What to do if your project won't work -don't stomp on it

by LEO SIMPSON

Many readers build EA projects and are pleased with the results. But some projects don't work at switch-on and cause a lot of frustration. What is the answer?

Among the many hundreds of letters we receive each month from our readers there are inevitably a few that go like this:

"I built your XYZ project described in month, year and it doesn't work. I have carefully double-checked all my work and so has a mate of mine who is a technician with a large organisation. He can't find anything wrong with my work and reckons there is probably a design fault in the project. In desperation I have even replaced all the CMOS ICs and now write to you as a last resort. Can you help me?"

Such letters usually make us shake our heads in resignation. Here we have a situation that is difficult for us to retrieve. The reader wants to keep faith with EA but has had the nasty suspicion placed in his mind that the project is a lemon. After all, EA does regularly admit its mistakes in the "Notes & Errata" section in most months. Is it likely that this poor reader has copped one of EA's as yet undiscovered mistakes?

All right let's face it, we do make some mistakes and some of these take a while to come to light. But eventually mistakes that are brought to our notice are published in "Notes & Errata".

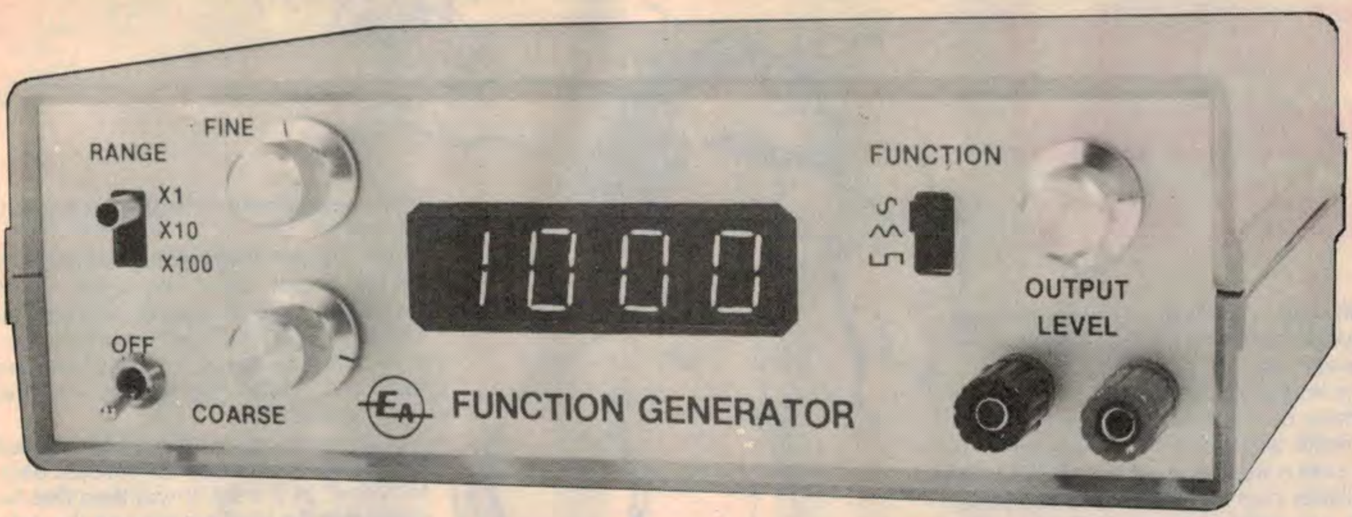
Kitset suppliers often become aware of errors in parts lists or diagrams before we do. They make the necessary correction and then sometimes neglect to tell us about it. So whatever happens, the fact that a project is available as a kit is a good indication that it will be a "goer".

That is not to say that EA projects which are not available in kit form are no good. Kitset suppliers necessarily have to make decisions about which kits they will carry and those they will not. They can't do them all. There are just too many, as far as they are concerned.

More often than not though, the poor distraught reader is referring to a kit that has been built by the thousands. Kitset suppliers often like to refer to such kits as "chestnuts" meaning that they are ever popular, reliable and importantly to the kitset supplier, good money spinners.

So how do we go about answering such a letter? All letters that we receive are answered or acknowledged by the way, provided that the sender has remembered to include his address.

The main problem in answering the above letter is that the reader has provided us with absolutely nothing to go on. No voltages, no symptoms, nothing. So all we can do is write back and ask. Does it do such and such? Is the whatnot hot? and so on. Which means that our thoroughly discouraged reader has to go back to the forlorn little pile of bits sitting at the back of workbench, under his bed or where ever and try once again, to make some sense of it.



Many hundreds of this project have been built but if not assembled correctly it does not work.

So if you do get to the stage of desperation where you consider writing to EA as a last resort, please tell us as much as you can. Which voltages are correct and which are not? Are ICs getting hot? What are the readouts? What noises is it making?

Paradoxically, if you take the trouble to find out all this information you may solve the problem yourself and not have to write to us after all. And strangely, the fact that you have solved the problem yourself, by delving a bit deeper into it, will probably give more satisfaction than if the project had immediately worked at switch-on.

A practical example

As might be expected, the stimulus for this article has come from a number of recent experiences in the EA editorial department. One of these involved a long-time acquaintance of one of our staff members. This reader had been an amateur radio operator for many years but it had been some time since he last built anything. In fact, the last project he built had used valves!

And so he had come to our staff-member asking for reassurance about one of our projects and whether we thought he could put it together. He wanted to build the Function Generator described in April 1982. Naturally our collective response was along the lines of, "Give it a go. She'll be right" and "Why not" and other such remarks intended to bolster this frail body once more venturing into the joys of electronics.

Having psyched himself up, our newly enthused constructor went out and bought the full kit for the Function Generator. In no time at all he had it all put together.

Well, you guessed it. It didn't work. It wasn't quite dead but it certainly was not in first class health either. "Please help" he said "I'm desperate. I've checked everything several times and everything looks right". It did too. The kit was from Dick Smith Electronics and had gone together very well. What was wrong?

I suppose that this is where EA staff have a very large advantage over typical readers. In the first place we designed it. Second, we know it works. Large numbers of this kit have been built. Third, and perhaps the most cogent, we are quite confident of being able to fix it. If all our readers were in the same position they would have little use for EA.

Having said that, our staff member still started out in the same position as any reader confronted with a non-working project. He did not know why it was not working. What was the evidence? There must always be symptoms even if they are of the catastrophic smoking kind.

The symptoms

First, the four digit counter was not working correctly and permanently displayed "7777" regardless of how the frequency controls were varied. Second, it was quickly discovered that there was no audio output from the front panel terminals. Oh, and the readout was quite dim and appeared to flicker sequentially across the four digits.

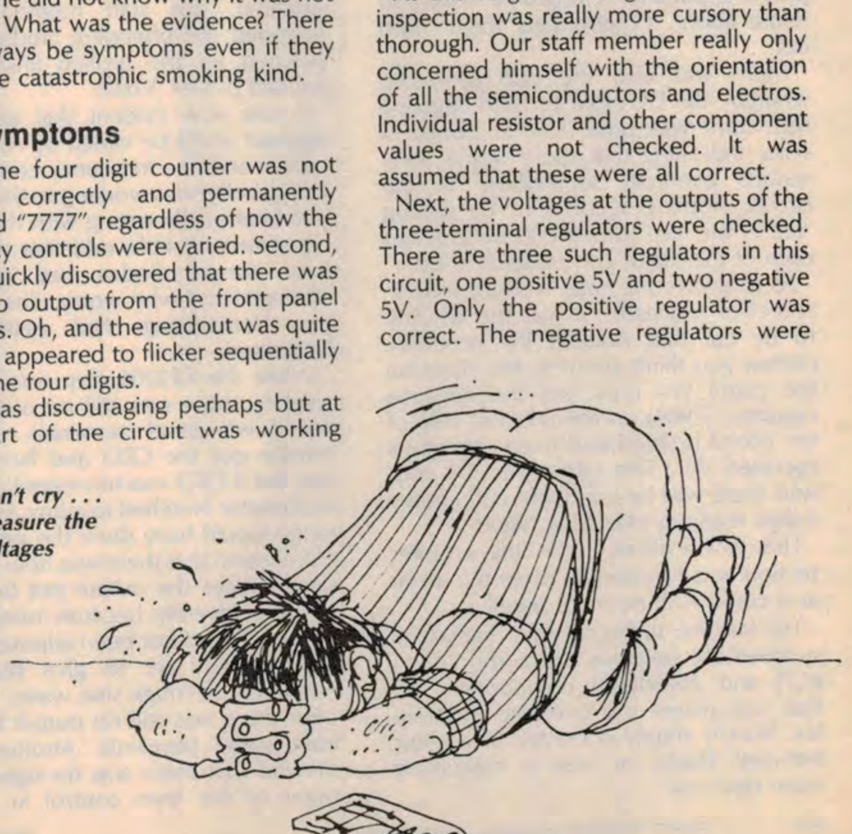
This was discouraging perhaps but at least part of the circuit was working because the displays were alight. That would probably mean that the relatively expensive 74C926 counter chip was not dead. That much could be surmised from those few symptoms.

Let us now follow through the steps taken by our staff member to discover where the fault lay.

First step was to take the PC board out of the case and give it a thorough visual examination. On the whole it looked very good. There appeared to be no solder bridges or missed joints. A couple of the PC pin solder joints had not really tinned well so these were touched up. But nothing untoward was really obvious.

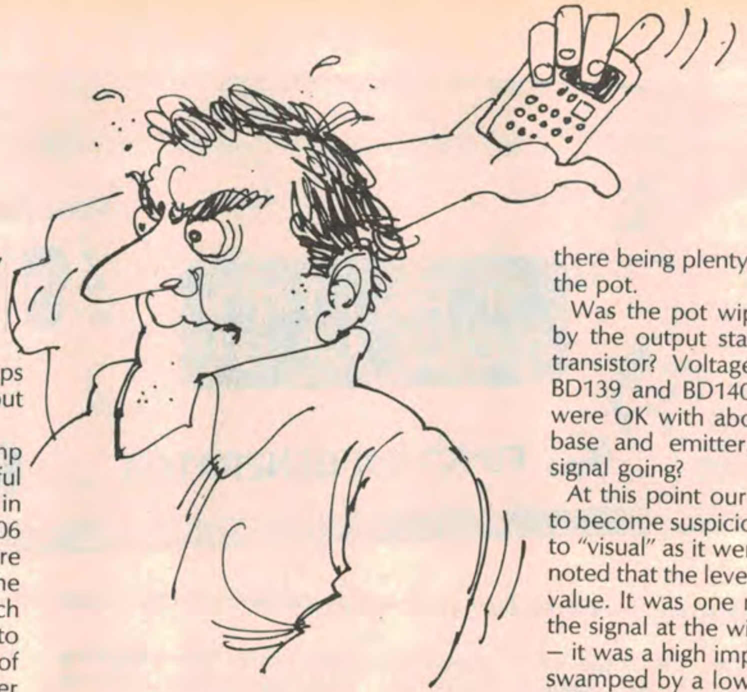
At this stage of the game, the visual inspection was really more cursory than thorough. Our staff member really only concerned himself with the orientation of all the semiconductors and electros. Individual resistor and other component values were not checked. It was assumed that these were all correct.

Next, the voltages at the outputs of the three-terminal regulators were checked. There are three such regulators in this circuit, one positive 5V and two negative 5V. Only the positive regulator was correct. The negative regulators were



Don't cry . . . measure the voltages

What to do if your project won't work



both very low in output which perhaps would explain why the four digit readout was very dim.

It is important at this stage not to jump to hasty conclusions but it can be useful to make assumptions. For example, in this case it was assumed that the XR2206 oscillator chip was faulty (because there was no audio output) and that the 74C926 was OK. In making such assumptions you have to be prepared to admit that a completely different set of assumptions might lead to a quicker solution. In other words, you might be wrong.

On the basis of the above assumptions our staff member further surmised that the XR2206 or its output stage was somehow loading down the output of the associated 7905 regulator. Accordingly, he proceeded to cut links on the board until the output of that regulator was isolated.

We should mention that this was a trial and error process with the power being re-applied after each link was cut to check the result. When you have a fault condition it is not wise to leave the power applied for a long time while you fiddle about. Components might burn out.

There was also the odd symptom whereby the DC input to both negative regulators was quite low at about -3 volts, indicating that there was a fairly serious overload somewhere in the circuit. Nothing seemed to be getting "red in the face" though, as he touched each of the major components in turn.

As is always the case with these trial-and-error processes, it was the last link to be cut that isolated the problem. (When you think about it, this must be the case.) We now had the negative regulator (7905) on the lefthand side of the board isolated and it was giving its specified -5V. The other was OK too. And there was now a bright and cheery 4-digit readout, indicating "0000".

This was evidence that the counter section was functioning properly, as far as it could with no input signal.

The last link to be cut was that which supplied the negative rail to the 74C14 (IC7) and associated components. So that was where the overload problem lay. Was it simply a matter of a short between tracks or was it something more devious?

Being completely open-minded about it, our staff member closely examined the underside of the board, in the vicinity of the 74C14, for evidence of shorts. None was found. Then another look at the top of the board around IC7. Compare board with wiring diagram. Uh huh, there it is. The two diodes associated with IC7d were the wrong way around. This was placing a short, via two diodes, across the ±5V supplies but the negative rail appeared to be affected more.

Without stopping to analyse the situation, our staff member quickly swapped the offending diodes around, patched up the broken links and re-applied power. Voila!

It was now evident that the display readout could be varied by rotating the coarse and fine frequency controls. The XR2206 chip was working so that nothing had been really wrong with the unit.

It seemed a little odd that those two low current diodes had not been damaged but why worry. The unit was now functioning. Not quite, as it happened.

While the XR2206 chip was evidently working there was still no output from the front panel terminals. Time to trundle out the CRO and have a look see. But a CRO was not essential here. A multimeter switched to a low AC voltage range would have done the job.

We found that there was now plenty of signal across the output pot but it was clipping severely because trimpots R2, R3 and R4 had not been adjusted. These were quickly set to give reasonable output and a rough sine wave.

But there was still no output from the front panel terminals. Another check showed that there was no signal at the wiper of the level control in spite of there being plenty of signal at the top of the pot.

Was the pot wiper being shorted out by the output stage? Was there a dud transistor? Voltage checks around the BD139 and BD140 confirmed that they were OK with about 0.8 volts between base and emitter. So where was the signal going?

At this point our staff member started to become suspicious and switched back to "visual" as it were. It was then that he noted that the level pot was not the right value. It was one megohm. No wonder the signal at the wiper was disappearing – it was a high impedance source being swamped by a low impedance load.

Then the penny dropped. Our intrepid constructor had inadvertently swapped the 1MΩ coarse frequency control pot for the 22kΩ level pot. Twiddling the coarse frequency control also revealed a lack of control range, as might be expected.

So. Two mistakes produced the problems. The reversed diodes had the most dire consequences but the swapped pots produced strange symptoms too.

Perhaps the most important lesson is that these faults could easily have been found by careful visual inspection. Our constructor swore on a "stack of data books" that he had closely checked his work. We took his word for it and then went through the rigmarole just described.

We are not saying that visual inspection will cure all problems but it will probably solve most. You should proceed on the basis that a mistake in assembly has been made.

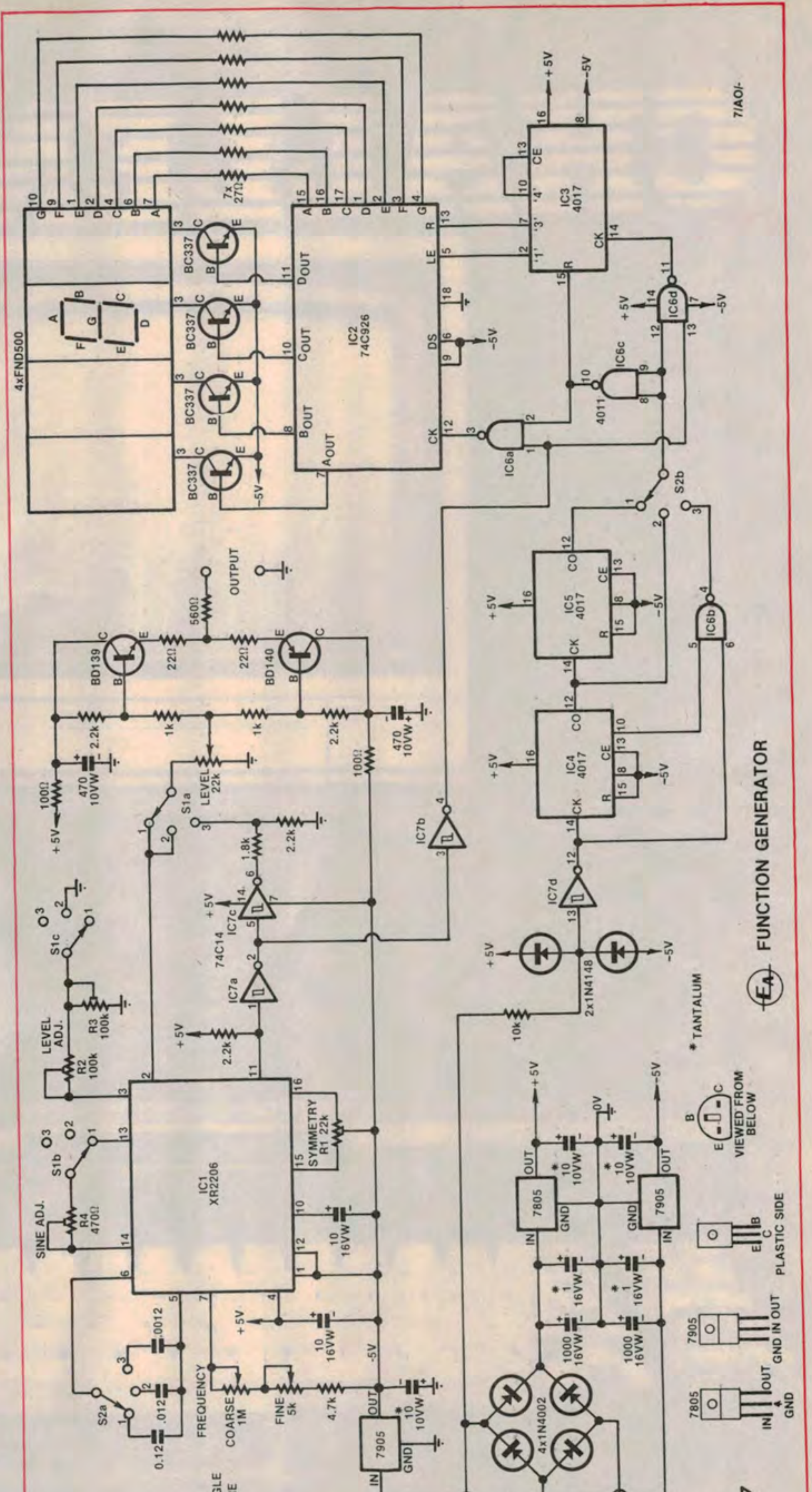
Defective components are relatively rare and few components are ever damaged during soldering, which brings up another important point.

Many constructors are frightened of soldering ICs and transistors. Instead of soldering the joints properly they merely wave the iron somewhere in the vicinity of the joint and hope that it'll be okay. It won't.

Look. ICs and the majority of semiconductors are designed for the rigours of flow soldering. They are rated for soldering at 300°C for 10 seconds. How many people hold the iron on the joint for 10 seconds? None. It would be silly. Normal soldering will not damage components.

Here's how to do it. Make sure the iron is hot, clean and well-tinned. Shove it firmly on the joint for a second or so and make sure the joint is good and hot.

The circuit of the Function Generator which was originally published in April 1982.



Then tin both the copper pad and the component lead and make sure the solder flows evenly over the whole joint. Don't use too much solder.

If the joint looks messy after the first attempt leave it a minute or so and then have another go. Reheat the joint and then a touch of solder, to provide the necessary flux, will make a clean job of it. (And don't take that remark about "necessary flux" as being a suggestion to use any sort of solder paste. The ordinary resin-cored solder is all that is required.)

Remember that you are most unlikely to damage an IC because of overheating while soldering. The most likely damage, if you are too heavy handed or using too large an iron, is that the copper pad and track on the PC board will lift. This sometimes happens if you are desoldering components without the aid of a solder sucker or solder-wick.

Of course you still have to take precautions against static damage when soldering MOS components. But CMOS ICs are pretty rugged. As long as you solder the two supply pins first and use a jumper lead to connect the metal shaft of your iron to one of the supply tracks on the PC board there is little chance of damage.

Those who know better

While the vast majority of constructors do try and follow our articles closely in building their projects there are some who reckon they know better. And do they "come a gutser". These people don't like certain aspects of a project design so they change it. In this category our friends the amateurs figure strongly I'm afraid. They tend to take liberties.

The classic example of this concerned the UHF transceiver project described in our September, October and November issues last year. By all accounts this project has been very successful and many hundreds have been sold by Dick Smith Electronics. But there have been problems brought about by the constructors simply not following instructions.

At the extremely high frequencies used on the UHF bands it is absolutely critical that all component leads be as short as possible. Coils must be wound exactly as specified. But we have seen non-working transceivers that looked like birds' nests rather than the neat and tidy design presented on our September 1983 cover. Needless to say, when all the components were shortened back, coils correctly wound and inserted, the units operated correctly.