# SWTPC PR-40 Printer

## Use, Maintenance & Troubleshooting in the 21st Century

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Southwest Technical's famed little impact printer kit is a useful and fun vintage peripheral to connect to your early microcomputer. It's a straightforward device to understand and debug, and easy to drive from simple 8-bit programs. SWTPC's own documentation is great, of course, but fifty years on these printers can suffer maintenance issues and failures that prevent their modern operation.

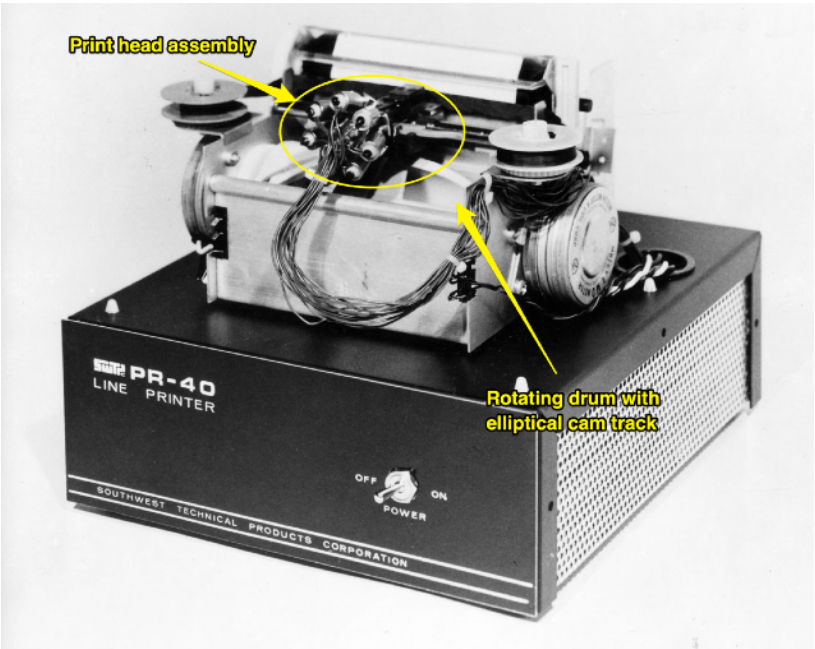
This is a document outlining some information learned the hard way plus some additional technical odds and ends that are not in the original documentation and may be of use or interest. It is not comprehensive.

The nice thing about this printer is that with the exception of the transformer (which never breaks) and the monolithic print head itself (more on that later), pretty much the whole machine is made up of parts that can be replaced by stuff that is still possible to source without too much difficulty.

If you're bringing up a PR-40, especially if it's been sitting unused for decades, and especially especially if it had seen heavy use and/or was stored somewhere grimy, you should clean up the print mechanism before doing anything else.

## The Print Mechanism

The print mechanism is the whole rig bolted onto the top of the sheet metal box. It's a third-party OEM impact print mechanism by LRC (and/or Eaton?). This was an off-the-shelf component used in adding machines and similar. The print head contains a block with seven vertically arranged pins, each one actuated by a solenoid coil. (The "flower" of cylinders you see as you look at the print head is the set of solenoid coils.)




There are three points of signal connection with that tie it to the SWTPC base: a 15-pin AMP connector with the tiny wires that run to each coil of the print head itself; four heavier gauge wires from the AC motor mounted to the side; and three wires that come from the small microswitch that detects the position of the carriage.

The printer works by driving the motor to rotate an elliptical cam track (in one direction only). The print head has a cam follower pin underneath it and sweeps back and forth across metal guide rail (and thus paper) as the motor turns. Separately, the coils for the pins are controlled by the electronics, and energizing a coil throws its pin out of the print head and into the ribbon and paper. The distance of the pin displacement is very small, less than a millimeter, and the coils are energized very briefly. All of the timing that coordinates the sweep of the head with the pin coil actuation happens in the printer's electronics.

The motion of the print head will also push the gear teeth on the bottom of the ribbon spool each time it reaches one side. When the ribbon has wound to one end, the resistance will push the little arm on the head to its other position which reverses the side being spooled and thus reverses the ribbon. This is very clever.

Your first stop for using this printer will be to **clean and lubricate the mechanism**. The simplest way to do this is to remove the print head entirely first: Unscrew the two hex head screws that hold the print head guide rail in place, then wiggle the rail-with-print-head out of the metal frame.

Now you can slide the head off of the rail. Clean the print head block with alcohol on a q-tip. Wipe clean the guide rail with an alcohol soaked rag, and clean out the two metal guide rings in the print head that the rail passes through. Clean anything else that seems crusty or dirty or sticky. Clean the old grease off the cam follower pin at the bottom of the print head.

With the print head still removed, use alcohol and q-tips and toothpicks and whatever else you have on hand to clean out all the old grease from the cam track on the rotating part. (You can just add new grease but the old stuff will still gunk it up a bit.) Be careful when you rotate this by hand, it only goes one way — top away from you — and if you do it backwards at the wrong part of the cycle you can damage the microswitch.

*Note on lubrication: people often have strong opinions about mechanical lubricants; this is just how I approached it. If you feel differently, definitely go with what your experience suggests!*

Once the old grease is cleaned out, **apply new grease**. I use Phonolube, which is great for this sort of thing, but can be hard to find, so silicone grease or similar should work too, maybe white lithium grease? (Ensure that your grease is not unkind to plastics.)

Notice that the front lip of the fixed frame also has a track in it (facing away from you, easy to miss) that the flat front part of the print head moves in. This can be cleaned and relubricated also. The same stuff should work here (it's also a plastic/metal interface) though SWTPC did use a different kind of grease for this track; I used Phonolube here again, but a silicone grease would work as well. **Apply some new grease** here.

Slide the print head back onto the guide rail. It *should* slide freely along the rail **with no grease on it**. I don't think this rail requires "grease" if the rail and the rings it moves through are very clean. If there's still some binding as it moves and/or you want to use some lubrication, a very light touch of light machine oil (sewing machine oil) on the rail or a very thin touch of white lithium grease should be OK.

(I did not relubricate the motor itself or the rotating barrel's axle— to access that spindle would require more disassembly than I wanted to do, but if yours is sticky it may be worthwhile.)

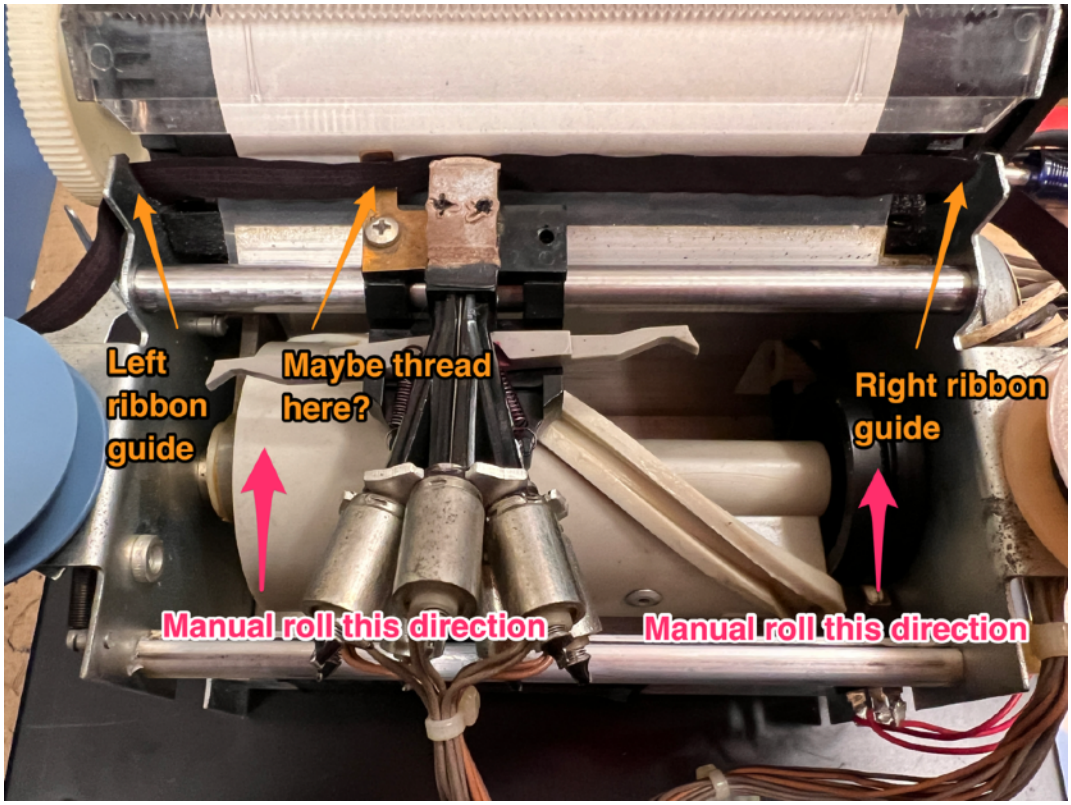
Make sure to angle the front "tail" of the print head back into the front track as you wiggle the sides of the guide rail back into their homes inside the metal frame. You'll also have to line up

the cam track with the print head so it drops into place correctly. Once you have done this, you should be able to rotate the drum gently by hand and the print head should zip freely along the rail. Re-screw the two screws to hold the rail in place.

Now your mechanism should be ready to print like it's 1976! If you're fortunate, this is all the maintenance that will be required, and you will be totally good to go and the printer will work right away for you. If not, skip down to Troubleshooting.

# Hints for Usage

The ink ribbon threads behind the symmetrical incised metal guides on either side of the platen width, and of course runs between the print head and the paper/platen. You may (or may not) find that print quality improves if you also detour the ribbon through the "slot" made by the brass bracket on the print head. There is a spring loaded tensioner on the left of the mechanism by the spool, and I run the ribbon inside of this lever.




You can advance the paper with the white gear wheel at the left side of the platen roller of course, but note that the this only works well if the carriage is towards the left side of the paper as in its normal "home" position— if it's over at the right, you'll find the advance *sort of* works but also grinds the gears in the process— avoid doing it in that position.

You can move the carriage by hand by using a finger to push the barrel roller surface *away* from you. If there's not enough space for your finger, you can do the same with the drive gear at the right with the motor belt. (When touching the motor belt your finger should be clean of grease or oil.)

**Important:** the barrel roller *seems* to be moveable in both directions but if you roll it the wrong way (towards you), you can jam and deform the microswitch without realizing it. *Always roll it away from you*.

**Don't run the printer continuously for more than a couple minutes**. This is stated in the SWTPC instructions but bears repeating. This mechanism was designed for adding machines and cash registers, not for printing long documents onto reams of paper. The risk of burning out a solenoid coil increases the hotter the coils get. According to the manual, you can adjust down the "intensity" of the print impression which shortens the length of time the coil is energized for each impact. (I haven't tried this adjustment.)

# Character Set

Shown here is the printer's character set as depicted in the data sheet for the National Semiconductor 5241ABL character ROM. Note that the caret (^) character maps to an up arrow. The underscore character will be omitted from the printer's output; it appears below the baseline and so requires an eighth row of dots, which the printer does not have.

FIGURE 8. MM4241ABL/MM5241ABL Vertical-Scan ASCII-7 Graphic Subset

# Consumables

PR-40 printers consume peculiar **paper** and **ink ribbons**, and unfortunately neither of these will be on the shelf at Office Depot today, but they're not impossible to come up with.

The paper is 3 7/8" wide and is *regular one-ply bond paper* (i.e. it is *not* thermal or silver or any other specially coated paper). This used to be a standard, common paper roll size (as noted in the documentation), but it has not been standard for some time, and you will be disappointed if you look to modern office suppliers. You can watch for NOS rolls of it on eBay etc, but you can

also request that rolls be cut to size for you by a speciality office supplier. (The diameter of a full roll can be about 3” or a bit over I think). Don’t pay collector prices for plain paper, folks!


The ink ribbons are unique to this mechanism. Don’t bother looking for “SWTPC” branded stuff, you won’t find it and you don’t need it anyway. Because the print mechanism was a third-party part and used in multiple devices, you can search for “LRC 7000” or “Eaton 7000” or similar combinations to look for ribbon spools, both NOS as well as new-new. As of this writing, there are multiple sellers at various price points. The most “popular” consumer printer that used this mechanism was probably the Atari 820 of the later 70s, and supplies for that printer will also work in your PR-40.

Nothing lasts forever, and ink from decades ago especially so. Even if you can find NOS ribbons, you may be better off finding a source of new ones, or DIY’ing new ribbon onto your existing spool.

You can order fresh 5/16” inked fabric ribbon (it’s an unusual but not unavailable size) and hand wind it onto the spools. The original color of the ink was a sort of aniline purple familiar from old register receipts. Black might be more useful, if you can source that.

# Troubleshooting Tips

Multiple things were wrong with the PR-40 unit I recently got working. Here is what I learned while trying to get the SWTPC diagnostic program to work:

***If the motor doesn’t run at all…***

The motor turns the big barrel which moves the carriage. If the printer should be printing, the carriage should be moving. First of all, be sure that you’ve cleaned and lubricated the mechanism as outlined above. It’s plausible that enough ancient gunk could harden to prevent it from rotating at all even if the motor is trying to turn. Spot check that the motor’s belt is intact and taut, but in my case the original belt survived just fine.

If the carriage can move freely but the motor isn’t turning, you can trace back from the motor control on the power PCB. The basic forward sequence to understand is: The motor control signal originates in the Q output of the flip-flop at IC8 (pin 5). This is normally high when the device is at rest, and goes low when the motor should run. The signal moves through the open-collector buffer at IC7 (in pin 9, out pin 8). The output of that 7407 is then routed to the power supply PCB, where it goes through R2 into the base of the Q1 transistor. When the motor is meant to be turned off, the base of Q1 will measure about 8V. When the motor should be turned on (ie, when the motor control TTL line has gone low) you should see about 2V at the base of this transistor. The collector pin of Q1 has no voltage when it’s turned off, but when turned on current runs through a voltage divider to the gate of a triac, which is the device that actually switches on to allow AC to pass through the motor.

If the motor is not running, start by checking the AC running through the triac, and if there isn't any, go backwards until you find the break in the logic chain. I had a bad Q1 (SS1122 transistor) which needed replacement; the motor control logic upstream of that was behaving correctly.

***If the carriage moves but no printing happens…***

If no printing is happening at all, it's likely not an issue with individual solenoid or driver units, but something in the character output (which occupies most of the logic complexity). The FIFO output goes to the input of the character ROM, which drives the solenoids through 7407 buffers. Make sure the chip enable signals are reasonable on the character ROM to understand if it's outputting anything at all.

The character ROM output lines go *low* to indicate that a dot should be printed, which ends up turning on the corresponding solenoid coil.

The clocking of the character ROM is done via IC4 and IC8 and IC6, but IC10 is the free running oscillator (555 timer) that clocks all of that stuff. If that 555 is not working, the whole output chain will be frozen. This was an issue I had, which required replacing the 555 timer at IC10.

***If printing works but some of the dots are missing…***

The print head has seven impact pins arranged vertically. If some are firing correctly but some are not, then the culprit will likely be somewhere between the character ROM and the solenoid.

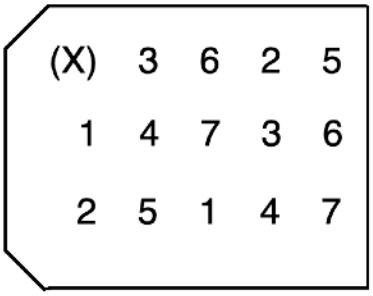
Below is a table indicating the signal path for each of the pins in the print head as they run from the character ROM to the solenoid and back. This table is in top-to-bottom order for the character output, so the first row corresponds to the top row of dots in the output (i.e. transistor Q6 is responsible for driving the topmost row of dots). Note that the order of the solenoid driver transistors on the PCB is **NOT** in order of the pin arrangement.

| For print impact pin (from top)… | Character ROM output | 7407 Buffer (output) | Solenoid driver | J2 drive pin | J2 return pin |
|---|---|---|---|---|---|
| 7 | B8 (pin 22) | IC3 pin 2 | Q6 | 15 | 8 |
| 6 | B7 (pin 21) | IC3 pin 4 | Q5 | 14 | 7 |
| 5 | B6 (pin 20) | IC3 pin 6 | Q4 | 13 | 6 |
| 4 | B5 (pin 19) | IC3 pin 8 | Q7 | 12 | 5 |
| 3 | B4 (pin 18) | IC7 pin 2 | Q3 | 11 | 4 |
| 2 | B3 (pin 17) | IC7 pin 4 | Q2 | 10 | 3 |
| 1 | B2 (pin 16) | IC7 pin 6 | Q1 | 9 | 2 |
| 0 | B1 (Not connected) | | | | |

If you believe that signals are reaching all of the solenoids correctly, then you will want to check the resistance of the solenoid path that is not activating correctly. Each solenoid has two connections to the 15-pin plug (with 14 wires) at J2. The layout of the pairs of coil wires is shown below.

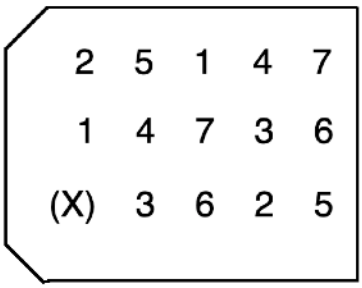
You can unplug J2 and measure the resistance between the two connectors for a specific coil with a meter. These coils should measure just about 10 ohms. (Orientation of measurement is not important, solenoid coils do not have a polarity.) If you see a dead short in a coil that doesn't work, that's bad: the coil probably overheated once and burned. That cannot be repaired. If you see an open circuit, it's also possible that the coil burned but failed open. But an open circuit can also be caused by a break in one of the small wires leading to the print head or a detachment from the J2 plug pins. Inspect carefully for breaks before concluding the worst.

Conventional view as if looking down through the plug, at the J2 socket:




View of socket. Paired numbers = one coil.
Dots numbered from 7 at the top to 1 at the bottom

The view of the actual bottom of the plug, in other words, where you'll be probing with your ohmmeter:




Looking at the plug surface. Paired numbers = one coil.
Dots numbered from 7 at the top to 1 at the bottom

Note that in both diagrams, the solenoids are numbered in descending order from 7 at the top to 1 at the bottom, matching the first column of the table above.

# Replacement Parts

Fortunately, the circuit in the printer is mostly made up of commodity TTL chips. The two ICs that are a little unusual are the 40x9 bit FIFO (Fairchild 33511DC) and the vertical scan character generator (MM5241ABL), but both of these are currently available as obsolete parts from eBay and elsewhere for a few dollars.

It was common for SWTPC to use specific transistors and other parts that are now obsolete and difficult or expensive to source, but you don't need exact part replacements in most cases!

The "RCA125" Darlington transistors that switch the solenoid coils are hard to find, but a TIP127 is both easy to find today and seems to have been the factory parts used in the unit that I was working on, so it is appropriate in both senses.

The exact "SS1122" transistor (from National Semi) in the motor control circuit is impossible to locate today but fortunately many high voltage PNP transistors are suitable here, including the commodity MPSA92. The 2N5415/6 also works and has the original "can" case style.

The only component that is not easily replaced is the print mechanism itself, and in particular the print head assembly. The head assembly is a monolithic device with the seven sealed coils glued onto it, and the pins permanently affixed in channels. It probably can't be repaired if something's wrong with it, like a burned and nonfunctioning coil. You'd have to try to replace the whole thing. The only source for these would be other printers that use the same LRC 7000 mechanism. Far be it from me to suggest stripping parts out of an otherwise working device, but should you have access to (for example) an Atari 820 printer, though scarce itself, that would probably be cheaper and easier to use as a donor than another PR-40.