A Scientific Computer — 6

Final program examples, tv interface and radio teleprinter interface

By J. H. Adams, M.Sc.

THE FINAL TWO programs in Table 18 were used to ease the design of active filters for the teleprinter interface. The filters are based around the LM3900 quad Norton amplifier i.c. and a low-pass version is shown in Fig. 24. The display in Fig. 25 shows a run of the first program which computes the resistor values required for a given gain, Q and fixed capacitor values. The program will intervene if the ratio of the capacitors is too low for correct operation, and when presenting the results it uses two graphic characters to enhance the appearance. New values for C_1 and C_2 may be entered repeatedly until the resistors are near enough to preferred values for the accuracy required.

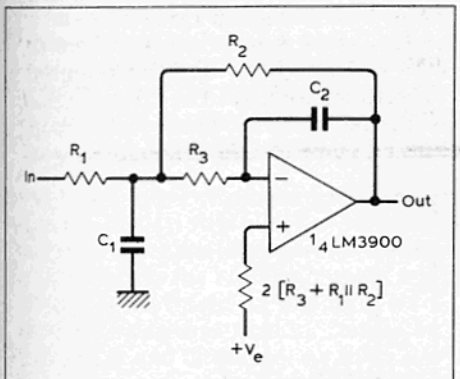

Fig. 24. *Low pass filter used for the teleprinter interface.*

```
002 PRINT "  LOW PASS ANALYSIS"
003 PRINT " INPUT R1, R2, C1, C2 NOW . . . "
005 INPUT R S C D
006 AXIS 125 8
008 LET F=1
011 GOSUB 232
014 LET E=60 G -
017 GOSUB 232  -
020 LET G=G E +
023 IF G<0 THEN 32
024 LET Z=F LOG
026 PRINT "F ="F1, "HZ"
027 GRAPH G Z
028 LET F=F 10 RT *
030 GO 17
032 HALT
034 ERASE
036 GO 1
232 LET X=1E12 2 / PI / F / C /
235 LET Y=1E12 2 / PI / F / D /
238 LET A=X Y / R S * X / Y / - 1 - SQ
241 LET B=X R S + - Y / SQ    -   -
244 LET G=A B + ROOT REC LOG 20 *
247 RETURN

0000
```

```
004 PRINT "   LOW PASS FILTER PROGRAM"
005 PRINT " INPUT GAIN + Q REQUIRED, CORNER FREQUENCY, C1 + C2"
020 LET W=2 PI * F *
023 LET C=C 1E12 /
026 LET D=D 1E12 /
029 LET S=1 K G / - ROOT 1 + 2 / Q / K / W / C / 1000 /
032 LET R=S A /
035 LET T=W C * SQ S * K * REC 1E00 /
038 PRINT "R1 ="R2, "kΩ,  R2 ="S, "kΩ,  R3 ="T, "kΩ"
039 INPUT C D
040 GO 11
041 END
050 PRINT "REDUCE THE RATIO OF C2 TO C1.  INPUT NEW VALUES NOW . . ."
051 GO 39
053 INPUT D
056 LET D=D 1E12 /
059 GO 29

00CB
```

Table 18. Two programs for designing active filters based on the LM3900.

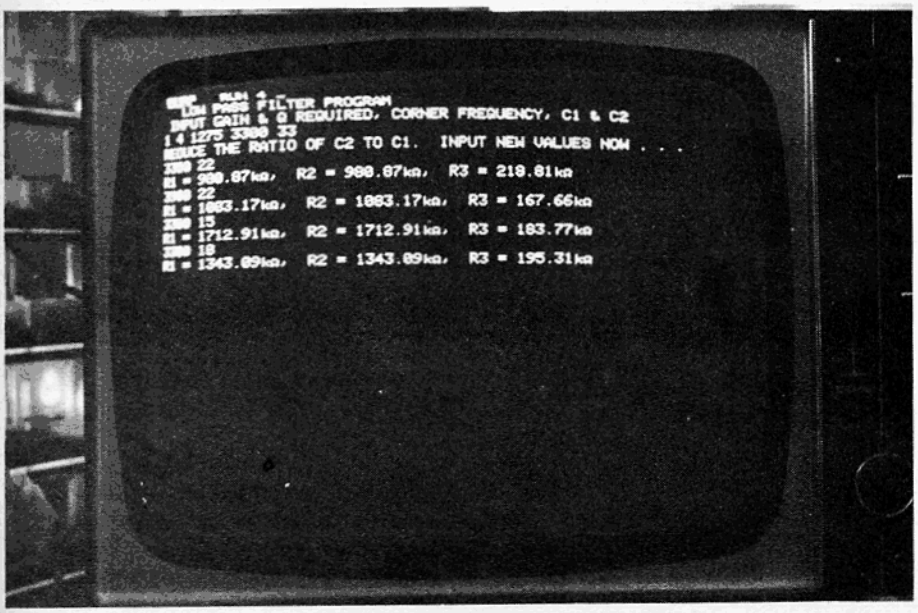

Fig. 25. *V.d.u. showing a computer run for the circuit in Fig. 24.*

The second program can then be used to give a gain versus frequency plot of the filter's characteristics. In Fig. 24, R_3 is assumed to be equal to R_1. The program terminates when the gain falls below unity, but it may be re-run by pressing the space bar as described in part 4.

A specific tv interface

It was mentioned in part 2 that if a live tv chassis is used for the v.d.u., a mains isolation transformer is necessary. This expense can be avoided by using a television set such as the Ferguson or Ultra model 3845 which has a fully isolated power supply. A simple interface for this set is shown in Fig. 26. All of the connections are made to the tube base except for the sync. input. Resistor R_{72} on the tv's p.c.b. is lifted at the end nearest to the back of the set, and a wire from the empty pad is taken to a changeover switch which connects the original sync, or that from the computer

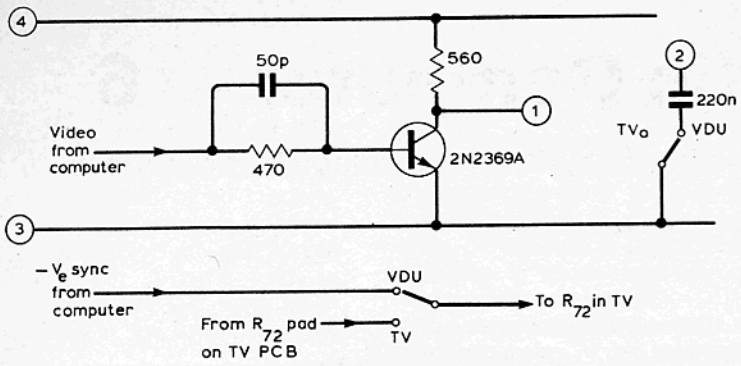

Fig. 26. *Tv interface for the Ultra model 3845. The numbers in circles are pin connections on the c.r.t. base.*

to the p.c.b. With negative going sync. supplied from the computer, a display should be obtained which, with the switch in the v.d.u. position, synchronises without any adjustment to either the horizontal or vertical holds. It is possible that the display will not completely fit onto the screen, but this can be rectified by the following alterations.

Loosen the polythene clamp which holds the scanning coils onto the neck of the tube and slide the plastic end of the width adjusting collar (this fits between the coils and the tube neck) to reduce the width of the picture. If the display is still too wide, connect a voltmeter between pins 3 and 4 on the tube base and adjust the preset resistor R_{69} which is just in front of the line timebase compartment. This sets the h.t., normally 11.3V, and should produce the required change with less than a one volt alteration. If the display is not horizontally centred, adjust the position of the core in the line oscillator coil (this can be found behind the line compartment nearer to the centre of the set than the "set h.t." preset). This must be done with a non-metallic tool.

If the television is tuned to a station whilst in use as a v.d.u., the tv picture may faintly modulate the display. This can be avoided by tuning off the station, unplugging the aerial or turning down the contrast control. If a brighter display is required, a higher supply voltage to the 2N2369A will be necessary. This can be supplied by the computer or from the 90V supply on pin 6 of the c.r.t. base. If the 90V is used, a potential divider must be connected because the maximum collector voltage of a 2N2369A is well below 90V. Whichever supply is chosen, the collector load should be increased proportionately from the 560Ω shown in this design.

Radio-teleprinter interface

One task for which this computer is well suited is the reception and transmission of radio teleprinter signals — RTTY. The system described here consists of hardware which converts f.s.k. (frequency shift keying) signals into digital levels, and software which is used to receive the serial stream of data, recognise the start of bytes and then frame, translate and display them. This software allows the Baud rate, the style of encoding and the code used to be controlled by the programmer.

The receiver should use a product detector or a b.f.o. so that the f.s.k. signals are available as two audio tones. The difference in frequency between the tones will depend upon the shift being used by the sender of the RTTY, but will usually range from 170 to 850 Hz. If the receiver's bandwidth can be reduced to this extent, the wanted/unwanted signal ratio will be improved and this will produce more reliable decoding. However, even with conventional bandwidths, the first two amplifiers in Fig. 27., which are connected as high and low-pass active filters with gains and Qs of one and a bandpass of approximately 1200 to 2100 Hz, will filter out the required tones to some extent. The filtered signal is then fed into a 565 phase locked loop. This i.c. compares the input signal with

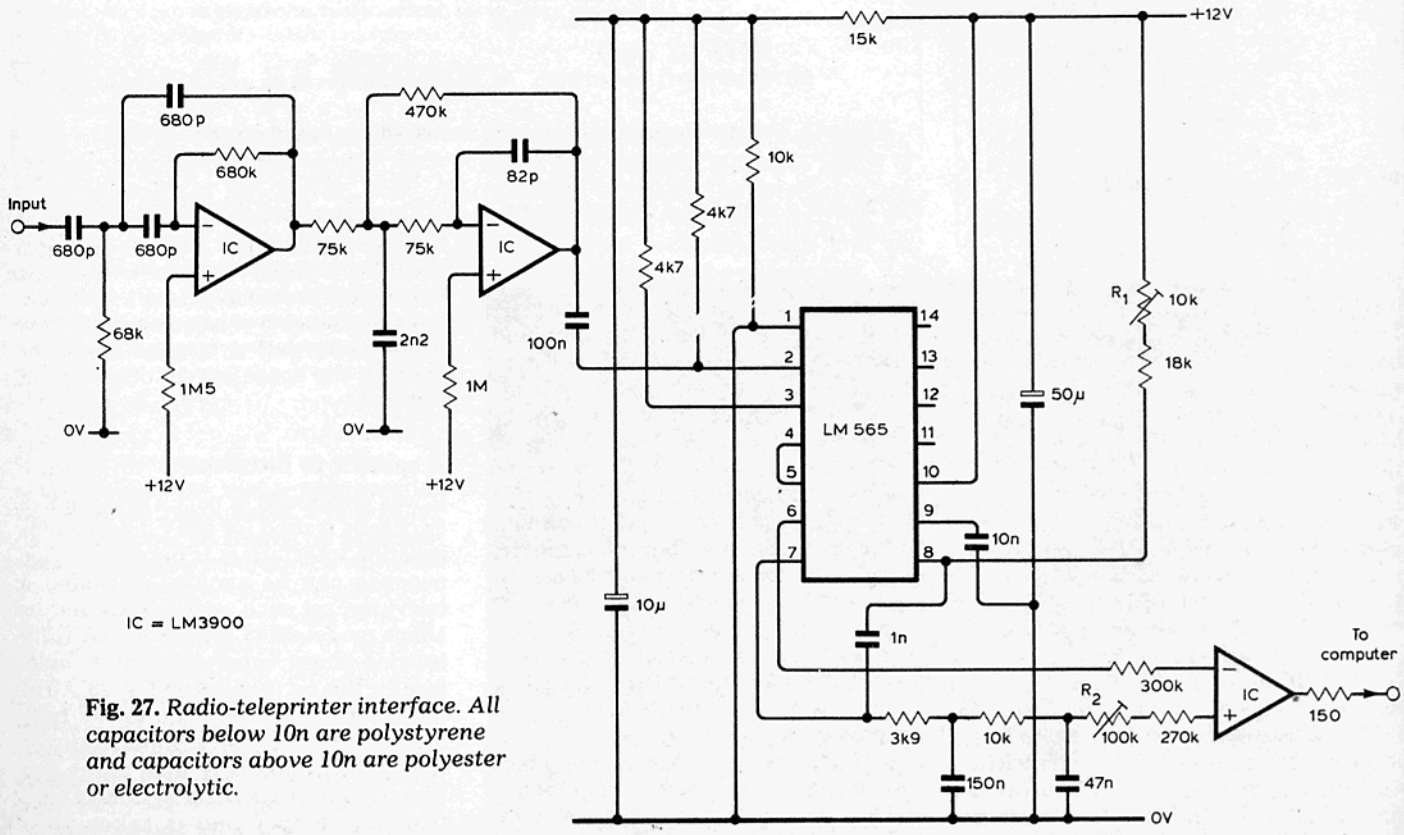

Fig. 27. *Radio-teleprinter interface. All capacitors below 10n are polystyrene and capacitors above 10n are polyester or electrolytic.*

```
1C00 11 40 80 21  80 1C DB 00  E6 04 20 FA  CD 36 03 10
1C10 D[illegible] 00 E6 04  20 F0 0[illegible] 03  CD 36 03 9[illegible]  1[illegible] F[illegible] 01 [illegible]
1C20 05 D[illegible] 00 E[illegible]  C4 [illegible] [illegible]7 4F  CD 3[illegible] C[illegible] [illegible]  C[illegible] 36 03 [illegible]0
1C30 1[illegible] EF 7[illegible] 0F  0F 0F 2F E[illegible]  1F FE 0[illegible] 2[illegible]  C4 2E [illegible]0 1[illegible]
1C40 C5 F[illegible] C4 20  C4 2E A0 1[illegible]  BD E5 [illegible]5 6F  7E E1 FE EE
1C50 2[illegible] B4 FE FF  20 05 C[illegible] C4  03 18 AD 12  13 FE 20 20
1C60 A5 7D E6 3F  FE 37 D4 C4  03 7A FE [illegible]  20 9B CD 93
1C70 03 1[illegible] 8D FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
1C80 EE 0B 11 15  EE 0A 17 01  18 06 19 13  02 04 1A 05
1C90 16 03 10 09  07 12 0C EE  0D 0E 08 20  0F EE 14 EE
1CA0 EE 2[illegible] 31 37  EE EE 32 2D  2F 25 36 27  3F EE 2B 33
1CB0 3D 3A 30 38  00 34 29 EE  2E 2C 64 20  39 EE 35 EE
%
```

Table 19. RTTY software to be run at 1C00.

that of a v.c.o. which has been set at a frequency between the two tones. The result of this comparison will contain a low frequency component which after filtering is used to pull the oscillator to the frequency of the incoming tone. This voltage therefore switches in sympathy with the tones and is fed to a comparator which produces the digital output.

If reception only of RTTY is required, the oscillator's free-running frequency should be set at the midpoint of the active-filters pass band. Alternatively, when a complete terminal is used and standard frequencies are required, e.g. 1275 and 1445 Hz for a narrow shift, the oscillator is set to the midpoint of these frequencies. Before this adjustment is made, R_2 should be set so that with no input to the unit the output is on the point of changing state. With an input of 10mV at the required change-over frequency, R_1 should be set in the same way.

A 12V supply is available from the computer and the output of the unit should be fed, via the serial input buffer IC_{53}, to the line which feeds data bus line D_2.

A RTTY byte consists of a start bit, 5 data bits and 1½ stop bits. The software makes two checks 1ms apart for a start bit, to improve the noise immunity, and when it is successful in finding a start bit the data byte is read in, translated into ASCII and displayed. As there are two sets of characters in the RTTY, Murray code numbers and letters, the computer is set initially to letters and section 1C39 to 1C48 of the program, see Table 19, recognises and acts upon the Murray bytes to draw the correct ASCII byte for display. Because most teleprinters have more than the v.d.u's 64 characters per row, the section 1C5D to 1C72 ignores conventional carriage return and line feed bytes, but looks for spaces in the last eight character positions on a row. When one is found a new line is called which avoids the split words and short lines that occur with most v.d.u. systems. If this facility is not required, e.g. when receiving lines of tabulated data, alter 1C5F to 18, 1C9D and 1CBD to FF to obtain a new line with every carriage return received. Section 1C80 to 1CBF contains the look-up tables for converting letters (1C80 to 9F) and numbers (1CA0 to BF) from Murray to ASCII. Note that without the graphics option, the Murray £ appears as a $. Tuning the receiver is most easily done by observing the output of the unit on an oscilloscope and tuning for the cleanest display, although after some practice the ear is quite adept at picking out the correct point. If after correct tuning the display is random, this may be due to the transmission rate being other than 50 or 45.5 Baud. In this case the byte XX following the calling of the software time delay (CD 36 03 XX) must be altered to change the delay length, see part 4 for details of the sub-routine. The time delay has been set at 21ms as a compromise between 45.5 and 50 Baud by calling two delays with an XX of A0 between data bits, and three delays of 9B at the beginning to clear the start bit when recognised, and to return half way into the first data bit. Three times 9B plus the 10 time delay called between the two start bit checks equals 1½ times two A0 delays. If the code makes no sense when receiving at the correct Baud rate, it is probable that the sense of shift is reversed which causes the computer to read 1s as 0s and vice-versa. This can be corrected by changing sidebands on a receiver using a product detector, or by tuning the b.f.o. to the tones on the other side of zero beat. This problem is most easily recognised by characters appearing regularly but without spaces which suggests that the timing is correct, or if the test signals often transmitted by such stations are received as SYSYSYSY . . . instead of RYRYRYRY. Narrow shift RTTY transmissions can usually be found between 14080 and 14100kHz during most of the day. □

Points arising

Unfortunately the following errors occurred in part 1 of the series. In the memory circuit of Fig.1. D_0-D_8 should read D_0-D_7. The 1k2 and 220Ω resistors on the base of Tr_1 in Fig. 2 should be transposed. For the kit, move R_2 to R_1 and fit a 220Ω in the R_2 position. Pin 15 of $IC_{4,5}$ should be connected to 0V and to maintain the correct order for D_0-D_7, the two outputs from $IC_{4,5}$ to IC_7 should be transposed. In the diagram on the left of Fig. 3, the NO arrow should be placed above the Read strobe box.

Two points have arisen from comments by constructors of the computer. Clock instability causing horizontal jitter on the picture can be eliminated by changing the 470Ω resistors at IC_{28} to 1kΩ. Due to manufacturing tolerances in some 4528 monostables, the tape reader may not function.

If this occurs replace the 27kΩ resistor connected to the 4528 with a 50kΩ preset, feed a 1V r.m.s. sine wave at 1800Hz into the tape reader and adjust the preset until the 4013 output which connects to the monostable is just changing state. The preset can then be replaced with the nearest preferred value resistor.

In conclusion

This section completes the scientific computer series. Due to a lack of space the firmware details have not been published but readers who wish to program their own r.o.ms can obtain a firmware list by sending a s.a.e. to this office.

We hope to support this design in the future with a floppy-disk drive and further practical programs. However, readers are invited to submit details of their own modifications or programs for publication.

We understand that John Adams is prepared to undertake the service or repair of computers built from a kit. Constructors experiencing difficulties should contact the author at 5 The Close, Radlett, Hertfordshire (Radlett 5723).

SIXTY YEARS AGO

After World War 1, amateur radio enthusiasts were left wondering for a time what was to happen to them. Then, as reported in the September 1919 issue, all pre-war licences were cancelled, preparatory to sweeping changes being introduced. In the present-day uncertainty about citizen's band, one hears remarks which could have applied to the situation of sixty years ago.

". . . said an official of the General Post Office to a Daily Express representative, we are very careful to see that applicants are not simply out for amusement. Before the war we had a good deal of trouble with silly fools who apparently asked their best girls to tea and amused them by sending out 'S.O.S.' signals on their wireless sets. Now that there have been such improvements in the apparatus inanities of this kind will be very obstructive to messages of commercial importance."

All we have to say with regard to that statement is that any practical wireless man knows how the "fools" could be soon discovered and eliminated; no ban has been placed upon private motor cars simply because a "fool" occasionally runs over a pedestrian. As for amusement, we should like to know why people may not amuse themselves in any way they please, provided they do not infringe the liberties of other citizens or transgress against the law. The amateur is willing to be supervised and to conform to reasonable regulations; he is even willing to act as a policeman of the aether amongst his own class, but judging from the look of things there exists a desire to obliterate him altogether. America has bowed — stiffly, it is true — to Prohibition, but she did not agree to the proposal to stifle amateur wireless telegraphy. Why should you? What are the Wireless Clubs doing to defend their rights? It was the American amateurs themselves who won their day, though they interested their legislators in the matter. Have our Wireless Clubs knowledge of any Member of Parliament who will stand up for them in the House?