Carlson SuperProbe2 PCB Kit Assembly

MK0 Kit with NO PARTS
MK1 Kit with 29 Parts
MK2 Kit Improved with 37 Parts
MK1ASM Kit with Assembled & Tested PCBs
MK2ASM Kit with Assembled & Tested PCBs

This is an advanced SMD skill PCB build. Please take your time!

Introduction
First, thanks for purchasing this kit. Our original implementation of the SuperProbe followed the exact circuit design by Paul Carlson as laid out by Yannick99 in 0805 SMD components. This SuperProbe2 design follows the original Carlson design except for three improvements:

1. The POP noise LED is powered by a 4th cable wire allowing a constant LED supply voltage.
2. The POP noise LED driver is changed to a N-channel MOSFET for improved drive performance.
3. An additional emitter-follower output buffer is added to the amplifier PCB for optionally driving a meter or scope or external amplifier.

The SuperProbe2 PCBs have several changes for improved assembly.

1. Both PCBs have SMD devices horizontally oriented to minimize PCB rotation during component attachment.
2. The Probe PCB now has 4 through-holes for cable attachment.
3. The POP noise LED is oriented for easier assembly.
4. The amplifier PCB has absorbed components and connections that previously were external.
    a. The R7 POT overload incandescent lamp is not mounted on the PCB.
    b. The amplifier power switch has dedicated terminals on the PCB.
    c. The amplifier power LED has its ballast resistor and dedicated terminals on the PCB.
    d. The audio new output driver has dedicated terminals on the PCB.
    e. The amp/probe 4-wire cable has dedicated (4) through-hole connections on both PCBs.
    f. The amplifier has multiple dedicated power and ground connections on the PCB.

Each of these improvements should make assembly and testing easier with fewer potential errors.

These instructions cover five versions of the SuperProbe2; namely kits MK0, MK1 & MK2, MK1ASM, MK2ASM.

- **MK0** – Just the bare PCBs for the amplifier and probe. For the DIYer who wants to source all of the parts and packaging independently. Herein is a complete parts list with sufficient information to source parts from DigiKey, Mouser or others. Photos and diagrams provide examples of what can be done to complete the probe, including housings for the amplifier and probe head.

  You have the option of building the PCBs using Carlson's original schematic and components, or implementing any of the enhancements described in these instructions. Consult and follow the schematics to implement your choice of options.

- **MK1** – Includes all of the components needed to populate the amp & probe PCBs plus the outboard POTs, including adequate spare parts. No power supply components are included. In addition to sourcing an amplifier and probe case, you will need a power source using primary or rechargeable batteries <5.5VDC, 2W 4-ohm speaker, coaxial probe tip etc.

The MK1 assembly sequence implements all of the improvements described in these instructions. Sufficient components are provided to construct the PCBs without the improvements and adhere strictly to Carlson's original schematics.

- **MK2** – Includes everything from the MK1 kit and adds most of the peripheral and construction hardware for completing a SuperProbe2 except for cases, speaker and power source. This kit includes the following:
    - MK1 kit
    - Power toggle switch
    - Power LED
    - Coax probe tip wire
    - 22 ga insulated construction wire
    - Heat shrink insulation
    - POT knobs
    - 4-wire multi-wire signal cable with integral 4-wire 3.5mm plug
    - 4-wire signal 3.5mm jack
    - 2-wire audio output 2.5mm jack

  As with the MK1 kit, the MK2 assembly sequence implements all of the improvements described in these instructions. Sufficient components are provided to construct the PCBs without the improvements and adhere strictly to Carlson's original schematics.

- **MK1ASM** – This kit is identical to the MK1 kit except that the 2 PCBs are fully assembled and tested, and implement all of the improvements described herein. As with the MK1 kit, numerous other components are required to complete the SuperProbe2. In addition to sourcing an amplifier and probe case, you will need a power source using primary or rechargeable batteries <5.5VDC, 2W 4-ohm speaker, coaxial probe tip, cabling, connectors, etc.

- **MK2ASM** - This kit is identical to the MK2 kit except that the 2 PCBs are fully assembled and tested, and implement all of the improvements described herein. As with the MK2 kit, you will need to source cases, speaker and power supply.

Preconstruction Tips

Before beginning the kit assembly, it would be beneficial to review this set of instructions as well as several resources found on the internet. In particular are Carlson's original YouTube videos and several other independent build descriptions.

- Carlson's video: https://www.youtube.com/watch?v=uVkJqqZroN0
- Yannick99 Instructable: https://www.instructables.com/Carlsons-Super-Probe/
- DIY Thru-hole design: https://stufinnis.co.uk/superprobe.html
- EEVBlog: https://www.eevblog.com/forum/oshw/paul-carlsons-super-probe/

Version 2 Kit Building Improvements and Options

Carlson made several compromises in the original design in order to reduce the number of different components and simplify the overall design. We have made several improvements to facilitate assembly and improve functionality:

- Gain POT protection lamp – Carlson located this "fuse" lamp in the POT wiper circuit so as to protect the POT element in the event that the power wire to the probe accidently became grounded when plugging/unplugging the cable. The 1730 6V 40mA incandescent lamp is small and delicate, making offboard mounting in the amplifier case problematic. There is nothing special about the original location of the lamp, and it would be better for assembly if it was located on the amplifier PCB. Therefore, we have repositioned the lamp between R7 pin 1 and the primary VCC power, and located the lamp in the center of the PCB.
- The original SMD PCBs used surface pads for most of the connections to the amp and probe PCBs. This can be problematic when multiple wires need a connection to the same pad. In the SuperProbe2 PCBs, most connections from the PCBs to off-board components now have a dedicated one-to-one through-hole mounting point, including connections for a power switch, power LED, and audio.
- Unlike the original SMD PCBs, SuperProbe2 PCBs now have all of the SMD components oriented horizontally to facilitate easier SMD assembly under a microscope. No more rotating of the PCBs to attach 4-5 identical components!

- The POP noise LED has been a compromise for simplicity. Unlike the rest of the probe circuit that operates on microamps, the LED needs at lease a few milliamps or more for good visibility. But the collector supply was fed from the same gain control POT as the rest of the probe. Therefore, at anything other than full gain, there was a decreasing voltage available to drive the LED. We now wire the LED from a fixed supply that is independent of the probe supply through a 4-wire cable and appropriate 4-pin plug & jack. (We provide the ability to wire the probe in the older original configuration, but do not recommend it. Since the kit is wired with 4-wire cabling, either method can be assembled. (Use either R14 (1K) on the probe PCB or R10 (1K) on the amplifier PCB, ***but not both!***)
- The original POP LED 2N3904 drive transistor, T5, is a medium beta device of 100-200 current gain. It is difficult to fully turn on T5 with the pulses passed through C9 (360pF). We have replaced the T5 2N3904 bipolar device with a 2N7002 N-channel MOSFET. We find that, under most conditions, this MOSFET can be pulse driven to higher conduction than the BJT and produces brighter LED flashes. R17 (20Meg) was added to insure a known impedance to ground on the MOSFET gate.
- The amplifier PCB transistor T2 is a simple buffer of the input to the LM4871 to provide a DC coupled audio output for viewing on a scope or multimeter. When in use, it is important to consider the attached instrumentation and the effect of ground loops. ***This is both a noise issue and a potential safety issue. Be sure you understand the implications of interconnecting other equipment containing earth grounds. Also, since this output is DC coupled, avoid shorting the audio output leads, as this will overheat T2 with excess current.***

Assembly

The PCB parts are almost exclusively SMD 0805/1206/SOT23 size components, and will require a skill level and tool set commensurate with these parts. Some form of microscope is also highly desirable for assembly and inspection. The new probe PCB has 3 #0-80 mounting holes located in ground pads, but you will have to use your own creativity to fashion the complete probe housing. The 2 pads on top next to the probe tip input are grounded to the back-plane. Use these for reinforcing the tip support (see photos). At the 4-wire cable end there is a ground pad on the top, as well as a 4-terminal thru-hole connector for 4-wire cabling. Check and re-check your cable connections to the PCBs, jack and plug terminals to assure no connections are mixed up.

There are up to 37 different components shared between the two PCBs (depending on the kit), each in its own plastic bag (including wire & shrink tube). They are numbered and labeled to match the parts list. I recommend sorting the poly bags by number so you don't lose track of any. For a sane and successful assembly, **DO NOT OPEN MORE THAN ONE BAG AT A TIME!** I don't think that there is a good or bad sequence to the assembly, and you do not need to follow the bag numbering. But you had best attach all of one type of component to both PCBs before opening another bag, and check off the parts on the PROBE & AMP *part lists* (Tables #2 & 3) as you go. (For most components, there are 1-3 extras, but not for the expensive parts!)

Use a good quality clean or no-clean liquid or gel flux. But clean your assembly with soap & water, IPA or acetone (as appropriate for the flux used). Pay particular attention to the amplifier PCB T5 MOSFET. Flux residue is generally conductive, and dross around T5 will cause gate-ground leakage (bad). Use caution in washing the probe PCB switch & pot. We recommend mounting these thru-hole components last and then hand-cleaning.

Only 3 components are polarized (5 - 22uF caps, 1 - Schottky diode & 1 - LED). Look closely at the pictures and schematics where we have added "+" marks and arrows indicating component ***band*** positions. In particular, note that the Schottky diode banded end should point ***toward*** transistor T5's base pin and C9. It is easy to get this wrong.

R16 (10K) in the output EF (T6) of the probe PCB is not normally installed. But if you choose to test or use the probe PCB as a stand-alone circuit you will need this to bias the output emitter follower. Then you can drive any audio amplifier through its input filtering network.

The amplifier PCB speaker circuit ***is NOT grounded***, so take care that you never let a speaker lead touch the common or it may permanently damage the LM4871 chip.

4-Wire Cabling

We have provided the advanced (MK2/MK2ASM) kits with 4-wire interfacing cables, jacks and plugs. We recommend using the 4th wire POP LED power configuration for all assemblies, installing the 1000-ohm LED ballast resistor as R10 on the AMP PCB and NOT installing R14 on the probe PCB. (The pre-assembled PCBs are already wired this way.) I reiterate, pay close

attention to the wiring of the amplifier jack *tip, ring1, ring2 & gnd*. *Note down the color code of the cable plug tip, ring1, ring2 & ground and wire the cable to the probe PCB to match the amplifier*.

For those building the MK0, MK1 or MK1ASM SuperProbe2, you can follow these instructions to use the 4-wire interface design using the parts list to source from Amazon, Mouser, Digi-Key, or use a 3-wire interface utilizing stereo cabling and jacks. In the latter case install the 1K-ohm resistor at R14 on the probe PCB and NOT R10 on the AMP PCB.

Amplifier Audio Output

You have the option to install a signal buffer and external *audio output* driver on the amplifier PCB. This will allow viewing the noise signal on a meter or oscilloscope. ***Do keep in mind with this addition that the probe and amplifier become grounded to the earth mains within certain mains connected equipment. Standard safety precautions must be observed!*** To use this feature, install transistor T2 and resistor R11 (1Kohm) on the amp PCB. Connect the ***AO*** terminals to an appropriate connector on the case such as an RCA jack or 2.5mm mono-jack (observing the proper polarity.)

Protection Incandescent Lamp

This lamp is now PCB mounted. When the PCB is completed and cleaned, we recommend adding a dab of RTV glue or similar to hold the lamp fixed.

Testing

Because this kit is only part of the complete SuperProbe2, there are many ways of testing each PCB. Check the power rail for shorts or very low resistance and compare to the schematic data tables. Check for bridged solder joints. Use a current limited supply or series resistance and measure power supply current. The probe PCB draws only hundreds of micro amps, while the amp PCB noticeably more with the speaker attached. If you have problems with the SuperAmp, check your power supply connections and contacts. The LM4871 requires 100-200 mA to power up, where it then idles at 10-20mA. A poor power supply will cause motor-boating where the amp repeatedly powers up and down. The SuperAmp schematic shows the expected DC node voltages with VCC=4.2V. (The LM4871 can operate up to 5.5VDC.)

Case & Housing Options

Almost anything can be used to house the amplifier, and we have included a quality 3.5mm stereo jack & plug for probe interconnection. The amplifier can be powered using 4.2-5.5VDC from a variety of sources. But 4-AA batteries are the limit for the integrated power IC in the amplifier. Do stick with some form of 4 ohm 2 watt speaker, as reviewers have complained about performance with other speakers.

The probe case ***must*** be all metal and connected to the ground plane of the probe PCB (bottom), the shield of the wire probe tip and common of cable to the amplifier. A bare metal probe case can be a hazard around high-voltage circuits. Use insulation and safety techniques any time the supply voltage within the equipment under test is greater than 40-50VDC.

You can use just about anything for the actual probe tip wire. I use some 1/8” semi-rigid copper coax. (Included with MK2 kit.) Just insure that only about 1/16” of the tip of the wire has the shield removed. (This tip can be re-insulated.) Use the photos to guide the construction of the probe tip. The idea is to flair out part of the shield to function as a ground and support on the PCB bottom. The center conductor is trimmed to solder to the input pad.

We also offer a ***Case Kit*** and a ***Stainless-Steel Probe Housing Kit*** (when available). The former, shown in some of the pictures, provides a machined ABS case, 800mAH Li-Poly battery and charger, charging cable & 4-ohm speaker. The latter includes a 1” dia SS machined split case and mounting hardware for the probe PCB.

- CaseKit https://www.hwcz.com/phpSP/MCSP_CaseKit.php
- SS Probe Kit https://www.hwcz.com/phpSP/MCSP_MK3.php

Component Availability

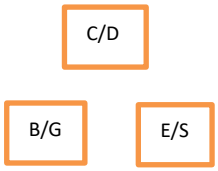
The 6V-40mA 1730 lamp is no longer manufactured as of 11/2024. While we have a reasonable supply on hand, they are becoming hard to obtain. To be effective, 5-6V 30-50mA bulbs are required. Typical 8-12V bulbs ***will not develop sufficient joule resistance to offer protection.*** Bulb testing @ 6VDC is the only practical way to identify usable lamps. At 4.5-5V the lamp should dimly glow at 30-50mA.

The original POP noise LED specified (SSL-LX3054SRD) is EOL so our kits have switched to the TLLK4401 from Vishay. This LED has excellent luminescence and angular viewing at low current.

Capacitors, particularly the Tantalum and high-value multi-layer ceramic devices go in and out of supply frequently. The SuperProbe2 circuits are quite able to work with various device tolerance parameters. It is unlikely the SuperProbe2 will be subject to -55C or 125C, nor are 10-15% thermal variation an issue. This means 10-20% capacitors are fine. The choice of dielectric material can greatly influence prices, so stick to class 2 dielectric such as X5R, X7R, X8R and be cost conscious. There is no clear need for COG (NP0) dielectric devices.

All of the resistors are one form or another of thick-film ceramics. Nothing more accurate than 5% tolerance is needed, though 1% is generally available at comparable prices.

The 2N3904 BJT and 2N7002 MOSFET devices are readily available, but case codes vary depending on footprint pinouts. It is imperative that the correct footprint device is installed. This little drawing shows the top-down footprint for ***ALL*** transistors.



All of the SMD footprints for the transistors are SOT23 with 75mil B-E center spacing. Please be aware that SOT323, a very similar footprint, has a 50mil spacing that will make the transistor SMD assembly a bit challenging. (They will fit, but just barely.)

Master Poly-package Part List

The following list in **Table – 1** indicates all of the parts included in the kits. The GREEN (or shaded) backgrounds are the preferred kit component part numbers. We have also indicated both the required component count (total both PCBs) and the included kit component count, so you can lose a component or two in some cases. ***Each package contains ALL parts of a particular type and are fitted to the amp & probe PCBs according to the schematic reference designators for each PCB. For instance Poly-package 2 contains 6-22uF caps, 2 for C2/C6 on the amp PCB & 3 for C2/C5/C7 on the probe PCB, with 1 extra. Note that reference designators are NOT unique across the 2 PCBs!***

Before Applying Power the First Time

Before applying power, it is well worth checking resistances to ground from various nodes and comparing to the schematic. In particular, check the potentiometer terminals for shorts. While the incandescent lamp will protect the R7 pot during normal operation, wiring or soldering shorts can damage the pots.

Re-check the wiring of the 4-wire jacks, plugs & cabling between the amplifier and the probe. It is easy to get the connections mixed up. To re-cap, the table below is the pin assignment for the currently supplied cable and jack:

Cable & Jack Wiring			
Schematic Pins	Pin Name	Cable Coloring	Jack Pin
1	sleeve	Black	M
2	tip	red	2
3	ring 1 (outer)	white	3
4	ring 2 (inner)	green	4

Table 1 – Combined Parts List with Bag Numbers

SuperProbe2 Kit MK1(29) or MK2(37)			12/31/2025	V5.3				
bag line #	*desc*	*part #*	*alt part #*	*qty-req*	*qty-kit*	*val*	*size*	*note*
MK1 Kit								
1	C	CL21B103KBANNNC		2	5	0.01uF	0805	
1X	C	CL21B222KBANNNC	C0805C222K5RACTU	1	2	2.2nF	0805	
2	C	TAJA226K010RNJ	TAJA226K010TNJ	5	6	22uF	1206	+band
3	C	CL21B104KBCNNNC		3	5	0.1uF	0805	
4	C	CL21A475KOFNNNE		4	5	4.7uF	0805	
5	C	C0805C361J5GACTU(C0G)	C0805C361J5HACAUTO(X8R)	1	2	360pF	0805	
6	C	CL21B105KAFNNNE		1	2	1uF	0805	
7	D	1PS76SB70,135	1N5711WS	1	2	1N5711	SOD323	K band
8B	T	MMST3904	MMBT3904	7	10	2N3904	SOT23	BJT
8M	T	2N7002BK,215	2N7002ET1G	1	2	2N7002	SOT23	NMFET
8R	R	RK73B2ATTD206J		1	2	20Meg	0805	
9	R	ERJ-6GEYJ335V		5	7	3.3Meg	0805	
10	R	CRGCQ0805F15K		3	5	15K	0805	
11	R	CRGCQ0805F2K7		1	2	2.7K	0805	
12	R	CRGCQ0805F1K0		7	10	1K	0805	
13	R	CRGCQ0805F330K		1	2	330K	0805	
14	R	CRGCQ0805F10K		1	2	10K	0805	
15	R	CRGCQ0805F22K		3	5	22K	0805	
16	R	ERJ-6ENF6802V	CRGCQ0805F68K	1	2	68K	0805	
17	R	CRGCQ0805F100R		1	2	100	0805	
18	VR	CT-6EP104	CT-6EX104	1	1	100K	TH	
19	VR	P160KNP-0EC15B2K		1	1	2K	PNL	LIN
20	VR	P160KNPD-4QA15A5K		1	1	5K	PNL	AUD
21	SW1	OS102011MA1QN1	EG2350	1	1	SPDT	TH-RA	
22	U	LM4871MX/NOPB		1	1	LM4871	SMD	
23	PCB	HWC		1	1	SupAmp2		
24	PCB	HWC		1	1	SupProbe2		
25	LED	TLLK4401	SSL-LX3054SRD	1	1	17mcd	T1-red	
26	Lamp	1730	CM683	1	1	6V-40mA		
Plus MK2 Kit								
27	Knob	Amazon	1106WA	2	2	6mm	knurled	
28	jack	X0034GNW21	161-7900-EX	1	1	3.5mm	4-wire	
29/30	Cbl/plug	X003A231H5		1	1	3.5mm	4-wire	
31	SW2	B0799HC3VY	200MSP6T1B1M2REH	1	1	toggle		
32	Wire	#22 teflon		4	4	ft	#22	wire
33	RCA	161-0253	RCJ-033	1	1	audio jack		aud out
34	HSTube	1/8" shrink tube		1	1	ft		
35	LED	WP710A10SED	SSL-LX3054SRD	1	1	1100mcd	T1-Org	Pwr LED
36	coax	3.5" coax		3.5	1	in		
37	ties	3" zip ties cable relief		1	2			

Table 2 – Super Amplifier Check Parts List

v5.3	SuperAmp2 12/20/25			
Kit	***Bag #***	*Quantity Needed*	***Reference***	*Part*
MK1	❑ *2*	2	C2,C6	22uF
MK1	❑ *3*	1	C3	0.1uF
MK1	❑ *4*	2	C4,C5	4.7uF
MK1	❑ *6*	1	C1	1uF
MK1	❑ *8*	2	T1, T2	2N3904
MK1	❑ *12*	4	R3,R9,R10,R11	1K
MK1	❑ *15*	3	R1,R2,R5	22K
MK1	❑ *16*	1	R4	68K
MK1	❑ *17*	1	R6	100
MK1	❑ *19*	1	R7 POT	2K
MK1	❑ *20*	1	R8 POT	4.7K
MK1	❑ *22*	1	U2	LM4871
MK1	❑ *26*	1	DS1	6V-40mA
MK2	❑ *27*	2	KB	6mm Knurl Nobs
MK2	❑ *28*	1	J1	3.5mm 4-w jack
MK2	❑ *30*	1	SW1	Pwr SW
MK2	❑ *32*	24"	#22	Hook up wire
MK2	❑ *33*	1	J2	RCA jack
MK2	❑ *34*	12"	1/8"	Shrink tube
MK2	❑ *35*	1	D1	Org Pwr LED

Table 3 – Super Probe Check Parts List

V5.4	SuperProbe2 Revised:12/31/25			
Kit	***Bag #***	*Quantity Needed*	***Reference***	*Part*
MK1	❑ *1*	2	C1,C3	0.01uF
MK1	❑ *1X*	1	C10	2.2nF
MK1	❑ *2*	3	C2,C5,C7	22uF
MK1	❑ *3*	2	C4,C6	0.1uF
MK1	❑ *4*	2	C8,C11	4.7uF
MK1	❑ *5*	1	C9	360pF
MK1	❑ *7*	1	D2	1N5711
MK1	❑ *8B*	5	T1,T2,T3,T4,T6	2N3904
MK1	❑ *8M*	1	T5	2N7002
MK1	❑ *8R*	1	R17	20Meg
MK1	❑ *9*	5	R1,R4,R7,R9,R15	3.3MEG
MK1	❑ *10*	3	R3,R6,R11	15K
MK1	❑ *11*	1	R8	2.7K
MK1	❑ *12*	3	R2,R5,R10,(R14)	1K
MK1	❑ *13*	1	R12	330K
MK1	❑ *14*	1	(R16)	10K
MK1	❑ *18*	1	R13 (Trim POT)	100K
MK1	❑ *21*	1	SW1	SPDT
MK1	❑ *25*	1	D1	POP-LED
MK2	❑ *29*	1	JP1	3.5mm 4-w plug
MK2	❑ *31*	39"	4-wire cable	cable
MK2	❑ *36*	3.5"	coax tip	cable
MK2	❑ *37*	1	zip tie	restraint

Feedback
It takes quite a bit of effort to put kits like this together, and it is easy to make a mistake or omission. If you find errors, omissions, or if you have suggestions on the instructions, kit, packaging or anything else, I would be happy to receive feedback.

- Is the cable long enough?
- Are there enough extra SMD parts?
- Are the instructions adequate?
- Do you have tweaking feedback for us?

We would encourage you to add your implementation to the Instructables “I Made This” section!
The easiest way to provide feedback would be by email to:

Kevin
hcsales@hwcz.com or ppsales@hwcz.com

Thanks
We have incorporated a number of customers’ suggestions and corrections that have made these instructions more accurate and easier to follow.

References
https://www.youtube.com/watch?v=uVkJqqZroN0&t=2583s
https://www.instructables.com/Carlsons-Super-Probe/
https://www.hollywoodcontrols.com/phpSP/MCSP_SelectionGuide.php