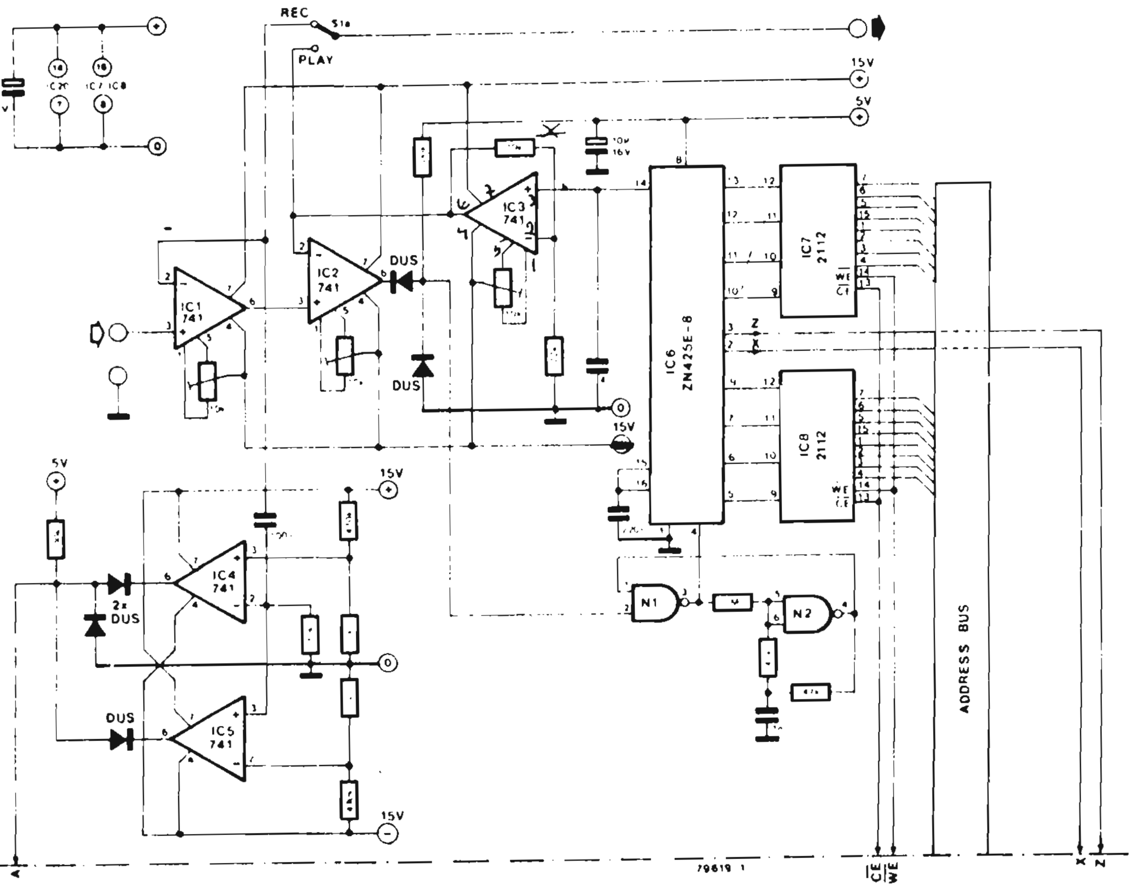
Circuit 100: 256-note sequencer
In figure 1a, pins 4 of IC1 . . . IC3 should, of course, be connected to −15 V. In figure 1c, a 1 n capacitor is shown between pin 3 of N38 and supply common. This capacitor should be connected between pin 4 of N24 and supply common.

256-note sequencer

1a

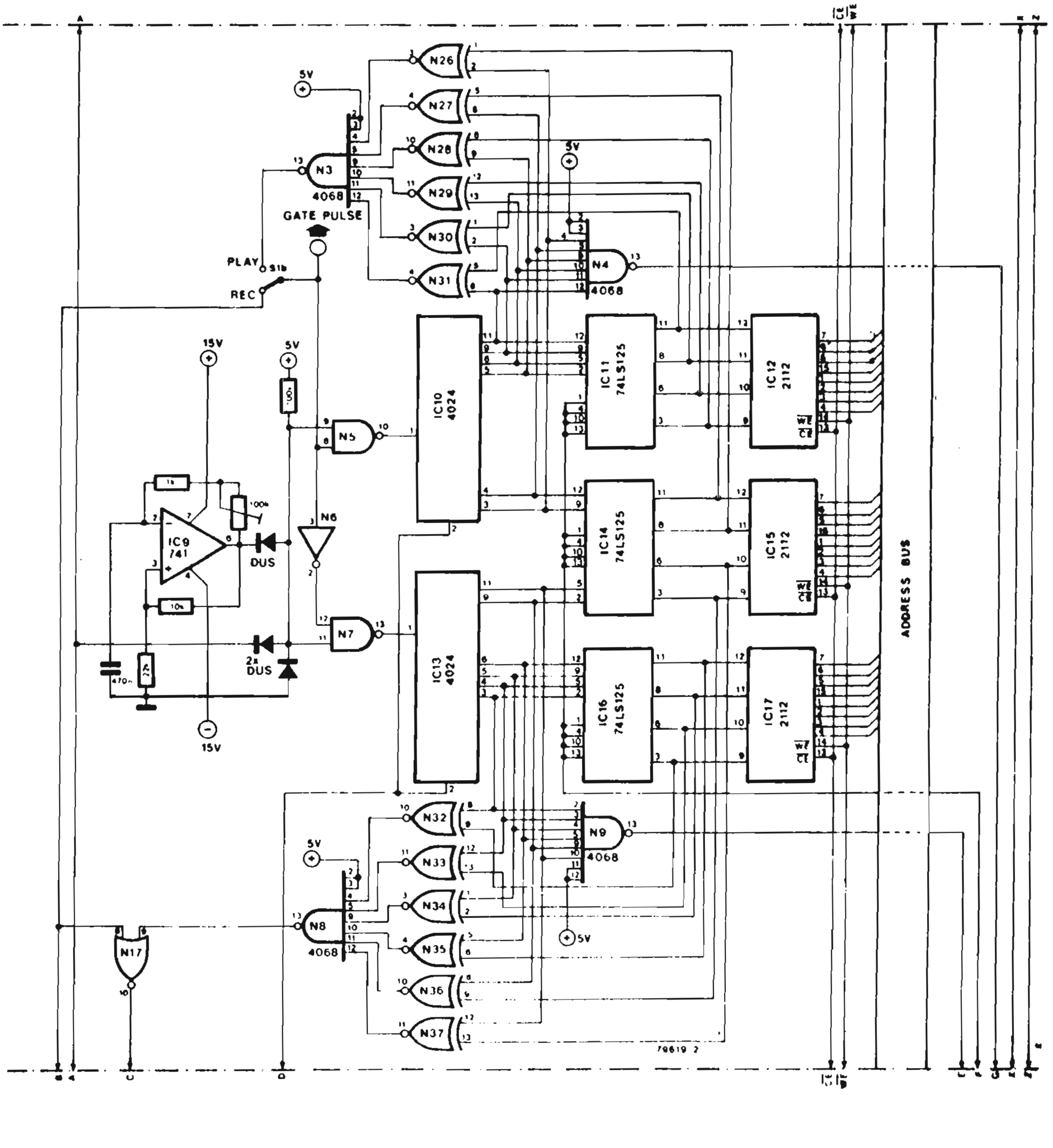


The sequencer is intended to be used in conjunction with a voltage controlled synthesiser. It can store a sequence of up to 256 notes which can then be played back automatically.
The sequence of voltages produced by the keyboard circuit of the synthesiser are fed to an 8-bit A/D converter and then stored. The length of the note and the length of rests between notes are also encoded with the aid of a clock generator and two counters. When the stored sequence of notes is to be played back, the 8-bit data word corresponding to the keyboard voltage level is read out of the memory and re-converted back into an analogue voltage by a D/A converter. Similarly, the note and rest length data are decoded to ensure that the original melody is obtained.
The above approach offers the following advantages over other systems which employ an 'encoded keyboard'.

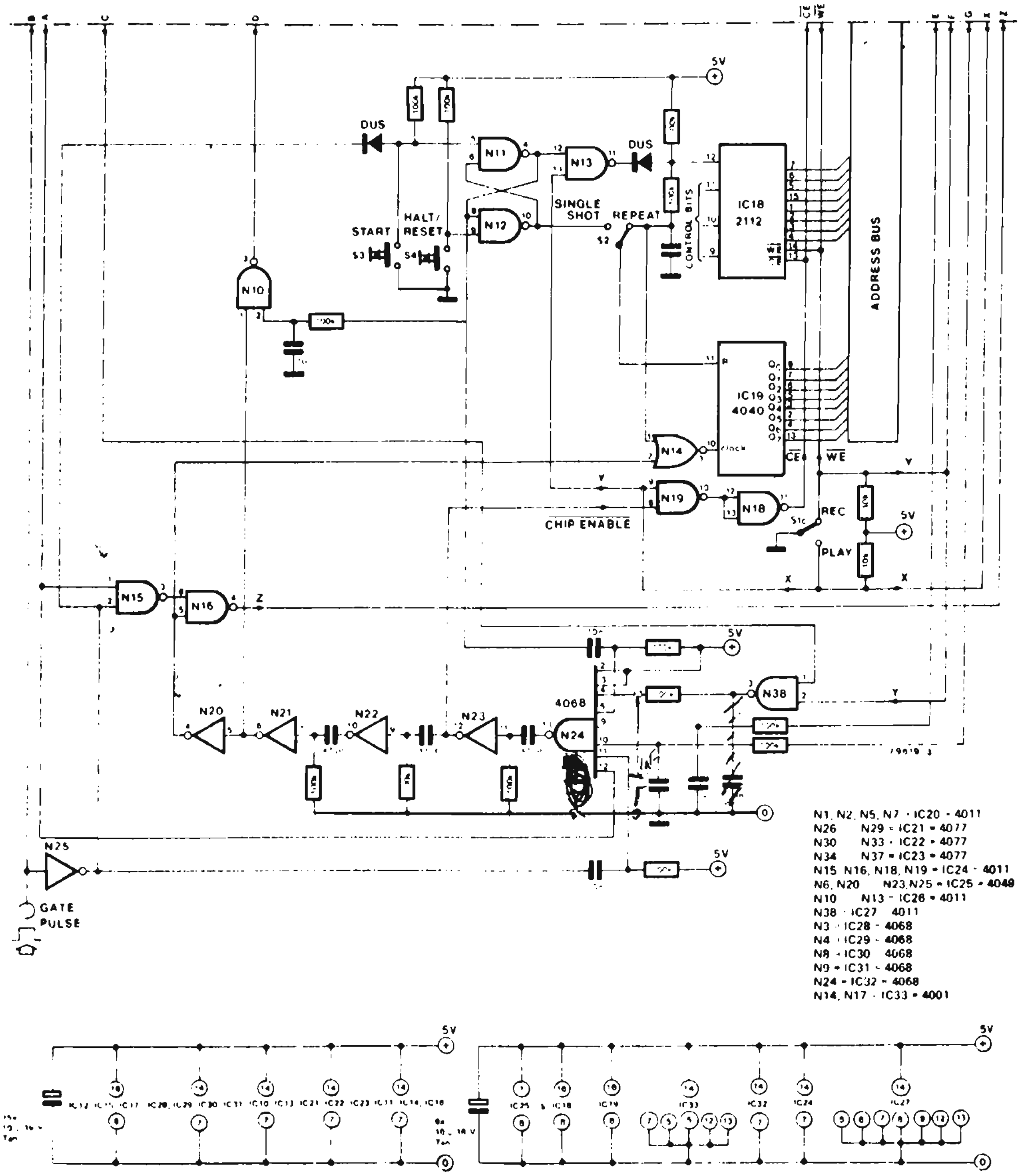
1. The existing keyboard does not need to be modified.
2. An 8-bit A/D converter is cheaper than an encoded keyboard.
3. By using a 2-way converter (A/D and D/A) the original sequence of notes can be reproduced with a high degree of accuracy.

The circuit functions as follows:
To store a sequence of notes, switch S1 is set to the 'record' position; the memory is simultaneously switched to the 'write' mode. When one of the synthesiser keys is pressed, the keyboard gate pulse sets flip-flop N11/N12, taking one of the data inputs of IC18 low and setting the address counter, IC19. The gate pulse also triggers a dynamic shift register formed by N20 . . . N24. This shift register performs a number of functions: resetting IC10 (the 'note counter') and IC13 (the 'rest counter'), resetting the AD - D/A converter, ZN425, enabling the memory IC18, and clocking the address counter. The result of these control signals are that the first memory location remains empty.
The keyboard voltage is digitised by the ZN425. IC10 counts clock pulses provided by IC9 for the duration of the note. When the key is released, IC10 again counts the clock pulses from IC9, this time to time the rest. When the next key is pressed the store cycle is initiated, and the previously obtained information is written into the second memory location. Of course one cannot always use the keyboard gate pulse to determine the length of a note, especially if playing 'legato'. For this reason a detector (IC4, IC5) is included which determines when the keyboard voltage changes. The detector consists of a differentiating network followed by a window comparator, which provides a negative pulse when the voltage level alters. When either IC10 or IC13 reach their maximum count (6 bits), the

1b



1c



output of N4 or N9 goes low starting a new store cycle and resetting the counters. In this way either a note or rest can be programmed into two or more memory locations.

It was stated that the first memory location remains empty. However if one wishes to start the sequence of notes with a rest, this location can be filled by pressing S3, which triggers ICs 10, 13 and 18 independently of the keyboard gate pulse. IC13 then counts clock pulses until a key is pressed, whereupon the above-described reset and store cycles write the 6-bit data word corresponding to the rest into the first memory location of ICs 12 and 15.

To playback the sequence of notes stored in memory, switch S1 is set to the 'play' position, switching the memory to the 'read' mode and the ZN425 to D/A conversion.

To regain the note and/or rest length information, IC10 is clocked until its output state corresponds with the data outputs of IC12 and IC15. During this period the gate pulse output remains high, and only goes low when the two sets of data coincide; clock pulses are then fed to IC13 until its output state coincides with the data outputs of ICs 15 and 17, whereupon the memory addresses are systematically scanned by IC19 and the stored data read out to the D/A converter.

The output (pin 12) of IC18 goes high when the replay sequence is finished. If the sequence of notes is to be repeated, (S2 is switched to the 'repeat' position) the address counter 'wraps round' and begins again with the lowest address. The unused pins of IC18 can be employed as extra control inputs and connected (via suitable buffers!) to VCOs, filters, etc.

Two final remarks:

Portamento and/or (coarse and fine) voltage controls should be connected after the sequencer.

The A/D - D/A converter will accept the output of a 3-octave keyboard. A 4-octave keyboard can be used if the feedback resistor of op-amp IC3 is increased from 10 kΩ to 18 kΩ.

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