# elektor

up-to-date electronics for lab and leisure

D 71683

102

October 1983

85 p.
IR 123p. ( incl.VAT )
$ 2 75

- simple anemometer

- music quantisizer

- Basicode 2: BASIC for all computers

READERSHIP SURVEY RESULTS

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*A windspeed meter for all who want to know a little more about the weather than shown by the barometer which can be built by any electronic hobbyist.*
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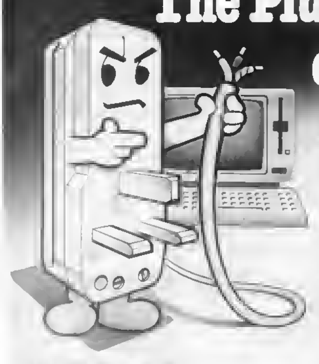

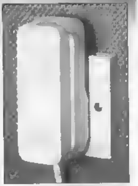


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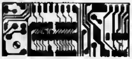

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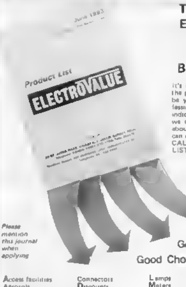

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# Readership survey results

By and large, Elektor readers are male, in the 18-40 age group, and employed. More importantly, they are actively interested in practical projects they can build themselves. There's a 50/50 split between computer owners and computer-free households – but in the latter group there appears to be an even split between 'I wish I had one' and 'I'm glad I haven't'. Furthermore, the vast majority are curious to know what other readers think. So, here we go . . .

For those of you who don't know: we included a 'Readership Survey' in our July/August issue. The first question was: 'Are you interested in the results?' Some 80 per cent said 'Yes', and only 2 per cent said 'No, it's a waste of paper' (the rest didn't answer this question). To keep that 2 per cent happy, we'll try to keep it short . . .

*"It took me exactly 20 min. 27 sec. to fill out this survey."*

So far, we have had a response equal to 5 per cent of our readership. The replies are still pouring in, but the basic trends seem sufficiently clear. To avoid prejudice, we will first list the results obtained so far; then we will give our comments.

*"I could do with more computer peripherals."*

*Likes and dislikes*

Throughout Europe, the trend is similar; in the U.K., the various areas of electronics rank as follows:

| | |
|---|---|
| 1. Computer interfaces, peripherals | (58%) |
| 2. Digital (other than computers) | (55%) |
| 3. Measuring equipment | (51%) |
| 4. Audio/Hi-fi | (51%) |
| 5. Microcomputer construction | (50%) |
| 6. Microcomputer software | (40%) |
| 7. Domestic applications | (38%) |
| 8. Radio/HF | (33%) |
| 9. For other hobbies | (28%) |
| 10. For use in cars | (28%) |
| 11. Electronic music | (24%) |
| 12. Video | (20%) |

Noteworthy exception abroad: 'Domestic applications' rates first place in France (our French editorial staff have a simple explanation: 'You should know French women! How else can you justify your hobby?'). The 'other hobbies' are mainly photography (10%) and trains, boats, cars, remote control, and so on (7%). The Germans add tropical fish, and the Dutch aren't into robotics yet.

*"There should be more audio" . . . "More RF, please" . . . "More digital and video" . . . "How about radio control?"*

*Elektor contents*

In general, practical information scores highest and 'practical news' takes second place. The survey ranked each feature from 'wouldn't read Elektor without it' through to 'waste of paper', and – to make things difficult – asked how many pages should be allowed for each. The results are revealing . . .

The vast majority vote for 'nothing but' or 'more' practical projects (over 90%); practical information (85%); application notes (70%), info-cards (65%), and theoretical information (60%). Neutral ranked from positive to negative bias: Market, Selektor, Technical Answers, Ejektor, Editorial introduction/opinion, computer programs, readers' letters, book reviews, circuits for fun, and tests of commercial equipment. No feature is completely negative: even 'tests' scores 19% 'more', 37% 'neutral', and 43% 'less'.

*"Include more computer hardware for other computers than the Junior."*

However, the 'page rating' is significant; on average, our readers prefer the following content:

| | |
|---|---|
| ■ Selektor | 3½ pages |
| ■ Projects | 27 pages |
| ■ Practical information and theory | 12 pages |
| ■ Market | 3 pages |
| ■ All other features (!) | 4½ pages |

*"There must be some great wits on your team. After all, what else is an engineer but a comedian with a soldering iron?"*

*Projects*

Thank you very much – we're flattered! Seventy-five per cent of our readers build more than two projects per year – 30 per cent 'as described', and 60 per cent 'with a few modifications' (mainly to use available components, fit a case, or tie in to other equipment). Component availability is 'no problem' (21%), or 'usually fairly easy' (54%) – only 3 per cent rate it as 'hopeless'. The projects usually 'work first time' (60%), or 'after some trouble-shooting' (40%) – 0.9 per cent say they 'rarely work at all'. If there is a problem, 88 per cent can 'usually', and 11 per cent 'sometimes', solve it themselves. Otherwise, they 'ask a friend for help'.

To our surprise, the vast majority own (and/or have access to) a wide range of measuring equipment: multimeter (110%), lab power supply (92%), oscilloscope (87%), tone generator (77%), and even frequency counter (70%).

*"The PCBs are rather expensive, so I make copies."*

Our p.c. boards are widely appreciated! In fact, 50 per cent claim that they prefer to buy them! (Would that it were so . . . but this is nonsense! We *know* how many we sell – nowhere near that many! Are you really buying *our* boards? You know, the ones on blue material, with black and white component and track screen, and solder mask? Not green epoxy, surely – we don't make those!).

Then, reliability 'compared to the competition'. We hesitate to say – 55 per cent consider our circuits 'more reliable', while 25 per cent say 'about the same'. We've got one per cent 'less reliable', and 19% 'don't know'. No comment.

*"Your balance is very good. Don't change it!"*

*Buying habits*

Since this section is primarily of interest to advertisers and our own commercial department, we'll be brief!

In general, complete kits are not in demand – only 16 per cent of our U.K. readers prefers this option. The other two options, 'components and PCBs separately' and 'only components' rate 43% and 45% respectively.

Roughly half our readers spend up to £ 100 per year on their hobby, the other half spend more; 25 per cent spend 'more than £ 200'. Abroad, the trend is similar – the

**Table 1.**

| Magazine | Elektor (%) | 'C' (%) | 'G' (%) | 'J' (%) | 'H' (%) | 'F' (%) | No. 1 Germany (%) | Joint Nos 1 France (%) | | No. 1 Holland (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | (%) | (%) | |
| Subscribers | 55% | 8 | 5 | 8 | 2 | 12 | 14 | 14 | 12 | 11 |
| Regular readers | 37 | 25 | 17 | 20 | 8 | 7 | 14 | 27 | 26 | 17 |
| Occasional readers | 7 | 37 | 46 | 36 | 37 | 26 | 43 | 47 | 50 | 44 |
| Total | 99 | 70 | 68 | 64 | 47 | 45 | 71 | 88 | 88 | 72 |
| Very good | 63 | 20 | 7 | 30 | 4 | 11 | 8 | 8 | 5 | 8 |
| Good | 31 | 34 | 31 | 37 | 27 | 27 | 32 | 35 | 18 | 39 |
| Average | 3 | 33 | 45 | 24 | 47 | 37 | 36 | 33 | 42 | 38 |
| Poor | 0.6 | 10 | 12 | 7 | 16 | 18 | 20 | 19 | 25 | 12 |
| Very poor | — | 3 | 5 | 2 | 5 | 7 | 4 | 5 | 9 | 3 |
| Contents biased towards | You know! | Projects | Projects | News & Descriptive articles | Projects | Projects | Projects | Projects | | Projects |

**Table 2**

| Other reading | U.K | Germany | Holland | France |
|---|---|---|---|---|
| Specialist magazines | 3.2 | 2.3 | 2.8 | 1.1 |
| General periodicals | 1.0 | 1.0 | 1.4 | 1.1 |
| Daily newspapers | 0.9 | 0.8 | 1.2 | 0.4 |

French and Dutch spend slightly less (60% less than £ 100). 'Professionally', we seem to spend (or authorize) astronomical budgets: 'more than £ 5000' rates 18 per cent in the U.K., and about ten per cent in France, Germany, and Holland. Even the most conservative estimate, based on these results, would be that we are spending at least £ 250 million per year!

What do you look for in advertisements? Components! (90%). Then microprocessors (43%), books (41%), measuring equipment (33%), tools (31%), and commercial equipment (20%).

*"PS. The paper is good, too, and your ink is the only one that's black enough to photograph."*

'All' (29%) or 'most' (60%) of the articles are read, and on average this takes 4½ hours — first time round. With all the reading and re-reading, we have found estimates of more than 100 hours! It surprised our editorial staff — and pleased our advertising manager! — to find that a similar trend applies to the advertising section. 'I check all adverts' rates 12 per cent, and 'I look through most of them' scores 45 per cent. On average this takes 1¼ hours.

The questions relating to 'subscription' versus 'newsagent', 'since when are you a subscriber?' and so on, were intended as a check, to ensure that we were evaluating a representative cross-section of our readership. In practice, some correction proved necessary (subscribers were over-represented); the percentages given in this article were modified accordingly. (Perhaps this was poor commercial policy; subscribers are slightly more 'pro Elektor', so the results would look even better if we hadn't corrected them . . .).

'What happens to your copy — do you 'pass it on, keep it, or throw it away?' Just as we thought: 97% keep it, two per cent pass it on, and only one per cent throw it away. More on this under 'comments' — both yours and ours.

*"Corrections to previous issues should be given a prominent place. This is the acid test for a magazine. You pass . . ."*

### *Reading habits*

We asked how many other magazines you read, and how the electronics magazines score. The idea was to discover what kind of *readers* we have (as opposed to *electronic hobbyists)*, and at the same time to evaluate your preferences — after all, we read those other magazines, too!

*"Keep up the good work!"*

We were pleased to find that 63 per cent of our U.K. readership consider Elektor 'very good', and 31 per cent 'good'. This gives us a reference for the others. It should not come as a surprise that the more practical-project oriented magazines are read more often. Furthermore, third place (out of fifteen) goes to a magazine which is known for its high editorial standard. The actual percentages are given in table 1.

The reasons given for buying and reading Elektor follow the same trend. 'Interesting articles' and 'hobby' take first and second place throughout Europe. The 'professional appearance' comes third in the U.K. — but it ranks far lower abroad, where other magazines have a similar appearance. 'For want of something better' scores last-but-one in the U.K., but it takes third place in France — which says a lot about the other magazines in these two countries!

*"Yes, computers have a future — but don't RAM them down our throats every month."*

### *Readership profile*

Just as we thought: the 'typical Elektor reader' doesn't exist! In the U.K., electronics is 'a hobby' for 34% and both hobby and profession for 58 per cent. All age groups are represented, although there is a slight bias towards the 20-30 group. At the extreme ends, 'under 17s' are slightly under-represented in the U.K. (three per cent as opposed to eight per cent throughout Europe); 'over 60s' account for 5% in the U.K. and 3% overall.

The question 'male or female' turns out to be redundant . . . we seem to be 99.9% male! In fact, we have received replies from only about half-a-dozen women — out of a total of close to ten thousand replies tallied so far!

About one third of our readers have no formal qualifications in electronics. At the other end of the scale, there are some 12 per cent 'corporate engineers'. There is a broad sweep in 'other education', through to 28 per cent with a university degree. Sixteen per cent are students — and 57% are employed ('not employed' rates three per cent in the U.K.). 'Do you own a computer?' 'Yes' scores 53% with over eleven per cent owning more than one. Of the devices listed, just over 40% are 6502-based and nearly 40% are Z80 machines. Sinclair wins hands-down, as you might expect; then there are quite a few Apples (mainly Apple II), BBCs (mainly model B), TRS80s (mainly model I), VIC 20s, Acorn Atoms, and NASCOMs.

*"Keep computer programs and HiFi reviews to their own specialist mags."*

## Your comments (and ours)

*Microprocessors in Elektor?*

There are two noteworthy trends: 'Please, keep Elektor free from these pests — if I want programs, I'll buy a specialist magazine!', and 'Microprocessor hardware, OK, provided you don't waste too many pages on it and provided it's suitable for commercial machines'. Points taken — as regular readers may have noticed, your editor has already been doing his utmost to move that way: less on microprocessors, and what there is aimed at practical value for a maximum number of readers!

*"I don't mind a bit of computer, but please mix it with some RF, audio, and digital."*

*Circuits and contents*

Several comments were made by a significant number of readers (more than one per cent, that is):

- Please specify suppliers for awkward components, or use more standard components (BC 107, etc.) or list alternatives.
- Include test-points, etc., as an aid to trouble-shooting.
- Some indication of construction cost would be useful; also, more information on the type of case to use.

*General comments*

Apart from the pleasingly large group of 'I like Elektor' and 'Your p.c. boards are best', several other general comments scored over 1%:

*"PPS. This paper is b . . . . . awful to read in artificial light. Can't you go back to the pre-'76 stuff?"*

- The printing and general appearance are far superior to other mags, but the older paper (pre-1977) was even better.
- A several-year cumulative index would be very welcome (that fits, given the fact that nearly everyone keeps his copies!).
- Please don't adopt the revolting trend of including adverts in the editorial section.

*"Your PCBs are of superb quality and at reasonable prices. Don't ever do away with them!"*

- Those special p.c. board layout pages are a great halp (this scored 37% in the relevant question!), but don't use them as an excuse to delete the layout from the article proper.

Lots of other comments didn't score so high, but they seem valid for everyone. For instance, just one reader so far has suggested that 'Missing Links' could be included on the p.c. board layout pages. That way, they can be cut out and pasted in the original article. Great idea! While on the subject of 'Missing Links', we received several further requests 'please, repeat them over several months', 'please, publish them sooner', 'please, print a year's index at regular intervals', 'please, include them on the contents page' . . . Also: 'Elektor circuits are error-prone — just look at all those Missing Links'! That one appears at least as often as the more positive 'To err is human, but to admit it is noble'.

*"Postage stamps cost more than transistors!"*

One other comment ranks almost top of the list in the U.K. (but nowhere else!): 'This survey should be reply-paid'. Yes, we considered it — but when we did a few sums, we got cold feet! People with some experience in this field warned us that we could then expect upwards of 25% response. That would let us in for a postage bill for over £ 10,000! So, reluctantly, we politely asked each reader for a 12½p stamp.

## Final note

We are often told that component availability is a problem, but the survey fails to confirm this. We have a total response, for all countries, of 78% 'no problem', or 'usually fairly easy'. The U.K. figures are even more favourable than the overall picture: 21% 'no problem' as opposed to 17% overall. So where's the fire? After all, there's plenty of smoke! While reading through all the comments, we noticed several possible explanations:

- We *have* used a few awkward ones (the WD 55 is an often-quoted example), and these tend to stick in the mind.
- Many readers seem reluctant (partly for sound financial reasons) to order components by mail. In the local shops, however, a typical dialogue seems to run lika this: 'A TCA 440, sir? Never heard of that one. Who makes it? You don't know! Oh, I see, it's a circuit you found in Elektor . . . well, then, it'll only be available in Germany'. (This conversation was overheard by a reader, who notes that TCA 440s are readily available from Technomatic at £ 2.20).

*"Do you intend to produce back issues of INFOcards or a repeat series?" (Answer: Yes!)*

- Often, a special device will be available off the shelf in only a few shops. You can spend a small fortune in telephone bills trying to locate them.
- Readers often build circuits from four or five years back. In some cases, the components are then no longer available.

So, what can we do about it? After all, we still have a good 20 per cent of our readers in the 'often a problem' category — and they're not all from Canada, New Zealand, or Taiwan. In future, we'll try to remember to add the manufacturer's name. Also, we'll try to work out a satisfactory way of giving a list of suggested suppliers, without playing favourites if we can avoid it.

*"I live in Brazil and some components are not available here."*

Finally, we wish to thank all those readers who participated in this survey. We have learnt a lot, and gathered several new ideas for improving the magazine. Now, let's see how soon we can put them into practice!

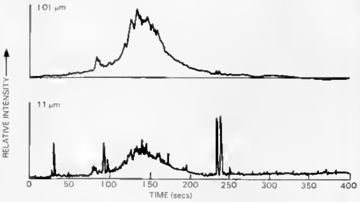
*"Isn't it boring, going through all these comments? Merry Xmas!"*

## Discovering the infra-red universe

From an orbit 900 km above Earth, where it is unhampered by the atmosphere, the new infra-red astronomical satellite IRAS is revealing an exciting universe of previously unknown objects. Its 57-cm primary mirror is in the process of detecting important astronomical sources of infra-red radiation. It will increase a thousandfold the number of such sources known to us.

Infra-red radiation is a big part of the energy budget of the universe. Astronomers want to know its full significance in order to tackle a whole range of fundamental astronomical questions. But the problem is that water vapour and other gases in the atmosphere absorb infra-red radiation from space and emit it, too. It reaches the Earth's surface in only a few, narrow bands or 'windows'.

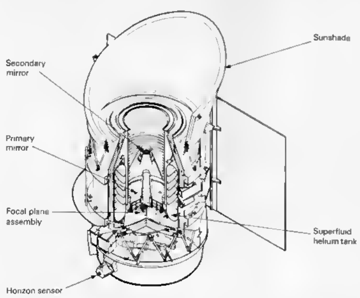
IRAS is now helping to solve this problem with an all-sky survey in the infra-red part of the spectrum. And it is detecting infra-red sources with up to a thousand times greater sensitivity than could be obtained by earlier observations from rockets, aircraft, balloons and ground-based observatories.



Scans of the Milky Way taken by the telescope on its first day of operation. The data came from a single 400-second sweep from South to North, 25 degrees long at an angle of about 45 degrees across the galactic plane in the constellation Crux, the Southern Cross. The upper trace is dominated by emission at a wavelength of 100 µm from cold dust within the clouds of gas that collapse to form the stars in the MilkyWay; its jagged profile represents an integration of emissions from individual clouds of dust and gas hundreds of light-years across. The power trace shows intensity at a wavelength of 11 µm and is mainly due to emission from billions of stars; narrow spikes are caused by single stars that are bright or nearby. A bulge at the centre shows the most dense concentration of stars, while a slow rise at the right of the trace comes from warm dust in the plane of the solar system.

The infra-red spectrum stetches from the edge of red light, at a wavelength of one micrometre, to the beginning of radio waves at one millimetre; the IRAS telescope is designed to detect infra-red wavelengths from eight to 119 µm. There are 62 rectanguler detectors at the focal plane of the telescope; their composition and the way in which they are deployed enables astronomers to observe objects in four separte wevebands simultaneously.

IRAS has come into being through close collaboration by the UK, the Netherlands and the USA. The mission operations organization is at the Rutherford Appleton Laboratory (RAL), near Oxford, where a 12-metre steerable dish sends commands to the satellite and receives observational and engineering data twice daily when it passes within receiving renge.



The IRAS telescope, a modified Cassegrain design. It has primary and secondary mirrors to reflect radiation on to detectors in the focal plane.

### Data stores

IRAS has a computer that controls the satellite and handles observation data. Two tape recorders on board can store up to 900 million bits of observational information for the RAL to receive at one million bits per second. All the satellite's systems are powered by solar panels, which supply 250 W.

Dutch scientists and engineers designed and manufactured the spacecraft, which weighs 266 kg. The 810-kg telescope was designed and built in the USA.

Observations and engineering data, as they come in from the satellite, pass through two computer systems to provide a constant supply of information on which control of the mission is based.

### Frequency gap

Astronomers need IRAS to fill the gap between optical and radio astronomy. So far, infra-red astronomy has been used mainly to look at objects already observed at light and radio frequencies but which also emit in the infra-red region.

The frequency at which the radiation from any object reaches a peak depends upon the temperature. The higher the temperature the further the peak shifts towards shorter wavelengths, that is, higher frequencies. Most bodies that can be seen through an optical telescope have temperatures above 6000 K, which is about the surface temperature of the Sun. But while billions of objects, chiefly stars and galaxies, radiate strongly at the frequencies of light, there may be just as many cooler objects at temperatures from a few tens to a few hundred kelvin that radiate in the infra-red region. Without infra-red telescopes they could never be observed and studied.

For example, besides cool bodies there are hot, bright stars hidden from us by clouds of dust. Their light is absorbed by cloud particles and re-radiated at infra-red wavelengths. Light cannot penetrate the dust clouds because the dust particles, about the size of particles of smoke, are larger than the wavelengths of light. But radiation at the much longer, infra-red wavelengths can pass through.

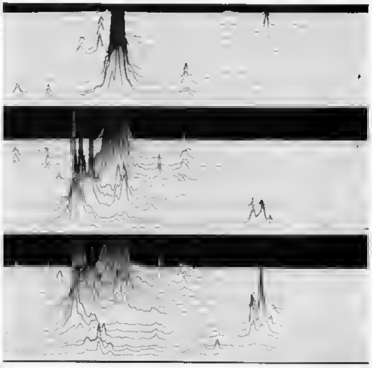
For this reason, the IRAS telescope can see to the centre of our galaxy, the Milky Way, which dust clouds hide from optical view. The galactic centre is a big astronomical mystery: although it occupies only about a millionth of the galaxy's volume, it radiates one tenth of the galaxy's energy. IRAS data should lead astronomers to a better understanding of what is happening there.

### Other galaxies

Astronomers will also be able to compare our galaxy in infra-red with others. There are, for example, certain ordinary-looking galaxies whose radiation in the infra-red is about ten thousand times that coming from the centre of the Milky Way. How energy in this form is produced in such vast amounts is at present unknown.

The very massive and hot stars that ionize vast clouds of hydrogen by their radiation are well known to astronomers. Only very intense radiation from massive stars could break apart the hydrogen of such clouds into protons and electrons. Because of their great mass, such stars last only for some millions of years, so their presence indicates that stars are being formed or that formation has recently taken place. Indeed, there are dust clouds of heavy elements in these regions where stars are being born.

The energy from the gravitational collapse of dust clouds is radiated as infra-red waves. The clouds become denser and hotter and protostars form which eventually begin thermonuclear reactions and blaze forth as new stars in the visible part of the spectrum. But, before this happens, astronomers can investigate star formation by observing the infra-red radiation produced. IRAS can detect proto-stellar objects with the mass of the Sun over a substantial part of our galaxy, so enabling astronomers to calculate the rate of star formation.



**Three scans across the large Magellanic Cloud, the nearest galaxy to ours, taken by IRAS. Each scan records outputs over 75 seconds from 15 detectors on a wavelength of 60 μm during the first day the telescope was exposed. Dozens of sources of radiation are revealed, many invisible to optical telescope. Most are probably newly-forming stars. The intense emission left to centre may be from a star thousands of times more massive than the Sun.**

### Synthesized elements

The more massive a star, the shorter its life. A star more than three times the mass of the Sun, for instance, consumes its substance in nuclear reactions at a rate proportional to the cube of its mass. But, during their life-cycles, stars synthesize all elements heavier than helium; and in its old age a star ejects its synthesized elements as a shell of dust which absorbs light from the star and re-radiates in the infra-red region. In this way stars give back to the interstellar medium matter that they have transformed, which in turn forms into new stars and any planets they may have.

So IRAS will contribute to our understanding of how interstellar dust is consumed in the processes of star formation, and resupplied by very old stars. Astronomers plan to find out what proportion of matter stars lose at the end of their lives and to calculate the rate of ejection of new matter into space. For example, recent research shows that silicates are a dominant constituent of interstellar dust, so that by observing at appropriate infra-red wavelengths astronomers can map the distribution of silicates in our galaxy.

**IRAS control centre at RAL, responsible for monitoring the status of the satellite and collecting data from its primary telescope and other experiments. The satellite passes over the centre at least twice daily. Incoming data gives scientists a brief check on objects that have been observed and controllers can make checks on the spacecraft itself. Data is sent to the Jet Propulsion Laboratory for complete processing.**

### Cooling

The main technical problem in observing the infra-red universe, quite apart from the need to rise above the atmosphere, is the need to keep the telescope cool. All objects more than just a few degrees above absolute zero radiate some energy in the infra-red range (and that of course includes the satellite, the telescope and everything associated with them), so the big engineering problem was to keep the telescope as cool as possible in order to detect the faintest infra-red sources. Obviously, anything fainter than the infra-red radiation from the telescope itself cannot be detected.

The detector package at the focal plane of the telescope, with its 62 rectangular detectors, is kept at about two degrees above absolute zero by surrounding the telescope with a tank containing 475 litres of superfluid helium. It is the rundown time of the cooling system that limits the working life of IRAS.

### Data received

Following the launch by NASA from the Vandenberg base in California on 26 January, the satellite was placed in its nearpolar orbit to circle Earth 14 times a day. Engineering tests confirmed that all systems on board worked correctly and, on 31 January, the protective cover of the telescope was ejected. Within an hour the first infra-red images from outer space were received, and during the first day over 4000 infra-red sources were detected, about the same as the total number that had previously been seen at such wavelengths.

The infra-red detectors proved to be over 100 times more sensitive than any that had been used in earlier missions and the boil-off rate of the liquid helium promises a working life of at least 250 days — well up to expectations. It will be long enough for astronomers to obtain a detailed all-sky catalogue of infra-red sources and to make their special observations.

First images produced from the data have revealed infra-red sources in the Large Magellanic Cloud (LMC), sources not visible from Earth with optical telescopes. LMC is 155 000 light-years away, and is the closest galaxy to our own. From a nebula of gas and dust within the LMC known as 30 *Doradus*, an image has appeared of a cloud with long, separated filaments giving it a spidery appearance: astronomers have nick named it Tarantula. The nebula is a giant region where there are clouds of hydrogen that have been ionized by ultra-violet radiation from a very hot star. A new cluster of massive stars, each 10 to 100 times as heavy as the Sun, has probably been born there recently; some astronomers have suggested that the nebula contains a monster star, thousands of times more massive than the Sun.

*Edward Ashpole SPECTRUM 183*

## Better way of depositing semiconductor compounds

The metallo-organic chemical vapour deposition (MOCVD) process, used for depositing very thin ultra-pure layers of semiconductor compounds on to substrates, has been made very much safer and less expensive by the development in Britain of a range of completely new compounds which do not have the toxic, explosive and reactive-with-the-ambient characteristics of existing compounds. Moreover, these improvements have enabled the manufacturer to develop greatly simplified deposition equipment, which is said to be substantially lower in cost than existing equipment.

Key to the improved process is the use of solid adducts which are much more stable than the metal alkyls traditionally used for MOCVD. This is of particular significance to the electronics industry where the current use of highly reactive materials involves hazards in preparation, purification and handling. Side reactions when using conventional alkyls also present problems and can yield decomposition products in an uncontrolled way.

The adducts — which can be precursors for indium phosphide, gallium arsenide or gallium aluminium arsenide — are vaporised at relatively low temperatures of about 100°C. Transport of the vapour over a heated slice of the bulk substrate to be coated allows the organic enveloper to decompose leaving the inorganic constituents as an epitaxial deposit. Two or more compounds may be decomposed simultaneously to yield a third compound.

Selection of the organic part of the compound molecule determines the volatility and ease of decomposition. The molecule can be designed to yield pure metal on decomposition or to form a carbide nitrate, oxide, sulphide or other required derivative. Hence applications in protective coatings, and electrical insulation and conduction are also expected.

The complex and expensive systems traditionally required for MOCVD can be replaced by much simpler equipment. As well as supplying the precursor compounds, the manufacturer offers the low-cost Epitor 01/1S deposition system. Further savings are possible because the adduct precursors can be purified more simply and effectively as a result of their diminished reactivity.

*Made in Britain.*

**The majority of modern hobby computers use the programming language BASIC. However, that does not mean that a BASIC program can be exchanged between two different types of computers, either directly or via a cassette. The BASIC commands may well be the same but the way in which the computer deals with them and how they are put on cassette are often completely different. Basicode was developed to solve this problem. It is a sort of universal communication standard to allow BASIC programmes to be interchangeable between different types of computers.**

# basicode-2

## a code to make BASIC programmes exchangeable

It is about two years since NOS, the Dutch broadcasting company, came up with the idea of developing a standardised code to make it possible to exchange BASIC programs between two different types of computers. As with most things that Murphy gets a hand in, this is not entirely straightforward. First of all there is the problem of storage on cassette. Most hobby computers use cassette recorders as a means of storing programmes. The method of registering data on tape and the frequencies used are different for each type of computer. A second difficulty is the BASIC language used. Even though a standard BASIC exists, each computer uses a different 'dialect' with its own peculiarities. There is also a problem as regards how programs are stored and processed within a computer, as there is no international agreement on this. Because of these factors BASIC, even though it is widespread, is not at all interchangeable between two computers that 'think' differently.

The Basicode standard is a fixed audio code by means of which BASIC programs can be stored on cassette. Through this standardisation, programs can be written onto cassette from any type of computer and read back to any type of computer. That is not to say that Basicode is simply a translation programme to store BASIC programs on tape in a specific manner. Just as important are the agreement on the BASIC commands used, the arrangement of line numbers, the names of variables and the screen format.

At present there is already a second version of Basicode available that uses a series of standard subroutines. At the same time a few other points have been changed from the original version with the aim of making Basicode even more universal. This Basicode-2 is the subject of this article.

### Basicode on tape

Basicode uses frequencies of 1200 and 2400 Hz. A logic '0' corresponds to one whole period of 1200 Hz while a logic '1' is two full periods of 2400 Hz.

Each byte is transmitted serially at a rate of 1200 baud, and every byte is built up as follows (see also figure 1):
- 1 start bit (logic zero)
- 8 data bits, least significant bit first
- 2 stop bits (logic one)

The BASIC programme is coded character by character in the form seen when a LIST command is given. No internal computer notation is used. All letters and figures are simply represented in ASCII code. Every BASIC instruction must be followed by a space, and each BASIC line must be finished with CR (carriage return, $8D_{hex}$). The most significant bit of every ASCII sign is made '1'.

A complete programme on tape consists of the following sections:
- a leader consisting of a 5 second tone of 2400 Hz
- the ASCII sign 'start text' ($82_{hex}$)
- the BASIC programme in ASCII code
- the ASCII sign 'end of text' ($83_{hex}$)
- a 'checksum'
- a trailer, consisting of a 5 second tone of 2400 Hz.

The checksum, which is used for error detection, consists of a bit-by-bit exclusive OR function of all previous bytes (including the 'start text' sign). This checksum is 8 bits long (1 byte).

### The Basicode-2 protocol

#### General agreements

The only BASIC statements allowed are those which are known by all computers. These statements are listed in table 1, and we will return to this later. A number of line numbers are reserved for special defined subroutines. This ensures that certain operations are possible that cannot easily be achieved in standard BASIC. These routines are not transmitted with the pro-

gram, so they must either be a part of the Basicode translation programme or they must be written in separately before RUNning a BASIC programme.
The screen dimensions are fixed at 24 lines of 40 characters. Because some computers have less than 24 lines on the screen or less than 40 characters per line, it is recommended that no more than 16 screen lines be used and that the lines should be kept as short as possible.
A program line, including line number, spaces and carriage return, can have a maximum of 60 signs.

### How a program is built up

The following groups of line numbers are reserved in Basicode-2:
0-999: standard routines. These are specially developed for the computer in question and are supplied through the translation programme or are read in separately.
1000: the first line of the program. It must have this form:
1000 A = (value): GOTO 20: REM program name (value) is the maximum number of characters that are used together in all strings. By jumping to line 20, the computers that need it reserve some memory space for the strings.
1010: the first line that can be used for the program.
1010-32767: space for the pogram.
There is no compulsory system within the programme, but the developers of Basicode recommend the following groupings:
1000-19999: main program
20000-24999: subroutines for the programme, in which statements exist that are not permitted in Basicode-2
25000-29999: data statements
30000-32767: REM statements. These can be a description of the program, references or the name and address of the programmer.

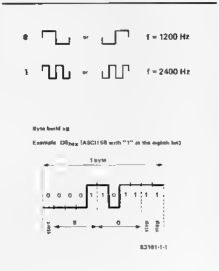


**Figure 1. This is how the transfer format is built up in Basicode. Note that transfer begins with the least significant byte.**

It is recommended that the line numbers are increased in steps of 10. As regards the subroutines at lines 20000-24999, these should be avoided as much as possible. If this is not possible, it should be made perfectly clear what each subroutine does.

### Standard subroutines in Basicode-2

These subroutines are very much dependent upon each particular computer so this is just a general description of the function of the subroutines with no examples given.

*GOSUB 100*: This clears the screen and places the cursor at position 0.0 (upper left corner of the screen).

*GOSUB 110*: Set the cursor at a specific place on the screen. The desired location must be stored in variables HO and VE. HO is the position in a line (0 is completely left) and VE gives a line number (uppermost line is number 0). As the screen format in Basicode-2 is 40 characters on 24 lines, HO cannot be greater than 39 and VE no bigger than 23. The values of HO and VE do not change by calling this subroutine.

*GOSUB 120*: The position of the cursor on the screen is set in the variables HO and VE. With this system HO = 0 is the first position in a line and VE = 0 is the top line. This routine can be used with the previous one to, for example, move the cursor one or more lines higher or lower.

*GOSUB 200*: See if a button is pressed and store the value of this key in IN$. If no key is pressed at that moment, IN$ is empty. In principle, control characters could also be stored but this requires caution as these have different meanings for different computers. One exception is RETURN, which is ASCII code 13 in all computers.

*GOSUB 210*: This routine waits until a key is pressed and stores the vlaue in IN$. This routine actually waits for a key to be pressed, whereas in the previous one a value was only stored if a key was pressed at the actual instant when the routine was running.

*GOSUB 250*: This subroutine gives a bleep in computers that have this facility. The frequency and duration of the bleep are not specified here.

*GOSUB 260*: An arbitrary number between 0 and 1 is generated and stored in variable RV.

*GOSUB 270*: The whole variable space is cleared up and the routine finds out how much memory space remains (the variables are not cleared!). The number of free bytes is stored in variable FR.

*GOSUB 300*: The value of variable SR is stored as a string in SR$. The string cannot contain a space at the beginning or end of a number. This is in contrast to STR$ which does this sometimes. STR$ is not permitted as a Basicode-2 statement in any case.

*GOSUB 310*: This routine supplies a string SR$ built up as follows. The value of SR$ is equal to the contents of variable SR and is always in fixed-point notation. The total length of SR$ contains CT characters and the number of characters after the decimal point is defined by CN. If the number does not fit in the stated format SR$ consists of CT asterisks. CT, CN and SR are not changed by calling this routine. An example of this routine is: CT = 7, CN = 3 and SR = 0.6666, then SR$ = '   0.667'.

*GOSUB 350*: Prints SR$ on the printer but does not finish the line yet. This makes it possible to print different strings one after another on the same line.

*GOSUB 360*: Closes a print line with a carriage return and new line command.

### Variables

To ensure that the interchangeability of programs is maintained, there are some limitations as regards the variables used in any program:

- Numeric variables are always real and with single precision.
- The name of a variable can only have a maximum of two characters, and the first must be a letter. The second may, depending on use, be a letter or number. String variables have a $ after the name. Lower case letters are not permitted in a variable.
- Logic variables can only be either true or not true. Any value that could be confused with something else by the computer may not be used, for example +1 for true and 0 for not true.
- It must not be assumed that all variables are reset to zero at the start of a programme.
- String variables can be no longer than 255 characters.
- Variables may not begin with the letter Q, as this is reserved for the standard subroutines.
- Variables AS, AT, FN, GR, IF, PI, ST, TI, TI$, and TO may not be used.
- The variables HO, VE, FR, SR, CN, CT, RV, IN$ and SR$ are used for communication between the BASIC programme and the standard subroutines.

**Table 1. These are the permitted BASIC commands and operations.**

ABS
AND
ASC
ATN
CHR$
COS
DATA
+
−
*
/

DIM
END
FOR
GOSUB
GOTO
INT
IF
↑
=
<
>

INPUT
LEFT$
LEN
LET
LOG
MID$
NEXT
<>
<=
>=

NOT
ON
OR
PRINT
READ
REM
RESTORE

RETURN
RIGHT$
RUN
SGN
SIN
SQR
STEP

STOP
TAB
TAN
THEN
TO
VAL

### BASIC limitations

Table 1 gives a summary of all the permitted BASIC commands and operators. Here some basic agreements are necessary. There are some variants in the BASIC language but usually the meanings of commands are much the same as in the official BASIC, so we will not discuss the variations here.

There are, however, a few points about BASIC commands that do require clarification. A variable name may not be used directly after a GOSUB or GOTO; so A = 1000 : GOTO A is not permitted. The command IF must always be followed by THEN. For example: IF . . . THEN A = 5, IF . . . THEN 1000 and IF . . . THEN GOSUB 20000. The form IF . . . THEN . . . . ELSE is not allowed. Comments or multiple variables are not permitted after an INPUT; so INPUT 'The value is'; A$ is forbidden. A line number may not be given after RUN. If using the TAB statement, remember that some computers start counting at zero and others begin at one.

### In practice

Those are the most important points about Basicode-2. Apart from these, a translation program and the 'permitted' subroutines are needed but we will not give them here because they are different for each computer. The translation program is in machine code and sometimes has a BASIC part, depending on the type of computer. There are already programs available for various different types of computer, and generally a specialized computer club can help here. If everything went according to plan, the Basicode-2 book is already available, giving the complete Basicode-2 protocol and several different translation programmes for common types of computer. Further information can be obtained from Hans G. Janssen, Hobbyscoop, Postbus 1200, 1200 BE Hilversum, The Netherlands. The Basicode-2 book itself, which is printed with English and Dutch in the same book, is also available from Hobbyscoop. Basicode programs are also broadcast during the Hobbyscoop programme on Sundays from 17.10 . . . 17.45 GMT (summer) or 18.10 . . . 18.45 (winter) on 747 kHz.

Finally, to return to our own Junior Computer. Elsewhere in this issue we have an article giving the translation programme and various subroutines for the BASIC Junior Computer. Translation programmes for both the expanded Junior and the DOS junior are available and this article has both of them! ◀

**The theory of electronic music synthesis is largely based on the characteristic of 1 V/octave, which has been used so much over the years that it is now almost universally accepted as the standard. This characteristic defines the relationship between a musical unit (the octave, which is the interval between two frequencies, one of which is twice as large as the other) and an electrical unit (the volt). Because the octave is composed of twelve equal semitones, the volt is also divided into 12 equal fractions. In this way a specific voltage always exists for each note in every octave. This control voltage then feeds various synthesizer modules (principally VCO and VCF) in steps of 83.33 mV, or multiples of this 'step'. The quantisizer described here is used to produce control signals which agree with this characteristic given a signal that is not broken up into steps of 83.33 mV, no matter what its origin! That means that the tonal range which can be generated is almost infinitely variable.**

# music quantisizer

## analogue/digital converter + transcoder + digital/analogue converter = control of musical scales

This quantisizer is not a generator, it is more like an interface between two other synthesizer modules; in fact, it could be better called a converter or transcoder. That means that it is supplied with one signal and it outputs a different one. There is, of course, a relationship between the two signals, the output is a quantized version of the input; this output, then, is 'chopped up' into the famous V/octave characteristic so that it produces the different steps of a musical scale defined by the user.

Figure 2 shows the relationship between the input and output signals of the quantisizer. Here we see the curve of the input signal (in this example it is an envelope, but it could originate from a LFO, a sequencer, a pedal . . . . or whatever), and two examples of output signals from the quantisizer (QOV = quantisizer output voltage). One of these contains all the notes in the musical scale and follows the input quite closely. The other signal, however, contains only the three notes of the major chord.

### 'Quantisized! What does that mean?

The word 'quantisizer' comes from the combination of 'quantizer' and 'synthesizer'. Quantizing is a process by which a physical size is divided into discrete values which are multiples of a fixed, non-reducible unit. In our case this unit is the musical semitone or the corresponding 1/12 of a volt (83.33 mV). The circuit described here has two fundamental modes of operation (with numerous variants that we do not have the space to deal with here): one with trenscoding or range-changing, and the other without. In this latter case, the quantisizer is no more than a precision analogue/digital converter. A voltage applied at the input is converted into a digital value, which is immediately reconverted into an analogue value.

This procedure allows a curve to be modified to the usual V/octave characteristic, or alternatively a characteristic of Y x 1 V/octave could be converted to the standard 1 V/octave, always assuming, of course, that the input signal has the correct degree of accuracy (± ½ LSB). Possibly more interesting for μP owners is the fact that the quantisizer without transcoding provides two good quality, independently addressable converters on the same board.

The other mode of operation is far more spectacular, in so far as it permits some sort of musical order to be assigned to even the least musical of control signals.

Figure 1 shows the block diagram of the quantisizer, consisting of six successive stages for processing the signal. An input amplifier for weak signals also ensures that the alternating signals have d.c. offset compensation. This is followed by the analogue/digital (A/D) converter, which has its own clock. Every 63 μs this converter provides an 8-bit digital code whose magnitude is proportional to the amplitude of the input signal. This data is then stored in a latch (ideally an addressable latch as this would enable the A/D converter to be used with a microprocessor independently of the rest

1

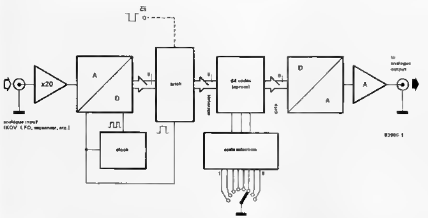


**Figure 1. The quantisizer consists of a chain of elements for processing synthesizer control signals. It is of interest not only because of the accuracy of it's V/octave characteristic but also its ability to generate control voltages calibrated according to musical scales or chords. As far as the ear is concerned it is like a type of 'sequancer-arpeggiator'. Both the A/D and D/A converters can be used independently.**

of the circuit). This same eight bit code is applied to an EPROM as the low byte of an address. Each address contains some specific data that is input to the D/A converter, the output of which is proportional to the magnitude of the digital code. The whole significance of the quantisizer lies in the choice of these codes. The high order bits for addressing the static memory are supplied by a musical scale selection circuit that is accessible by the user. The memory area is divided into eight zones, allowing transcoding to 8 musical scales.

## Converting to digital form

Part of the circuit for the quantisizer is shown in figure 4. This shows input amplifier IC1, A/D converter IC3, latch IC4 and clock IC2. The signal is input to R4 and thereafter to the non-inverting input of IC1, after being offset by a d.c. voltage set by P1. The A/D converter can only deal with positive voltages. Of course, many of the signals in a synthesizer are alternating voltages (from an LFO for example). The gain of this amplifier is set by means of P2 and can be between twenty and unity. Thus, with this input circuit, the quantisizer is truly universal.

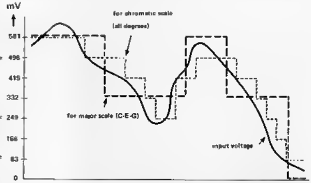
The amplitude of the signal is limited by P3 before the ZN 427 (figure 3a shows the simplified internal diagram of this IC) converts it to digital form. As the internal reference voltage of IC3 is 2.5 V, the maximum possible value of input signal is the same. This IC also needs a clock signal (to pin 3) and a start conversion signal SC (pin 4). The clock generator circuit (N1) provides a signal of 140 kHz. The start conversion signal is a combination of the clock signal and the end of conversion signal, provided by the ZN 427 itself and inverted by N4 before being applied to flipflop N2/N3. With this configuration, the end of each conversion causes the next one to begin, as the diagram of figure 3b shows.

At the start of the conversion, the highest order output bit, 7, *(note: contrary to our normal designation the manufacturer of the ZN 427 calls it bit 1)* is set to logic high and all other bits are set logic low. The voltage to be converted, $V_{IN}$, is compared with a voltage equal to ½ $V_{REF}$ output from the D/A stage of the ZN 427. The logic level of bit 7 is established definitely at the next successive falling edge of the clock signal. It is high if ½ $V_{REF} < V_{IN}$ and low if ½ $V_{REF} > V_{IN}$. At the same time the following bit (bit 6) is set logic high and its logic value is determined on the next trailing edge as a function of a comparison between the output of the D/A converter and the voltage to be converted.

This procedure is repeated until the logic levels of all eights bits have been set. Immediataly after the value of the lowest order bit is established, the EOC output of the IC goes logic high and the digital data appears as the output at the buffers of the converter and it remains there until the new start of conversion signal arrives. This whole sequence takes nine clock pulses. Because the clock cycle is 7.1 μs duration (the frequency is 140 kHz as we said), the total conversion time is 63 μs, which means that the frequency of the sampling signal is 15 kHz. That is more than enough for VLF (Very Low Frequency) and non-periodic signals. But . . .
. . . it is a bit low for audio signals (the sampling frequency should be at least twice the highest frequency of the signal to be converted). However, with the minimum conversion time guaranteed by the manufacturer of the ZN 427, 15 μs (with a clock signal of 600 kHz), the sampling frequency is about 60 kHz! Admittedly this has little to do with the quantisizer but the qualities of the circuit merit their being brought to your attention, possibly for future experimentation.

**Figure 2. For any given input voltage the quantisizer can deliver eight different output curves, each of which follows a certain musical scale. In the example shown here the light dotted O0V follows the chromatic scale, and the heavy dotted Q0V voltage only gives the notes of the major chord.**

2



3a

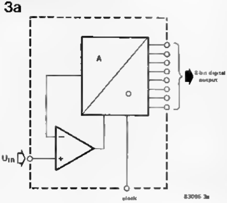


**Figure 3a. This is the simplified internal structure of the ZN 427-E8 analogue/digital converter IC from Ferranti. The two important stages are the digital/analogue converter controlled by an external clock and the comparator whose inputs are the output voltage of the D/A converter and the voltage to be converted, $V_{IN}$.**

3b

**Figure 3b. This is a diagram of the signals during a conversion cycle of the ZN 427. The conversion time is always the same (nine clock cycles) no matter what the value of the voltage to be converted. In our example, the end of conversion pulse emitted by the converter itself produces a new start-conversion pulse.**

We intentionally chose an addressable latch with high impedance outputs for IC4. When pin 1 of a 74LS374 is logic high its outputs are 'invisible' to a µP bus to which they are connected. An input has also been provided for an address decoding signal (AD) so that this first section of the quantisizer is autonomous and could even be connected directly to a computer bus. In this case the jumper marked with a ⋆ must be removed.

## Transcoding

Now that we have the digital code things are starting to become a bit more musical . . . and a bit more involved for those who are not musically inclined. At this level, the digital and the musical are closely interwoven. What we call transcoding occurs in the 2716 EPROM, and, as we have already said, its low order address bits (bits 0 . . . 8) are given by the digital data provided by the circuit of figure 4. The high order address bits are, as figure 5 shows, given by the musical scale selection circuit. The user addresses the eight zones of the EPROM by means of S1 and S3 (or S2). One of the input lines of latch IC7 is set logic low by the common point of rotary switch S1. The other lines are made logic high by the polarising resistors R16 . . . R23. When the user momentarily presses S3 or closes S2 the low logic level applied on pin 11 of the 74LS373 causes these logic levels to be output from the latch. From there they go to IC6 which forms a three bit binary code based on them. These three bits correspond to address lines A8 . . . A10.

Because latch IC7 is not permanently valid, the user can jump from one code to another without 'hearing' the intermediate codes. The new address decoding for the EPROM is only valid while S3 is pressed (or S2 closed) and it is only at this moment that the zone is changed. Inside each of these zones, the same data may occur in several successive addresses, as table 1 shows. This means that for different A/D codes we get the same D/A code, and consequently the same output voltage QOV. Thus, in table 1a the data changes every four addresses so that after D/A conversion QOV increases by 83.33 mV. With this code all the degrees of the chromatic scale are present.

This is the first zone of the 2716, and is accessed by switching S1 to position 0. If we switch to position 1, we are in a different zone in which not all the chromatic degrees appear (table 1b). In fact it is the major scale, or if you prefer, only the white keys on a piano keyboard. Now the QOV voltage no longer changes by 83.33 mV, but by multiples of this value: first there are two full tones, then a semitone, etc.

It is also clear that there is an order of precedence between the various degrees. In the example of table 1a (the chromatic scale) there were four addresses per note, whereas in table 1b note D has six addresses, while note F has seven and notes C and E each have eight. This implies that the voltages producing these last two notes have statistically more chance of appearing as the QOV output than the former two.

If switch S1 is turned to position 2 (and S3 is pressed) the QOV output is the voltage corresponding to the scale of black notes on the piano (the pentatonic scale). Table 1c is a summary of the organisation of the zones of the EPROM and shows the other scales and musical ratios available.

For the same input signal there are various outputs available from the quantisizer, as is shown in figure 6. Here we see that for the same LFO triangular signal input, the musical phrase output depends on the position of S1.

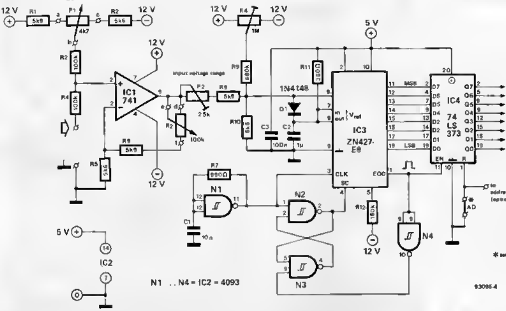
So we have: tonic C major (S1 = 3), dominant G major (S1 = 5), sub-dominant F major (S1 = 6), the complete major scale (S1 = 1), the chromatic scale (S1 = 0), the pentatonic scale (S1 = 2), and to finish this example, the relative minor chord (S1 = 4). This diagram also indicates when S3 has to be pressed after changing the position of S1.

The data appearing at the output of the EPROM are applied directly to D/A converter (IC8) and this is straightforward, so it requires no further comment. The output stage is a buffer with offset compensation, using P5, and with a 10 turn pot (P6) for controlling the 1 V/octave characteristic.

## Options

We have already mentioned that the transcoder does not have to be used, so if this is the case, EPROM IC5 should be removed. If the aim is to construct a precision A/D-

4



D/A converter, the six most significant address inputs should be connected to the six most significant data outputs and the two least significant bits to ground. As well as IC5, all the components for scale selection should be omitted (these are marked with an asterisk on the diagram of figure 5). If the converters are to be used individually, all the components just mentioned are omitted as is the jumper marked with an asterisk in figure 4. In this case, the A/D data is available at the first eight address pins of IC5 (not inserted, remember!), while the D/A data can be applied on the eight data pins of IC5. Do not forget to apply a checking signal at point AD (figure 4,

Figure 4. This is the analogue/digital part of the quantisizer circuit. Even though it is on the same printed circuit board as the digital/analogue converter from figure 5, this converter is completely autonomous. The jumper marked with an asterisk can replaced by a checking signal from latch IC4. If outputs D0 . . . D7 are to be connected to a micro-computer bus, this IC must be a 74LS374. This device has three state outputs that are high impedance if pin 1 is logic high.

5

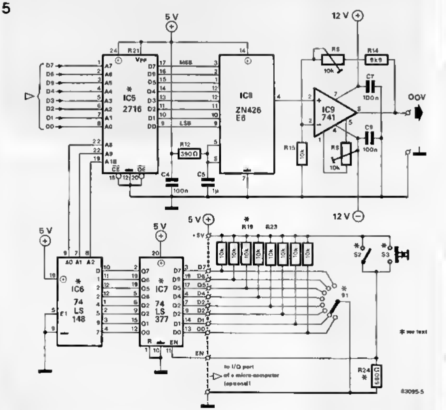


Figure 5. This is the digital/analogue section of the quantisizer. EPROM IC5 contains the digital codes that correspond to various musical scales after being converted into a QOV voltage by IC8 and IC9. The user chooses one of the eight scales using S1 . . . S3. These switches and the associated resistors could be replaced by the output port of a micro-computer.

6

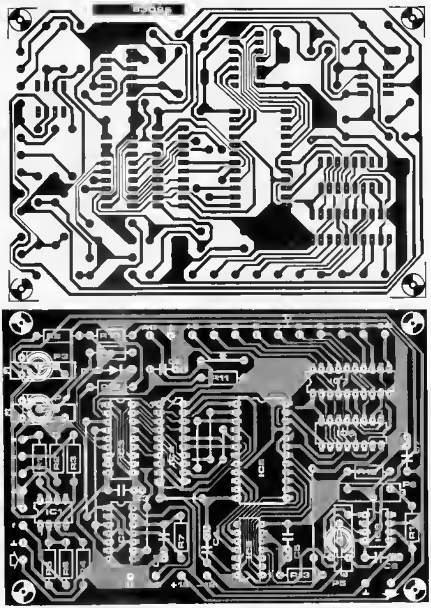


**Figure 6. If S3 is pressed at the lowest point of the control signal (triangular output of an LFO) and the position of S1 is switched between two hollows, you change smoothly from one scale or chord to another. It is obvious that the musical phrase follows the contours of the control signal but the degrees are different and occur in greater or lesser numbers for each scale. This, of course, has an effect on the rhythm which is slower if there are less degrees present.**

Parts list

Resistors:

R1,R2,R5,R6,R8 = 5k6
R3,R4 = 100 k
R7,R24 = 680 Ω
R9 = 680 k
R10,R14 = 6k8
R11,R13 = 390 Ω
R12 = 180 k
R15 . . . R23 = 10 k
P1 = 4k7 lin.
P2 = 100 k lin.
P3 = 25 k 10 turn pot
P4 = 1 M 10 turn pot
P5 = 10 k 10 turn pot
P6 = 10 k 10 turn pot

Capacitors:

C1 = 10 n
C2,C5 = 1 μ (MKT)
C3,C4,C6,C7 = 100 n

Semiconductors:

D1 = 1N4148
IC1,IC9 = 741
IC2 = 4093
IC3 = ZN 427-E8 (Ferranti)
IC4 = 74LS377 (74LS374; see text)
IC5 = 2716 (pre-programmed, see text)
IC6 = 74LS148
IC7 = 74LS373
IC8 = ZN 426 E8 (Ferranti)

Miscellaneous:

S1 = single pole 8-way rotary switch
S2 = single pole single throw switch
S3 = pushbutton (push to make)

pin 1 of *IC4 = 74LS374*!).
There is a further option: leave out S1 . . . S3 and R16 . . . R24 and control the musical scale selection circuit via the output port of a micro computer!

## Construction and adjustment

There should be no problems with constructing this circuit, particularly if the printed circuit board design shown here is used. One important point to note, however, is that resistors R16 . . . R24 are soldered directly to the pins of rotary switch S1. The 2716 EPROM is available pre-programmed from Technomatic Ltd.
Adjusting this circuit begins with setting the output buffer (after the usual checks, of course). IC5 is removed from its socket and pins 1 . . . 3 and 9 . . . 13 of IC8 are connected to earth. The output of the IC should be zero. The output of IC9 (pin 6) should also be zero. If this is not the case, then adjust P5 until it is. Then pins 13 and 1 of IC8 are connected to +5 V and P6 is adjusted until the output of IC9 is 1.00 V. Now pin 13 of IC8 is connected to ground and pin 2 to +5 V (as well as pin 1) and the output from IC9 should be 2.00 V. Any deviation can be corrected using P6. After this adjustment, the 1 V/octave characteristic of the QOV voltage is set. The output of IC9 should be 3.00 V when pins 3 and 13 of IC8 are connected to +5 V and pins 1, 2 and 9 . . . 12 are earthed.
Before inserting the EPROM, IC5 should be checked to ensure that the high order address bits are present on pins 19, 22 and 23. These should, of course, also agree with the position of S1, not forgetting to press S3 after S1 is changed each time.
Now the same adjustment must be carried out on the A/D conversion circuit. IC1 is removed from its socket and pin 6 (or the

7

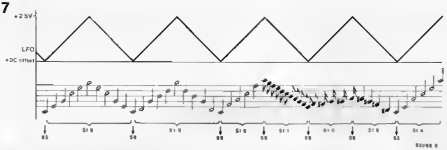


**Figure 7. This is the component overlay for the printed circuit board, with all the components from figures 4 and 5, except for resistors R16 . . . R24 and S1 . . . S3.**

| zones | notes | number of addresses |
|---|---|---|
| 1 | major chord | |
| | C | 8 |
| | D | 6 |
| | E | 8 |
| | F | 7 |
| | G | 6 |
| | A | 6 |
| | B | 7 |
| 2 | pentatonic chord | |
| | C# | 10 |
| | D# | 9 |
| | F# | 10 |
| | G# | 9 |
| | A# | 10 |
| 3 | C major | |
| | C | 16 |
| | E | 16 |
| | G | 16 |
| 4 | A minor | |
| | C | 16 |
| | E | 16 |
| | A | 16 |
| 5 | G major | |
| | D | 16 |
| | G | 16 |
| | B | 16 |
| 6 | F major | |
| | C | 16 |
| | F | 16 |
| | A | 16 |
| 7 | D major | |
| | D | 16 |
| | F# | 16 |
| | A | 16 |

| addresses | zone 0 notes | data (hex) |
|---|---|---|
| XX = 00 | do – C | 00 |
| XX = 01 | | |
| XX = 02 | | |
| XX = 03 | | |
| XX = 04 | do # – C# | 04 |
| XX = 05 | | |
| XX = 06 | | |
| XX = 07 | | |
| XX = 08 | ré – D | 08 |
| XX = 09 | | |
| XX = 0A | | |
| XX = 0B | | |
| XX = 0C | ré# – D# | 0C |
| XX = 0D | | |
| XX = 0E | | |
| XX = 0F | | |
| XX = 10 | mi – E | 10 |
| XX = 11 | | |
| XX = 12 | | |
| XX = 13 | | |
| XX = 14 | fa – F | 14 |
| XX = 15 | | |
| XX = 16 | | |
| XX = 17 | | |
| XX = 18 | fa # – F# | 18 |
| XX = 19 | | |
| XX = 1A | | |
| XX = 1B | | |
| XX = 1C | sol – G | 1C |
| XX = 1D | | |
| XX = 1E | | |
| XX = 1F | | |
| XX = 20 | sol # – G# | 20 |
| XX = 21 | | |
| XX = 22 | | |
| XX = 23 | | |
| XX = 24 | la – A | 24 |
| XX = 25 | | |
| XX = 26 | | |
| XX = 27 | | |
| XX = 28 | la # – A# | 28 |
| XX = 29 | | |
| XX = 2A | | |
| XX = 2B | | |
| XX = 2C | si – B | 2C |
| XX = 2D | | |
| XX = 2E | | |
| XX = 2F | | |
| for the next 4 octaves, add $30_{hex}$ per octave | | + 04<br>/½ tone |

wiper of P3) is connected to ground. Then adjust P4 so that pins 11 . . . 18 of IC3 are logic low.

Potentiometer P3 could be adjusted by ear as a function of the control signal applied to the quantisizer. The aim is to set this pot until the musical phrase generated by a VCO to which the QOV voltage is fed follows the contours of the control signal without clipping.

Having done that, the quantisizer is almost ready for use. All that remains is to find a suitable supply, whether that is from the host synthesizer or a separate circuit with regulator ICs just for this purpose. The current consumption is about 120 mA at 5 V and much less at ± 12 V.

Elsewhere in this issue we have an article about an 'EPROMmer' using the main board of the Junior Computer. Need we say more about exclusive, custom-made transcoder EPROMs?! ◼

Table 1a

| Address | hex | Data | D/A QOV |
|---|---|---|---|
| 0 0 0 0 | 00 | 0 0 0 0 0 0 0 0 | 0 mV |
| 0 0 0 1 | 00 | 0 0 0 0 0 0 0 0 | |
| 0 0 0 2 | 00 | 0 0 0 0 0 0 0 0 | |
| 0 0 0 3 | 00 | 0 0 0 0 0 0 0 0 | |
| 0 0 0 4 | 04 | 0 0 0 0 0 1 0 0 | 83 mV |
| 0 0 0 5 | 04 | 0 0 0 0 0 1 0 0 | |
| 0 0 0 6 | 04 | 0 0 0 0 0 1 0 0 | |
| 0 0 0 7 | 04 | 0 0 0 0 0 1 0 0 | |
| 0 0 0 8 | 08 | 0 0 0 0 1 0 0 0 | 167 mV |
| 0 0 0 9 | 08 | 0 0 0 0 1 0 0 0 | |
| 0 0 0 A | 08 | 0 0 0 0 1 0 0 0 | |
| 0 0 0 B | 08 | 0 0 0 0 1 0 0 0 | |
| 0 0 0 C | 0C | 0 0 0 0 1 1 0 0 | 250 mV |
| 0 0 0 D | 0C | 0 0 0 0 1 1 0 0 | |
| 0 0 0 E | 0C | 0 0 0 0 1 1 0 0 | |
| 0 0 0 F | 0C | 0 0 0 0 1 1 0 0 | |
| 0 0 1 0 | 10 | 0 0 0 1 0 0 0 0 | 333 mV |
| 0 0 1 1 | 10 | 0 0 0 1 0 0 0 0 | |
| 0 0 1 2 | 10 | 0 0 0 1 0 0 0 0 | |
| 0 0 1 3 | 10 | 0 0 0 1 0 0 0 0 | |
| 0 0 1 4 | 14 | 0 0 0 1 0 1 0 0 | 417 mV |
| 0 0 1 5 | 14 | 0 0 0 1 0 1 0 0 | |
| 0 0 1 6 | 14 | 0 0 0 1 0 1 0 0 | |
| 0 0 1 7 | 14 | 0 0 0 1 0 1 0 0 | |
| 0 0 1 8 | 18 | 0 0 0 1 1 0 0 0 | 500 mV |
| 0 0 1 9 | 18 | 0 0 0 1 1 0 0 0 | |
| 0 0 1 A | 18 | 0 0 0 1 1 0 0 0 | |
| 0 0 1 B | 18 | 0 0 0 1 1 0 0 0 | |
| 0 0 1 C | 1C | 0 0 0 1 1 1 0 0 | |

EPROM (zone 0)

Table 1b

EPROM (zone 1)

| Address | hex | Data | D/A QOV |
|---|---|---|---|
| 0 1 0 0 | 00 | 0 0 0 0 0 0 0 0 | 0 mV |
| 0 1 0 1 | 00 | 0 0 0 0 0 0 0 0 | |
| 0 1 0 2 | 00 | 0 0 0 0 0 0 0 0 | |
| 0 1 0 3 | 00 | 0 0 0 0 0 0 0 0 | |
| 0 1 0 4 | 00 | 0 0 0 0 0 0 0 0 | |
| 0 1 0 5 | 00 | 0 0 0 0 0 0 0 0 | |
| 0 1 0 6 | 00 | 0 0 0 0 0 0 0 0 | |
| 0 1 0 7 | 00 | 0 0 0 0 0 0 0 0 | 1 tone |
| 0 1 0 8 | 08 | 0 0 0 0 1 0 0 0 | 167 mV |
| 0 1 0 9 | 08 | 0 0 0 0 1 0 0 0 | |
| 0 1 0 A | 08 | 0 0 0 0 1 0 0 0 | |
| 0 1 0 B | 08 | 0 0 0 0 1 0 0 0 | |
| 0 1 0 C | 08 | 0 0 0 0 1 0 0 0 | |
| 0 1 0 D | 08 | 0 0 0 0 1 0 0 0 | 1 tone |
| 0 1 0 E | 10 | 0 0 0 1 0 0 0 0 | 333 mV |
| 0 1 0 F | 10 | 0 0 0 1 0 0 0 0 | |
| 0 1 1 0 | 10 | 0 0 0 1 0 0 0 0 | |
| 0 1 1 1 | 10 | 0 0 0 1 0 0 0 0 | |
| 0 1 1 2 | 10 | 0 0 0 1 0 0 0 0 | |
| 0 1 1 3 | 10 | 0 0 0 1 0 0 0 0 | |
| 0 1 1 4 | 10 | 0 0 0 1 0 0 0 0 | |
| 0 1 1 5 | 10 | 0 0 0 1 0 0 0 0 | ½ tone |
| 0 1 1 6 | 14 | 0 0 0 1 0 1 0 0 | 417 mV |
| 0 1 1 7 | 14 | 0 0 0 1 0 1 0 0 | |
| 0 1 1 8 | 14 | 0 0 0 1 0 1 0 0 | |
| 0 1 1 9 | 14 | 0 0 0 1 0 1 0 0 | |
| 0 1 1 A | 14 | 0 0 0 1 0 1 0 0 | |
| 0 1 1 B | 14 | 0 0 0 1 0 1 0 0 | |
| 0 1 1 C | 14 | 0 0 0 1 0 1 0 0 | |

Table 1c

| ADDRESSES | | SCALES* |
|---|---|---|
| 0000 | 00FF | chromatic scale |
| 0100 | 01FF | major chord |
| 0200 | 02FF | pentatonic scale |
| 0300 | 03FF | major chord C-E G |
| 0400 | 04FF | minor chord A-C-E |
| 0500 | 05FF | major chord G-B D |
| 0600 | 06FF | major chord F-A-C |
| 0700 | 07FF | major chord D-F#-A |

* every scale covers 5 octaves

**Table 1a. This is an extract from the contents of zone 0 of the EPROM. All the degrees of the chromatic scale are present and the addressing is equally divided among them (4 addresses per note). Obviously, the probability of occurrence of each of the twelve notes is the same.**

**Table 1b. This is part of the contents of zone 1 of the EPROM. Only the seven degrees of the major scale are present. The addressing is not divided equally among them as some notes have more 'musical weight' than others. This means that some notes occur more often and last longer than others.**

**Table 1c. The eight zones of the EPROM with the scales and chords obtained in each of them. No matter how many notes per octave are present, the range of QOV produced by each zone is five octaves.**

**LEDs are normally only used in those applications for which they were designed: as indicator or control light. A rather less usual application is their use as light source in a dark room.**

# solid-state dark room lighting

## LEDs as light source

Using one or more LEDs for dark room lighting is not as odd as may appear at first sight. Particularly not when you consider the advantages over conventional lighting.

- Because of the well-defined spectral colours of LEDs, filters are not necessary.
- LEDs are usable when work is carried out on black and white paper, multi-grade paper, colour negative paper, and orthochromatic materials.
- The life of LEDs is not shortened by continuous on/off switching.
- LEDs do not produce heat.
- LEDs do not radiate infra-red rays.

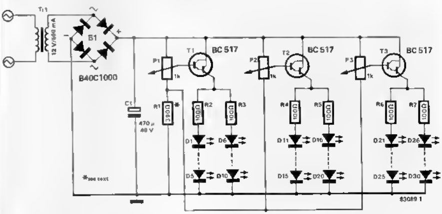
Of course, a standard LED does not give as much light as a conventional lamp, but this problem could be overcome by the use of more than one LED. This article describes dark room lighting with LEDs which give many times more light than standard LEDs, so that you don't need to hang whole arrays of LEDs from the wall. If required, the viewing angle can be increased by placing the LEDs further apart. Furthermore, a length of transparent, corrugated perspex may be placed in front of the LEDs. To ensure that different types of paper can be processed (each type of paper is sensitive to different colours), the circuit is divided into three parts. Each part has a different colour LED so that three colours are catered for: red, green, yellow.

### The circuit

As shown in figure 1, the circuit is quite simple, making a compact construction easy to attain. The different colour LEDs are each connected to an adjustable voltage supply. The required light intensity can be set between low and maximum with presets P1, P2 and P3 respectively. At nominal intensity each LED draws a current of 20 mA, so that the total current consumption is about 120 mA maximum. Bear in mind, however, that the maximum LED current should not be exceeded: as shown in table 1, the maximum current for some LEDs is only 35 mA. When such LEDs are used, resistors R2 . . . R7 should be 220 Ω. It is, of course, not necessary to build all three stages: according to requirement and personal preference, one or two stages may be sufficient. On the other hand, the number of stages may be more than three. In these cases only the value of R1 needs to be modified to the new layout: if only one

Figure 1. The circuit diagram shows that the dark room lighting can be built in almost no time at all.

1



D1 . . . D10 = MV 5752; HLMP 3316, HLMP 3750 (red)
D11 . . D20 = MV 5352; HLMP 3416, HLMP 3850 (yellow)
D21 . . . D30 = MV 5252, HLMP 3519; HLMP 3950 (green)

Table 1

| Manufacturer | Type | Viewing Angle | $I_{LED}$ (max) (mA) | Luminous intensity in mcd at $I_{LED}$ | | Wavelength (nm) | | |
|---|---|---|---|---|---|---|---|---|
| | | | | mcd | $I_{LED}$ | red | yellow | green |
| General Instruments | MV 5252 | 28° | 35 | 15 | 20 mA | | | 565 |
| – do – | MV 5352 | 28° | 35 | 45 | 20 mA | | 585 | |
| – do – | MV 5752 | 28° | 35 | 40 | 20 mA | 635 | | |
| Hewlett-Packard | HLMP 3316 | 35° | 90 | 30 | 10 mA | 626 | | |
| – do – | HLMP 3415 | 35° | 60 | 30 | 10 mA | | 585 | |
| – do – | HLMP 3519 | 24° | 90 | 50 | 20 mA | | | 569 |
| – do – | HLMP 3750 | 24° | 90 | 125 | 20 mA | 636 | | |
| – do – | HLMP 3850 | 24° | 60 | 140 | 20 mA | | 583 | |
| – do – | HLMP 3950 | 24° | 90 | 120 | 20 mA | | | 565 |
| Stanley | H 500 | 10° | 300 | 500 | 20 mA | 560 | | |
| – do – | H2K | | 300 | 2000 | 20 mA | 660 | | |

This table shows various types of LED which meet the requirements laid down in this article.

stage is required, R1 should be 1.2 kΩ; with two stages, 680 Ω.

As mentioned earlier, the LEDs must have a high light output: table 1 gives a number of suitable types. Other high-efficiency types may, of course, be used provided that their spectral colours are in line with requirements.

## Selecting the right colour LED

The type of paper being processed is the determining factor when selecting the correct LEDs. Generally, there is a 'safe' colour for each type of photographic paper to which the paper is not sensitive and this is the only colour light you should use during processing.

### Normal black and white paper

When this type of paper is being processed, all three colours may be used simultaneously. None the less, some care is advisable with the colour green as the wavelength of this colour lies close to the sensitivity curve of this paper (see figure 2). Light intensity is not critical for this paper so that the dark room lighting may be adjusted to maximum. The minimum distance between paper and lighting must be determined by trial and error.

### Multi-grade paper

Multi-grade paper is processed in layers which are particularly sensitive to the colours blue and green. Only red and yellow LEDs should therefore be used in this case. None the less, if you use the 'prohibited' green LED interesting effects are obtained.

### Colour negative paper

Because of the special composition and high sensitivity of this paper, use only the yellow LEDs with reduced light output. Better still, use indirect diffused light by pointing the light source at maximum intensity towards the wall or ceiling. If these are dark, use a sheet of white paper as a reflector.

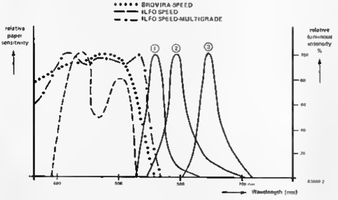
### Colour reversal paper

As this type of paper is sensitive to all colours, it can only be processed in total darkness.

### Orthochromatic material

When working with these materials, use only red LEDs. Intensity is best determined by means of test strips. Such strips should really be used with the other types of paper as well to determine for how long, at what minimum distance, and at what intensity the LED lighting can be used. The graphs given in figure 2 should prove useful for this purpose, although they are, of course, well-known to experienced photographers. ◼

2



① = green (MV 5252 HLMP 3515; HLMP 3950)

② = yellow (MV 5352 HLMP 3416, HLMP 3850)

③ = red (MV 5752, HLMP 3316, HLMP 3750)

Figure 2. The sensitivity graphs of various types of photographic paper are given in dotted lines. The graphs in solid lines show the operating wavelengths of the different colour LEDs.

**No, this article does not deal with a regulator for 10,000+ volts, but for all that, 125 V is 'high' voltage when it concerns an integrated circuit. The type TL 783 IC does not only give an output of 125 V (maximum), but also allows a differential between its input and output voltages of 125 V. That is more than three times the usual 40 volts!**

# high-voltage regulator

An integrated, presettable voltage regulator with only three connections is not likely to hit the headlines these days. The news about the TL 783 is that it tolerates a voltage differential between its input and output of 125 V, and is capable of delivering an output of 125 V (maximum). On top of that, it equals or exceeds the parameters, with the exception of output current, of 'improved' types like the LMX 17, LM 117, LM 217, and LM 317. The high voltage differential is made possible by the use of a DMOS (double-diffusion metal oxide semiconductor) output transistor. At the same time, this transistor limits the maximum output current of the circuit to 700 mA. Figure 1 shows the correlation between output current and voltage differential.

The TL 783 contains a protection circuit consisting of a current and a temperature limiter. The temperature limiter switches the output off as soon as the chip temperature reaches 165°C, and automatically switches it on again when the temperature drops below 165°C. Current limiter is, strictly speaking, a misnomer, as this stage is really a load limiter: it prevents the IC dissipating more than 20 W.

Figure 2 shows a typical circuit using a TL 783: the function of D1 and D2, as well as that of C1 . . . C4, is virtually the same as if a LMX 17 were used. Briefly, C1 is not to be confused with a smoothing capacitor (not shown) which follows the rectifier. It is necessary to prevent voltage peaks and

1

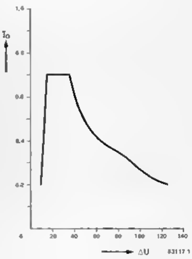


Figure 1. Maximum output current $I_o$ as a function of the differential ΔU between input and output voltages.

2

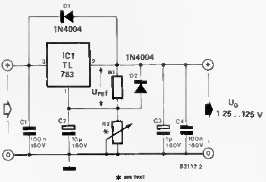


Figure 2. The external circuit diagram of the TL 783 voltage regulator. Values of R1 and R2 for a given output voltage are calculated according to the chart in figure 3.

other noise from reaching the regulator, there by reducing the possibility of this device to oscillate. Use is thereby made of the property of capacitors to act as frequency-dependent resistors, and of the characteristics of metallized polystryrene or polyester capacitors at high frequencies. Capacitor C4 serves virtually the same function at the output as C1 at the input. Capacitor C2 suppresses any ripple present on the input to the IC; for a value of 10 $\mu$F, the suppression is not less than 80 dB across the total range of output voltages. Capacitor C3 is the usual smoothing electrolytic at the output. The two diodes are necessary because of the capacitors: when the circuit is switched off, polarity reversal may take place owing to the slow discharge of the capacitors and this could cause damage to parts of the IC. The diodes prevent this by short-circuiting the voltages.

Figure 3 shows a chart for the computation of R1 and R2. Both these resistors should not be less than 0.25 W. Starting point of the chart is the maximum output voltage, $U_O$max. If $U_O$ is smaller than 43 V, the left-hand side of the chart is used for the calculation. Assuming that R2 is variable, we take R1 = 220 Ω as the basis for our calculation. If the output voltage is equal to, or greater than, 43 V, the right-hand side of the chart is used. Always measure the actual resistance of the variable resistor as these types normally have wide tolerances. Table 1 shows some typical values for the resistances at various output voltages. ◼

**Table 1. Examples of the use of figure 3.**

**R2 variable**

| $U_O$max | R1 | R2 |
|---|---|---|
| 100 V | 595 Ω<br>(560 + 33) | 47 kΩ |
| 75 V | 373 Ω<br>(270 + 100) | 22 kΩ |
| 50 V | 256 Ω<br>(220 + 33) | 10 kΩ |

**R2 fixed**

| $U_O$max | R1 | R2 |
|---|---|---|
| 100 V | 493 Ω<br>(470 + 22) | 39 kΩ |
| 75 V | 369 Ω<br>(330 + 39) | 21.75 kΩ<br>(15k + 6k8) |
| 50 V | 244 Ω<br>(220 + 22) | 9.506 kΩ<br>(6k8 + 2k7) |
| 24 V | 220 Ω | 4.004 kΩ<br>(2k2 + 1k8) |
| 12 V | 220 Ω | 1892 Ω<br>(1k5 + 390) |
| 5 V | 220 Ω | 660 Ω<br>(330 + 330) |

**Table 1. Some values of R1 and R2 calculated with the aid of figure 3 for various values of required output voltages.**

3

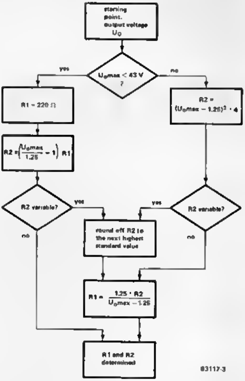
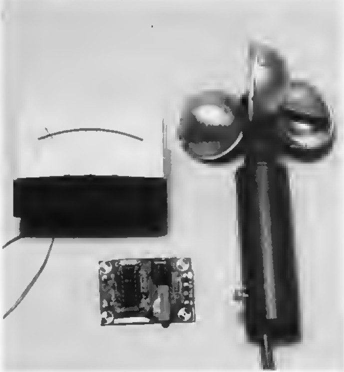


**Figure 3. Chart for the computation of resistors R1 and R2 in figure 2.**

4

**Figure 4. Pin connections of the TL 783.**



**Not even meteorology is safe from electronics eny mora, it seems. While it is true that the rotating mechenical element is still an essential part of this 'instrument', the bulk of the work is now done by electronic components. The anemometar dascribed here is more than an instantaneous wind velocity meter, as it also stores the maximum and minimum values measured over a certain period of time.**

# anemometer

## wind speed on a moving-coil meter

The word 'anemometer' may sound a bit unusual to most people who are involved in electronics. This is hardly surprising since it comes from two old Greek words *anemos* (wind) and *meter* (to measure). When the two are combined, the result is an instrument familiar to weather men the world over. It contains a number of rotating scoops that catch the wind and is used to measure the wind speed. We are not suggesting you should set up your own weather station (that is one quick way to lose friends), but it is certainly nice to get your own idea of the weather, and the wind speed is one thing a barometer cannot tell you (no matter how hard you 'tap' it)!

Before we get to the circuit of the anemometer, let us first see exactly what an anemometer is. As the photo of the prototype at the heading of this article clearly shows, it consists of a rotating (wind)mill mounted in a holder. The actual mill consists of three or four hemispheres, or something similar, which turn when caught by the wind. The speed of rotation depends, of course, on the speed of the wind. Wind speed is generally stated according to the Beaufort scale. This is a system devised in 1808 by Sir Francis Beaufort, an English admiral, to relate the strength of the wind with the advisability of going to sea. He defined a twelve-way scale ranging from calm to hurricane force. Nowedays wind speed is often given in units of m/s or in knots and the relationship between the various scales is given in table 1.

The anemometer described here uses a magnet to open and close a reed switch once per revolution of the mill. This information can be processed electronically so that the speed of the wind causing this rotation can be shown on a moving coil meter or a display. It is interesting to be able to see not only what the instantaneous wind speed is, but also the maximum and minimum values measured over a certain period of time. This is a feature of the circuit that should appeal especially to amateur meteorologists.

### From wind speed to analogue voltage

In most 'cheap' (by which we mean 'affordable for hobbyists') anemometers, the revolutions of the mill are converted into a number of pulses. That can, for example, be done with a reed switch and a magnet. The magnet is fixed to the axle of the mill and the reed switch is mounted firmly in the case of the anamometer. Once every revolution the magnet comes close to the reed switch and this causes the contact to close. The number of times the switch closes is therefore equal to the number of revolutions of the mill per second. in other words, the number of pulses per second given by the reed switch is directly proportional to the wind speed.

Table 1.

| Beaufort scale | Description | . Wind speed | | |
|---|---|---|---|---|
| | | m/s | mph | knots |
| 0 | calm | 0 . . . 0.2 | 0 . . . 1 | 0 . . . 1 |
| 1 | light air | 0.3 . . . 1.5 | 1 . . . 3 | 1 . . . 3 |
| 2 | light breeze | 1.6 . . . 3.3 | 4 . . . 7 | 4 . . . 6 |
| 3 | gentle breeze | 3.4 . . . 5.4 | 8 . . . 12 | 7 . . . 10 |
| 4 | moderate breeze | 5.5 . . . 7.9 | 13 . . . 18 | 11 . . . 16 |
| 5 | fresh breeze | 8.0 . . . 10.7 | 19 . . . 24 | 17 . . . 21 |
| 6 | strong breeze | 10.8 . . . 13.8 | 25 . . . 31 | 22 . . . 27 |
| 7 | moderate gale | 13.9 . . . 17.1 | 32 . . . 38 | 28 . . . 33 |
| 8 | fresh gale | 17.2 . . . 20.7 | 39 . . . 46 | 34 . . . 40 |
| 9 | strong gale | 20.8 . . . 24.4 | 47 . . . 54 | 41 . . . 47 |
| 10 | whole gale | 24.5 . . . 28.4 | 55 . . . 63 | 48 . . . 55 |
| 11 | storm | 28.5 . . . 32.6 | 64 . . . 75 | 56 . . . 65 |
| 12 | hurricane | 32.6 + | 75 + | 65 + |

It would be much easier to work with an analogue voltage instead of a frequency for further processing of the signal. Therefore the pulse frequency of the reed switch is first converted to a voltage with a small converter circuit. This is the circuit shown in figure 1. The reed switch of the anemometer is connected between ground and the inputs of schmitt triggers N1 . . . N3. Resistor R1 ensures that the inputs of these gates are '1' when the reed switch is open. Zener diode D1 protects the inputs against noise that could be set up at the sensor or in long leads. Together with P1, R2 and C1, N1 . . . N3 make up a monostable multivibrator. At every rising edge of schmitt triggers N1 . . . N3 a logic zero is present at the inputs of N4 . . . N6. Because of the time constant C1/R2 + P1 it takes a certain time before N4 . . . N6 reach their upper triggering threshold. The pulse output from these gates always lasts the same length of time and this pulse is produced every time the reed switch opens. Three schmitt triggers in parallel are used here to ensure that enough output current is produced.

The pulse output from N4 . . . N6 is subsequently converted to an analogue voltage by means of integrator R3/C2, and this voltage is buffered by IC2.

The level of the analogue voltage can be adjusted using P1 so that the circuit gives, for example, 1 V when the wind speed is 30 m/s (this is dependent upon the type of anemometer used). This voltage can in principle be applied directly to a moving coil meter (1 V full scale deflection) or a digital meter.

## The memory section

The circuit shown in figure 2 is the diagram of the memory section of the anemometer. It may seem a bit complicated at first glance but this is due to the fact that it is not easy to store an analogue value in memory for a long period of time. In this case, the analogue value is first converted to its digital equivalent which is stored in a counter. To find the maximum and minimum values, the instantaneous wind speed must constantly be compared with the previous maximum and minimum values stored in memory. For this comparison the digital value is first reconverted to analogue form by means of a D/A converter.

The 'memories' for the maximum and minimum values of wind speed are IC7 and IC8. These are dual four-bit binary counters, which can be reset by pressing push button S2. The clock input of each counter is provided by a square-wave generator (N1 for IC7 and N2 for IC8) supplying a frequency of about 200 Hz. Each generator can be switched on or off via opamps A2 and A4. Diodes D1 and D2 and resistors R9 and R10 protect the inputs of N1 and N2 from negative voltages (as the opamps have a symmetrical supply). The outputs of IC7 are connected to three-state buffers, whereas IC8 uses the inverting type. The outputs of all these buffers are connected to the inputs of D/A converter IC9. The oscillator around N3 and N4 (whose frequency is about 100 Hz) defines which of the two counters is connected to the inputs of the D/A converter. If the output of N3 becomes logic zero the outputs of IC7 are connected to the inputs of IC9, and if the output of N4 becomes logic zero the inverted output signals of IC8 are connected to the D/A converter. The buffers of the unused counter are switched to high impedance.

The D/A converter gives an output of between 0 and 1 V, depending on the digital input signal it receives. This analogue voltage is available at the output of opamp A5. The maximum output voltage can be set with potentiometer P2.

The comparator section is built up around ES1, ES2 and A1 . . . A4. The two electronic switches are driven by ES3 and T1. These latter two are needed to adapt the output signal from oscillator N3/N4 to the sym-

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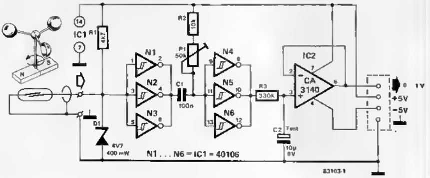


**Figure 1. The measuring section which converts the pulses generated by the wind mill into an analogue voltage. The circuit consists of a monostable multivibrator followed by an integrator and buffer.**

2

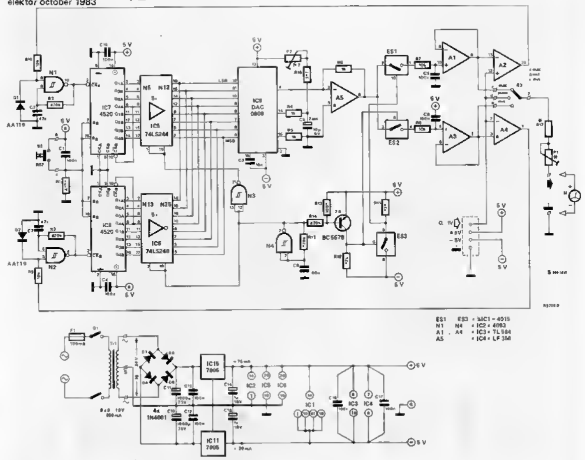


Figure 2. The memory section. Counters IC7 and IC8 store the maximum and minimum values of the wind speed respectively. The contents of the counters are continuously compared with the instantaneous wind speed by the D/A converter and the circuitry around A1 . . . A4. Whenever it is necessary, the counters are adjusted to the new situation.

3

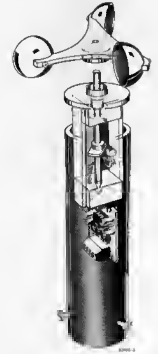


Figure 3. This is an example of how a wind mill for the anemometer can be made.

metrical supply voltage used in the comparator section. At the moment IC7 is connected to IC9, ES1 is simultaneously closed. Capacitor C5 is then charged to the voltage supplied by A5. Opamp A1 serves as a buffer for this capacitor and the voltage across C5 is compared with the instantaneous 'wind voltage' via A2. In the other case (IC8 connected to IC9) ES2 is closed. Now C6 is charged and the output of buffer A3 is compared with the instantaneous wind voltage via A4.

The output signal from the converter circuit goes to A2, A4 and switch S3. If S3 is in mid position the meter indicates the instantaneous wind speed. The corresponding voltage is compared with the voltages across capacitors C5 and C6 via A2 and A4. The voltage across C5 represents the maximum and that across C6 the minimum value. If the instantaneous value is greater than the voltage across C5, the output voltage of A2 is +5 V. Oscillator N1 then causes the count on IC7 to increase, and consequently the voltage across C5 increases. This continues until the capacitor voltage is just greater than the instantaneous voltage. The output of A2 then falls to −5 V and oscillator N1 is blocked. Because the counter can only count upwards, the highest value is always stored. Whenever the instantaneous value is greater than the counter value, the counter is adjusted to the new value.

The minimum value is stored in much the same way. In this case the voltage across C6 is compared with the instantaneous value. Now, however, the output of A4 is +5 V if the instantaneous voltage is lower than the capacitor voltage. Then N2 oscillates and IC8 counts up. Because N13 . . . N20 are inverters, the output voltage of the D/A converter is actually lower, so that the voltage across C6 decreases. This means that the voltage across C6 drops as the content of the counter increases. Whenever the instantaneous voltage is lower than the minimum value in the counter, the counter is adjusted accordingly.

The reason for continually switching between the two counters is to avoid the need for a second D/A converter, as these are not cheap.

The 'memories' are reset to zero by pressing push button S2. In this way the maximum and minimum values can be read from the meter, by switching S3, once a day, for example, and the circuit can then be reset ready for the next day. The values of R17

**Parts list, memory board**

Resistors:

R1 . . . R4,R14,
R15 = 470 k
R4,R5 = 1 k
R6 = 1 k 1%
R7 . . R10 = 10 k
R11,R12 = 47 k
R13 = 100 k
R16 = 2k7
R17 = see text
P1 = see text
P2 = 2k2 ten turn preset

Capacitors:

C1,C4 . . . C6,C8,C12,C13,
C16 . . C18 = 100 n
C2,C7 = 47 n
C3 = 10 n
C9 = 10 µ/6 V tantalum
C10,C11 = 1000 µ/25 V
C14,C15 = 1 µ/16 V

Semiconductors:

D1,D2 = AA 119
D3 . . . D6 = 1N4001
T1 = BC 557B
IC1 = 4016
IC2 = 4093
IC3 = TL 084
IC4 = LF 356
IC5 = 74LS244
IC6 = 74LS240
IC7.IC8 = 4520
IC9 = DAC0808
*(Technomatic)*
IC10 = 7805
IC11 = 7905

Miscellaneous:

S1 = double pole mains switch
S2 = single make push button
S3 = single pole, 3-way rotary switch
F1 = 100 mA slow blow fuse
Tr1 = 2 x 8 . . . 10 V/ 250 mA transformer

4

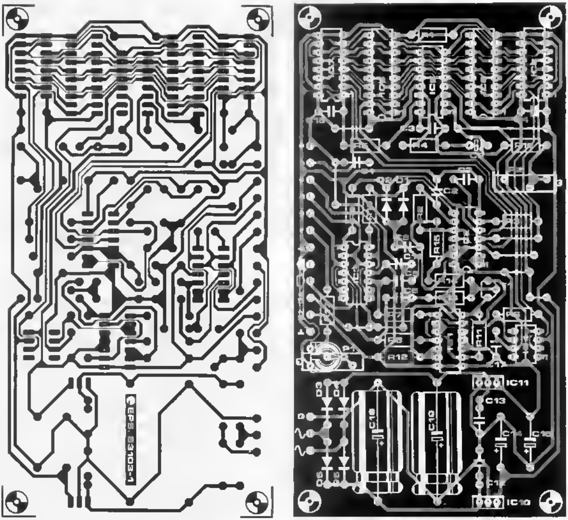


**Figure 4. The printed circuit board shown here contains the memory circuit and the power supply for the whole circuit.**

**Parts list, measuring board**

Resistors:
R1 = 4k7
R2 = 10 k
R3 = 330 k
P1 = 50 k preset.

Capacitors
C1 = 100 n
C2 = 10 µ/6 V tantalum

Semiconductors
D1 = 4V7/400 mW
zener diode
IC1 = 40106
IC2 = CA 3140

5

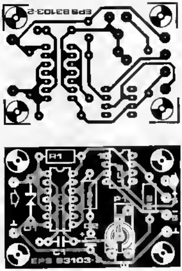


Figure 5. The printed circuit board layout for the measuring/converter board.

and P1 depend on the sensitivity of the moving coil meter used; for a 100 µA meter R17 is 6k8 and P1 is 5 k.
The power supply is straightforward. It simply contains two voltage stabilizers and a few other components to give a symmetrical supply of ± 5 V.

### The anemometer

Various manufacturers supply anemometers, but they are generally reluctant to supply the mechanical part without the electronics. These are not cheap in any case. With this in mind we set out to see whether we could build the mechanical part of the anemometer ourselves. The design we came up with is shown in figure 3. This sort of 'd.i.y. windmill' has the disadvantage that it is not calibrated so that it is not possible to get an accurate reading of the wind speed. However, it could be improved by comparing it with a 'real' anemometer, but that comes very close to being another 'catch 22'!
The only comment about mounting the windmill is that it should be located where it will not be affected by 'false' winds. Calibrating the mounting stand should not be any problem.

### Constructing the electronics

The measuring/converter and memory sections of the anemometer can be built on the printed circuit boards shown in figures 4 and 5. After assembling the boards, the whole circuit, complete with switches, transformer, meter and so on, can be placed in a suitable case. The scale for the meter is shown in figure 6.
The converter section must now be adjusted. To do this, the auxiliary circuit shown in figure 6 is needed. This produces a frequency of 50 Hz and is connected to the input of the converter section. If we want to measure wind speeds up to 30 m/s for a maximum output voltage of the section of 1 V, the wind speed corresponding to 50 Hz and the corresponding theoretical output voltage from IC2 can be calculated for any windmill. Using a DVM at the output of IC2, this voltage can be set by adjusting potentiometer P1.
Next set the reference voltage of the D/A converter on the memory board. An accurate (digital) meter is needed here also. Connect the meter to the MIN connection of S3 (or the output of A3). Then press S2 and while it is pressed adjust P2 to give exactly 1 V on the meter.
Now, with S2 still pressed, adjust P1 so that the meter of the anemometer gives exactly full scale deflection. The whole circuit is now calibrated and ready for use.
It can also be convenient to have two measuring ranges for the meter, for example, 0 . . . 10 m/s and 0 . . . 30 m/s. This can quite simply be done by using a changeover switch and an extra resistor and potentiometer, with resistances about three times as large as R17 and P1. The potentiometer is then set so that the meter gives full scale deflection for an input voltage of 0.333 V (for a range of 0 . . . 10 m/s).

### Other applications

The memory circuit designed for this anemometer is a fairly universal layout and can easily be used for other applications. How about a thermometer with maximum and minimum memory, for example? For this the whole memory board can be built and only the measuring board has to be changed for a circuit that converts a measured temperature into an analogue voltage with a maximum value of 1 V. In that case, the meter has of course to be given a temperature scale. ■

Figure 6. This is a scale which could be used for the meter.

6

7

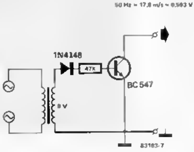


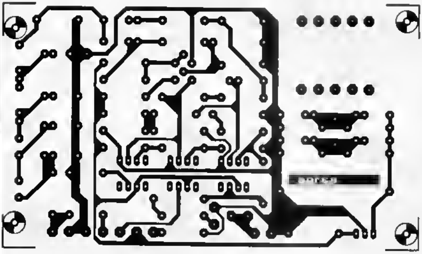
Figure 7. This is a calibration circuit giving a frequency of 50 Hz to adjust the measuring section.

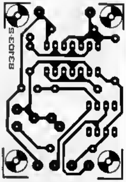
# service

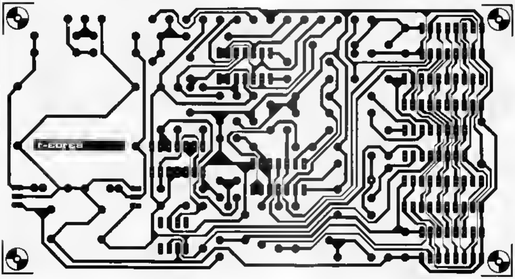
## PC board pages

The following pages contain the mirror images of the track layout of the printed circuit boards (excluding double-plated ones as these are very tricky to make at home) relating to projects featured in this issue to enable you to etch your own boards.

- To do this, you require: an aerosol of 'ISOdraft' transparentizer (available from your local drawing office suppliers; distributors for the UK: Cannon & Wrin), an ultraviolet lamp, etching sodium, ferric chloride, positive photo-sensitive board material (which can be either bought or home made by applying a film of photo-copying lacquer to normal board material).
- Wet the photo-sensitive (track) side of the board thoroughly with the transparent spray.
- Lay the layout cut from the relevant page of this magazine with its printed side onto the wet board. Remove any air bubbles by carefully 'ironing' the cut-out with some tissue paper.
- The whole can now be exposed to ultra-violet light. Use a glass plate for holding the layout in place only for long exposure times, as normally the spray ensures that the paper sticks to the board. Bear in mind that normal plate glass (but not crystal glass or perspex) absorbs some of the ultra-violet light so that the exposure time has to be increased slightly.
- The exposure time is dependent upon the ultra-violet lamp used, the distance of the lamp from the board, and the photo-sensitive board. If you use a 300 watt UV lamp at a distance of about 40 cm from the board and a sheet of perspex, an exposure time of 4 . . . 8 minutes should normally be sufficient.
- After exposure, remove the layout sheet (which can be used again), and rinse the board thoroughly under running water.
- After the photo-sensitive film has been developed in sodium lye (about 9 grammes of etching sodium to one litre of water), the board can be etched in ferric chloride (500 grammes of $Fe_3Cl_2$ to one litre of water). Then rinse the board (and your hands!) thoroughly under running water.
- Remove the photo-sensitive film from the copper tracks with wire wool and drill the holes.







# missing link

## Parallel-serial keyboard converter
(May 1983, page 5-50)

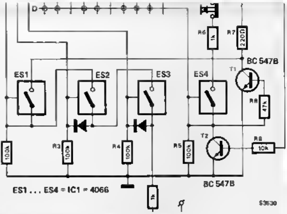
If this circuit is used with the ASCII keyboard also published in May 1983 the value of C5 can be critical. It is given as 220 n in the parts list but

- for 1200 baud C5 = 47 n is better
- between 200 and 900 baud C5 = 120 n

is suitable.

## Acoustic telephone modem
(February 1983, page 2-42)

The formulae on page 2-50 may be misleading as no units have been stated. In formulae a and b R is in kΩ and C in μF, but for all other formulae R is in Ω and C in F. In all cases $f_l$ and $f_h$ are in Hz.



## Morse decoding with the Z80A
(May 1983, page 5-60)

We have discovered that two lines in the hex dump listing for this article were interchanged. The data on line 200 should be on line 220, and the contents of line 220 should be on line 200.

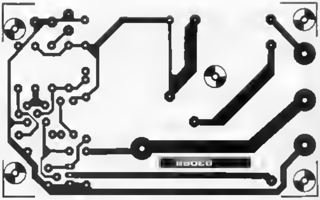
## Low cost CMOS lock

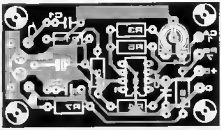
(Summer circuits 1983, page 7-75)

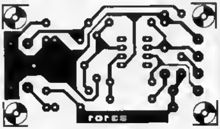
**PC board pages**

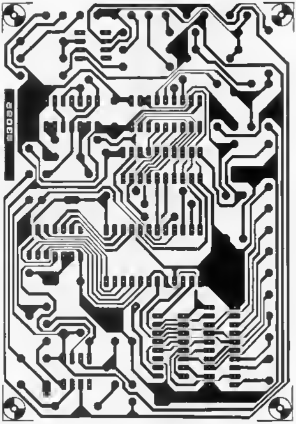
Unfortunately some Summer gremlins crept into this circuit, removing components and changing values, so that the lock will open when the first number of the combination is pressed. To correct this two diodes and one resistor must be added, and the value of R7 must be changed to 220 Ω. The correct layout, minus gremlins, is shown in the diagram here.

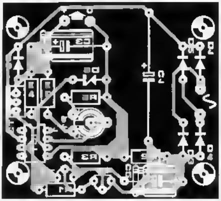
```
200: 22 00 .. .2 00 20 20 00 00 22 00 20 2. 20 22 00
212: 00 00 22 00 00 20 22 22 2. 00 00 00 02 02 22 22
220: 41 42 43 44 45 46 47 48 49 4A 4B 4C 4D 4E 4F 50
230: 51 52 53 54 55 56 57 58 59 5A 30 3. 32 33 34  5
240: 36 37 38 39 2E 2C 3A 3F 27 2D 2F 2D 2D 2. 55 4.
252: 4F 4B FF
```

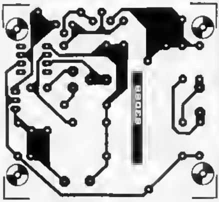












# service

PC board pages

E. Stöhr

**Many integrated circuits are now so familiar to most of us that we tend to overlook some of their remarkable characteristics. Here we take a well-known voltage regulator, the 723, and hook up a digital/analogue converter to its input and the result is that we can program the output voltage very precisely and can also select the maximum output current (with a digital command, no less!). This circuit should interest anybody who wants to use the 'digital' accuracy of a microprocessor system to meet stringent analogue requirements.**

# programmable power supply

## digital/analogue power supply interface

We are not dealing here with an ordinary digital/analogue converter: its conversion time of 5 µs is, of course, pretty good but its high output current of 2 A is far from ordinary (see technical characteristics). The programmable output voltage is divided into three digitally switched ranges as is the case with the output current.

### Circuit description

The heart of the circuit is the 8-bit digital/analogue converter, IC1. The output of this IC, $E_O$, supplies a high impedance analogue signal which is proportional to the value of the binary word applied to its inputs B1 . . . B8. This binary word, supplied via the data bus of the programming system, travels to latches IC5 and IC6 which are controlled by signals which we will talk about later.

The 'power part' of the circuit consists of integrated circuit voltage regulator IC3 which compares (and corrects) the output voltage with the reference voltage supplied by IC2. Darlington T9 ensures that the output current is usefully large: about 2 A. Resistors R18 . . . R20 and preset potentiometers P3 . . . P5 adjust the maximum output current and maximum output voltage.

As we are dealing with a power supply, it will not come as a surprise that the circuit contains a bridge rectifier and a smoothing capacitor for the supply of IC3 and T9 as well as a second regulator which provides a stable reference voltage ($U_{ref} = 10.0$ V) for IC1.

### Switching

Besides the two latches already mentioned (IC5, IC6), there is an identical second pair, IC7 and IC8 which is also tied to the data bus. These latter latches control transistors T1 . . . T8 which switch the various resistors and potentiometers in the voltage and current ranges. As T4 and T5 are connected to relays Re4 and Re5 (which connect the current-limiting resistors in parallel), and T1 . . . T3 are connected to Re1 . . . Re3 (which switch the voltage ranges), there are three unused outputs left which may be used for additional low power relays.

The control signals for the two sets of latches are binary. If the X (SELECT) and Y (ENABLE) signals are both 1, the output of N1 is zero; latches IC5 and IC6 are then 'transparent' and the converter is connected directly to the data bus. If either the X or the Y signal changes state, the latches block and their outputs hold the last binary word input before they cut off.

When X is 1 and Y is 0, the low level output from N3 makes latches IC7 and IC8 'transparent': the logic levels present on the data bus are then transferred directly to the bases of switching transistors T1 . . . T8.

If neither of the situations outlined above pertains, the circuit is completely isolated from the system controlling it.

Summarising, in the first situation mentioned, the microprocessor controls the output voltage, while in the second situation, the voltage and current ranges are switched.

### Construction

Depending on the programming system used, the circuit described may have to be changed to meet individual requirements. The bus configuration, the voltages corresponding to the different logic levels and the address decoding needed to obtain signals X and Y are the elements which may have to be changed.

Relays Re4 and Re5 must each be able to handle the maximum output current; Re1 . . . Re3 may be miniature DIL types and can be mounted directly onto the printed circuit board.

The 5 V supply section for IC5 . . . IC8 can also serve as an interface between the D/A converter and the microprocessor system bus.

Power transistor T9 must be mounted on a heat sink capable of dissipating up to 60 watts, and this assembly should be well ventilated. The use of thermoconductive paste (silicone grease) is advisable.

### Adjustment

A digital voltmeter and a digital command

**technical characteristics**

- input voltage 5 V DC (TTL), 12 V DC (CMOS)
- resolution: 8 bits
- output voltage 0 . . . 30 V programmable in three ranges
- programmable ranges
  0 . . . 5 V (1 bit = 19.5 mV)
  0 . . . 13 V (1 bit = 50 mV)
  0 . . . 30 V (1 bit = 117 mV)
- switchable output current 2 A, 0.5 A, 50 mA
- drive via signals SELECT and ENABLE (these can be obtained by address decoding)

1

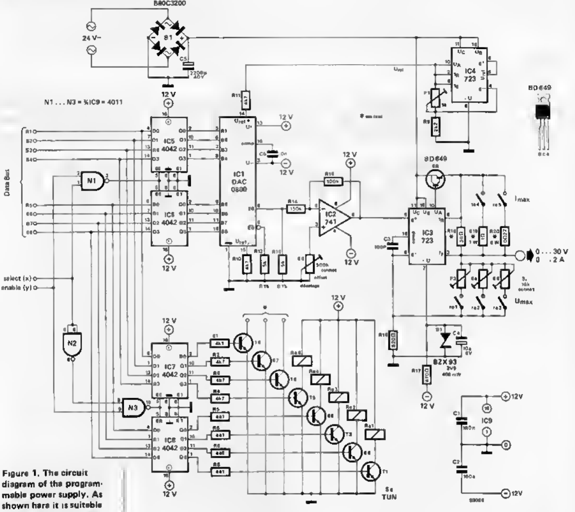


**Figure 1. The circuit diagram of the programmable power supply. As shown here it is suitable for CMOS input levels but can be made TTL compatible by changing the supply voltage to IC5 . . . IC8 to 5 V.**

decoding

| X | Y | Function |
|---|---|---|
| 1 | 1 | D/A conversion |
| 1 | 0 | range switching |
| 0 | 1 | — |
| 0 | 0 | — |

**The signals for X and Y are obtained by using a suitable combination of address lines of whatever computer is used.**

system (preferably a microprocessor) to program the voltage supply are required for adjusting the circuit.

First, apply eight logic 0 levels to inputs B1 . . . B8 and a logic 1 to the SELECT (X) and ENABLE (Y) lines. Adjust P1 such that the output voltage ($U_{ref}$) from IC4 is exactly 10.000 V on the digital voltmeter. Next, set the ENABLE (Y) line to logic 0 and data lines B4 and B8 to 1. Relays Re1 and Re5 should make. Reset the ENABLE line to 1 and all data lines B1 . . . B8 to 0. The output voltage ($U_{output}$) should be zero volts. If not, adjust P2 to compensate for the offset.

Set all lines B1 . . . B8 to logic 1 and adjust $U_{output}$ with P3 until it is 5.000 V. Check the output current which should be about 2 A.

Then, set B5 and B7 to logic 1 and all other B lines and the ENABLE line to 0; relays Re2 and Re4 should now make. Reset the ENABLE and B1 . . . B8 lines to 1 and adjust $U_{output}$ to 13.000 V with P4; the output current should now be about 500 mA.

Finally, set line B6 to logic 1, and all other B lines to 0. When a logic 0 is applied to the ENABLE line, and this line and the B1 . . . B8 lines are immediately reset to 1, relay Re3 makes and Re4 breaks. Adjust the output voltage to 30.000 V with P5; the output current should not exceed 50 mA.

The programmable power supply is now ready for use. It will be very useful in applications requiring great precision and flexibility. All that remains is to write the necessary software to control this power interface: a small computer system such as the Elektor Junior Computer is eminently suitable. If you have written any interesting programs for using this interface and you think others might benefit from them, we should be pleased to hear from you. ◼

**Elsewhere in this issue we described the theory behind Basicode-2 so it is only natural that we should show how the Junior Computer can use it. Here we give the Basicode software and everything else that is necessary to allow the Junior Computer to use Basicode-2. This means that the Junior Computer can now easily exchange BASIC programs stored on cassette tape with other computers. Moreover, 'received' programs can run directly on the JC, so that BASIC in combination with Basicode is a universal, completely exchangeable computer language.**

# basicode-2

## interface for the Junior Computer

Junior communicates with other computers

As we have already described all the various facets of Basicode, we will simply begin here by talking about the Junior with Basicode. The Basicode translation programs for the expanded Junior and the DOS Junior are not the same as they use different BASICs and handle their memory in different ways. To use Basicode, either an expanded Junior with KB-9-BASIC and Elekterminal or a DOS Junior and Elekterminal are needed.

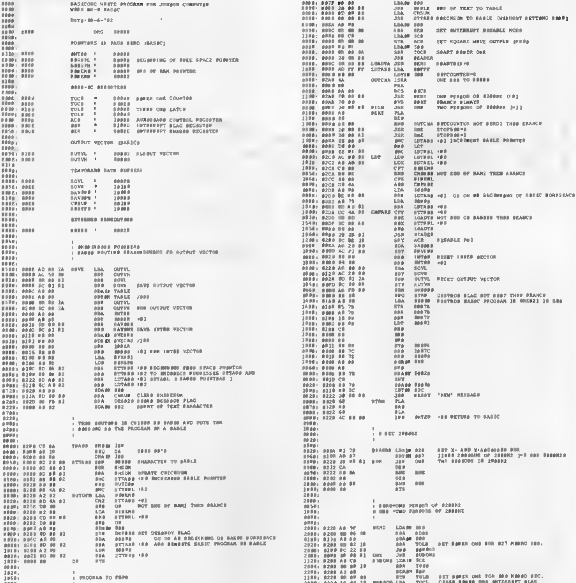
### The translation programs

The translation programs for both Junior versions are written in machine code. The complete source listing is given in table 1, complete with explanatory text. This is for the expanded Junior with KB-9-BASIC. The source listing for the DOS Junior is not given as it is almost the same as this listing, only a few of the addresses are different. The hexdumps are shown in table 2 (Junior with KB-9-BASIC) and table 3 (DOS Junior).
In the expanded Junior with KB-9-BASIC the translation program is at addresses $0200 . . . $059B, and in the DOS Junior it is at $E000 . . . $E39B. These ranges are selected because there is generally RAM there, and the programs really have to be in RAM to work properly (so they cannot be placed in an EPROM). Once the program is typed in, it can simply be written to a cassette or floppy disk, so that the next time it is to be used it can easily be read in. The program consists of a write and a read section. We will concentrate on the expanded Junior in order to describe how the program is used, but at any point where the DOS Junior differs, this is indicated by the comments in brackets.

#### Reading

First the Basicode translation program is typed in (or read in, if it is already stored on cassette). Both read and write programs can be stored in one file on cassette: SA = 0200, EA = 059C (DOS Junior: SA = E000, EA = E39C). Next the KB-9-BASIC is read in from cassette (see Elektor April 1982), or from a floppy in the case of the DOS Junior. Then the BASIC can be started in the usual way. At this stage a Basicode program can be loaded. This requires the small interface described at the end of this article. A program is loaded as follows:
First type NEW to erase any old programs. Then type:
POKE 8256,0 : POKE 8257,4 : X = USR(X)
(POKE 574,0 : POKE 575,226 : X = USR(X))
followed by a (carriage) return.
The sign ≡ now appears on the hex display of the Junior and indicates that there is no synchronization. The cassette recorder can then be started. If the program receives any signals the ≡ sign jumps back and forth on the two right-hand displays. If the 2400 Hz header is now received, a slowly jumping sign appears on the right-hand displays. This shows that the program is working on synchronizing. This jumping display lasts about 2 seconds, then the sign is stationary on both displays for the rest of the leader. At the end of the leader when the actual program begins, both displays show L/, and as long as the data is properly received this sign lights evenly on both displays. When the complete program is received, the computer automatically gives a listing of it on the screen or printer. After doing this, the computer gives an 'OK'.
If an error has appeared while reading in the program, the message 'CHECKSUM ERROR' is given after the listing. In this case the program must be checked or it could be read in again in the hope of a better result. On no account must the listing be interrupted by pressing a key. If this is done, there is a chance that both BASIC and Basicode programs will have to be read again (or retyped!). Even if faults are seen in the listing, such as lines being written over one another (that can happen if there is sudden interference on the tape), you must still wait until the

Table 1



computer is finished with the listing and gives the 'OK' or 'CHECKSUM ERROR' message. Then by simply working in BASIC, you can check the program and correct it. There is also a possibility that the computer may not recognize the end of the program and carries on as if it were reading the program, and the hex display remains lighting. In this case the RST key could be pressed, but then the BASIC would have to be read in again. That is not the ideal situation. A better solution is to look for the end of another Basicode program on the tape and play this out. The computer will then recognize this end and will report back on the screen. Of course, the last part of the program read in will no longer be correct but at least you can examine the part of the program that is correct and in this case the BASIC does not have to be read in again.

If the program that must be read in is too large for the available memory space, the computer returns with 'OUT OF MEMORY', and no listing appears. If a listing of the part that is written in is required it can be obtained as follows:

POKE 8256,156 : POKE 8257,4 : X = USR(X)

(POKE 574,156 : POKE 575,226 : X = USR (X))

followed by a (carriage) return.

### Writing

A BASIC program is written out in the following manner using Basicode:

```
                       BASICODE READ PROGRAM FOR JUNIOR COMPUTER
                       WITH KB-9 BASIC

                       DATE: [illegible]

[illegible]                  ORG   [illegible]

                       POINTERS AT PAGE ZERO (BASIC)

[illegible]            [illegible] =  [illegible]  BEGINNING OF FREE SPACE POINTER
[illegible]            [illegible] =  [illegible]
[illegible]            [illegible] =  [illegible]  END OF RAM POINTER
[illegible]            [illegible] =  [illegible]

                       6522-IC REGISTERS

[illegible]            PCR    =     [illegible]  PERIPHERAL CONTROL REGISTER
[illegible]            [illegible] = [illegible]  INTERRUPT FLAG REGISTER
[illegible]            [illegible] = [illegible]  INTERRUPT ENABLE REGISTER

                       6532-IC REGISTERS

[illegible]            PAD    =     [illegible]  DATA REGISTER OF PORT A
[illegible]            PBD    =     [illegible]  DATA REGISTER OF PORT B
[illegible]            [illegible] = [illegible]  CLEAR (INTERRUPT DISABLED)

                       INPUT VECTOR (BASIC)

[illegible]            [illegible] = [illegible]  INPUT VECTOR
[illegible]            [illegible] = [illegible]

                       TEMPORARY DATA BUFFERS

[illegible]            CHSUM  =     [illegible]  CHECKSUM
[illegible]            [illegible] = [illegible]  [illegible] COUNTER
[illegible]            [illegible] = [illegible]
[illegible]            [illegible] = [illegible]  [illegible]
[illegible]            [illegible] = [illegible]  HALF PERIODTIME
[illegible]            [illegible] = [illegible]
[illegible]            [illegible] = [illegible]

                       EXTERNAL SUBROUTINES

[illegible]            PRCHA  =     [illegible]  PRINT CHARACTER ROUTINE

                       ;
                       ; [illegible] AND [illegible]
                       ;

[illegible]            [illegible] LDA#  [illegible]
[illegible]                    STA   [illegible]   SET INTERRUPT DISABLE [illegible]
[illegible]                    LDA#  [illegible]
[illegible]                    STA   PCR     SET CB1 NEGATIVE EDGE DETECT
[illegible]                    STA   CHSUM   CLEAR CHECKSUM
[illegible]                    LDA#  [illegible]
[illegible]                    STA   [illegible]
[illegible]                    LDA   [illegible]     [illegible] OF FREE SPACE [illegible]
[illegible]                    STA   [illegible] +01  [illegible]
[illegible]                    LDX   [illegible]
[illegible]                    INX           [illegible] FOR [illegible]
[illegible]                    CPX   [illegible]
[illegible]                    BCS   STOP
[illegible]                    STX   [illegible] +02

[illegible]            [illegible] LDA#  [illegible]
[illegible]                    STA   [illegible]  SET PERIOD COUNTER
[illegible]                    LDA#  [illegible]
[illegible]                    JSR   [illegible]  DISPLAY NOSYNC CHARACTER
[illegible]            [illegible] JSR   PERIOD
[illegible]                    CMP#  [illegible]
[illegible]                    BCC   [illegible]  PERIODTIME IS [illegible] PERIODTIME
[illegible]                    CMP#  [illegible]
[illegible]                    BCS   [illegible]  PERIODTIME IS [illegible] PERIOD[illegible]
[illegible]                    INC   [illegible]
[illegible]                    BNE   [illegible]  NOT 256 PERIODS THEN BRANCH
[illegible]                    [illegible]
[illegible]                    JSR   SYNC    DISPLAY SYNC CHARACTER
[illegible]                    [illegible]
[illegible]                    INC   [illegible]
[illegible]                    BNE   [illegible]  NOT [illegible] PERIODS OF [illegible] THEN BRANCH
[illegible]                    [illegible]      [illegible] T T [illegible]
[illegible]                    [illegible]
[illegible]                    [illegible] [illegible]  [illegible] PERIODTIME - [illegible] = [illegible]
[illegible]                    STA   [illegible]
[illegible]            [illegible] [illegible] SYNC
[illegible]                    JSR   [illegible]  [illegible] STARTBIT
[illegible]                    CMP   [illegible]
[illegible]                    BCC   [illegible]  [illegible] PERIOD THEN BRANCH
[illegible]                    BCS   [illegible]  BRANCH ALWAYS
[illegible]            [illegible] JSR   [illegible]  [illegible] STARTBIT
[illegible]                    CMP   [illegible]
[illegible]                    BCS   [illegible]
[illegible]            [illegible] JSR   [illegible]  READ ONE BYTE

[illegible]            [illegible] STA   [illegible]  CHARACTER TO TABLE
[illegible]                    CMP#  [illegible]
[illegible]                    BEQ   [illegible]  [illegible] OF TEXT CHARACTER THEN BRANCH
[illegible]                    INC   [illegible] +01  INCREMENT POINTER
[illegible]                    BNE   [illegible]
[illegible]                    INC   [illegible] +02
[illegible]            [illegible] LDA   [illegible]
[illegible]                    CMP   [illegible] +02
[illegible]                    BNE   [illegible]  NOT END OF RAM THEN BRANCH
[illegible]                    LDA   [illegible]
[illegible]                    CMP   [illegible] +01
[illegible]                    BNE   [illegible]
[illegible]            STOP    LDY#  [illegible]
[illegible]                    JSR   [illegible]  "OUT OF MEMORY" MESSAGE
[illegible]                    LDA#  [illegible]
[illegible]                    STA   [illegible]
[illegible]                    [illegible]        RETURN TO BASIC

[illegible]            [illegible] [illegible] [illegible]
[illegible]                    CMP   [illegible]
[illegible]                    BCC   [illegible]
[illegible]                    JSR   [illegible]  READ CHECKSUM
[illegible]                    LDA#  [illegible]
[illegible]                    STA   [illegible]
[illegible]                    LDA   [illegible]  TABLE STARTADDRESS TO [illegible]
[illegible]                    STA   [illegible] +01
[illegible]                    LDA   [illegible]
[illegible]                    [illegible]
[illegible]                    STA   [illegible] +02
[illegible]                    LDA   [illegible]
[illegible]                    LDY   [illegible]
[illegible]                    STA   [illegible]  SAVE INPUT VECTOR
[illegible]                    [illegible] [illegible]
[illegible]                    LDA#  [illegible]
[illegible]                    LDY#  [illegible] /256
[illegible]                    STA   [illegible]  NEW INPUT VECTOR
[illegible]                    STY   [illegible]
[illegible]                    RTS

                       ;
                       ; THIS ROUTINE IS CALLED BY BASIC AND TRANSFERS
                       ; EVERY CHARACTER FROM THE TABLE TO BASIC
                       ; BY [illegible] GIVES A LISTING OF THE PROGRAM
                       ;

[illegible]            [illegible] LDA   [illegible]  CHARACTER FROM TABLE
[illegible]                    [illegible]
[illegible]                    JSR   PRCHA
[illegible]                    INC   [illegible] +01  INCREMENT POINTER
[illegible]                    BNE   [illegible]
[illegible]                    INC   [illegible] +02
[illegible]            [illegible] LDA   [illegible] +02
[illegible]                    CMP   [illegible] +02
[illegible]                    BNE   [illegible]  NOT END OF TABLE? THEN BRANCH
[illegible]                    LDA   [illegible] +01
[illegible]                    CMP   [illegible] +01
[illegible]                    BNE   [illegible]
[illegible]                    LDA   [illegible]
[illegible]                    STA   [illegible]  RESET INPUT VECTOR
[illegible]                    LDA   [illegible]
[illegible]                    STA   [illegible]
[illegible]                    LDA   CHSUM
[illegible]                    BEQ   [illegible]  NO CHECKSUM ERRORS THEN BRANCH
[illegible]                    LDY#  [illegible]
[illegible]                    JSR   [illegible]  "CHECKSUM ERROR" MESSAGE
[illegible]            [illegible] LDY#  [illegible]
[illegible]                    JSR   [illegible]  "OK" MESSAGE
[illegible]                    LDA#  [illegible]  [illegible] RETURN
[illegible]                    [illegible]
[illegible]            [illegible] [illegible]
[illegible]                    RTS

                       ;
                       ; MEASURE ONE PERIODTIME
                       ;

[illegible]            PERIOD  JSR   [illegible]
[illegible]            [illegible] LDA#  [illegible]
[illegible]            [illegible] BIT   [illegible]
[illegible]                    BEQ   [illegible]  NO ACTIVE EDGE ON CB1-INPUT THEN BRANCH
[illegible]                    STA   [illegible]  CLEAR CB1 FLAG
[illegible]                    LDA#  [illegible]
[illegible]                    EOR   PCR
[illegible]                    STA   PCR     OPPOSITE ACTIVE CB1 EDGE DETECT
[illegible]                    LDA#  [illegible]
[illegible]                    [illegible]
[illegible]                    EOR   [illegible]  GET ELAPSED TIME IN ACCU
[illegible]                    STA   [illegible]  RESET TIMER
[illegible]                    [illegible]
[illegible]                    CLC
[illegible]                    ADC   [illegible]  FULL PERIODTIME IN ACCU
[illegible]                    STA   [illegible]  SAVE LAST HALF PERIODTIME
[illegible]                    RTS

                       ;
                       ; READ ONE BYTE
                       ;

[illegible]            [illegible] LDA#  [illegible]
[illegible]                    JSR   [illegible]
[illegible]                    LDY#  [illegible]  THE BITCOUNTER
[illegible]            [illegible] PHA           SAVE ACCU
[illegible]                    JSR   PERIOD
[illegible]                    CMP   [illegible]
[illegible]                    BCS   [illegible]  [illegible] PERIOD[illegible] THEN BRANCH
[illegible]                    JSR   [illegible]  SECOND [illegible] PERIOD
[illegible]                    SEC
[illegible]                    BCS   [illegible]  BRANCH ALWAYS
[illegible]            [illegible] CLC
[illegible]            SHIFT   PLA
[illegible]                    RORA          NEXT BIT TO ACCU
[illegible]                    DEY
[illegible]                    BNE   [illegible]  NOT 8 BITS THEN BRANCH
[illegible]                    [illegible]
[illegible]                    EOR   CHSUM
[illegible]                    STA   CHSUM   UPDATE CHECKSUM
[illegible]                    [illegible]
[illegible]                    [illegible] [illegible]  CLEAR BIT 7
[illegible]                    RTS

                       ;
                       ; DISPLAY SYNC-CHARACTER ON [illegible].DISPLAY
                       ;

[illegible]            SYNC    LDA#  [illegible]
[illegible]            [illegible] STA   PAD
[illegible]                    LDA   [illegible]
[illegible]                    [illegible] [illegible]
[illegible]                    STA   [illegible]
[illegible]                    [illegible]

                       ;
                       ; OUTPUT MESSAGE [illegible]
                       ;

[illegible]            [illegible] LDA   [illegible]  LOAD CHARACTER
[illegible]                    CMP#  [illegible]
[illegible]                    BEQ   [illegible]  END OF TEXT CHARACTER
[illegible]                    JSR   PRCHA
[illegible]                    INY
[illegible]                    JMP   [illegible]
[illegible]            [illegible] RTS

[illegible]            [illegible] =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  'O
[illegible]                    =  'U
[illegible]                    =  'T
[illegible]                    =  '
[illegible]                    =  '[illegible]
[illegible]                    =  '[illegible]
[illegible]                    =  '
[illegible]                    =  '[illegible]
[illegible]                    =  '[illegible]
[illegible]                    =  '[illegible]
[illegible]                    =  '[illegible]
[illegible]                    =  'T
[illegible]                    =  'T
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  'C
[illegible]                    =  '[illegible]
[illegible]                    =  'T
[illegible]                    =  'C
[illegible]                    =  '[illegible]
[illegible]                    =  '[illegible]
[illegible]                    =  '[illegible]
[illegible]                    =  '[illegible]
[illegible]                    =  '
[illegible]                    =  '[illegible]
[illegible]                    =  '[illegible]
[illegible]                    =  'T
[illegible]                    =  '[illegible]
[illegible]                    =  'T
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  'O
[illegible]                    =  'T
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  '[illegible]
[illegible]                    =  'T
[illegible]                    =  'T
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
[illegible]                    =  [illegible]
```

Table 1. This is the source listing for the complete translation program. This particular example is for the expanded Junior with KB-9-BASIC. The listing for the DOS Junior is almost identical to the one shown here, with the exception of a few address locations.

**Table 2**

```
M
HEXDUM9: 0700,0383
        0  3  7  3  4  5  9  7  0  9  A  B  C  0  E  F
0200: AD 57 2A AC 53 2A 0D F0 03 8C F1 03 A9 47 A0 02
0710: 0D 52 2A 8C 53 2A A5 04 A4 05 0D F2 03 8C F3 03
0770: A9 77 A0 07 05 04 04 05 A5 7E A4 7F 0D 49 02 8C
0730: 4A 07 0D A0 02 8C A1 07 A0 00 0D F4 03 0D F0 03
0740: A9 02 C9 0A F0 30 09 00 0D FF FF 4D F4 03 8D F4
0750: 03 EE 49 02 D0 03 EE 4A 02 A5 05 CD 0A 07 D0 19
0290: A5 04 CD 49 07 D0 0F A9 FF 0D F8 03 A5 70 0D 49
0270: 07 A5 79 8D 4A 07 60 40 90 40 A9 0D 70 42 02 A9
0200: 03 70 47 07 AD F4 03 70 40 07 A9 7F 0D 0E 10 A0
0290: C0 0D 00 10 A9 01 0D 05 10 70 70 03 70 39 03 AD
07A0: FF FF A0 00 4A 40 00 05 70 39 03 70 03 70 40 03
0200: 60 00 D0 F0 70 46 03 70 49 03 EE A0 07 D0 03 EE
07C0: A1 07 AC A1 07 AE A0 07 C4 05 D0 0E E4 04 D0 0A
07D0: A5 70 0D A0 07 A5 79 0D A1 02 CC 4A 07 D0 0D EC
07E0: 49 02 D0 00 20 70 03 8C 00 10 AD F7 03 AC F3 03
0790: 05 04 04 05 AD F0 03 AC F1 03 0D 57 2A 8C 53 2A
0300: AD F0 03 F0 70 A5 70 05 70 05 7D 05 7F A4 70 C0
0310: C0 C0 04 7A 04 7C 04 7E A0 00 A0 91 78 CE 91 70
0370: A0 2C 70 59 05 90 A4 60 4C 03 00 A2 70 A0 17 20
0330: 46 03 CA D0 FA 00 D0 F7 90 A9 9F 0D 08 10 A9 01
0349: 0D 07 10 4C 53 03 70 49 03 A0 CE 0D 06 10 A9 00
0350: 0D 07 10 AD 04 10 2C 0D 10 54 F0 AD 04 10 2C 0D
0390: 16 50 F0 60

JUNID0

M
HEXDUMF: 0400,0590
        0  1  2  3  4  5  6  7  0  9  A  0  C  0  E  F
0400: A0 7F 0D 0E 10 A9 00 0D 8C 10 0D F4 03 A9 73 0D
0410: 02 1A A5 7E 0D 05 04 A4 7F E0 E4 05 00 63 0E 00
0470: 04 A9 10 0D F6 03 A9 39 20 4D 05 20 FD 04 C9 77
0430: 90 EF C9 4E 00 E0 EE F5 03 D0 F0 A0 70 40 05 90
0440: CE F9 03 D0 E6 0A 30 E9 9C 0D F7 63 70 40 05 70
0450: 00 05 CD F7 03 90 F5 00 00 70 00 05 CD F7 03 00
0460: F0 20 24 05 0D FF FF C9 03 F0 21 EE 95 04 D0 03
0470: EE 90 04 A5 05 CD 99 04 D0 DF A5 04 CD 65 04 D0
0400: D6 A0 00 20 59 05 A0 97 0D 07 1A 60 70 00 05 CD
0400: F7 03 90 F0 20 74 05 A0 67 0D 07 1A A5 7E 0D 0F
94A0: 04 A6 7F E0 0E C0 04 AD 57 24 AC 50 24 0D F9 93
0400: 0C FA 03 A0 0E A0 04 6D 57 74 8C 50 74 90 AD FF
04C0: FF A0 70 34 13 EE 0F 04 D0 03 EE C0 04 AD 99 04
04D0: CD C0 04 D0 29 AD 05 04 CD 0F 04 D0 1E AD F9 03
04E0: 0D 57 74 AD FA 03 0D 50 74 AD F4 03 F0 05 A0 17
04F0: 20 50 05 A0 25 70 59 05 A9 0D 90 90 60 70 00 05
0500: A9 07 2C 0D 10 F0 F0 0D 0D 10 A9 01 4D 0C 10 ED
0510: 0C 10 A9 FF AA 4D F9 1A 0E F5 1A AA 10 0D F0 03
0520: 0E F0 03 90 A9 55 70 4D 05 A9 00 40 20 FD 04 CD
0530: F7 03 00 09 20 FD 04 30 00 01 10 90 9A 00 D0 E0
0540: 40 4D F4 93 0D F4 03 40 79 7F 60 A9 09 0D 00 1A
0550: AD 07 1A 49 07 0D 07 1A 90 00 90 05 C0 03 F0 07
0560: 20 34 13 C0 4C 59 05 60 0D 0A 4F 55 54 70 4F 46
0570: 70 4D 45 4D 4F 52 50 9A 0D 03 0D 0A 43 40 45 43
0500: 40 53 55 4D 20 45 52 57 4F 52 0A 0D 03 0D 0A 4F
0590: 40 0A 00 03 0D 0A 4E 45 57 0A 0D 03

JUN108
```

**Table 2. The hexdump for the translation program for the Junior with KB-9-BASIC.**

**Table 3**

```
HEXDUMF: E000,E103
        0  1  2  3  4  5  9  7  0  9  A  0  C  D  E  F
E000: AD 11 23 AC 17 23 0D F0 E1 8C F1 01 A9 41 A0 E0
E010: 0D 13 73 0C 17 23 A5 04 A4 05 0D F2 E1 0C F3 E1
E020: A9 77 A0 E9 05 04 04 05 A5 7E A4 7F 0D 49 E0 0C
E030: 4A E0 0D A0 E0 0C A1 00 A0 00 0D F4 E1 0D F0 E1
E049: A9 07 C9 0A F0 30 09 00 0D FF FF 4D F4 E1 0D F4
E050: E1 EE 40 E0 D0 03 EE 4A E0 A5 05 CD 4A E0 D0 19
E090: A5 04 CD 49 E0 D0 0F A9 F9 0D F0 E1 A5 70 0D 49
E070: E0 A5 79 0D 4A E0 40 40 90 40 A9 0D 70 47 E0 A9
E000: 03 70 42 E6 AD F4 E1 70 40 E0 A9 7F 0D 0E F0 A9
E090: C0 0D 00 F0 A0 01 0D 05 00 70 20 01 70 30 01 AD
E0A0: 9F FF A0 06 4A 40 00 95 70 39 E1 70 03 70 49 E1
E000: 90 00 D0 F0 20 44 E1 20 46 E1 EE A0 E0 D0 03 EE
E0C0: A1 E0 AC A1 E0 AE A0 E0 C4 05 D0 0E E4 04 D0 0A
E0D0: A5 70 0D A0 E0 A5 79 0D A1 E0 CC 4A E0 D0 0D EC
E0E0: 40 E0 D0 00 70 70 E1 0C 00 F0 AD F7 E1 AC F3 E1
E0F0: 05 04 04 05 AD F0 E1 AC F1 E1 0D 11 73 0C 17 73
E100: AD F0 E1 F0 20 A5 79 05 70 05 7D 05 7F A4 70 C0
E110: C0 C0 04 7A 04 7C 04 7E A9 09 A0 01 70 C0 91 70
E170: A0 2C 70 59 E3 00 A0 90 4C 03 00 A2 70 A0 17 70
E130: 46 E1 CA D0 FA 00 D0 F7 60 A9 9F 0D 06 F0 A9 01
E140: 0D 07 F0 4C 53 E1 70 40 E1 A9 CE 0D 06 F0 A9 00
E150: 0D 07 F0 AD 04 F0 2C 0D F0 50 F0 AD 04 F0 7C 0D
E190: F0 50 F0 60

JUN10E

K
HEXDUMF: E200,E300
        0  7  7  3  4  5  4  7  0  9  A  0  C  D  E  F
E200: A9 7F 0D 0E F0 A9 00 0D 8C F0 0D F4 E1 A9 73 0D
E210: 07 FA A5 7E 0D 95 E2 A6 7F E0 E4 05 00 93 0E 99
E770: E7 A9 10 0D F9 E1 A9 36 70 4D E3 70 FD E2 C9 22
E230: 90 EF C9 4E 10 E0 EE F5 E1 D0 F0 A0 74 40 E3 90
E240: CE F6 E1 D0 E6 0A 30 E9 0C 0D F7 E1 70 40 E3 70
E250: 00 E3 CD F7 E1 90 F5 00 00 70 00 E3 CD F7 E1 90
E200: F0 70 24 E3 0D FF FF C9 03 F0 21 EE 65 E2 D0 03
E770: EE 99 E7 A5 05 CD 66 E2 D0 DF A5 04 CD 95 E7 D0
E700: D4 A0 00 70 59 E3 A9 67 0D 02 FA 60 70 00 E3 CD
E700: F7 E1 90 F0 70 24 E3 A9 97 0D 07 FA A5 7E 0D 0F
E2A0: E7 A9 7F E0 0E C0 E7 AD 01 23 AC 02 73 0D F9 E1
E200: 0C FA E1 A9 0D A9 E7 0D 01 23 0C 07 73 90 AD FF
E2C0: FF A0 0D 03 73 EE 0F E7 00 03 EE C0 E7 AD 60 E2
E2D0: CD C0 E2 D0 76 AD 95 E7 CD 0F E7 D0 1E AD F9 E1
E7E0: 0D 01 23 AD FA E1 0D 07 73 AD F4 E1 F0 05 A0 17
E2F0: 20 59 E3 A0 25 20 59 E3 A9 0D 60 90 40 20 00 E3
E300: A5 07 2C 0D F0 F0 F0 4D 0D F0 A9 01 4D 8C F0 0D
E310: 8C F0 A9 FF AA 4D F0 FA 9E F5 FA AA 10 9D F0 01
E320: 0E F0 E1 90 A9 55 20 4D E3 A0 09 40 20 FD E2 CD
E330: F7 E1 00 09 20 FD E2 30 00 01 10 98 6A 00 D0 E8
E340: 40 4D F4 E1 0D F4 E1 90 29 7F 90 A9 09 0D 00 FA
E350: AD 02 FA 49 02 0D 02 FA 00 09 08 E3 C9 03 F0 07
E360: 20 43 23 C0 4C 59 E3 40 0D 0A 4F 55 54 20 4F 40
E370: 70 4D 45 4D 4F 52 59 0A 0D 03 0D 0A 43 40 45 43
E300: 40 53 55 4D 20 45 52 52 4F 52 0A 0D 03 0D 0A 4F
E399: 4B 0A 0D 03 0D 0A 4E 45 57 0A 0D 03

JUNIOR
```

**Table 3. Hexdump for the translation program for the DOS Junior.**

POKE 8256,0 : POKE 8257,2 : X = USR(X) : LIST
(POKE 574,0 : POKE 575,224 : X = USR(X) : LIST)

The recorder is then set to record and started. Only then is the (carriage) return given. The whole program is then saved on the tape in Basicode form. After the computer gives the 'OK' signal the recorder can be stopped. It is also possible to save only a part of the program on tape (for example, lines 1000-1090):

POKE 8256,0 : POKE 8257,2 : X = USR(X) : LIST 1000-1090
(POKE 574,0 : POKE 575,224 : X = USR(X) : LIST 1000-1090).

Before the BASIC program is stored on tape, the computer 'translates' the program first into 'LIST' format and places that in a table which appears above the BASIC program in the RAM range. With large programs, the RAM range may not be big enough to store both of these so after the program is stored on tape the computer returns the 'NEW' message. This means that the original BASIC program is erased from the memory. As it is in Basicode form on the tape anyway, it can also be read in again.

## Details of the translation program

This next section is a description of the write and read routines (more details are given in the listing of table 1).

### The write program

When this routine is called by means of X = USR(X), the OUTPUT vector (of the BASIC Junior) is changed for the start address of a machine code routine (TABLE in the write program). This routine stores an ASCII character from ACCU into RAM. After giving a LIST command (with POKE . . . : POKE . . . : X = USR(X) : LIST), the computer will list the program on the screen (or on the printer). Because the OUTPUT vector is changed (it normally points to the 'print character' routine), the TABLE routine is used to store the listing in RAM above the original BASIC program. The program is then stored in this table in LIST format.

After the BASIC Junior notes the end of the program and is therefore finished listing, it jumps via the JMP command at addresses 0003 . . . 0005 to SVECAS. This routine sets the whole table onto cassette with 1200 and 2400 Hz tones. When that is done the OUTPUT vector and the JMP at address 0003 are reset and the computer returns to BASIC.

### The read program

After this program is called by X = USR(X), the Basicode program is read from cassette and stored in the form of a table in RAM. Again the program is in LIST format. When the 'end of text' character and the checksum are read in, the whole program is located in this table, the INPUT vector (in the BASIC Junior) is changed for the start address of the LDIND routine, and the computer returns to normal BASIC.

The computer should now really wait for an input from the terminal (the INPUT vector normally points to the receive character routine), but because the INPUT vector points to the LDIND routine the characters are called one by one from the table by the BASIC Junior (and printed at the same time). This makes it seem as if a program is being typed in at high speed. The program thus read out of the table is then processed and stored in the normal way.

Finally, the INPUT vector is reset and the computer returns with 'OK'. Tbe user can then work with the program as usual.

## BASIC subroutines

Apart from the translation program there is also a need for some subroutines, written in Basicode-2 protocol. These are dealt with in depth in the descriptive article, 'Basicode-2', in this issue.

Three of these subroutines are not usable with the Junior/Elekterminal combination. These are routines 120, 200 and 250. Subroutine 120 relates to the position of the cursor on the screen and subroutine 200 checks whether at a specific moment a key is pressed. Neither is possible because of the arrangement of the Elekterminal. Subroutine 250 just gives a bleep, but the Elekterminal is mute.

If the main BASIC program calls subroutine 120 or 250 nothing happens because in the Junior these subroutines consist of the 'RETURN' command. For subroutine 200 IN$ is an empty string so that it seems as if no key is pressed at that moment.

The standard subroutines for the expanded Junior and the DOS Junior, both with the Elekterminal, are given in tables 4 and 5 respectively. Subroutines 350 and 360 should really refer to a printer but in our case they refer to the terminal.

The subroutines can be read in either before or after the Basicode program. That makes no difference as long as they are present when the program is RUN. If, for example, the Basicode program has already been read in, the subroutines can simply be added by reading them in using POKE . . . : POKE . . . : X = USR(X).

Two program sections can be added to form one program by reading them both in separately. The only prerequisite is that the two parts have no identical line numbers.

## Practical points

After reading in a Basicode programme it is only common sense to check it through carefully. Often there are some details that have a different meaning on your computer to what they meant to the computer on which the program was developed. This is a common reason for programs not to work.

Consider this case, for example: we have a Basicode program that draws a maze, and it contains the necessary PRINT statements. If part of the maze is now drawn on the screen and the program wants to PRINT something in the middle of the maze, a carriage return and line feed are automatically generated after the print statement. With the Elekterminal a carriage return

**Table 4**

```
LIST

 1R GOTO !RRR
 2R GOTO 1R1R
 1RR PNINT
 1R1 PONE6745,2RR:PRIHT CHR$)12)1
 1R2 PONE6745,3
 1R3 RETURN
 1)@ 1F HO>$3 TREH RETURN
 ))) 1F VE>)5 THEH RETHRN
 ))2 POKE$745,2RR:PRINT CHR$(2R);
 113 POKE6745,3
 114 PNINT
 115 1F HO=R GOTO 117
 11R POR OD=1 TO NO:PR)NT CHR$)9)1:NEXT
 3)7 POR OP=-) TO )5-VE:PRINT CHR$ 11};:NEXT
 ))@ RETURN
 )2@ RETUNN
 20R 1H$="":RETURN
 21R OS=PEEH 1825611;OT=PEEH 1$257)
 211 POHER256,))R*16+)4):PONE@257,{)*)$+2)
 212 D=USR :O)
 213 PONE@256,O6:POKE@257,OT
 2)4 OX=1PEEK 16754) AND 127)
 215 1N$=CNR$ )OX1
 2)$ NETHRN
 25R RETHRN
 26R RV=RND)1):RETURN
 27R PR=FRE 1R):RETUHH
 3@@ )P SR<.R) AND S@>-.R) THEN @R=@
 30) 1P SGN )SR)=-) TREH SR$=$TR$(SR):NETURH
 3R2 SN$=N1O$ 1STR$ 16R),2):RETURN
 31R OS=ARS(SR)+,5*)@'-Ch:O)=)HT )OS):OD=O@-D)+)
 3)1 SRS=""
 312 )P O6>=1E9 THEN 32)
 313 )F CN=R THSN ODS="":GOTO 3)7
 314 )F OD=) THEN ODS=",":GOTO 3)R
 3)5 OD$=M1D$ 1STN$ 1OD),3,CN+1)
 3)6 1F LEN 1OO$)<CR+1 THEN OD$=OO@+"R":GOTO 3)$
 317 RR$=M1D$ 1STH$ 1O)),2)+OD$
 3)@ 1F SR<R AND VAL 1SR$)<>R THEN SR$="-"+RR$
 3)9 1F LEN 1SR$)<CT THEN SRS=" "+SR$:GOTO 31R
 32R 1P LEN 1RN$)>CT THER SR$=""
 321 )F LEN 1SR$)<CT THER RRS=SR$+"*":GOTO 32)
 322 @ETUNN
 35R PRINT SRS;:RETURN
 36@ PRINT :RETURN
OK
```

**Table 4. The standard subroutines for the expanded Junior with KB-9-BASIC.**

**Table 5**

```
L)RT

 1R GOTO 1RRR
 2R GOTO 1R1R
 )@R PRINT
 1R1 POKE64R$9,2@@:PR)NT CHR@))2)1
 )@2 POHE44R$9,3
 )R3 RETURN
 3)@ 1F HO>63 THEN RSTURN
 )11 )F VE>15 THEN RSTURH
 ))2 POHE64RR9,2R@:PR)NT CHR$ 12@)1
 ))3 POHE64RRR,3
 )14 PRINT
 115 1F HO=@ GOTO ))7
 )16 POR OD=1 TO NO:PR)NT CHR$ 19)1:NEXT
 ))7 POR OF=-3 TO 15-VE:PR)NT CHR$ {)));:REXT
 11R NETHRN
 )2R RSTURN
 2@N 1N$="":NETURN
 2:R OS=PSER :574):OT=PSER 1575)
 211 POKE574,()*)$+))):POKE575,))5*)$+14)
 212 O=USN (O1
 213 POKE574,OG:POKE575,OT
 214 OX=PEEH 19R55)
 215 1N$=CNN$ 1OH)
 2)$ RETUHH
 25R RETURN
 2$R RV=RND 11):RETURN
 27R PR=FRE )R):RETURN
 3RR 1F SR<.R1 AND $R>-.@1 THER SR=@
 3$) 1F SGN (SR)=-1 THSN SR$=STR$ 1ER):RETHRH
 3R2 SRS=M1O$ 1STR$ 1EN),2):RETURN
 31@ OS=ABS 1SR)+.5*1R'-CN:O)=)NT 1O6):OD=OS-O)+)
 3)) SR$=""
 3)2 1F OS>=1E9 THER 321
 313 1F CN=@ THEN OD$="":GOTO 3)7
 3)4 1F OD=1 THEN OO$=",":GOTO 316
 315 OD$=M1O$ 1STR$ 1OD),3,CN+1)
 31R 1F LEN :DO$)<CH+1 THEN OD$=OD$+"R":GOTO 3)$
 3)7 SR$=M1O$ 1STR$ 1O1),21+DO$
 3)@ 1F SR<R AND VAL(SRS)<>R THSN SR$="-"+SR$
 319 1F LEN(SRS)<CT THEN SR$=" "+SRS:GOTO 319
 32R 1F LEN(SRS)>CT THEN SR$=""
 321 1F LEN 1SRE)<CT THEN SR$=SR$+"*":GOTO 321
 322 RETURN
 35R PRINT SRS;:NETURN
 36R PRINT :RSTUNN

Ok
```

**Table 5. The standard subroutines for the DOS Junior.**

1

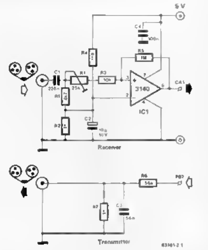


**Figure 1. The circuit diagram for the interface circuit that must be connected between a cassette recorder and the Junior Computer.**

**Parts list**

Resistors:
R1 = 4k7
R2,R4,R7 = 1 k
R3 = 10 k
R5 = 1 M
R6 = 56 k
P1 = 25 k preset

Capacitors:
C1 = 220 n
C2 = 10 µ/10 V
C3 = 56 n
C4 = 100 n

Semiconductors:
IC1 = 3140

2

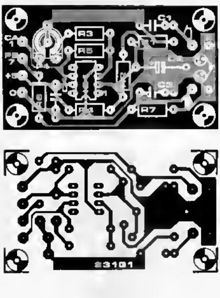
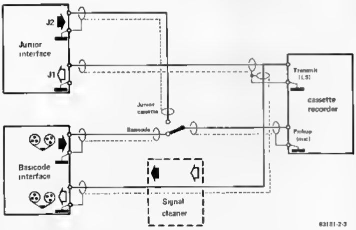


**Figure 2. The printed circuit board layout for the interface circuit.**

**Figure 3. This shows the wiring layout that must be used if both the normal Junior cassette interface and the Basicode interface are to be used together.**

3



means that everything after the print statement on this line is erased. In this example the program can easily be adapted by following the PRINTs in question with a ;. The CR and LF are not produced then and the program runs properly.

A program could, of course, also call a subroutine that the Junior/Elekterminal does not recognize (120, 200 and 250). Subroutines 200 and 250 are no real problem and can easily be avoided, but is is sometimes more difficult to do without routine 120. If sub 120 is used, for example, in a game to define the position of the cursor on the screen, it can be very difficult to adapt the program. Subroutine 120 is also quite often used to define the screen size. This can also be done by leaving out the appropriate lines and stating on the free lines how large the screen is (16 lines of 64 characters on the Elekterminal). In the case where, for example, the screen format is defined for a section of a program, and after leaving this section, variables VV and HH must contain the height and width of the screen. In our case this program section is simply changed by VV = 15 : HH = 63 (remember that the first position has always number zero).

A final note about tha @ sign in KB-9-BASIC. If the computer sees this sign the whole line is erased and CR and LF are given.

## The hardware

The hardware for the Basicode interface consists of a small adapter circuit which is connected between the cassette recorder and the Junior Computer. The circuit diagram is shown in figure 1. It consists of a transmitter and a receiver section. The receiver contains only one IC (3140) which is connected as a schmitt trigger/level adapter. Using P1, the trigger level can be set between certain limits, but normally the circuit works correctly if the pot is roughly in mid position. The transmitter section simply reduces the output signal from the Junior and filters out the higher harmonics from the signal.

The printed circuit board for the interface (figure 2) is designed so that two phono plugs (for input and output) can be soldered directly onto the board using some wire links. Points CA1 and PB7 are connected to the corresponding points on the VIA connector on the interface board.

If the normal Junior cassette interface and the Basicode interface are to be connected at the same time (the former is needed to read in machine code programs), care must be taken when wiring the interfaces. The wiring diagram for connecting both interfaces is given in figure 3. Any deviation from this layout is likely to result in earth losses occurring and the possibility of oscillation is greater. This same diagram also shows a block called signal cleaner! This circuit, which is also described in this issue, is only needed if the signal from the recorder (or radio) is of very poor quality. It is easy to try without this interface first and if this does not work, the circuit could always be added. ◄

**New cars are invariably fitted with an electronic voltage regulator. To give owners of older cars the opportunity of also taking advantage of this far more reliable device, we have designed our own regulator.**

# electronic voltage regulator...

## . . . for older cars

The electronic voltage regulator fitted to virtually all new cars is indisputably more reliable than its electro-mechanical counterpart. The latter has been with us for a long time and during all that time its main drawback has been its limited life. Contacts gradually burn away; the contact spring loses its 'spring', and so on. If this results in the battery not being charged properly, it's not so bad. After a few push-starts, you finally decide that a new regulator has to be fitted and that's that. If, however, the battery is constantly overcharged as a consequence, it literally cooks and is soon destroyed. Often, this causes irreparable damage to the dynamo or alternator as well. If that happens, the repair bill comes as quite a shock!

Problems caused by wear and tear are unknown to electronic regulators. These devices also have further advantages: if the regulator is fitted close to the battery, the battery temperature becomes a factor in the regulation, and then there is the absence of that dreadful radio interference so characteristic of electro-mechanical regulators (unfortunately, there is still the ignition . . .).

### What is regulated and how . . .

. . . will be explained here. Cars have had their starter motor, battery, and dynamo or alternator fitted under the bonnet (or in the boot!) for a very long time. Carbide lamps have also been replaced by electric lights . . . The battery needs a certain minimum voltage to be charged. The brilliance of the headlights or other lamps should not ba dependent upon the engine speed. It is clear that the voltage generated by the dynamo or alternator must be kept constant within well-defined limits. As the speed with which the dynamo/alternator is driven by the engine constantly fluctuates, and the output of the dynamo/alternator depends primarily on the voltage across the rotor winding, the regulator is made to control that voltage.

Figure 1 shows how the generator, voltage regulator, and battery are interconnected. The output of the dynamo/alternator, D+, serves as supply for the entire electrical system of the car and also as the input to the voltage regulator. The regulator has internally been preset to a desired output (= reference) voltage level. The difference between D+ and the reference voltage is variable and equal to the rotor voltage. When D+ rises with the engine speed, the regulator lowers the rotor voltage until D+ corresponds to the reference voltage again.

1

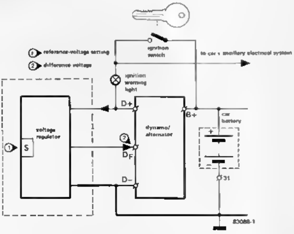


Figure 1. The principle of the regulator applicable to electro-mechanical and electronic types alike.

### The circuit diagram

The circuit diagram of the electronic voltage regulator, together with an (a.c.) alternator and battery is shown in figure 2. It should be remarked here at once that the regulator will work equally well with a (d.c.) dynamo or an alternator with full-wave rectification instead of the single-wave shown. There is, in fact, only one limitation: the regulator is for use with 12 V negative earth systems only!

We cannot dwell on the detailed operation of the alternator: that is best left to a textbook on d.c. and a.c. generators. For our purposes it is sufficient to know that when the rotor is revolving and a current flows through its winding, an alternating current is generated in the stator windings. The connections to the exciter coil are by means of slip rings. The alternating current is rectified by diodes $D_{L1} \ldots D_{L3}$ and $D_{L4} \ldots D_{L6}$ which are located in the alternator housing. Part of the output from the alternator (D+) is fed to the voltage regulator and the remainder to the battery and car's electrical system. This

2

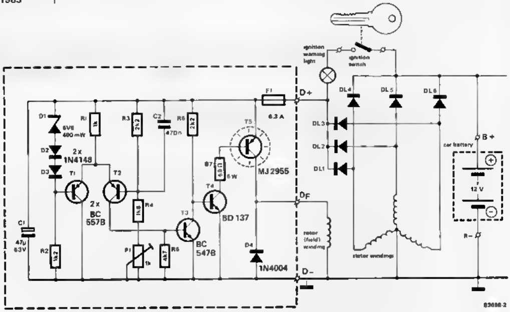


**Figure 2. The circuit of the electronic voltage regulator. To clarify the set-up, the alternator, battery, ignition switch, and ignition warning light have been included.**

pattern may vary from vehicle to vehicle. The output from the alternator is smoothed to an acceptable level. Diodes D2 and D3 and zener D1 provide a reference voltage of 6.9 V. Transistors T1 . . . T3 form a differential amplifier, with the base of T1 functioning as the inverting input and the base of T2 as the non-inverting input. The collector of T3 is the output.

As soon as the ignition is switched on, a current flows from the battery to the base of T4 via the ignition warning light and resistor R6. Transistor T4 conducts and drives T5, which ansures that a current flows through the rotor winding via terminal $D_F$.

When the engine starts, the alternator will produce some output. Once the engine speed reaches about 1500 RPM, the stator windings generate a rapidly rising voltage. Because of the constant voltage across D1 . . . D3, the base potential of T1 will rise in unison with the alternator output. However, because of the voltage divider R3, R4, P1, the base voltage of T2 will rise less rapidly. Consequently, the base of T1 will become more positive than that of T2, so that the latter conducts harder. The consequent base voltage applied to T3 causes this transistor to conduct also and this in turn makes the base potential of T4 fall. The rotor current, and therefore the alternator output, decreases and causes the base potential of T2 to rise above that of T1. Transistor T2, and therefore T3, conducts less which makes T4 and T5 conduct harder. This results in an increase in rotor current and, consequently, alternator output. The base of T2 will then become less positive than that of T1 and . . . . .

Capacitor C2 serves as a by-pass for any noise emanating from the car's electrical system. Diode D4 short-circuits the back-e.m.f. induced in the rotor winding at the moment the ignition is switched off.

In the introduction it was stated that new cars are invariably fitted with an electronic voltage regulator. This regulator is normally built into the alternator housing which has, of course, advantages, but also a disadvantage: if the regulator goes faulty, you invariably will have to buy a complete new alternator. This expense you will not have with the one described in this article.

### Construction and calibration

All components of the regulator are fitted on the printed circuit board shown in figure 3. Note, however, that transistor T5 must be provided with a suitable heatsink. Some care is required when adjusting the circuit for use: calibration must be carried out before the regulator is fitted in the car. You need a high-performance (preferably digital) voltmeter, preferably two independent power supplies, and an ordinary 12 V/18 W car bulb.

The set-up for the calibration is shown in figure 4. Power supply 1 should be able to deliver at least 100 mA with a variable, stabilized output voltage of between 0 V and 15 V. Supply 2 represents the load (battery and car electrics) and should provide 12 V at 1.5 A. It could, of course, be replaced by a well-charged car battery.

The calibration should be carried out at an ambient temperature of about 20°C.

Once everything has been arranged as shown in figure 4, set supply 1 to its lowest output voltage and then increase the output slowly,

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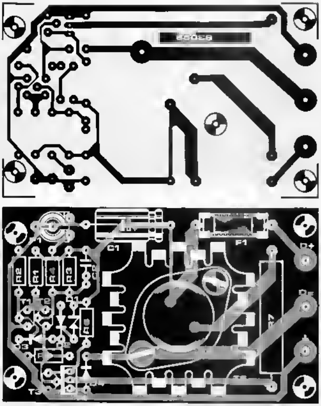

**Figure 3. The printed circuit board for the regulator.**

**Part list**

Resistors:
R1 = 1 k
R2 = 1k2
R3, R6 = 2k2
R4 = 1k8
R5 = 4k7
R7 = 68 Ω/9 W

Capacitors:
C1 = 47 µ/63 V, electrolytic
C2 = 470 n

Semiconductors:
T1, T2 = BC 557B
T3 = BC 547B
T4 = BD 137/139
T5 = MJ 2955
D1 = zener diode 5V6/400 mW
D2, D3 = 1N4148
D4 = 1N4004

Miscellaneous.
F1 = fuse 6.3 A, delayed action
Heatsink for T5: 45 x 45 x 25 mm

watching the reading on the digital voltmeter (the reading on the built-in voltmeter of the supply is of no use here). When the voltmeter reads 3 . . . 5 V, the lamp should light. When the voltage is increased further, the lamp will burn brighter and brighter, but extinguish when 14.3 V is reached. This 'turn-over' voltage is set by P1 on the regulator. It is advisable to repeat this procedure by first lowering and then increasing the voltage again.

Once P1 has been set, gradually reduce the output of supply 1 from 15 V. When 13.9 . . . 14.0 V is reached, the lamp should light again. The hysteresis of about 0.3 V is largely dependent upon R3.

Fitting the regulator in the car should generally not present a problem: the three terminals on the printed circuit board are designated as per DIN-norm which is also used by most car (and generator) manufacturers. None the less, if the terminals on the dynamo/alternator in your car are not marked D+, D−, and DF, it should not be very difficult to determine the correct connections (to which the existing regulator is, of course, fitted). ◼

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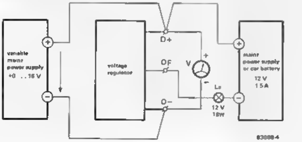

**Figure 4. Before the regulator is fitted in the car, it must be very carefully calibrated. This figure shows how the regulator and test equipment should be set up.**

**Battery eliminator or mains adapter? The names can be confusing as they're interchanged freely and both refer to a unit which plugs directly into a standard 13 A mains socket to provide a low-voltage d.c. output. Fortunately, there seems to be a growing tendency to use the name 'mains adapter' for unregulated supplies, and 'battery eliminator' for the more sophisticated, stabilized ones. The unit presented here provides a stabilized voltage which is variable about ± 25 per cent from nominal at an output current of 250 . . . 300 mA. Ripple voltage is low at 2 mV$_{pp}$ at maximum output.**

# battery eliminator

## stabilized, variable-voltage power supply

It is not too difficult to convert a bought-out mains adapter to a battery eliminator by simply adding a voltage regulator. As, however, the results were not very satisfactory, we decided to start from scratch and also provide current limiting.

The unit is built in a small standard case which is connected to the mains by a short leed, resulting in a neat, practical unit.

The output voltage range is determined by a fixed voltage divider, the precise output voltage by a preset. We have intentionally designed the unit around common components which virtually every electronics hobbyist is likely to have lying around. A 78XX regulator IC could, of course, have been used, but this might have meant purchasing one to many of you. Our design offers you the chance to make use of some of those components which have been lying idle for too long.

### The circuit diagram

Transistors T1 and T2 form the current limiter which will be described later. The 'work horse' of the circuit – see figure 1 – is T3, a high-power, low-frequency transistor type BD 139. Its base is driven by a voltage regulator formed by a standard 741 opamp (IC1). The supply for the regulator is taken directly from C1+ to ensure that regulation can take place over the largest possible range. Capacitor C3 is included to provide further stabilization of the output voltage.

We now come to the heart of the matter: the voltage regulation. Voltage divider R4-D6 provides a stable reference voltage which is applied to the non-inverting input of the 741. The wiper of preset P1 is connected to the inverting input. If the output voltage rises, the potential at the inverting input also rises via the voltage divider consisting of R5, P1, and R6. The output of IC1 then becomes more negative and the current through T3 decreases. When the output voltages drops, for instance, because of a higher load, the reference voltage at pin 3 of the 741 is higher than that at pin 2. The output of the opamp becomes more positive and the current through T3 increases. In both cases, a new, stable equilibrium is reached quickly between the output voltage of the circuit as a whole and that of IC1.

This does not take the current limiter into consideration. If the voltage across R2, the current sensor, exceeds 0.6 . . . 0.7 V, T1 conducts. A current then flows from the output of IC1 to earth via R1 and the collector-emitter junction of T1. Transistor

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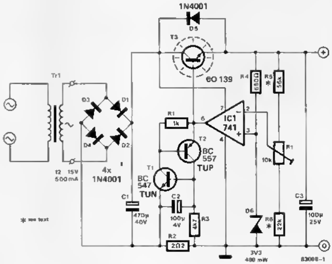
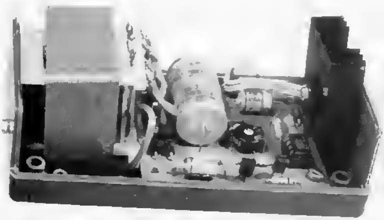


**Figure 1. The circuit diagram of the battery eliminator which provides both voltage stabilization and current limiting at a reasonable cost.**



T2, a p-n-p type, conducts because its base, due to the voltage drop across R1, is more negative than its emitter. A further current flows therefore into the base of T1 from the collector of T2 and both transistors continue conducting. That is the reason why this particular limiter has been called 'pseudo thyristor'.

What happens to T3 in this case? As its base current – which flows to earth via the pseudo thyristor – is pinched off, it changes state and the output voltage drops to zero. The output current of IC1 then becomes small and the current-limiter transistors remain in the conducting state. The eliminator is therefore adequately protected against overload and short-circuit conditions. To be sure, this simple circuit has neither an indicator to show that the current limiter has come into operation nor a reset to switch off this protection device. Therefore, if the output voltage 'dies', you have to pull the plug from the mains socket and reinsert it to make the eliminator operational again. The current limiter also provides protection against thermal overload, because the base-emitter voltage at which T1 starts to conduct decreases with rising temperature ($U_{BE} = -2$ mV/°C). This means that the limiter may also come into operation if at relatively high current the temperature inside the housing rises.

Table 1

| secondary voltage | R5 (kΩ) | P1 (kΩ) | R6 (kΩ) | Output voltage range (V) | |
|---|---|---|---|---|---|
| | | | | calculated | measured |
| 10 | 15 | 10 | 22 | 4.6 .. 7.0 | 4.3 .. 6.7 |
| 12 | 22 | 10 | 15 | 6.2 .. 10.3 | 6.0 . 10.6 |
| 15 | 56 | 10 | 22 | 9.1 .. 13.2 | 9.0 .. 14.6 |

All measurements at $I_{out}$ = 250 mA

**Table 1. The resistance values given here cover a total range of 4.3 . . . 14.6 V which should meet most demands.**

### Construction

As most of the components are mounted on a printed circuit board, construction is fairly simple. We have not made provision on the board for the transformer, so that the choice of this item remains reasonably flexible. Preset P1 can be replaced by a potentiometer to enable external adjustment of the output voltage.

Table 1 gives the values for R5, R6 and P1 for various transformer secondary voltages, and the corresponding output voltage ranges (both calculated and measured on our protoype). The maximum output current is about 250 . . . 300 mA but somewhat lower with rising temperatures as explained before.

**Parts list**

Resistors:

R1 = 1 k
R2 = 2Ω2, 0.5 W
R3 = 4k7
R4 = 680 Ω
R5 = 56 k see table 1
R6 = 22 k
P1 = preset 10 k linear

Capacitors:

(all electrolytic)
C1 = 470 µ/40 V
C2 = 100 µ/4 V
C3 = 100 µ/25 V

Semiconductors

T1 = BC 547
T2 = BC 557
T3 = BD 139
D1 . . . D5 = 1N4001
D6 = zener diode 3V3, 400 mW
IC1 = 741

Miscellaneous:

Heat sink for T3: about 37 mm high, 8.6°C/W
Mains transformer: secondary 10 . . . 15 V/ 500 mA
Case, plastic 120 x 65 x 65 mm

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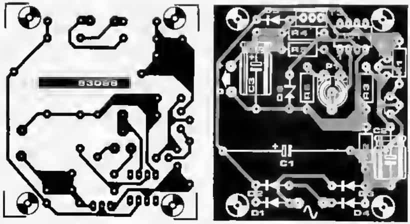

**Figure 2. The printed circuit board of the battery eliminator is designed to receive all components, except the mains transformer. The mirror image of the track layout is contained in the PC pages.**

**This transistor selector will enable you to determine the class — A, B, or C — into which a transistor falls. The class is defined by the d.c. current gain, $h_{FE}$, as follows: class A: $h_{FE}$ up to 200**

**class B: $h_{FE}$ 200 . . . 400**

**class C: $h_{FE}$ above 400**

**This is roughly the same classification as used by manufacturers on low-power transistors.**

# transistor selector

The classification A, B, or C, given by manufacturers in their data books does not always indicate exact values. Normally, the three classes are given minimum, maximum, and typical values, and therefore they overlap to some extent. It may sometimes be necessary to check the class printed on the transistor. Or it may be that you want to find a replacement in the 2N . . . series for a BC . . . type with an equivalent d.c. current gain. In such cases you will find this selector a very useful tool.

## The circuit diagrams

The selector can, of course, be used for both n-p-n and p-n-p transistors. For clarity, we have split the complete circuit diagram shown in figure 3 into two parts: figure 1 for n-p-n transistors and figure 2 for p-n-p types.

### n-p-n transistors

If a PP3 battery is used as power supply, the base current in the transistor under test amounts to about 10 µA. The collector voltage is then given by

$U_C = U_b - U_{R2} = U_b - I_C R2 = U_b - h_{FE} I_B R2$

where $U_C$ = d.c. collector voltage
$U_b$ = supply voltage = 9 V
$U_{R2}$ = voltage drop across resistor R2
$I_C$ = d.c. collector current
$I_B$ = d.c. base current = 10 µA
$h_{FE}$ = d.c. current gain

Substituting the known values into this formula, we obtain:

$$U_C = 9 - 0.015\ h_{FE} \text{ volts}$$

If we now substitute the 'turn over' values

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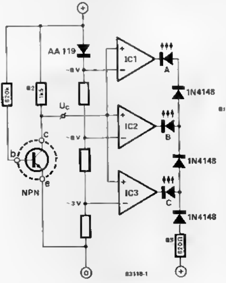

Figure 1. The circuit for checking n-p-n transistors. The coding of the LEDs corresponds to the usual classification of the d.c. current gain.

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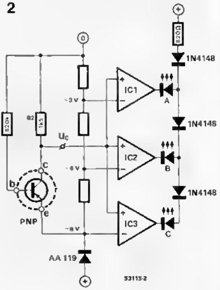

Figure 2. Compared with figure 1, the circuit for p-n-p transistors appears up-ended. The differences between the two are explained in the text.

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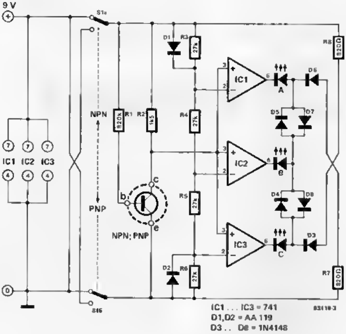

Figure 3. Combining the circuits of figures 1 and 2 yields that for the complete transistor selector. The only addition is switch S1.

of $h_{FE}$, we obtain values for $U_C$ of 6 V when $h_{FE} = 200$ and 3 V when $h_{FE} = 400$. In other words, the greater the d.c. current gain, the smaller the collector voltage. A moment's reflection will show why: the greater the d.c. current gain, the greater the collector current and resulting voltage drop across R2, and the smaller the voltage across the collector-emitter junction of the transistor being checked.

The collector voltage is applied to the non-inverting inputs of three comparators: opamps IC1 . . . IC3. The inverting inputs of these opamps are derived from a voltage divider, R4 . . . R6, across the supply voltage (R3 is, of course, short-circuited by diode D1). When $U_C$ is smaller than 3 V ($h_{FE} > 400$), the output of IC3 is low and LED 'C' lights. The outputs of the other two opamps are also low, but the anode voltage of LEDs 'A' and 'B' is too low for the LEDs to light. When $U_C$ is greater than 3 V, the voltage at the output of IC3 is nearly 9 V. No current then flows through LED 'C' and LED 'B' lights. When $U_C$ is greater than 6 V ($h_{FE} < 200$), the output of IC2 is nearly equal to $U_b$ and only the output of IC1 remains low so that LED 'A' lights.

The above reasoning depends upon a voltage drop across R8 which ensures just sufficient anode voltage for the lighted LED. It may be that owing to circuit tolerances in your particular case this is not entirely possible: the solution is then to increase R8 to, say, 1 kΩ.

### p-n-p transistors

The corresponding diagram for selecting p-n-p transistors is shown in figure 2. The arrangement of the LEDs for classes A, B, and C, remains as before. Now, however, because the supply voltage polarity has been reversed, a higher d.c. current gain will cause a higher collector voltage. The voltage applied to the comparators is, therefore, in this case not that across the collector-emitter junctinn, but that across R2. Otherwise the operation of the circuit is identical to that for n-p-n transistors.

### The complete circuit . . .

. . . is not so difficult to follow now. The sections for n-p-n and p-n-p transistors have been combined. The polarity of the supply voltage is reversed by means of a double-pole switch, S1. Diodes D1 . . . D3 and D6 ensure that the circuit operates satisfactorily whatever the position of S1. We have used germanium diodes in the D1 and D2 positions, as these have a smaller voltage drop than silicon types.

The selector may be constructed on a piece of VERO or other prototyping board: it is not critical. This board may then be fitted in a small case, together with the battery. The case should, of course, be provided with three connecting clips for the transistor to be checked. ◼

**Although a cassette recorder remains one of the best value-for-money systems available, an audio cassette is a far from ideal memory for computers. Like many others before them, the producers of a popular West German TV computer programme hit this snag and approached the Elektor laboratories for a solution. This resulted in the FSKleaner, a useful device for all applications where a 'messy' FSK signal must be processed.**

# FSKleaner

## cosmetics for FSK signals

Basicode is a standard audio code which enables BASIC programs written on one micro-computer to be used on another, provided this has a Basicode interface. It is transmitted as a TV or radio signal.
Programs are broadcast (at the time of going to press) every Sunday from 17.10 . . . 17.45 GMT (summers) or 18.10 . . . 18.45 GMT (winters) on 747 kHz by NOS (Nederlandse Omroep Stichting = Dutch Broadcasting Foundation)

Figure 1 shows the principle of the FSKleaner in block form. The FSK signal containing the data is taken from the headphone output of a radio receiver or cassette recorder and applied to the FSKleaner input. The processed output of the FSKleaner can then be fed into a second cassette recorder or loaded into a computer directly or via a Basicode interface.

You may, of course, at first sight query whether an FSKleaner, and indeed a Basicode interface, is really required. All we can say is: 'In our opinion it is!' If, for instance, you record from the radio or from the umpteenth copy of a cassette, it is more than likely that the received data are affected by white noise. The signal then looks something like that shown in photo 1 (top) or even worse. Our FSKleaner will, in these cases, ensure a 'clean' signal as shown in photo 1 (bottom).

Another problem is the varying level of the FSK signal. We have assumed that the output of the radio receiver or recorder, depending upon the setting of the volume control, may vary between 450 $\mathrm{mV_{eff}}$ and 4 $\mathrm{V_{eff}}$. The level of the FSK signal must, of course, be sufficient to be compatible with the input requirements of the computer.

Both problems are taken care of in the FSKleaner: a band-pass filter removes most of the white noise, while a compressor ensures that the output remains reasonably constant for variations in input level of about 20 dB.

Yet other problems may arise, however: if the FSK signal output of the FSKleaner is still not 100 per cent compatible with the computer, a Basicode interface (see article elsewhere in this issue) between the FSKleaner and the computer will put matters right.

### Bits from the recorder

The cassette recorder is, and is likely to remain for some time, the best-value-for-money general memory available to the amateur programmer. The ones and zeros are converted to a.f. signals which can readily be recorded on magnetic tape. In Basicode (see article elsewhere in this issue) two tones are used: the '0' is represented by one full cycle of 1200 Hz, the '1' by two full cycles of 2400 Hz. At the Basicode's conversion speed of 1200 baud (= bits/sec), for instance, a signal as shown in photo 1 is obtained.

FSK (Frequency Shift Keying) is the name given to the transmission of logic information by means of switching between two distinct, different frequencies representing the zeros and ones respectively.

Unfortunately, neither the 'logic' frequencies nor the baud rate have been standardized, so that this information has to be gleaned from your own computer handbook. This is of little consequence here as we merely want to explain what the FSK signal is all about.

### The circuit (figure 2)

The input resistance of the FSKleaner is determined by resistor R2. A low value has been chosen for this component to ensure good matching with a low-ohmic headphone output. Then follows a band-pass filter, L1 . . . L3/C1 . . . C5, which has an insertion loss of about 6 dB. The signal is then applied to amplifier A1 which has an amplification of some 40 dB, sufficient to raise even small signals to an acceptable level. In case the output of A1 is too high, it can be attenuated by preset P1 to match the input level requirement of the computer

1

Photo 1. Example of an FSK signal in Basicode. At the top: the distorted signal. At the bottom: the output signal of the FSKleaner. Coordinates: horizontal 500 μs/division; vertical — top — 100 mV/division, bottom 2 V/division.

2

Photo 2. The operation of the compressor is shown very clearly. The amplitude of the 1800 Hz input signal increases with time (top). The compressor controls the input to the final amplifier so that the output of the FSKleaner is nearly constant (bottom). Coordinates: top and bottom, 2 V/division (vertical), 1 s/division (horizontal).

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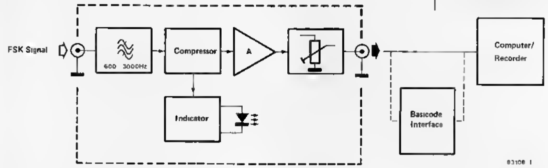

Figure 1. Block diagram of the FSKleaner showing how the received data are transferred to the computer or recorder. The optional Basicode interface is described elsewhere in this issue.

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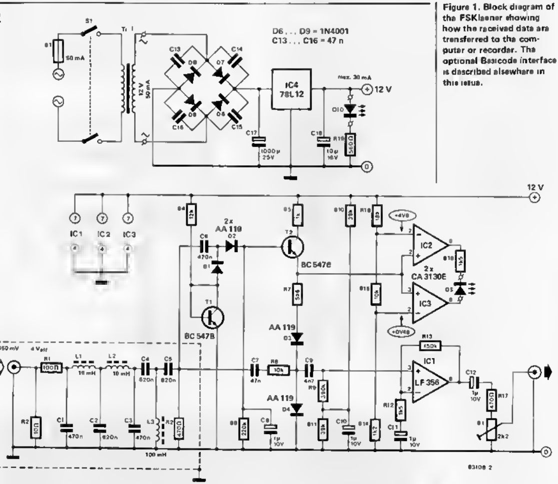

Figure 2. The circuit diagram of the FSKleaner consists essentially of a band-pass filter, compressor and indicator stage, and output amplifier A1. When the input level lies between 0.45 and 4.0 V, an LED, D5, lights to indicate that the FSKleaner output is fully compatible with the input requirements of the computer.

or cassette recorder. The non-inverting (+) input of A1 is biased by R9/R11/C10, so that an asymmetrical 12 V power supply will suffice. So much for the direct signal path.

### The compressor

A vital part of the circuit is formed by the compressor which, in a manner of speaking, indirectly passes part of the signal and yet affects it directly. How? This can be seen from photo 2: the triangle at the top shows a sinusoidal 1800 Hz tone the amplitude of which increases gradually with time. The effect of the compressor can be seen at the bottom of photo 2: above a certain level of input signal, the compressor ensures that the output of the FSKleaner remains virtually constant.

The input to the compressor section is taken from across R3 via C6 to diode D2 where it is rectified. In this way a control voltage is obtained for transistor T2. The collector current of T2, and consequently the and D4 to earth, is therefore dependent upon the signal strength. The higher the current, the smaller the impedance of the diodes, and the greater the attenuation of the input voltage to A1. Simple but effective!

The voltage developed across R4 and transistor T1 is used to bias diodes D1 and D2. T1 is connected as a diode which ensures that even small input voltages are rectified. The decay time of the control voltage is determined by the time constant R6·C8. The rise time, determined by tha time constant R3·C8, is very short so that the circuit is not unnecessarily overdriven. Finally, a comparator consisting of amplifiers A2 and A3 gives an indication of the operation of the compressor. When the emitter voltage of T2 lies between 0.48 V and 4.6 V, LED D5 lights to indicate that the input level to the FSKleaner lies in the preferred range. The LED can thus be considered an 'all systems go' indicator.

## Construction and use

The FSKleaner is built on the printed circuit board shown in figure 3. This board also houses the mains power supply. If you don't have a transformer with correctly spaced terminals for the board, drill new holes – there's plenty of space, provided, of course, that the transformer is not too large for the board.

The band-pass filter at the input of the FSKleaner must be isolated from the rest of the circuit by a suitable tin screen which is soldered to two pins in positions shown in figure 3: the screen is indicated by the broken lines at the left.

Finally, mount the entire board in a (preferably) earthed case so that the rest of the circuit is also screened from external noise sources. We hasten to erase the impression that we're dealing with a critical construction: we merely feel that it would be a pity to undo the care taken to remove most noise from the circuit by careless mechanical construction.

We now come full circle by referring once more to figure 1. The FSKleaner is normally fitted between the headphone output of

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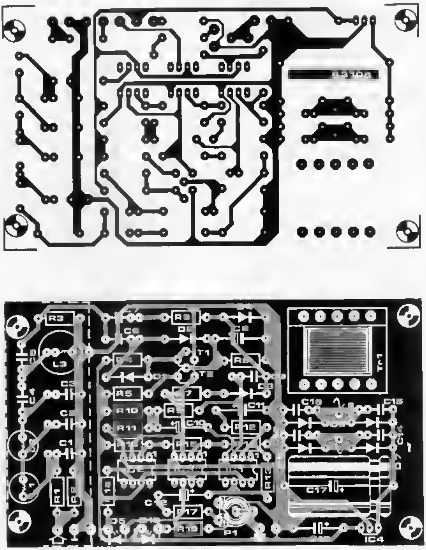

Figure 3. Layout and track pattern of the printed circuit board for the FSKleaner. The band-pass filter is screened with a thin housing of tin. The connections to and from the mains transformer must be wired at the foil side of the board.

**Parts list**

Resistors:

R1 = 100 Ω
R2 = 10 Ω
R3,R17 = 470 Ω
R4 = 12 k
R5 = 1 k
R6 = 220 k
R7 = 5k6
R8,R15 = 10 k
R9 = 390 k
R10,R11 = 39 k
R12,R18 = 1k5
R13 = 150 k
R14 = 1k2
R16 = 18 k
R19 = 560 Ω
P1 = 2k2 preset

Capacitors:

C1,C3,C6 = 470 n
C2,C4,C5 = 820 n
C7,C13 . . . C16 = 47 n
C8,C10 . . C12 =
1 µ/10 V
C9 = 4n7
C17 = 1000 µ/25 V
C18 = 10 µ/16 V

Inductors:

L1,L2 = 10 mH
L3 = 100 mH

Semiconductors:

D1 . . . D4 = AA 119
D5 = LED red ('high efficiency')
D6 . . . D9 = 1N4001
D10 = LED red
T1,T2 = BC 547B
IC1 = LF 356
IC2,IC3 = CA 3130E
IC4 = 78L12

Miscellaneous:

F1 = miniature fuse, 50 mA, with panel type holder
Tr = mains transformer, secondary 12 V/50 mA
S1 = mains switch
Metal case
Panel type input and output terminals

a radio receiver or tape recorder and the 'cassette' input of a computer or 'line' input of a second recorder. You therefore have to make up interconnecting cables as required.

If the recorder is not provided with automatic recording level, set the recording level control to maximum and adjust P1 on the FSKleaner for the correct output level during a test recording. If appropriate instruments are available, set the output level to 0 dB. Where automatic recording level is available, merely set P1 to maximum.

If it appears that the output signal of the FSKleaner is not entirely free from noise, a Basicode interface should be used between the FSKleaner and computer or recorder as shown in figure 1.

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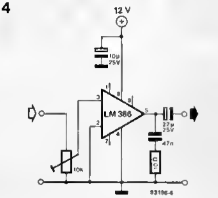


**Figure 4. Circuit diagram of the additional pre-amplifier required for use with cassette decks. The amplifier requires an additional 12 V stabilized supply at about 200 mA.**

The Basicode interface needs a supply voltage of 5 V to ensure that its output level is absolutely right for driving the computer. If this supply is not available from the computer, tap off 12 V from C18 on the FSKleaner board and apply this to a 5 V voltage regulator, for instance, a 78LS05. The 5 V supply can also be obtained by taking 12 V from across C18 and applying it across a 4V7 zener diode in series with a dropping resistor.

If during reception of the FSK signal the Basicode interface is correctly set up, no problems whatsoever should be encountered with loading the computer. The set-up was tested in our own computer laboratory for long periods and proved highly satisfactory.

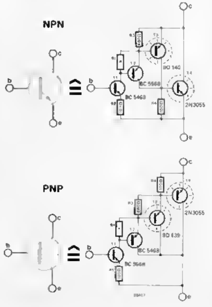
Finally, if the data are taken from a cassette recorder without power amplifier, a pre-amplifier has to be provided between the recorder and FSKleaner owing to the low input impedance of the FSKleaner. Resistor R2 must then be removed from the FSKleaner and the pre-amplifier shown in figure 4 connected to the input. The pre-amplifier gives an amplification of about 26 dB, so that sensitivity and input impedance are increased. The pre-amplifier is most easily constructed on a small VERO board. The pre-amplifier requires an additional (not necessarily separate) supply of 12 V at 200 mA: this can, of course, be provided by a larger mains transformer (250 mA) and a suitable stabilizer (for instance, a type 78M12). ◼

# useful tip...

## . . . 2N3055 super Darlington pair

There is often a need for a transistor with somewhat higher than normal specifications for the collector voltage and current, maximum dissipation, and current gain. This can successfully be achieved by using a combination of complementary transistors connected to work as a single n-p-n or p-n-p transistor.

In the circuits shown here four transistors are used. By carefully choosing the values of R1, R3, and R4, the overall current gain will be of the order of one and a half million! The circuit characteristics are virtually the same as those of a 2N3055, so that a maximum of 115 W can be dissipated at 25°C, while the maximum collector voltage and current are 60 V and 15 A respectively. The saturation voltage of the n-p-n combination is about 2 V, that of the p-n-p combination around 3 V. ◼



**Many readers have asked in their letters how the main board of the Junior Computer can be used without an interface to program EPROMs, or how the JC can be used as a simple independent EPROMmer. Two readers, in particular, sent in a proposal about how this could be done, and, with their contributions, we reveal yet another facet of the 'Junior' Computer.**

M. Seiler and
R. Kisse

# EPROMmer using the Junior Computer

## programming 2716 EPROMs with the Junior Computer

It is now becoming very commonplace to see EPROMs being used for more and more different applications. In the most common current format (2716 = 2 k bytes), these components are used to store not only programs but also look-up tables resulting from code conversions or other forms of character generation; this was seen, for example, in some more recent articles on ator with lower case letters), or the new ASCII keyboard (code version), and, of course, there are many more examples. For really convenient use it is indispensable to have a programmer which makes it easy to transfer data stored in RAM into the EPROM.

### A compromise

Combining the main board of the Junior Computer with the programmer published in January 1982, page 1-26, appears to offer an interesting compromise needing only slight changes to the address decoding. Apart from two extra resistors, there are no new components needed. Quite the opposite, in fact, some of the components on the original EPROM programmer have to be removed! Those in question are R1 . . . R4, S3 . . . S6 and IC5. If you are reluctant to remove this IC (74LS85), the same effect can be achieved by breaking the connections between its pin 6 and pin 5 of IC10 (N7) and also pins 2 and 12 of IC8 (FF1/FF2).

The original address decoding circuitry is disabled completely and replaced by the circuit at the top of figure 1. This combination of two logic gates supplies a single Chip Select signal (active with a high logic level) from the two input signals (K) produced by IC6 on the main board of the Junior Computer.

The inputs to the EXOR gate are pins 4 and 5 of IC12 and pin 6 is the output. Both inputs of the AND gate, pins 1 and 2 of IC9, have to be fitted with polarizing resistors connected to the positive supply. Then two of the eight possible connections from table 1 must be made; the actual ones to be used depend on the address decoding desired. This EPROMmer can only be used for 2716 EPROMs as programming 2732s is something quite different.

Figure 2 suggests how the two cards could be connected using two 64-pin female connectors. As this sketch indicates, it is strongly recommended that the connecting wires be insulated.

Any further information required in connection with this project can be found in the article mentioned before or in the Junior Computer books. ◾

Table 1

| Address | Decoding | |
|---|---|---|
| 0800 – 0FFF | K2·28c | K3·18c |
| 0C00 – 13FF | K3·18c | K4·17a |
| 1000 – 17FF | K4·17a | K5·15a |
| 1400 – 1BFF | K5·15a | K6·15c |

**Table 1. Two K signals are needed to address a 2 k EPROM. The links used will depend on each individual user's requirements.**

EPROMmer using the Junior Computer
elektor october 1983

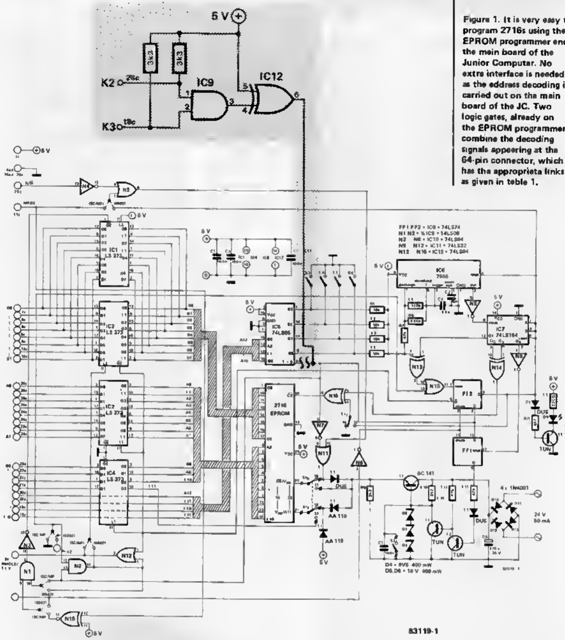


**Figure 1. It is very easy to program 2716s using the EPROM programmer and the main board of the Junior Computer. No extra interface is needed as the address decoding is carried out on the main board of the JC. Two logic gates, already on the EPROM programmer, combine the decoding signals appearing at the 64-pin connector, which has the appropriate links as given in table 1.**

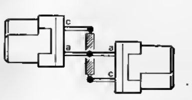


**Figure 2. This is a suggestion of how the two cards could be connected with 64-pin connectors. Make a 'dry run' before soldering anything and be sure that the connectors are turned the right way.**

# applikator

## A (re)new(ed) eight bitter: the 65C02

Even though it belongs to the same family, the 65C02 from Rockwell (and Synertek) is in some ways completely different to its older, popular brother, the 6502, which is used in many personal computers, our own Junior Computer among them. However the new IC is based on the old one and part of the reason why it is so long in coming is that the designers wanted not only to achieve some new features, but also to avoid losing any of the capabilities of the old chip. As yet none of these 65C02s have become available so we have not been able to experiment on further expanding the Junior but that is no reason not to describe the IC as we hope it will soon become available.

We will start by describing the most important characteristics of the 65C02 in brief.

*One*. The 65C02 is a CMOS chip. This means that the current consumption and the power dissipation are considerably less than in the case of the 6502. The reduction is from 575 mW (6502) to 20 mW (1 MHz version) power dissipation! In the 2 MHz version the dissipation doubles to 40 mW, while for the 3 and 4 MHz versions which will also be available the figures are 60 mW and 80 mW respectively. The minimum clock frequency is 100 kHz for the 6502 and 0 Hz for the 65C02 and, in this 'stand by mode', the 65C02 dissipates just 10 µW. Other, CMOS related, advantages are the appropriately high tolerance in the supply voltage (5 V ± 20% versus 5 V ± 10%) and the improved noise margin (logic zero: 0.8 V instead of 0.4 V). Furthermore the inputs and outputs are still completely TTL compatible.

*Two*. There are versions (Rockwell 65C102 and 65C112) with interesting signal connections for applications in systems requiring more than one microprocessor. If the BE (Bus Enable) input is made '0' the µP is decoupled (three state) from the data bus, the address bus and the R/W line. It is therefore possible to use the related memory (temporarily) for another intelligent chip. However, DMA (Direct Memory Addressing) is undesirable while an instruction is being processed whereby memory is read, data is processed and rewritten (read-modify-write). These instructions are: ROR, ROL, ASL and LSR (with the exception of accumulator addressing), DEC, INC, and the new instructions RMB, SMB, TRB, and TSB. While these instructions are being carried out the ML (Memory Lock) output is '0' and some gates could be used to make BE '0'.

*Three*. The reset input RES is equipped with a schmitt trigger. This makes it completely straightforward to use an RC network to automatically start a system with a 65C02 (power on reset). Another novelty is that the D flag is also reset when the reset instruction is used, so the CLD instruction occurs in the reset routine.

Up till now we have been describing the more important hardware orientated improvements. It is also good to see that, through improved 'bus management', the memory in the 2 MHz version can be 30 ns slower than in the case of the 6502 (maximum access time is 340 ns instead of 310 ns), but that is a software improvement, of course.

*Four*. All the software improvements are given in table 1, which has the same format as Appendix 2 of the Junior Computer book 1. This table shows that there are some new instructions, and thus new mnemonics, and there are also some existing instructions that can be carried out by more addressing modes (including some new ones).

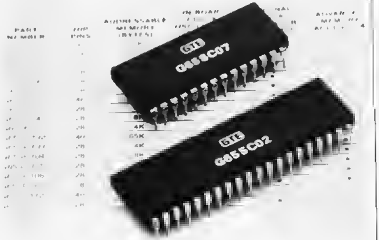
*Five*. The INA and DEA instructions are a handy alternative for:
CLC and ADCIM 01 (INA), and
SEC and SBCIM 01 (DEA).
There is also something similar for making a memory location 00. Formerly that was done with LDAIM 00 followed by STA; now all that is needed is STZ.

*Six*. The BRA instruction (BRanch Always) can be used instead of a JMP, as long as the jump is not too large. In relocatable programs we can do without (absolute) JMPs completely.

*Seven*. Suppose A, X and Y have to be saved on the stack at the beginning of a subroutine or interrupt routine. A look at table 2 will quickly show the advantages to be gained by enabling X and Y to be directly pulled and pushed. This saves both bytes and time.

*Eight*. A JMP (IND) instruction already existed, but now there is also a JMP (IND,X). The difference between both instructions is illustrated in figure 1. It sometimes happens that at a particular point in a program a choice has to be made from a number of jump addresses. Think of an assembler or disassembler, where the jump address is tied up with the addressing mode (thirteen possibilities for the 6502). Assuming the choice depends on the value of X, figure 1a shows everything that must happen in the case of the JMP (IND). First the operand address INAD of the JMP (IND) must be loaded (in RAM!) via X-indexed addressing from the 'jump table' TAB. Only then is the jump carried out. Comparing this with figure 1b shows that the indirect jump to TAB occurs immediately, based on the same value of X.

*Nine*. The instructions ADC, SBC, CMP, AND, OR, EOR, LDA and STA can now be executed in Indirect addressing mode on condition that



the operand address (= indirect address) lies in page zero. This means that no Y index ((IND), Y) is now needed to specify page 0 for an effective address.

Table 1

| mnemonics and description | addressing mode(s) | hex opcode | number of clock pulses (N) | number of bytes | flags affected |
|---|---|---|---|---|---|
| **ORA**<br>"OR" memory<br>with accumulator<br>A∪M→A | (IND) (5) | 12 | 5 | 2 | N·—Z· |
| **SBC**<br>subtract memory<br>from accumulator<br>with borrow<br>A·M·C̄→A (3) | (IND) (6) | F2 | 5 (4) | 2 | N·—ZC |
| **STA**<br>store accumulator<br>in memory<br>A→M | (IND) (5) | 92 | 5 | 2 | — |
| **BIT**<br>test bits in<br>memory: A∩M<br>M7→N, M6→V | IMM<br>Z, X<br>ABS, X | 89<br>34<br>3C | 2<br>4<br>4 (1) | 2<br>2<br>3 | M7M6—Z· |
| **JMP**<br>jump to new<br>location | (IND), X (6) | 7C | 6 | 3 | — |
| **TRB**<br>test & reset<br>memory bits with<br>accumulator<br>Ā∩M→M<br>M7→N; M6→V | ABS<br>Z | 1C<br>14 | 6<br>5 | 3<br>2 | M7M6—Z· |
| **TSB**<br>test & set<br>memory bits with<br>accumulator<br>A∪M→M<br>M7→N, M6→V | ABS<br>Z | 0C<br>04 | 6<br>5 | 3<br>2 | M7M6—Z· |
| **BBR** (7) (8)<br>branch on: | | | | | — |
| bit M0 = 0 (BBR0) | Z & REL | 0F | 5 (2) | 3 | |
| bit M1 = 0 (BBR1) | Z & REL | 1F | 5 (2) | 3 | |
| bit M2 = 0 (BBR2) | Z & REL | 2F | 5 (2) | 3 | |
| bit M3 = 0 (BBR3) | Z & REL | 3F | 5 (2) | 3 | |
| bit M4 = 0 (BBR4) | Z & REL | 4F | 5 (2) | 3 | |
| bit M5 = 0 (BBR5) | Z & REL | 5F | 5 (2) | 3 | |
| bit M6 = 0 (BBR6) | Z & REL | 6F | 5 (2) | 3 | |
| bit M7 = 0 (BBR7) | Z & REL | 7F | 5 (2) | 3 | |
| **BBS** (7) (8)<br>branch on: | | | | | — |
| bit M0 = 1 (BBS0) | Z & REL | 8F | 5 (2) | 3 | |
| bit M1 = 1 (BBS1) | Z & REL | 9F | 5 (2) | 3 | |
| bit M2 = 1 (BBS2) | Z & REL | AF | 5 (2) | 3 | |
| bit M3 = 1 (BBS3) | Z & REL | BF | 5 (2) | 3 | |
| bit M4 = 1 (BBS4) | Z & REL | CF | 5 (2) | 3 | |
| bit M5 = 1 (BBS5) | Z & REL | DF | 5 (2) | 3 | |
| bit M6 = 1 (BBS6) | Z & REL | EF | 5 (2) | 3 | |
| bit M7 = 1 (BBS7) | Z & REL | FF | 5 (2) | 3 | |
| **RMB** (7)<br>reset memory bit: | | | | | — |
| M0 (RMB0) | Z | 07 | 5 | 2 | |
| M1 (RMB1) | Z | 17 | 5 | 2 | |
| M2 (RMB2) | Z | 27 | 5 | 2 | |
| M3 (RMB3) | Z | 37 | 5 | 2 | |
| M4 (RMB4) | Z | 47 | 5 | 2 | |
| M5 (RMB5) | Z | 57 | 5 | 2 | |
| M6 (RMB6) | Z | 67 | 5 | 2 | |
| M7 (RMB7) | Z | 77 | 5 | 2 | |

**Notes**

(1) Add to N1 if a page size is exceeded.

(2) Add to N1 if the jump is to a location on the same page; add to N2 if the jump is to a location on another page.

(3) Borrow = not-carry (C).

(4) Add to N1 for decimal calculations. This applies also for existing addressing modes.

(5) (IND): for an address on page 0 in which the right hand byte consists of the effective address, the second byte = ADL; the left byte of the effective address is located in the next highest address on page 0.

(6) (IND,X): for the 16-bit number, formed from the second (L) and third (H) bytes of the instruction, the contents of the X register is summed. This sum is the address containing the right hand byte of the effective address; the left hand byte of the effective address is in the next highest address.

(7) Rockwell types R65C02, R65C102 and R65C112.

(8) First byte: opcode;
second byte ADL of address on page 0;
third byte: offset.

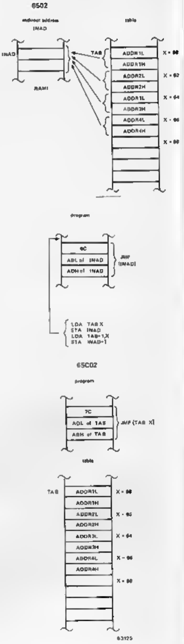
*Literature*
*Rockwell R 65C00 CMOS Microprocessor System data sheet.*
*Note: There is also a revised version with 'debugging'.*
*Synertek SY 65C00 CMOS 8-bit Microprosessor Family data sheet.*
*GTE data sheet G 65CXX series and G65SC1XX series*
*Junior Computer book 1.*

| | | | | | |
|---|---|---|---|---|---|
| **SMB (7)**<br>set memory bit: | | | | | —— |
| M0 (SMB0) | Z | 87 | 5 | 2 | |
| M1 (SMB1) | Z | 97 | 5 | 2 | |
| M2 (SMB2) | Z | A7 | 5 | 2 | |
| M3 (SMB3) | Z | B7 | 5 | 2 | |
| M4 (SMB4) | Z | C7 | 5 | 2 | |
| M5 (SMB5) | Z | D7 | 5 | 2 | |
| M6 (SMB6) | Z | E7 | 5 | 2 | |
| M7 (SMB7) | Z | F7 | 5 | 2 | |
| **PHX**<br>push X-register on stack<br>X↓ S-1→S | IMP | DA | 3 | 1 | —— |
| **PHY**<br>push Y-register on stack<br>Y↓ S-1→S | IMP | 5A | 3 | 1 | —— |
| **PLX**<br>pull X-register from stack<br>X↑ S+1→S | IMP | FA | 4 | 1 | —— |
| **PLY**<br>pull Y-register from stack<br>Y↑ S+1→S | IMP | 7A | 4 | 1 | —— |
| **STZ**<br>store zero in memory<br>0→M | ABS | 9C | 4 | 3 | —— |
| | Z | 64 | 3 | 2 | |
| | Z, X | 74 | 4 | 2 | |
| | ABS, X | 9E | 5 | 3 | |
| **DEC (DEA)**<br>decrement accumulator by one<br>A-1→A | A | 3A | 2 | 1 | N-----Z- |
| **INC (INA)**<br>increment accumulator by one<br>A+1→A | A | 1A | 2 | 1 | N-----Z- |
| **BRA**<br>branch relative always (2) | REL | 80 | 2 | 2 | —— |
| **ADC**<br>add memory to accumulator with carry<br>A+M+C→A | (IND) (5) | 72 | 5 (4) | 2 | NV----ZC |
| **AND**<br>"AND" memory with accumulator<br>A∩M→A | (IND) (5) | 32 | 5 | 2 | N-----Z- |
| **CMP**<br>compare memory and accumulator<br>A-M | (IND) (5) | D2 | 5 | 2 | N-----ZC |
| **EOR**<br>"EXclusive OR" memory with accumulator<br>A ⩒ | (IND) (5) | 52 | 5 | 2 | N-----Z- |
| **EOR**<br>"EXclusive OR" memory with accumulator<br>A ⩒ M→A | (IND) (5) | 52 | 5 | 2 | N-----Z |
| **LDA**<br>load accumulator with memory<br>M→A | (IND) (5) | B2 | 5 | 2 | N-----Z- |

Table 2

| old 6502 | | number of bytes | N | new 65C02 | | number of bytes | N |
|---|---|---|---|---|---|---|---|
| PHA | A↓ | 1 | 3 | PHA | A↓ | 1 | 3 |
| TXA | | 1 | 2 | PHX | X↓ | 1 | 3 |
| PHA | X↓ | 1 | 3 | PHY | Y↓ | 1 | 3 |
| TYA | | 1 | 2 | | | | |
| PHA | Y↓ | 1 | 3 | | | | |
| PLA | | 1 | 4 | | | | |
| TAY | Y↑ | 1 | 2 | | | | |
| PLA | | 1 | 4 | PLY | Y↑ | 1 | 4 |
| TAX | X↑ | 1 | 2 | PLX | X↑ | 1 | 4 |
| PLA | A↑ | 1 | 4 | PLA | A↑ | 1 | 4 |
| | | ←— 10 | —→ 29 | | | ←— 6 | —→ 21 |

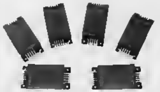
bytes 10 → 6 = – 40%
time 29 → 21 = – 27.6%



## Large alphanumeric LED displays

Regisbrook Ltd have added another new line to their impressive range of specialist opto-electronic components by acquiring the marketing rights to the German-built Elcos MA 35 large-scale alphanumeric character displays.

The highly flexible LED displays have a character height of 31 mm, making them ideal for large public signs or point-of-sale advertising applications. MA 35 displays feature a 5 x 7 dot matrix, and are designed for tight side-to-side stacking to provide an uninterrupted message, visible through a wide viewing angle of 140 degrees.



The devices are available in red, yellow or green and are fully compatible with a wide range of drivers and power supplies. They are designed for simple solder connection, and are drilled for mounting.

By adding the MA 35 large-scale displays to their existing stock lines, Regisbrook complete a product portfolio which can effectively cater for any display application from micro-circuit indicators up to massive public information systems.

*Regisbrook Limited,*
*Studio House,*
*215 Kings Road,*
*Reading RG1 4LS*
*Berkshire*
*Telephone: 0734 665955*

(2768 M)

## 'The smartmouth speech synthesiser'

Smartmouth is a small, self-contained unit that sits alongside the computer. It has its own loudspeaker, as well as an auxiliary audio output socket. No specialist installation is required and it does not require soldering. A single connection to the 'User Port' gives the unit all its data and power requirements. It comes complete with 'demo' and development programs on cassette and full software instructions.

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Due to its unusually low memory requirements, typically using only 4 – 8 bytes per word, it is now possible to incorporate speech into existing programs without using up massive amounts of memory. Alternatively, a dedicated 'speech' program is able to contain several thousand words.

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The instructions supplied explain how to string together individual speech sounds, (Allophones) to produce your words. As there are only 64 Allophones to choose from, words can be assembled with both ease and speed. (Examples chosen from a wide variety of words are listed.)

The Smartmouth is available exclusively from Technomatic, at £37.00 + £2.00 p&p + VAT and has a full year guarantee.

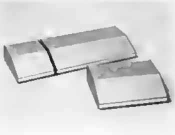
*Technomatic Ltd.,*
*17 Burnley Road,*
*London, NW10 1ED.*
*Telephone: 01452 1500*

(2773 M)

## Desk-top cases

A new, lightweight case primarily intended for desk-top applications such as intercoms and controls is now available from West Hyde.

Attractively styled with smooth contours, the Empress case is manufactured from 2 mm aluminium and has a black and natural anodised finish. It has a sloping top surface at the front which places switches, knobs and meters at an ideal angle.



The case is available in four sizes, all with a common profile, so that two or more can be placed side by side on a worktop to form attractive 'suites'.

The Empress case is supplied complete with self-adhesive feet and is available ex-stock from West Hyde.

*West Hyde Developments Ltd.,*
*Unit 9 Park Street Industrial Estate,*
*Aylesbury,*
*Bucks. HP20 1ET.*
*Telephone: 0296 20441*

(2776 M)

## LCD thermometer

A hand held LCD thermometer which costs under £25 including VAT, delivery, battery and post and packing, is being marketed by Hero Electronics.

The price of £24.95 in one off quantities means this precision thermometer can be used in many domestic as well as industrial applications and represents a major breakthrough in pricing.

The thermometer incorporates a high definition LCD display with a measuring range of 0°C to 99.9°C which can be read to an accuracy 0.1°C. The sensor and lead clip neatly into the case and can be easily detached. A hinge support, and fixing recess enable the portable instrument to be converted for wall, or table top mounting.

The thermometer is currently being used by the electronics industry to measure component temperatures. It has a wide range of industrial uses wherever temperature measurement of air, liquids or body surfaces is required. In the domestic field uses envisaged are in: photography, greenhouses, wine and beer making and in checking the flow and return temperatures in domestic heating.

*Hero Electronics Limited,*
*Dunstable Street,*
*Ampthill,*
*Bedfordshire MK45 2JS.*
*Telephone: 0525 405015*

(2775 M)

# Junior-Paperware

(in 2 vols.)

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Junior paperware 1 contains the modifications of the PM/PME EPROM and the source listings and hex-dump of the software cruncher and puncher; Junior paperware 2 gives the source listing of the bootstrap loader for Ohio Scientific Floppys and the hex-dump of the EPROM.

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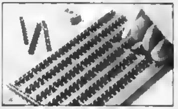

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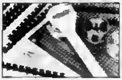

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