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IMPROVING

AN INEXPENSIVE 8038 SIGNAL GENERATOR KIT

And Learning Mandarin in the Process

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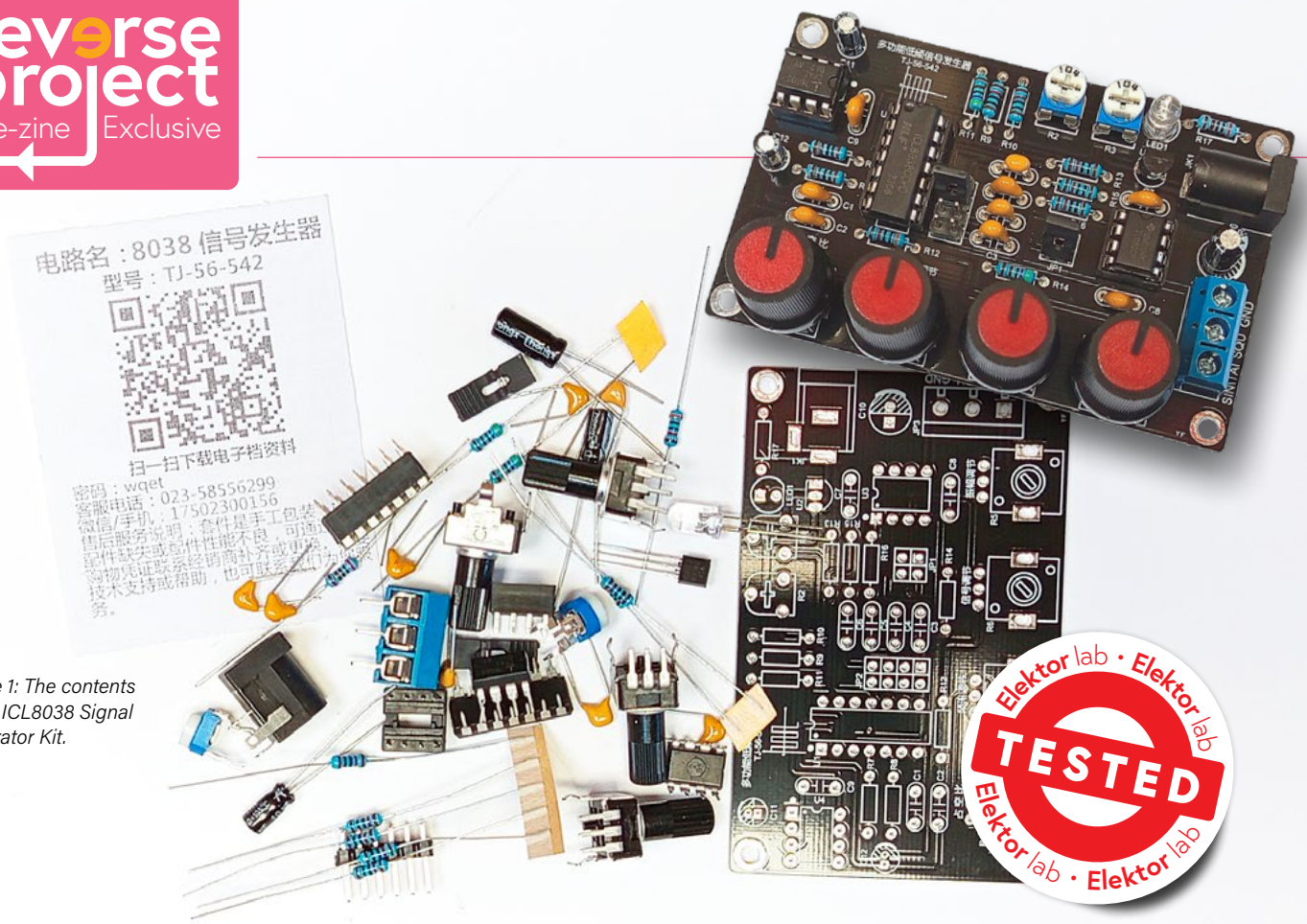

Figure 1: The contents of the ICL8038 Signal Generator Kit.

Improving an Inexpensive 8038 Signal Generator Kit

And Learning Mandarin in the Process

By Clemens Valens (Elektor)

The ICL8038 precision waveform generator from Intersil has been obsolete for more than 20 years and has been hard to come by since. However, today, kits built around the device are plentiful on online marketplaces. I ordered one of them for about €10 (including acrylic enclosure) and had a close look.

The ICL8038 precision waveform generator, introduced by Intersil in the early 1980s and discontinued 20 years later, quickly became a popular device for sound and signal-generating applications like music synthesizers and measurement instruments. Like the XR2206 monolithic function generator, it has gained cult status among electronics hobbyists. Even though the 8038 is obsolete, it is easy to find online as part of small, low-cost signal generator kits. These generators produce sine, triangle, and rectangle (square) wave signals up to 400 kHz (measured by me). The duty cycle of the rectangle wave is adjustable, and so are the DC offset and the amplitudes of the sine and triangle waves (not of the rectangle wave).

The ICL8038 Signal Generator Kit I bought (**Figure 1**, the same kit is sold under all sorts of names) comes without documentation, except for a tiny piece of paper printed in Chinese and with a QR-code on one side. The QR-code takes you to a webpage where you must enter a password to access the documentation. The password is printed below the QR-code, and it is "wqet" (**Figure 2**). Now you can download the assembly manual, which is also in Chinese. This is not a problem as a readable schematic (reproduced in **Figure 3**) is provided, and the PCB has

clear printing on it. Also, there are many photographs of the assembly steps.

No Reverse Polarity Protection

Assembling the kit is quick and easy, as long as you work your way up from the smallest (resistors) to the tallest (potentiometers) components (**Figure 4**). Make sure you get the orientation of the ICs right. When you power the assembled kit from a 12-VDC power supply (center pin is plus), a bright blue LED shines you in the eye. This only tells you that your power supply is working and that you connected it correctly. If the LED doesn't light up the first time, chances are that you can bin the kit as it doesn't have a reverse polarity protection.

Crash Course Mandarin

If you passed the power hurdle successfully, continue by connecting an oscilloscope to the square wave output (*SQU* on JP3) to see if the generator is working. Set potentiometer R1 in the middle position. On the PCB it is labelled 占空比, zhàn kōng bǐ in pinyin (pinyin is the Latin alphabet system for transcribing the sounds of Chinese characters). This is Chinese for "duty cycle" (sooner or later, we will have to learn Mandarin anyway, so we might as well start now). Turn R4, next to R1 (and labelled 频率调节, pín lǜ tiáo jié, "frequency adjustment"), all the way to the right. Place a jumper on pins 3 and 4 of JP2 (second position from the top, next to C5). The oscilloscope should now show a square wave (i.e., a 50% duty cycle) with a frequency of about 700 Hz and an amplitude of 12 V. The minimum value is 0 V. Turn R4 and R1 to see if the generator responds. Note that turning R1 influences the frequency too. Setting either of the potentiometers too low will make the signal disappear.

Adjusting the Sine Wave

Next is testing the sine wave. First, set the duty cycle of the square wave to exactly 50%. Then connect the oscilloscope to pin 2 of JP1 (the pin closest to C3).

Figure 2: Enter the password 'wqet' to access the assembly manual. (Source: 56dz.com)

Figure 3: The schematic of the 8038 Signal Generator. Note how three power supplies are used, one for the 8038 and two for the op-amps.

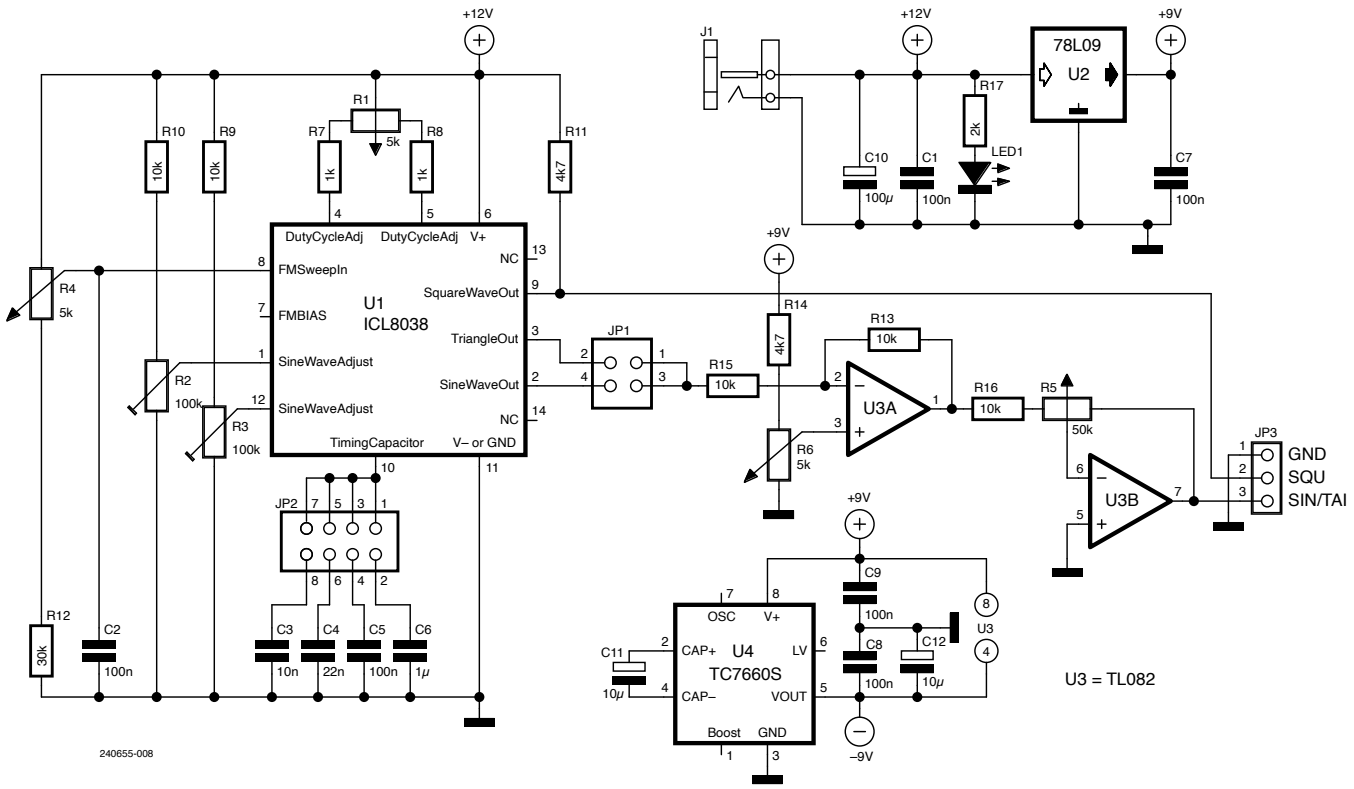

Figure 4: The assembled kit. I left the protective film on the acrylic to give a wooden feel to the device. However, I did remove the film from the top side to simplify reading of the engraved text.

You should see a sine-like wave with an amplitude of about 2.6 V_{PP} and a DC offset of 6 V. Using a small screwdriver, adjust the peaks of the sine with trimmers R2 and R3. Do not make them too round. It may look prettier if you do, but it means more distortion.

Check the triangle wave on pin 4 of JP1 (the pin above pin 2). It should have a DC offset of 6 V and an amplitude of approx. 4 V_{PP}.

The kit is now ready for use. Connect the oscilloscope to the *SIN/TAI* output of JP3 and place a jumper on JP1. Adjust R6 (**信号调节**, xìn hào tiáo jié, "signal adjustment") to set the DC offset of the sine or triangle wave (depending on how you place the jumper on JP1). The amplitude is controlled by R5 (**振幅调节**, zhèn fú tiáo jié, "amplitude adjustment").

Figure 5: The logo on this TL082 looks a lot like, but is not identical to, a real Texas Instruments logo on a 555.

It Does Sawtooth Too

For some reason, the vendors of the 8038 signal generator kit do not mention that it can also produce sawtooth or ramp signals. They are, however, part of the 8038 specifications, and the kit supports them out of the box. Indeed, simply by adjusting the duty cycle potentiometer R1, you can turn the triangle wave into a sawtooth with either a rising or falling slope. This, of course, also affects the symmetry of the sine wave because, in the 8038, the sine wave is nothing more than a remodelled (wave-shaped) triangle (this is also the reason why its amplitude is lower). Actually, the duty cycle control of the kit is really the symmetry control of the triangle.

Mishaps Are Intended

My kit stopped working after about 15 minutes. The reason was that U4, a 7660 switched-capacitor voltage converter, stopped working. Why? I don't know, but the wonky Texas Instruments logo printed on U3, a TL082 dual op-amp, might have had something to do with it. As **Figure 5** shows, the logo is not quite right and looks as if it was drawn by someone who didn't understand the real logo. The real logo shows the state of Texas with a 't' in it, and with an 'i' in the 't'. Arduino UNO clones have similar issues with the little Italy icon on it that's not quite right. I was lucky to find another 7660 in my stock, and so I could repair the generator. To be sure, I also replaced U3 by a real op-amp.

With the help of ChatGPT, I had translated the Chinese text printed on the tiny piece of paper (**Figure 6**). The side without the QR-code has four assembly warnings. Number 2 reads as follows (I added the highlighting):

2. Some components in the kit may have faults or substandard performance. ***This is intended*** *to test the assembler's ability to troubleshoot and improve performance through fault detection, correction, and measurement. It can aid in enhancing relevant knowledge and skills.*

Okay, so it was on purpose that my kit broke down after 15 minutes. Darn Chinese, they almost got me!

Making the 8038 Great Again

If you played with the offset and amplitude controls, you may have noticed that they do not work that well. Luckily, this is easy to fix. Looking at the schematic, we see that R6, that controls the DC offset, can be set from 0 V to 4.5 V. This is a bit strange, because the 8038's sine and triangle outputs have a DC offset of 6 V as the IC is

powered from 12 V, not from 9 V. The range of the offset control can be increased to 6 V by changing the value of R14 from 4.7 kΩ to 2.7 kΩ.

Regarding R5 (the potentiometer that controls the output amplitude), we learn from the schematic that it allows setting the gain of U3B from 0 to −5. This is too much (too little, actually, as it is a negative value). Increasing the value of R16 to 22 kΩ makes things a bit better. Now at least the sine wave can profit from the full range of R5. For an undistorted triangle wave, R16 should be something like 33 kΩ. Replacing JP1 by a DPDT toggle switch where the second pole switches R16 (while the first pole selects the signal) might be the easiest solution to get it right for both the sine and triangle wave.

Flexible Square Wave

The square wave has a fixed amplitude, which is set by R11 connected to +12 V. However, the square wave output of the 8038 is an open-collector output, and so its maximum level can be set anywhere in the range from 0 to 36 V (the maximum voltage of the 8038) and maybe even higher. Therefore, it may be interesting to connect R11 to either a potentiometer between 0 V and +12 V or to a voltage in the circuit that connects to this output. That way, no level shifting is required.

Another improvement of the kit would be to add a reverse polarity protection diode in series with J1 (anode to J1) or, easier, as a crowbar over C1 (cathode to +12 V). Furthermore, the 8038's power supply pins are not decoupled and, according to the 8038's datasheet, C2 should connect to +12 V instead of to ground, but these are details.

Okay, that's it for now. The ICL8038 Signal Generator Kit is a cheap and fun kit to have a play with. I will never use it for project development, but maybe someday I'll make a doorbell or some other musical gadget out of it. If you have a good idea, please let me know.

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Figure 6: This slip of paper measuring 6.5 cm by 5 cm has some interesting assembly warnings, especially warning No. 2.

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Questions or Comments?

Do you have technical questions or comments about his article? Email the author at clemens.valens@elektor.com or contact Elektor at editor@elektor.com.

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› **ICL8038 Signal Generator DIY Kit (5 Hz – 400 kHz)**
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WEB LINKS

[1] Product page: https://56dz.com/p/2251.htm