

IC-402

430MHz SSB CW TRANSCEIVER

INSTRUCTION MANUAL

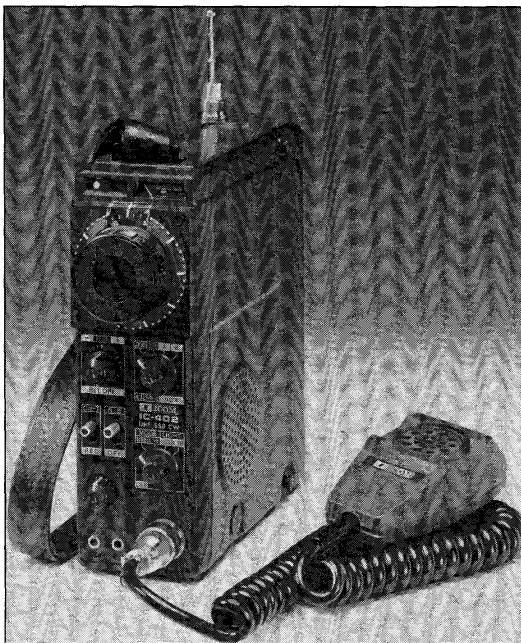


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SECTION I INTRODUCTION

Congratulations on the purchase of the IC-402 portable 70cm SSB transceiver. The IC-402 was designed to be operable anywhere like most portables, but we also included features found in most base sets like a very effective noise blanker, RIT, S & RF meter, CW monitor, and a full 3 watts output on either USB or LSB. Two built-in crystals and the stable VXO allow operation between 432.00 and 432.40MHz. If you wish to expand the range of the IC-402, we have also provided 2 spare crystal sockets for your convenience. With a slight retuning of the IC-402, and installation of a crystal, you may also work through OSCAR in USB for up-link (for mode B of AMSAT OSCAR 7) and in LSB for down-link (for mode J of AMSAT OSCAR 8).



The aluminum die cast frame provides a very strong yet light housing for the 2 circuit boards, and the aluminum sides snap off easily if service is ever necessary or to change batteries.

The IC-402 operates on 9 inexpensive C cell batteries, or an external 13.8V DC source. The IC-402 will also operate on nicad batteries, contained in the BC-20/BC-15 nicad battery/charger kit. For AC operation, we recommend the IC-3PS which not only provides power for the IC-402, but also doubles as a stand and holder for the IC-30L 10 watt linear amplifier.

You can use the built-in whip antenna for portable use, or an external antenna connects to the antenna connector with adapter instead of the whip antenna of the IC-402.

We are sure that you will have years of lasting enjoyment from your IC-402, manufactured by the leader in communication equipment: ICOM INCORPORATED.

SECTION II SPECIFICATIONS

General:

Number of Semi-conductors	Transistors 36 FET 7 IC 6 Diodes 59
Frequency Coverage	430.0 ~ 435.2MHz
Frequency Stability	Less than 200Hz per hour at +25°C
Antenna Impedance	50 ohms unbalanced
Power Supply Requirements	DC 13.8V ±15% Negative Ground 1A max.
Current Drain	Transmitting: A3J Approx. 670mA A1 Approx. 930mA Receiving: At max audio approx 320mA With no signal approx 100mA Dial Light: Approx 40mA
Dimensions	183mm (H) x 61mm (W) x 162mm (D)
Net Weight	2.0kg including batteries.

Transmitter:

Emission Mode	A3J (USB, LSB) and A1
RF Power Output	A3J 3W (PEP) A1 3W
Carrier Suppression	More than 40dB below peak power
Unwanted Sideband Suppression	More than 40dB down at 1000Hz AF input
Spurious Radiation	More than 60dB below peak power
Microphone	Impedance: 600 ohms Input level: 10mV typical Dynamic or optional Electret condenser microphone
CW Monitor	Built-in. Audio level adjustable by VOL knob.

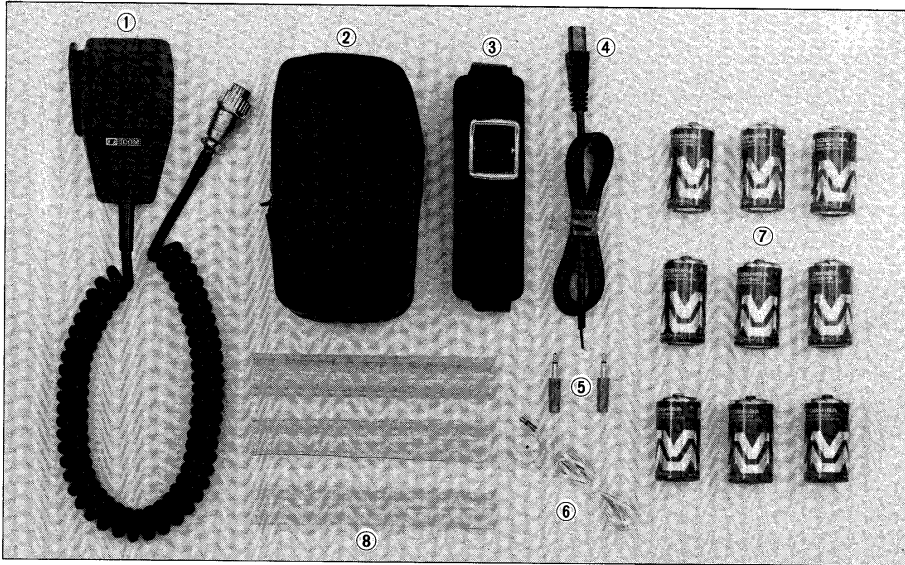
Receiver:

Receiving System	Dual Conversion Superheterodyne
Intermediate Frequency	1st: 57.6 ~ 57.8MHz 2nd: 10.74MHz
Spurious Response Rejection Ratio	More than 60dB
Sensitivity	Less than 0.5μV for 10dB S+N/N
Selectivity	±1.2KHz at -6dB ±2.4KHz at -60dB
Audio Output	More than 1W
Audio Output Impedance	8 ohms

432.00~432.40MHz built-in (2 crystals). Each crystal gives 200KHz continuous coverage. Two spare crystal sockets are provided for additional frequency ranges between 430.00~435.20MHz.

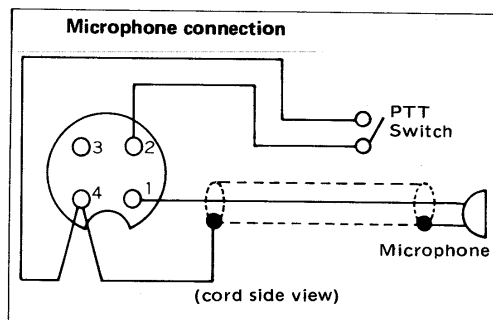
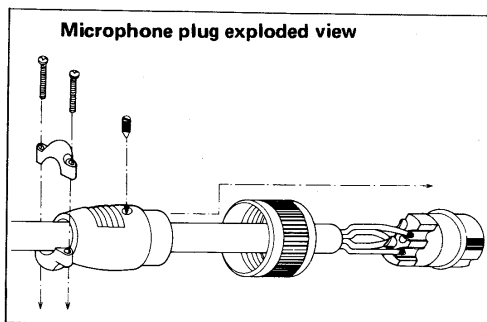
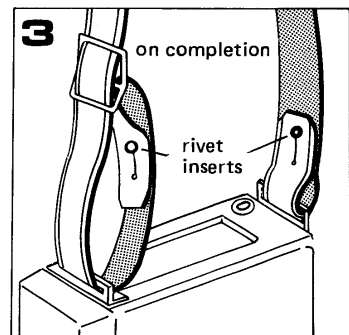
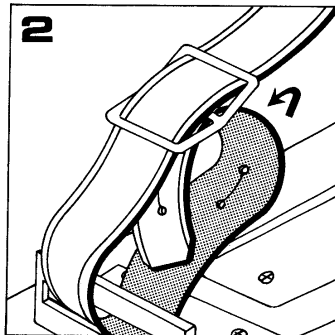
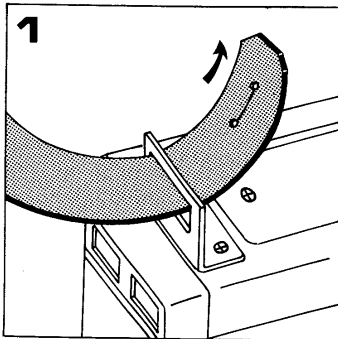
SECTION III ACCESSORIES

Various accessories are packed with your transceiver. Be sure not to overlook anything. Also it's a good idea to keep packing cartons in case of moving or if return for service is necessary.



1. Dynamic Microphone	1	5. Ext. Speaker Plug, Key Plug	2
2. Microphone Case	1	6. Earphone	1
3. Shoulder Strap	1	7. Dry Cells Type "C"	9
4. Power Cord	1	8. Battery Tubes	3

Shoulder strap attachment



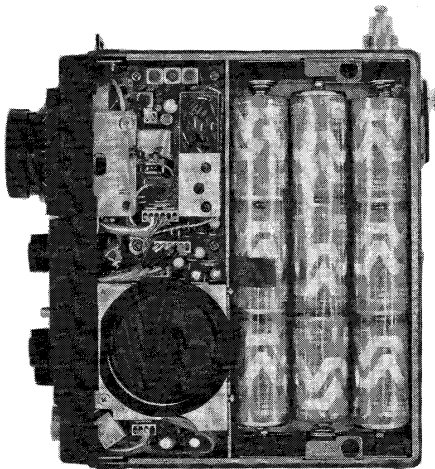
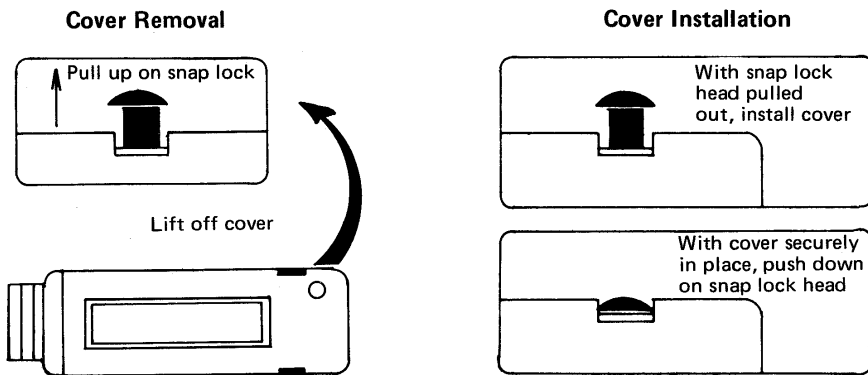
SECTION IV PRE-OPERATION

BATTERY INSTALLATION

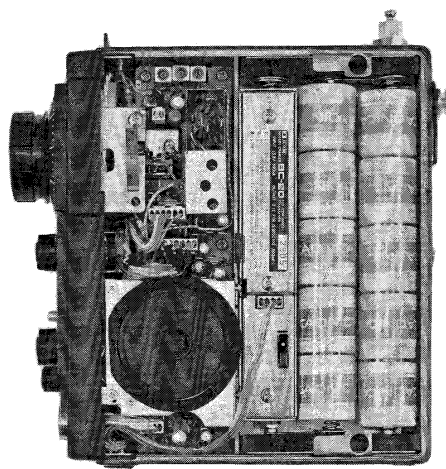
Dry Batteries:

Place the mode switch in the OFF position. Remove the side that covers the battery case and speaker. Install the batteries into the battery tubes (three in each) taking care to observe the same direction (polarity).

Carefully install the battery tubes in the manner shown in photograph 1, placing the last three batteries in the inner column. Again take care to observe polarity, and place the battery tubes on top of the ribbon so when the batteries need to be removed, a simple pull on the ribbon will make removal easier. With the batteries properly in place, carefully replace the side cover.



Photograph 1
Dry Batteries Installation



Photograph 2
Nickel-Cadmium Batteries
and Charge (BC-20) Installation

Nickel-Cadmium Batteries and Charger: BC-20

First, install the charger in the battery case (the speaker side) of the transceiver housing as shown in photograph 2. The polarity of the switch end of the charger must be positive and on the case side, negative. Accordingly the negative polarity must be connected to the spring side of the battery case.

Next, install five nickel-cadmium batteries in the battery tubes in the same direction. Make certain the (–) minus side is next to the spring. After installation of the charger and batteries in the case, connect the connector from the transceiver housing to the socket of the charger. Make sure the switch of the charger is ON, then install the side cover as before.

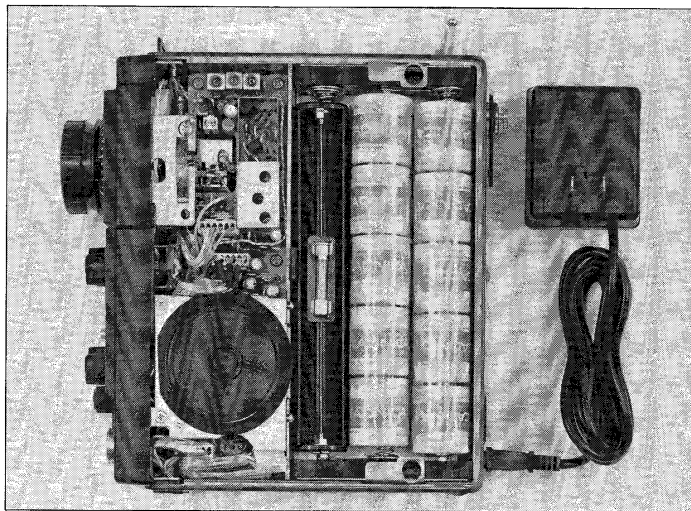
AC BATTERY CHARGER: BC-15

The BC-15 consists of an 117/220 Volt AC charger, 10 900mAh nickel-cadmium batteries, and a fuse box.

To install the BC-15 in the IC-402, first put the Fuse Box into position, and then install the nickel-cadmium batteries in accordance with Photograph 3. After installation is completed, connect the output plug of the AC Adapter to the External Power Supply Jack on the back of the IC-402. For recharging, refer to the manual instructions for the AC adapter.

After charging is completed, the batteries can be used in the same manner as dry cells. However, the voltage of nickel-cadmium batteries drops rapidly just before they are exhausted, so when the Power Indicator LED of the transceiver goes out, be sure to immediately stop using it, and charge the batteries again.

For use of the other sections, please refer to the charger instruction manual.



Photograph 3
Nickel-Cadmium Batteries
and Charger (BC-15) Installation

WHEN TO REPLACE BATTERIES

When the Power Indicator LED does not light up with the power switch ON, or when it lights up during reception and goes out during transmission, the batteries are exhausted. Use batteries of the same type, for mixed types might cause leakage. Replace worn batteries with a complete new set. If used with old batteries, the life of new ones might be shortened. Battery life is shortened more by transmitting than by receiving, since several times more current is drawn in transmit. To prolong battery life, therefore, practice as follows:

- * Try to minimize the transmit period.
- * Reduce volume during reception.
- * Be sure to cut off power source when set is not used.

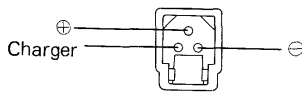
More working hours are available if high-performance batteries such as Alkaline type are employed.

EXTERNAL POWER PLUG CONNECTION

External Power Source

For use at home or in the car, please use the external power source which assures you of stable communication without concern about battery consumption.

1. Use either a regulated power supply or car battery of 13.8V DC and of over 1A current capability. (Though this transceiver may work at 11 to 15V DC, use it preferably at the rated voltage.)
2. Correctly connect the external supply as shown in the figure. If polarity is reversed, source power is cut off by the protection circuit and the unit will not operate.
3. When the transceiver is kept out of use for a prolonged period, the unit is operated for extended periods by external power only, or when the batteries are exhausted, etc., remove the batteries to protect the unit from possible damage by battery leakage.



External Power Supply Jack Connection



Power Cord Connection

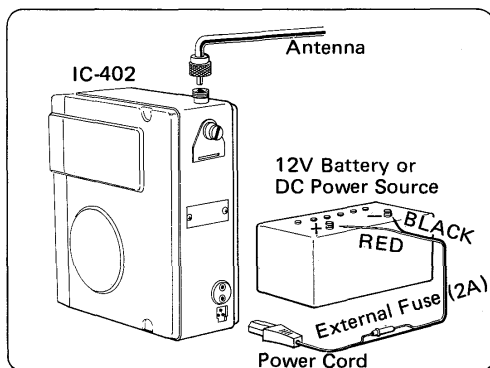
FOR OUTDOOR USE

1. Insert the supplied batteries. (Refer to "BATTERY INSTALLATION")
2. Attach the supplied shoulder strap through the fixture on the body (as shown in the drawings on page 3).
3. Fully extend the whip antenna for operation. Keep the collapsible antenna depressed when the set is not in use so that it will not be damaged.

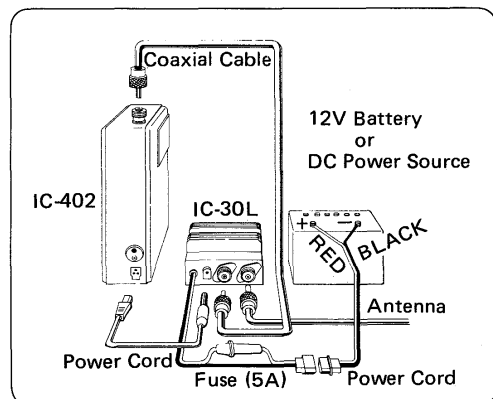
FOR USE IN THE CAR

1. Avoid using the unit near the outlet of heaters, air-conditioners, etc.
2. Install the unit in a convenient place to avoid disrupting safe driving.
3. For the best power source, connect to the car battery through a fuse (1A-2A).
4. Firmly ground to the car body a mobile antenna (e.g. whip antenna) that requires it.

Cable Connection



Connection using IC-30L



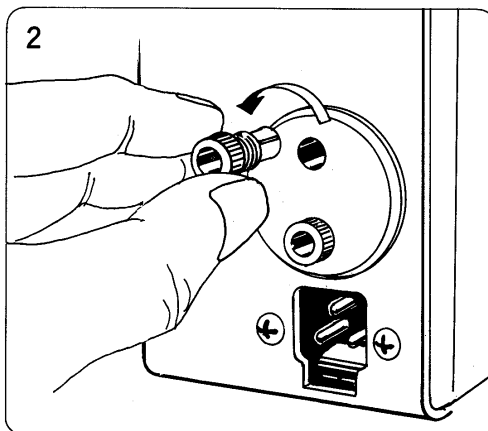
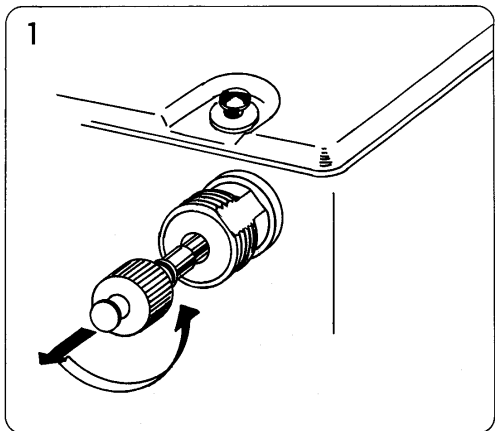
FOR FIXED USE

1. Avoid installing the unit in places exposed to rain, water splash, direct sunshine, dust, vibration, or heat.
2. An external antenna should be used for indoor operation. The use of the whip antenna indoors may cause TVI, BCI, Hi-Fi interference, malfunction of stabilized DC power supply, etc. When using an external antenna, be sure to remove the whip antenna.
3. For fixed use, an external power supply is more economical than batteries.
4. Use of the linear amplifier IC-30L and AC power supply IC-3PS give excellent performance for fixed use.
5. Use of IC-SM2 electret condenser microphone is recommended for optimum fixed station operation.

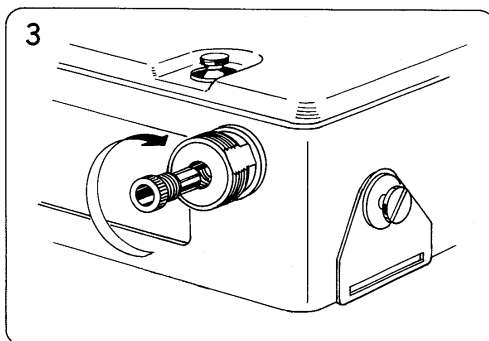
HOW TO CONNECT EXTERNAL ANTENNA

The whip antenna mount on the IC-402 can be converted to a receptacle for a standard PL-259 coaxial connector to avoid possible mismatching. For conversion, do the following:

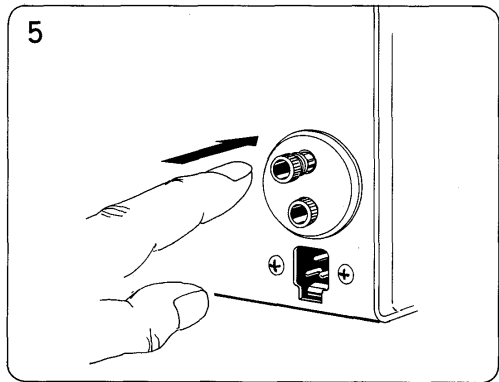
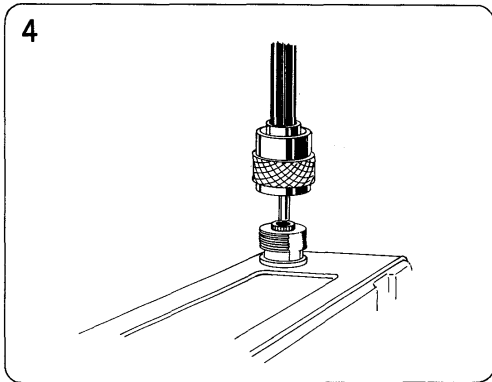
1. Remove the whip antenna by turning the base of the antenna counter-clockwise and then pulling it out.



2. Remove the adapter for PL-259 connector from the adapter holder located on the rear panel by turning it counter-clockwise. Either one of the two adapters may be used.
3. Screw the adapter into the hole from which the whip antenna was removed as tightly as possible with your fingers.



4. Connect the PL-259 connector of the external antenna to the converted antenna receptacle.
5. To use the whip antenna after conversion, follow the above instructions in reverse (from 4 to 1). However, to replace the adapter in the holder, it is necessary only to push it back into the hole.



The IC-402 has a spare adapter, but both should be kept in the holders when not use.

EXTERNAL ANTENNA

1. Select a high performance antenna (a multi-element beam or gain antenna) and set it up in the highest possible position.
2. Use a 50 ohm antenna and coaxial cable.
3. On UHF, the power loss in the antenna cable is large, so use a cable with the lowest possible loss and make it as short as possible.

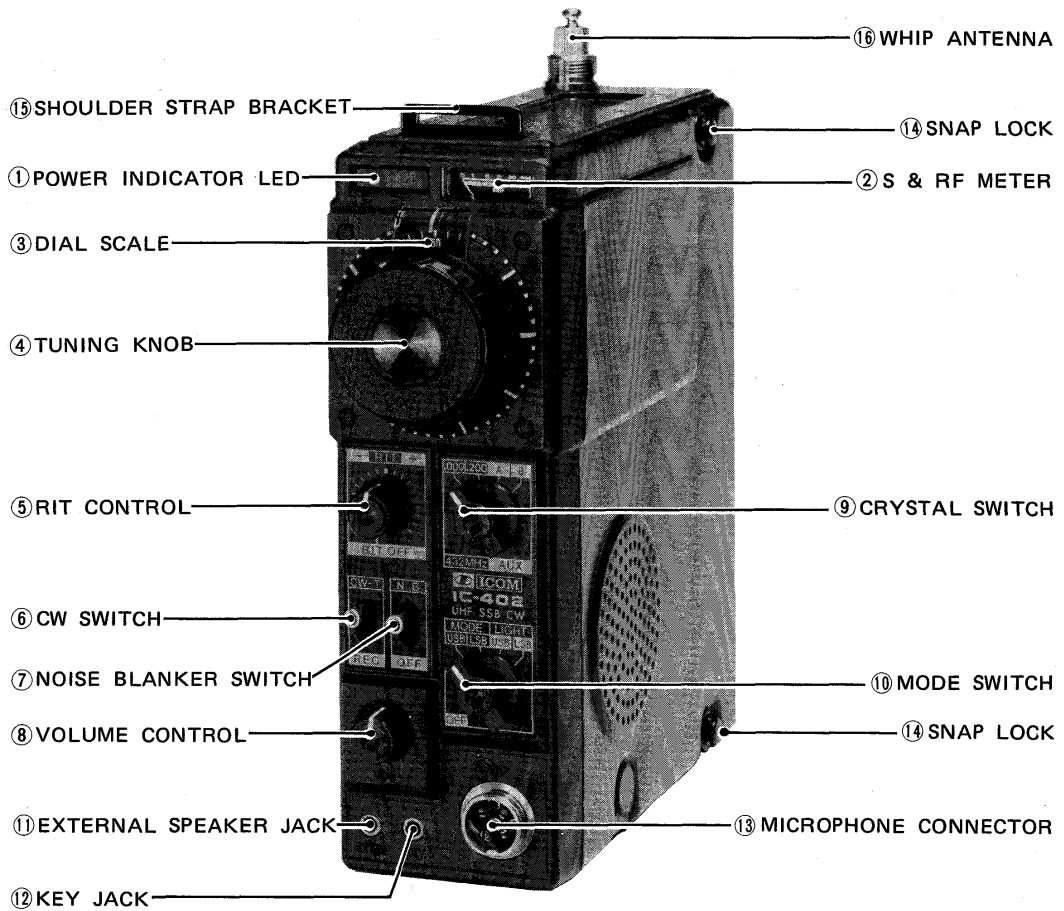
FOR SATELLITE COMMUNICATION USE

At present there are two active satellites for amateur radio use, AMSAT OSCAR 7 was launched in November, 1974 and AMSAT OSCAR 8 was launched in March, 1978. Satellite communications can be made by using an IC-402 for receiving/transmitting and IC-211(E), IC-245(E) or IC-202S (2 meter SSB/CW transceiver) for transmitting/receiving in Mode B and Mode J. For frequency information refer to the chart below. Further information on communicating through satellites can be found in various amateur radio books and periodicals.

FREQUENCY CHART

SATELLITE	MODE	UPLINK (Transmitting) FREQUENCY	DOWNLINK (Receiving) FREQUENCY	BEACON
AMSAT OSCAR 7 (AO-7)	A	145.85MHz ~ 145.95MHz (USB/CW)	29.4MHz ~ 29.5MHz (USB/CW)	29.502MHz 435.100MHz
	B	432.125MHz ~ 432.175MHz (USB/CW)	145.975MHz ~ 145.925MHz (LSB/CW)	145.972MHz
AMSAT OSCAR 8 (AO-8)	A	145.85MHz ~ 145.95MHz (USB/CW)	29.4MHz ~ 29.5MHz (USB/CW)	29.402MHz
	J	145.90MHz ~ 146.00MHz (USB/CW)	435.2MHz ~ 435.1MHz (LSB/CW)	435.097MHz

SECTION V DESCRIPTION OF CONTROLS AND CONNECTIONS



1. POWER INDICATOR LED

Shows when power is applied to the IC-402 and also indicates battery condition. When this LED is not illuminated with the power ON, the battery voltage is approximately 9.5V or less.

2. S & RF METER

Indicates the relative signal strength of incoming signals and output power of transmitted signals.

3. DIAL SCALE

The dial is divided into 10KHz increments with a total coverage of 200KHz. The operating frequency is read by adding the frequency shown on the dial to that shown on the crystal switch, or in the case of the spare crystals, by adding the dial reading to the lowest range frequency of the crystal installed. (see page 13)

4. TUNING KNOB

Tunes the frequency.

5. RIT CONTROL

Independently swings the receiver frequency $\pm 2.5\text{KHz}$ so that signals that are slightly off frequency may be tuned for clarity without affecting the transmitting frequency. For switching OFF the RIT to make the receiving and transmitting frequencies the same, turn the RIT control knob fully counter-clockwise to the RIT OFF position.

6. CW SWITCH

Be sure to set the MODE SWITCH at the USB position, or else your CW signal will not be transmitted. A CW MONITOR is built in, and the audio level can be adjusted with the VOLUME CONTROL.

7. NOISE BLANKER SWITCH

In the NB position, the noise blanker is put into the circuit and noise pulses will be reduced.

8. VOLUME CONTROL

Controls the audio output level. Controls the side-tone audio level in the CW transmit mode.

9. CRYSTAL SWITCH

Selects the crystal to be used in the 1st local oscillator, and therefore also selects the frequency range.

10. MODE SWITCH

Selects a desired sideband (USB or LSB) in the MODE position. To turn ON the meter light, set the switch to USB or LSB in the LIGHT position. The brightness of the light may be slightly dimmer in the USB mode than in the LSB mode.

For CW operation, set at the USB mode.

11. EXTERNAL SPEAKER JACK

An external speaker can be connected here. The impedance of the speaker should be 8 ohms. With the external speaker connected, the built-in speaker will be disabled.

12. KEY JACK

Accepts a CW key for CW operation.

13. MICROPHONE CONNECTOR

A 600 ohm microphone is connected here.

14. SNAP LOCKS

Convenient snap-locks hold the sides in place. To remove them for any service or to replace the batteries, simply pull out on the center of the snap-locks and the cover can easily be removed. When replacing the covers be sure that you have placed the covers properly in the grooves provided, then push down on the center of the snap-lock. (see page 4).

Note: When the sides are placed in the grooves, the snap-lock center must be pulled out.

15. SHOULDER STRAP BRACKET

Connect the shoulder strap here for easy carrying. (see page 3).

16. WHIP ANTENNA and EXTERNAL ANTENNA CONNECTOR

Make sure that the whip antenna is fully extended when used. When an external antenna is used, the whip antenna base functions as an external antenna connector by simple conversion. (see page 7.)

17. EXTERNAL ANTENNA ADAPTER HOLDER

Holds two adapters, including one spare adapter. Use the adapter following the instructions on page 7 when using an external antenna.

18. MICROPHONE HANGER

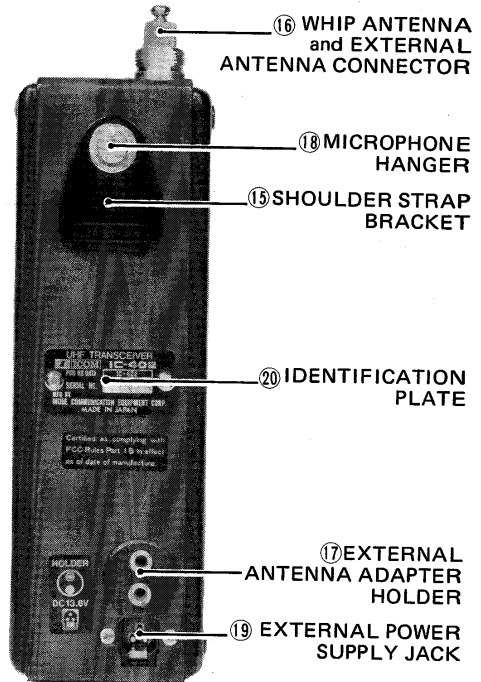
When not in use, the mike can be hung out of the way.

19. EXTERNAL POWER SUPPLY JACK

Any well regulated power supply with an output of 13.8 volts can be connected here, instead of using the batteries installed. Inserting the power plug into the jack disables the internal battery source. When the BC-20 nicad battery pack is used, the external power source will charge the batteries.

20. IDENTIFICATION PLATE

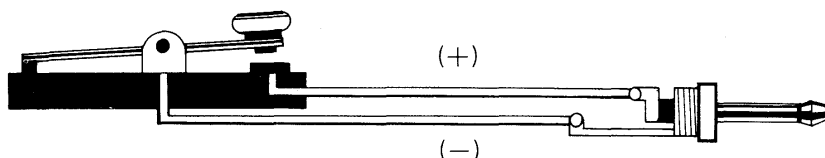
States model number and serial number.



SECTION VI OPERATION

1. After the batteries have been installed, or the IC-402 is connected to an external power source, turn the MODE switch to the desired sideband in the MODE position. If the surrounding light is too dim to see the S & RF meter or frequency, turn the switch to the desired sideband in the LIGHT position, and the meter and dial will be illuminated.
2. Extend the whip antenna to its full length, or if you wish to use an external antenna, connect the cable to the EXTERNAL ANTENNA CONNECTOR after converting the whip antenna base.
3. Connect the microphone to the MICROPHONE CONNECTOR on the front panel.
4. If you wish to use the CW mode of transmission, connect a key to the KEY JACK on the front panel. You do not have to disconnect the microphone for CW operation.

Key Wiring Diagram



5. Place the CRYSTAL switch in the proper position for the portion of the 70cm band you wish to operate in, whether it be CW or SSB. If you wish to operate outside of the 432.00~432.40 MHz portion of the band, it will be necessary for you to install an additional crystal in one of the spare crystal sockets provided for this purpose. (see page 13)
6. Turn the tuning knob until you reach the desired frequency or a signal is heard. Adjust the volume control for a comfortable level of listening. You may wish to place the Noise Blanker switch in the NB position. This activates the noise blanking circuit which will suppress noise pulses. After selecting the operating frequency, if the received signal seems to drift, adjust the RIT control until the signal is again clear.
7. For SSB operation, hold the microphone close to your mouth, push the PTT switch on the microphone, and speak in a clear, normal tone of voice. For CW operation, after connecting your key and setting the MODE switch to the USB position, place the CW switch in the CW-T position and the IC-402 will transmit when the key contacts are closed. To receive, place the switch back in the REC position.

A/B POSITION SPARE CRYSTALS

The IC-402 comes with 2 crystals installed in the 1st local oscillator for operation between 432.00 ~ 432.40MHz with each crystal covering 200KHz. If you wish to work another part of the band, all that is needed is to install the proper frequency crystal in either the A or B spare crystal socket, tweak it, and you are ready for operation. Also a crystal can be installed to work the 435.00 ~ 435.20MHz portion of the band if you want to use the amateur communication satellite of AMSAT OSCAR 8 (AO-8).

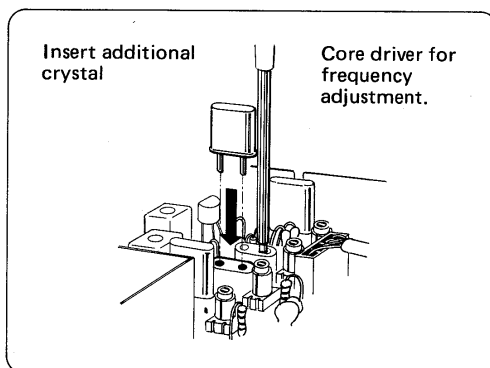
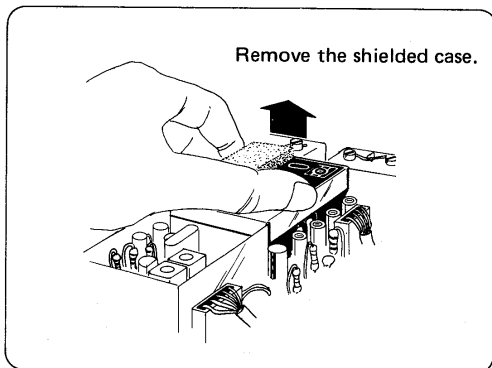
Additional crystals can be ordered from your authorized ICOM distributor or dealer by specifying a crystal number or center frequency in the crystal chart.

Crystal Chart

Xtal No.	Center Freq. (MHz)	Range (MHz)	Freq. at CP1 (MHz)	Freq. at CP2 (MHz)	Remarks
65-1	430.1	430.0-430.2	124.133,33	372.400	
65-2	430.3	430.2-430.4	124.200,00	372.600	
65-3	430.5	430.4-430.6	124.266,67	372.800	
65-4	430.7	430.6-430.8	124.333,33	373.000	
65-5	430.9	430.8-431.0	124.400,00	373.200	
65-6	431.1	431.0-431.2	124.466,67	373.400	
65-7	431.3	431.2-431.4	124.533,33	373.600	
65-8	431.5	431.4-431.6	124.600,00	373.800	
65-9	431.7	431.6-431.8	124.666,67	374.000	
65-10	431.9	431.8-432.0	124.733,33	374.200	
65-11	432.1	432.0-432.2	124.800,00	374.400	Installed
65-12	432.3	432.2-432.4	124.866,67	374.600	Installed
65-13	432.5	432.4-432.6	124.933,33	374.800	
65-14	432.7	432.6-432.8	125.000,00	375.000	
65-15	432.9	432.8-433.0	125.066,67	375.200	
65-16	433.1	433.0-433.2	125.133,33	375.400	
65-17	433.3	433.2-433.4	125.200,00	375.600	
65-18	433.5	433.4-433.6	125.266,67	375.800	
65-19	433.7	433.6-433.8	125.333,33	376.000	
65-20	433.9	433.8-434.0	125.400,00	376.200	
65-21	434.1	434.0-434.2	125.466,67	376.400	
65-22	434.3	434.2-434.4	125.533,33	376.600	
65-23	434.5	434.4-434.6	125.600,00	376.800	
65-24	434.7	434.6-434.8	125.666,67	377.000	
65-25	434.9	434.8-435.0	125.733,33	377.200	
65-26	435.1	435.0-435.2	125.800,00	377.400	For AO-8

INSTALLATION

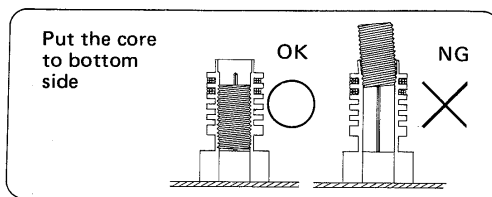
1. Place the mode switch in the OFF position. Remove the side that covers the main unit (opposite side of the battery case), as in BATTERY INSTALLATION. (see page 4).
2. Remove the shielded case that covers the crystal sockets. Insert additional crystal(s) into A and/or B spare crystal socket.



FREQUENCY ADJUSTMENT

A frequency counter capable of measuring 130MHz or 400MHz is needed for the frequency adjustment.

1. When using frequency counter capable of measuring 130MHz:
 - a. Connect the frequency counter to CP1 near the crystal sockets, with ground connected to the chassis.
 - b. Set the crystal switch to the position of the crystal to be adjusted, and the mode switch in the USB or LSB position.
 - c. Adjust the appropriate coil until the frequency shown in the chart on page 13 is obtained, with the coil core to the bottom side as shown in the figure.
 - d. Readjust the installed crystals using the same procedure.
 - c. Replace the shielded case.



2. When using a frequency counter capable of measuring 400MHz:
 - a. Replace the shielded case.
 - b. Connect the frequency counter to CP2 near the crystal filter, with ground connected to the chassis.
 - c. Adjust the appropriate coil until the frequency shown in the chart on page 13 is obtained using the same procedure described above.

SECTION VII THEORY

CIRCUITS

Section X shows a block diagram of the IC-402.

The receiving section is a dual conversion superheterodyne, employing a wide band variable crystal oscillator (VXO) as the 2nd local oscillator. The transmitting section is a dual conversion system which employs a filter-type SSB generator using a 10.74MHz crystal filter and the same local oscillators as the receiving section. A double-balanced mixer is used for the 1st transmitting mixer and a Schottky diode mixer is used for the 2nd transmitting mixer to minimize spurious radiation. Although a portable unit, the IC-402 also features built-in circuits such as RIT, AGC, ALC, and a noise blanker.

RECEIVING CIRCUIT

RF AMPLIFIER

The signal from the whip antenna or an external antenna passes through the low-loss helical cavities L46 and L47 in the main unit, through the coaxial relay RL1 and through the helical cavities L1 and L2 at the input of RF amplifier Q1. High-molecule cores provide excellent RF response and silver-plated cavity cases give a very high Q, more than 500 with no load. This kind of cavity is used for the circuits which handle signals of about 400MHz, besides being used in the RF amplifier.

RF amplifier Q1 has approximately 12dB gain and the output signal is filtered by helical cavities L3 and L4 which provide a 6MHz band width.

1ST AND 2ND MIXER CIRCUITS

Q2 of the main unit is a MOS FET for the 1st mixer. The signal from the RF amplifier is fed to the 1st gate and a signal of approximately 700mV from the 1st local oscillator is fed to the 2nd gate of Q2. The output signal of Q2 is filtered for 57.6~57.8MHz by the band pass filters, consisting of L5~L7 and L1 of the MIX unit.

Q1 of the MIX unit is the 2nd mixer. The 2nd local oscillation signal is fed to the source of Q2 through diode switch D1. The 1st IF signal is fed to the gate of Q2 and converted to the 2nd IF signal of 10.74MHz.

2ND IF AMPLIFIERS AND BALANCED DEMODULATOR

The signal from the 2nd mixer passes through L9 and 20KHz-wide monolithic filter FL1 which rejects nearby signals affecting noise blanker operation. The output signal of the filter is fed to the noise blanker circuit and to SSB crystal filter FL2 through buffer amplifier Q3 and diode switch D1. FL2 has a 2.4KHz bandwidth for SSB reception. The output signal of FL2 is amplified by IF amplifiers IC1, IC2, and IC3. The gain of each IF amplifier is approximately 34dB, which is very suitable for SSB reception of which the AGC range is 70dB to provide stable reception. R23, connected to Pin 7 of IC3, is for adjustment of IC3's amplification to set the S-meter sensitivity. The output signal of the IF amplifiers passes through diode switch D8 and is fed to the balanced demodulator, D19 and D20, which also functions as a balanced modulator in the transmit mode. The BFO signal from the BFO unit is fed to L6 of the main unit, where the signal is converted to audio signals.

AUDIO FREQUENCY AMPLIFIER CIRCUIT

The audio frequency signal from the balanced demodulator is filtered by active low-pass filter Q6 to reject unwanted signals above 3KHz. The volume control R2 adjusts this output level

which is fed to AF amplifier IC4, which has approximately 35dB gain to drive the speaker. D22 applies bias to IC2 to mute audio during transmit and provide silent transmit-receive switching.

NOISE BLANKER

A part of the output signal from FL1 is amplified by IC5 and IC6 and detected by D30 and D31. This detected output is separated into audio signal components and pulse components. The signal component is integrated by R100 and C164, then amplified by Q20, and fed through the buffer amplifier Q21 to IC5 and IC6 as AGC voltage. The pulse component is fed to Q4 through a differential circuit. The noise pulse turns ON Q4 and, as long as noise exists, turns ON D3 and turns OFF noise blanker gate diode D1, thus preventing the noise from being transferred to the crystal filter FL2.

AGC AND S-METER CIRCUIT

A part of the IF signal is picked up from IF amplifier IC3, passes through C34 to be detected by D9 and D10, and then is amplified by Q5. The output signal is processed by C36, R27 and R28 for the fast attack and slow release AGC characteristics. The processed signal is amplified by Q5 and is fed through the buffer amplifier to IC1 and IC2 as the AGC voltage. A part of the output signal of Q6 is fed through the S-meter full-scale adjustment variable resistor R31 and reverse current protect diode D11 to the S-meter.

TRANSMIT UNIT

AF AMPLIFIERS

The AF signal from the microphone connector J5 is adjusted by the mic gain adjustment R27 and amplified by Q7, Q8 and Q9, which have a total gain of approximately 50dB.

BALANCED MODULATOR AND 1ST IF AMPLIFIER

The AF signal from the AF amplifiers is fed to the balanced modulator (commonly used as a demodulator in the receive unit), and the BFO signal is fed through L26. To provide good temperature compensation characteristics, dynamic range, and low distortion operation, Schottky diodes and twist-wound coils are used in this circuit. The carrier-null adjustment is made by R49 and C69. In the CW mode, a voltage to unbalance the modulator is supplied through D18. The DSB signal generated by the modulator passes through D21 and is amplified by Q10, which is controlled by the ALC voltage. The output signal of Q10 is fed through D6 to FL2 to produce SSB, in the reverse direction of that for receive operation.

1ST MIXER, BUFFER AMP, AND 2ND MIXER

The SSB signal from FL2 of the main unit passes through diode switch D2 and is fed to the double-balanced mixer consisting of Q2 and Q3 of the MIX unit. However, the 2nd local oscillation signal is supplied to the mixer through D2 and the SSB signal is converted to 57.6 ~ 57.8MHz, which is amplified by Q11 on the main unit and then fed to the 2nd mixer. The 2nd mixer consists of Schottky diodes D23 and D24, and the local oscillation signal is supplied to the mixer through D17. This mixer converts the signal to the transmitting frequency.

LINEAR AMPLIFIER

Q12, Q13, Q14 and Q17 on the main unit are linear amplifiers and bring up the output level of the 2nd mixer (approximately 0.1mW) to 3W, which is the transmitting RF output. L34 ~ L37 located

in front and back of Q12 and Q13, are helical cavities to suppress the spurious signals. The final transistor Q17 is a newly developed mesh-emitter transistor which is extremely effective against overloading.

BIAS CONTROL, ALC, RF-METER CIRCUIT

Q15 and Q16 on the main unit control the idling current of Q14 and Q17 respectively. Q15 and Q16 function as voltage regulators and lower the impedance at the bases of Q14 and Q17 to minimize any distortion caused in the linear amplifiers. Q14 and Q17 are located near the heat sink for good temperature compensation.

The ALC circuit provides a negative voltage when the driving power exceeds the voltage set by R86. The negative voltage through D27 is fed to the gate of Q10 to protect from overdriving. D32 is to compress the RF output when too high a power voltage is supplied. D28, which is M-coupled to L45, rectifies the RF signal picked up, which then drives the RF meter.

T/R SWITCHING RELAY, ANTENNA FILTER

The output signal of the linear amplifiers passes through the T/R switching relay RL1 on the main unit; the harmonics of the signal are then filtered by a helical cavity which is commonly used for both transmitting and receiving before being fed to the whip antenna (or an external antenna). The helical cavity has a 45MHz band-width and its insert loss in the band is approximately 0.3dB. The 9V remote control voltage for the use of an external linear amplifier is supplied to the antenna terminal through R88 when in the transmit mode.

COMMON CIRCUITS

1ST LOCAL OSCILLATOR

The voltage through the crystal select switch on the front panel is supplied to one of diodes D12 ~ D15 and turns ON the diode to connect a crystal to the oscillator. Q8 functions as an over-tone oscillator and a tripler. The crystal is oscillated in the 41MHz range. The oscillating frequencies can be adjusted by changing the inductance of L14 ~ L17. L18 ~ L20 at the collector of Q8 are tuned for the 120MHz range to pass the tripled signal of the oscillated frequencies. Q9 is another tripler to obtain the 370MHz range. The helical cavities located at the output of Q9 suppress the unwanted signals resulting in a clean 1st local oscillator signal, which is fed to the receive 1st mixer through D16 and to the transmit 2nd mixer through D17.

2ND LOCAL OSCILLATOR, RIT CIRCUIT

A wide-range VXO Q4 on the sub-unit oscillates in the 15MHz range. X1 is a specially designed crystal and the oscillating frequency can be varied by 200KHz by changing the value of C4, which is connected to the Tuning Control on the front panel.

The variable frequency range of the VXO is set with L2 and C12, and C13 is to compensate for linearity of the dial scale. The oscillated signal is tripled by Q5, L3 ~ L6 suppress the spurious signals, and the signal is then fed to the receive 2nd mixer through D1 and transmit 1st mixer through D2.

When the RIT switch is turned ON, Q1 and Q2 are turned ON and the voltage is supplied to RIT variable resistor R1 on the front panel. The voltage set with R1 is fed through R9 on the sub-unit to a variable capacitance diode D3, which varies the oscillating frequency of the VXO in the range of $\pm 2.5\text{KHz}$.

When the RIT is OFF, or when in the transmit mode, both Q1 and Q2 are turned OFF and RIT adjustment resistors R3 and R4 set the RIT control voltage.

For the RIT circuit, 9V regulated voltage is used, and to avoid the frequency instability caused by the power source fluctuation, this circuit has the current regulator consisting of Q3, D1 and D2 and Zener diode D4 for voltage regulation. This regulated power source is also supplied to the 1st local oscillator.

BFO, KEY, CW MONITOR CIRCUITS

The BFO signal is oscillated by Q1 with a crystal and fed through the emitter follower Q2 to the balanced modulator/demodulator, which is used for both transmit and receive. In LSB, D1 is turned ON, C2 and C3 in series with X1 are grounded, and the oscillator puts out a 10.7415MHz signal.

In CW mode, by turning OFF D1 and turning ON D2, L1 is inserted between C2, C3, and ground, and the oscillating frequency is shifted to 10.7395MHz.

In USB, both D1 and D2 are turned OFF, L2 is added to L1 between C2, C3 and ground, and the frequency is shifted to 10.7385MHz.

CW keying is controlled by turning the BFO ON/OFF with diode switch D3. A CW monitor signal is oscillated by a CR phase oscillator Q18, and its oscillating frequency is approximately 900Hz. The emitter of Q18 is connected to the keying circuit and the signal is controlled by keying. The output of the monitor oscillator is connected to the Volume Control on the front panel, and then the signal is fed to IC4 on the main unit to drive the speaker.

POWER SUPPLY CIRCUIT

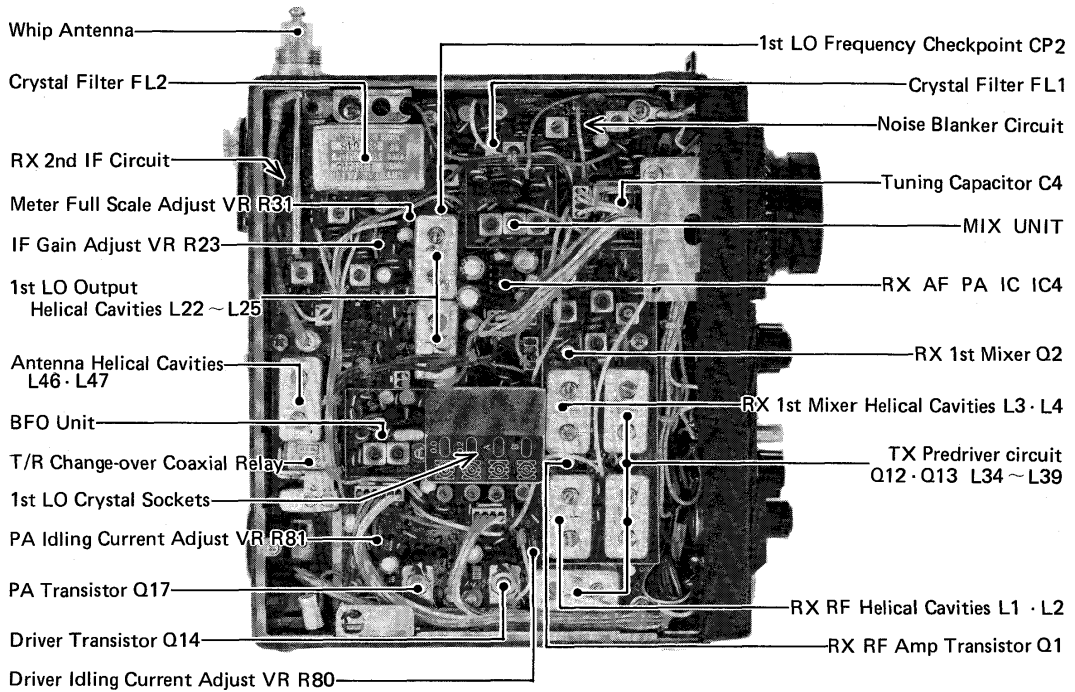
9V regulator voltage is supplied by Q11, whose base is stabilized by a current regulator consisting of D6, D7, and Q10 and Zener diode D8 and D1, the power indicator LED on the front panel.

The +9V regulated voltage for the receive mode is supplied by Q12. A current regulator Q13 turns ON D10 and the regulated voltage is supplied by D8 to the base of Q12. When in the transmit mode, the base of Q12 is grounded through D11. D9 discharges the receive +9V immediately. The receive regulated +9V is supplied to the RF amplifier, the 1st and 2nd mixers, RIT circuit, etc. The receive +6V is supplied by a regulator Q14 the base of which is controlled by Zener diode D13. This regulated +6V is supplied to IF amplifiers, AGC and noise blanker circuits, etc.

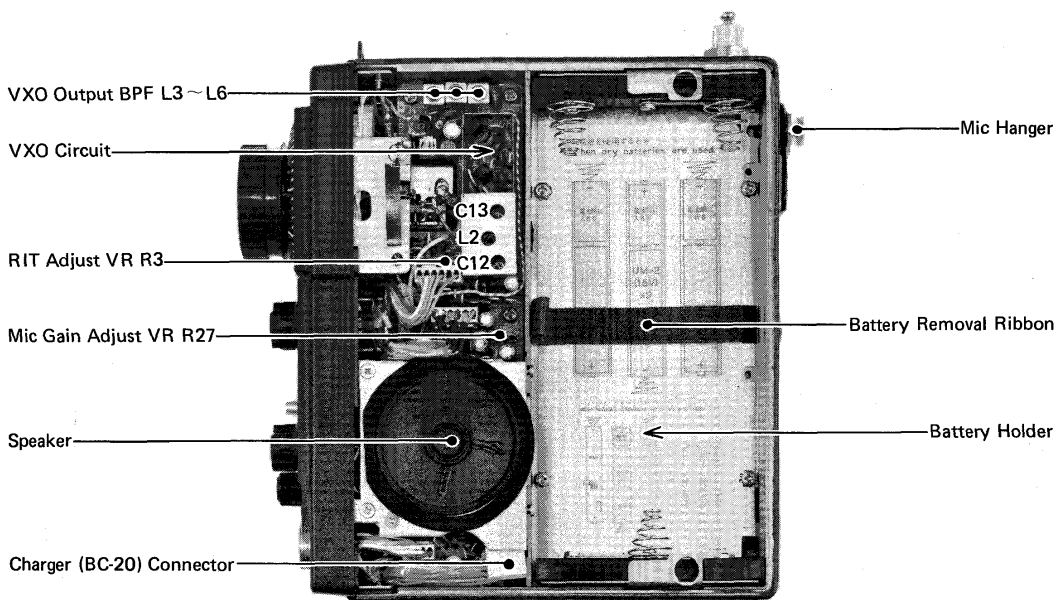
The +9V regulated voltage for the transmit mode is supplied by Q17. A current regulator Q15 turns ON D17 and the base of Q17 is controlled by D8. When in the receive mode, the switching circuit which consists of D15 · D16 · Q16 grounds the base of Q17 so that the output voltage of Q17 becomes 0V. D18 discharges the output voltage immediately when the mode is switched from transmit to receive. D19 discharges the +9V for SSB in the same manner. The +9V transmit regulated voltage is supplied to the transmit 1st mixer, transmit buffer amplifier, and the bias control circuit of the linear amplifiers, etc.

SECTION VIII INSIDE VIEW

MAIN UNIT SIDE



SPEAKER SIDE

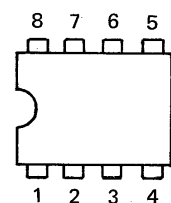


SECTION IX VOLTAGE CHART

Measuring instrument : 50KΩ/V multimeter

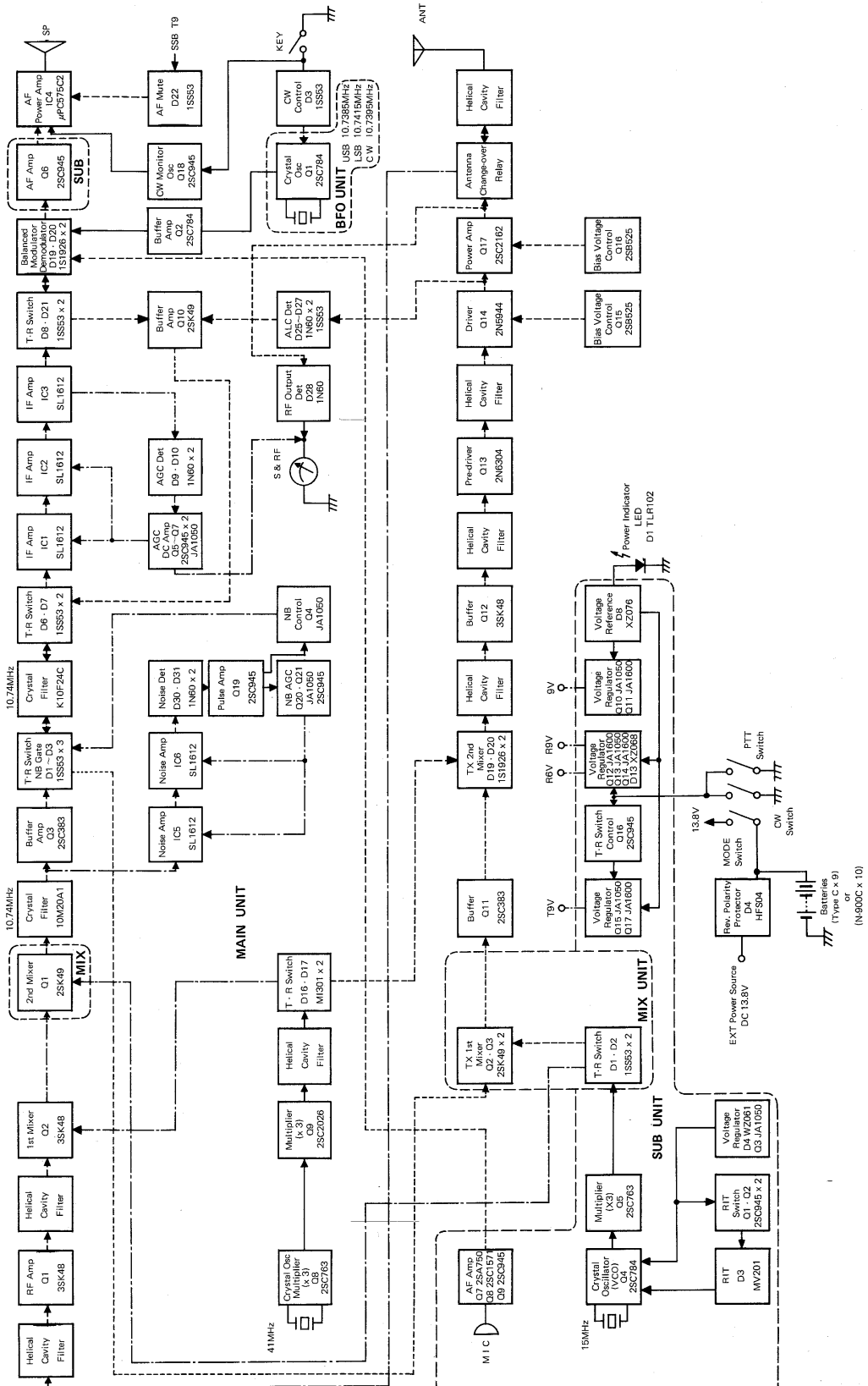
Unit	Q No.	Mode	Transistor			F E T				Remarks
			(B)	(C)	(E)	(G1)	(G2)	(D)	(S)	
Main Unit	Q1	R				0	4.8	8.8	0	CW-T KEY DOWN NB ON NB ON NB ON
	Q2	R				0	0	9.0	0	
	Q3	R	5.7	9.1	5.0					
	Q4	R	8.8	0	8.7					
	Q5	R	0.09	4.5	0					
	Q6	R	4.6	0	5.8					
	Q7	R	0	5.8	0					
	Q8	R	2.2	5.9	2.2					
	Q9	R	0.67	8.3	0.65					
	Q10	T				0	—	8.7	0.24	
	Q11	T	1.1	8.9	0.41					
	Q12	T				0	4.8	8.8	0	
	Q13	T	1.23	8.4	0.48					
	Q14	T	0.7	12.9	0					
	Q15	T	0.08	0	0.7					
	Q16	T	0.09	0	0.75					
	Q17	T	0.75	12.9	0					
	Q18	T	0.56	5.2	0					
	Q19	R	0.01	5.8	0					
	Q20	R	5.4	0	5.9					
	Q21	R	0	5.9	0					
Sub Unit	Q1	R	6.5	5.9	5.9					RIT ON RIT ON
	Q2	R	0.65	0.01	0					
	Q3	R	7.4	5.9	8.1					
	Q4	R	2.5	5.9	1.85					
	Q5	R	1.2	8.4	0.75					
	Q6	R	2.2	4.5	1.65					
	Q7	T	5.1	2.7	5.8					
	Q8	T	2.7	5.8	2.1					
	Q9	T	5.8	9.4	5.3					
	Q10	R	11.5	9.4	12.2					
	Q11	R	9.4	12.2	8.7					
	Q12	R	10.1	12.6	9.4					
	Q13	R	12.2	10.1	11.5					
	Q14	R	6.6	12.5	6.0					
	Q15	T	11.4	10.1	12.0					
	Q16	R	0.7	0.02	0					
	Q17	T	10.1	11.9	9.4					
BFO Unit	Q1	R	3.0	5.2	2.4					
	Q2	R	2.4	5.2	2.6					
MIX Unit	Q1	R				0	—	8.9	0.7	
	Q2	T				0	—	8.8	0.65	
	Q3	T				0	—	8.8	0.85	

Unit	IC No.	Mode	Pin No.								Remarks
			1	2	3	4	5	6	7	8	
Main Unit	IC1	R	0	5.0	1.7	0	0.8	0.8	0	0	
	IC2	R	0	5.3	1.8	0	0.75	0.75	0	0	
	IC3	R	0	5.6	1.8	0	0.75	0.75	1.3	0	
	IC4	R	1.4	13.0	12.2	7.4	6.2	13.0	0	1.75	
	IC5	R	0	5.6	1.8	0	0.75	0.75	0	0	NB ON
	IC6	R	0	5.9	2.1	0	0.75	0.75	0	0	NB ON



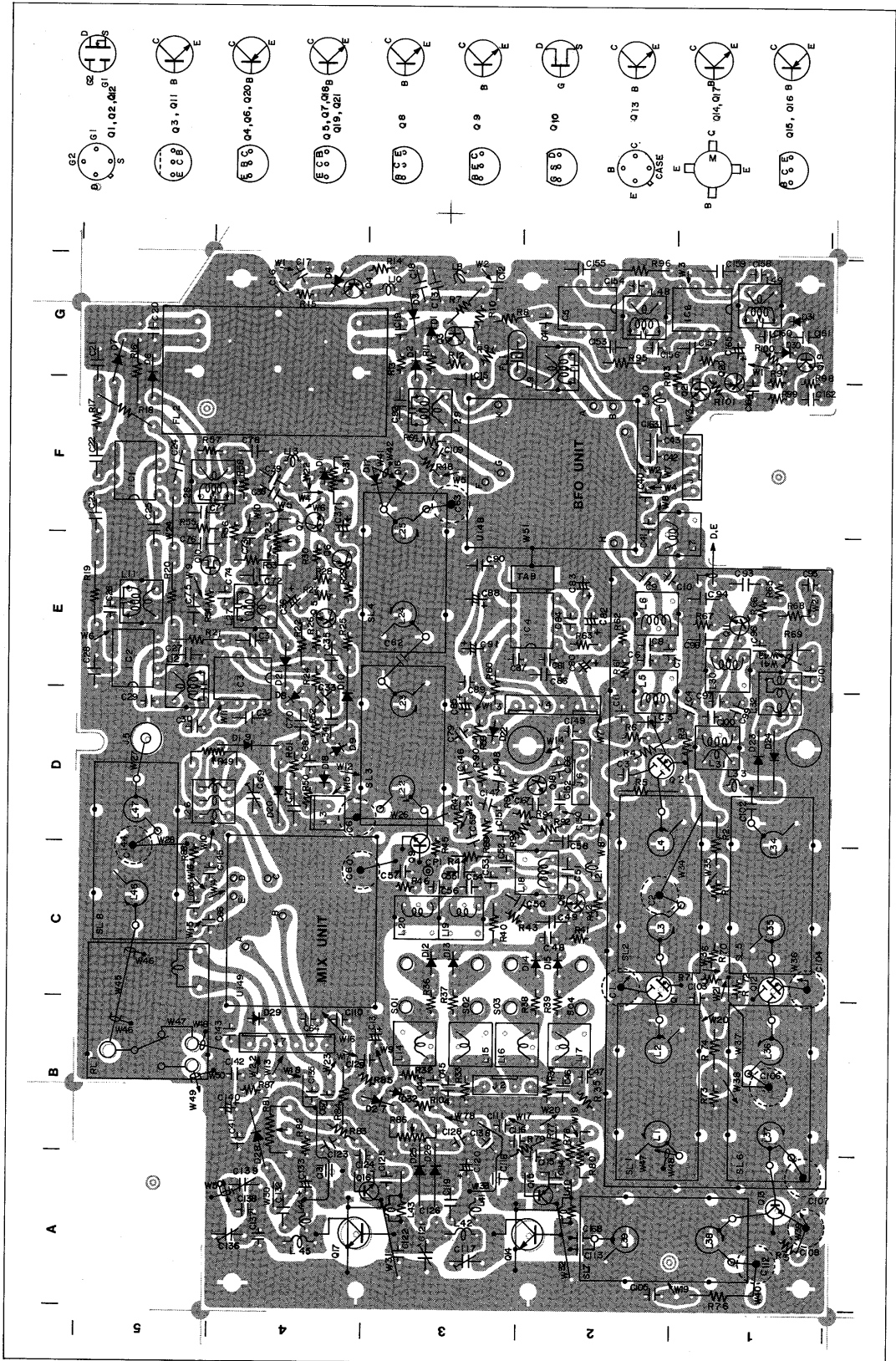
(Top View)
IC1~IC6

SECTION X BLOCK DIAGRAM



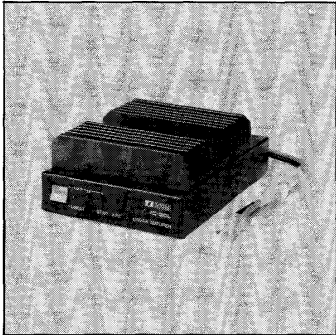
SECTION XI BOARD LAYOUT

MAIN UNIT

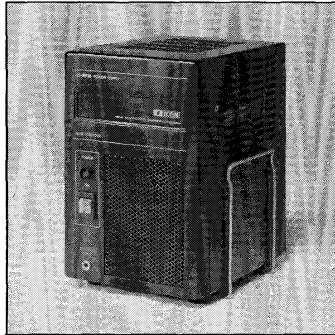


SECTION XII OPTIONS

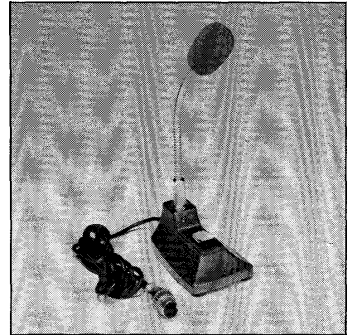
We have prepared a variety of options for the portable transceiver IC-402 in order to enlarge its use as a portable, mobile and fixed set.



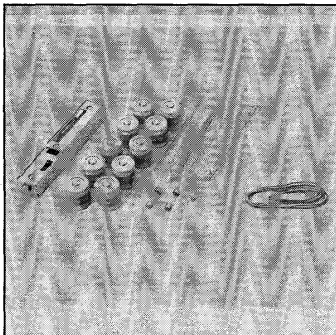
**IC-30L
LINEAR AMPLIFIER
430MHz 10W**



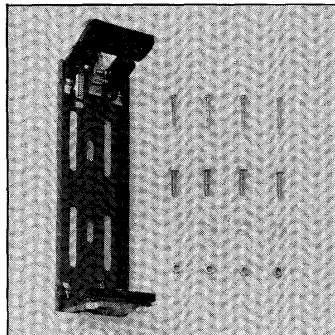
**IC-3PS
POWER SUPPLY
13.8V 3A**



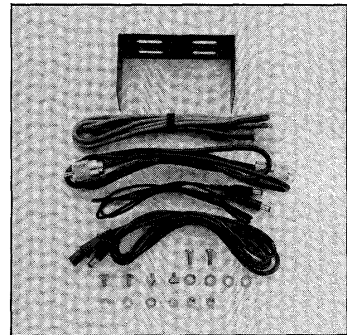
**IC-SM2
DESK MICROPHONE
ELECTRET CONDENSER
TYPE**



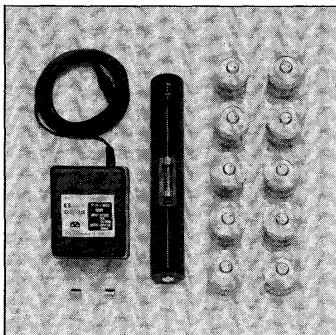
**RECHARGEABLE
BATTERY PACK
BATTERY CHARGER BC-20
BATTERY N-900C x 10
(900mAh)**



**MOBILE MOUNTING
BRACKET (B)
FOR IC-402**



**MOBILE MOUNTING
KIT FOR IC-30L**



**RECHARGEABLE
BATTERY PACK
AC BATTERY CHARGER
BC-15
BATTERY N-900C x 10
(900mAh)**



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OSAKA JAPAN