QEX 90

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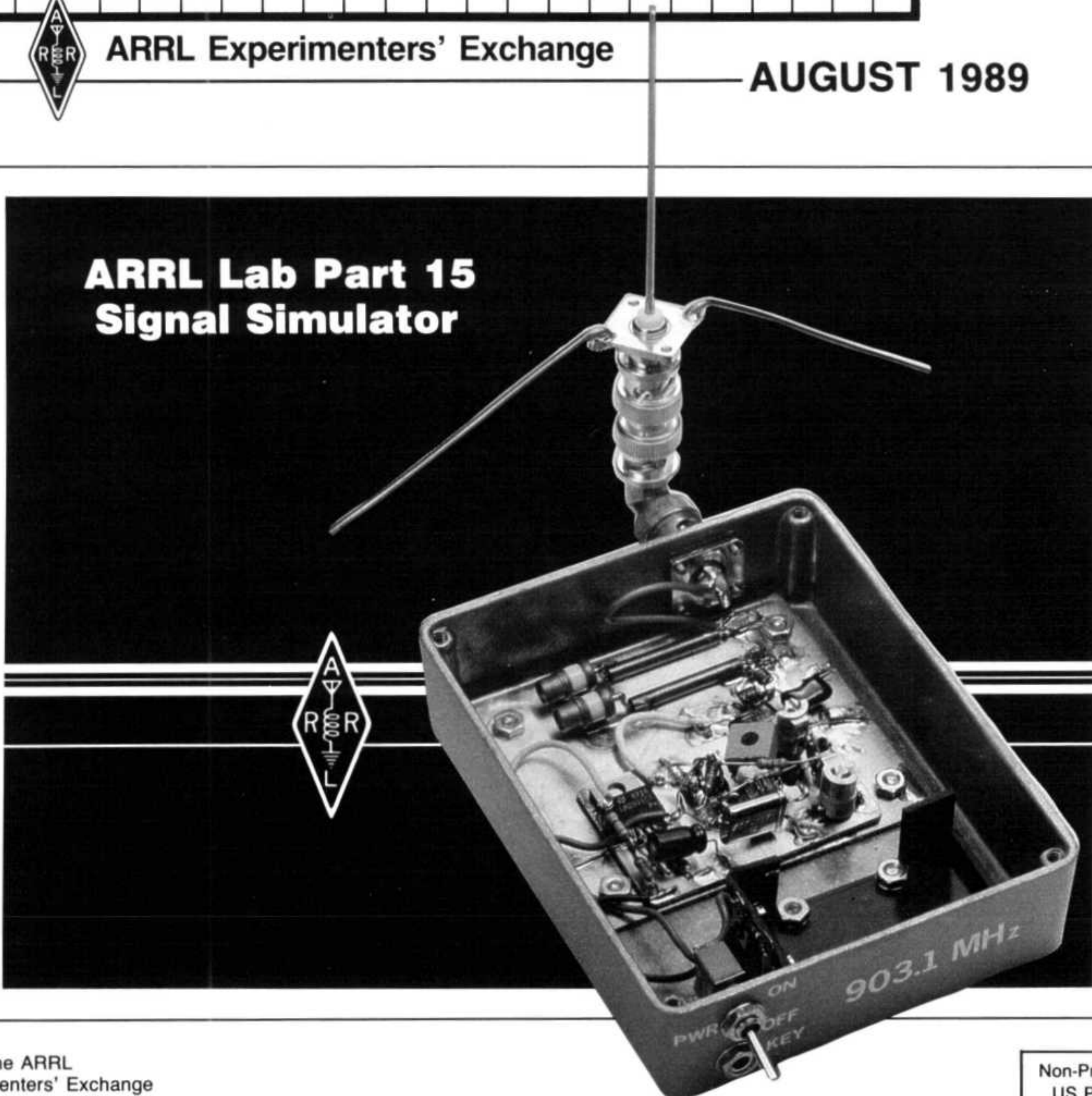
ARRL Experimenters' Exchange

AUGUST 1989

ARRL Lab Part 15 Signal Simulator



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COLUMNS

AUGUST 1989 QEX ADVERTISING INDEX

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1) provide a medium for the exchange of ideas and information between Amateur Radio experimenters
2) document advanced technical work in the Amateur Radio field
3) support efforts to advance the state of the Amateur Radio art.

All correspondence concerning *QEX* should be addressed to the American Radio Relay League, 225 Main Street, Newington, CT 06111 USA. Envelopes containing manuscripts and correspondence for publication in *QEX* should be marked: Editor, *QEX*.

Both theoretical and practical technical articles are welcomed. Manuscripts should be typed and double spaced. Please use the standard ARRL abbreviations found in recent editions of *The ARRL Handbook*. Photos should be glossy, black-and-white positive prints of good definition and contrast, and should be the same size or larger than the size that is to appear in *QEX*.

Empirically Speaking. . .

Part 15 Engineering Discussions

On July 27, 1989, Technical Department Manager Chuck Hutchinson, K8CH, Lab Engineer Zack Lau, KH6CP, Counsel Chris Imlay, N3AKD, and I made an ex parte presentation to FCC Chief Engineer Dr. Thomas Stanley and others. The occasion was that the FCC had recently denied our Petition for Reconsideration and Motion for Stay concerning new Part 15 standards. Part 15 covers both non-licensed low-power intentional radiators and unintentional radiators. The purpose of the meeting was to explain how Part 15 emitters in the new standards adversely affect the amateur service particularly in the 33-, 13-, and 9-cm bands. We explained that the problem is like a three-legged stool.

• One leg is the Part 15 emission limits. We'd like them lower. They are sufficiently high that devices in neighboring houses a block or so away can cause serious interference to amateur uses of these bands.

• Another leg is consumer education (or lack thereof). The amateur service enjoys secondary status in these bands, while the Part 15 devices are not supposed to interfere with primary or secondary services and are not immune from interference from those services. Try telling that to the neighbor who's incensed because you're interfering with his new whizbang gadget he paid good money for to Krazy Audio Guy.

• The third leg of the stool is interference complaint resolution. The Field Operations Bureau has a limited budget. Many citizen complaints are handled by correspondence; ie, the Field Office sends out a form letter which may suggest that the cause is the amateur station, even though that station has been operating within the rules and found to be "clean." We are particularly concerned about possible imposition of operating restrictions as a result of interference to a Part 15 device, even though the Part 15 device has no status.

We explained that it might be possible to live with any one of the above problems, but the combination of the three is unacceptable. Furthermore, the mere fact that these devices operate in the three ham bands mentioned sets the stage for a ham being declared a nuisance under a contractual agreement, which could result in an eviction from an apartment or other residence.

In order to demonstrate what a Part 15 emitter sounds like in a ham receiver, we brought along a 903.1 MHz simulator with an output power of 3 microwatts (see cover). In tests conducted in Newington, CT, we placed the simulator in W1AW so that the path included two brick walls, several clumps of trees, a short open field, and a thick woods. Strong signals were received out to a block away from W1AW, and weaker signals were heard out to two blocks. Naturally, being well versed in Murphy's Law, we fully expected the equipment to fail completely in Dr. Stanley's office. Murphy was sleeping—it worked. But strong signals got only as far as beyond the first door and wall, both of which were metal. The signal could be heard as the emitter was walked down the hall, taken down the elevator and carried outside the front door six floors below. Besides the metal partitions, the man-made noise level at 903.1 MHz was surprisingly high.

We believe that our message was received. While it remains to be seen what effect that message will have on Part 15 rules, the Office of Engineering & Technology has a better understanding of problems hams have sharing spectrum with Part 15 devices located in the same neighborhoods.—*W4RI*

Modular Multiband Transcevier—*Part 1*

By Mike Grierson
G3TSO/KD3CL

The not-so-daunting approach to building your own top-class 10-watt multiband HF SSB transceiver

Reprinted from
RADIO COMMUNICATION
October 1988

Construction of a multiband ssb transceiver is a project likely to deter the most ardent constructor; however, by building a series of small modules the apparent complexity of such a project can be greatly reduced. With careful design, individual modules can be constructed, tested and aligned where necessary, before being brought together as a project exhibiting a high degree of sophistication.

One of the major stumbling blocks encountered by anyone designing or building multiband equipment is the process of band changing. Traditionally, large rotary switches are used; these often reach from the front to the back of the equipment, with numerous wafers switching a multitude of different circuits. The switches are hard to find, difficult to wire up and impose serious limitations on the mechanical layout and construction of the equipment.

This switching problem can now largely be overcome by the use of diode and relay switching. Individual circuits can be switched remotely by a single dc voltage taken from an 11-way wafer switch. The layout of modules is thus independent of the switch location and so each module can be mechanically self-contained making testing and alignment a simple process. Equipment can be constructed to suit the individual requirements of the constructor and may either be spread out into a large chassis or packed neatly into a high density package in order to produce miniature equipment. Modules also permit considerable flexibility in future development or modification of equipment as well as making servicing somewhat easier.

With the increasing cost and complexity of commercial amateur radio equipment, home construction is once again becoming a viable proposition. Components are available from a number of mail order suppliers as well as at numerous rallies. Use of modern components, broadband techniques and integrated circuits makes construction and alignment considerably easier than it was two decades ago when home construction was more commonplace.

AN OUTLINE

The heart of the G3TSO modular transceiver is a modified version of the well known G4CLF board. This was based upon the Plessey communications ICs and described fully in my earlier article *A 30W SSB Transceiver for 160 metres* (*RadCom* July/Aug 85). The current design uses a 9MHz i.f and could easily be substituted by any other 9MHz unit such as the G3ZVC board or a commercial MLX board. The modules to be described could easily be used in conjunction with the G3OGQ transceiver (*RadCom* April 83) or the PW Helford to add to the original two band design.

The choice of a 9MHz i.f enables a single vfo operating from 5·0 to 5·5MHz to provide coverage of both the 14MHz and 3·5MHz bands with a minimum of switching. Local oscillator injection for multiband operation is achieved by mixing the 5MHz vfo signal with the output from a switched xtal oscillator, which is then filtered and amplified to provide the +7dbm required by the ring mixer on the G4CLF board. The new WARC bands have not been included in the design as the primary mode of operation was to be ssb, but their inclusion would not be particularly difficult and the pcb's layouts could be expanded to accommodate the extra filters and xtals.

Availability of suitable PA transistors for home construction is erratic, particularly if they are to be obtained at a sensible price. With this in mind a suitable low cost alternative was sought, resulting in the use of a kit pa currently obtainable from Cirkit Holdings. The kit is designed to give 10W continuous output over the frequency range 1·5 to 30MHz and employs a pair of 2SC1945 PA tranistors. They are well capable of providing up to 20W output for ssb or cw operation with less than 2mW of drive. This is ideal for low power operation as a pa in its own right or it can be used to drive a solid state or valve linear amplifier to considerably higher output.

Bandswitching has been achieved by using low capacitance switching diodes; signals are able to pass through those diodes that are biased on from a 13V supply and are confronted by a high impedance path from those diodes that are biased off. This is a technique used in almost all modern commercial equipment and enables bandswitching to be effected with a single wafer bandswitch linked by ribbon cable to the various modules that require switching. In practice, a second wafer is used on the bandswitch to enable selection of the appropriate oscillator xtal. The low pass filters used in the transmitter output path are switched using miniature relays as much larger currents are present in this part of the circuit.

An swr detector is included in the design. This provides both forward and reverse alc voltages used to control the output power on transmit and provide final protection under high swr conditions. Meter indications of Fwd and Ref power are displayed on a combined S-meter.

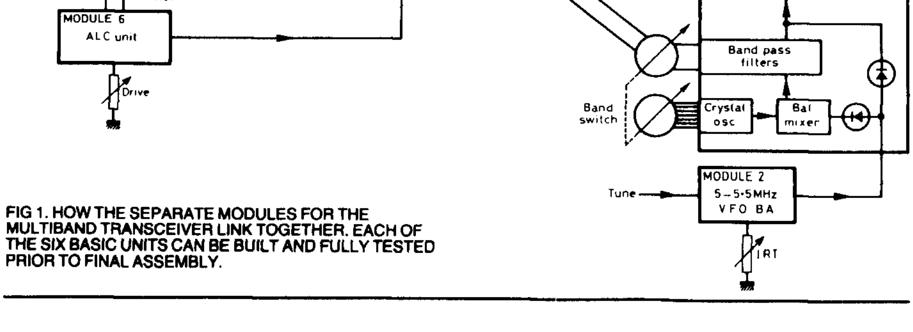


FIG 1. HOW THE SEPARATE MODULES FOR THE MULTIBAND TRANSCEIVER LINK TOGETHER. EACH OF THE SIX BASIC UNITS CAN BE BUILT AND FULLY TESTED PRIOR TO FINAL ASSEMBLY.

THE CIRCUIT

A block diagram of the basic multiband transceiver is illustrated in Fig 1. For simplicity this will be broken down into a series of six modules, each of which can be constructed and tested in its own right. All are constructed on relatively small pcbs designed to complement the dimensions of the G4CLF exciter module.

MODULE 1: 'G4CLF' MODIFIED BOARD

The G4CLF exciter unit (Fig 2) is very similar to the unit described in *RadCom* July 85 and it is only intended to describe the differences rather than the board itself.

Crystal filter and carrier xtals have been

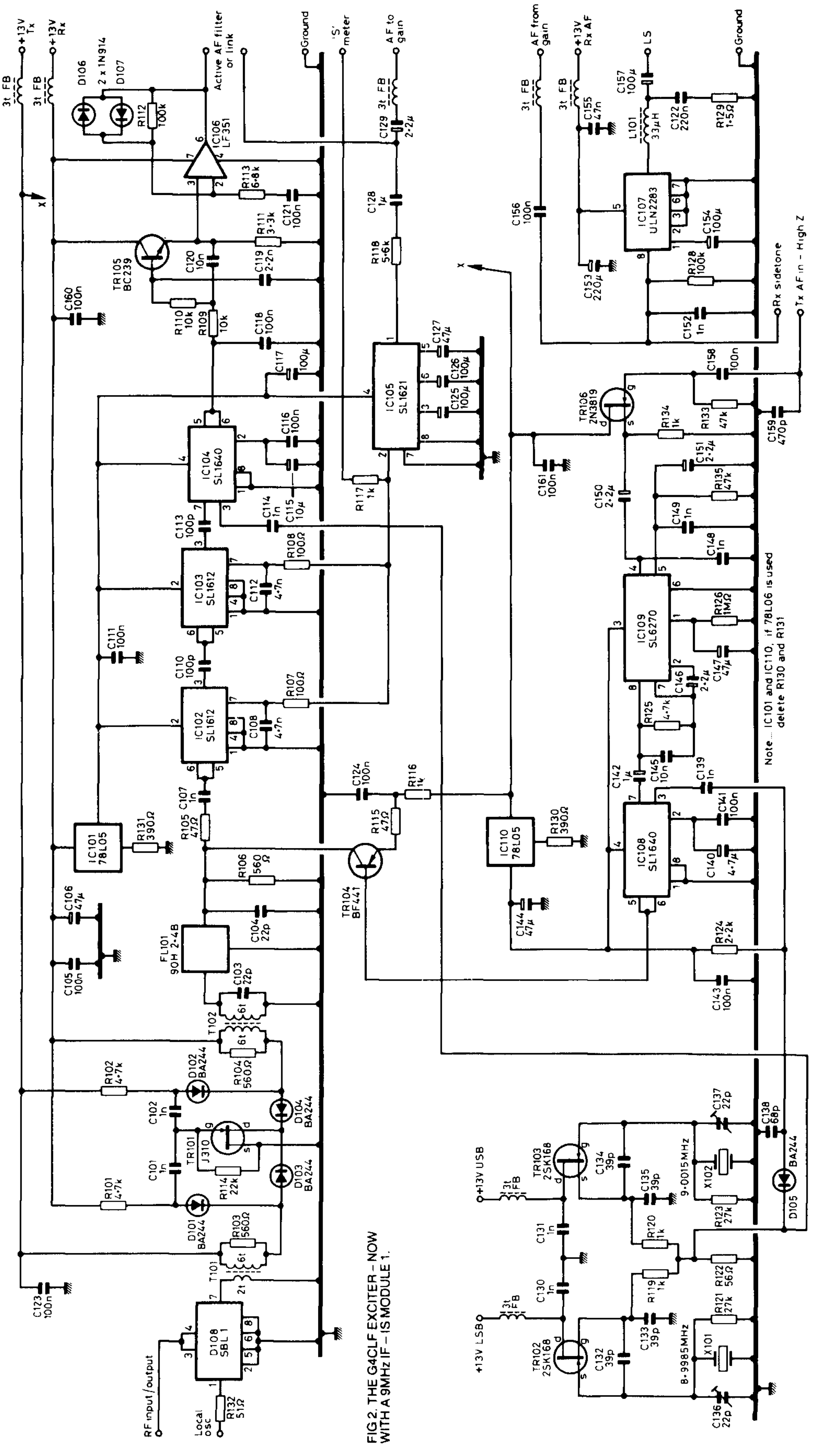


FIG 2. THE G4CLF EXCITER – NOW WITH A 9MHz IF – IS MODULE 1.

MODULE 1

R101,102,125	4.7k
R103,104,106	560R
R105,115	47R
R107,108	100R
R109,110	10k
R111	3.3k
R112,128	100k
R113	6.8k
R114	22k
R116,117,119, 120,134	1k
R121,123	27k
R122	56R
R124	2.2k
R126	1M
R133,135,127	47k
R129	1.5R
R130,131	390R
R132	51R

C101,102,107,114 130,131,139,148, 149,152	1nF C
C103,104	22pF C
C105,111,116,118, 121,123,124,141,161 143,156,158,160,	100nF C
C153	220µF A
C108,112	4.7nF C
C110,113	100pF C
C115	10µF T
C119	2.2nF C
C120	10nF C
C117,125,126,154, 157	100µF T
C106,127,144,147	47µF T
C129,146,150,151	2.2µF T
C136,137	22pF Trimmer
C132,133,134,135	39pF C
C159	470pF C
C128,142	1µF T
C140	4.7µF T
C145,155	47nF C
C122	220nF
C138	68pF C

IC101,110 78LO6 or 78LO5 Reg with R130,131

IC102,103	SL1612/SL612
IC104,108	SL1640/SL640
IC105	SL1621/SL621
IC106	LF351
IC107	ULN2283
IC109	SL6270

TR101	J310
TR102,103	2SK168
TR104	BF441, BF451
TR105	BC239
TR106	2N3819 (see text)
FB 3t	FX1115 (7 required)

L101 33 µH Toko 283-AS-330
D101–105 BA244 switching diodes
D101,107 1N914

X101 8.9985MHz
X102 9.0015MHz } Supplied with filter

T101,102, 6t + 6t FX2249 or equiv

FL101 90H2.4B 9MHz 8 pole 2.4kHz SSB Filter – IQD

A: aluminium. C: ceramic
T: tantulum. Poly: polystyrene

changed to 9MHz types and the IQXF-90H2·4B filter is recommended. It is supplied by IQD Ltd of Crewkerne and comes complete with the two matching carrier xtals. Several component values immediately adjacent to the filter have been altered as the matching characteristics are different to the original 10·7MHz filter. The transformers T101 and 102 specify cores no longer available from Mullard, but an identical core is available from Birketts of Lincoln, or alternatively the Fairite 28-43002402 balun core available from Cirkit would suffice.

Transistors TR102 and 103 have been changed to 2SK168 types and the rare 78LO6 regulator ICs can be replaced by the more common 78LO5 type with a 390ohm series resistor in the earth return lead.

Plessey ICs continue to be available from a number of sources including Cirkit and Bonex, while the below spec variety is available from Birketts at a very much lower price. The latter should ideally be tested before use and a batch of six surplus ics will usually produce about three serviceable items.

TR106, a microphone matching stage, has been added to the pcb to allow use of a high impedance mic. TR106 is not required for mics with an impedance of less than about 1kohm, in which case the stage may be omitted and the mic input fed directly to C150 which should be reversed in polarity. It is important to retain C159 for rf decoupling, and if the mic lead is long an additional decoupling capacitor of about 200pF should be connected across the mic skt.

A small plug and skt has been added in the audio line immediately after IC106 for the inclusion of an active audio filter, which is particularly valuable if cw operation is required. The agc bandwidth will also be improved with the filter connected in this position, and will characterise the sharp tuning of a xtal filter.

My original article (*RadCom* July 85) used a rather complex pcb which proved difficult to reproduce. A revised layout is now provided (Fig 3) – this has a much simplified track pattern and can be easily reproduced using rub-on type transfers. The new pcb has retained the original component layout (Fig 4) and is constructed on double-sided glass fibre board. All ground returns are made to the ground plane side of the board and all holes that are not ground returns should be lightly countersunk to prevent accidental shorting of components to ground. Ic locations are 8 pin DIL and can be used with either the SL1600 devices or the SL600 if the pins are bent to fit the hole structure. Some ground plane was originally added to the track side of the pcb to enable screening of the oscillator unit, but this proved unnecessary. Screening of the xtal oscillator unit on the groundplane side of the pcb is essential for the correct operation of the receiver.

So far a number of the modified boards have successfully been made by other amateurs; indeed my own board worked immediately it was switched on.

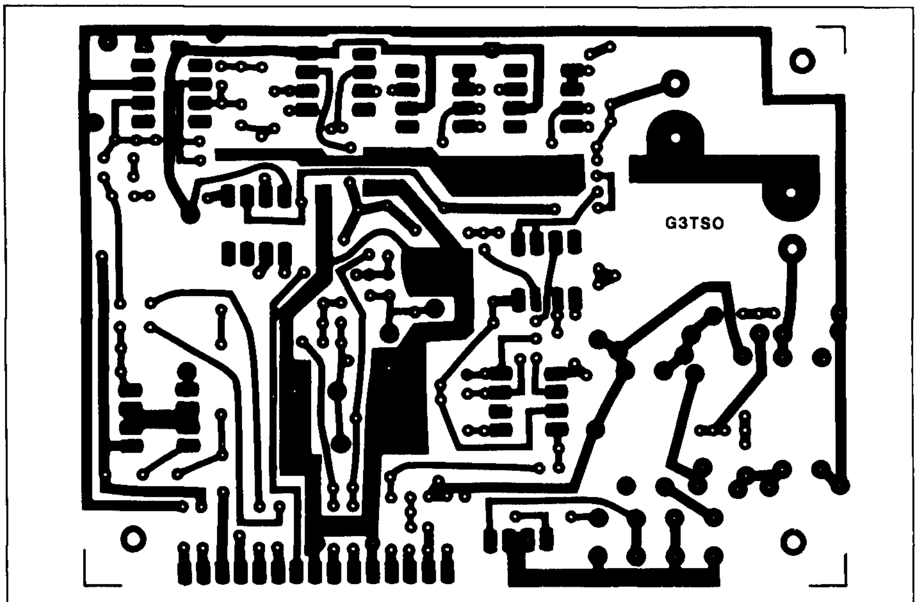


FIG 3. THE SIMPLIFIED PCB FOR THE EXCITER IN FIG 2 – ACTUAL SIZE.

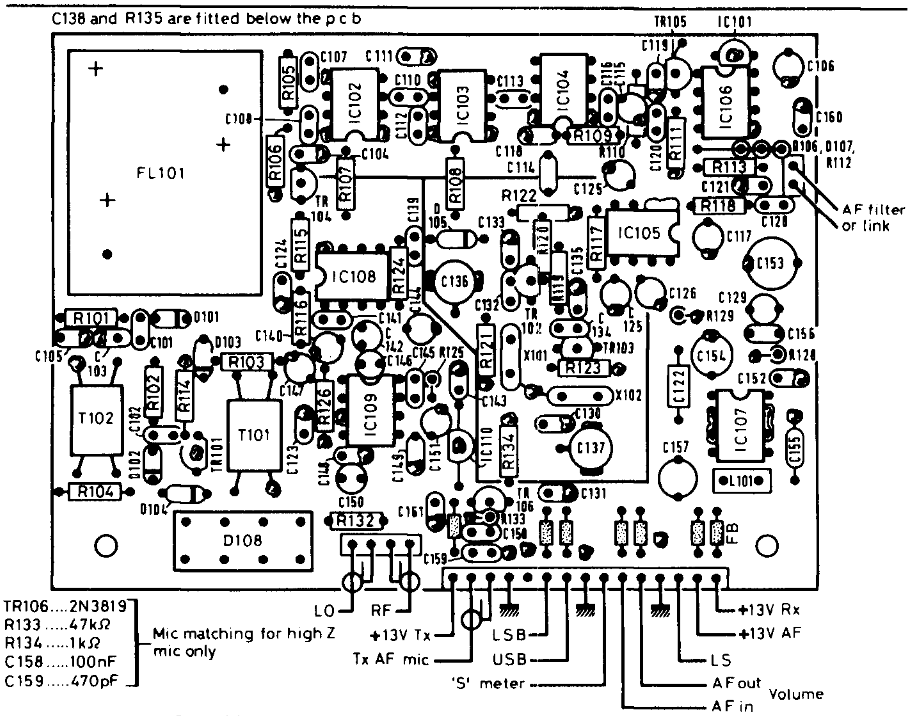


FIG 4. COMPONENT LAYOUT FOR THE EXCITER (OTHER SIDE OF FIG 3).

MODULES 2 AND 3: VFO AND PREMIX UNIT

Fig 5 illustrates both modules 2 and 3, the VFO, the premix mixer, xtal osc, band pass filters and broad band amplifier. These are capable of producing the required local oscillator (LO) signal to the SBL1 mixer in module 1.

THE VFO

The vfo is a conventional Clapp version of the Collpits tuneable oscillator employing a 2N3819 FET. The type is not critical and almost any high gain FET device will suffice.

The coil L201 was wound on an ex-equipment (Collins) ceramic former provided with an iron dust slug to vary the inductance. Special attention should be paid to the s lug which must be iron dust – not ferrite – and should be securely mounted to prevent vibration. Most purpose-built ex-equipment coils have a lockable or tightly fitting slug and if alternative coil formers such as the Neosid type are used, the cores must be tightened by taking a length of wool through the former to lock the core. It is better to use a coil with no slug in preference to a loose one, but alignment will be more difficult.

The coil is securely mounted to the side of the vfo enclosure with a clearance of at least 0·375" all round it . C205 is a plated brass capacitor with bearings at either end and is the RF27 unit type with a capacitance of approximately 50pF.

Capacitors C206, C207 and C209 are polystyrene types and C203 is silver mica. This has the effect of providing an element of positive temperature coefficient to counter the negative temp coef of the polystyrene type. Any residual drift can usually be reduced by substituting C203 with a similar value capacitor of different manu-

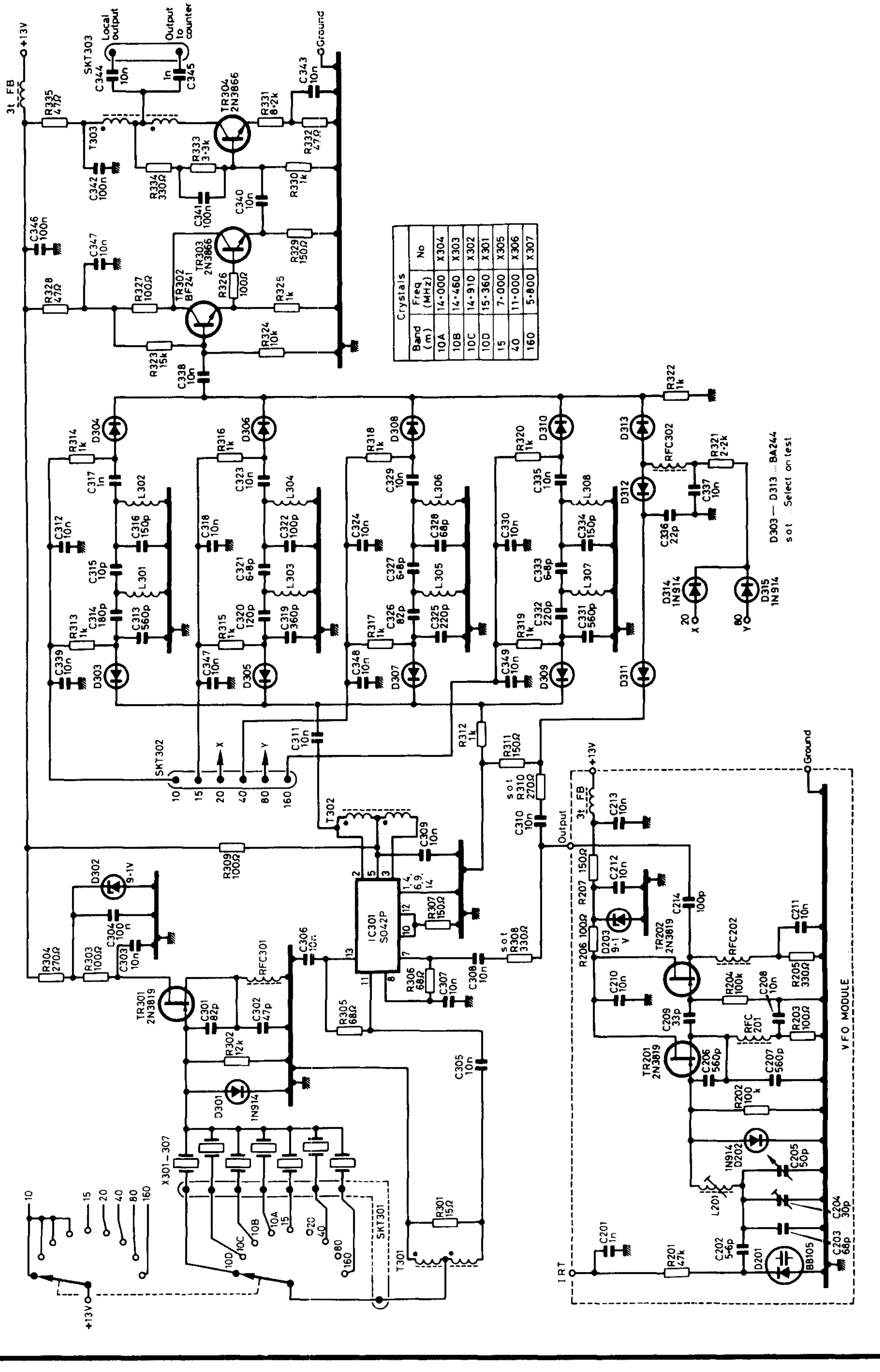


FIG 5. CIRCUIT OF MODULES 2 AND 3 – THE VFO, THE PREMIX MIXER, XTAL OSCILLATOR, BAND-PASS FILTERS AND BROAD-BAND AMPLIFIER.

facture or design. If any form of frequency jumping occurs it can be caused by high rf currents present in C203. This can be eliminated by making C203 up from three lower value capacitors wired in parallel.

D203, a silicon diode, serves to stabilise the gate voltage of the fet oscillator while D203 provides a regulated supply for the vfo and

MODULE 2

R201	47k
R202,204	100k
R203,206	100R
R205	330R
R207	150R
D201	BB105Varicap
D202	1N914
D203	9.1V zener
TR201,202	2N3819
RFC301,302	1mH axial choke
C201	1nF C
C202	5.6pF C
C203	68pF SM
C204	30pF Airspaced trimmer
C205	50pF Variable (see text)
C206,207	560pF poly
C208,210,211 212,213	10nF C
C209	33pF poly
C214	100pF poly
L201	29t 24 swg 19mm ceramic former with slug adjustment Approx 5uH
FB2	3t FX1115

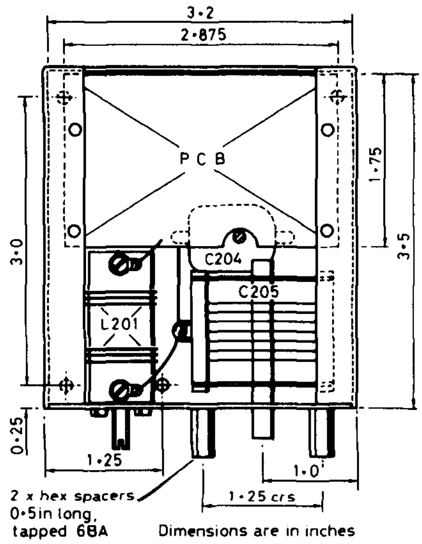


FIG 6(A). LAYOUT OF COMPONENTS INSIDE THE PURPOSE-BUILT ALUMINIUM BOX F OR MODULE 2 – THE VFO.

buffer amplifier. Irt or clarifier operation is provided by varying the dc voltage on D201 and provides about 2·5kHz variation either side of the carrier frequency.

Output from the vfo is loosely coupled to the gate of TR202 another 2N3819 FET acting as a source follower which serves to buffer the vfo from any marked changes in load. The output level from this stage is designed to feed IC301 the premix mixer and is inadequate for direct injection to the SBL1 without further amplification.

The vfo is housed in an aluminium box purpose-built to house C205 and L201 (Fig 6a) and a small pcb. Rigid construction techniques should be used throughout with heavy gauge wire used for all off-board connections. All components should be firmly mounted to the pcb, which in turn should be secured to the enclosure with a minimum of four screws. C203 can be mounted above the pcb on pillars to enable component changes to be made without having to remove the pcb.

Mechanical stability of a vfo is vital if worthwhile electrical stability is to be achieved. Moving or vibrating components can give rise to fm, frequency jumping and instability.

The pcb layout (Fig 6b) includes some unnecessary tracks which were originally intended to provide a higher level of output required to drive the SBL1. In this design it is left unused. The pcb component layout is illustrated in Fig 7.

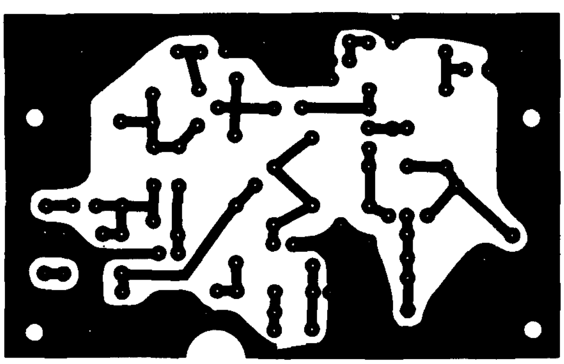
VFO ALIGNMENT

The VFO is aligned by adjusting L201, C204 and C205; the values indicated permit coverage of 5·0 to 5·5MHz ± 20kHz at the band edges for the full range of C205.

To commence alignment, centre C205 and C204 and ensure that the dc feed point to the irt circuit is grounded. With power applied to the vfo adjust the slug in L201 until the vfo oscillates at 5·250MHz; this can be checked with a suitable receiver or a digital frequency meter. The tuning capacitor C205 should be swung through its entire range and coverage of the vfo checked. Typically the vfo may tune to one end of the desired range but not the other, in which case, if the tuning range is insufficient, reduce the value of C204, readjust L201 and check the coverage again. If the coverage is too great then increase the value of C204 and repeat the operation. After several adjustments of C204 and L201 it should be possible to tune the range 5·0 to 5·5MHz with a little over at each end – say 10 to 20kHz. When the lid is placed onto the vfo unit

MODULE 3

R301		15R
R302		12k
R303,309,326,327		100R
R304,310		270R
R305,306		68R
R307,311,329		150R
R308,334		330R
R312,313,314,315, 316,317,318,319, 320,322,325,330		1k
R321		2.2k
R323		15k
R324		10k
R328,332,335		47R
R331		8.2R
R333		3.3k
D301,314,315	1N914	
D302	9.1V zener	
D303 – 313	BA244	
TR301	2N3819	
TR302	BF241	
TR303,304	2N3866	
IC301	SO32P Siemens-Bonex	
T301,302,303	3t + 3t bifilar Fairite 28-430002402	
RFC301,302	100µH axial choke	
FB	3t FX1115	
C301		82pF C
C302		47pF C
C303,305,306,307,308 309,310,311,312,318, 323,324,329,330,335, 337,338,339,340,343, 345,347,348,349		10nF C
C304,341,342,346		100nF C
C313,331		560pF poly
C314		180pF poly
C315		10pF C
C316,334		150pF poly
C317		1nF C
C319		360pF poly
C320		120pF poly
C321,327,333		6.8pF C
C322		100pF poly
C325,332		220pF poly
C326		82pF poly
C328		68pF poly
C336		22pF poly
	(IQD Stock No)	
X101 15.360MHZ	M451A	
X102 14.910MHZ	M455A	
X103 14.460MHZ	M459A	
X104 14.000MHz	A195A	
X105 7.000MHz	A136A	
X106 11.000MHZ	A139A	
X107 5.800MHz	To order	
All HC18/U-IQD Ltd.		
L301,302	Toko S18 0.45µH white	
L303,304	1µH Toko KANK3335R	
L305,306, 307,308	1.5µH Toko KXNSK4513BM or KXNSK4172EK	



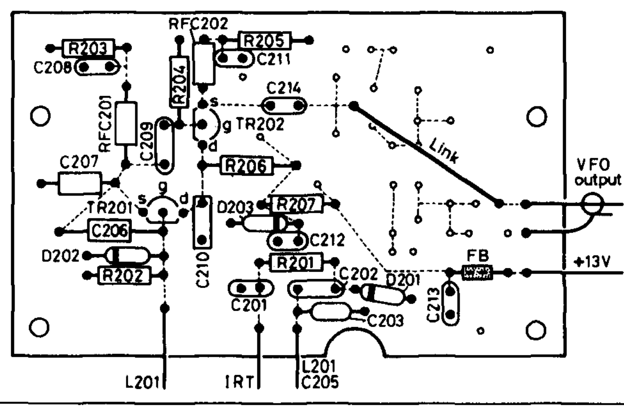


FIG 6(B). VFO PCB TRACK LAYOUT AND (RIGHT) FIG 7 – THE COMPONENTS.

the frequency coverage may change significantly owing to extra capacitance and some form of external adjustment of L201 and C204 is desirable.

The irt may be checked by applying a dc bias to R201. The component values indicated on the chassis diagram (Fig 21) will allow a swing of the vfo frequency by about 2·5kHz either side of the nominal frequency. This is sufficient for most purposes but can be increased or decreased by changing the range of the bias voltage.

When the vfo is complete and aligned, the stability should be checked for over one hour. Any residual drift can be reduced by replacing C203 with either another silver mica capacitor of the same value or a combination of silver mica and polysterene types. This process is a little tiresome but will produce a vfo with very acceptable stability. It should be remembered that the application of a soldering iron introduces heat to the vfo components and must be allowed to dissipate before further stability checks are made. A drift of less than 100Hz in 30 minutes is tolerable, but greater amounts can be annoying.

It is perhaps as well to mention at this stage that any slow motion drive unit used with the vfo should be mounted in the same plane as the vfo, or direct to the vfo enclosure, to prevent any frequency movement being caused by flexing of the chassis and front panel.

MODULE 3: THE PRE-MIX UNIT

Output from the vfo unit is fed via miniature RG174 coax to IC301 a Siemens SO42P double balanced mixer ic (Fig 8). R308 attenuates the signal slightly and may be adjusted to ensure that the vfo injection does not exceed 100mV rms at the mixer port. In addition, the vfo signal is routed via R310 to a diode switch comprising D311,312 and 313. On 14 and 3·5MHz the diode switch is biased on by applying a 13V supply from the bandswitch through diodes D314 and 315. This allows the vfo signal to pass directly to the wideband amplifier consisting of TR302,303 and 304, where it is amplified to the 500mV level required by the SBL1 mixer.

TR302 and 303 are configured as a Darlington pair providing high gain, high input and low output impedance, and serve to drive TR304, a 2N3866 power amplifier provided with negative feedback to improve linearity. The output of TR304 is transformed to 50ohms by T303, a 4:1 transformer, and should be at least 500mV rms. Stage gain is set by R331, nominally 8·2ohms and can be adjusted if necessary. The output is fed by RG174 coax to the SBL1 ring mixer via R134, a 50ohm series resistor located on module 1. R134 is an attempt to match the lo output to the SBL1. In the original module it was not included, but is an idea borrowed from Atlas. The purist may prefer to use a pi or T matching network which will necessitate raising the lo output level.

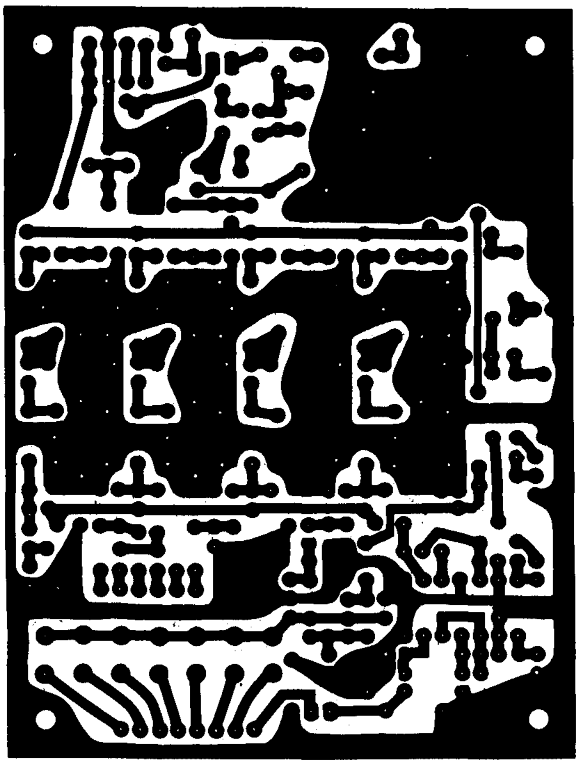
TR301 is an fet xtal oscillator employing a 2N3819; again most high gain FETs will suffice. It is switched for multiband operation and the choice of xtal frequencies ensures that the oscillator is only required to operate over the range 5·8 to 15·0MHz. Xtals are HC18/U types specified for fundamental parallel resonance. They are soldered in and have their cans grounded. No provision is made for the adjustment of individual xtal frequencies.

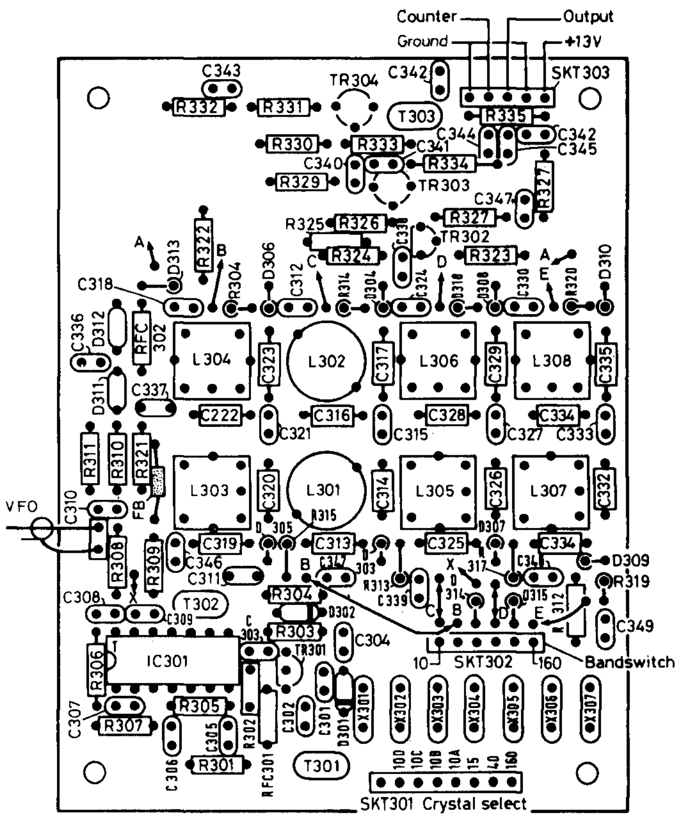
Output from the oscillator is taken by sampling the xtal current in T301, a 4:1 step-up transformer coupled directly to the second input port on IC301, the pre-mix mixer. Output from the mixer is developed across T302, a balun transformer providing a 50ohm match to the following bandpass filters. On 3·5 and 14MHz no xtal is selected, the mixer ceases to function and the vfo signal is routed directly to the broadband amplifier. On the remaining bands the vfo is mixed with the xtal oscillator and the resulting signals are filtered in the band pass filters before final amplification. The mixing process is as follows:

Band (metres)	Xtal (f1) (MHz)	VFO (f2) (MHz)	Output (f1 + f2) (MHz)
160	5·800	5·0 – 5·5	10·8 – 11·3
40	11·000	,, ,,	16·0 – 16·5
15	7·000	,, ,,	12·0 – 12·5
10A	14·000	,, ,,	19·0 – 19·5
10B	14·460	,, ,,	19·46 – 19·96
10C	14·910	,, ,,	19·91 – 20·41
10D	15·360	,, ,,	20·36 – 20·86

Fortunately the vfo and xtal oscillator signals are balanced out to a low level in the double balanced mixer, but the sum and difference signals are present and unwanted ones must be filtered out. A series of diode switched bandpass filters are used and are tuned to accept the f1 + f2 frequencies. Each of the four filters comprises of a pair of top coupled parallel tuned circuits with a 50ohm input impedance and a high output impedance. The lc ratio of the filters is chosen to provide adequate bandwidth over the desired bands. One filter is used for all four segments of 28MHz.

FIG 8. MODULE 3 (THE PREMIX UNIT) PCB TRACK LAYOUT, ACTUAL SIZE, AND (RIGHT) FIG 9 – THE COMPONENTS.





Choice of xtal frequencies for the three bands results in the i.o being on the low side of the signal and has the effect of causing sideband inversion on the hf bands. This effect can be used to change the lsb signal on the lf bands to usb as used by convention on the hf bands. The only complication is the mixing process used on 3·5MHz where the vfo is subtracted from the i.f with the result that sideband inversion occurs and in addition the band tunes in reverse. The sideband inversion can be overcome by switching the sideband oscillators when 3·5MHz is selected. This is achieved with the diode network comprising D8 – D13 (Fig 21). The sideband selector switch is labelled 'Normal' and 'Invert' and produces usb on the hf bands and lsb on the lf bands when in the 'Normal' position. 'Invert' selects the opposite sideband on any band.

The choice of oscillator xtals is based upon a range of off-the-shelf xtals from IQD Ltd. They are cheap and provide the required band coverage including complete, but overlapping, coverage of 28MHz. This may cause a few calibration problems with a mechanical dial but is of little consequence if a dfm is used. Choice of 7·00 and 14·0MHz xtals presents a slight problem in that the harmonics from both these xtals appear on the lower band edge of the 21MHz and 28MHz bands. They are quite weak and in practice fall slightly below the lower band edge. A simple cure for the cw operator wuld be to use xtals for 6·990MHz and 14·990MHz, so ensuring that the unwanted signals are well out of band. The vfo tuning will be offset by 10kHz but can be compensated for by using an additional irt circuit operated by the bandswitch if required. As the transceiver was intended for ssb operation the use of the existing xtals has proved perfectly satisfactory.

Module 3 is constructed on a single-sided glass fibre pcb measuring 3" × 4". The track layout is illustrated in Fig 8 and the component layout in Fig 9. The board has a high component density and it is important to use miniature components. In addition there are a number of flying links located above the pcb. Toko coils are used and may be off the shelf types of appropriate inductance or rewound from surplus units.

TESTING AND ALIGNMENT

No alignment of the xtal oscillators is required or even possible. In practice, xtals tend to oscillate slightly low in frequency. The mixer and broadband amplifier have no adjustments other than the selection of R308 and R310 – the actual values used are indicated in Fig 5. R308 is chosen to set the vfo injection to IC301 at 100mV rms.

With 13 volts applied to either D314 or D315, the vfo signal should appear at the input to the broadband amplifier. If power is applied to the amplifier then the vfo signal should be available at the output at around 500mV rms. The output level is adjustable by selecting R310 which should be chosen to give a similar output level on 14MHz and 3·5MHz to that obtained when the mixer unit is operating.

The xtal oscillator may be tested by applying 13V and connecting a jumper lead across SKT 301 to select the appropriate xtal. Each xtal should be checked in turn to ensure that the circuit oscillates and that the frequency is correct. The xtal oscillator injection to IC301 should not exceed 100mV rms.

Bits

Boston Computer Society Establishes Amateur Radio Special Interest Group

The Boston Computer Society (BCS) has announced the establishment of an Amateur Radio Special Interest Group. The BCS Member Services Committee voted to establish the new ham radio group to tap the synergy existing between personal computing and amateur radio.

"The formation of this special interest group will bridge two distinct, but complementary fields of interests," said Barry Porter, director of the Amateur Radio Special Interest Group. "It exposes personal computer users to ham radio, while allowing amateur radio operators to take advantage of the wealth of resources made available by the BCS, such as an abundance of technically competent members, an enthusiastic volunteer-based organization and extensive membership benefits."

Porter explained that applications for computers in ham radio include digital radio communication, network management, earth-based and satellite station control, video/FAX signal processing and a number of special-purpose applications, such as propagation prediction, satellite tracking, record-keeping and telemetry.

The Special Interest Group was formed by a core group of BCS members after more than a year of planning and organization. Monthly meetings and a group newsletter covered such topics as packet radio, shortwave listening (SWL), amateur satellites and reception of high resolution weather satellite images. The group's plans include several technology-related projects, both hardware- and software-based. In addition, an Amateur Radio Novice license class will be offered in the fall.

For further information contact: Barry Porter at 617-341-2639 or 617-769-6000 extension 174, or Tom Walsh, 617-466-2392.

Radio Sputnik Bulletin from RS3A

On July 4, 1989, AMSAT-NA ex-president Vern Riportella, WA2LQQ, made his first visit to the Radio Sputnik Laboratory and RS satellite command station, RS3A, in Moscow. He met with RS program leaders: Valery Salenko, Laboratory Director; Vladimir Luban, Vice-director; Valadimir Eraksin, Project Group Chief; German Mikle, Project Group Engineer; Leonid Maksakov, RA3AT, Command Station RS3A Chief Leonid Labutin, WA3CR, Radio Sport Federation of USSR Communication Committee member, and; Boris Stepanov, UW3AX, Editor of *Radio* Magazine. Discussed were questions about the history of amateur satellite communications in the USSR; organization of some competitions and nets through amateur satellites; use of some operational modes of satellite transponders; coordination of national AMSAT tasks, and; the exchange of information. In the USSR, it is hoped that this historical meeting will be a new step forward in amateur world cooperation and success is wished for the launch of the new OSCAR birds.

NEW FROM McGRAW-HILL

Digital Video in the PC Environment, by Arch C. Luther, investigates digital video interactive (DVI) technology, showing how it combines interactive full motion video, stereo audio, and powerful computer graphics. Discussions are devoted to issues involved in DVI such as video digitizing, selection of video material, video production consideration, and real-time operations and multitasking.

An Intertext/McGraw-Hill copublication. 330 pages, illustrated, 6 inches by 9 inches. Available in hardcover, $39.95, and paperback, $27.95. Publication date: February 1989.

High-Frequency Switching Power Supplies: Theory and Design

A blend of theory and practice, this guide includes material on effective designing in all phases, diagrams, tables and examples that supplement various discussions. Detailed explanations of advances in magnetic amplifiers, new topologies for operation over 100 kHz, resonant converters, synchronous rectifiers, bipolar transistors and MOSFETs. Also examined are PWM control integrated circuits, output supervisory circuits, feedback loop stability analysis, the EMI-RFI problem and power safety standards. *High-Frequency Switching Power Supplies: Theory and Design*, by George C. Chryssis, is available from McGraw-Hill, 1-800-2-MCGRAW. Cost: $39.95, 287 pages, second edition.

Correspondence

The Rockwell R24MFX Modem

This is a brief description of some experimental work we did using an inexpensive modem IC to transmit "high speed" digital data over an HF radio link. The experiments were prompted by our work with a commercially available product (Gammafax), designed to enable a personal computer to transmit and receive facsimile, which would successfully transmit facsimile over HF but not data, although it would over the public telephone system. Specifically it concerns our experimentation with a modem IC made by Rockwell, the R24MFX, which is aimed at the rapidly growing facsimile market. While extensive testing over HF has not been done, indications are that it will operate quite well over a link that is not suffering from fading. It is also quite interesting to experiment with, as it is designed to be operated on a computer bus via which one can access quite a variety of diagnostic data.

The IC comes as a 64-pin QUIP (four rows of staggered pins) which can make it somewhat hard to handle. Fortunately Rockwell also has available a socketed evaluation board, the R24MEB/TX00-D120-001. This makes interfacing with the chip quite simple since it has a ribbon cable header, op-amps for buffering, and all other necessary parts to make it a functional component. The total cost was in the vicinity of $200 (Canadian). The Rockwell *Modem Products Data Book* is also a good (free) investment as it covers the R24MFX, as well as other modem products quite thoroughly and also has some good applications notes.

The IC is based on digital-signal-processing technology and as a result has a fair amount of "smarts," much of which is available to the user when the evaluation board is interfaced to personal computers using many of the available prototyping boards. We used the JDR Microdevices PR1 prototype board and an IBM AT clone running a "C" program developed specifically for the chip. The modulation used is differentially encoded QPSK (four available phase changes) of an 1800-Hz tone at 1200 bauds resulting in a rate of 2400 bits per second. In addition to this there is a synchronous 300-baud FSK mode of operation which is required in a facsimile modem for control purposes. The IC has built-in switched capacitor filters, an adaptive equalizer which will correct for limited channel amplitude and phase distortions which cause intersymbol interference, and a data scrambler to protect from loss of synchronization due to certain data patterns. The signal bandwidth required is approximately from 700 Hz to 3 kHz (-20 dB points of transmitted spectrum). It can be shifted by simply changing the master crystal frequency and the two capacitors in the analog single pole filters which provide input antialiasing protection and output filtering. The baud rate, signaling frequencies, etc, all scale uniformly. Other interesting features which were made use of through access of the chip's internal RAM memory were:

Applied AGC—the amount of agc (up to 40 dB) the chip is applying to the incoming signal to maintain the desired signal amplitude.

EQM Value—the "error vector magnitude squared," which is indicative of the expected error rate.

Delta F—the frequency correction the chip is apply to the incoming frequency to bring it into the required tolerance—a useful feature for use with HF SSB radios.

One task that must be done by the user is to "byte" synchronize the receiver and transmitter. This can be done in software by searching the incoming data stream for a known transmitted pattern which is the method we used. There are also serial data lines which would allow a USART such as Intel's 8251 to perform this task. In our test, synchronizing data was sent only once at the beginning of the transmitted message of typically 30,000 bytes—we did not have any problems with bit slipping. Since it is very hard to characterize HF channels—which makes the tests somewhat subjective—on a channel with static bursts quite audible over the modem signal the worst error rate we obtained was 0.6% during the course of the experiment. When the channel was noticeably fading, the modems refused to connect. Another item to be aware of is the automatic training session which is specific data sequence stored in the chip which is transmitted prior to the user's message and which is removed by the receiver. This is used to set up the adaptive equalizer for the channel characteristics at the time of transmission and takes about three-fourths of a second—something to bear in mind if a ARQ type of error correction is to be used. The adaptive equalizer can be frozen in a specific state and the training session omitted if desired, but we did not try any transmissions in this mode.—*James Parks, Institute of Ocean Sciences, PO Box 6000, 9860 West Saanich Road, Sidney, British Columbia, Canada V8L 4B2*

Corrigendum

The following errors appeared in N4ICK's, June *QEX* article "Practical Spread-Spectrum: Clock Recovery with the Synchronous Oscillator."

a) The drawing for Fig 1 was printed as Fig 2, and vice versa. The captions are correct.

b) Under the title **Adjustments**, the text should read: "A digital frequency counter is connected to the output of U4 (pin 11) to determine the frequency of the oscillator. The counter probe is then transferred to the output of the synchronous oscillator, U5 pin 10. The wiper of R1,"

c) The sign "%" was omitted twice in the paragraph entitled **Tracking Range:** "This 1.5% tracking range is generally in agreement. . ." and "Typically less than 0.006% which is but a fraction. . ."

d) The title of that paragraph should read **Tracking Range** not **Tracing Range**.

—André Kesteloot, N4ICK

Bits

Coherent CW

G3RHI and I are trying to get started on coherent CW, having lost interest some years ago when the system seems to have lost favor with the amateur fraternity. We understand that there are amateurs in Holland and Germany who may be operating the system and wonder if there is still any interest in the States. We would be pleased to hear from anyone who may like to help in reviving coherent CW, though it will be some time before we are operational.—*Peter Lumb, G3IRM, 2 Briarwood Avenue, Bury St Edmunds, Suffolk IP33 3QF, England.*

VHF⁺ Technology

By Geoff Krauss, WA2GFP
16 Riviera Drive
Latham, NY 12110

Low Noise Amplifiers, and Components therefore

This column was written late because I've gotten wrapped up in reviving the GaAsFET preamp in the W2SZ/1 1296 MHz receiver converter in time for the June VHF + contest; replacement of this 4/81-built LNA is a project that fits in very well with all of my topics this month. First, I have received favorable response to the question of whether the time is right for another 'GFP LNA survey, both from you the readers and from some involved manufacturers. Terry Cummings, WA6WCB, of California Eastern Labs (the US distributor of NEC VHF + devices) has sent along a number of samples, including some of their latest NE32084 hetero-junction GaAsFETs (pseudo-HEMTs), which look to have under-1.0 dB noise figures at 10 GHz! I'm expecting samples of Avantek ATF-10135 devices and will let you know how they work out. These would be devices to build the "Simple Low-Noise Microwave Preamplifiers" from the May 1989 *QST* article by Al Ward, WB5LUA. I did obtain some of the required 51-ohm chip resistors as samples from Jay Benson, the Sales Manager of International Manufacturing Services, Inc, 50 Schoolhouse Lane, Portsmouth, RI 02871-2418. Jay is willing to send catalogs and samples or small quantity orders to "anyone showing an interest in chip resistors" (but, please, don't be greedy); the IMS type RC1206 (250 mW) units seem best for this amplifier job.

In response to a previous request for information on a source of Avantek GaAsFETs, a number of commercial source distributors have been suggested to me. All, however, have at least a $25 minimum order requirement. This makes it very hard to buy a single device. John Molnar, WA3ETD (SHF Systems, PO Box 666, Nashua, NH 03061), wrote me a note to say that he has Avantek ATF10135 devices for $12.50 each. He also was planning to source kits for 1296 converters, 3456 transverters (the WA8NLC design featured in June 1989 *QST*), etc, apparently in conjunction with Bill Olson, W3HQT (Down East Microwave, Box 2310, RR 1, Troy, ME 04987).

I did buy some 10135s for use in 1296 LNAs. One interesting design is in the article "Low-Noise VHF and L-Band GaAsFET Amplifiers," again by Al Ward of Avantek, in the February 1989 issue of *RF Design*. This article covers a set of single-stage 400-1600 MHz LNAs (sample designs just happen to be at frequencies of 450, 900 and 1300 MHz!) which use extra source-lead inductance to obtain noise match with good input VSWR. Unfortunately, there is no layout artwork. This is very inconvenient at 1296 (it would make duplication almost impossible above 2300 MHz). Al's design (0.50 dB noise figure and 14.5 dB gain) appears to be somewhat intolerant of minor changes in layout and/or components. I tried several layout versions, varied chip capacitors over a fairly large range and used whatever RFCs and resistors (carbon, tin-film, etc) were available, and came out with five units that, as tested with three different NF meters (a pair of HP8970s and an AIL75, with several different noise heads) had the specifications shown in Table 1.

I had two only subminiature 0.33 μH RFCs (units 1 and 3), so use of non-optimum RFC and resistors may explain lower gains in units 2 and 4; the low current at which unit 5 had minimum NF is suspect—I can explain this only by possible damage to the #5 device, which "jumped" out of its package and bounced around on the floor (you will understand when you see the nested pair of plastic domes that these devices are shipped in—be very careful in opening!). On the other hand, I took no rigorous grounding precautions with any of the devices; there does not *appear* to be a need for grounding everything when handling the device. I only needed to carefully pick the device up by a source or drain lead; much easier to work with than some GaAsFETs of the not-too-distant past. And, the LNAs are completely stable (do not oscillate, even with highly-reactive source and/or load!). Al also has a 900-MHz version.

My conclusion: When layout and components mesh, probably the best, and definitely the simplest, noncavity LNA that I have tried for 1296 MHz is a kit, from sources of Al's other preamps.

State-of-the-Art: the 23-cm band (1240-1300 MHz)

It has always been fairly easy to generate *some* signal for mid-UHF transmission, as by use of the third harmonic of 420, the ninth harmonic of 144, etc. The major roadblock to 23-cm use was reception! Given that one wanted to use superheterodyne receiving methods, the early users of this band were on a continuing quest to find a best form of down-conversion mixer, as no form of preamplification was available. Originally, a bare diode mixer (8-dB NF and conversion *loss*) was used. The first improvement was to filter both the incoming RF (to remove the noise at the image frequency) and the incoming LO (to remove harmonics, which mixed with the available RF and gave IF signals at useless frequencies). The famous cavity and interdigital filter mixers found in the Handbooks of the '50s, '60s and '70s are examples (5-dB NF and 15-dB conversion gain, due to a *post*-mixer IF amp). A good converter/receiver front end today will still have this filtering, but will not stop there, as low-noise, positive-gain amplifiers are now fairly easy to design and build. Because gain can be provided before the mixer, it is no longer necessary to have an active, gain-providing mixer (a feature of many late-70s/early-80s designs, particularly those of European origin). Indeed, use of more than a few dB of conversion gain can worsen the overall front end performance. With reasonable band pass filtering right at the reception input (necessary to keep out-of-band signals from overloading the broadband RF stages), typical 23-cm front ends can be expected to have noise figures in the 2-4 dB range. There are many 23-cm converters available today, both in kit and built forms. Most are compromise designs, trying to satisfy the largest number of users, each has some shortcomings. By far the biggest problem is not sensitivity (which can be improved to the under-1.0 dB range by the addition of a good GaAsFET preamp) or selectivity (which can be improved by the addition of a low-loss cavity/IDF filter before the preamp or converter), but low stability and high spuriousity! I have a number of com-

Table 1

Unit	*1*	*2*	*3*	*5*	*6*	*2+5+ cabling*
Noise Figure (dB)	0.51	0.57	0.48	0.83	1.01	0.65
Forward Gain (dB)	14.30	12.61	13.46	12.97	7.81	20.34
Preamp Current (mA)	21 +	20 –	20	23	10.5	30.5

mercially available converters with the LO chain built right into the same compartment as the 23-cm circuitry. Not only is the frequency-determining crystal out in the open, with no attempt to control its temperature and such, but all of the multiplier stages can squirt all sorts of undesired signals around the converter (and perhaps even out to the antenna). What is the solution? A separate LO unit, or at least a separate LO-chain compartment, shielded from the rest of the front end; thermal compensation, of any effective form, can then be more easily provided for the crystal. This should be just as important for the exciter of a CW or FM transmitter, or for the common LO chain of an SSB transceiver.

Yes, complete FM transceivers *are* available for the 23-cm band. They have a power output in the 1-3 watt class, as there are a number of devices for class-C solid-state amplifiers in this range and units are relatively easy to build. One safety consideration for potential purchasers to think about: How close to you (and particularly to easily RF-heated parts, like eyes) will the antenna be when the unit is in transmit? There are even commercially available repeater base stations for 23 cm. The maximum commercially available solid-state power amplifier level is around 75 watts, with about 13 dB gain (see Down East Microwave model 2370PA). This effectively replaces the older single-tube 7289-class amplifiers so common in larger 23-cm stations. However, output power in excess of 100 watts still requires use of a vacuum tube. There are a number of two-tube designs and ready-made units, such as available from Hi-Spec (Box 387, Jupiter, FL 33468) and others, that can provide 150 + watts; just how much more than 150 watts seems to depend a lot upon the type of cooling used and the length of time one is willing to tolerate before the tube seals melt. I have heard of tubes which hold the promise of 300 + watts of output power from a single bottle, but the price is high and availability scarce. One interesting design was presented by WBØDRL at a Northeast VHF Conference held in the last year or so. This amp uses a cull of an EIMAC UHF-TV tube ($300?, but I'm sure anyone who pays going rate for 8877s would not blanch at this).

Even more available are transverters for converting SSB signals up to 1296 MHz. Typical IFs are 28 or 144 MHz, and power inputs of less than 1 watt are generally required. Output power is in the 1-10 watt range, and can be linearly increased to at least 60 watts, solid-state, and to over 200 watts with multiple-tube units. It probably should be noted that there have been a few amp designs which use 4 or 6 tubes of the 2C39/7289 lighthouse variety. Most experiences seem to indicate that tube match and tuning are *very* finicky and delicate. Of course, if you're bouncing signals off the moon, every watt is important, but most 23-cm stations make due with something a little less costly (in time, anyway). In considering the purchase/construction of any 23-cm equipment, careful examine the ruggedness of construction (frequency stability, in particular, requires a very rigid unit) and the ease of parts replacement (that cheaper transverter suddenly becomes more expensive if you have to go to Holland to get a new output device!).

There is some older equipment, occasionally seen at flea markets, which is completely inappropriate for use on today's 23-cm band: APX-6 WBFM conversions, Korean-war-vintage TWTs, etc. There is also some equipment, such as power varactor-diode frequency triplers (typically, 10 watts in at 432 and 4 watts out at 1296) that may be of great interest to contest/portable stations. There are any number of antennas of interest, some commercially available (Yagis made with linear or circular "loop" elements), and much more in the amateur press. As will all other specialized aspects of most hobbies, it is often best to talk to those already immersed, before you jump in.

Bits

Active Amateur Radio Satellities

Satellite	*Mode*	*Uplink*	*Downlink*
RS-(10)/11	A	145.860-145.900	29.360-29.400
	T	21.160-21.200	145.860-145.900
	K	21.160-21.200	29.360-29.400
	K/A	21.160-21.200	29.360-29.400
	K/T	145.860-145.860 21.160-21.200	29.360-29.400 and 145.860-145.900
	Robot	21.120 and/or 145.820	29.403
	Beacons		29.357, 29.403, 145.857, 145.903
RS-10/(11)	A	145.910-145.950	29.410-29.450
	T	21.210-21.250	145.910-29.450
	K	21.210-21.250	29.410-29.450
	K/A	21.210-21.250 and 145.910-145.950	29.410-29.450
	K/T	21.210-21.250	29.410-29.450 and 145.910-145.950
	Robot	21.130 and/or 145.830	29.453
	Beacons		29.407, 29.453, 145.907, 145.953
OSCAR-10	B	435.050-435.155	145.850-145.955
	Beacon		145.810
UoSAT-OSCAR-11		145.826 MHz FM	
FUJI-OSCAR-12			
	JA	145.900-146.000	435.900-435.800
	Beacon		435.797
	JD	1. 145.850 2. 145.870 3. 145.890 4. 145.910	435.910
OSCAR-13	B	435.420-435.570	145.975-145.825
	B Beacon		145.812
	J/L (L)	1269.620-1269.330	435.715-436.005
	and (J)	144.425-144.475	435.990-435.940
	J&L Beacon		435.651
	RUDAK	1269.710	435.677
	S	435.601-435.637	2400.771-2400.747
	S Beacon		2400.325

Components

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NEW INTEL MICROPROCESSORS

Intel has announced three new microprocessors to extend the range of their line. The new chips are the i486, the 386SX, and the 386DX. The 386SX and 386DX are enhancements of the 80386 microprocessor, which is found in all of the latest high-performance IBM PC compatible and IBM PS/2 computers. The i486 extends the performace beyond the 386 family to what Intel calls "mainframe-level performance." These new chips will no doubt find their way into many ham shacks in the form of powerful desktop and laptop computers. All of the new chips are 100% binary compatible with each other.

The i486

The 486 has a 32-bit internal and external architecture allowing true mainframe-like performance. In addition, the 486 includes Reduced Instruction Set Computing (RISC) techniques for frequently used instructions and pipelining. These two features will enable the chip to perform significantly faster than older microprocessors in just about any application. RISC allows instructions such as LOAD and STORE to execute in just a single clock cycle, rather than two-to-four as is the case with older chips. And, it is clock cycles per instruction rather than clock speed that truly determines the processing speed of a given computer.

Another forward-looking feature of the 486 is its multiprocessor instructions. These instructions allow several processors to perform in optimum harmony in environments using more than one 486. This is especially helpful when running an operating system such as UNIX. In fact, AT&T, Convergent, Olivetti, and Prime (all companies hot on UNIX development) all participated in development.

For those of you interested in benchmark numbers, the 25 MHz 486 provides 15 VAX MIPS, and the 33 MHz part gives 20 VAX MIPS. A VAX MIPS is equivalent to one million instructions per second running on a DEC VAX computer. In other words, these are *fast*!

(EDITORS NOTE: Yes, MIPS is both plural and singular. There is no "MIP"; since MIPS means million instructions per second, and a "MIP" would be a meaningless "million instructions per.")

The 486 is produced using Intel's one-micron CHMOS IV process. In other words, the chip uses the latest CMOS transistor technology, with line widths of *one millionth of an inch*. That's really packing the transistors onto the IC. . . in fact, there are 1.2 million transistors on the microprocessor, occupying a space of only 0.414 × 0.619 inches (see photo 1).

The 486 will find a home not just in personal computers, but in the lucrative (or so it is predicted) workstation and file server market. Translated, that gives them a product to compete with Sun microsystems.

Samples will be available about the time you read this, and even though production quantities won't be available until near the end of the year, several manufacturers of personal computers, including IBM and Compaq, have already announced plans to build machines using the 486. So, if you have a need for a super-fast, super-power PC, or if you just are one of those folks who "has" to have the latest and greatest, look for these machines next year. Software written to take advantage of the 486 should also start appearing by next year too, as dozens of companies have jumped on the bandwagon and announced "support" for the 486. . . whatever that actually means. If you thought that 40-pin DIP ICs were incredible, consider that the 486 is packaged in a *168-pin* pin-grid array (see photo 2).

As many people learned when the first 16-bit microprocessors appeared in the early 80s, a lightening-fast microprocessor coupled with "older" peripherals doesn't satisfy the intent. So, Intel

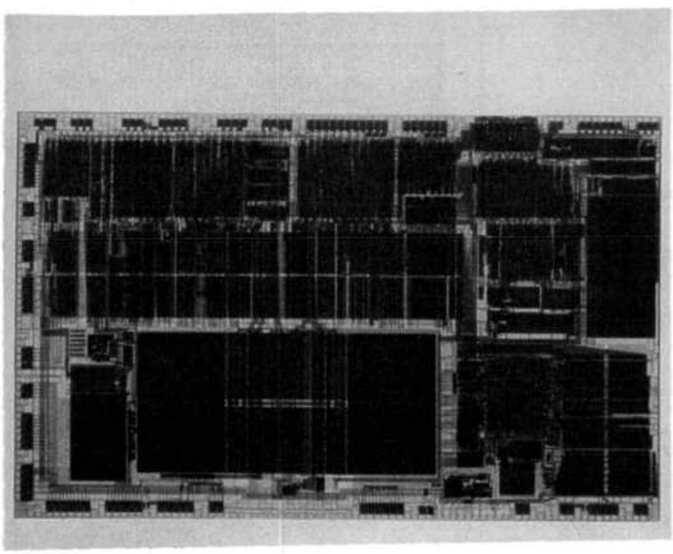

Photo 1—The i486 microprocessor packs 1,180,235 transistors into a 0.414″ × 0.619″ die. Featuring a high-level of integration, the i486 CPU has on-chip: a floating-point unit, 8k cache and memory management with paging.

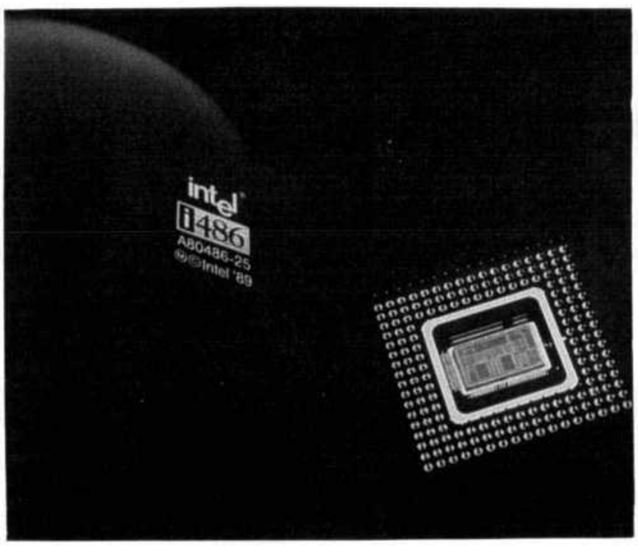

Photo 2—The i486 microprocessor provides the highest performance available across the $15 billion software base of DOS, Windows™/386, OS/2™, USIX™ System V/386, Xenix™ and iRMX® operating system applications.

introduced a line of new peripheral chips coincident with the 486. Briefly, the new peripherals include the 82596CA LAN coprocessor for networking, the 85C508 Programmable Logic Device for interfacing to high-speed memory, and the 82480 DMA controller. They also have two 82350 chips sets for integrating the 486 into either an EISA (in other words AT-like) or MCA (PS/2 compatible) architecture. It sure seems like Intel has all the bases covered.

The 386DX

No, the 386DX isn't the Luxury version of the latest import car. It's the souped-up version of Intel's hot 80386. I know, I haven't yet had time (or money) to get a PC based on the plain ole 386 either, but you can't stop progress. The 386DX is Intel's 33 MHz version of the 386 chip.

The 386DX is a healthy speed improvement over the previously announced 25 MHz 386, and like the 486 has a compatible set of peripherals. The 386DX can make use of the same peripheral chips mentioned above, plus the 387DX math coprocessor. The chip should be available now, and it's 1000-piece price is $367. If you think that's expensive, consider that the original 8080 didn't cost too much less than that when it was introduced more than a decade and a half ago.

386SX

The final member of Intel's new trio of 32-bit microprocessors is the 16-MHz 386SX. This chip is intended primarily for laptop computers, and a couple have already hit the market. Although a '386-based laptop is a logic progression of technology, it still is mind boggling to consider that a computer smaller than a briefcase can now house the power of a mainframe computer that just 25 years ago occupied a large room (and required air conditioning and humidity control.

The key to using the 386SX in laptops is its virtue of low power consumption and high-temperature tolerance. The chip is capable of operating at up to 100 degrees fahrenheit. For even better battery life, it can be operated at lower clock speeds to reduce power consumption by 20 to 30% Amazingly, the 1000 piece price is just over $100. . .which should yield some attractive prices on very powerful laptops.

To complete the high performance laptop package, Intel also announced the 387SX math coprocessor and the 82385SX Cache Controller.

To get more information on any of the Intel products listed, contact them at Intel Corp, 3065 Bowers Avenue, Santa Clara, CA 95052-8065.

These announcements were so significant that I decided to devote then entire column to them this month. The next installment of *Components* will return to the normal variety of components for your home-brewing enjoyment.

Bits

Date Changed for AMSAT Space Symposium

At present, the launch of the MICROSATs is scheduled for November 10, 1989. Since this falls in the time frame of the 1989 AMSAT-NA Space Symposium, AMSAT-NA officials have changed the Symposium dates from November 10-12 to the weekend of *November 3-5*. Everything else remains the same: the location is still Des Moines, Iowa; registration is on Friday; seminars will be held on Saturday; the Annual AMSAT-NA Banquet will be Saturday evening, and; the Board of Directors meeting will be on Sunday. For more information about the AMSAT-NA Space Symposium contact AMSAT-NA HQ at 301-589-6062 or Ralph Wallio, WØRPK, at 515-961-6406.

Conductive Paint

Aremco-Shield 615 silver-elastomer compound is used as a conductive paint for EMI/RFI shielding. It bonds metals, glass, ceramic, and many plastics and offers an efficient conductive path. Available from Aremco Products, Inc, Box 429, Ossining, NY 10562.