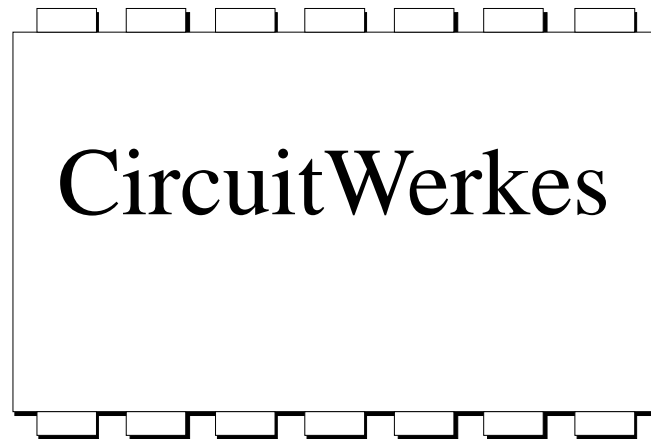


AC-12 Coupler Bay



Technical Manual

CircuitWerkes

3716 SW 3rd Place · Gainesville, FL 32607

(352) 335-6555 · Fax (352) 331-6999

e-mail info@circuitwerkes.com || <http://www.circuitwerkes.com>

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CircuitWerkes AC-12 Installation & Service Manual

Description

The AC-12 is a rack mountable bank of telephone autocouplers designed to automatically connect one of two send-audio busses or bidirectional audio to a series of single telephone lines. Each AC-12 consists of a rack enclosure (card cage), an audio amp/power supply card and up to 12 coupler cards. The power supply/audio input card provides two bridging, balanced, audio inputs which are sent to all of the coupler cards. The coupler cards (which are designated AC-1s) have remote control circuitry that provides several custom operating configurations, including remote signaling & control, pick-up inhibit & manual operation. The AC-1 uses a DPDT relay to provide two sets of dry contact outputs when the unit goes on-line. The contacts are user selectable as either momentary or latching. Jumpers J1 and J2 allow you to customize the operation of your AC-1. As shipped from the factory, each AC-1 is set to operate as an auto-answering coupler with momentary slave relay contacts which can be used to control external equipment. Each coupler card has manual pickup and hangup controls, an input select switch, an auxiliary in/out jack with level control and a clipping indicator to help you set the correct level. Each card also has its own voltage regulator and bridging buss inputs.

Installation & Operation

SETUP

The power supply card has two audio level set jumpers. When the jumpers are installed, they reduce the input sensitivity by about 16 dB (the factory default for an input level of +4dBm). If your signal level is too low, you can increase the buss-amp's gain by removing the jumpers.

The AC-1 internal jumpers (J1, J2 & J3) are used to modify the coupler's behavior. J1 is a six position jumper location that allows the user to select which ring the AC-1 answers on. The position of the jumper selects the answer to occur at the beginning of any of the first through six incoming rings. The ring counter outputs are labelled on the PC Board. J2 is a two position jumper that selects whether the relay closure will be momentary or latching. When the jumper plug is between the middle pin and the "L" pin the relay will be latched on while the coupler is on-line. When the jumper is connected between the middle and the "M" pin (default setting), the relay will close momentarily when the coupler first picks up the line. J3 selects whether the card's audio is ground reference or not. When the card is to be used with bussed audio, J3 must be on. If the AC-1b card is to be used independantly as an IFB, etc., you may remove J3 causing the 1/4" auxilliary jack to be balanced. Of course, if the auxilliary jack is used with J3 installed, the ring connection will be referenced to ground.

The AC-12 card-frame can be mounted in almost any convenient 5-1/4" of rack space. Four rack screws and washers are included for your convenience.

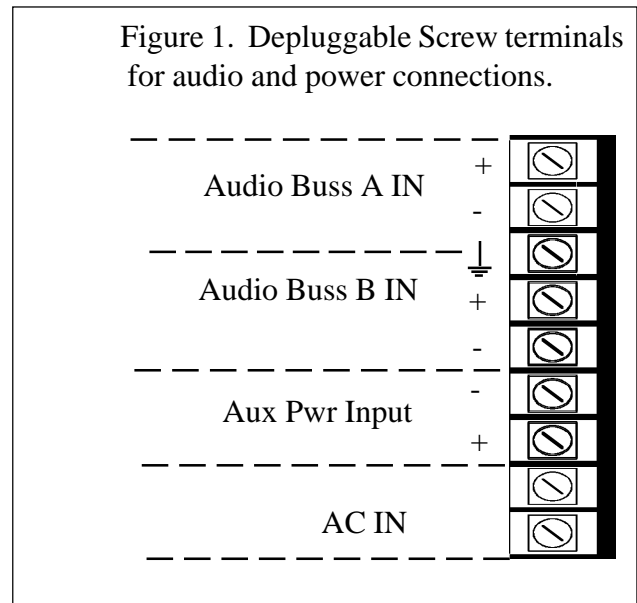
The unit is shipped with all cards and the smoked Lexan front cover in place. The protective paper backing on the Lexan panel should be removed for maximum viewing enjoyment.

Connections

Each AC-1 connects to the phone line via a standard RJ-11 jack which is mounted on the rear of the coupler card. The power and buss-audio connections are made on a depluggable 9 position terminal strip. See figure 1 for wiring details.

Each coupler card has an independent regulator fed from the bridge rectifier on the Power Supply/ Amp card. The power supply/audio card we include with the AC-12 is capable of delivering ample current to operate a full bank of twelve couplers and will accept from 12 to 18 Vac or 16 to 24Vdc. A power transformer is provided with each bank of couplers; however, if you wish to supply your own, it must be able to provide at least 1.5A continuously for a full bank of couplers. An Auxilliary Power input is provided for a redundant 12Vdc power supply. This supply should be able to deliver 1.5A & we suggest a regulated supply of 2.5A or more.

Your buss 1 and buss 2 audio connections are also made via the terminal strip located on the power supply/ audio card. **When feeding a buss-input with unbalanced audio, the unused input terminal should be tied to ground. If the unused input terminal is not tied to ground, noise and crosstalk may result.**



Each coupler also has its own auxiliary audio connector. The connector is a TRS 1/4" phone jack. The audio is unbalanced with the sleeve tied to ground. To simultaneously send and receive audio, an external hybrid must be connected.

The 10 position user interface connector provides all other input and output connections to the AC-1. A ten position mating connector and crimp pins are supplied for each AC-1 card. The crimp pins can be installed with almost any generic crimp tool that works with the crimp terminals for D-SUB connectors. See figure 2 or the AC1 card schematic diagram on page 8 for pinout information.

Pin a is the remote pick-up trigger. By grounding this pin, you will cause the unit to go on line. This function is provided for live, manual control of the AC-1.

Pin b is a momentary low output which happens when the AC-1 first picks up the line. This output is independent of the J-2 position, is TTL compatible and can sink up to 100 mA.

Pins c,d,& e are the NO, NC, and Common Auxiliary relay contacts. The relay dry contacts are rated at 2 Amps and 125 Volts.

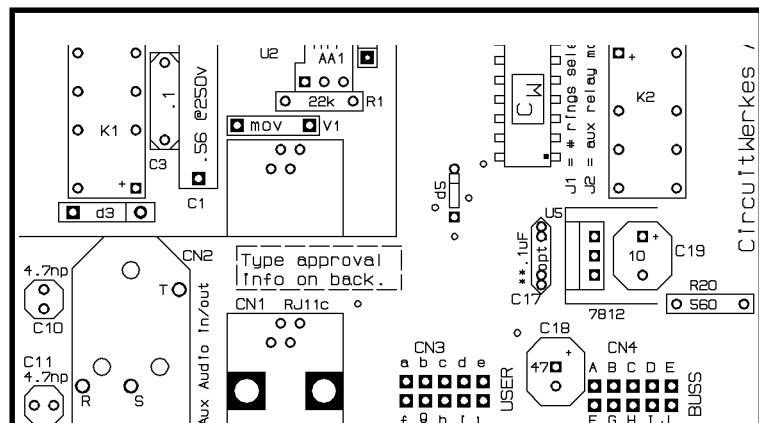
Pin f provides remote hang-up control. By momentarily connecting this pin to ground, you will force the AC-1 to hang up the line. You may use this function any time you wish to manually hang up the line.

Pin g is an open collector indicator for "ring". Whenever the coupler detects a ring, this pin sinks to ground for the duration of the ring signal.

Pin h is ground.

Pin i is regulated (12Vdc) Vcc. Do not exceed 50mA

Pin j provides an open collector status indication for "online". When the coupler answers, this pin sinks to ground for the duration of the call.



Basic Operation

When you first connect power to the AC-12, the couplers, appearing to have a mind of their own, may momentarily seize the line and then hang up. On more recent cards, the Ring LED will momentarily light then go out. This is a normal self test. In normal operation the couplers should automatically answer their phone lines and remain on line until the calling party hangs up. They should then drop the line and be ready for the next call. If the couplers do not disconnect at the end of a call, you may live in one of the few areas where the phone company does not provide the standard zero crossing voltage at the end of a call. You can verify this by unplugging the coupler from the phone line while it is active. The unit should immediately go off line. If it does not, the unit is defective and should be repaired. If it does go off line, then the unit is working correctly and you will need to explore other options. Please call us for suggestions.

The coupler may be used to either send or receive audio. Audio may be sent in one of three ways. You can connect an audio source to either or both of the two inputs at the audio/power supply card. Any audio present at the two inputs is routed to all of the coupler cards via the cardcage busses. You can select either buss 1 audio, buss 2 audio, or no buss audio (center-off position) with the switch on the front of the couplers. A secondary audio path is also available at the individual couplers. On the rear edge of each card is a 1/4 inch, TRS phone jack. This jack is connected, through a variable resistor (R21), to the audio leads of the telephone transformer. The audio input at this jack is approximately 600 ohms & may be either balanced or unbalanced depending upon J3. When J3 is connected the audio is unbalanced. J3 must be connected when bussed audio is sent to the card. Since this audio path is passive, you may either send or receive audio from the coupler through the jack. To use the Aux in/out jack you will want to place the input select toggle switch in the center (off) position, so that neither buss is selected. R21 will allow you to adjust the Aux send (or receive) audio. FCC regulations require that no signals greater than -9dBm be transmitted on the voice phone network. As a result of this regulation, the AC-1's internal limiter (diodes d1 & d2) will clip and the clipping LED will light as signals begin to exceed this level. Some clipping of peaks is normal. The LED should be on about 20% of the time. If it stays on for longer, you can use the gain set resistor to reduce the level. The outgoing signal should be clearly heard when you call the unit. If you are sending a balanced audio feed into the couplers that has no ground reference, you may notice that the clipping indicators do not light up. Because of the single ended power supply limitations of the coupler and the desire to maintain a true balanced capability, this is a normal situation. If you would like to use the clipping indicators to set levels, you can momentarily unbalance the cards with jumper J3 to set the levels.

To receive audio from the phone line, simply connect your input to the AC-1's auxiliary audio connector. Any audio present on the phone lines will appear at the AC-1 audio connector. Audio level may be adjusted with R21, the auxiliary-audio level set resistor. Since the unit passes audio even when not on line, incoming ring signals will appear at the audio jack as well. This may sound like a chattering sound when amplified. Although this signal is normal and is limited to approximately -9dBm, we recommend that you do not leave the coupler's output connected to active high power amplifiers, or headphones amps, when it is not on line.

Front Panel Controls

The Power supply card has one indicator and two multi-turn variable resistors. The LED indicates the presence of power at the card. The upper gain control is used to control the level of audio buss 1. As you might have guessed, the lower control is used to adjust audio buss 2. Each adjustment should be set until the clipping LEDs on the individual coupler cards are off for at least 80% of the time.

The AC-1's front panel controls and indicators: The front edge of each coupler card contains four indicator lamps, two momentary push type switches, a three position toggle switch, and a variable resistor. The top LED is a power indicator and shows that the card is seated in the cage and is receiving Voltage. The red LED marked "ring" lights up during an incoming ring to show you that the unit is receiving an incoming call. When the unit connects to the incoming call, the green "online" LED will be illuminated, indicating that the unit is on line. When the pickup switch is momentarily pushed, the unit will pick up (seize) the line. When the release switch is momentarily pushed, the coupler will hang up, releasing the line. When the three position switch is in the up position, buss 1 audio is sent to the coupler. In the down position, buss 2 audio is sent to the coupler. When the switch is in the middle position, no buss audio is connected to the card.

****NOTE:**** Whenever you use the auxiliary audio connector, the switch should be in the middle position, or buss audio will appear at the coupler and at the jack. Below the buss switch is a 15 turn gain control trimmer. This may be used to set the input and output level at the auxiliary jack. Below the gain trimmer is the clipping LED. This LED lights whenever the audio level at the transformer exceeds -10dbm. If the LED is on for more than 20% of the time, you should adjust the appropriate level control to compensate. As noted previously, if your audio feed to the couplers is balanced *and* has no ground reference, the clipping indicators will not light. Momentarily unbalancing the cards with jumper J3 will allow you to use the clipping indicator to set levels.

Removal and Installation of Cards:

With the exception of the Power/Audio Input card, any card may be removed or installed in the frame while the AC-12 is operating. All cards have on-board Voltage regulators and a high audio input impedance, so there should be no effect on any other card in the frame.

Removal:

1. Unplug the telephone line cord from the RJ-11 jack.
2. Gently separate the buss connector from the card.
3. Pull the card forward and out of the frame, from the front.

Installation

1. Slide the card into the frame and gently push it back until it stops.
2. Hold the card in place and connect the buss connector to the card.
3. Plug in the telephone cord

Care & Feeding

Generally, the AC-12 may be placed anywhere other electrical equipment is in operation. As always, it is best to avoid extreme temperatures, immersion, or high impacts of the sort associated with ten-story drops or descending sledge hammers. Individual cards may be pulled and blown off with compressed air or brushed with a soft bristled brush. If you wish to clean the outside of the AC-12, use a damp cloth soaked in a mild soap and water solution. Detergents, alcohol, or solvents may mar the case or front cover.

Theory of Operation

POWER SUPPLY/AUDIO CARD:

Power from an external power transformer is rectified by the bridge and filtered. A jumper selectable line of six 6A diodes in series is available for dropping the input voltage from power transformers rated at over 15Vac or 16Vdc. This reduces the load on the linear Voltage regulators and reduces associated heating. The filtered dc is then sent to the buss to power other cards. Filtered dc is also sent to the onboard regulator after which it is used to power the audio input amplifiers. The AUX PWR INput is designed for an optional 13.8V regulated DC supply (provided by the user) which may function as a backup supply . A 6A diode steers this supply port off when the main supply is active. Leds are provided for main, aux. & regulated power. A jumperable, flashing LED indicates when either power supply fails.

The card contains an LF353 or similar IC with two audio amps. Each one of these amplifiers is operated independantly and used to drive one of the two busses. Audio enters each amp through an H-pad attenuator. This attenuator may be jumper selected in or out. When the jumper is connected, the input gain is reduced by approximately 16dB. DC blocking caps C1,2,4 & 5 keep the inputs DC isolated. Since the power supply is single-ended, R15 & R16 form a voltage divider which sets the input reference at $VCC/2$. Capacitor C7 provides an AC reference to ground, stabilizing the amplifiers. Resistor-capacitor combinations R6/C3 and R13/C6 provide feedback, gain set, and additional low pass filtering which improves the stability and RF rejection of the AD-12. The outputs are sent to the buss through gain control resistors R7 & R14. R19 & R20 provide a constant and low impedance to the audio buss so that the level does not change as cards are added or removed from the buss. A schematic and parts layout diagram for the power supply / audio card can be found near the back of this manual.

AC-1 COUPLER CARDS

The AC-1 consists of three separate sections - the audio section, the logic section, and the type approved protective coupler section, which is designated MPC-2.

AC-1 Audio Section:

Buss audio from the power supply/audio card is routed to S3 a three position, single pole toggle switch. the output of S3 passes to pin 6, the inverting input, of U7b, part of an LM324 quad op-amp. U7b acts as a high impedance input buffer and also provides for a small amount of gain over the buss level. Biasing for U7a and U4b is provided by resistive divider R25/R26 which sets the reference voltage at $1/2$ of V_{cc} or approximately 6Vdc. The output of U7b feeds U7c which is configured as a unity gain follower that feeds the MPC-2 line transformer through R29 and C16. Bias reference for U7d is provided by dc coupling the output of U7b directly to the non-inverting input of U7d.

U4a and U7c make up the clipping indicator circuit. When audio is present at the MPC-2 telephone transformer, it is sampled and amplified by U7a which operates as a medium gain amplifier. The amplified output of U7a passes to comparator U7c. R33 & R34 form a voltage divider that sets the crossing point for the comparator output. When the amplified peak audio voltage exceeds the threshold set by R33/R34 the output changes states causing LED D15 to illuminate. Diode D14 provided hysteresis to insure that the clip LED is completely off below the preset threshold.

The auxiliary audio path is completely passive. Variable resistor R21 is connected to the audio path at the junction of R29 & C16. I/O gain is set by adjusting R21 for the desired level. R20 assures that the input resistance never drops below 560 Ohms. The 1/4" audio jack is ac coupled to the rest of the circuit through C10 and C11, two 4.7uF non-

polarized capacitors . Because the audio path is passive to the jack, audio may be either sent or received. When the auxiliary audio path is used, you must set the buss select switch to the middle “off” position to prevent mixing buss audio and auxiliary audio. If you require a balanced audio path for the auxiliary audio port, removing J3 will unground the ring connection. As with all phone interfaces, full duplex transmission is possible through the use of an external hybrid.

Logic & Control section:

The ring detect output of the MPC-2 is pulled up by resistor R3, smoothed by capacitor C5 and fed to the input of U3A, a 4093 Schmitt-triggered NAND gate which provides a clean square wave output. The cleaned-up output from U3A is routed to a 4017 which operates as a ring counter. U4a is configured as a timer that resets the 4017 counter if the line stops ringing before the coupler picks up. The incoming ring signal also drives ring indicator transistor, Q2. Several outputs from the 4017 are brought out to a six position jumper block. When the ring count reaches the selected (jumpered) output, it is passed via C22 along to inverter U3c and also to Q1 which provides a momentary ground sink to drive the aux. relay and pulsed open-collector out on the User interface (CN3). The output of U3c drives an SR latch made from U4c, U4d which, when latched energizes the MPC-2 seize relay. The smoothed ring pulse remains low long enough for the line current detector output of the MPC-2 to keep nand gate U3b from resetting the s-r latch. When the calling party hangs up, the Telco Central Office (CO) signals with a momentary zero-crossing (the line voltage momentarily reverses or drops to zero). The line current detector output goes high during this zero crossing and forces the output of nand gate u3b low, which resets the R-S latch, hanging up the line. U3d is a reset timer which prevents the AC-2b from erroneously seizing the line when the power is first applied. U4b is a simple inverter which provides a high output to seize the line when the pick-up switch is thrown.

Auxiliary relay k2 provides 2 sets of dry contacts for the user. K2 's operation mode is controlled by J2. In position M, k2 is energized by transistor q1 for the duration of the monostable set-pulse. When J2 is in position L, k2 is energized by q4 for the duration of the call. Form-C contacts from K2 are available on User interface connector CN3. Pins c, d, and e are NO, NC, and common respectively

MPC-2 type approved section:

The telephone line tip and ring connect through an RJ-11c jack to the MPC-2 circuit board. An MOV across the line suppresses any hazardous transients. Two 0.1 uF DC blocking capacitors pass audio to the telco transformer when the unit is off-line. One input of an H11AA1 ac input optocoupler is connected to TIP through normally closed contacts on the DPDT relay, K1; the other input connects to RING through a .56uF capacitor and a 22k resistor. When a ring occurs the optocoupler's output transistor turns on and provides an open collector output, which is the ring detect output of the MPC-2. When 12vdc is applied to the field of the DPDT relay, the ring detect optocoupler is taken off line and the relay closures make a dc path from tip and ring to one side of the transformer. The line-current detect optocoupler is then also connected between tip and ring through a 1k current limiting resistor. When the MPC-2 has seized an active telephone line current flows through the input of the line-current detect optocoupler, turning on the optocoupler's output transistor and providing an open collector output which is the MPC-2's line-current detect output. When the caller hangs up the optocoupler turns off, signalling that the call is over. FCC required signal limiting is accomplished with special back to back diodes across the user side of the telco transformer. While removing these diodes may result in improved audio performance, we do not recommend their removal because it will void the unit's warranty, the FCC type approval and possibly allow excessive signals to pass through the coupler. Because of FCC regulations, any modification of the MPC-2 voids the unit's type approval.

Trouble Shooting

Problem: Ring LED lights but unit does not pick up on incoming ring.

Solution: J1 missing, U3,U4, or U6 toasted, Q3 torched.

Problem: Picks up then hangs up.

Solution: U3 or U4 (4093) dead, or H11AA1 line current detector on MPC-2 is zotched.

Problem: Unit won't hang up; online LED stays on even when phone line is unplugged.

Solution: U3 (4093) is probably fried.

Problem: Online LED doesn't light when coupler picks up.

Solution: Q4 is bad, or LED has become very unhappy.

Problem: Ring LED stays lit continuously.

Solution: U3 (4093) or Q2 not operating properly, power supply oscillating.

Problem: Aux relay doesn't activate in momentary mode, but coupler does connect.

Solution: Q1 is toast or J2 is missing.

Problem: Aux relay doesn't activate in latching mode, but coupler does connect.

Solution: Q4 is toast or J2 is missing.

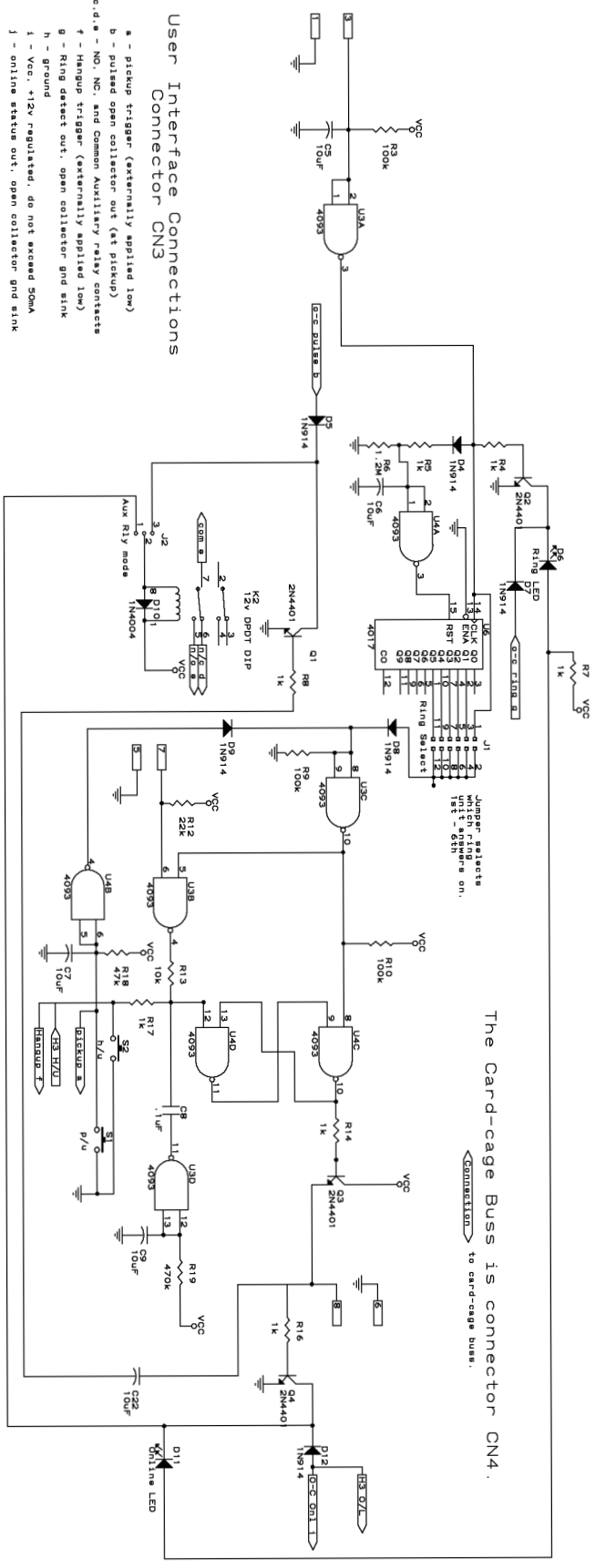
Problem: Nothing happens, coupler appears to be in hibernation.

Solution: Check for proper connection to phone line and power first; suspect fault in connection to the buss, a failed power supply / audio amp board (if all couplers are dead) , or the 7812 regulator on the afflicted AC-1 card. Optionally, wait for spring to see if coupler stops hibernating.

Notes:

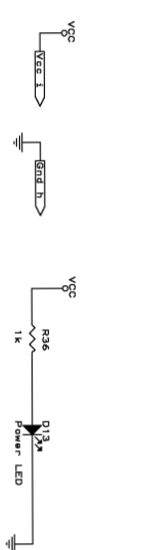
1. Transistors Q1 - Q4 are medium gain switching transistors. They can be replaced by an equivalent like the ECG123A or the Radio Shack 276-1617.

CircuitWerkes AC11b Enhanced Card-cage Autocoupler

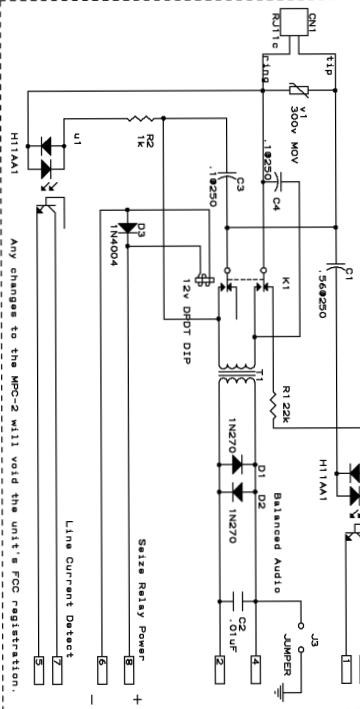


User Interface Connections

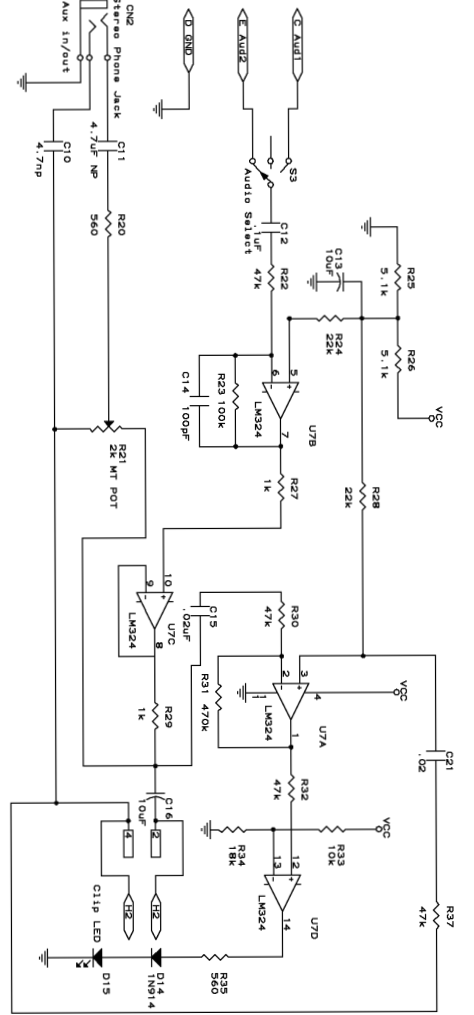
- a - pickup trigger (externally applied low)
- b - pulsed open collector out (at pickup)
- c,d,e - NO, NC, and Common Auxiliary relay contacts
- f - Hangup trigger (externally applied low)
- g - Ring detect out, open collector and sink
- h - ground
- i - Vcc, +12v regulated, do not exceed 50mA
- j - online status out, open collector and sink



MPC-2 Type Approved Section



Connections between MPC-2 and the rest of board appear in this style module port. MPC-2



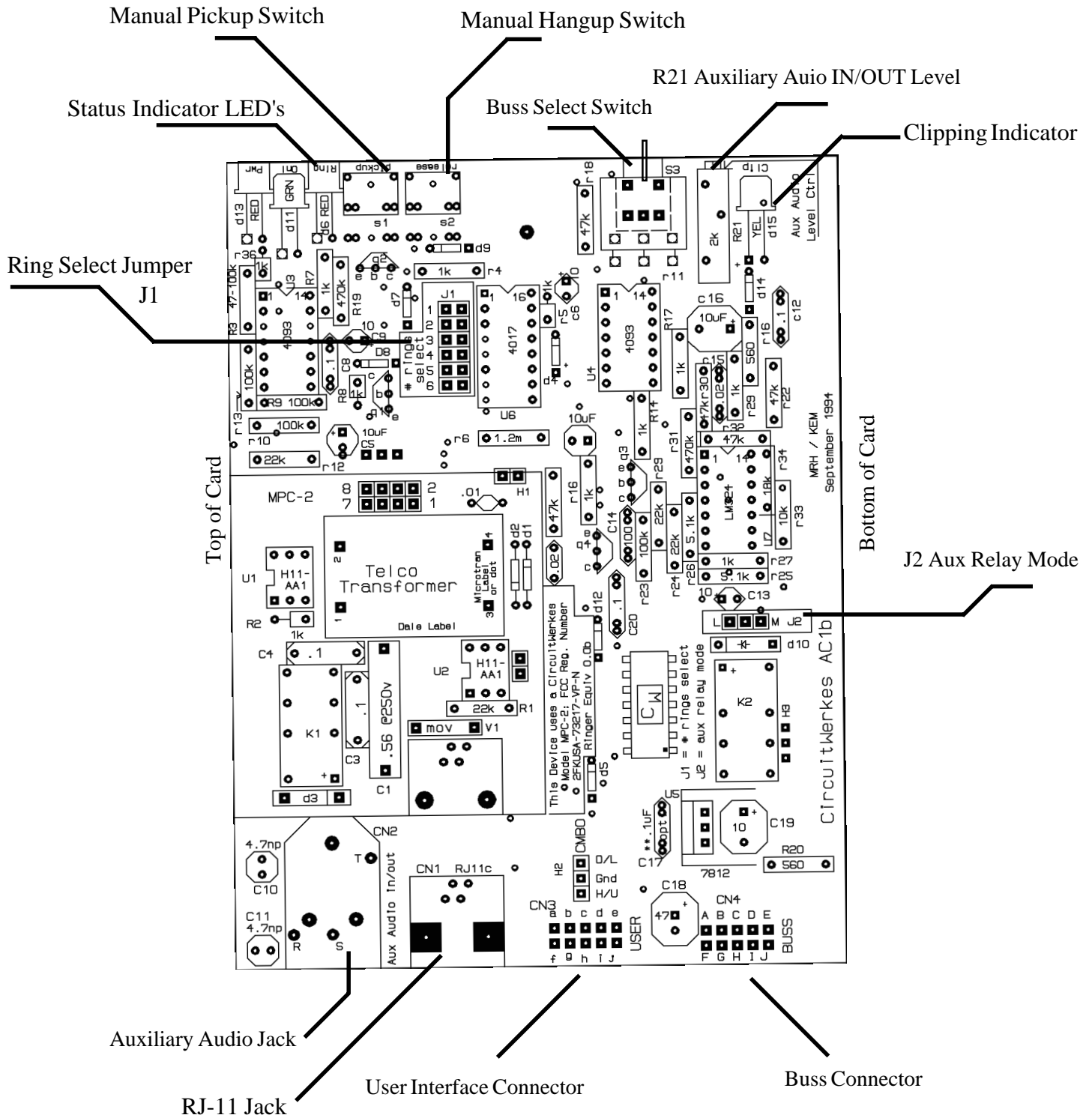
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CircuitWerkes
3716 SW 3rd Place
Gainesville, FL 32607
(904) 351-5252

AC-11b Card-Cage Autocoupler

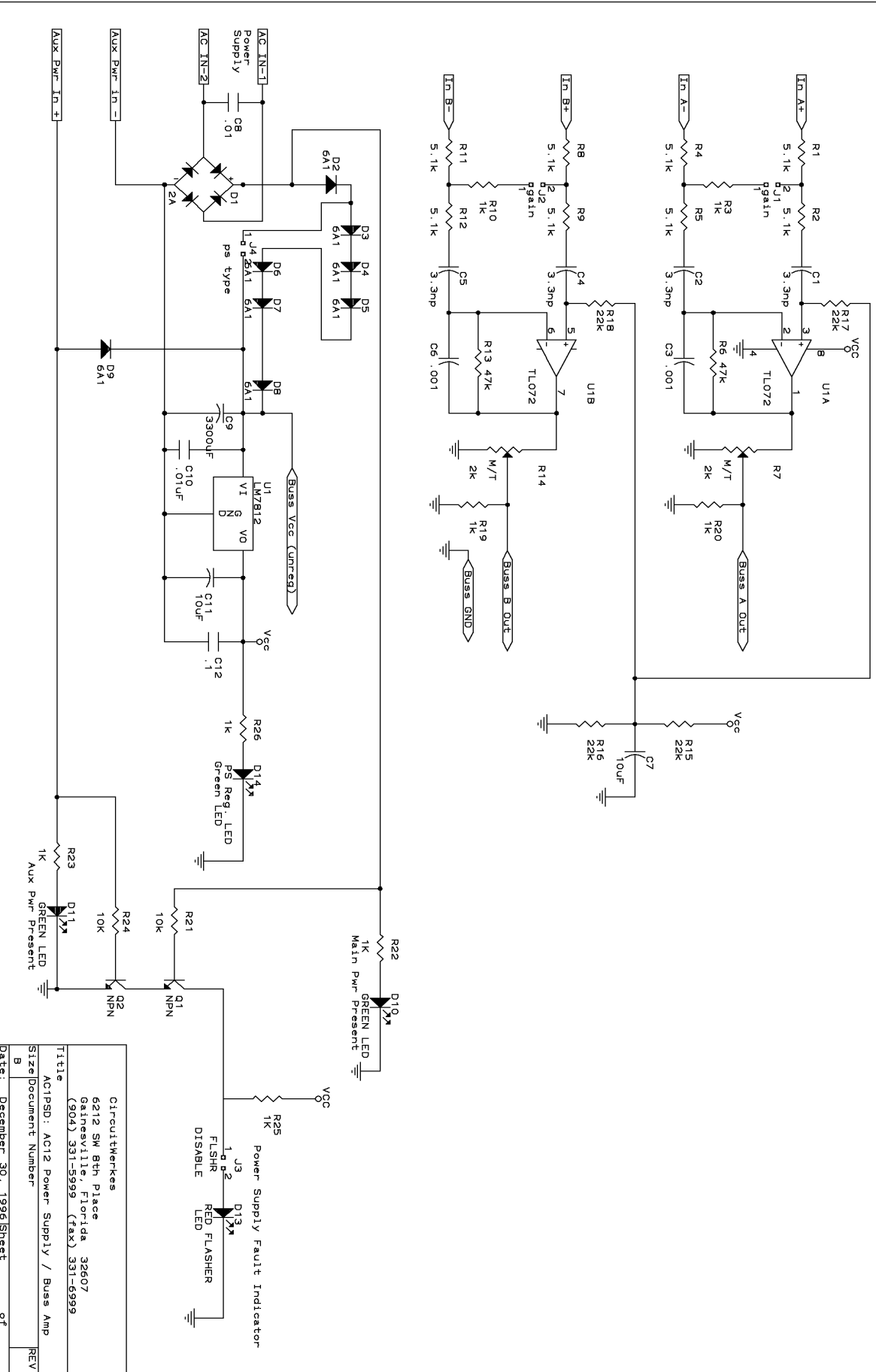
REV 01

AC-1b Autocoupler Parts Layout (not to scale)





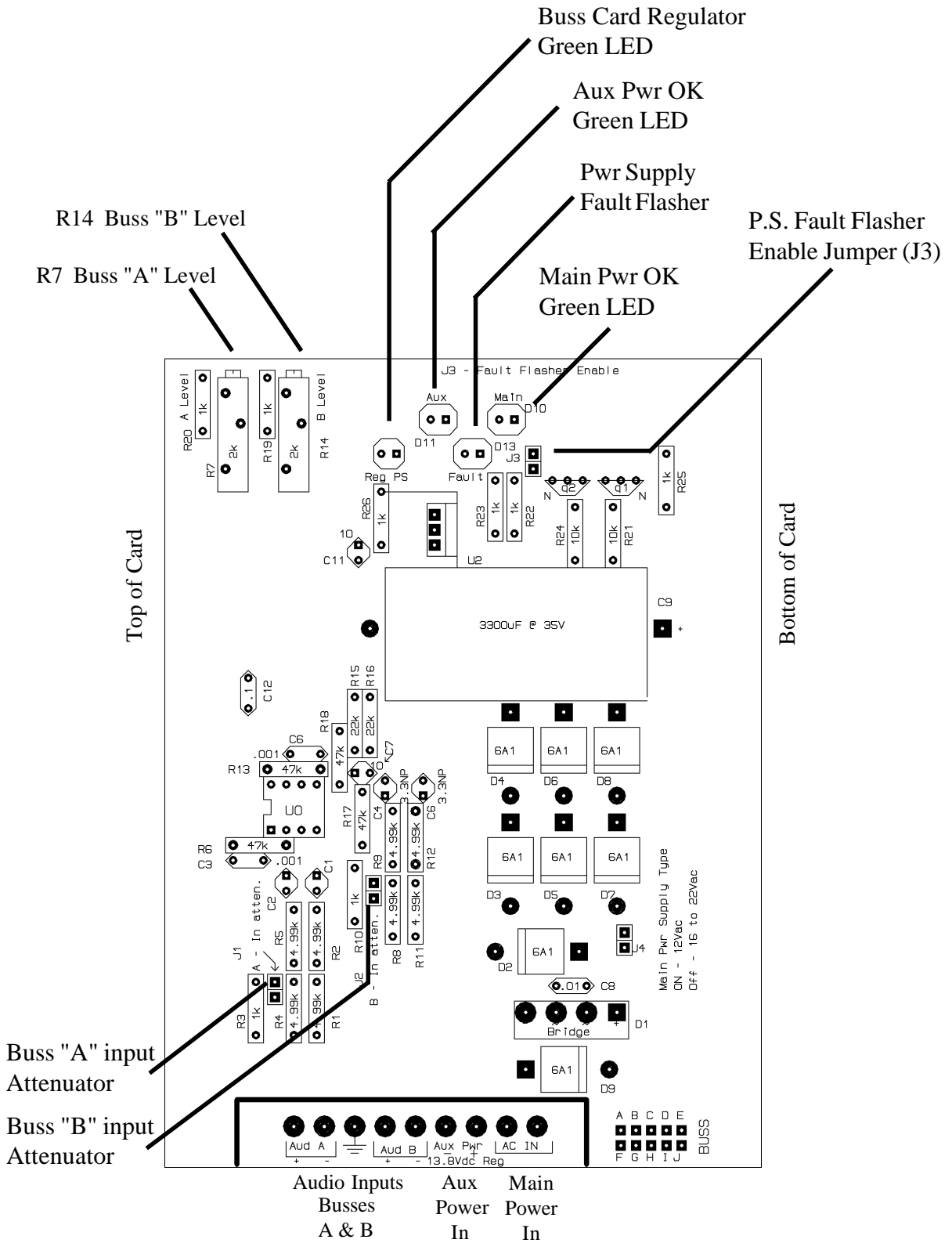
CircuitWerkes AC12 Power Supply / Buss Amp Model1 AC1PS - 97a



Power Supply / Audio Card Schematic

CircuitWerkes 6212 SW 8th Place Gainesville, Florida (904) 331-5999 (fax) 331-6999	
Title	AC1PSD: AC12 Power Supply / Buss Amp
Size	Document Number
Date:	December 30, 1996 Sheet 07

Power Supply / Audio Card Parts Layout (not to scale)



Appendix A {Information the FCC makes us include...}

NOTIFICATION TO THE TELEPHONE COMPANY

This equipment complies with Part 68 of the FCC Rules. You will find the label located on the solder side of the PCB, and on the bottom or back of the equipment enclosure if device is enclosed. This label contains the FCC Registration Number and Ringer Equivalence Number (REN) for this equipment. You must, upon request, provide this information to your telephone company. The REN is useful to determine the quantity of devices you may connect to your telephone line and still have all of those devices ring when your telephone number is called. In most, but not all areas, the sum of the RENs of all devices connected to one line should not exceed five (5.0). To be certain of the number of devices you may connect to your line, as determined by the REN, you should contact your local telephone company to determine the maximum REN for your calling area.

JACK TYPES NEEDED

Connection to the telephone network should be made by using standard modular telephone jack type RJ11C.

INCIDENCE OF HARM

If your telephone equipment causes harm to the telephone network, the telephone company may discontinue your service temporarily. If possible, they will notify you in advance. But if advance notice is not practical, you will be notified as soon as possible. You will be informed of your right to file a complaint with the FCC.

RIGHTS OF THE TELEPHONE COMPANY

Your telephone company may make changes in its facilities, equipment, operations or procedures that could affect the proper functioning of your equipment. If they do, you will be notified in advance to give you an opportunity to maintain uninterrupted telephone service.

MALFUNCTION OF THE EQUIPMENT

In the event this equipment should fail to operate properly, disconnect the unit from the telephone line. Try using another FCC approved telephone in the same telephone jack. If the trouble persists, call the telephone company repair service bureau. If the trouble does not persist and appears to be with this unit, disconnect the unit from the telephone line and discontinue use of the unit until it is repaired. Please note that the telephone company may ask that you disconnect this equipment from the telephone network until the problem has been corrected or until you're sure that the equipment is not malfunctioning.

COIN SERVICE OR PARTY LINE USE

This equipment may not be used on coin service provided by the telephone company. Connection to party lines is subject to state tariffs.

REPAIR OR SERVICE INFORMATION

In the event of the need for service or repair, call CircuitWerkes at (352) 335-6555 for a Return Merchandise Authorization number (RMA). Then carefully package the unit along with a note of the problem and send it to the address below. Clearly indicate the RMA number on the outside of the box. We cannot accept returns without an RMA. Be sure to include your address (not a PO box), telephone number and best time to call.

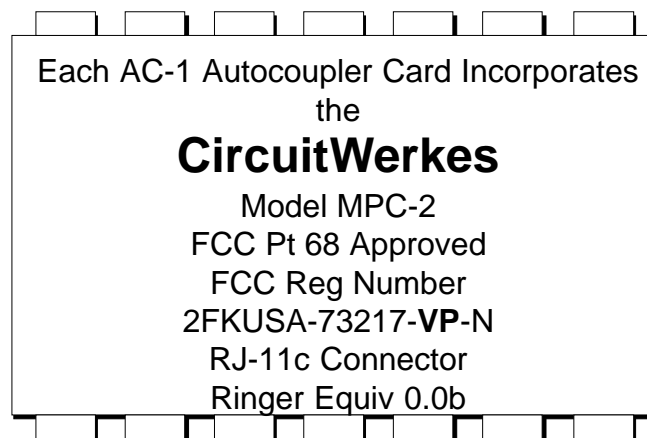
CircuitWerkes

Attn: Customer Service Dept.
3716 SW 3rd Place
Gainesville, FL 32607

CircuitWerkes Limited Warranty

This product is warranted against defects for two years from date of purchase from CircuitWerkes and CircuitWerkes authorized distributors. Within this period, we will repair it without charge for parts and labor. Proof of purchase-date required. Warranty does not cover transportation costs, or a product subjected to misuse, accidental damage, alteration (except as authorized by CircuitWerkes), improper installation, or consequential damages.

Except as provided herein, CircuitWerkes makes no warranties, express or implied, including warranties of merchantability and fitness for a particular purpose. Some states do not permit limitation or exclusion of implied warranties; therefore, the aforesaid limitation(s) or exclusion(s) may not apply to the purchaser. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.



Product information updates and latest manual releases/updates may be downloaded from our web site at www.circuitwerkes.com.

Notes: