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The ARRL Experimenters' Exchange

ARRL Board Actions Support Packet Radio

The ARRL Board of Directors, at their October 25-26 meeting, passed a number of motions that are important to the development of packet radio. Probably the most significant action was the Board's approval of the AX.25 Amateur Packet Radio Link-Layer Protocol document which was agreed upon by the ARRL Ad Hoc Committee on Amateur Radio Digital Communication in September. Printed copies of the protocol will be available from ARRL Hq. in the near future for $8.00 U.S., $9 Canada and elsewhere.

Approval of the AX.25 link-layer protocol is the culmination of several years' work by individual volunteers, packet-radio clubs and the ARRL digital committee. It is not just a piece of paper, but the protocol has been validated by nearly two years of field usage in different terminal-node controllers (TNCs) such as designed by Tucson Amateur Packet Radio (TAPR), Vancouver Amateur Digital Communications Group (VADCG), and other commercial products.

Look for an article on this protocol in the December 1984 issue of QST.

The ARRL Board gave the go-ahead for the final drafting of a petition asking the FCC to permit unattended automatic control of digital communications on frequencies above 30 MHz. Present FCC rules permit unattended automatic control only for three specified types of operation: repeater, beacon, and auxiliary; each having their own limitations in the rules.

The Board commended the work of the digital committee, thus far, and urged the committee to press on with its development of network and transport protocols.

The Board also approved an ARRL Packet-Radio Development Program that outlines ways that the League can support and complement the work of individual experimenters and packet-radio clubs. As an example: Look for more packet-radio visibility in QST.

For a detailed report of all October Board meeting actions, check the QST "Moved and Seconded" column.

Fourth ARRL Digital Communications Conference Call for Papers

The American Radio Relay League will hold its Fourth Amateur Radio Computer Networking Conference on March 30, 1985 in San Francisco, CA. The conference will be in cooperation with the West Coast Computer Faire being held March 30 through April 2.

The deadline for receipt of camera-ready papers is March 1, 1985. All papers should be mailed to Marian S. Anderson, WB1FSB, American Radio Relay League, 225 Main Street, Newington, CT 06111. If you plan to present a paper, please request an author's kit and identify the title of your paper immediately. Proceedings will be sold at the conference and by mail from ARRL Hq.

Technical papers are invited on all aspects of amateur packet radio and other forms of Amateur Radio digital communications via terrestrial, ionospheric, meteor-scatter and satellite media including AMSAT-OSCAR 10 and PACSAT. Topics may include network and system architecture, proposed standards, hardware, software, protocols, modulation and encoding schemes, applications, and practical experience.

Cellular (Amateur) Radio

Any of you out there in radio land want to try your hand at writing a tutorial on cellular radiotelephone technology and how it might be applied to Amateur Radio? Does cellular technology offer a way of overcoming saturation on 2-meter FM? Is it the way to handle wide-area repeating? Should amateurs be thinking about a cellular approach to some of the UHF bands?

Never Mind!

CW Communications/Peterborough has announced that it will retain 73: Amateur Radio's Technical Journal. Earlier this summer, they had announced plans to consider selling the monthly magazine, despite its profitability, because of 73's noncomputer-related content.

Glad you're going to stick around! — W4RI

Correspondence

In This Issue

The second half of a two-part article on liquid-crystal displays begins on page 3. It is a reprint from the IEE PROCEEDINGS-I issue on Molecular Electronics. Part I appeared in the October 1984 issue of QEX. The author, I. A. Shanks, B.SC., Ph.D., C.Eng., M.I.E.E., was formerly with the Royal Signals and Radar Establishment, Malvern, Worcester, England, and is now with Unilever Research, Colworth Laboratory, Colworth House, Sharnbrook, Bedford MK44 1LQ, England.

BITS (p. 9) takes a look at three Conferences being held around the country. On page 8, Clint Bowman, W9GLW, shares his notes on building, "An Experimental Two-Meter Converter with Gallium-Arsenide Transistors."

You might have noticed a change in the QEX subscription card. Elsewhere by Surface Mail has been deleted. If you were a subscriber using this service, your QEX is still arriving in the same manner. For future renewals, however, foreign subscriptions will have to be sent via Air Mail.

During the next year, a special QEX promotional mailing will be held. A certain number of issues will be mailed each month to Extra class licensees who are also ARRL members. We are trying not to duplicate anyone's mailing, however, errors happen. Should you receive a sample copy in your mail, please pass it along to a friend or take it to your club meeting.

This issue of QEX features a different type of "Correspondence" column. Approximately four thousand calls and letters are received each year by the Technical Information Specialist (TIS) at ARRL Hq. Many of these questions are beyond the scope of TIS because they deal with equipment modifications or schematics for discontinued gear. Because of this, we have decided to share a number of these qustions with the QEX readership each month. If you have a response, we ask that you write the inquirer direct. We are also interested in receiving a copy of your answer.

* I am searching for an interface circuit that will connect the 80-V/40-mA loop of my page printer to the TTL input of my AFSK generator. -- Claude Laget, F9LC, 65 Rue de la Gaite, 94170 le Perreux, France.

* I would like to continue my experiments in TV transmission. Is there a circuit for a TV repeater with maximum output power of 1 Watt? -- Salvador Ravanal, CE5IG, M. Cordova 26, Concepciòn, Chile.

* I recently purchased an old oscilloscope, but its circuit diagram was missing. The manufacturer is The Northern Radio Company, Inc., New York, NY. Does anyone know where I can obtain both the circuit diagram and information about this company? -- P. K. Wilmot, In Front of Ananda Centrel Collage, Igela, Elpitiya, Sri Lanka.

* I have an old transmitter manufactured by Lysco of Hoboken, NJ. The model no. is B 129 and the serial no. is 148. I would like to get a copy of the schematic, as well as information on what frequencies it was designed for. — Scott Larson, KWØB, Box 68, Murdock, MN 56271.

* I am searching for information regarding facsimile weather map transmissions in the HF band. The maps are broadcast on 4.855, 9.396 and 14.826 MHz by an on-shore agency unknown to me. They are annotated maps made from satellite photos for maritime use. I plan to collect the data and display it on a CRT rather than use a FAX machine, but I need the exact format of the data stream. Is anyone familiar with these broadcasts or the originating agency? — Wayne Stilwell, KE6A, 1495 Bittern Dr., Sunnyvale, CA 94087.

* I am interested in performing experiments such as propagation studies with my rig. Is there a book on this subject? — Vincent Fertitta, W2PFK, 179 Potomac Ave., Buffalo, NY 14213.

* I homebrewed the high-performance 20-meter receiver featured in the 1978 April and May issues of QST. I have had pleasing results, but I wonder if anyone has made a 40-meter receiver. I would like the coil data for the tuned circuits. -- W. F. Rhodes, Sr., W8MOW, 216 Dellsing Dr., Vandalia, OH 45377.

* In the VHF Manual, (no. 23, 3rd edition, 2nd printing, p. 248), a Gonset Communicator II is converted to FM (narrowband). Can you change the Communicator III or an Ameco Model TX 62 transmitter also? — Ralph G. Johnson, WA9TSA, 324 Sullivan St., Louisa, KY 41230.

* I would like to convert a VHF Engineering Synthesizer II for use on the 440-MHz band. Has anyone experimented with this? — Joseph Moomaw, Jr., W4XD, 304 Valley View Dr., Staunton, VA 24401.

* Does anyone have the address for Clegg? My equipment is in need of repair. -- Leon E. Hartley, KA4BEN, Box 261, Andalusia, AL 36420.

* I have a Signal 1030 Transceiver and plan to buy a Tandy 2000 microcomputer that runs at 8 MHz. Is there a report available on the harmful interference received from the model I will be using? — Dean Biggood, WT4A, 4921 NW 19th Place, Gainesville, FL 32605.

* I have purchased a 6-meter transceiver, but would like further information on 6-meter propagation, nets, beacons, groups such as SMIRK, contacts and etiquette. -- John F. Schilke, KA7ORO, 184 Harding Blvd., Oregon City, OR 97045.

(i) low average viscosity η for fast response times

(ii) high birefringence Δn for good contrast in the twisted nematic effect or low Δn for good contrast in the dyed-phase-change effect

(iii) high $|\Delta\varepsilon|$ for low operating voltages or low $\Delta\varepsilon$ for multiplexed twisted nematic displays

(iv) low electrical conductivity ($\sim 10^{-8}$ siemens) for the twisted nematic and dyed-phase-change effects and somewhat higher (10^{-6} siemens) conductivity for dynamic scattering displays

(v) the pitch of a cholesteric mixture

(iv) the splay twist and bend elastic constants (K_{11}, K_{22}, K_{33}), their relationships to one another and their variations with temperature

(vii) the orientation order parameter S should be high for good contrast guest-host displays so that residual colouration of the bright state is minimised.

This long list is by no means complete and is intended only to indicate the levels of skill required in selecting new materials to synthesise and use in formulating mixtures to match the extreme variations of requirements which are encountered. Implicit in this is the considerable amount of theoretical and experimental effort which has gone into devising methods for accurately measuring the values of these, frequently inaccessible, material parameters as a matter of routine and feeding back the results to guide the efforts of the organic chemists who synthesise the materials. Put together as a whole, these aspects combine into the concept of molecular engineering mentioned in the introduction. The interested reader is referred to an excellent recent review [25].

Even this is not the end of the story concerning materials requirements. The anisotropic pleochroic dyes necessary for the guest-host effect produce their own complex requirements which are summarised as follows:

(*a*) they must possess adequate solubility in the liquid crystal host at the lowest temperatures to be encountered, together with an extinction coefficient which is high enough to give good absorption in the resulting solution

(*b*) they should be extremely pure, have a high electrical resistivity and meet the highest standards of chemical, photochemical, electrochemical and thermal stability so that long display lifetimes are achieved

(*c*) they should be strongly anisotropic in their absorption and should order well in the liquid crystal with their transition moments parallel to the director to give a high optical figure of merit S_{op} ($\geqslant 0.7$ for good contrast),

$$S_{op} = \frac{A_{\parallel} - A_{\perp}}{A_{\parallel} + 2A_{\perp}} \quad (-\tfrac{1}{2} \leqslant S_{op} \leqslant 1)$$

where $A_{\parallel}$ and $A_{\perp}$ are the absorbances measured in a spectrophotometer using linearly polarised light with its plane of polarisation parallel or perpendicular to the director of a parallel homogeneous layer of liquid crystal in which the dye has been dissolved. S_{op} is normally calculated at the peak absorption wavelength of the dye

(*d*) they should be available in a range of colours which can be mixed to give a good black

(*e*) they should be safe

Early work [26] produced azo dyes which gave displays that looked good but faded or discoloured rather quickly. Recent work by BDH Chemicals Ltd. [27] and ICI Ltd in conjunction with the research group at RSRE has screened over 200 pleochroic dyestuffs (many synthesised specially) and resulted in dyes [28] which simultaneously satisfy all of the above requirements. This, together with the improved understanding of the ordering of dyes in liquid crystals which is emerging from current research [29, 30], should contribute to the future success of such dyed displays.

7 Applications of liquid-crystal displays

Any of the effects described above can be used to make a simple, directly driven reflective or transmissive display, i.e. one in which each display element has its own connection to the drive electronics and the voltages applied to these produce a desired voltage difference at ON elements and zero voltage difference at OFF elements. Such displays, in twisted nematic form, are frequently found in digital watches, clocks and voltmeters which use seven electrode segments and a counter electrode to produce each digit. Guest-host displays are now also finding their way into such products. The main reasons for this lie in the low voltage and power requirements of the LCD, its legibility in bright ambient light and its low cost. It is true that some problems remain, such as its sluggish response at low temperatures (due to the increased viscosity of the liquid crystal) but recent work, e.g. in producing low-viscosity liquid crystals [31] and in identifying a fast turn-off mechanism [32], is progressively eliminating or alleviating these problems.

This move towards LCDs is also observed when more complex displays are considered. These may have several thousand elements, and it ceases to be practicable to make connection to each element to give each one an individual signal at an appropriate time of its own. Under these conditions it becomes necessary to matrix address the display or to time multiplex the drive voltages. The problems inherent in this approach and the optimum methods of implementing it are the subject of an excellent review by Clark [33] and it would be pointless to recapitulate them here in detail. In summary, however, the problem arises from the fact that OFF elements do not have zero voltage difference and that a finite ratio of V_{on} to V_{off} exists for any drive method and tends to unity as the display complexity increases. The state of the art is a commercially available, 5 V, twisted nematic display module capable of showing four lines of 40 alphanumeric characters with a restricted viewing angle over a temperature range of about 0–50°C [34]. This is shown in Fig. 10. Looking slightly to the

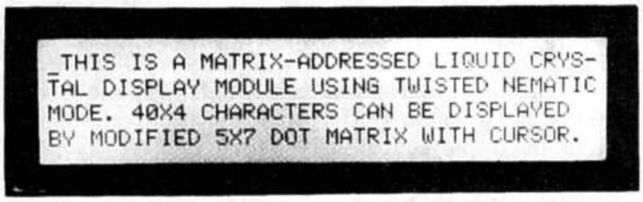

Fig. 10 *Photograph of a commercially available twisted nematic, matrix display made by Toshiba*

This can display 4 lines of 40 alphanumeric characters over a temperature range of 0 to 50°C and includes electronic drive circuitry operating from a single 5 V supply with a power consumption of 150 mW
[Photograph: Toshiba Corporation]

future, workers at Hitachi [35] have demonstrated a matrix-addressed, twisted nematic television display having 120 × 160 elements and 16 levels of grey scale. This performance is achieved at the expense of peak contrast and viewing angle and by using a complex electrode structure so that each column of the matrix display requires four separate connections. It represents, nevertheless, a very significant achievement.

Multiplexing or matrix addressing becomes even more difficult when the dyed-phase-change is considered since the presence of V_{off} can reduce the contrast of the display and make the turn-off of previously ON elements intolerably slow. Two-way multiplexing has been demonstrated, however, and it is expected that a dramatic improvement will be achieved in the near future.

Higher complexity twisted nematic displays having up to about 20 lines of characters may be obtained in the future using a 2-frequency matrix addressing technique, also reviewed by Clark [33]. Owing to a dielectric relaxation exhibited at low frequency by some liquid-crystals, a high-frequency voltage may be used to oppose the effect of a low-frequency drive voltage due to the change in sign of $\Delta\varepsilon$ (Fig. 11). Using this method, workers at Seiko [36] in

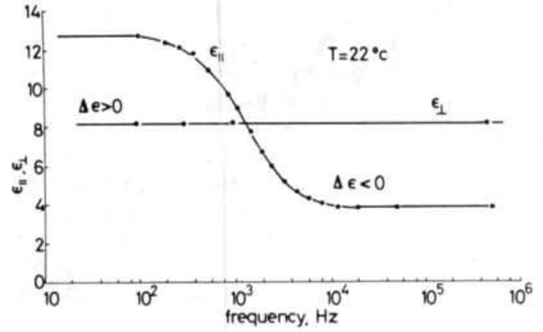

Fig. 11 *Diagram of the low-frequency dielectric relaxation in $\varepsilon_{\parallel}$ exhibited by a so-called 2-frequency nematic liquid crystal*

The resulting change in the sign of $\Delta\varepsilon = \varepsilon_{\parallel} - \varepsilon_{\perp}$ at the crossover frequency f_c allows alternating voltages of frequency $f \gg f_c$ to oppose the effect of those having $f \ll f_c$ when both are applied simultaneously. Alternatively, bursts of low (500 Hz) and high (100 kHz) frequency voltages may be applied in sequence to drive a display ON and OFF rapidly at repetition rates up to 100 Hz
[Reference 31]

Japan have demonstrated a prototype twisted-nematic matrix display capable of presenting up to 8 lines of 64 alphanumeric characters over a temperature range of about 0–40°C using temperature compensation of the drive voltages. The choice of suitable 2-frequency materials is very limited at present, however, and although materials are being developed, this and other problems make it likely that some time will elapse before such displays become generally available. The method may, however, find particular applicability in the case of dyed displays in order to substantially improve their present, poor level of multiplexibility.

8 Alternatives to conventional multiplexing

It has been shown by Nehring and Kmetz [37] and Clark, Shanks and Patterson [38] that, if the information patterns to be displayed can be restricted, the intractable problems inherent in multiplexing can be significantly ameliorated or even completely avoided. For example, if only a few elements in a matrix column are to be distinguished, then significantly higher ratios of V_{on} to V_{off} may be obtained. In particular, it has been shown that a novel addressing method, utilising the correlation properties of pseudorandom binary sequences, may be used to obtain the equivalent of direct drive (zero voltage difference at OFF elements) in complex liquid-crystal oscilloscope matrix displays [39] and analogue meter or clock displays [40] where the information presented is the position of a hand or hands relative to a scale. A commercially produced digital storage oscilloscope with a 126 × 256 dyed-phase-change matrix display is shown in Fig. 12. This method does not degrade with display complexity, and the direct-drive capability of the analogue meter may be of great use in permitting the design of liquid-crystal vehicle instruments which can operate over a wide enough temperature range to be useful and have a small enough

Fig. 12 *Commercially available digital storage oscilloscope with 10 cm × 6 cm dyed-phasechange liquid-crystal display*

The 126 × 256 matrix display is driven directly from 15 V CMOS logic circuits and uses a nonmultiplexed correlation addressing method to give a single- or dual-trace display
[Photograph: Scopex Instruments Ltd.]

number of connections to be manageable. Directly driven, full circular PPI radar displays have also been achieved using this method [41] and a prototype is illustrated in Fig. 13.

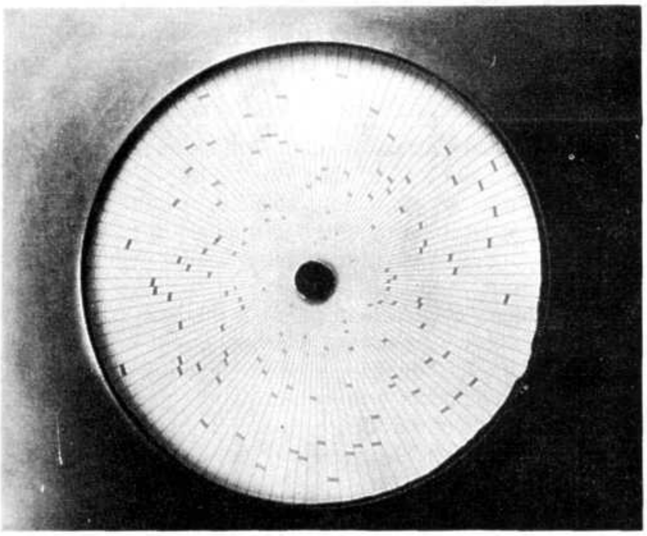

Fig. 13 *Prototype 120 × 60 element polar co-ordinate radar display developed at RSRE, Malvern*

The full circular display uses nonmultiplexed correlation addressing of a novel matrix format [41]. It employs the dyed-phase-change effect and also incorporates an internal reflector which eliminates parallax effects
[Photograph: J. Glasper, RSRE, Malvern, England]

Another method of avoiding the limitations imposed by multiplexing complex displays is to address the display optically. Workers at Hughes Research Laboratories [42] have demonstrated a projection display system using a liquid-crystal light valve. This contains a reflective light-blocking layer between the liquid crystal and a photoconductive layer. Light is imaged from a CRT onto the photoconducting layer to allow more or less of an applied alternating voltage to be developed across the liquid-crystal layer using capacitive coupling through the blocking layer. The nonemissive image thus formed in the liquid crystal is then projected onto a screen or can be used with laser illumination in optical-signal processing applications.

A different type of optically addressed projection display, capable of displaying high-resolution text, graphics and pictures, has been demonstrated by workers at the IBM Research Laboratory [43]. This utilises a cell containing a smectic liquid crystal upon which information may be written or erased using a laser beam, which is scanned using galvanometer mirror-deflection units, in conjunction with an applied voltage. The information is stored as a scattering texture in the smectic film and is projected onto a screen for viewing.

Yet another approach to high-complexity displays is the revival and improvement of an idea tried in the early days of LCDs [44]. This consists of a CRT having a liquid-crystal faceplate which is addressed directly using the electron beam [45].

9 Integrated electronics displays

Another approach to solving the problem of the low ratios of V_{on}/V_{off} encountered when multiplexing or matrix addressing liquid-crystal displays which have to show highly complex information is to integrate nonlinear electronic devices into the display adjacent to the liquid-crystal layer. These serve to increase this ratio by providing an improved threshold characteristic and maintaining the voltage on an ON element. This increases the performance of the display obtainable with any liquid-crystal mixture. A number of different technologies may be used. Zinc oxide varistor layers and metal-insulator-metal (MIM) films have been used. Field-effect transistors (FETs), charge-coupled devices and back-to-back Zener diodes, fabricated on single crystal or amorphous silicon [46] substrates or on thin layers of II–VI semiconductors, such as cadmium selenide, have also been investigated. The use of a single-crystal silicon substrate does, of course, impose limitations on the display size related to the diameter of available silicon wafers. The thin-film transistor (TFT) approach, using amorphous silicon or cadmium selenide, does not suffer from this restriction and relatively large area displays may be considered. An internal reflector must be used in some cases because the rear substrate is opaque and, in these cases, the twisted nematic is excluded as it requires a polariser in front of the reflector. A summary of recent achievements is given in Table 2. By employing these techniques it can be seen that flat-panel television displays may be made using liquid crystals, but the real problem is to achieve acceptable yields of displays which have no visual defects and to be able to produce them commercially at reasonable cost levels. Defining the extent of this yield problem is an expensive exercise involving the manufacture of such displays on a realistic scale, but liquid crystal on silicon displays are presently being test manufactured by Matsushita and Toshiba and an extensive programme leading to the test manufacture of amorphous silicon LCDs has begun in the UK. The Matsushita display is pictured in Fig. 14. It would, therefore, seem that some quantification of this problem and an identification of the main problem areas should be achieved in the next two or three years.

10 Prospects for the future

It is, of course, impossible to predict future developments accurately, but if we let the present momentum relating to the uses of LCDs guide our imaginations, we may just be able to glimpse something of what is to come.

It would seem a fairly safe bet that the uses of quite simple LCDs in calculators, instruments, petrol (gasoline) pumps, cameras, watches, hi-fi equipment, TV and radio sets will continue and that plastic cells with replace present

Table 2: Recent achievements in liquid-crystal display devices

Nonlinear device	Layer material	Liquid-crystal display	Details	Source
MOSFET	Single-crystal Si	Dynamic scattering	36 × 48 mm display 500 mW display power consumption, 240 × 240 display elements, pocket TV with total power consumption of 1.3 W	Matsushita Co. [47]
MOSFET	Single-crystal Si	Dynamic scattering	30 × 40 mm display, 700 mW display power consumption, 240 × 220 display elements	Toshiba [48]
MOSFET	Single-crystal Si	Dynamic scattering	44 × 44 mm 175 × 175 display elements, TV display	Hughes Research Labs. [49]
MOSFET	Single-crystal Si	Dyed-phase-change	23 × 32 mm, 10 mW display power consumption, 210 × 200 display elements, TV display	Suwa Seikosha [50]
MOFSET	Single-crystal Si	Dyed-phase-change	35 × 35 mm (approximately), 40 × 40 display elements, graphics display	Standard Telecommunications Laboratories [51]
TFT	Amorphous Si	Twisted nematic	14 × 10 mm (but extendable to large area), 7 × 5 elements with simulation of 250 way multiplexing	Dundee University/ RSRE [52]
TFT	Cadmium selenide	Twisted nematic	152 × 152 mm, 180 × 180 display elements, TV display	Westinghouse [53]
Varistor	Zinc oxide sintered ceramic	Dyed-phase-change	51 × 127 mm, 70 × 175 display elements, 175 way multiplexed	General Electric [54]
MIM nonlinear capacitor	$Ta/Ta_2O_5/Cr$	Twisted nematic	32 × 32 display elements with simulation of 100-way multiplexing	Bell-Northern [55]

glass ones in many applications. The arrival of LCDs in telephones, cars and household equipment also seems

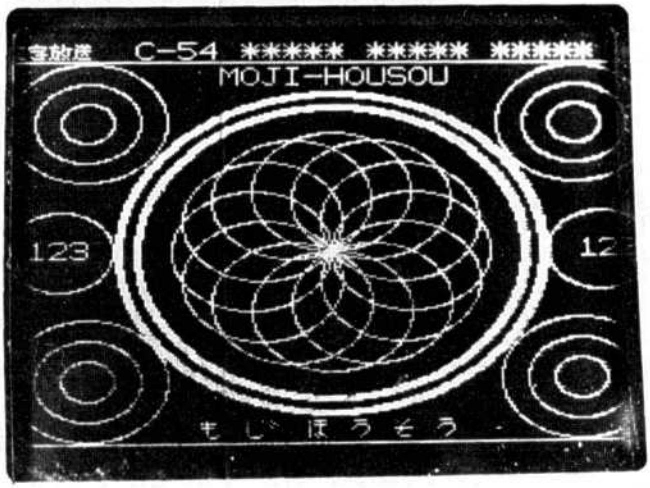

Fig. 14 *Photograph showing the graphics and character capability of the Matsushita liquid crystal on silicon display*

This employs dynamic scattering, measures 36 × 48 mm and has 240 × 240 display elements, each of which has its own MOSFET fabricated in the silicon wafer which forms the rear substrate. It is also capable of showing television pictures and a pocket television version is currently being test manufactured
[Photograph: Reference 47]

certain, as does their use in some items of military hardware. More complex displays are already available in programmable calculators, language translators and a range of battery-operated electronic games and toys. These uses will expand and, given the continuing development of electronic circuits, such displays will find further applications in pocket computers, battery-operated microprocessor-based portable systems and portable televisions or teletext systems capable of remotely accessing data such as stock-exchange or timetable information from a large computer.

It is also likely that LCD devices will be linked with touch panels or position sensors to furnish control panels without knobs or switches and to provide compact electronic keyboards whose keys indicate in which of a number of possible modes (for example character founts) they are operating. The incorporation of electronic circuits onto the display using some form of thick-film circuit technology is also envisaged, and this will allow many large instruments, such as oscilloscopes and frequency meters, to become portable or even pocket size. Projection displays will also become available.

LCDs will also, probably, find uses other than as displays in their own right. They may provide electronically switchable colour filters which can be used to convert monochrome CRT displays into field sequential colour presentations having high resolution and brightness and excellent colour saturation [21]. They may find applications in optical computers and optical signal-processing systems using lasers to analyse the information content of electronic signals (in, for example, radar systems) which have been converted into the optical domain using liquid-crystal devices [57]. Current research interests in bistable storage effects in liquid crystals [58, 59] and in thermally addressed smectic liquid-crystal displays [60, 61] may lead to future applications in optical memory devices and in nonlinear optics and integrated optics components.

Future developments in the physics and chemistry of liquid crystals are harder to predict. It is likely, however, that materials with improved temperature ranges and response speeds will be developed, and that an improved understanding of the relationships between molecular structure and physical properties will be achieved. New materials for 2-frequency multiplexing are also envisaged. Further improvements in displays using the guest-host interaction effect, the discovery of multiplexing methods for these and their subsequent widespread adoption seem likely. The increasing use of smectic liquid crystals in displays is foreseen and the development of complex displays with inherent memory may derive from this. Our knowledge of the physics of the statics and dynamics of liquid crystals, particularly that concerning smectic and cholesteric liquid crystals, will increase, as will that of their phase behaviour and the nucleation mechanisms which dominate some effects.

The scenario just outlined is inevitably based on the predictable, and it is worth pointing out that the recent history of liquid crystals is characterised by the very unpredictability of many of the discoveries made. Thus, the foregoing should be viewed with some scepticism as future significant discoveries may cause major changes in direction.

It should be clear, however, that LCDs have demonstrated their usefulness as devices of molecular electronics, and that this has largely come about through multidisciplinary collaborations in the molecular engineering required to identify and evaluate suitable materials. This is very much a feature of molecular electronics and applies equally in other areas, such as electronic sensors, electroactive polymers and Langmuir-Blodgett films. It is hoped that this review has helped to acquaint the reader with the methods of construction, operation and use of LCDs and to point out the impact which clever chemistry can have generally in the molecular electronics field.

11 Acknowledgments

The author would like to thank Dr. M.G. Clark and former colleagues at RSRE, Malvern, for their help in the preparation of this review.

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An Experimental Two-Meter Converter with Gallium Arsenide Transistors

By Clint Bowman,* W9GLW

The availability of the Motorola MRF966 low-cost dual-gate GaAs field effect transistor triggered a little bench work at my QTH to determine the usefulness of this device. This converter required less debugging and alteration of original circuit concept than any "scratch" gear I have ever constructed. With parts at hand, only a few days of casual work from schematic to operating board were required.

To some extent, I believe this is a testimonial to the MRF966. It appears to be a splendid device and should be useful for a variety of applications, especially for frequencies through 1296 MHz.

In my estimation, the mixer circuit has always been the weak link in the superheterodyne chain. I have fought mixers for 50 years from dc to microwaves, professionally and privately, and have never found a circuit that didn't require some compromise in gain, noise or intermod products.

The mixer circuit shown provides uniform, low-noise operation from 144 to 144.5 MHz with no "birdies" and appears to be quite tolerant to overloading from strong adjacent signals. More than adequate gain is available to drive a somewhat anemic transceiver operating as a tunable IF from 14 to 14.5 MHz.

No attempt has been made to optimize the bias on gate no. 2 for either MRF966 in the converter.

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Some additional gain can be obtained by replacing the ferrite balun cores in the output 14-MHz tuned circuit with air-wound coils if a bandwidth of about 200 kHz can be tolerated. I do not believe this additional gain is required, unless the transceiver is truly substandard. If air-wound coils are substituted, it is probably that the converter will have to be mounted in a shield box to prevent feed through of extremely strong 14 MHz signals.

Double-sided PC board stock was used. The MRF966 RF stage and associated input parts are mounted on side no. 2 of the board; the drain lead of this transistor is fed through a small clearance hole in the board to side no. 1. The MRF966 mixer and associated input circuitry is mounted on side no. 1 of the board; the drain of the mixer is then fed through the board to side no. 2. Output circuits are mounted on side no. 2 of the board.

The LO chain and power supply are mounted on side no. 1 of the board. The physical layout of the board follows almost exactly the layout of the schematic.

No additional shielding is used, however, it is possible that shield around the LO chain might improve overall noise figure theoretically. BNC connectors are used for input and output. No work has been done with the MRF966 as a preamplifier, but there is reason to believe it would be suitable for that service.

(The schematic for this project can be found on page 10.)

Construction Projects

Radio amateurs are hungry for some more construction projects, particularly the kind that can be completed within a weekend or a few evenings. ARRL Hq. would like to receive more manuscripts with Amateur Radio-related construction projects carried through to the printer-circuit-board level. Depending on the type of circuit, we'd like to consider these projects for QST, QEX, the Handbook, or other technical publications.

Bits

GLOBECOM '84 IEEE Global Telecommunications Conference

On November 26-29, 1984, the Atlanta Hilton Hotel will come to life as many distinguished individuals in the electronics field gather together for GLOBECOM '84. Forty-eight technical sessions covering more than 15 different areas will be featured. There are a variety of registration fees covering everything from sessions, exhibits and luncheons. A complete booklet offering information on speakers and topic schedules can be obtained by writing: GLOBECOM '84, P. O. Box 467007, Atlanta, GA 30346. A schedule of this year's events is shown below.

GLOBECOM '84

IEEE Global Telecommunications Conference

Communications In The Information Age

Technical Program

TUESDAY NOVEMBER 27 8:00 AM - 8:50 AM	Plenary Session									
TUESDAY NOVEMBER 27 9:00 AM - 12 Noon	1 LSI/VLSI BASED SUBSCRIBER TRANSMISSION AND CUSTOMER ACCESS FOR ISDN	2 SPECIAL APPLICATIONS OF FIBER OPTICS	3 PANEL DISCUSSION: ISDN AND COMPETITIVE COMMUNICATION SERVICES	4 TECHNICAL PREPARATIONS FOR THE GEOSTATIONARY ORBIT CONFERENCE	5 HIGH CAPACITY STATISTICAL SWITCHING FABRICS	6 NETWORKING AND DISTRIBUTED SYSTEMS SOFTWARE	7 ADAPTIVE ARRAYS AND CANCELERS	8 SYNCHRONIZATION AND TRACKING	TUTORIAL: FIBER OPTIC COMPONENTS SYSTEMS AND APPLICATIONS	TUTORIAL: QUALITY PROGRAM ANALYSIS
TUESDAY NOVEMBER 27 2:00 PM - 5:00 PM	9 SPEECH PROCESSING	10 ADVANCES IN COMMUNICATION TERMINALS FULL-COLOR VIDEOTEX	11 PERFORMANCE ANALYSIS OF PROTOCOLS	12 ADVANCES IN DATA COMMUNICATIONS	13 NEW SERVICES TRANSMISSION NETWORK PLANS AND PROGRESS	14 DIRECT BROADCAST SATELLITE SYSTEMS	15 PACKET RADIO SYSTEM ASPECTS	16 RADIO—NEW AND DEVELOPING TECHNOLOGIES AND APPLICATIONS		
TUESDAY EVENING NOVEMBER 27 7:00 PM - 10:00 PM	Panel Discussions					• Managing Software Quality • Best of ISSLS • OSI Aspects of Telematic Services				
WEDNESDAY NOVEMBER 28 9:00 AM - 12 Noon	17 MANAGEMENT OF THE QUALITY FUNCTION	18 FIBER OPTICS IN THE LOCAL NETWORK	19 LOCAL AREA NETWORKS	20 NEW DEVELOPMENTS IN VOICEBAND DATA TRANSMISSION TECHNOLOGY	21 ADVANCES IN TELECOMMUNICATIONS SWITCHING	22 MODULATION AND CODING I	23 THE 32 kb/s INTERNATIONAL CODING STANDARD	24 COMPUTER-AIDED MODELING, SIMULATION, DESIGN AND ANALYSIS OF COMMUNICATION SYSTEMS		
WEDNESDAY NOVEMBER 28 2:00 PM - 5:00 PM	25 QUALITY ASSURANCE OF NETWORKS	26 APPLICATIONS OF OPTICAL TECHNOLOGY FOR COMMUNICATIONS SWITCHING	27 NETWORK ANALYSIS AND DESIGN	28 INTERSATELLITE COMMUNICATION LINKS	29 SPREAD SPECTRUM COMMUNICATIONS	30 LANGUAGES FOR TELECOMMUNICATIONS SYSTEMS	31 OPERATIONS & DIGITAL NETWORK STANDARDS	32 MODULATION AND CODING II		
THURSDAY NOVEMBER 29 9:00 AM - 12 Noon	33 ASPECTS OF QUALITY ASSURANCE METHODOLOGIES IN DEVELOPMENT LIFE CYCLES	34 OPTICAL INTERCITY TRANSMISSION SYSTEMS	35 MULTI-ACCESS PROTOCOLS	36 REGIONAL/DOMESTIC SATELLITES: SYSTEM AND TECHNOLOGY ASPECTS	37 ADVANCES IN SSB-AM RADIO TRANSMISSION OVER TERRESTRIAL AND SATELLITE NETWORK	38 DEVELOPMENT ENVIRONMENTS FOR TELECOMMUNICATIONS SYSTEMS	39 BUSINESS COMMUNICATION NETWORKS FOR VOICE AND DATA	40 VLSI IN LOCAL NETWORK AND COMMUNICATION PROTOCOL		
THURSDAY NOVEMBER 29 2:00 PM - 5:00 PM	41 PRODUCT EVALUATION AND SUPPORT	42 LIGHTGUIDE MEDIA, APPARATUS AND APPLICATIONS	43 VIDEOTEX—AN UPDATE	44 TOPICS IN COMMUNICATION THEORY	45 TOPICS IN RADIO PROPAGATION	46 SOCIETAL EFFECTS OF TECHNOLOGY IN THE WORKPLACE: A STATUS REPORT	47 DIGITAL IMAGE PROCESSING	48 ADAPTIVE SIGNAL PROCESSING FOR COMMUNICATIONS		

Mini-Themes: Quality Assurance Management (light shading); Optical Communications (dark shading)

The Power Sources Conference

For those not living in the Atlanta area, you might be interested in attending The Power Sources Conference at the Sheraton-Boston Hotel and Hynes Auditorium. The date is November 27-29, 1984, and the Conference will focus its attention on a poorly understood element of every electronic system — the power source.

Write The Power Sources Conference, Inc., 3970 Atlantic Ave., Suite 204, Long Beach, CA 90807 for a complete program and registration information.

Call for Papers and Other Session Proposals

The Sheraton Inn Washington - Northwest (Washington, DC area), will sponsor a Conference on Software Maintenance during November 11-13, 1985. This Conference will bring software managers, maintainers, developers and researchers together to discuss new solutions to the continuing challenge of software maintenance and maintainability. CSM-85 will acquaint managers and practitioners with current advances and researchers with today's needs.

The submission deadline for authors is February 4, 1985. Acceptance notification will be April 26, 1985, and the final version is due no later than July 8, 1985.

Details of how the paper should be organized can be obtained by writing: IEEE Computer Society, Administrative Office, P. O. Box 639, Silver Spring, MD 20901. A list of suggested topics is included.

Twinkle Twinkle Little Star

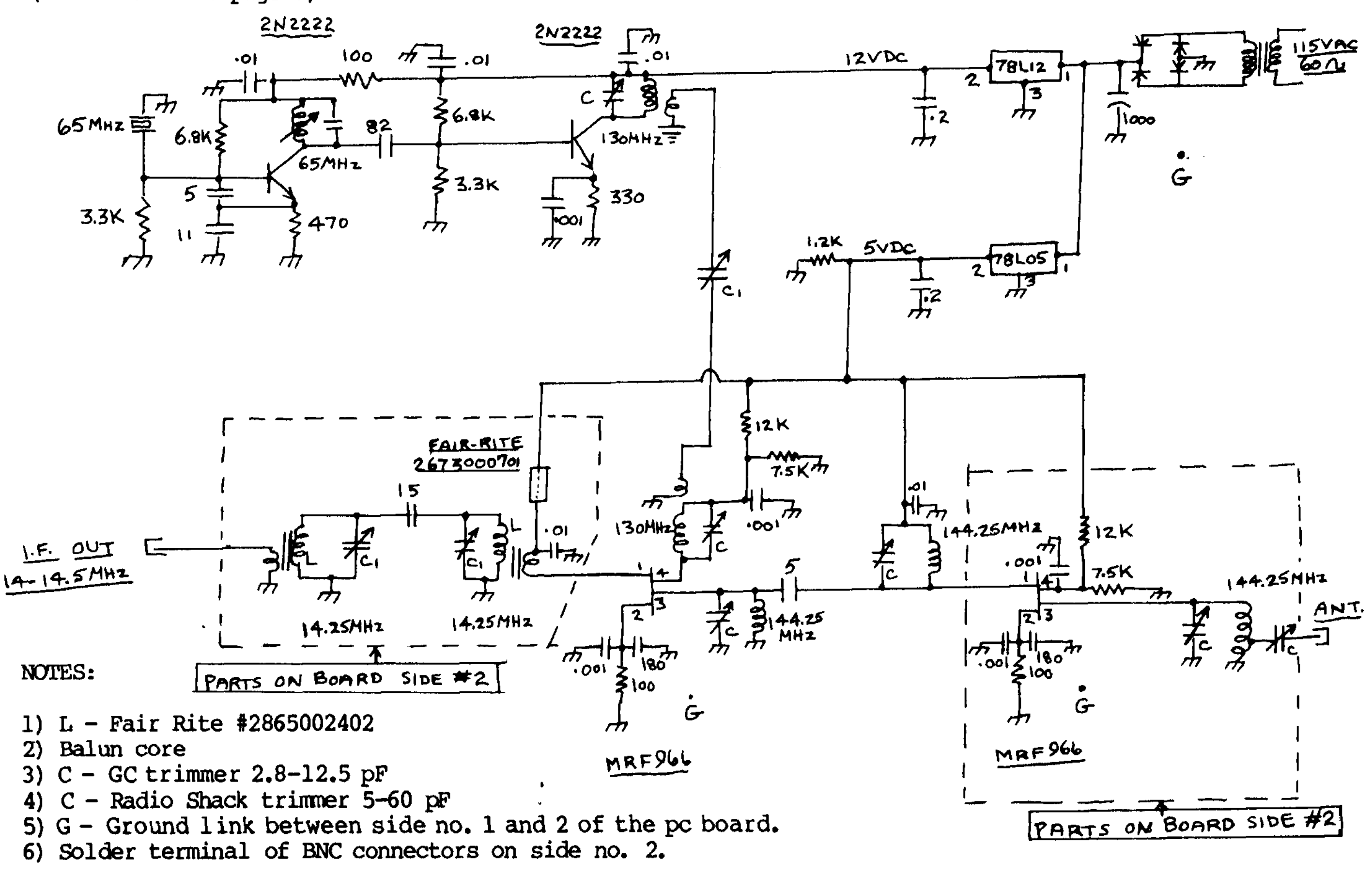
Extraterrestrial Paging Proposal

During the mid-1970's when the Voyager's were launched into space, the media was excited about information the craft would carry of planet Earth and its inhabitants. Should the probe be discovered by another deep-space civilization or land on an inhabited planet, these beings could learn about our solar system and the life it contains. Since that time, radio astronomy and the search for extraterrestrial life became a serious matter for many professional and amateur scientists.

On August 7, 1984, Beeple, Inc. d/b/a On Page Enterprises (On-Page) filed a request for Special Temporary Authority to operate a common carrier one-way paging station at Sudbury, Massachusetts on 900 MHz reserve frequency 930.0125 MHz. The purpose of this is to offer specialized extraterrestrial communications service to the public. On-Page proposes to transmit binary digitized radio messages of 25 words or less, photographs or drawings, "to the Sun, the Moon, any of the planets in our solar system, or any designated star outside the solar system." The message to be transmitted by On-Page would be provided by its customers. A copy of the transmission would be mailed to a recipient specified by the customer.

The Common Carrier Bureau has denied On-Page's request, noting that they had not demonstrated that extraordinary circumstances exist requiring temporary operations in the public interest or that delay in the institution of such temporary operations would seriously prejudice the public interest. On-Page's request will be treated as an application for developmental authority and has been assigned File No. 24719-CD-P/L-84. An amendment to the application was filed on September 11, 1984 — FCC Public Notice issued September 1, 1984.

(Continued from page 8)



NOTES:

1) L - Fair Rite #2865002402
2) Balun core
3) C - GC trimmer 2.8-12.5 pF
4) C - Radio Shack trimmer 5-60 pF
5) G - Ground link between side no. 1 and 2 of the pc board.
6) Solder terminal of BNC connectors on side no. 2.

Microcomputer Software for Scientists and Engineers

As a scientist or engineer you have unique needs for graphics on your Apple or IBM PC. Where do you look to answer those needs? Computer stores cater mostly to business applications and computer magazines display an overwhelming collection of untried, unproven packages.

How would you like to be able to create detailed scientific graphs and bar charts on your personal computer? Use PC-Draw to design your next project -- it uses the keyboard cursor keys or an optional light pen. Contour plots and vivid 3-dimensional surface plots can be created with the Golden Graphics System and SoftPlot. Want more information about these programs and others?

Scientific Software Products, Inc. has screened over 200 graphics packages. The scientists associated with SSP are actively involved in engineering and research. Some of their tested products perform such tasks as technical drawing, analytical graphics and quality charts.

A catalog is available by writing to SSP, 5726 Professional Circle, Indianapolis, IN 46241, tel. (317) 244-6163. Each product is described in clear, precise language. A concise report of the capabilities, features and specifications of each program is included. Their description also explains what the product won't do so that you will know exactly what to expect with each order. The company stocks each item so you can enjoy the benefits of using the products almost immediately.

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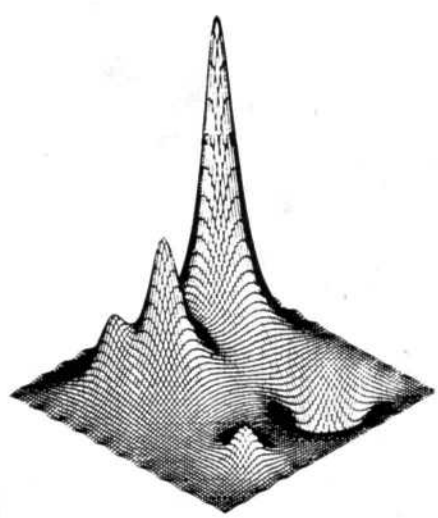

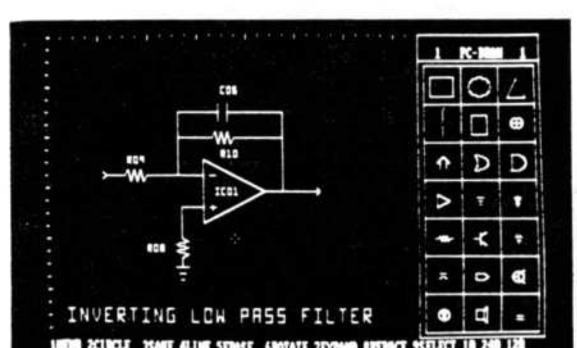

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