γ1: conductive polymer electrolytic, audio-grade electrolytic, film and multi-layer ceramic.   
  
C6D, C10D and C8U are conductive polymer electrolytic type for their ultra low ESR characteristics. They are through-hole with radial leads, 2.5mm lead-pitch, a maximum diameter of 6.3mm and a maximum height of 12.5mm.

* United Chemi-Con [PSA](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=united_chemicon-PSA)
* Nichicon [PLF](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=nichicon_plf)
* other similar

C22D, C24D and C25D are "audio grade" electrolytic capacitors. They are through-hole with radial leads, 2mm or 2.5mm lead pitch, a maximum diameter of 6.3mm and a maximum height of 12.5mm. C24D and C25D are the DAC's analog output coupling capacitors. See the film capacitor descriptions below for C24D/C25D options. If you plan to drive headphones directly from the γ1, then you should use Nichicon KW or FW 470µF 6.3V or 10V capacitors to avoid low-frequency roll-off. Note that some of these "for audio" electrolytic capacitors are non-polarized.

* Elna [RFS](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=elna_RFS_silmic2) (Silmic II)
* Nichicon [ES](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=nichicon_es) (Muse)
* Nichicon [KW](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=nichicon_kw)
* Nichicon [FW](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=nichicon_fw)
* Rubycon Black Gate NX Hi-Q
* Panasonic [AK](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=panasonic_AK)
* Elna ARD(ROD) (Starget)
* CapXon [NK](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=capxon_NK)
* other similar

C26D, C27D, C29D and C11U are through-hole, radial-lead 1µF "box"-style film capacitors with a lead spacing of 5mm. You may use metallized polyester (MKT or MKS) types (or metallized polypropylene (MKP) in a lower capacitance for C26D and C27D), but be sure that the footprint is no larger than 7.5mm x 5.5mm and the maximum height is 12.5mm. C26D and C27D are "bypass" capacitors for the C24D and C25D audio-grade electrolytic output coupling capacitors. Depending on your preference, you may omit C26D/C27D and run C24D/C25D unbypassed, or you may omit C24D/C25D and run C26D/C27D alone (but increase their capacitance of C26D/C27D to 3.3µF or higher to avoid low-frequency rolloff and phase shift within the audio band). If you choose the latter option, the Wima MKS2 3.3µF 50V or 4.7µF 16V capacitors are the only known ones that would fit.

* Wima [MKS2](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=wima-mks2)
* Vishay-BC [MKT370](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=vishay_bc_mkt370)
* Vishay-Roederstein [MKT1817](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=vishay_roederstein-mkt1817)
* Wima [MKP2](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=wima-mkp2)
* other similar

All remaining capacitors are multi-layer ceramic type, with through-hole, radial-leads and 2.5mm lead-spacing. Some capacitors have 2.5mm pitch leads but come pre-bent to 5mm, you must straighten them to fit the board. The TDK FK24 series 1µF multi-layer ceramic capacitor specified have smaller size and lower profile than most others of comparable specifications, ensuring that they will fit without hitting other parts when the DAC and USB boards are mated.   
  
C4U and C5U are C0G/NP0 grade, which provides the best thermal stability and is important for the crystal oscillator circuit. C18D is also C0G/NP0 but all other multi-layer ceramic capacitors are X7R grade because C0G/NP0 is only available in small capacitances. Do not use Z5U, Y5V or other lower grades.

* Kemet [C315 or C320 series](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=kemet-multilayer_ceramic)
* TDK [FK24](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=tdk_fk)
* Vishay [Mono-Kap](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=vishay-mono-kap)
* AVX [Skycap-SR](https://www.amb.org/cgi-bin/ds.cgi?c=capacitors&f=avx_skycap-sr)

#### Inductors and ferrite beads

L1D and L3U are miniature 47µH through-hole axial-lead inductors with a maximum body length of about 4mm and no wider than 2.3mm. L2D, L3D, L4D, L1U and L2U are through-hole ferrite beads.

* L1D, L3U: JW Miller [79F470K-TR-RC](https://www.amb.org/cgi-bin/ds.cgi?c=transformers_inductors_filters&f=jwmiller_79F) (available from AMB audio shop)
* L2D, L3D, L4D, L1U, L2U: Panasonic [EXC-ELSA35](https://www.amb.org/cgi-bin/ds.cgi?c=transformers_inductors_filters&f=panasonic_EXCEL) (available from AMB audio shop)

#### Pulse transformers

A 1:1 pulse transformer is used for T1D and T1U. The recommended transformers are as follows:

* Murata [DA101C](https://www.amb.org/cgi-bin/ds.cgi?c=transformers_inductors_filters&f=murata_DA101_series)
* Pulse [PE-65612](https://www.amb.org/cgi-bin/ds.cgi?c=transformers_inductors_filters&f=pulse_PE-65612)
* Newava [S22083](https://www.amb.org/cgi-bin/ds.cgi?c=transformers_inductors_filters&f=newava_S22083)
* Newava [S22133](https://www.amb.org/cgi-bin/ds.cgi?c=transformers_inductors_filters&f=newava_S22133)

#### Semiconductors

The integrated circuits in the parts list table above should be used, with alternatives as specified below. Some ICs come in several package styles, be sure to use the correct ones that the board is designed for.   
  
The default U3D stereo DAC chip is Wolfson WM8501GED/V which outputs 1.5Vrms at 0dBFS when the supply voltage is 4.5V. The Wolfson WM8759GED/V is pin-compatible and may be substituted, but the output voltage is 1Vrms under the same conditions. It is otherwise identical to WM8501GED/V.   
  
For U1U, the "technically-correct" USB DAC chip is the PCM2707PJT. The PCM2706PJT has the same TQFP-32 package, but several pins have different functions. These pins are unused in the γ1, thus the PCM2706PJT may be substituted and will function correctly.   
  
You may use either the LP2985 series or the TPS793xx series LDO voltage regulators for U5D, U6D and U3U, as shown in the parts list table above.   
  
For U4D, you may use MCP100 or DS1818 in TO-92 package. Each of these come in several "threshold voltage" variants. It is recommended that you use the 3.15V or 3.00V versions if available (see their datasheets for the meaning of the part number suffix). Similarly for U9D, the options are MCP101 or DS1817.   
  
The Q1D and Q2D transistors are specified to be 2N3904, but you may subtitute them with just about any NPN TO-92 transistor with the same pin-out. Some examples are 2N4401, PN2222, 2N5088 or MPS8099 just to name a few.   
  
Use a T-1 (3mm) high brightness red LED for LEDU. You may also use green or yellow, but do not use blue or white, because blue or white LEDs typically require around 4V or more and we only have 3.3V here. If you get insufficient brightness, decrease the value of R7U. The default value of 560Ω will run 2.7mA through a red LED, which usually has a forward voltage of around 1.8V. If you change R7U's value, do not exceed 10mA to keep the USB power consumption reasonable. Use this [online LED resistor value calculator](https://www.amb.org/cgi-bin/redir.cgi?t=http://www.muzique.com/schem/led.htm).

* U1D: Texas Instruments [TPS2115APW](https://www.amb.org/cgi-bin/ds.cgi?c=power_management&f=TPS2115A) (TSSOP-8)
* U2D: Cirrus Logic [CS8416-CSZ](https://www.amb.org/cgi-bin/ds.cgi?c=digital_audio&f=CS8416) (SOIC-28)
* U3D: Wolfson [WM8501](https://www.amb.org/cgi-bin/ds.cgi?c=digital_audio&f=WM8501) or [WM8759](https://www.amb.org/cgi-bin/ds.cgi?c=digital_audio&f=WM8759) (SOIC-14)
* U4D: Microchip [MCP100](https://www.amb.org/cgi-bin/ds.cgi?c=misc&f=MCP100) or Maxim/Dallas [DS1818](https://www.amb.org/cgi-bin/ds.cgi?c=misc&f=DS1818) (TO-92)
* U5D, U3U: Texas Instruments [LP2985AIM5-3.3](https://www.amb.org/cgi-bin/ds.cgi?c=voltage_regulators&f=LP2985) or Texas Instruments [TPS79333DBVR](https://www.amb.org/cgi-bin/ds.cgi?c=voltage_regulators&f=TPS793xx) (SOT23-5)
* U6D: Texas Instruments [LP2985AIM5-4.5](https://www.amb.org/cgi-bin/ds.cgi?c=voltage_regulators&f=LP2985) or Texas Instruments [TPS793475DBVR](https://www.amb.org/cgi-bin/ds.cgi?c=voltage_regulators&f=TPS793xx) (SOT23-5)
* U7D: Toshiba [TORX147PL](https://www.amb.org/cgi-bin/ds.cgi?c=digital_audio&f=TORX147PL) or Everlight [PLR135/T10](https://www.amb.org/cgi-bin/ds.cgi?c=digital_audio&f=PLR135_T10_toslink_rx) or Sharp [GP1FMV31RK0F](https://www.amb.org/cgi-bin/ds.cgi?c=digital_audio&f=sharp_gp1fmv31rk_e)  
  Note: Sharp module compatible with γ1 PCB v1.01 and later only
* U8D: Texas Instruments [SN74AHC1G02](https://www.amb.org/cgi-bin/ds.cgi?c=logic&f=SN74AHC1G02) (SOT23-5)
* U9D: Microchip [MCP101](https://www.amb.org/cgi-bin/ds.cgi?c=misc&f=MCP101) or Maxim/Dallas [DS1817](https://www.amb.org/cgi-bin/ds.cgi?c=misc&f=DS1817) (TO-92)
* U1U: Texas Instruments/Burr-Brown [PCM2707PJT or PCM2706PJT](https://www.amb.org/cgi-bin/ds.cgi?c=digital_audio&f=PCM2707) (TQFP-32)
* U2U: Texas Instruments [SN74AHC1G08](https://www.amb.org/cgi-bin/ds.cgi?c=logic&f=SN74AHC1G08) (SOT23-5)
* U4U: Texas Instruments [SN74HCU04](https://www.amb.org/cgi-bin/ds.cgi?c=logic&f=SN74HCU04) (SOIC-14)
* U5U: Toshiba [TOTX147PL](https://www.amb.org/cgi-bin/ds.cgi?c=digital_audio&f=TOTX147PL) or Everlight [PLL133/T10W](https://www.amb.org/cgi-bin/ds.cgi?c=digital_audio&f=PLT133_T10W_toslink_tx) or Sharp [GP1FMV31TK0F](https://www.amb.org/cgi-bin/ds.cgi?c=digital_audio&f=sharp_gp1fmv31tk_e) or Sys Concept [DLT1151A](https://www.amb.org/cgi-bin/ds.cgi?c=digital_audio&f=DLT1151A)
* Q1, Q2: [2N3904](https://www.amb.org/cgi-bin/ds.cgi?c=transistors/bipolar&f=2N3904) or similar (TO-92)
* LEDU: high brightness red LED, your choice (T-1, 3mm)

#### Connectors

* J1D: CUI [PJ-053DH](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=cui_PJ-053DH) DC power jack, PCB-mount 1.3mm center pin
* J2D, J4U: CUI [RCJ-041](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=cui_RCJ-04X) RCA jack, PCB-mount (a gold plated version of this is available from AMB audio shop).
* J3D: CUI [SJ1-3533NG](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=cui_SJ1-3533NG) 3.5mm stereo mini phone jack, PCB-mount
* J4D: 3P single-row pin receptacle (available from AMB audio shop)
  + Sullins [PPPC031LFBN-RC](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=sullins_pin_receptacle)
  + 3M [929850-01-08-30](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=3M_929_series_socket) (break-apart)
  + Multicomp [2212S-03SG-85](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=multicomp-2212S-0xSG-85_pin_receptacles)
* J5D: 5P single-row pin receptacle (available from AMB audio shop)
  + Sullins [PPPC051LFBN-RC](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=sullins_pin_receptacle)
  + 3M [929850-01-08-30](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=3M_929_series_socket) (break-apart)
  + Multicomp [2212S-05SG-85](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=multicomp-2212S-0xSG-85_pin_receptacles)
* J1U: Molex [54819-0519](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=molex_miniusb_b_pcbmount_54819-0519) Mini-B USB connector, PCB-mount
* J2U, J3U: 3M [929705 series](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=3M_929_series_header) 9P single row pin header, 0.318" mating length.(available from AMB audio shop)

#### Chassis / case

The γ1 is designed specifically for the Hammond 1455C80x series extruded aluminum cases.   
The γ1 full++ configuration (F) uses the Box Enclosures B2-080 series extruded aluminum case.

* Hammond [1455C801](https://www.amb.org/cgi-bin/ds.cgi?c=enclosures_cases&f=hammond_1455C801) anodized with aluminum end-panels   
  The default color is silver. Add BK suffix for black, BU suffix for blue, or RD for red.
* Hammond [1455C802](https://www.amb.org/cgi-bin/ds.cgi?c=enclosures_cases&f=hammond_1455C802) anodized with plastic end-caps   
  The default color is silver. Add BK suffix for black.
* Box Enclosures [B2-080](https://www.amb.org/cgi-bin/ds.cgi?c=enclosures_cases&f=box_B2-080) anodized with aluminum end-panels  
  Add the following suffix to specify the color:  
  BK - black  
  BL - blue  
  GD - gold  
  GR - green  
  RD - red  
  SI - silver  
  Box enclosures are available from [Newark](https://www.amb.org/cgi-bin/redir.cgi?t=http://www.newark.com), [Farnell](https://www.amb.org/cgi-bin/redir.cgi?t=http://www.farnell.com) and [RS Components](https://www.amb.org/cgi-bin/redir.cgi?t=http://www.rs-online.com).

#### AC adapter or power supply

A 5V DC *regulated* AC adapter ("wallwart") or external 5V DC *regulated* power supply may be used to provide power to any γ1 configuration equipped with U1D and the 1.3mm DC power jack.   
  
The AC adapter or power supply's output plug should be a barrel-type with 1.3mm ID female, the polarity is center-positive. A compatible plug for the 1.3mm DC power jack is the CUI [PP3-002D](https://www.amb.org/cgi-bin/ds.cgi?c=connectors_sockets&f=cui_PP3-002D) (Digi-Key CP3-1003-ND).   
  
The appropriate input AC mains voltage, frequency and plug style depends on your country. The output voltage should be between 4.85V and 5.4V DC, with a minimum current capacity of 300mA.   
  
A *linear* regulated power supply is preferred over a switching type for lowest noise. You may purchase one that is pre-built, or build your own.   
  
The [σ25 regulated power supply](https://www.amb.org/audio/sigma25/) is a suitable DIY option, and offers clean, linear-regulated power. For the γ1 (and γ2 upgrade), set up the σ25 to output 5V DC, and use a 2.8VA or higher power transformer with 9V secondary. The following is a partial sampling of such transformers:

|  |  |  |  |
| --- | --- | --- | --- |
| Transformer | Primary voltage | Vendor and part number | Notes |
| Pulse BV030-7597.0 2.8VA EI-30 | 115V | Digi-Key 567-1040-5-ND | For γ1/γ2, mount on [σ24 board](https://www.amb.org/audio/sigma24/) |
| Pulse BV030-7585.0 2.8VA EI-30 | 230V | Digi-Key 567-1042-5-ND | For γ1/γ2, mount on [σ24 board](https://www.amb.org/audio/sigma24/) |
| Myrra 44698 2.8VA EI-30 | 230V | Farnell 1689068 | For γ1/γ2, mount on [σ24 board](https://www.amb.org/audio/sigma24/) |
| Pulse BV030-7151.0 1.5VA EI-30 | 115V | Mouser 673-030-7151-0 | For γ1 only, mount on [σ24 board](https://www.amb.org/audio/sigma24/) |
| Amveco/Talema 62011 3.2VA toroidal | 115V/230V | Allied 70065727 or Digi-Key 1295-1105-ND | For γ1/γ2 |
| Amveco/Talema 62021 5VA toroidal | 115V/230V | Allied 70065733 or Digi-Key 1295-1110-ND | For γ1/γ2 |

The [σ11 regulated power supply](https://www.amb.org/audio/sigma11/) is another DIY alternative, providing the best in low-noise, high-current performance. It is more costly and complex than σ25 but merits consideration if you're also building the γ2 upgrade. See the σ11 website for details.