

Spectrum Management

Radiocommunication Information Circular

# **Information on the Amateur Operator's Certificate Examinations**

Radiocommunication Information Circulars are issued for the guidance of those engaged in radiocommunications in Canada. The information contained in these circulars is subject to change without notice. It is therefore suggested that interested persons consult the nearest district office of Industry Canada for additional details. While every reasonable effort has been made to ensure accuracy, no warranty is expressed or implied. As well, these circulars have no status in law. Additional copies of this or other circulars in the series are available from any office of the Department.

Comments and suggestions may be directed to the following address:

Industry Canada  
Radiocommunications and  
Broadcasting Regulatory Branch  
300 Slater Street  
Ottawa, Ontario  
K1A 0C8

Attention: DOSP

## General Information

The hobby of amateur radio, today more than ever, is an extension of scientific knowledge applied to telecommunications. Industry Canada believes that amateur radio should be accessible, so that those who are interested in the science and art of radiocommunication may avail themselves of every reasonable opportunity to learn, enjoy and contribute to its progress.

The Department also recognizes the necessity for amateur operators to have some technical and operating knowledge before being allowed on the amateur radio bands. This circular outlines basic information for individuals who wish to become amateur radio operators.

Anyone may become an amateur radio operator; there are no age or nationality restrictions. The best way to learn about amateur radio is to enrol in a class taught by amateur radio operators or clubs. Information on these courses is available from the amateur associations listed below. Study guides, question banks, technical books, Morse code tapes and other publications relating to amateur radio are available from the following organizations for a fee.

Radio Amateurs of Canada Inc. (RAC)  
720 Belfast Road  
Suite 217  
OTTAWA, Ontario  
K1G 0Z5  
Tel: 613-244-4367  
Fax: 613-244-4369  
E-Mail: rachq@rac.ca

Radio Amateur du Québec inc. (RAQI)  
4545 Pierre-de-Coubertin Avenue  
P.O. Box 1000, Station "M"  
MONTREAL, Quebec  
H1V 3R2  
Tel: 514-252-3012/252-3000 ext. 3422

While the scope and depth of the knowledge required are described on the following pages in general terms, the exact requirements for the various qualifications can be ascertained by referring to the appropriate bank of questions.

Anyone may use an amateur radio station, provided a qualified operator is in attendance to perform the control functions. Getting to know radio amateurs in your area and practising on their stations is an excellent way to learn about operating practices, station assembly, regulations, radio frequency propagation, antennas and a host of directly related data.

## Certificates and Privileges

There is only one certificate available for the amateur service: the amateur operator's certificate. The holder of this certificate may obtain as many as four levels of qualification. The Basic Qualification is required before an individual may operate an amateur radio station in Canada or hold a licence for such a station. The following paragraphs describe how to obtain each of the four levels of qualification and the privileges accorded to those who have reached these levels.

**Please note** that no operating privileges are accorded the holder of the Morse Code Qualifications (5 w.p.m. and 12 w.p.m.) or the holder of the Advanced Qualification unless the holder also possesses the Basic Qualification.

### **Basic Qualification**

The Basic Qualification provides the foundation for operation in the amateur radio service. To obtain the amateur operator's certificate with Basic Qualification, a candidate must successfully complete a theory/regulations/operating procedures examination.

The holder of the amateur operator's certificate with the Basic Qualification may:

1. operate on all amateur frequencies above 30 MHz, using all classes of emissions,
2. use a maximum of 250 watts DC transmitter input power, and
3. build and operate all station equipment, except for "home-made" transmitters.

### **Morse Code (5 w.p.m.) Qualification**

The examination for this qualification is a test of sending and receiving Morse code at a speed of not less than 5 w.p.m. for three consecutive minutes.

Individuals who hold this qualification, as well as the Basic Qualification, may operate in all amateur frequency bands below 4 MHz, in accordance with Schedule I of Radiocommunication Information Circular 2 (RIC-2) *Standards for the Operation of Radio Stations in the Amateur Radio Service*.

### **Morse Code (12 w.p.m.) Qualification**

The examination for this qualification is a test of sending and receiving Morse code at a speed of not less than 12 w.p.m. for three consecutive minutes.

Individuals who hold this qualification, as well as the Basic Qualification, may operate in all amateur frequency bands, in accordance with Schedule I of the Radiocommunication Information Circular 2 (RIC-2) *Standards for the Operation of Radio Stations in the Amateur Radio Service*.

### **Advanced Qualification**

The Advanced Qualification is for those individuals who have an in-depth knowledge of electronics, a good knowledge of the various types of amateur equipment and the ability to understand circuits with the intention of effecting repairs and building transmitters.

Individuals who hold this qualification, in addition to the Basic privileges, may:

1. build and operate transmitting equipment,
2. use maximum transmitter power of 1000 watts DC input,

3. sponsor repeaters and club stations, and
4. remotely control fixed stations, including the use of radio links.

## Examination Requirements

### Basic Qualification

The theory questions in the Basic Qualification examination require basic component analysis. Other subjects are examined at the concept or system level, rather than at a detailed circuit analysis level.

#### Basic Electronics

Candidates must:

1. understand the basic concepts and relationships of conductors, insulators, direct current, alternating current, electromotive force, resistance, power, capacitance, inductance, reactance, impedance and resonance;
2. be able to define Ohm's law and be able to do simple calculations using it;
3. be able to explain the function of a battery, a transformer, an AC power supply, and the basic blocks of a simple transmitter, receiver and transceiver; and
4. be able to identify diodes, transistors, integrated circuits and vacuum tubes, as well as the circuits for which they are used, and be able to describe their basic purpose.

#### Propagation and Antenna Systems

Candidates must be able to describe:

- sunspots, sunspot cycle, solar radiation, ionosphere, fading, absorption, refraction, radiation angle, multi-hop, MF/HF propagation, VHF/UHF propagation, transmission lines, antenna types, antenna impedance, standing wave ratio (SWR) and matching devices.

#### Interference and Suppression

Candidates must be able to:

1. describe and give examples of how to suppress front-end overload, audio rectification, harmonics, parasitics and intermodulation products;
2. explain the use and be able to show placement of low-pass, high-pass, band-pass and band reject filters; and
3. explain how shielding is accomplished and what its purpose is.

**Station Assembly**

Candidates must be able to:

1. explain the basic functioning of transmitters, receivers, transceivers, SWR bridges, power supplies, fuses, operational control settings and interconnecting cables;
2. explain how to achieve good grounding and lightning protection; and
3. show the proper position in relation to one another of the various pieces of equipment that may be found in an amateur radio station.

**Operations, Procedures and Regulations**

Candidates must:

1. be able to explain operational procedures for voice radiocommunications, Morse code transmission of messages, RTTY, AMTOR, packet transmission, repeater use, slow-scan and fast-scan television, as well as other modes of operation;
2. be able to explain the international and domestic regulations governing the operation of an amateur radio station;
3. demonstrate a good knowledge of the Q-code signals described in Radiocommunication Information Circular 25 (RIC-25), *Rules and Regulations Affecting the Amateur Service*; and
4. be able to recognize the emergency signals and indicate what procedures should be followed in their use (distress and urgency).

**Morse Code (5 w.p.m.) Qualification**

Candidates must demonstrate the ability to send by hand and receive by ear International Morse Code at a speed of not less than 25 characters per minute (5 words per minute) for a period of not less than three consecutive minutes.

**Morse Code (12 w.p.m.) Qualification**

Candidates must demonstrate the ability to send by hand and receive by ear International Morse Code at a speed of not less than 60 characters per minute (12 words per minute) for a period of not less than three consecutive minutes.

**Advanced Qualification**

This examination focuses on circuits and components, rather than on systems.

**Circuit Analysis**

Candidates will be expected to explain the use and operation of: oscillators, radio frequency amplifiers, buffers, multipliers, mixers, intermediate frequency amplifiers,

detectors, discriminators, audio frequency amplifiers, filters, speech amplification and processing as well as power supplies and regulation.

### **Transmitters, Receivers, Linear Amplifiers and Modulation Techniques**

Candidates must be able to:

1. describe transmitting, receiving and modulating principles for the following: continuous wave, single sideband, ACSB, AM, FM/PM, pulse, fast-scan and slow-scan television, RTTY, AMTOR, packet, translators, repeaters and satellites;
2. explain the terms "sensitivity", "selectivity", "stability", "noise figure" and "dynamic range";
3. explain in detail direct conversion and superheterodyne receivers; and
4. describe the use and operation of classes AB1, AB2 and B linear amplifiers and class A and class C amplifiers.

### **Propagation and Antenna Systems**

Candidates must be able to describe in detail:

- ionospheric layers, sporadic "E", aurora borealis, meteor scatter, EME transmission, tropospheric bending, VSWR, baluns, matching networks, transmatches, coaxial cables, balanced lines, velocity factor; dipole, Yagi, quad and trap antennas; grounding, groundplane, virtual height, radiation resistance, mirror image, and other propagation-related information.

### **Test Equipment and Construction**

Candidates must be able to explain the use or function of:

- multimeters, VSWR bridges, marker generators, frequency counters, dip meters, two-tone audio generators, dummy or artificial antennas, oscilloscopes, signal generators, attenuators, spectrum analysers, and other test equipment.

## **Certificate Examinations**

There are two routes open to candidates for obtaining the amateur operator's certificate (Basic, Morse Code (5 w.p.m.), Morse Code (12 w.p.m.) and Advanced Qualifications) - that is, they may be examined either by a delegated examiner or by the radio inspector at the local district office of Industry Canada.

### **Delegated Examiners**

Delegated examiners are available in many areas to give the Morse code and written examinations. They may be contacted through amateur radio clubs, technical schools or the local district office of Industry Canada in your area. Information regarding delegated examiners is to be found in Radiocommunication Information Circular 1 (RIC-1), *Guide for*

*Examiners Delegated to Conduct Examinations for the Amateur Operator's Certificate*, which is available from your local district office of Industry Canada.

When a private group or an individual gives an examination, costs are incurred, since they must procure facilities and provide the necessary services. The Department understands the need to recover costs, but wishes to underline that these charges are not levied on behalf of the Department.

### **Industry Canada Examiners**

If candidates wish to be examined for the Basic, Advanced or Morse Code 5 w.p.m. or 12 w.p.m. Qualifications by an Industry Canada radio inspector, they must make an appointment at any district office. Some district offices prefer to give the examination at a school or meeting hall, especially when a number of people have indicated they wish to sit the examination. However, for small groups and individuals, the examinations are usually given at the local district office. Although there are two parts to the Morse code examination, sending and receiving, only one qualification may be issued and only one fee levied. A fee of twenty dollars (\$20.00) is charged for each qualification, when the examination is given by a departmental official. To find the district office nearest you, please refer to your telephone directory.

Where necessary, Industry Canada examiners can help and make special arrangements for candidates who have physical disabilities. It is much easier for all concerned if such assistance is arranged when the appointment is made.

When a candidate fails an examination because the language he or she normally uses is neither English nor French, or because academic limitations restrict the ability to read the questions properly, an oral examination may be administered. A decision of this nature can be made only by a radio inspector.

### **Written Examinations**

For a written examination, each candidate will be supplied with a booklet containing the questions, formulae as required, and an answer sheet. The candidate must supply his or her name and address and other related information. The candidate may use mathematical tables and/or a non-programmable calculator to complete the examination, but these will not be supplied by the examiners.

Before the examination begins, the examiner will allow a few minutes for briefing purposes. After the examination begins, no questions will normally be permitted. The passing mark is 60 percent.

### **Basic Qualification Examination**

The examination is composed of 100 multiple-choice questions. At least 25 of these relate to domestic and international regulations; the remainder relates to theory and operating procedures.



## **Advanced Qualification Examination**

This examination consists of 50 multiple-choice questions regarding advanced radio theory.

## **Morse Code Examination**

The Morse code examination is in plain language and may include the twenty-six letters, the ten numbers, punctuation marks (comma, period, question mark, dash and fraction bar), Q-signals and emergency signals. In both the sending and receiving examinations, each character omitted or incorrectly sent or received is counted as one error. A mark of 100 percent is awarded for five errors or less, 99 percent for six errors, 98 percent for seven, 97 percent for eight, etc. The examiner will allow candidates two minutes to review and correct their copy before it is graded. The passing mark is 100 percent.

A candidate writing the exam for the Morse Code (12 w.p.m.) Qualification who does not already have the Morse Code (5 w.p.m.) Qualification will be awarded the Morse Code (5 w.p.m.) Qualification without further examination if a mark of over 60% (fewer than 45 errors) on both sending and receiving is achieved.

## **Miscellaneous**

Existing amateurs who hold the amateur radio operator's certificate or the amateur radio operator's advanced certificate are deemed, by regulation, to hold the Basic, Morse Code (12 w.p.m.) and Advanced levels of qualification. Those who hold the amateur digital radio operator's certificate are deemed, also by regulation, to hold the Basic and Advanced Qualifications.

Any person holding a Canadian radiocommunications operator's general certificate, a Canadian radio operator's first class certificate or a Canadian radio operator's second class certificate may apply for a licence, good for all qualifications and privileges, without further examination. Any person holding a Canadian radiotelephone operator's general certificate (aeronautical, maritime or land) may apply for a licence without further examination, but privileges are limited to those for the Basic Qualification.

A candidate for the amateur operator's certificate examinations may be examined for any qualification, in any order, but candidates may not apply for a licence until they have passed the Basic Qualification examination.

As previously mentioned, many amateur clubs and organizations provide instructional classes for individuals interested in becoming radio amateurs. In general, the instructors giving those classes will provide candidates with all the information they need, as well as the necessary study guides. Candidates, however, will have to devote time to study outside class, the amount of which will depend on their level of knowledge and their learning skills.

Most instructors giving radio amateur classes will distribute copies of this document, as well as the Radiocommunication Information Circulars listed below. However, candidates may also obtain, in limited numbers, copies of these circulars from any district office.

RIC-1 - *Guide for Examiners Delegated to Conduct Examinations for the Amateur Operator's Certificate*

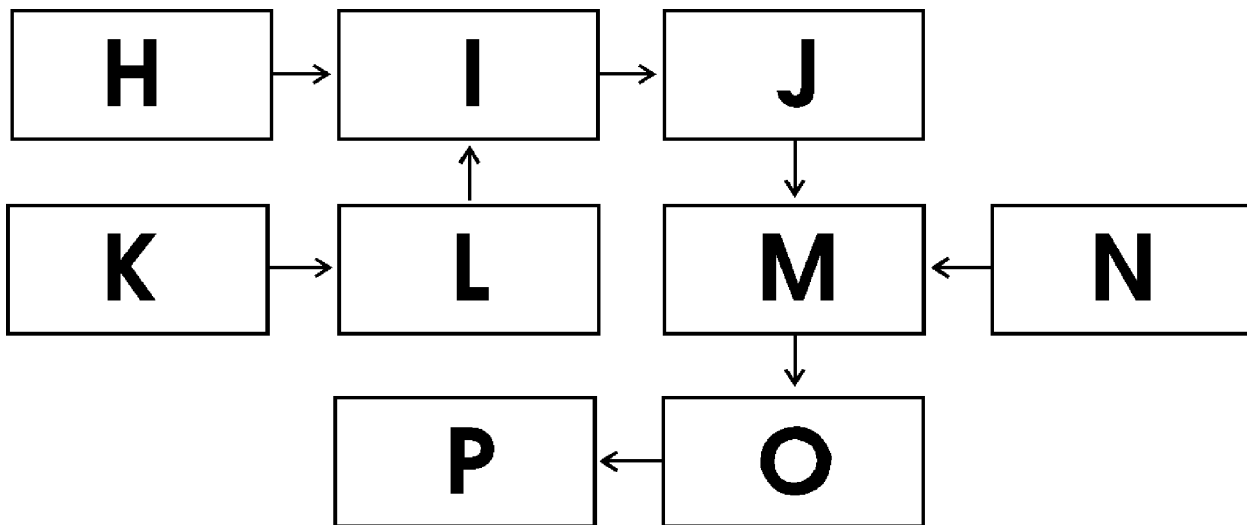
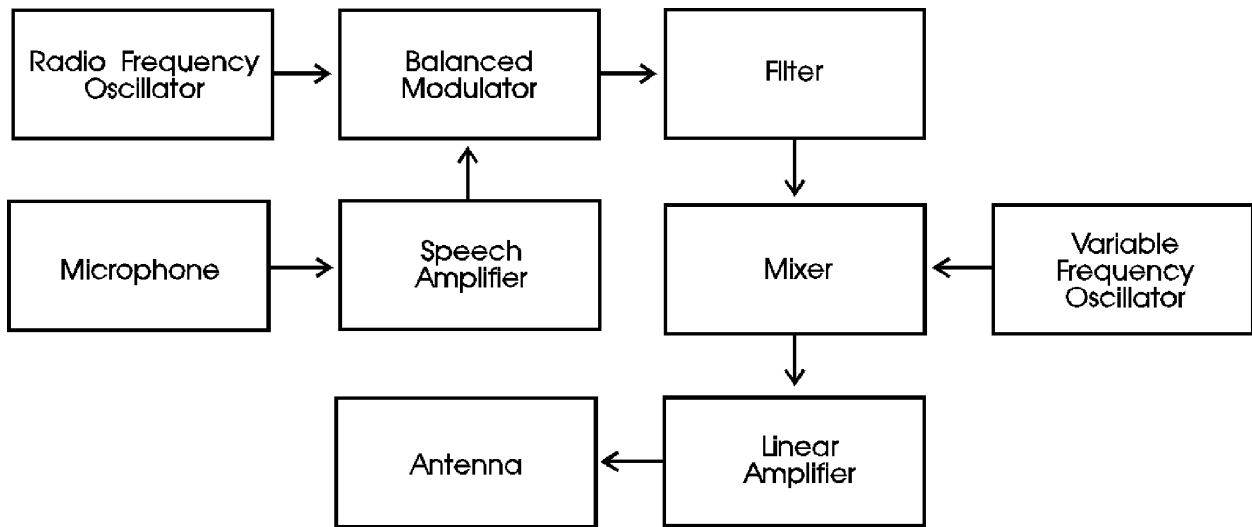
RIC-3 - *Amateur Service*

1. *Countries with Which Agreements or Arrangements Have Been Concluded to Permit the Exchange of Third Party Traffic*
2. *Countries with Which Reciprocal Operating Privileges Have Been Arranged*

RIC-25 - *Rules and Regulations Affecting the Amateur Service*

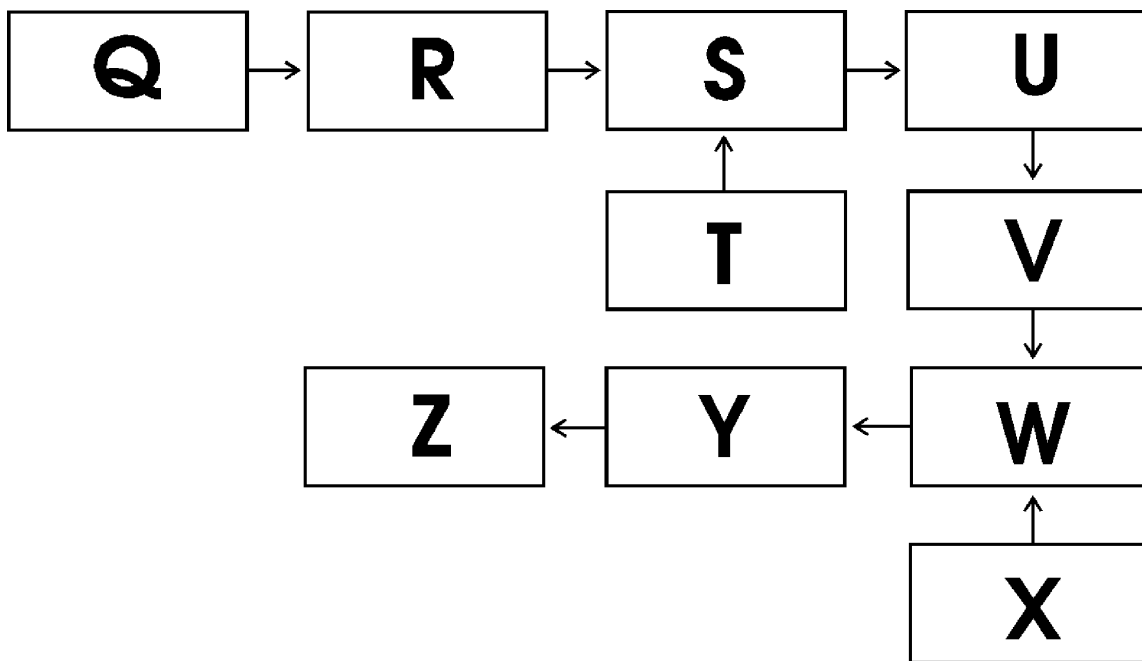
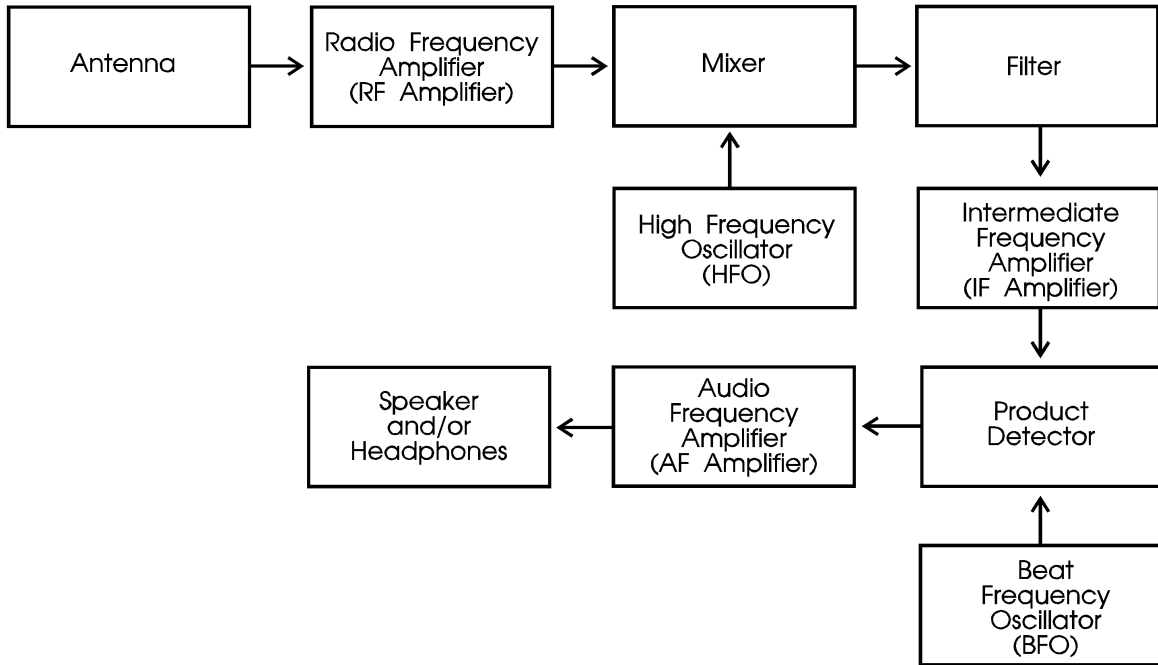
### Block Diagrams for the Basic Qualification

#### Single-Sideband Transmitter



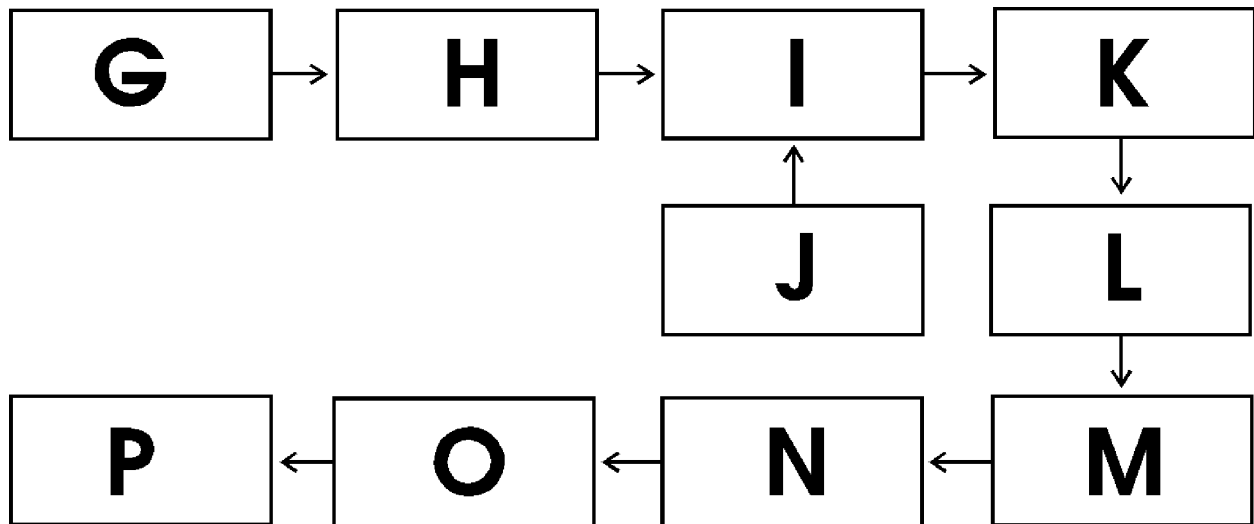
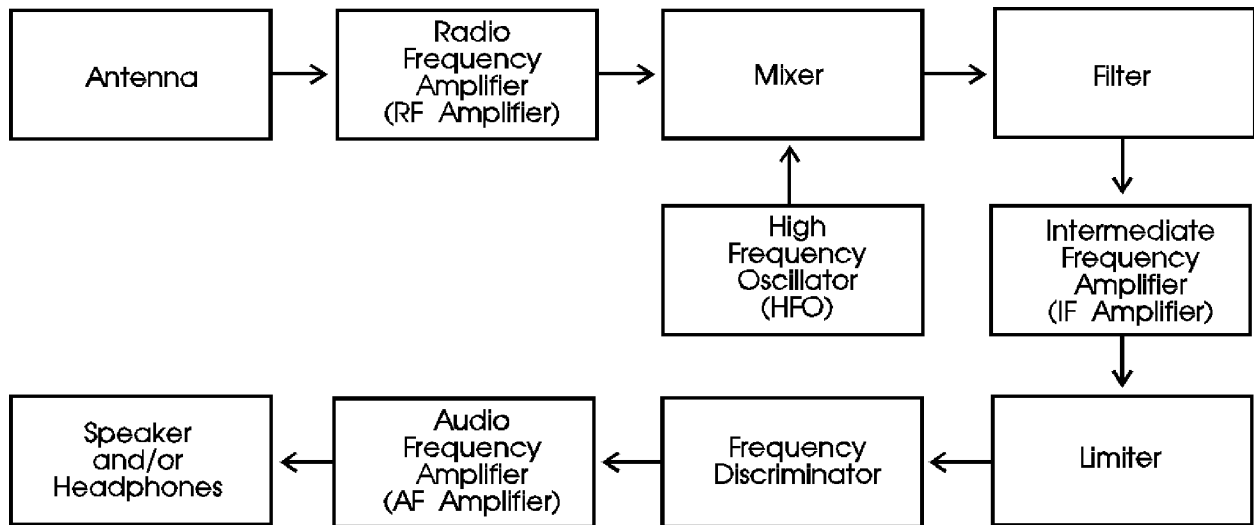
### Block Diagrams for the Basic Qualification

#### Single-Sideband and CW Receiver



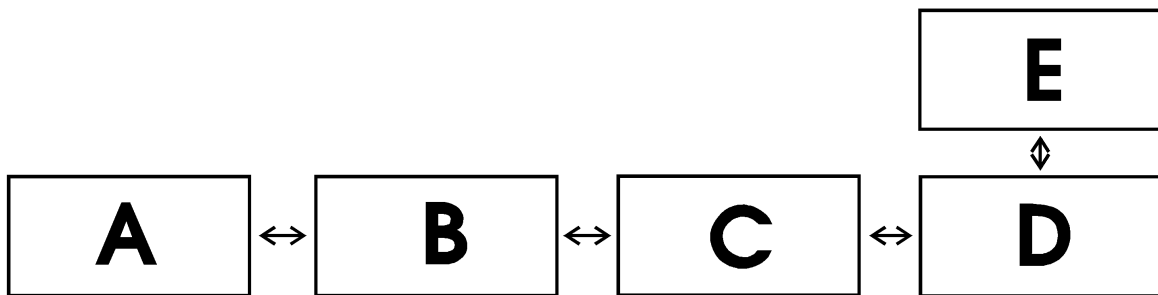
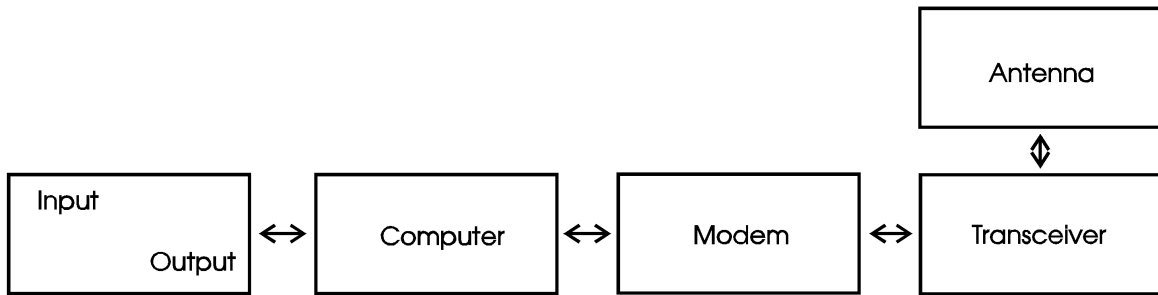
### Block Diagrams for the Basic Qualification

#### Frequency Modulation Receiver



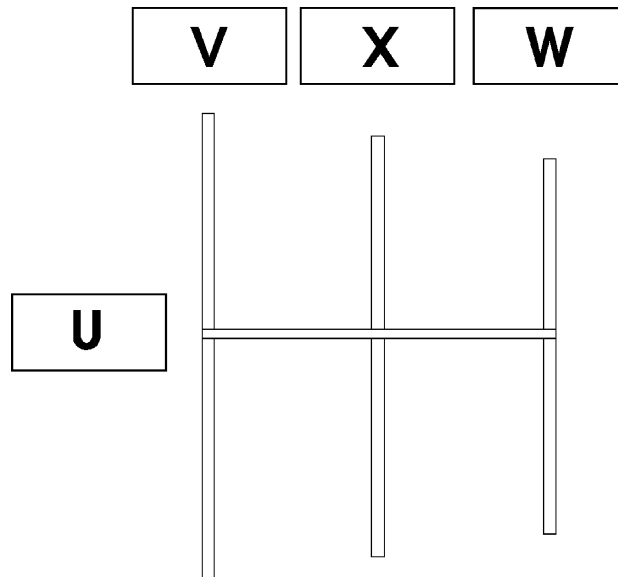
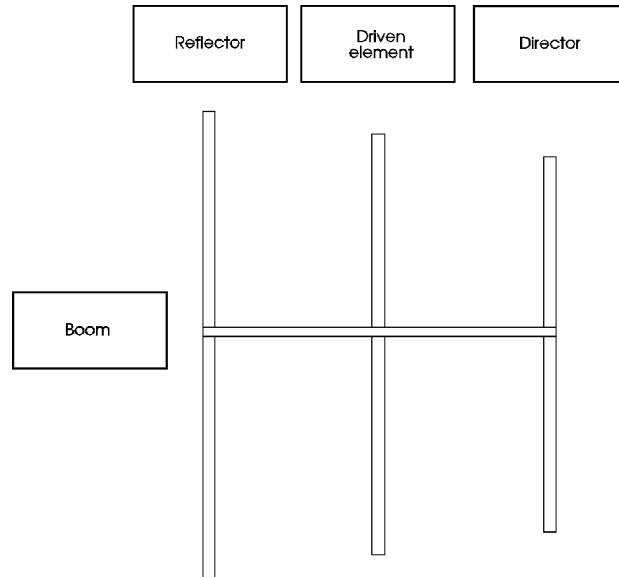
### Block Diagrams for the Basic Qualification

#### Digital System



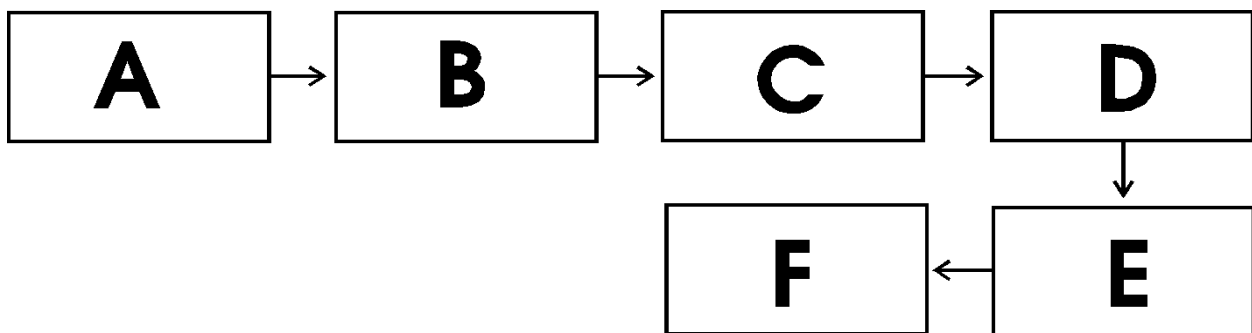
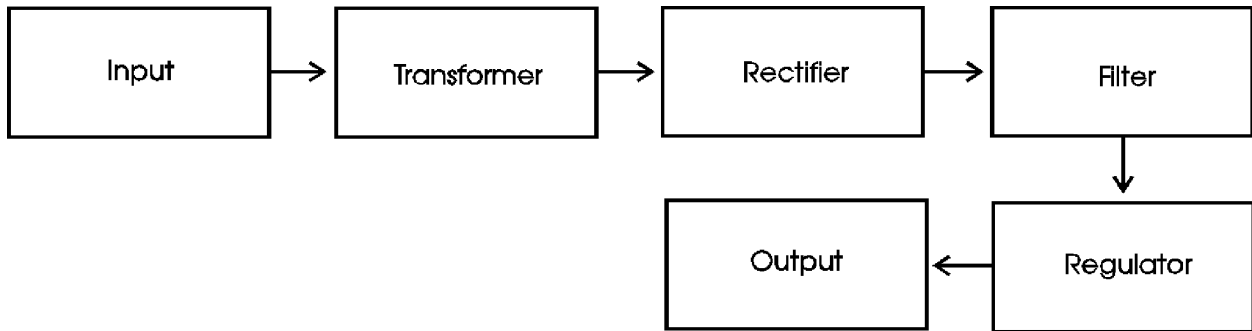
### Block Diagrams for the Basic Qualification

#### Yagi-Uda Three-Element Directional Antenna



### Block Diagrams for the Basic Qualification

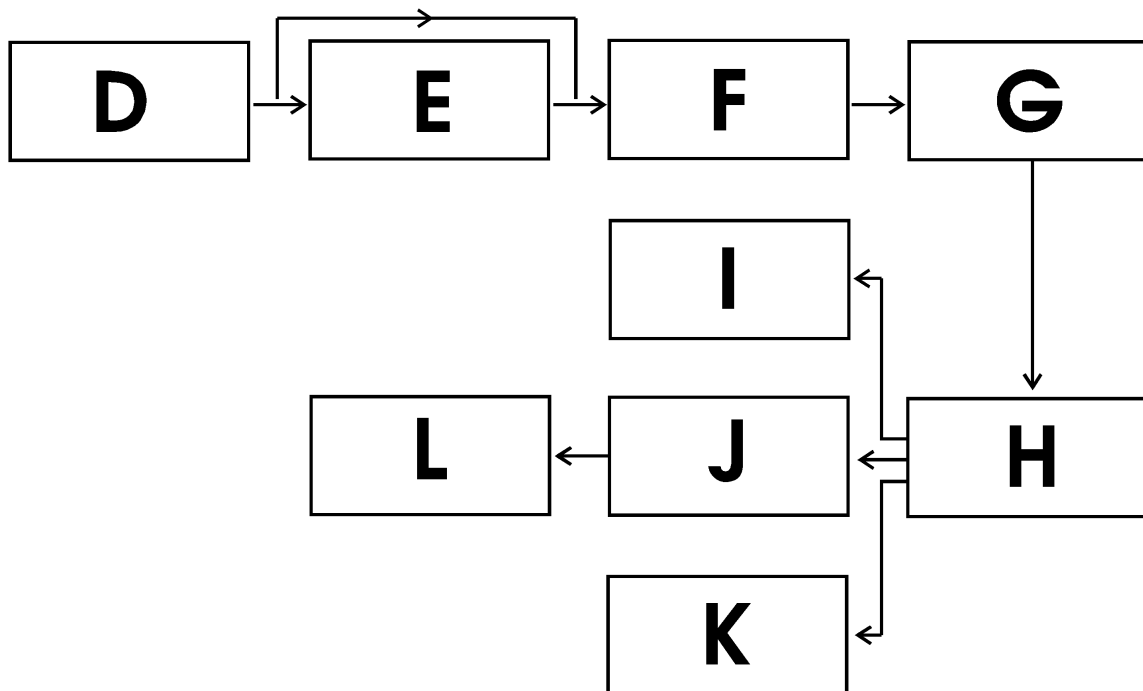
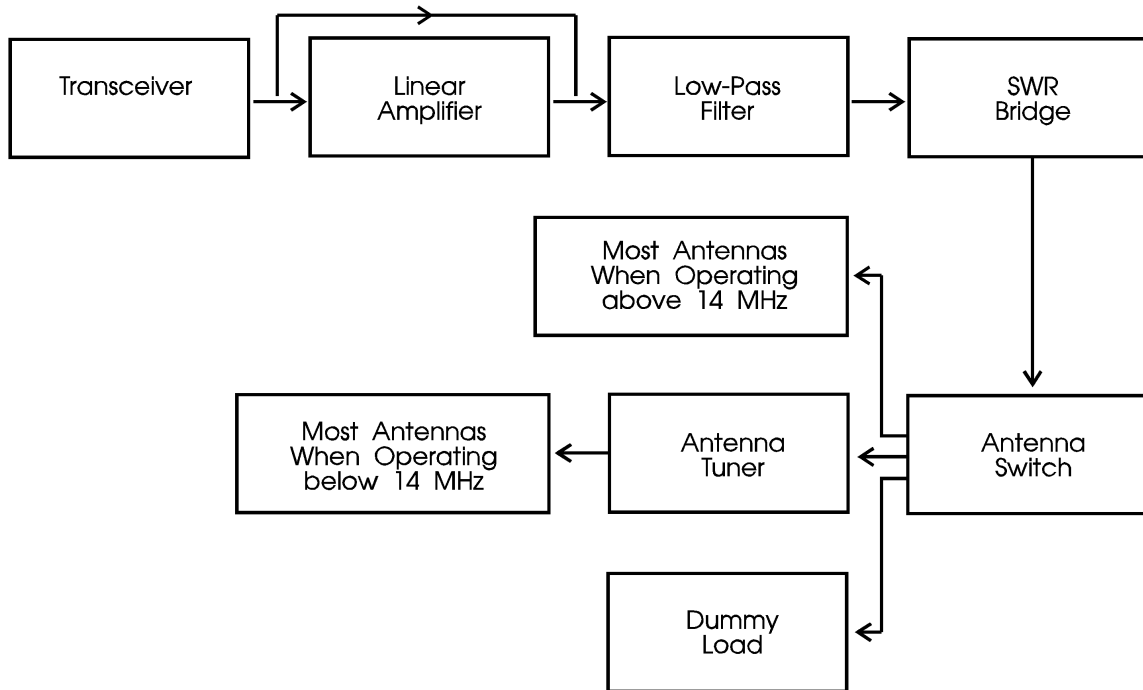
#### Regulated Power Supply





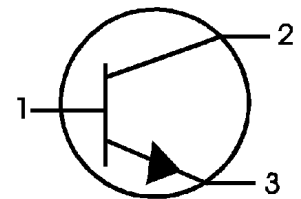
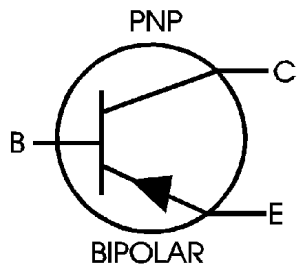
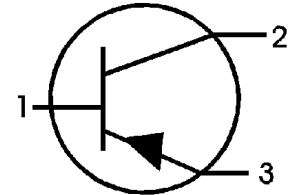
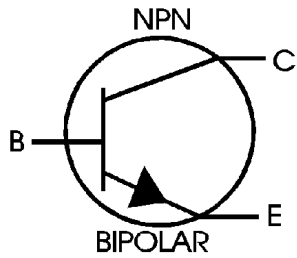
### Block Diagrams for the Basic Qualification

#### Placement of Component in a HF Station

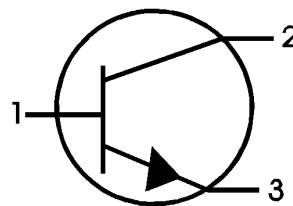
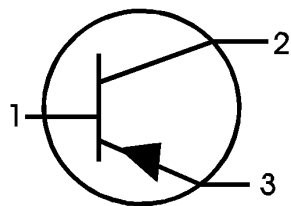


## Block Diagrams for the Basic Qualification

### Bipolar Transistor

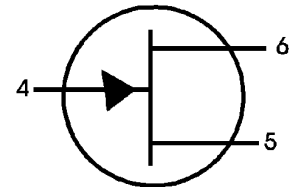
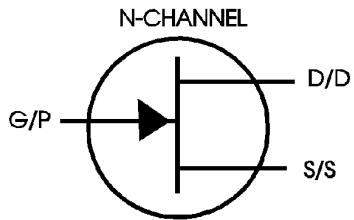


B	BASE	BASE	1
C	COLLECTOR	COLLECTEUR	2
E	EMITTER	ÉMETTEUR	3

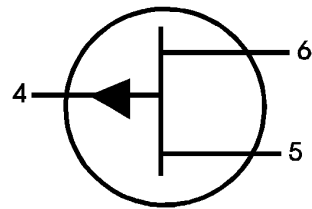
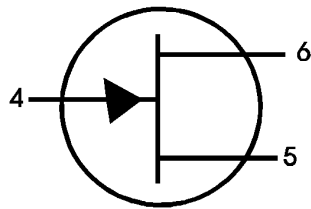
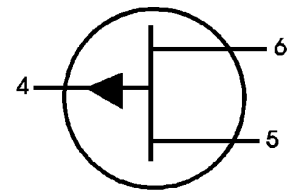
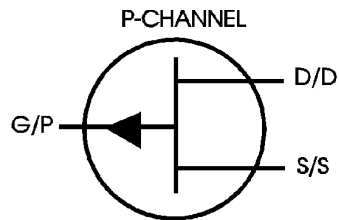


## Block Diagrams for the Basic Qualification

### Field Effect Transistor (FET)

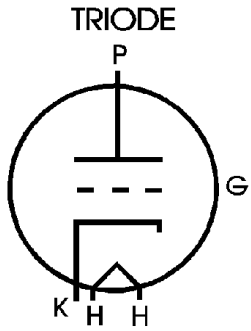


G/P	GATE	PORTE	4
S/S	SOURCE	SOURCE	5
D/D	DRAIN	DRAIN	6

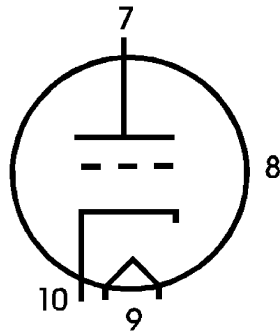
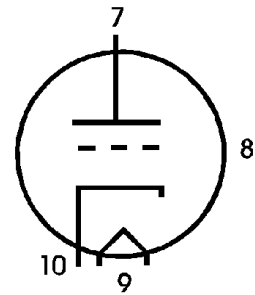


### Block Diagrams for the Basic Qualification

#### Vacuum Tube

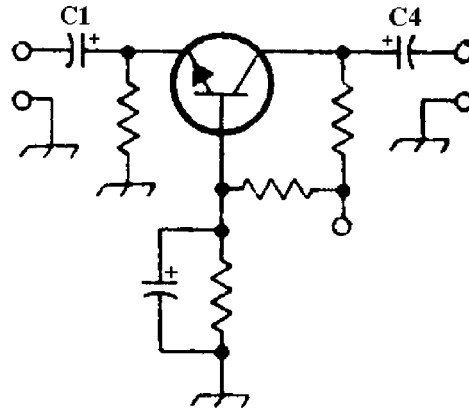
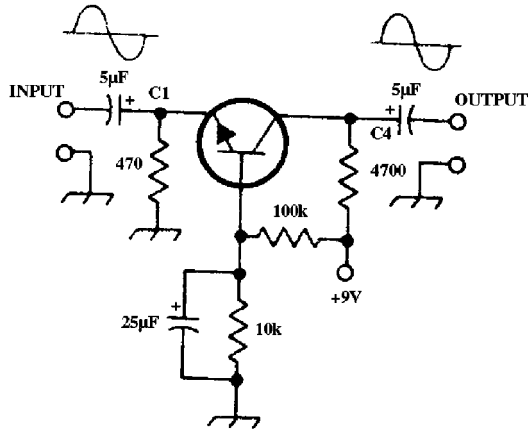


P	PLATE	ANODE	7
G	GRID	GRILLE	8
H	FILAMENT	FILAMENT	9
K	CATHODE	CATHODE	10

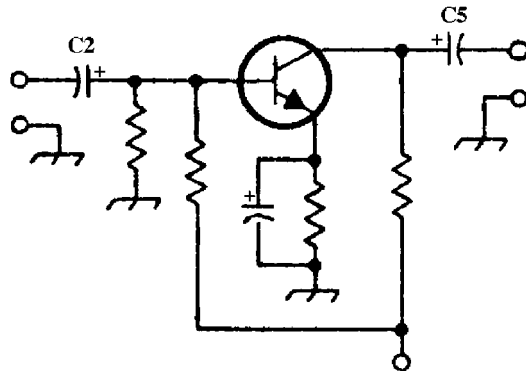
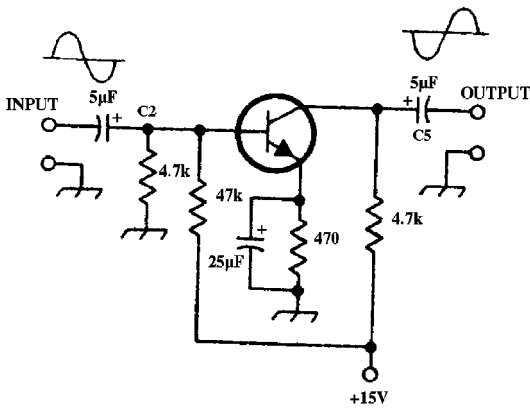


## Schematic Diagrams for the Advanced Qualification

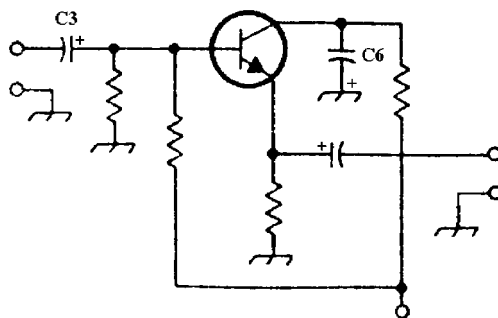
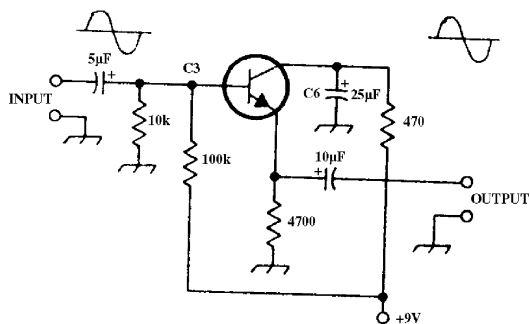
### 1. Common Base



### 2. Common Emitter

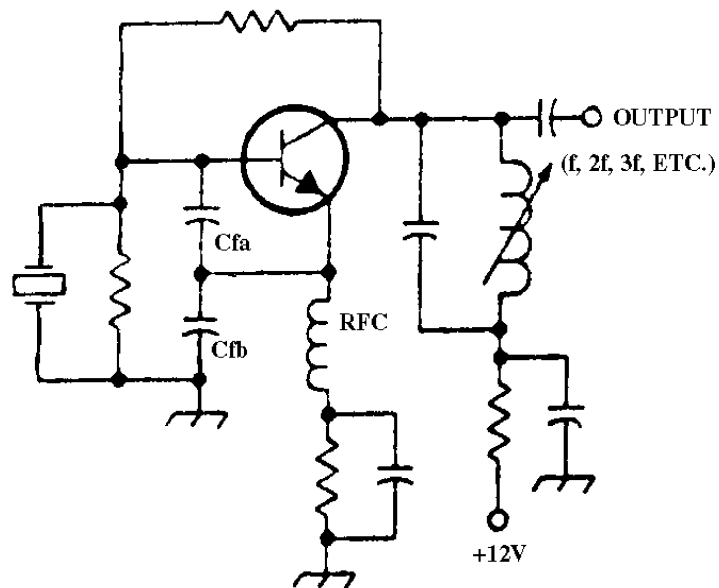
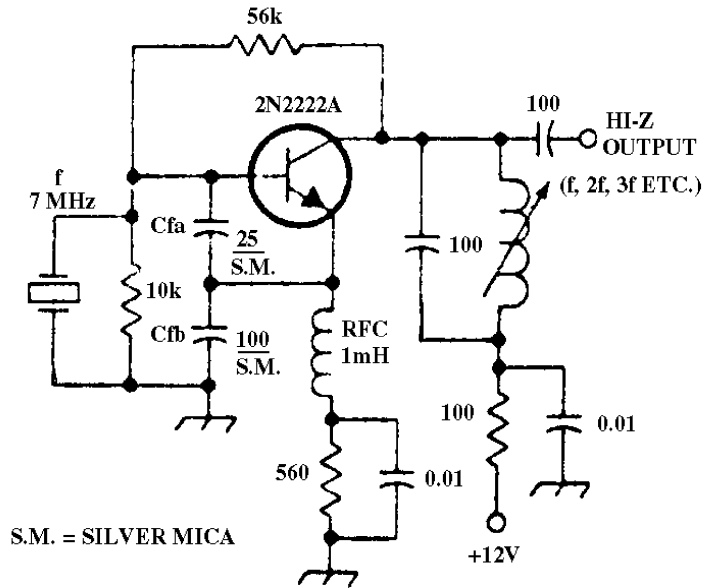


### 3. Common Collector



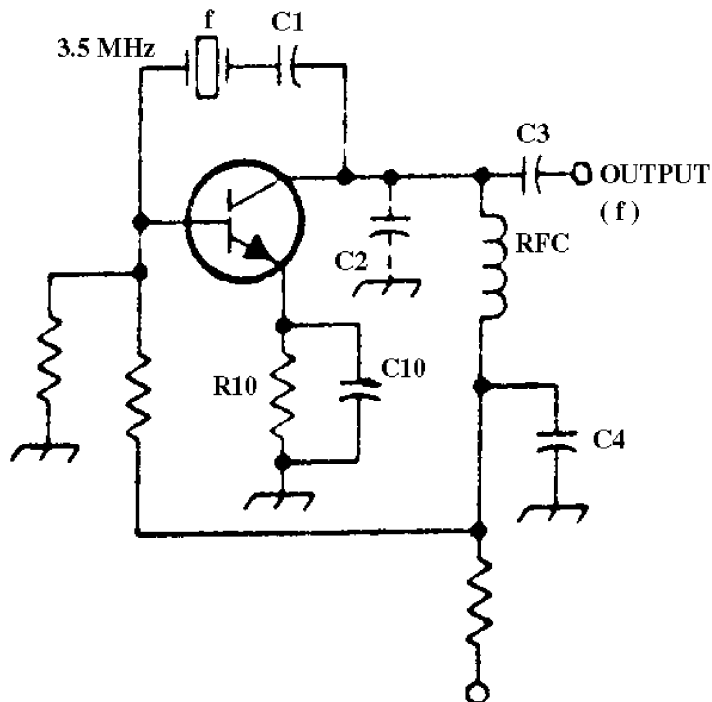
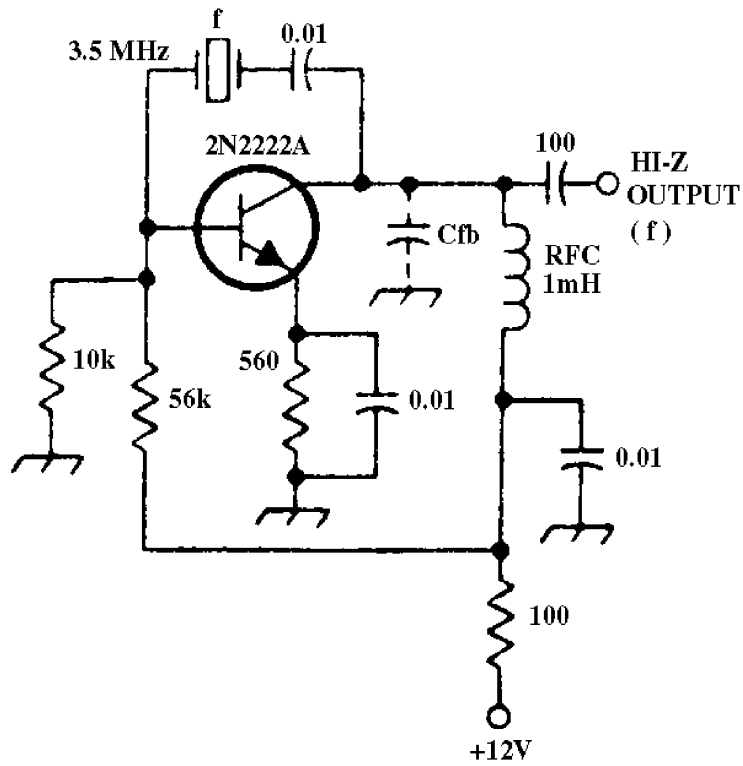
## Schematic Diagrams for the Advanced Qualification

### 4. Colpitts Oscillator



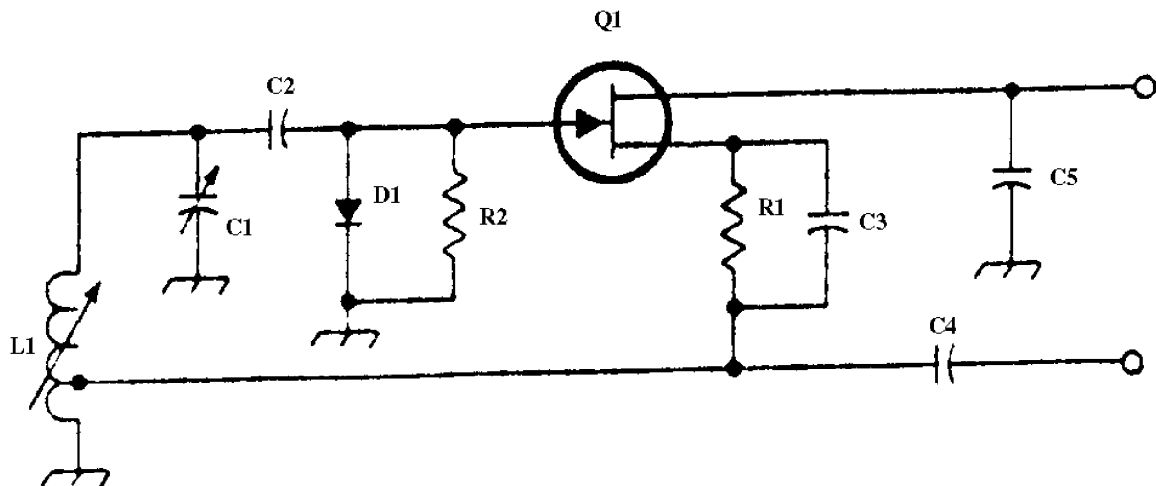
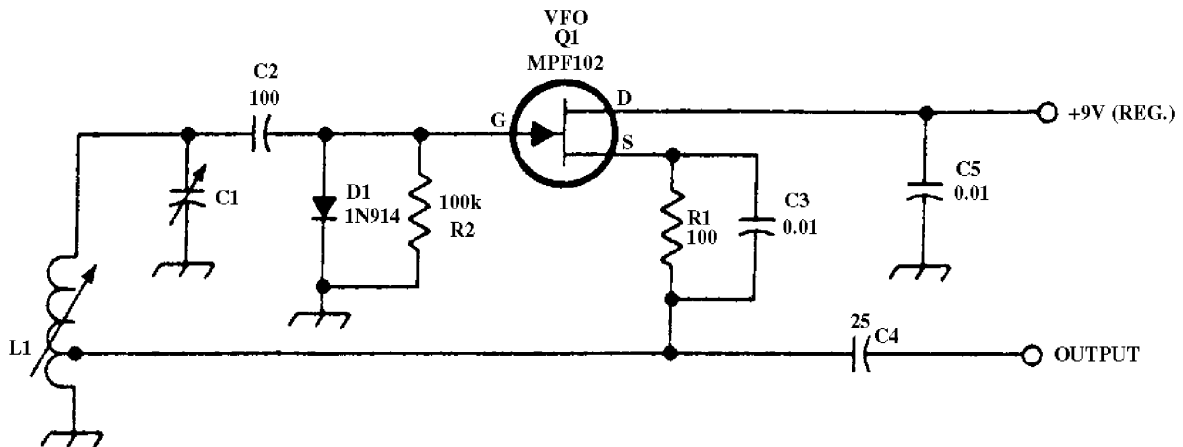
## Schematic Diagrams for the Advanced Qualification

### 5. Pierce Oscillator



## Schematic Diagrams for the Advanced Qualification

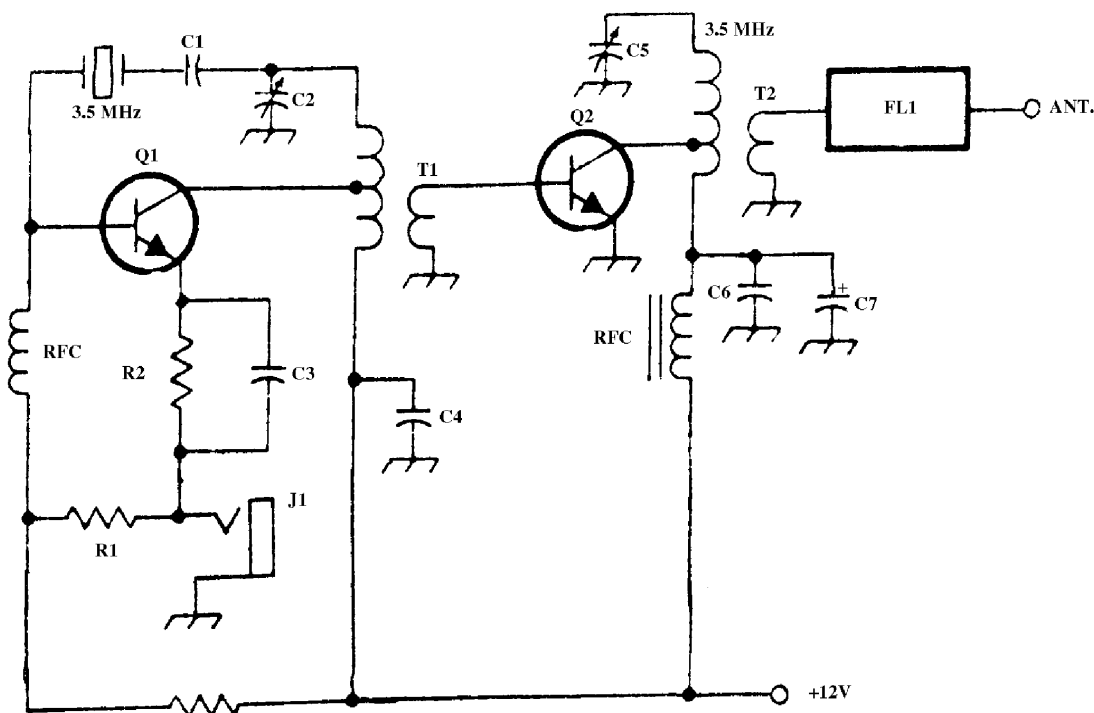
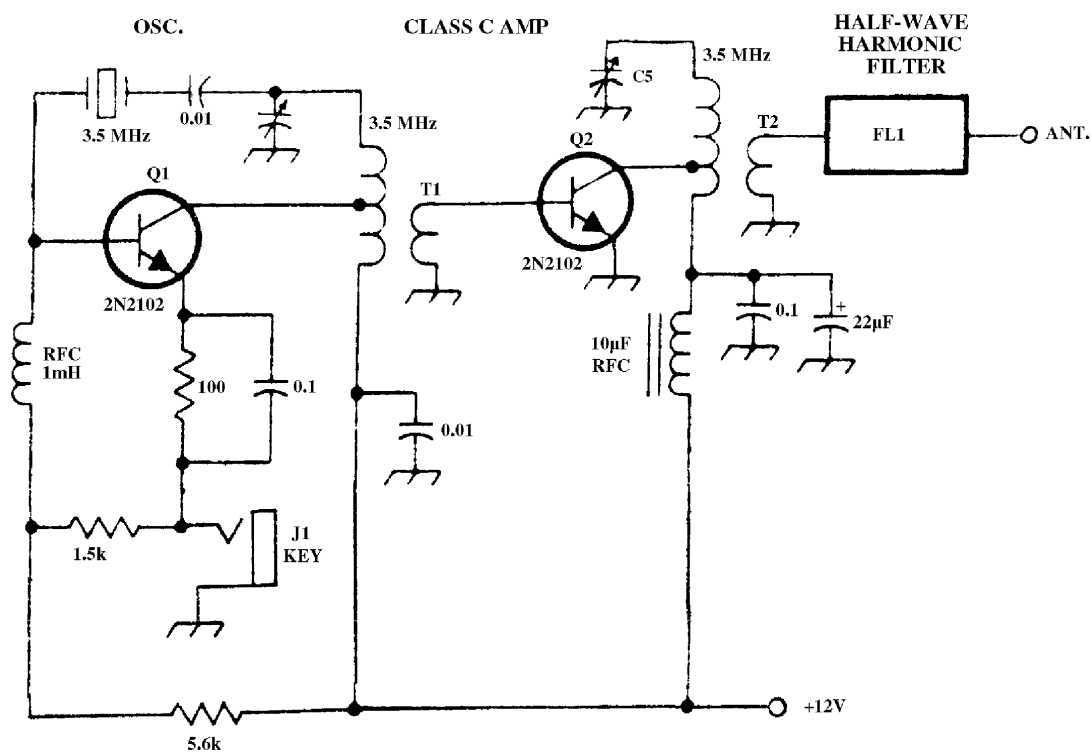
### 6. Variable Frequency Oscillator





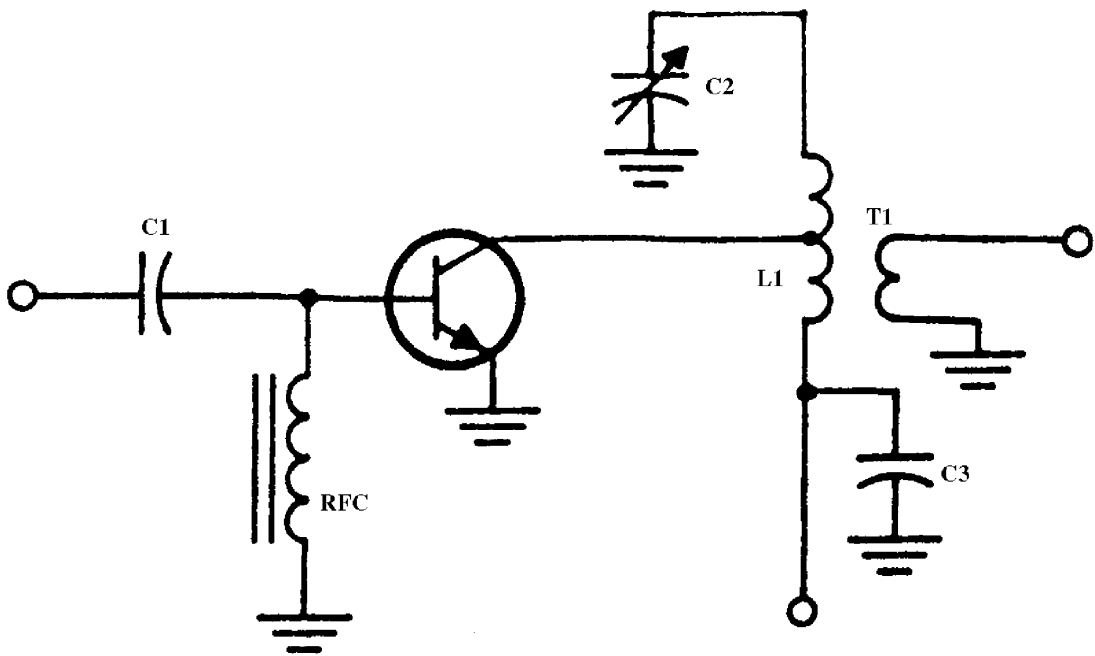
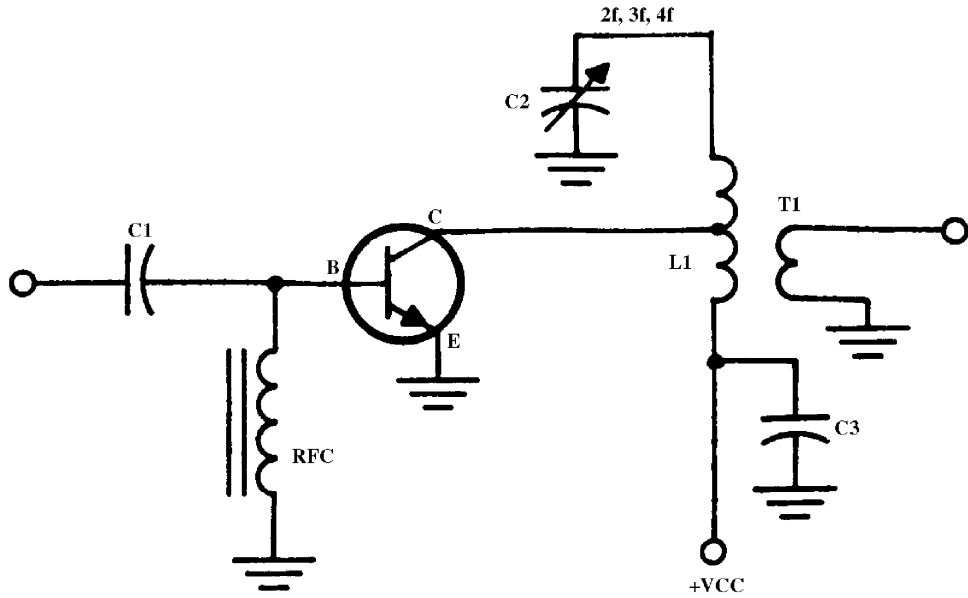
## Schematic Diagrams for the Advanced Qualification

### 7. Simple 2 stage CW Transmitter



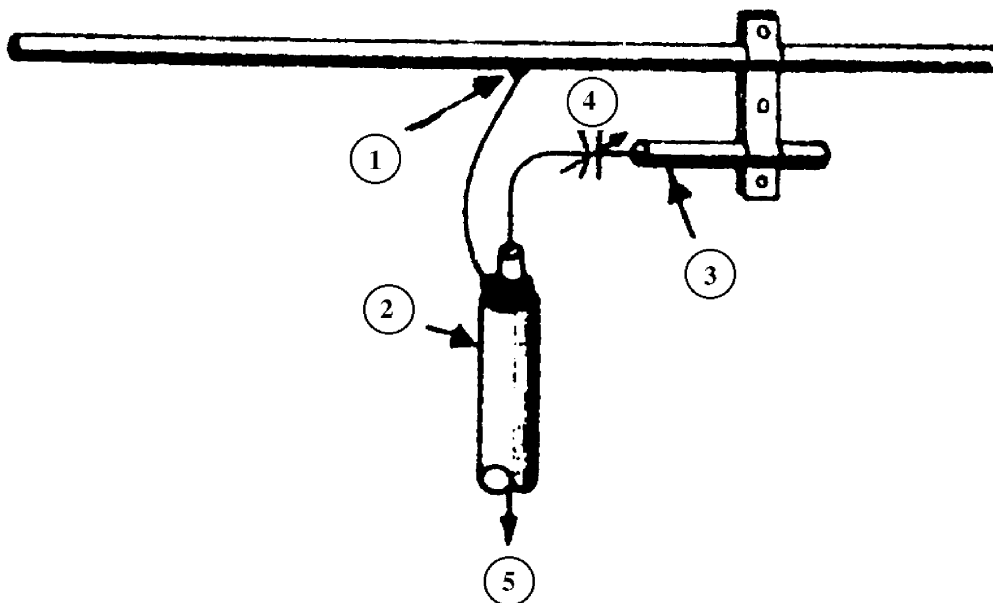
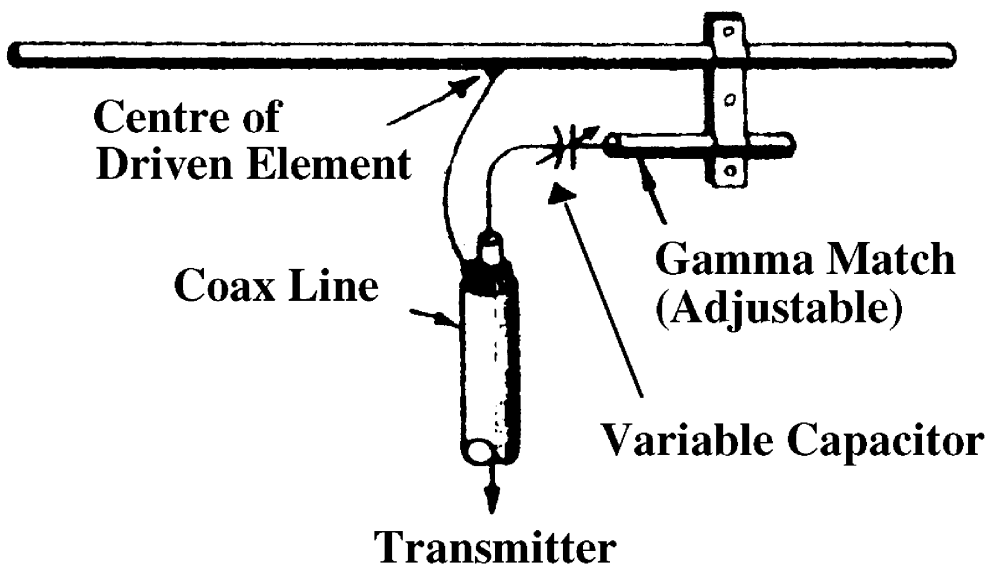
### Schematic Diagrams for the Advanced Qualification

#### 8. Frequency Multiplier



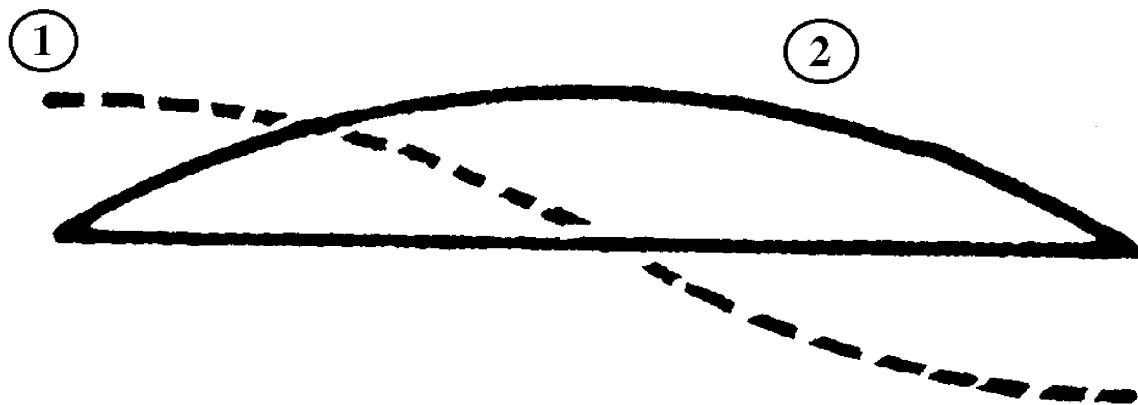
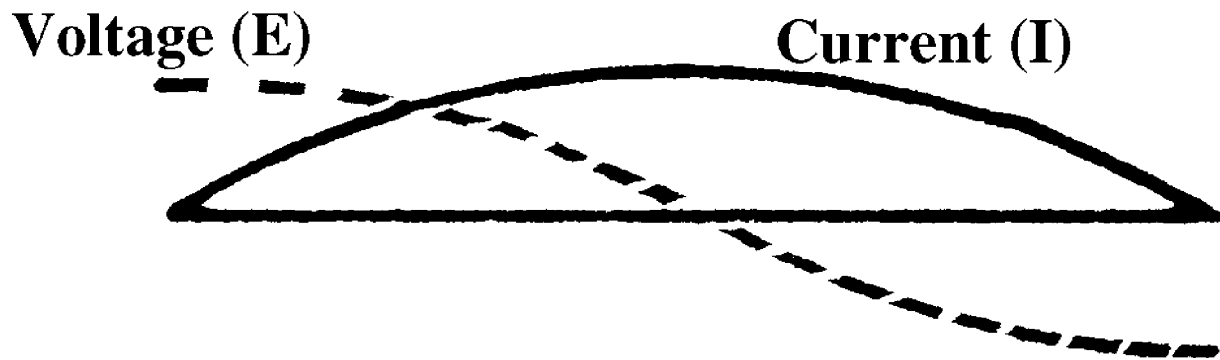
### Schematic Diagrams for the Advanced Qualification

#### 9. Gamma Match



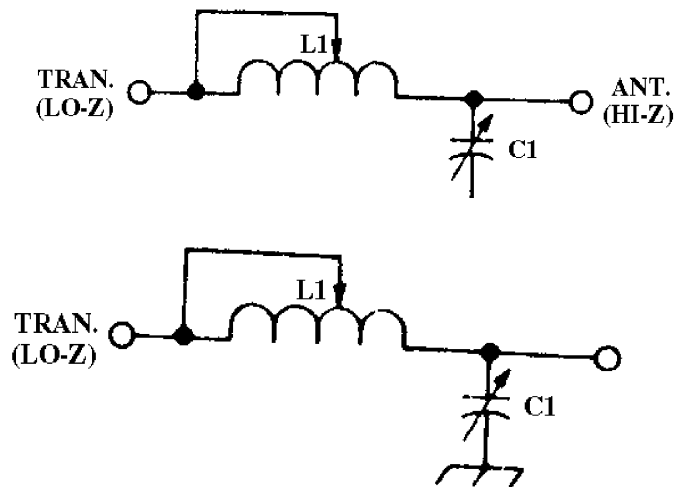
### Schematic Diagrams for the Advanced Qualification

#### 10. Fundamental (Half-Wave)

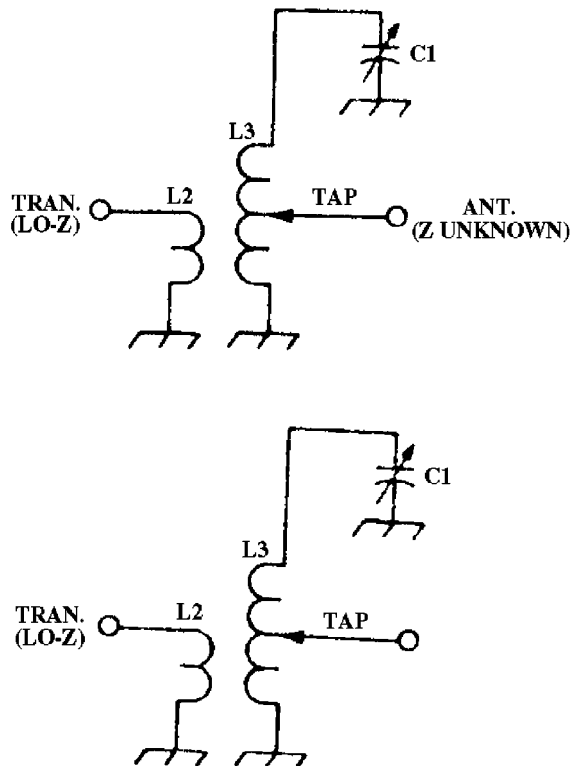


## Schematic Diagrams for the Advanced Qualification

### 11. Antenna Tuner "L" Type

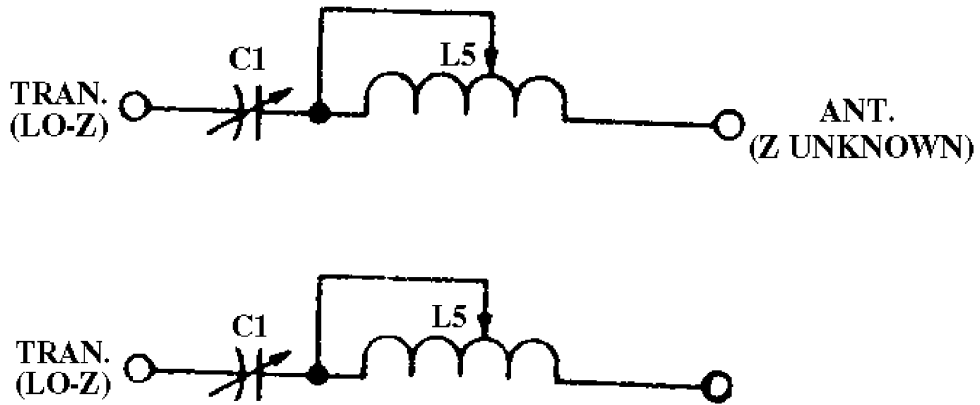


### 12. Antenna Tuner "Transformer" Type

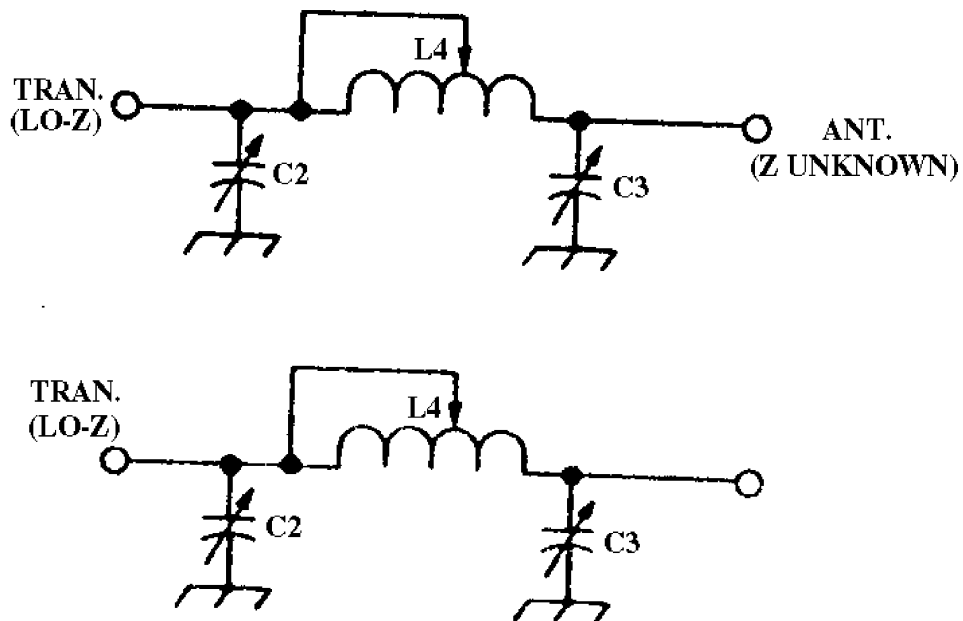


**Schematic Diagrams for the Advanced Qualification**

**13. Antenna Tuner "Series" Type**

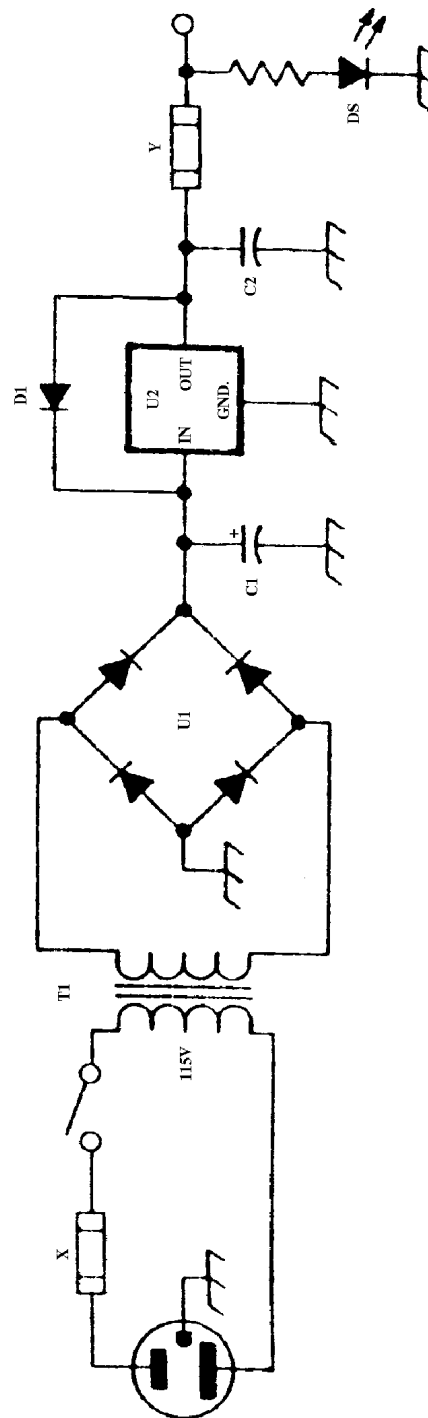
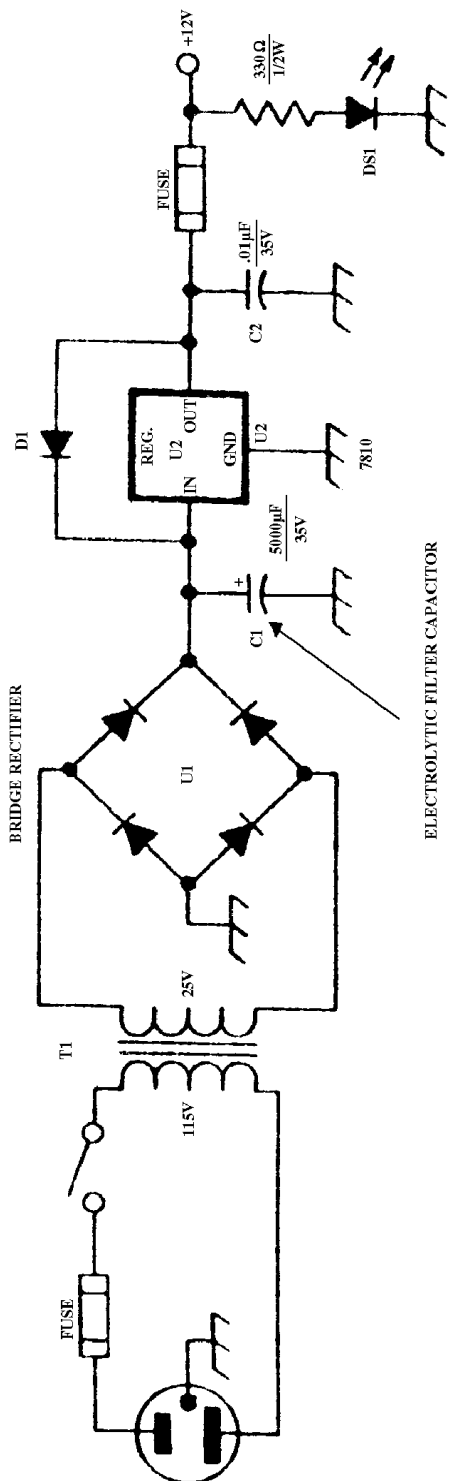


**14. Antenna Tuner "PI" Type**



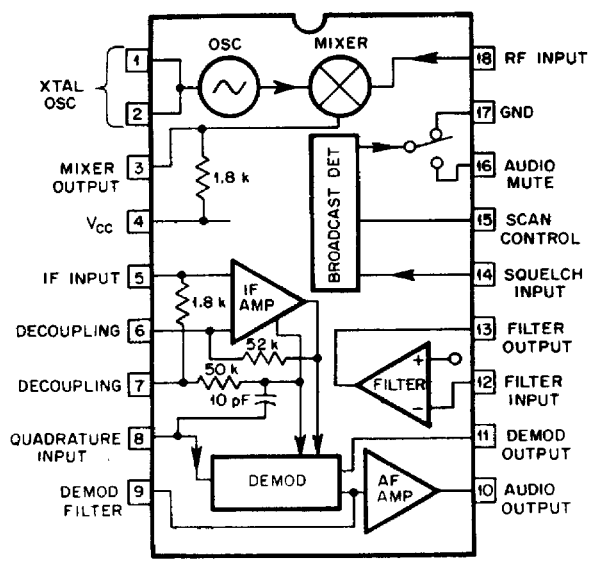
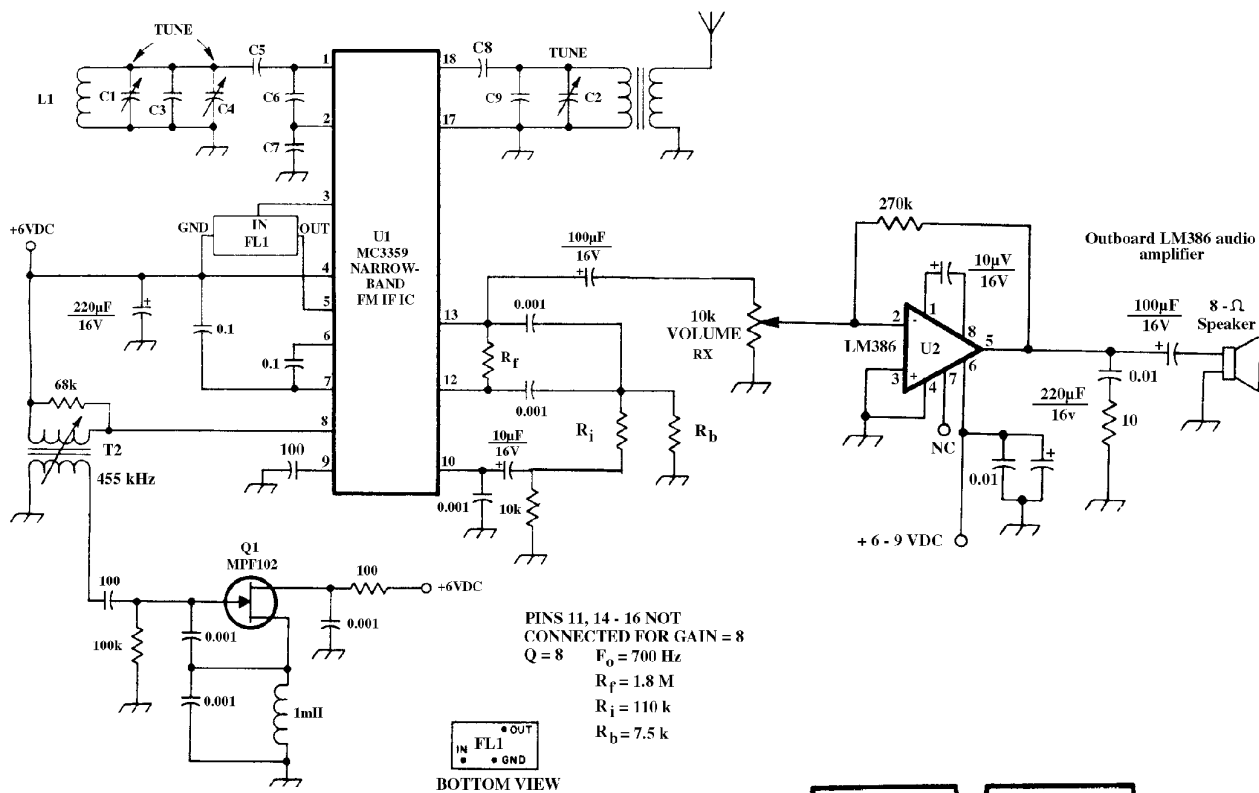
### Schematic Diagrams for the Advanced Qualification

#### 15. Power Supply



### Schematic Diagrams for the Advanced Qualification

#### 16. Superhetrodyne with one Receiver IC, one OP AMP and one FET







### Schematic Diagrams for the Advanced Qualification

#### 17. A grounded-grid Amplifier using a pi network input and a pi-L network output

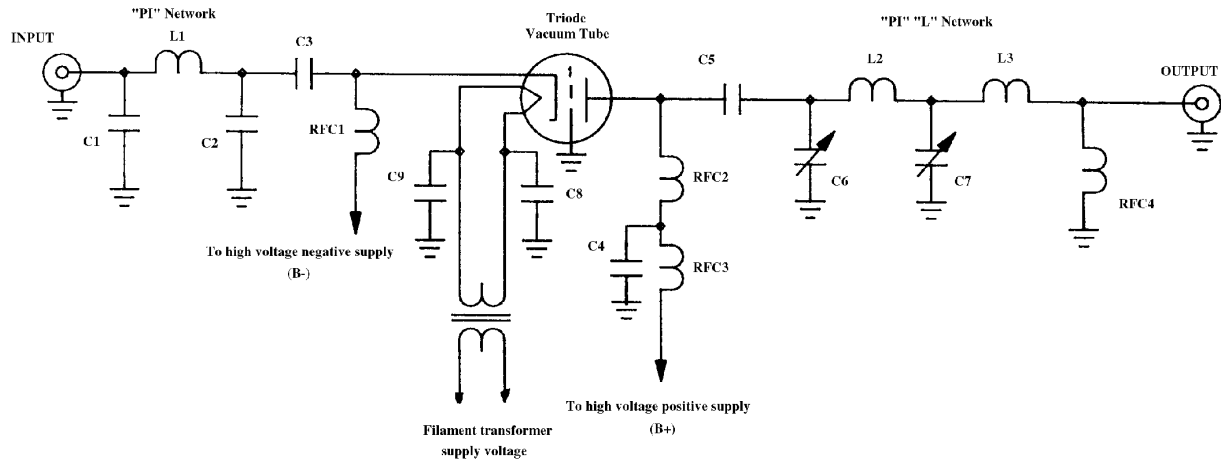
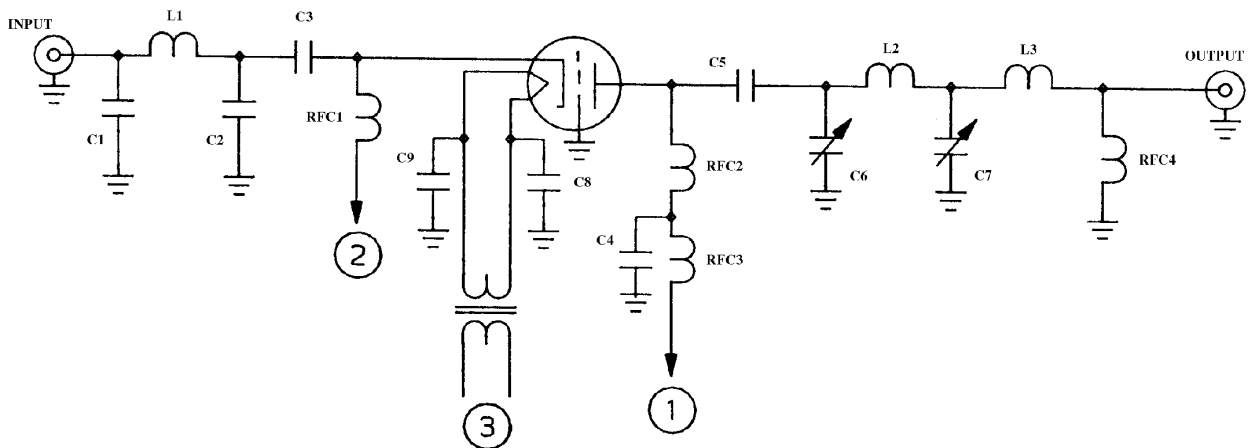
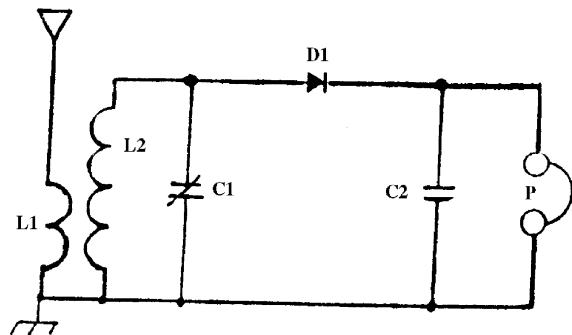


Diagram No. 17

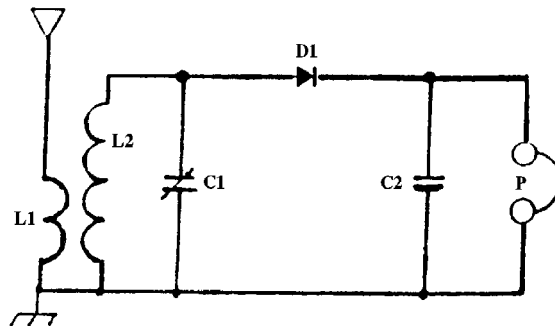


Schematic Diagrams for the Advanced Qualification

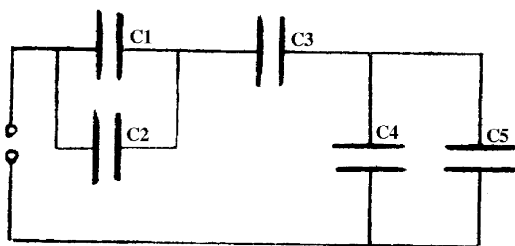
18. Diode Detector



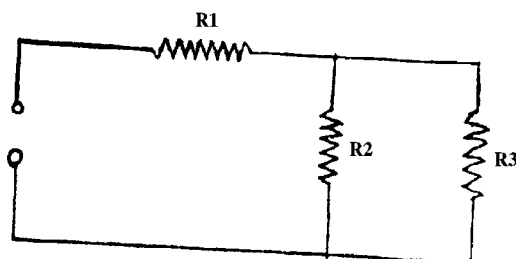
18.



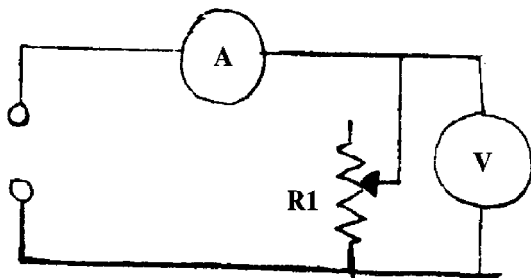
19.



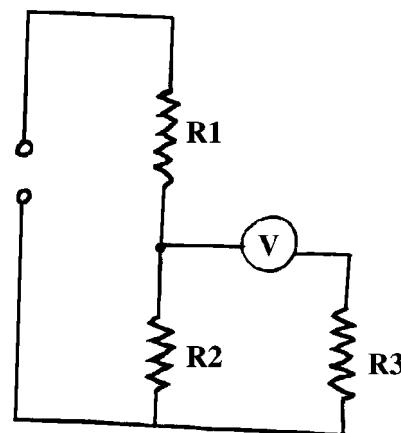
20.



21.

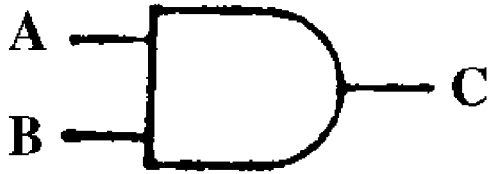


22.

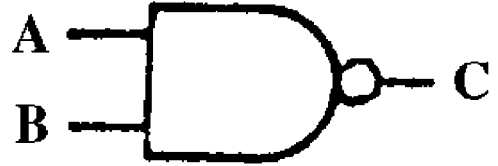


**Schematic Diagrams for the Advanced Qualification**

40. And



41. Nand



42. Or



43. Nor



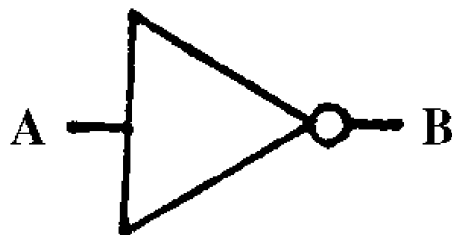
44. Exclusive or



45. Exclusive Nor

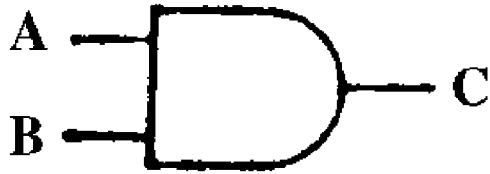


46. Not (Inverter)



### Schematic Diagrams for the Advanced Qualification

40.



41.



42.



43.



44.



45.



46.

