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XLO-5DC Five Channel Color Light Organ

12V DC Version

Rev 4.22

Introduction

This kit contains all the electronics you will need to build a high quality five-channel color light organ that runs on 12V DC. Two printed circuit boards and their related components are included:

- The main circuit board, which contains all the amplifiers, filters, and MOSFET circuits necessary to drive 5 sets of lights.

- The front panel circuit board contains the ultra-sensitive condenser microphone, sensitivity level control and the main power switch. It's designed to be mounted on the front or side of your constructed enclosure so that these can be easily accessed. You could also mount this front panel in a small, conveniently located enclosure and cable-over to the main board, which may be mounted in a larger hidden enclosure.

Features

- Runs on 12V DC – great for automotive installation
- Splits your music into 5 frequency bands, each band controls one light circuit
- Each band width and center frequency is individually adjustable
- Drives up to 2A per light circuit
- Flexible signal input options:
    - Condenser microphone with sensitivity adjustment
    - Audio line-level input from an iPod, computer, mixer, etc.
    - Mono or Stereo
    - Speaker level input (optional)
- Automatic Gain Control circuit constantly adjusts input sensitivity to match changes in music level
- Microphone, sensitivity control knob, and main power switch are on a separate small decorative circuit board that can be mounted to your front panel for easy access
- Expansion connector to optionally allow you to locate the channel level control pots and indicator LEDs to a separate control panel board XLO-5CP (sold separately).
- You can build light organs with 10 channels, 15 channels, etc. using the XLO-5. The adjustable filter center frequencies makes this possible; using multiple XLO-5's tuned to different center frequencies.
- 5 Indicator LEDs driven by the MOSFETs for testing before you hook up your lights
- This is an advanced kit with about 110 components.

Unpacking Your Kit

Carefully unpack and take stock of the components in your kit. The electronic components are packed in 4 bags labeled 'Bag A' though 'Bag D'. You will start your assembly with 'Bag A' and proceed in order to 'Bag D'. See Table 1 and Table 2 for a complete listing of your components.

NOTE: Bag D is excluded from orders shipped with XLO-CP Control Panel kit because these parts must NOT be installed in this case.

Assembly Instructions

It is very important that you read and understand all of the following instructions before you start your assembly so that you don't make any mistakes that might be difficult to recover from. The assembly should be done in the order listed in Table 1 and Table 2 or you may have difficulty physically accessing components for soldering.

What you'll need

- Soldering iron with small or medium tip
- Damp sponge for tip cleaning
- Solder
- Solder wick or solder sucker in case of solder bridging (stranded wire could substitute)
- Small needle nose pliers.
- Small wire cutters
- Small Phillips screwdriver
- Wire Stripper
- Magnifying glass to read the markings on the tiny components

General Assembly Guidelines

- **Take your time!!** Most mistakes are made when rushing through the assembly. Taking the time to double check every step will pay off with a first-time functional device.
- In cases where it is necessary to re-form the leads on components (such as resistors and diodes), be very careful not to put stress where the lead enters the component itself. The physical attachment of the lead to the component can sometimes be very fragile and the lead may break off if too much force is applied. Reforming the leads can be done by gripping the lead with small needle-nose pliers at the base of the component while bending the lead on the other side of the pliers.
- Use as little heat and solder as necessary to affix the components to the PCB (printed circuit board). Many of the parts in this kit are temperature sensitive. Overheating may damage them.
- Always clean the soldering iron tip on the damp sponge prior to every solder joint. Re-tin whenever the tip gets a little dull. (tinning is the application of fresh solder to the tip of the iron until its shiny, wipe excess on a damp sponge).
- When clipping the excess leads of the through-hole parts, don't try to clip too close to the PCB. Clip just above the solder joint to avoid fracturing the solder joint, which could lead to device failure sometime in the future.
- Carefully inspect each solder joint to make sure you didn't accidentally form a 'solder bridge', or connect two adjacent pads together. Remove solder bridges by using solder wick or a solder sucker. If the bridge is small you may be able to remove it by just reheating the joint and sliding the soldering iron across the bridge. If not, see the next step.
- If you need to remove solder from a hole (or a solder bridge) and you don't have solder wick or a solder sucker, you can use stripped stranded wire in place of solder wick. Place the stranded wire across the hole and touch the soldering iron to the wire, above the hole. As the wire heats it will melt the solder in the hole, and the melted solder will tend to wick up into the stranded wire. When the wire fills up with solder, move a clean part of the wire over the hole and repeat until the hole is clear of solder.

Safety Instructions

FAILURE TO FOLLOW THESE GUIDELINES COULD CAUSE FIRE, INJURY, DEATH or WORSE!:

- NEVER drive with your light organ turned on! It's probably illegal, and it would distract you or other drivers, and may lead to accidents.
- NEVER work on the unit while it's turned on!
- NEVER operate the unit around water or any moisture.
- NEVER bridge the fuse!! Replace blown fuse only with the specified capacity replacements.
- Mount both circuit board assemblies securely so they cannot shift around.
- When wiring your lights, always use the proper gauge wire for your expected load. 18 gauge or larger will suit most applications.
- Noticeable heat present in any of the wires or junctions means you may be exceeding the capacity of the wiring or connectors. You're strongly advised to upgrade the wiring if this is the case or fire could occur.
- Use electrical tape or other insulator to keep any wires from shorting to each other. Wires sometimes shift around over time and may short out later.
- Don't leave any exposed points that are electrically charged.

Main Circuit Board Assembly

You're ready to begin assembling your light organ main circuit board. Assemble the board in the order listed in Table 1. Use the install check boxes on the right side to track your progress. The 'Install Notes' column will alert you to any special instructions on the following page for each of the components. Refer to Figure 1 parts placement diagram to see these more clearly.

Table 1. Main Circuit Board Parts List

Pack √	Device	Value	Marking	Qty	Reference Designators	Bag	Install Notes	Install √
	MAIN CIRCUIT BOARD (PCB)	REV 4.1		1				
	RESISTOR	47K	YEL-VIO-ORA	6	R2,R4,R6,R8,R10, R41	A		
	RESISTOR	4.7K	YEL-VIO-RED	1	R40			
	RESISTOR	6.8K	BLU-GRY-RED	1	R38			
	RESISTOR	16K	BRN-BLU-ORA	1	R34			
	RESISTOR	33K	ORA-ORA-ORA	1	R32			
	RESISTOR	1K	BRN-BLK-RED	12	R3,R5,R7,R9,R11,R47, R49,R51,R53,R55,R56, R57	A		
	RESISTOR	100K	BRN-BLK-YEL	2	R12,R45	A		
	RESISTOR	91K	WHT-BRN-ORA	1	R13	A		
	RESISTOR	10K	BRN-BLK-ORA	8	R29,R31,R33,R35, R36,R37,R39,R43	A		
	RESISTOR	3K	ORA-BLK-RED	1	R17	A		
	RESISTOR	2.2K	RED-RED-RED	5	R18,R20,R22,R24,R26	A		
	RESISTOR	220	RED-RED-BRN	5	R19,R21,R23,R25,R27	A		
	RESISTOR	220K	RED-RED-YEL	1	R44	A		
	RESISTOR	1.1M	BRN-BRN-GRN	1	R28	A		
	RESISTOR	4.7M	YEL-VIO-GRN	1	R42	A		
	RESISTOR	82K	GRY-RED-ORA	1	R30	A		
	RESISTOR	180	BRN-GRY-BRN	1	R46	A		
	RESISTOR	330	ORA-ORA-BRN	1	R48	A		
	RESISTOR	470	YEL-VIO-BRN	1	R50	A		
	RESISTOR	560	GRN-BLU-BRN	1	R52	A		
	RESISTOR	680	BLU-GRY-BRN	1	R54	A		
	DIODE	1N4742	1N4742	1	D1	A	1	
	DIODE	1N914	1N914	1	D2	A	1	
	RESISTOR	15, 1/2W	BRN-GRN-BLK	1	R1	A		
	CERAMIC CAP	.015 µF	153	2	C28,C29	A		
	CERAMIC CAP	.022 µF	223	2	C26,C27	A		
	CERAMIC CAP	.047 µF	473	2	C24,C25	A		
	CAPACITOR	.1uF	104	13	C4,C5,C6,C7,C8,C9, C10,C11,C12,C13, C19,C31,C32	A		
	LED	LED		5	D3,D4,D5,D6,D7	D	2,10	
	IC – 8 PIN DIP	LM555	LM555	5	U1,U2,U3,U4,U5	B	3	
	IC – 14 PIN DIP	TL074	TL074	2	U6,U7	B	3	
	TRIMPOT	50K	503	5	VR1,VR3,VR5,VR7,VR9	D	10	
	TRIMPOT	5K	502	5	VR2,VR4,VR6,VR8,VR10	B		
	TRANSISTOR	2N3904	2N3904	5	Q6,Q7,Q8,Q9,Q10	B	4	
	TRANSISTOR - FET	J111	J111	1	Q11	B	4	
	ELECTRLYTIC CAP	.1uF	0.1uF	2	C22,C23	B	5	
	ELECTRLYTIC CAP	.33uF	.33uF	2	C20,C21	B	5	
	ELECTRLYTIC CAP	10uF	10uF	1	C30	B	5	
	FUSE CLIP			2	X4,X5	B	6	
	FUSE, 10AMP, 2AG			1	F1	B	6	
	HEAT SINK			5		C	7	
	POWER MOSFET	27N3LH5	27N3LH5	5	Q1,Q2,Q3,Q4,Q5	C	7	
	4-40 SCREW			5		C	7	
	4-40 NUT			5		C	7	
	TERMINAL BLOCK	2 CIRCUIT		1	J1	D	8,10	
	TERMINAL BLOCK	2 CIRCUIT		1	J2	C	8	
	TERMINAL BLOCK	10 CIRCUIT		1	J3	C	8	
	ELECTRLYTIC CAP	680uF	680uF	1	C1	C	5	
	NO PARTS GO HERE				J4		9	

Main Circuit Board Component Installation Notes:

1. Diodes are polarized devices, which means they only work when they're installed the right way around. A solid bar on one end of the diode marks the cathode. The cathode goes in the square hole on the PCB.
2. The LEDs are polarized, they won't light if installed the wrong way around. They have one lead longer than the other. Install the long lead (anode) in the square pad holes.
3. The Op amp IC's are also polarized. There is a notch or a dot molded into one end of the device. Align the notch or dot on the device with the notch on the silk screen. This is very important because the devices will be destroyed if installed backward.
4. The transistors are polarized. They have a flat side and a rounded side. Install these components in such a way that the shape matches the shape on the PCB silk screen.
5. Electrolytic capacitors are polarized devices also, be sure to install them the right way around (or else, when power is applied, they may explode!!). The positive lead is longer than the negative lead. The positive lead goes in the square hole on the PCB. Note that the polarity is also marked on the outer casing of the cap.
6. When installing the fuse clips, be careful to install with proper orientation. There is a small indentation on one end that prevents the fuse from slipping out. If you put the clips in backward you will not be able to install the fuse properly. It's a good idea to put the fuse in the clips prior to inserting as a unit into the PCB. This way you know the clips are installed properly before you solder them in. The fuse is fragile glass, be careful not to break it.
7. The MOSFET's are polarized devices. Their metal tabs must be mounted flush against the heat sink. These devices handle switching of the 12V DC current. Using needle nose pliers, bend the three leads down 90 degrees just outside the widened part of the leads. Place the heat sink into position on the PCB; align with the screw mounting hole. Insert the MOSFET leads into the PCB holes. Insert the 4-40 mounting screw from the top, through the MOSFET tab, through the heat sink and the PCB. Put the nut on the screw from the back of the board. Tighten the nut, being careful to align the heat sink with the rectangular pattern on the silk screen. Repeat this procedure with the remaining MOSFET's. Solder all the MOSFET leads. When complete, the heat sinks should not be touching each other.
8. Install the terminal blocks so that the wire entry points face toward the outer edge of the PCB, so that you can install the wires cleanly on the outer edge of the PCB.
9. J4 is only installed when using the XLO-5CP control panel option.
10. The 50K trimpots, the LEDs, and the J1 terminal block should NOT be installed when using the XLO-5CP control panel.

Front Panel Circuit Board Assembly

This board is designed to be used as a decorative front panel that you can mount on your light organ enclosure. It contains the condenser microphone, the primary sensitivity adjustment pot, and the main ON/OFF switch. Refer to Figure 2 below for component orientation.

NOTE: Bag D and the related PCB will not be present in kits shipped in conjunction with the Control Panel kit (XLO-5CP), since all the parts in bag D will not be needed in this configuration (and would lead to malfunction if installed).

Table 2. Front Panel Board Parts List (Bag D)

Pack √	Device	Value	Marking	Qty	Install Notes	Install √
	FRONT PANEL PCB		Rev 4.3	1		
	RESISTOR	33K	ORA-ORA-ORA	2	1	
	RESISTOR	100K	BRN-BLK-YEL	1	1	
	MICROPHONE			1	2	
	POTENTIOMETER	50K		1	3	
	KNOB			1	3	
	ROCKER SWITCH			1	4	

1. Resistors R1 and R2 are installed differently depending on your selected signal input mode:
    - For microphone input: Leave R1 and R2 empty
    - For line-in: install the two 33K resistors in R1 and R2. See Figure 2 for wiring of the line input(s). Connect just one for mono, or both for stereo left and right.
    - For speaker input: install the100K resistor in R1, leave R2 empty. Solder your audio transformer in position T1 (not included in the kit by default, contact Xkitz for info on the transformer) Transformer primary should connect to the square pad pin 1. See Figure 2 for wiring of the speakers inputs.
2. If you want to use microphone input mode, install the microphone. This device should be mounted on the front of the front panel PCB so it is exposed to exterior sounds. The microphone is a polarized device, so the orientation is important. It should be installed with the offset downward, aligned with the circle on the PCB. Solder the microphone terminals on the back of the PCB.
3. Remove the hex-nut and washer from the 50K pot. Mount pot to the back of the PCB facing forward. Orient it so that it's three terminals are aligned with the three rectangular pads on the PCB and the tab on the pot goes into the corresponding hole in the PCB (it may be a tight fit). Secure the pot with the washer and hex-nut. Bend all three terminals down slightly so that they are close to contacting the pads on the PCB (they may not be quite long enough to touch the pads). Solder the tabs to the pads on the PCB, using solder to bridge the gap if necessary. Push the knob onto the pot shaft.
4. Orient the rocker switch so that the two terminals are toward the bottom of the front panel PCB and snap it into the square hole. This way the unit will be turned on when the top of the rocker switch is depressed.

Front Panel Expansion Connector

The XLO-5DC has a 34 pin front panel expansion connector that allows you to relocate all of the control pots and indicator LEDs to a remote location such as an external front panel. If you use this connector, be sure to remove the on-board trim-pots and LEDs. Otherwise you'll have two sets of components wired in parallel, and it won't work properly. See the schematic diagram in Figure 4 for the wiring of this connector.

Xkitz currently offers a control panel kit, the XLO-5CP, that attaches to this connector and provides LED lighted slide pots to control the band widths (levels) and the main level input.

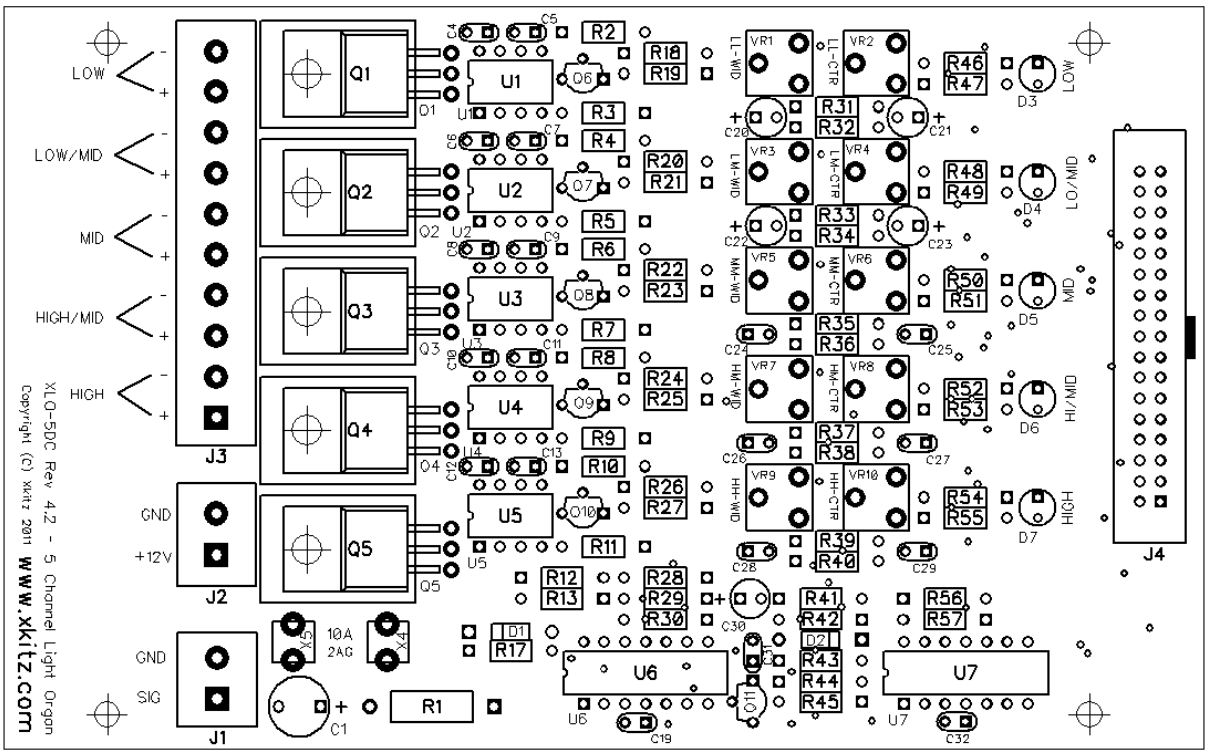

Figure 1. Main Controller PCB Component Placement (PCB dimensions: 5.75” x 3.5”)

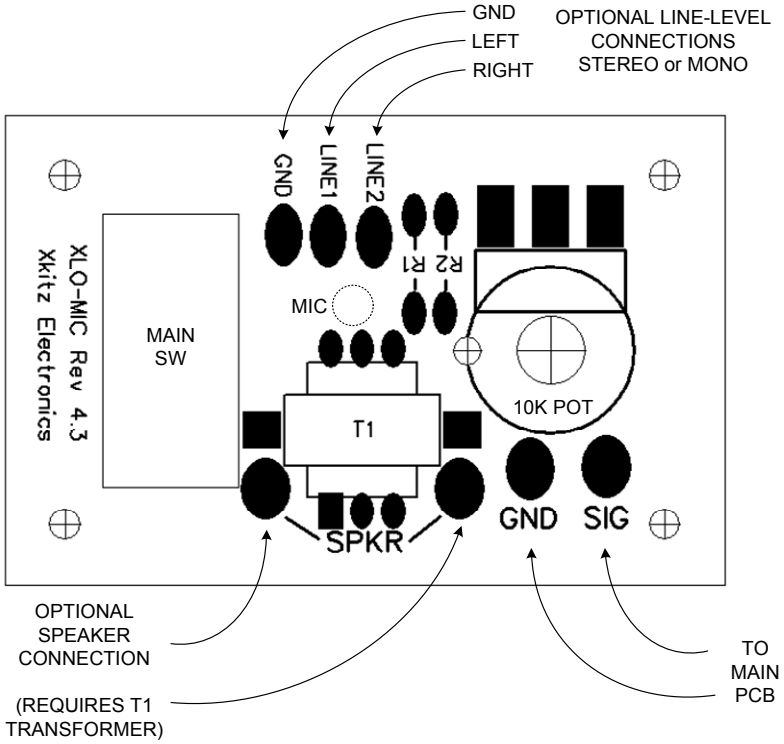

Figure 2. Front Panel Diagram (shows optional line-in and speaker connections)

Connecting the Main Board to the Front Panel Board

Now you're ready to mount and wire up the light organ assemblies in your car. Refer to Figure 5 for the system level wiring diagram. This diagram shows how the PCBs are wired together, as well as the wiring of the DC power, and the lamp circuits. Follow these steps to complete your enclosure wiring:

1. Mount the front panel and main controller assemblies within about 6 feet of each other, so that the audio signal wire is not too long and won't pick up too much electrical noise.
2. Either disconnect the car's battery or remove the fuse from the 12V circuit you're tapping into to power you light organ. Never work with a live power circuit.
3. Connect the +12V and ground wires from your car power to the front panel assembly, as shown in Figure 5, using 18ga or larger wire. If connecting directly to the battery, add an inline 10A fuse near the battery.
4. Now wire the switched +12V, GND, and SIG and GND (there's a signal GND and a power GND wire) connections to the main controller assembly. Again, use 18ga wire or larger for the +12V and GND connections. The thickness of the 'SIG' and its GND connections are not important. Thin speaker wire works ok for this.
5. Connect each of your lamp circuits as shown in Figure 5. If you're using LED based lighting, pay attention to the polarity.

Ideas for Light Systems

Your light organ can drive any type of 12V lights, but the best choice by far is to use LED based lighting systems. They have faster turn on / turn off time, so they appear much more responsive to the music than incandescent bulbs. You can get LEDs of all colors and brightness levels at places like **www.superbrightleds.com**.

Initial Power-up

Double check your wiring to make sure it matches the diagram in Figure 5. Now its time to power up your light organ for the first time. **This is a very critical step**. This is when any un-detected assembly errors, such as backward electrolytic caps, could lead to very bad consequences. So use eye protection and stand clear of the main circuit board when you switch it on for the first time in case anything explodes. Be ready to turn it off again quickly if necessary.

- Make sure the main power switch is OFF
- Reconnect your car battery (or replace the fuse)
- Turn all adjustment trim pots on the main controller all the way counter-clockwise
- Turn the main sensitivity adjustment on the front panel all the way counter-clockwise
- Turn the main DC switch ON (upper side of the rocker switch is pressed)
- Wait 10 seconds seconds, the lights may flash, but otherwise nothing should happen
- Hopefully, nothing popped or smoked!
- Turn the DC switch off again and go to the next step

Calibration and Testing

Now you're ready to test and calibrate your light organ. Follow these steps:

- Ensure the Light Organ main DC switch is OFF
- Using a small flat screwdriver, turn all trim-pots on the main PCB all the way counter-clockwise. This sets the sensitivity of all filters to minimum, and center frequencies to the highest end of their ranges (see Figures 6 and 7).
- Turn the main sensitivity pot on the front panel all the way clockwise (max sensitivity)
- Turn on some music at a comfortable volume, or connect your line-in source
- Turn on the Light Organ, wait a couple of seconds for the power to stabilize and the Automatic Gain Control circuit to settle
- Starting with the HIGH frequency band-width adjustment (HH-WID) and working to the LOW frequency (LL-WID), adjust the trim pots to get the desired level of activity on the corresponding set of lights. The pots are physically arranged to correspond to the nearby set of terminals (e.g. the LOW adjust pot is aligned with the 'LOW' terminals, etc.). Keep adjusting the pots until you get to a point where all the lights are behaving properly. There's no right or wrong here, it's just what looks good to you with your music.
- If one or more of the light circuits is staying on too much and you can't get it to calm down with the trim pot, turn down the main sensitivity adjustment on the front panel board and try the calibration again.
- Adjustment of the center frequency pots (HH-CTR through LL-CTR) is not strictly required, you can simply leave these turned all the way counter-clockwise if you choose to, and the frequencies responses of the filters will be as shown in Figure 6. But if you do want to alter the center frequencies of the bands, then you can do so by adjusting the 'xx-CTR' trim-pots. You can use a function generator, or just some musical instrument like a guitar or keyboard to tune your filter center frequencies.

Troubleshooting

If you're having trouble with your light organ, check Table 3 for possible cause and solution.

Table 3. Troubleshooting Guide

Problem	Possible Cause	Solution
Lights never turn on	No power to the circuit	Check that the DC power source is connected and working. Check the main power switch is turned on. Check the fuse on the main circuit board. Check that you have 12V between pins 4 and 11 of the TL074 Op Amp ICs. Check the signal connection between the front panel and main boards.
Lights flash randomly when no sound is present, or one or two lights are stuck on.	Noise on the DC line	DC line filter may help, or try to identify source of the noise and eliminate it.
	Interference from cell phone	Use coaxial cable to wire the mic to the main PCB may help, but some cell phone interference is very strong. Moving the phone away from the light organ is the best solution.
	Microphone wire is too long	Use coaxial cable to wire microphone.
	Input oscillation	Try disconnecting your input signal source and see if the problem improves. If so, you may need to shorten or shield your signal input cable. If not, check the test points below.
Lights are on too much of the time, not much activity, maybe blinking a little but not very interesting	Front panel sensitivity pot is set too high	Turn down the sensitivity knob on the front panel (counter clockwise)
	Line-in source is too high	Turn down the volume at the source. If driving from an iPod, turn down the iPod volume.

Test Points

If it's still not working, use a volt meter to check for the expected voltage levels on the test points listed below. Before checking these, disconnect all your output light circuits and turn all the trim-pots full counter-clockwise (or if using the XLO-5CP, all level pots full down). Connect the minus (-) probe to the GND terminal of J2. The pins of the op amps are numbered starting with pin 1 on the upper left corner (with the package notch upward), and increasing as you go counter clockwise around the chip. Check the following test points:

1. Pin 4 of U6 and U7 should be 12V. If not, check your input power supply, check the fuse, and check the orientation of D1 diode.
2. Pin 8 of U7 should be about 6V. If not check R56 and R57 are installed properly and have no solder bridges nearby.
3. Pin 7 of U6 should be about 6V. If not, check the nearby components are installed properly and there are no solder bridges or cold solder joints (check the schematic for associated components).
4. Pin 8 of U6 should normally be around 11-12V.
5. The following should all be about 6V. If any are not, check the associated components (see schematic):
   - U6 pin 1
   - U6 pin 14
   - U7 pin 1
   - U7 pin 7
   - U7 pin 14
6. Pin 2 of the five chips: U1-U5 should be about 12V. If not, check the associated 2N3904 transistors are installed properly and no solder bridges.
7. Pin 3 of the same five chips should be about 0V. If not, check the soldering on the LM555 and on the MOSFETs Q1-Q5

Our experience in supporting our customers when their boards aren't working has shown that the vast majority of problems are due to soldering or component placement problems. Use a magnifying glass and double check all your solder joints. Re-flow any that look at all suspicious. 99 out of 100 times, this will solve the problem.

If you're still having problems, please contact us at support@xkitz.com. We're always happy to help you get you board working properly.

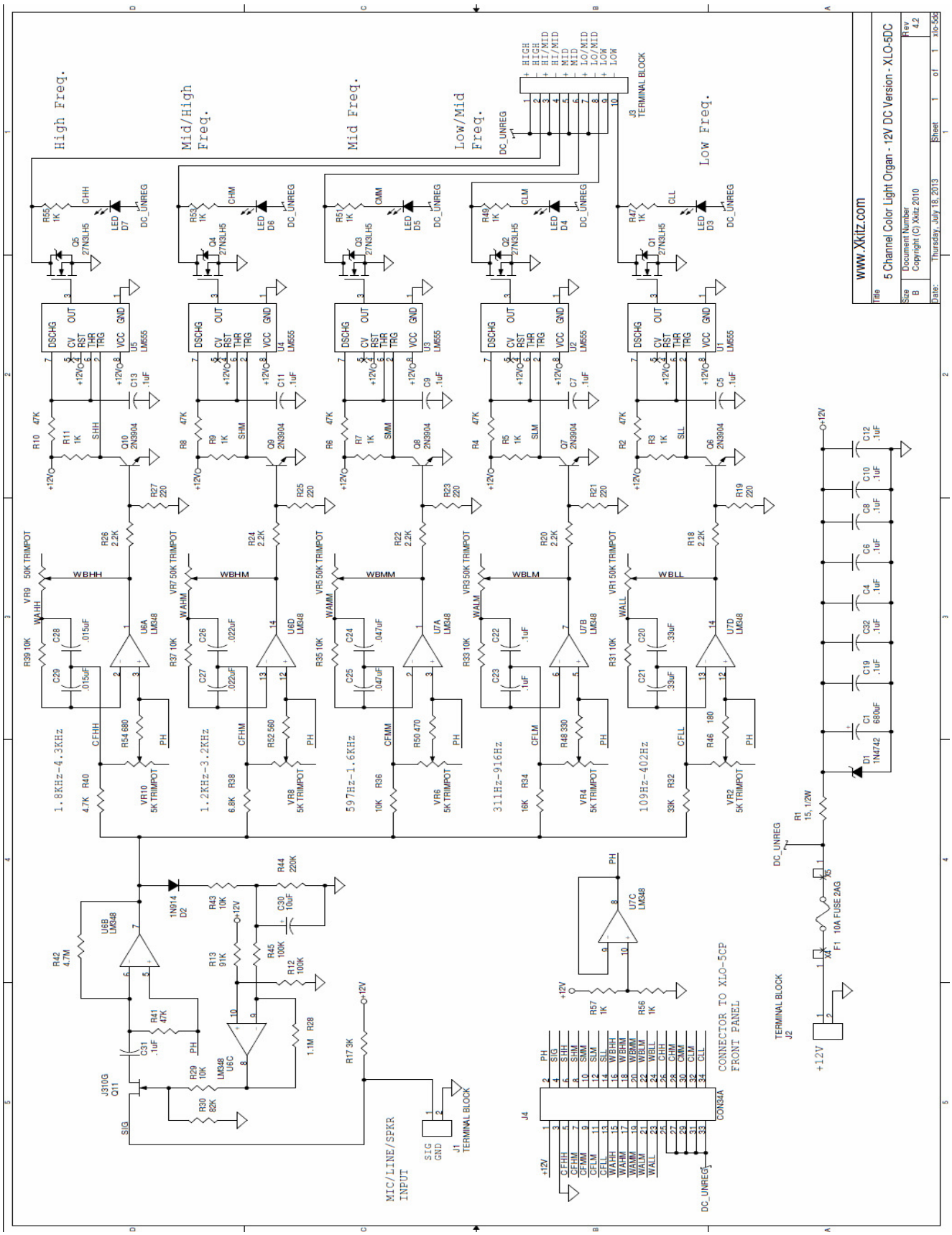

Figure 3. Main Board Schematic Diagram

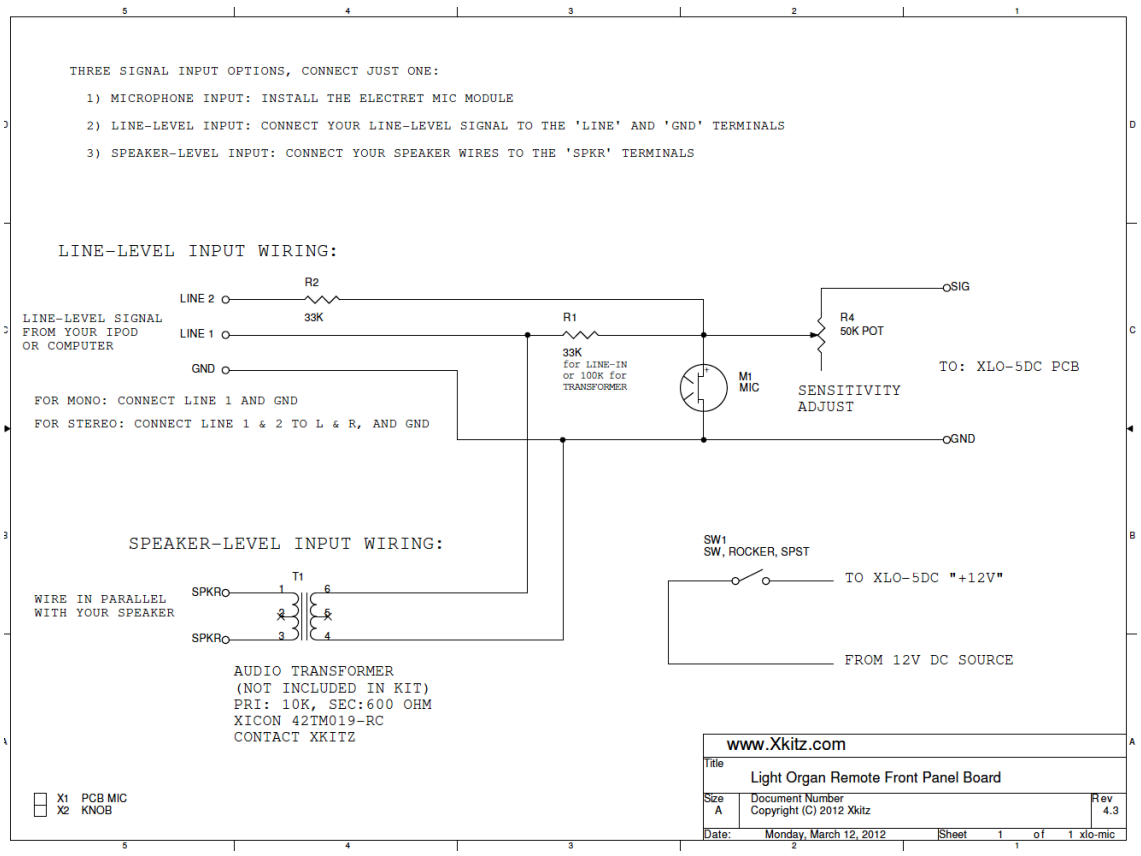

Figure 4. Front Panel Board Schematic Diagram

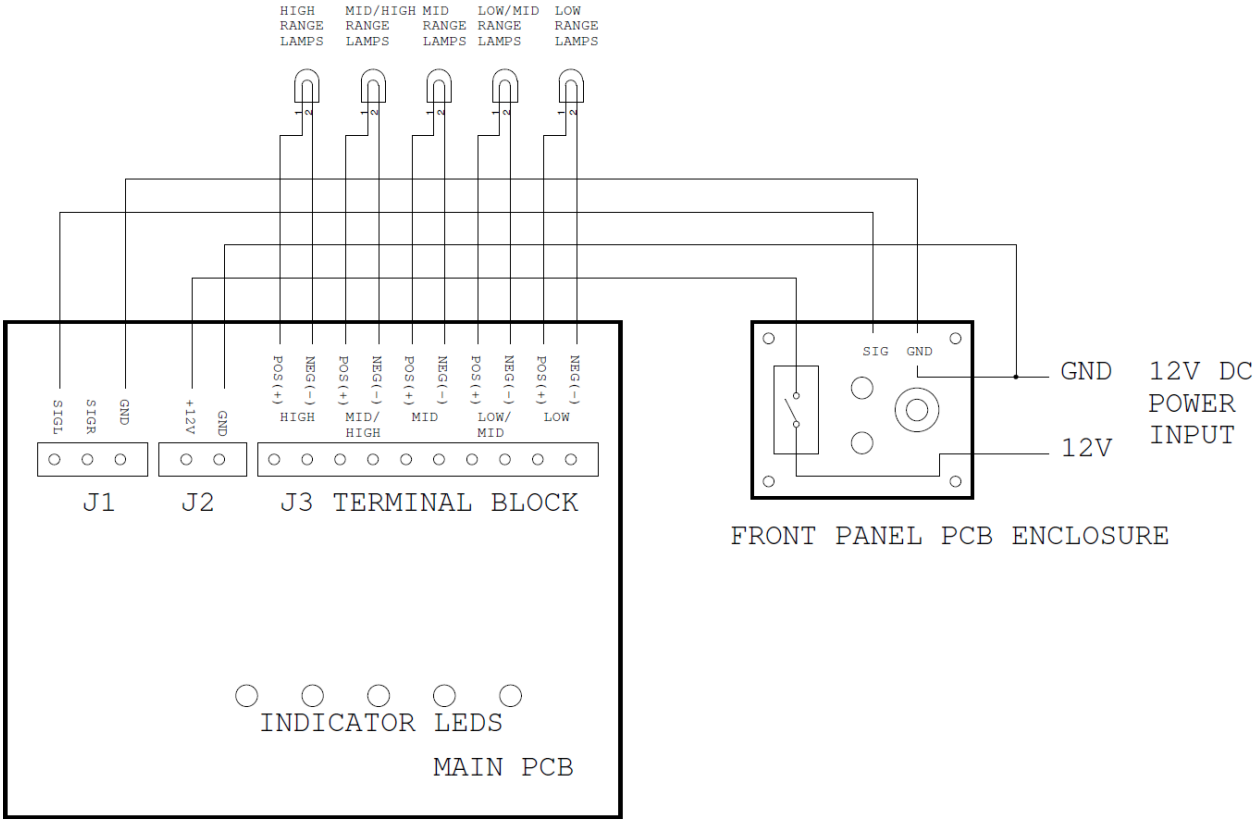

Figure 5. System Installation Wiring Diagram

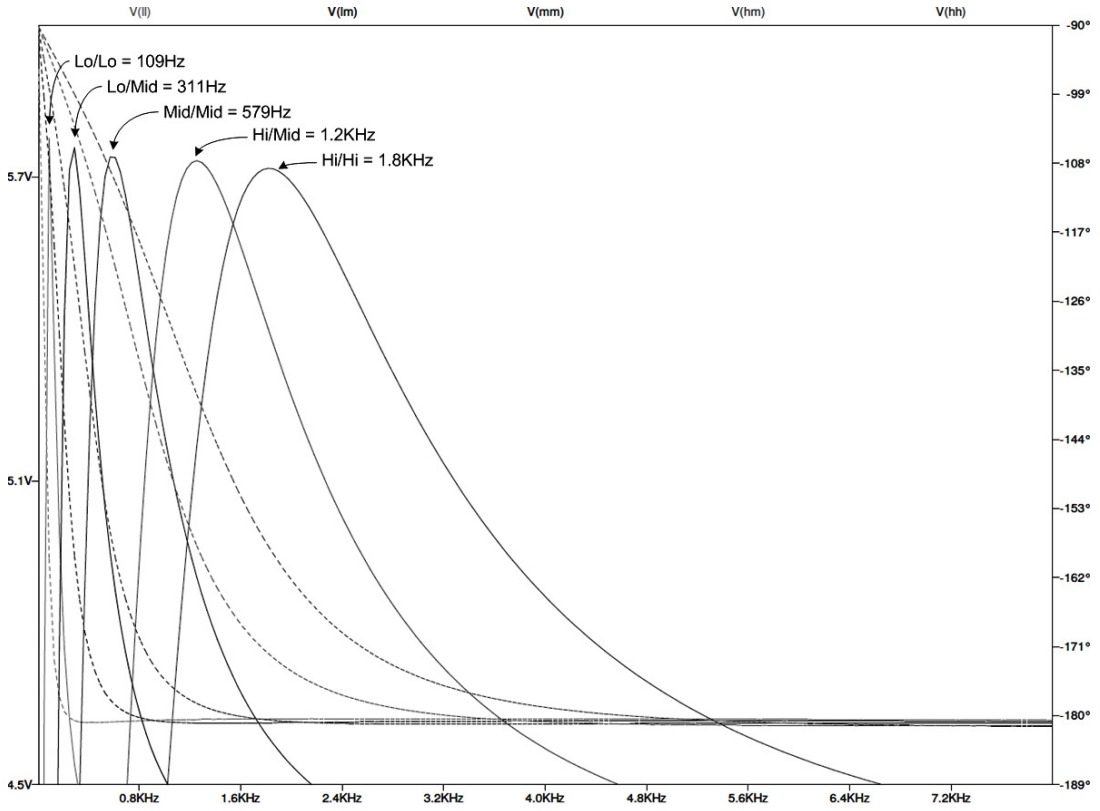

Figure 6. **Filter Frequency Response (Adjusted to Lowest Frequencies, trim-pots clockwise)**

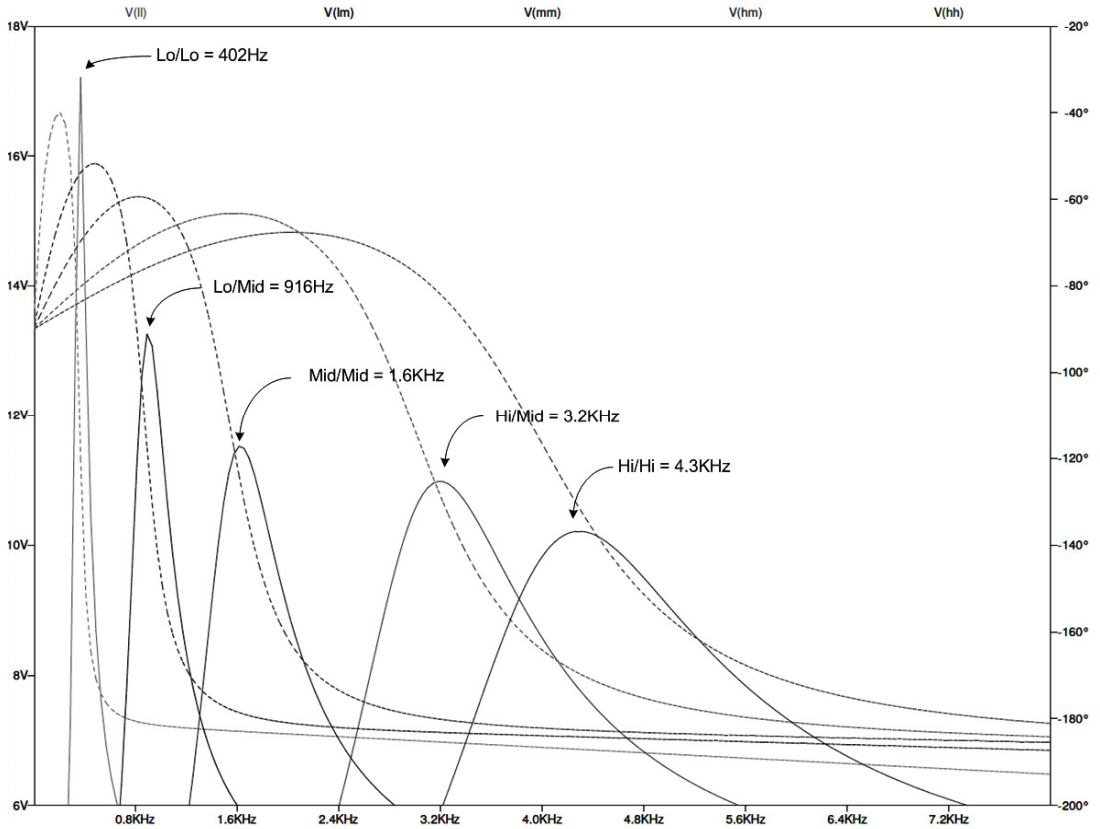

Figure 7. **Filter Frequency Response (Adjusted to Highest Frequencies, trim-pots counter-clockwise)**