HOME BREW
7MHz SSB TRANSCEIVER

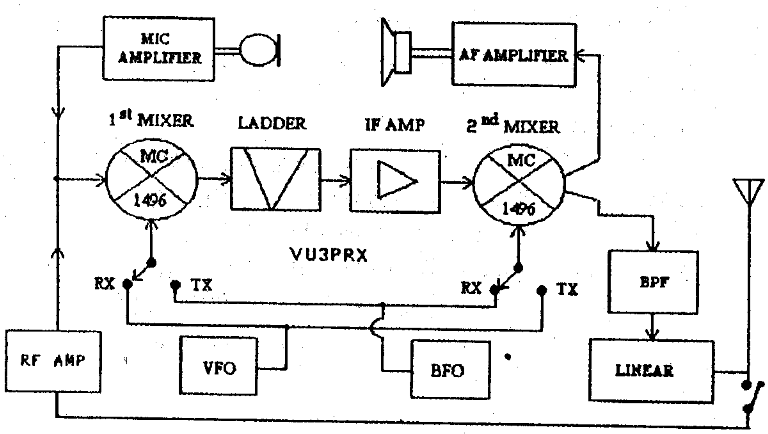
The transceiver described here is remarkably simple based on popular communication building block MC1496. It is fairly simple to build because most of the functions are performed by MC1496.

The emphasis during the design of the project was on repeatability, minimum number of switching and ability to modify for multi band operation.

In the beginning I would like to say that none of these circuit ideas are totally original and are taken from various books and magazines.

The circuit uses easily available components. Most of the coils are wound on low cost balun core. The circuit uses a ladder filter. Filter is build around four numbers of 4.43 MHz crystals. I used ladder filter because it is cheap and getting reasonably good reports.

The circuit uses two numbers of MC1496. First MC1496 functions as receiver mixer cum balanced modulator. Second MC1496 works as product detector cum transmit mixer. The block diagram of the transceiver is given below.



Presently the circuit is only for 7 MHz SSB operation. It can be modified for other bands by suitably changing VFO, transmit band pass filter and receiver band pass filter. I had avoided CW and AM provision for simplicity. CW and AM can be implemented by making some carrier to leak through balanced modulator. This can be done by offsetting balanced modulator by applying some external voltage to pin 4 of MC1496.

Before you start heating your soldering iron, here is some advice for beginners.

1. Avoid dry soldering- Many of the problems with unsuccessful project are dry soldering. Dry soldering is due to dirt in soldering surface Clean legs of the component and pcb surface before soldering. Use good quality soldering plaster and lead.

2. Before placing components- confirms the value of resistance, legs of transistors, pin configuration of IC. etc.

3. Assemble stage by stage- Never put all the components in the board expecting it will work perfectly when you switch on. It is highly recommended to follow some divide and conquer method. Divide your project into small modules that can be easily assembled and tested. Test each module thoroughly before going for next stage.

MC1496 DBM

A mixer is a nonlinear element that combines two signals. A mixer has three ports: F1 receives low level signal; F2 is high level signal (local oscillator) and F3 is the resultant mixer product.

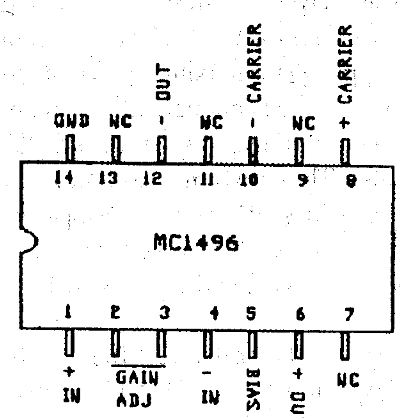
The output of the mixer contains number of different frequencies that obey the relationship $F3=mF1+nF2$. Where m and n are integers 0, 1, 2, 3.....

There are three types of mixers: single-ended, single balanced and double balanced. Double Balanced Mixer (DBM) suppresses F1 and F2 components of the output signal leaving only the sum and difference frequencies. Double Balanced Mixer provides superior suppression of the local oscillator and RF signals in the output leaving only the sum and difference frequencies. This is known as port to port isolation.

MC1496 is an active double balanced mixer made from bipolar silicon transistors formed into Gilbert transconductance cell.

The transceiver is designed around two numbers of MC1496. The first MC1496 performs the function of Receiver mixer and balanced modulator. Second MC1496 works as Product detector cum Transmit mixer.

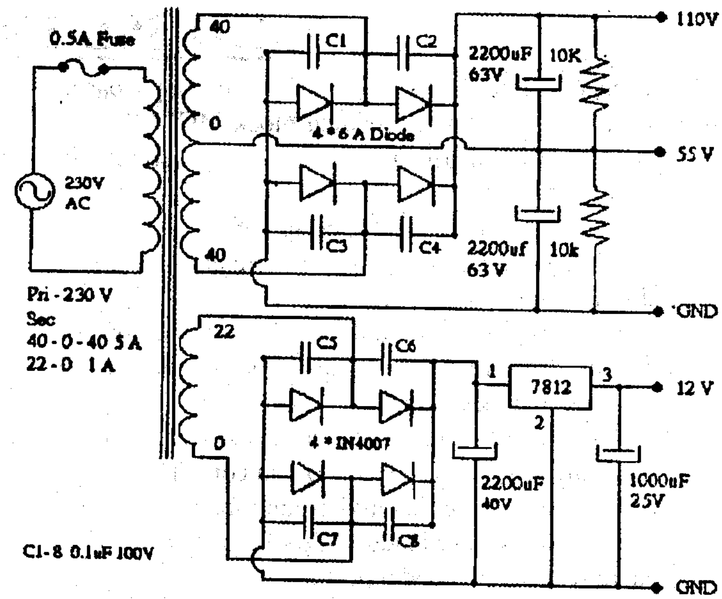
MC1496 is available is 14-pin DIP package. Brief descriptions of various pins are given below.



Pin 1 and pin 4 are balanced low-level inputs. Pin 8 and pin 10 are balanced high-level inputs. Pin 6 and pin 12 are outputs. Pin 5 is bias usually connected to Vcc through a resistor (normally 10k). Pin 2 and pin 3 determines gain of the mixer. The gain will be maximum when pin 2 and pin 3 are shorted. Gain can be adjusted by connecting some resistance between pin 2 and pin 3. Pin 7, pin 9, and pin 11 and pin 13 are not used.

DC Voltage measured at various pins of MC1496 given below. There may be slight variation in these voltages due to accuracy of measuring equipment or components used.

PIN	VOLTAGE	PIN	VOLTAGE
1	3.58V	8	6.51V
2	2.96V	9	NC
3	2.91V	10	6.51V
4	3.58V	11	NC
5	1.25V	12	11.8V
6	11.81V	13	NC
7	NC	14	0V [GND]



TEST EQUIPMENT'S

Assembling will be easy if you use proper test equipments. Average hobbyists can't go for sophisticated test equipments. In this project I had used multimeter and RF voltmeter for measurement. Using RF probe you can use multimeter as RF voltmeter. RF probe is essential test equipment for ham shack. It can be used as an FSM also.

To work as RF voltmeter put multimeter in volt range. For FSM I used multimeter in 0.25 ma range and connect a long wire to the probe. If you won't have a multimeter a vu meter can be used.

WINDING COILS

Most of the coils used are wound on balun core. They can work up to VHF range, normally used in TV boosters. A single balun core can handle up to 10 Watts. Band pass coils and coils used in IF amplifiers are wound on IFT former. Wind both primary and secondary in the same direction. If the start end of the primary is cold end, the start end of the secondary should also be a cold end.

POWER SUPPLY

The transceiver requires 12 volt for most of the circuitry and 120 V for the final. The power supply should be capable of supplying the maximum current required with good stabilization. I used commercially available 40-0-40 5A transformer. The transformer have 6V, 9V, 12V, and 22V windings also. The transformer cost me around Rs:370. Power supply provides 110 Volt 2.5 Amps or 55 Volt 5 Amps. Three-pin regulator IC is used for regulating 12-volt supply. Good heat sink should be provided for regulator IC.

All diodes in the bridge rectifier are shunted with 0.1 uF 100 V capacitor (C1 to C8) to keep the diode protected from high voltage transients on the AC line as well as reduce inter-carrier hum modulation of RF that may be picked up by the mains. Always use fuse in 120 V supply line. This can avoid hand full of burned IRF. It also protects the power supply itself. My final consumes around 1 A at peak. I used to 0.5 A fuse; it won't go QRT with 1 A peak current. It is better to use a fuse that can just withstand the peak current.

LADDER FILTER

The circuit uses ladder filter builds around 4.43 MHz crystals. I selected 4.43 MHz crystals for the filter because they are cheap and easily available.

By terminating input & output with a 1000E resistor, pass band ripple can be reduced. For R = 1000E and F = 4.43 MHz, the value of C0, C1, C2 are given below.

C0 = 101 PF (use 100 PF)
C1 = 65 PF (use 68 PF)
C2 = 14 PF (use 15 PF)

Ladder filter is assembled on a small PCB. The metal enclosures of all crystals are connected to ground through thick copper wire. For ladder filter you need four crystals and one crystal for carrier oscillator. Collect all crystals of same make and with same serial number.

AF AMPLIFIER

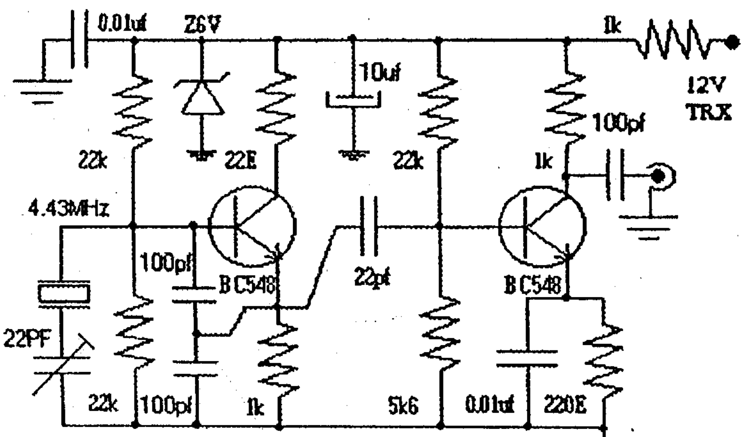
The receiver audio amplifier uses popular low noise IC LM386. Operational amplifier IC 741 is used as preamplifier. Both LM386 and 741 are available in 8 pin DIP.

LM386 is designed for operation with power supplies in the 4 V to 15 V range. Quiescent current is about 4 ma. It's input impedance is 50 K. Output automatically centers on a quiescent half supply voltage value. It provides 250 mw to 8 E speaker, which will be sufficient for comfortable listening level. The gain can be adjusted between 26 dB and 46 dB depending on the circuit at pin 1 and 8. here LM386 is configured for 26 dB gain.

IC 741 is a very popular Op.Amp. Many makes of IC 741 such as LM 741, AM 741, CA 741, CA 741, UA 741, uA 741 are available in market. Op Amps have two input terminals. For IC 741 pin 2 is inverting input, pin 3 is non-inverting input. Supply voltage can be in the range of 5 V to 18 V. Input impedance is 200 K. Here Op Amp is configured as inverting amplifier. Its gain can be adjusted by changing the value of resistance between pin 2 and pin 6.

CARRIER OSCILLATOR

Carrier oscillator is a crystal controlled oscillator using two numbers of BC548. The circuit does not use any coils or turned circuits. First BC548 is used as oscillator second BC548 is used as buffer. The carrier oscillator frequency is offset by 1.5 KHz above ladder filter (IF) frequency. The carrier oscillator frequency can be varied slightly by adjusting the trimmer in series with the crystal. The metallic enclosure of the crystal should be grounded for increased frequency stability.



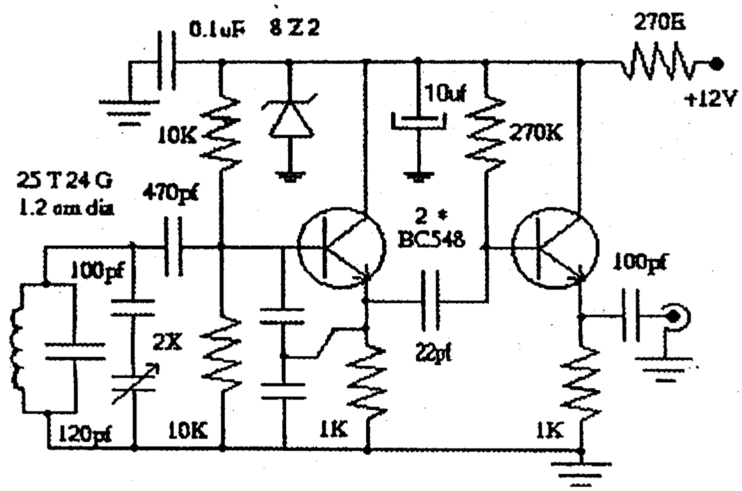
CARRIER OSCILATOR

IF AMPLIFIER

IF amplifier consists of two-stage collector turned amplifiers using BC548. It provides useful gain for both transmit and receive modes. The coil used are of same type, wound on ordinary IFT core. Primary is 15 turns. Secondary is 4 turns. Any thin copper wire such as 36 SWG can be used. The IF amplifier can be turned by connecting carrier oscillator at input and RF Volt meter at output. Adjust both coils for maximum deflection in RF Volt meter.

FRONT END

BF494 is used in receiver front end. The circuit provides enough gain. I had not used any turned circuit at collector



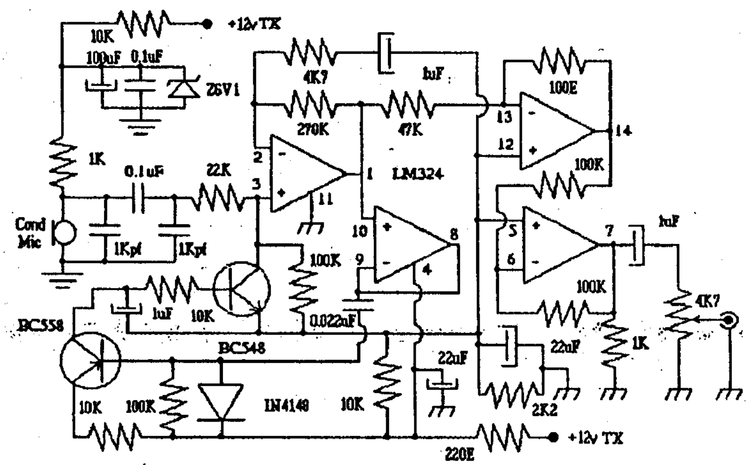
of BF494 to make it compatible for multi band operation. No AGC is provided to keep the things simple. AGC voltage can be taken from pin 12 or pin 6 of MC1496 and applied to base of BF494 through a 100K resistor.

VFO

Variable frequency oscillator uses two numbers of BC548. For 40 meter band VFO oscillates form 2.567 MHz to 2.667 MHz which on mixing with 4.43 MHz generates 7.0 MHz to 7.1 MHz. If you have a frequency meter it is easy to calibrate the VFO, otherwise connect a 2J gang condenser in parallel with VFO coil and adjust it to receive ham stations. VFO is fixed inside a small aluminum box.

MIC AMPLIFIER

Microphone amplifier consists of LM324 and two transistors. LM324 is available in 14 pin DIP. I brought it for Rs.6/-. It contains four identical operational amplifiers. Transistors BC548 and BC558 are used as compressor.



I used 2-wire shield wire for connecting microphone. One wire is used for condenser microphone and the other for PTT switch. Shield serves common ground to both.

LINEAR AMPLIFIER

The linear amplifier consists of 2N2222, SL100 and BD139. Heat sink should be provided for SL100 and BD139. All coils are wound on balun core. Some of the DC voltages measured are given below. These voltages are measured without any input using digital multimeter.

*DC	Emitter	Base	Collector
2N2222A	2.79 V	4.43V	9.54 V
SL100B	1.078 V	1.69V	12.05 V
BD139	7.5 mV	0.67V	12.01 V

Some of the RF voltages measured are given below. For measuring RF voltage, I had connected a crystal oscillator to input of the linear. These voltages are measured using digital multimeter and RF probe.

*RF	Emitter	Base	Collector
2N2222A	0.44 V	2,3V	0.82 V
SL100B	0.76 V	0.78V	4.87 V
BD139	0.55 V	1.3V	23.0 V

POWER AMPLIFIER

In my prototype I used IRF840 in the final. Most of the power FET are designed for high voltage operation. At lower operating voltages they saturate quickly limiting the output power. I had given 120 V for IRF840 it takes 1 Amp at peak. Gate voltage is fixed at 1V. Heavy head sink is essential for IRF. My heat sink measures 30 cm * 6.5 cm. Use a mica insulator and heat sink compound for fixing IRF. You can directly replace IRF840 with many of the power FET like IRF830, IRF530, IRF540 etc.,. When using a different IRF, supply voltage should be changed to less than half the maximum drain voltage (Vds). A zener diode rated slightly higher than the twice the supply voltage connected across drain and source can prevent drain source breakdown. Peak to peak gate voltage of magnitude more than 20 Volts can destroy the FET instantaneously. Two numbers of 15 Volt zener diodes are used to keep gate voltage swing below 20 Volts. Specifications for some of IRF series are given below.

FET	POWER	VOLT	CURRENT
IRF530	75 W	100 V	14 Amps
IRF540	125 W	100 V	27 A
IRF830	75 W	500 V	4.5 A
IRF840	125 W	500 V	8 A

ANTENNA

Proper antenna is essential for good reception and transmission. Horizontal dipole and Inverted 'V' antenna are popular among hams. I am using horizontal dipole antenna. Horizontal dipole is considered to be a fundamental antenna. Inverted 'V' is a variation of dipole with its center position raised. For inverted 'V' the angle at the center between the two halves should be between 90 degree to 120 degree for better results. Impedance of horizontal dipole is 70 ohms and a coaxial cable with impedance of 73 ohms like RG59 can be used. The impedance of inverted 'V' is around 50 ohms and a coaxial cable with impedance of 50 ohms like RG58 or RG8 can be used. The length of the dipole is half the wavelength. Any thick copper wire can be used. Cut the wire at the center and connect suitable coaxial cable at the center. For 7.05 MHz the length can be calculated as follows.

* Horizontal Dipole
  Length= 468 / F (in MHz)
  =468 / 7.05= 66.38 feet
* Inverted 'V'
  Length= 464 / F (in MHz)
  =464 / 7.05= 65.81 feet

CONCLUSION

The circuit is for 40 meter band. It can be modified for other bands by making suitable changes in the receiver band pass filter, transmit band pass filter and VFO. I had used 4.43 MHz ladder filter. If you want to use 9 MHz crystal filter or any other filter you need to change IF amplifier frequency, carrier oscillator and VFO. For multi band operation you need to switch VFO and both transmit and receive band pass filters. So go ahead and enjoy home brewing. ***(For Complete Circuit diagram see pages 15 & 16)***

OPERATING AWARDS
(ARRL HANDBOOK)

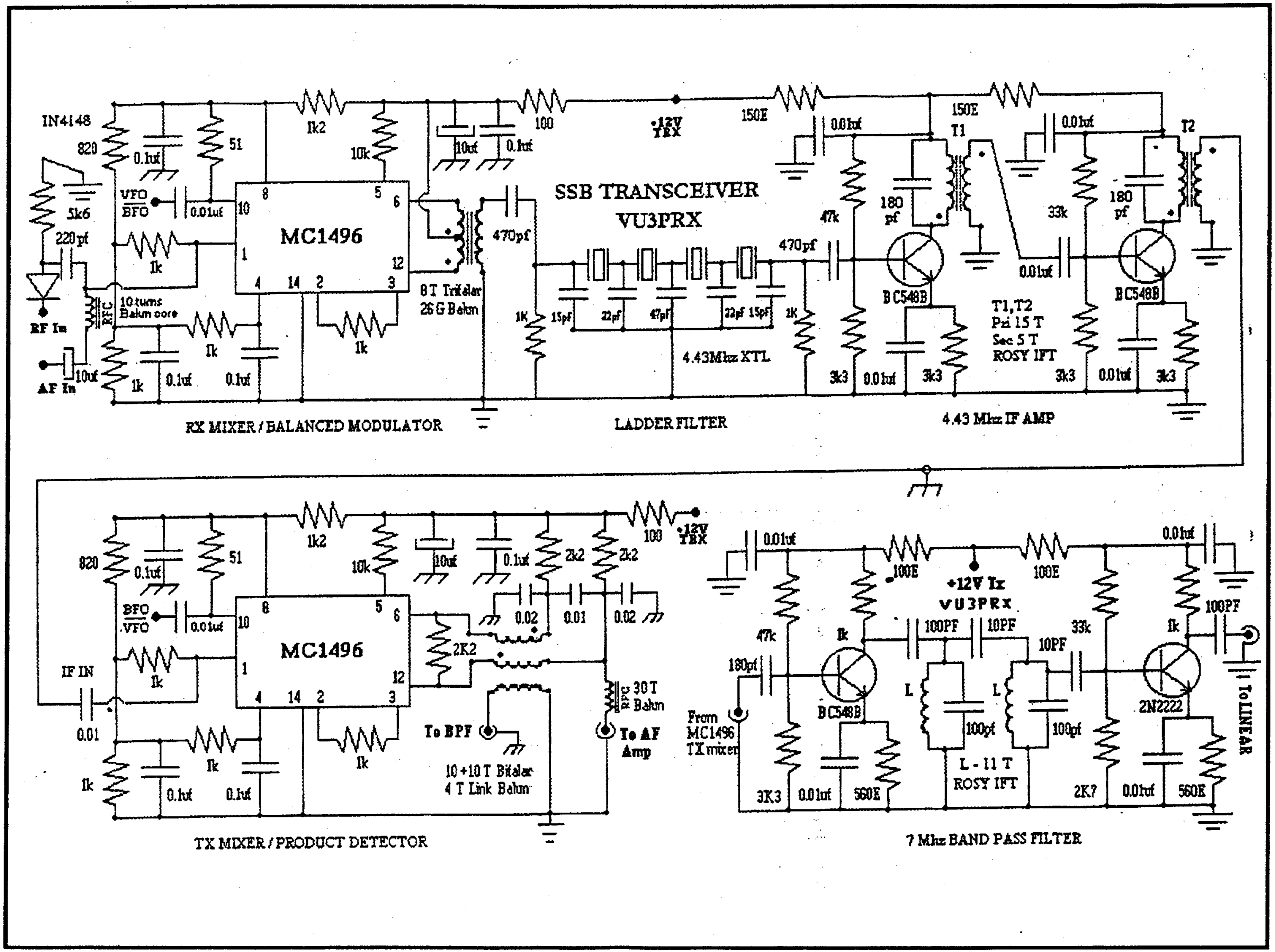
GERMANY (DL)
DLD Award

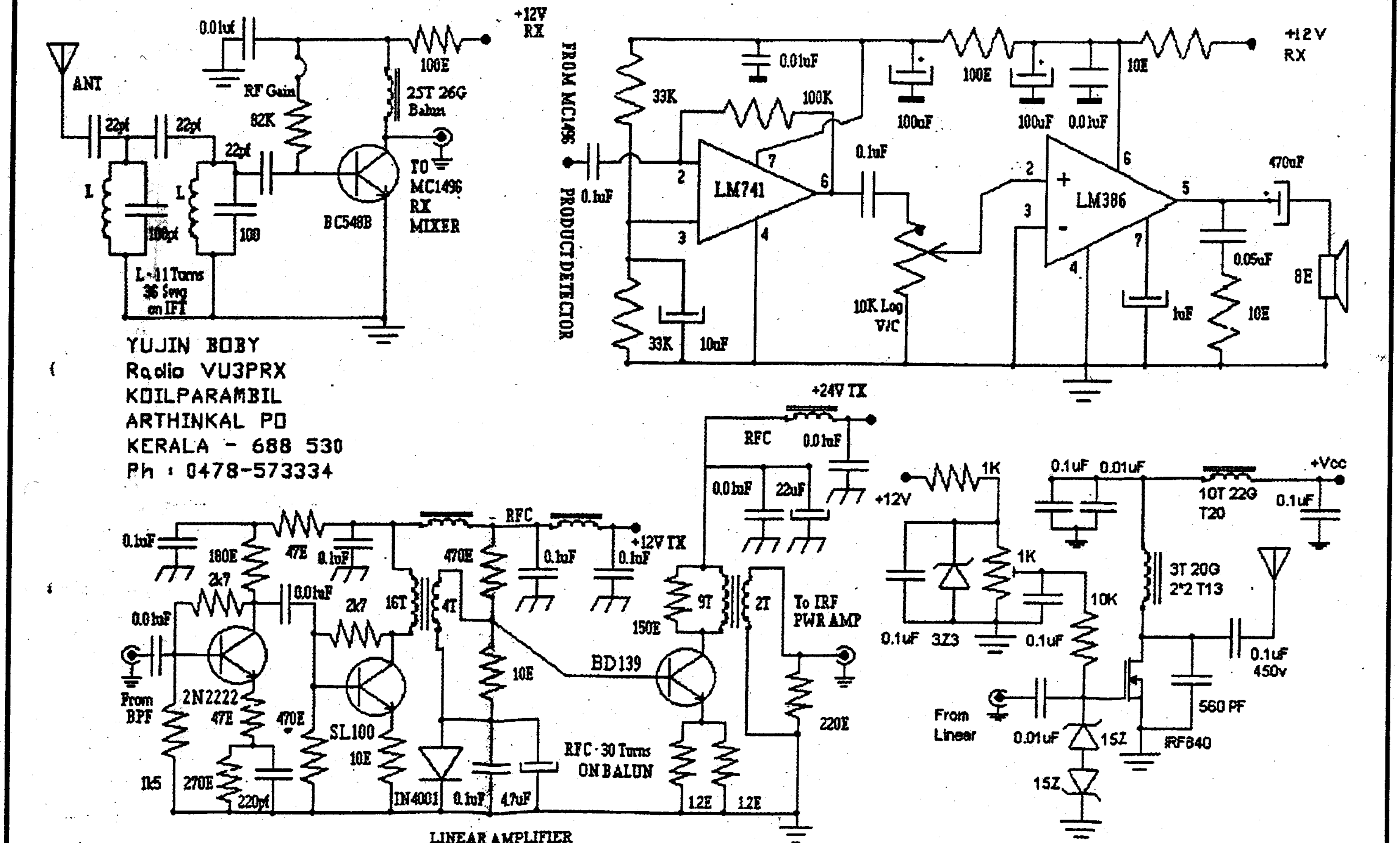
The DLD Award is an official award of the German Amateur Radio Club (DARC). It is available to all licensed radio amateurs and shortwave listeners (SWL). The names of new award holders will be published in the DARC magazine *CQ-DL*.

All members of DARC, its associate club VFDB, and club stations of both organizations are issued a *District Location Code* (DOK). To qualify for DLD, applicants must submit QSL cards from licensed radio amateurs showing a certain number of DOKs worked or- for SWLs-heard.

DLD Award Classes and Modes

* DLD is issued separately for each amateur band.
* DLD is issued in different classes on each band as follows: DLD 100, DLD 200, DLD 300, DLD 400, DLD 500 (with lapel badge), DLD 600, DLD 700, DLD 800, DLD 900 and DLD 1000 (with engraved badge of honor).
* For SWLs, the awards are known as DLD-SWL 100, DLD-SWL 200 and so on up to DLD-SWL 1000.
* All DLD Awards may be issued for mixed modes, or may be endorsed for single mode operation, providing that this is supported by QSL cards. ***(continued on page-20)***


SSB TRANSCEIVER
VU3PRX
IN4148
820
0.1uf
51
1k2
10k
10uf
0.1uf
100
+12V
TRX
150E
0.01uf
150E
0.01uf
T1
T2
5k6
VFO
BFO
0.01uf
MC1496
220pf
1k
10 turns
Balun core
RFC
RF In
AF In
10uf
1k
0.1uf
0.1uf
8 T Trifilar
26 G Balun
470pf
1K
15pf
22pf
47pf
22pf
15pF
470pf
47k
180
pf
BC548B
33k
0.01uf
T1,T2
Pri 15 T
Sec 5 T
ROSY IFT
4.43Mhz XTL
3k3
0.01uf
3k3
RX MIXER / BALANCED MODULATOR
LADDER FILTER
4.43 Mhz IF AMP
1k2
100
+12V
TRX
BFO
VFO
2k2
2k2
0.02
0.01
0.02
2K2
IF IN
0.01
30 T
RFC
Balun
To BPF
To AF
Amp
10 + 10 T Bifilar
4 T Link Balun
TX MIXER / PRODUCT DETECTOR
100E
+12V Tx
VU3PRX
100E
100PF
10PF
10PF
180pf
From
MC1496
TX mixer
L
100pf
L - 11 T
ROSY IFT
2N2222
To LINEAR
3K3
560E
2K7
560E
7 Mhz BAND PASS FILTER



YUJIN BOBY
Radio VU3PRX
KOILPARAMBIL
ARTHINKAL PO
KERALA - 688 530
Ph : 0478-573334