

An 11-pin Interface to the Motion Sound Rotary Amps

Bob Rinker
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This document describes circuits that can connect the 11-pin Leslie output found on many recent-model Hammond keyboards and clones to the Motion Sound rotary amplifiers. The circuit allows the rotary effect to be controlled from the keyboard, like a real Leslie. Motion Sound uses two different internal circuits on their amps – the Pro-3 and KBR series amps use one type, and the Pro-145 and guitar amps use another. I have designed separate circuits that work with each type.

Introduction

I recently purchased a Hammond XK3 keyboard and Motion-Sound Pro-3T rotary amp. I was surprised to find that there were no devices on the market that allowed the two units to be connected and have full control of the rotary from the keyboard. Therefore I went about designing my own. I determined the functions of the 11-pin pin connector and the Pro-3T from information on the web and by experimentation. The result is the first circuit I describe below.

A couple of people then inquired about a circuit for the Pro-145. I contacted John Fisher of Motion-Sound, who very graciously provided the information I needed to design a circuit for the Pro-145. While I don't own a Pro-145, there are several people who have reported success in using my design with their equipment.

While I tested the Pro-3T circuit specifically with my Hammond XK-3 and Pro-3T, it has since been used by others who own the KBR models, and other Hammond keyboards, and seems to work just fine. Similarly, several people have used the Pro-145 circuit with success. However, I make no promises. (*I would* be interested in hearing about your success stories and improvements, however).

Motion Sound has a simple circuit on their website (www.motion-sound.com) that (partially) emulates an 11-pin Leslie connection. It is simple and the circuit can be built into the cable itself, making for a tidy solution. Once built, one merely connects the cable between the 11-pin connector on the keyboard and the audio and control jacks on the Motion-Sound amp. It also works with both types of amplifiers.

However, I discovered several drawbacks with the design (at least when used with the XK3):

- It only implements slow and fast speeds, but not stop (brake) mode.
- On the XK3, the audio signal on pin 2 of the 11-pin (designated the "auxiliary" channel) is present only if the "Leslie" switch is turned "OFF" on the keyboard. Thus, the Motion Sound circuit only functions properly when the Leslie is switched OFF, which doesn't seem very intuitive.
- Audio on pin 1 (the "rotary" channel) can be configured to always be ON by selecting the "122XB" (single channel Leslie) setting for the external Leslie parameter on the XK-3 keyboard. However, pin 1 audio contains the simulated Leslie effect when the Leslie switch is turned on. The simulated Leslie effect is undesirable when the mechanical rotary effect is being used.

So, the simple circuit presents a compromise - either leave the Leslie switch OFF, and use the audio on pin 2, or modify the design to use the audio on pin 1, which contains the simulated Leslie effect when the Leslie is ON. A third alternative is to use the audio output from the "effects out" jack, which is always ON and does not have the simulated Leslie effect. However, then you lose the reverb effect, and it requires another plug in addition to the 11-pin. Messy at best.

My circuits make the Motion-Sound amp function like a "real" Leslie – the *Leslie*, *Brake*, and *Fast/Slow* switches on the keyboard function properly. Also, the additional auxiliary audio outputs (pins 2 and 3) on the 11-pin are made available via 1/4" phone jacks, and can be fed to additional amplifiers if desired, providing the functionality of a "multi-channel" Leslie.

Circuit Descriptions

Before looking at the circuits themselves, we need to understand the function of both the signals coming from the keyboard through the 11-pin connector, and the signals required by the Motion-Sound amps. The control signals in the 11-pin connector are pretty simple: The rotor should go to slow if the "SLOW" line (pin 8 on the 11-pin) is asserted (i.e., shorted to ground), to fast if the "FAST" line (pin 7) is asserted, and to stop if neither is asserted.

On the Motion-Sound side of things, the circuit replaces the "stomp box" supplied with the amp, and thus must replicate the conditions for the three modes. The stomp-box is the same for both types of MS amp, and contains switches for the SLOW/STOP (the "ring" connection on the stereo control plug) and FAST/SLOW (the "tip" connection) wires; the wire is shunted to ground (i.e., to the "sleeve" connection) when the corresponding switch is closed. The way in which the stomp box switches are used is slightly different for each type of amp however; they are described separately below.

Some notes about the circuits:

- The circuit requires external power, either from a 9V battery or an external supply. This is necessary because a voltage is applied to Pin 11 of the Leslie cable to turn off the simulated Leslie effect inside the keyboard. The documentation for the 11-pin connector says the voltage should be 24V DC. I have found that anything greater than around 6 volts works on my XK3. The circuit should function correctly with supply voltages of 6 to 15 volts, probably more (or less) if component values are tweaked a bit.
- I built the circuits in a small project box, first on a piece of breadboard, and then using a small printed circuit board I designed. Diagrams of both are included at the end of this description.
- None of the component values are very critical; many people will have the necessary parts in their "junk boxes." Also, the designs are very conservative, to reduce the possibility of damage to either unit.

Below are the schematics, a parts list, the breadboard layouts used for the circuit prototypes (for those who want to build the circuit that way), and finally a printed circuit board for each circuit. The bare printed circuit boards, as well as fully assembled units, are available; please contact me at rinker@cs.uidaho.edu if you are interested, or have any questions.

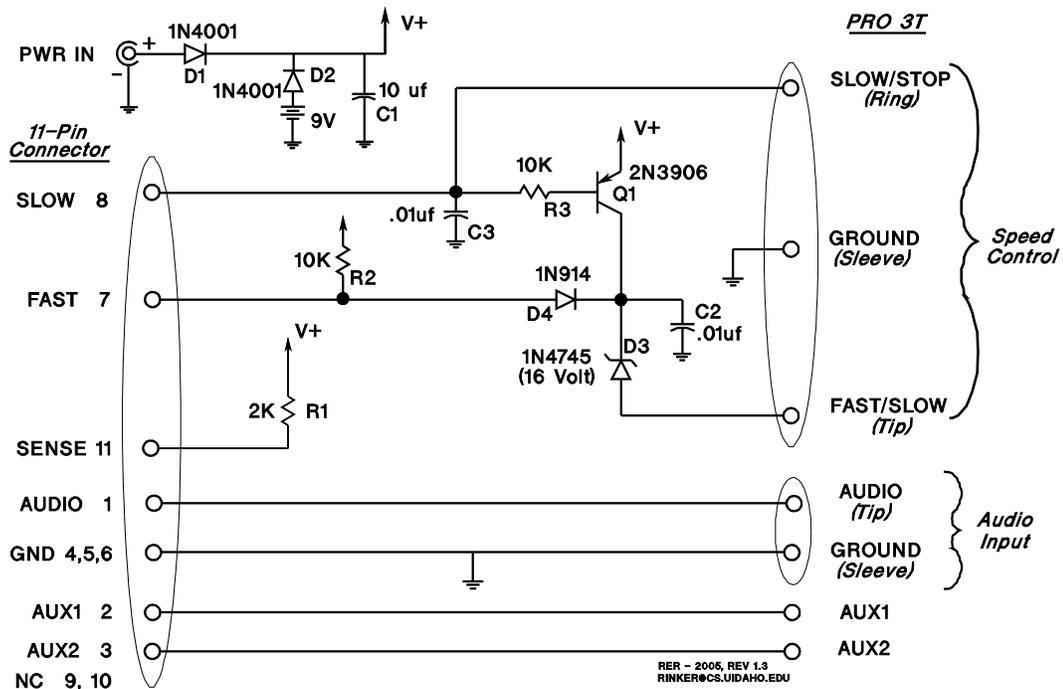
The Pro-3 Circuit

The Pro-3 (including the Pro-3T, Pro-3Tm, and KBR series amps) provides a bipolar ± 15 volt signal to the stomp box. The following table summarizes the possible switch positions and the status of the Pro-3T for each case:

SLOW/STOP Switch			FAST/SLOW Switch			PRO-3T
Switch	Voltage	Mode	Switch	Voltage	Mode	Mode
OPEN	+15 V	STOP	OPEN	-15 V	FAST	FAST
CLOSED	GND	SLOW	OPEN	-15 V	FAST	FAST
OPEN	+15 V	STOP	CLOSED	GND	SLOW	STOP
CLOSED	GND	SLOW	CLOSED	GND	SLOW	SLOW

The Pro-3 circuit works as follows:

- If neither SLOW (pin 8 of the 11-pin) nor FAST (pin 7) is grounded, the Pro-3T is in STOP mode - the SLOW/STOP line (going to the Pro-3) is left open (high), and FAST/SLOW is pulled up to ground via $R2$ and the two diodes $D3$ and $D4$ ($D3$ prevents the voltage from going above ground). This condition corresponds to the third line in the table above.
- If SLOW (pin 8) is grounded, then SLOW/STOP is grounded and $Q1$ turns on, causing FAST/SLOW to be pulled up to ground; the Pro-3T will be in SLOW mode.
- If FAST (pin 7) is grounded, then the current flowing through $R2$ is diverted to ground, and FAST/SLOW goes low (to $-15V$), causing the Pro-3T to go to FAST mode. It should never happen that both SLOW and FAST are grounded at the same time, but if it does, the circuit causes SLOW to override.
- Pin 11 is pulled high through $R1$. This turns the internal (simulated) Leslie off.



Parts List

Qty	Label	Part	Description
1	R1	2K Resistor	
2	R2, R3	10K Resistor	
1	C1	10 uf, 25V Electrolytic Capacitor	
2	C2, C3	0.01 uf disc Capacitor	
1	D1, D2	1N4001 rectifier diode	
1	D3	1N4745 16V Zener	I got mine from www.digikey.com , but could use three 5.1V zeners (Radio Shack 276-565) in series
1	D4	1N914 Small signal diode	
1	Q1	2N3906 Transistor	Any PNP low power will do!
1		9-15V power source	Battery or wall wart
1		Power Plug	If external power is used
1		11-pin plug	I got mine from www.bborgan.com
3		1/4" mono jack	One each for Audio, Aux1, Aux2
1		1/4" stereo jack	for speed control
1		Small project box	I used Radio Shack 270-238
1		breadboard	Piece of Radio Shack 276-170

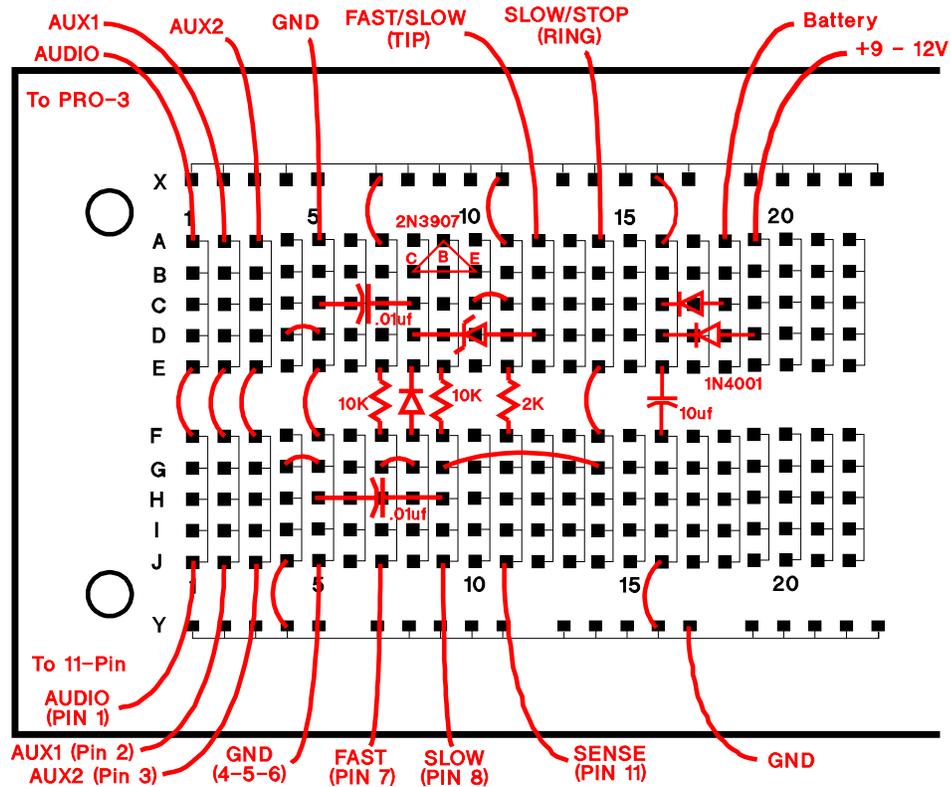


Figure 1: Breadboard layout of the Pro-3T prototype circuit

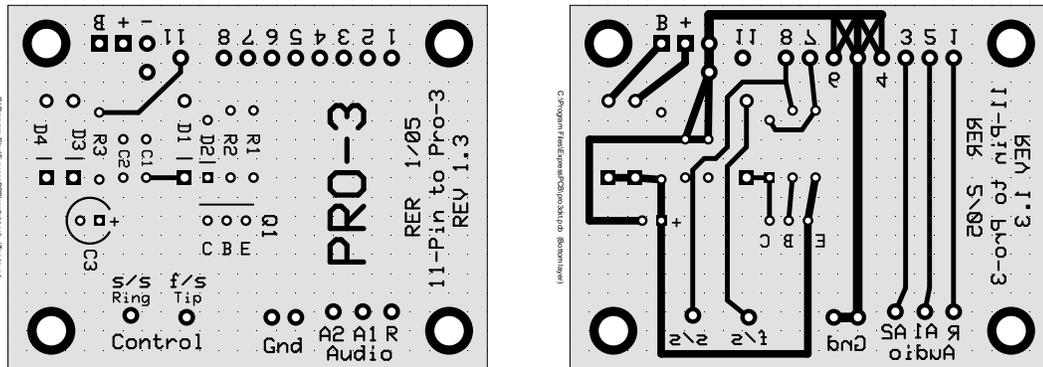


Figure 2: Component (top) side and copper (bottom) side of the printed circuit board for the Pro-3t circuit

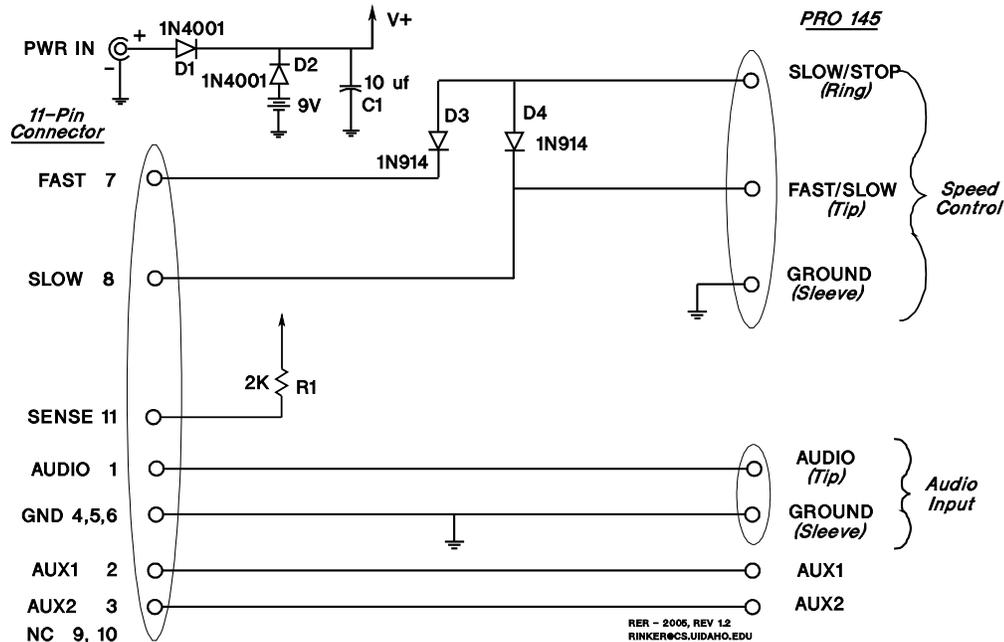
The Pro-145 Circuit

The Pro-145 Amp supplies a single-ended voltage (+15V) to the stomp box. The function table looks like:

SLOW/STOP Switch			FAST/SLOW Switch			PRO-145
Switch	Voltage	Mode	Switch	Voltage	Mode	Mode
OPEN	+15 V	STOP	OPEN	+15 V	FAST	STOP
CLOSED	GND	SLOW	OPEN	+15 V	FAST	FAST
OPEN	+15 V	STOP	CLOSED	GND	SLOW	STOP
CLOSED	GND	SLOW	CLOSED	GND	SLOW	SLOW

The Pro-145 circuit works as follows:

- If neither FAST (pin 7 of the 11-pin) nor SLOW (pin 8) are grounded, the Pro-145 is in STOP mode - both the SLOW/STOP and FAST/SLOW lines (on the Pro-145) are left open (high). This condition corresponds to the first line in the table above. STOP mode overrides the other modes.
- If FAST (pin 7) is grounded, then SLOW/STOP is pulled low by current flowing through *D3*, and the Pro-145 will go into the mode specified by the FAST/SLOW line. In this case, the FAST/SLOW line will be left open, indicating FAST mode. This state corresponds to the second line in the table above.
- If SLOW (pin 8) is grounded, then both the SLOW/STOP line (through *D4*) and the FAST/SLOW line are grounded, causing the state specified by the fourth line to occur, and the Pro145 will go to SLOW mode.
- Pin 11 is pulled high through *R1*. This turns the internal (simulated) Leslie off.



Parts List

Qty	Label	Part	Description
1	R1	2K Resistor	
1	C1	10 uf, 25V Electrolytic Capacitor	
1	D1, D2	1N4001 rectifier diode	
1	D3, D4	1N914 Small signal diode	
1		9-15V power source	Battery and/or wall wart
1		Power Plug	If external power is used
1		11-pin plug	I got mine from www.bborgan.com
3		1/4" mono jack	One each for Audio, Aux1, Aux2
1		1/4" stereo jack	for speed control
1		Small project box	I used Radio Shack 270-238
1		breadboard	Piece of Radio Shack 276-170

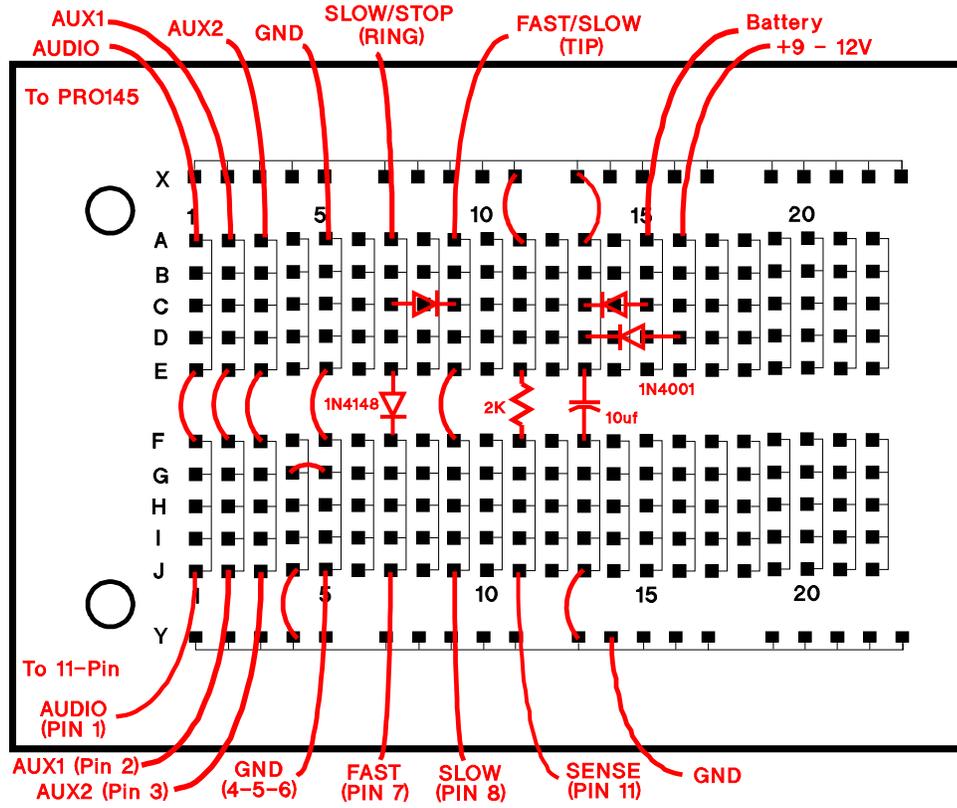


Figure 3: Breadboard layout of the Pro-145 prototype circuit

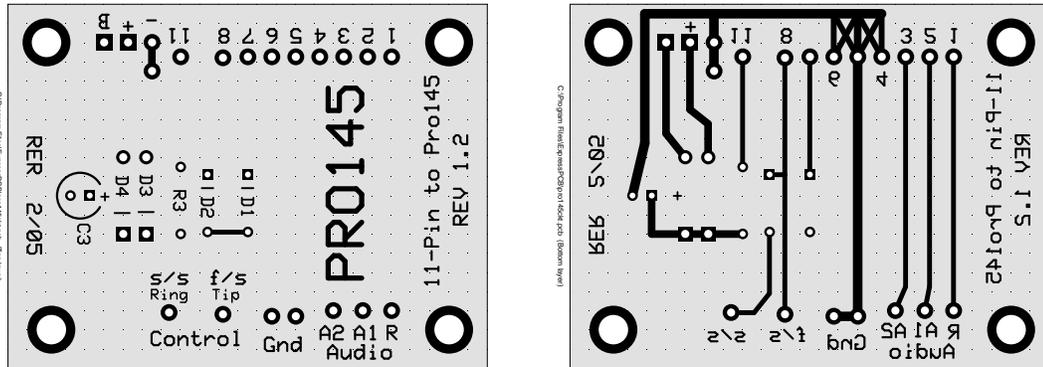


Figure 4: Component (top) side and copper (bottom) side of printed circuit board

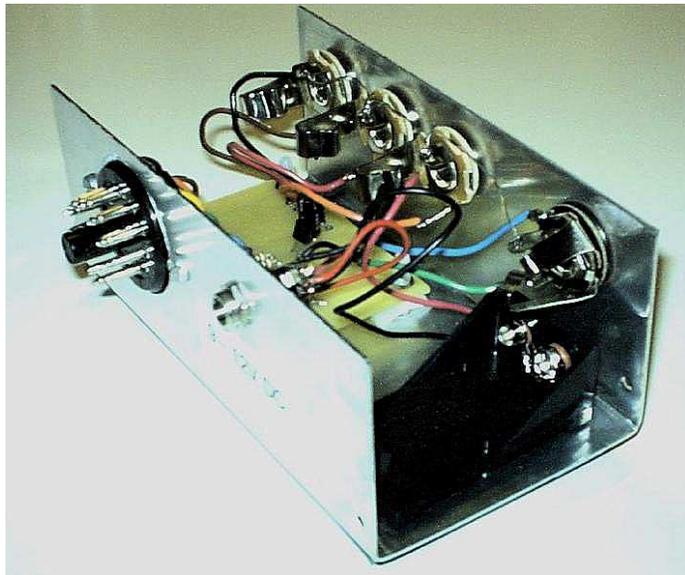


Figure 5: Front and back views of the completed interface unit, with the top removed



Figure 6: Front and back views of the completed interface unit