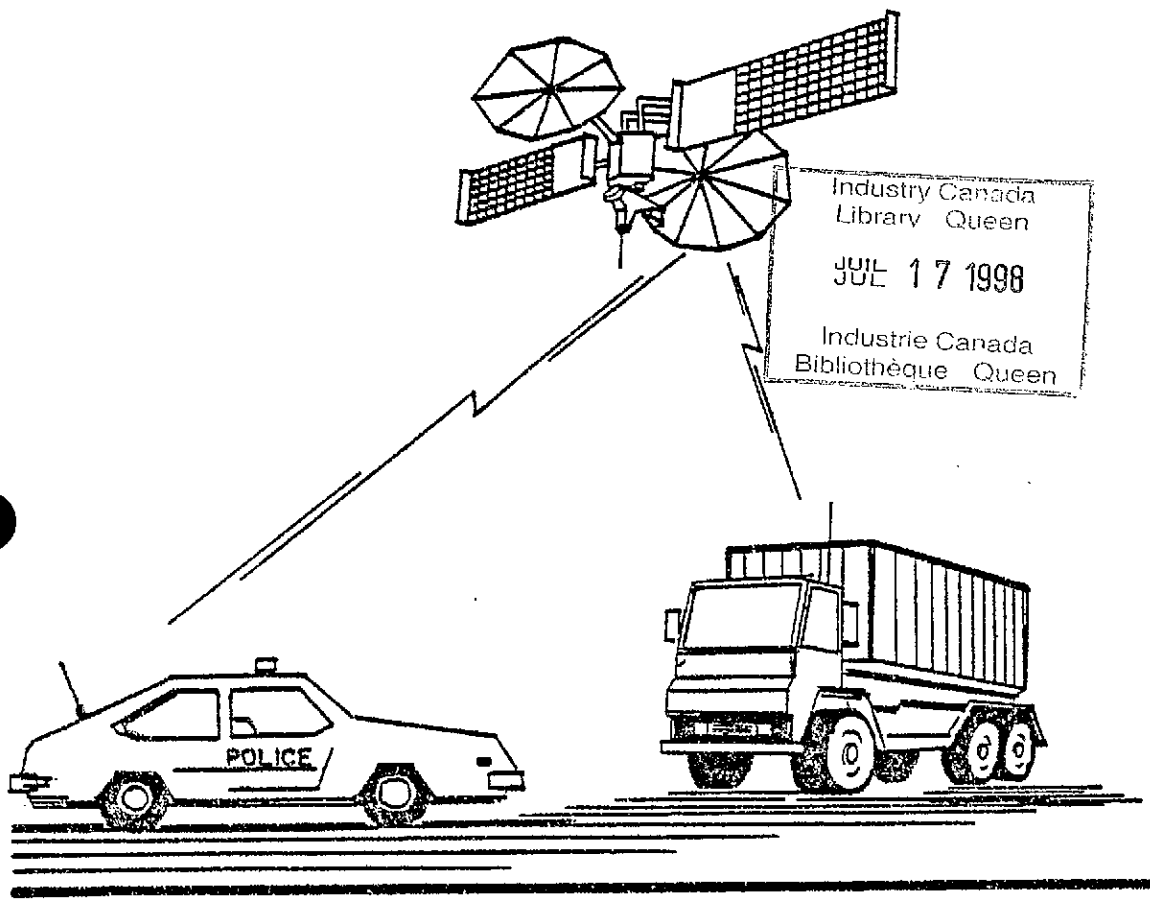
Report to

DEPARTMENT OF COMMUNICATIONS



MSAT MOBILE TERMINAL STUDY VOLUME 2

adga

Consulting Group

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APRIL, 1982

Government of Canada / Gouvernement du Canada

Department of Communications

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SPACE PROGRAM

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AUTHOR(S): A.Z. BASHIR, J.G. LAFABER, A.E. WALTHO

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FINAL REPORT

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SURVEY AND TECHNICAL ANALYSIS OF MOBILE RADIO TERMINALS

SUITABLE FOR MSAT COMMUNICATION SYSTEMS

final report

DSS File No. 15ST.36001-1-1793

VOLUME 2

APPENDICES

Study Conducted by: (1) A.Z. Bashir
J.G. Lafeber
A.E. Waltho

Authorized by: A.E. Waltho

A.E. Waltho, P. Eng.
Director of Engineering
ADGA Systems International Ltd.

APRIL 1982

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COI-866
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AEW/cb

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1. INTRODUCTION

As part of a program to determine the technical and economic viability of a commercial nationwide mobile communications system via satellite (MSAT), the Canadian Dept. of Communications has initiated a study to determine the cost of mobile terminals suitable for operation via the satellite. This document describes the functional and performance requirements of the required mobile terminals and is to be used as a reference in determining the cost and risk of modifying existing mobile radios to meet these requirements.

2. STATEMENT OF WORK

The contractor shall examine the functional and performance requirements as described in sections 4 and 5, and shall estimate the recurring and non-recurring cost of

either a) modifying existing or planned radio mobile terminals or selected modules therein to meet the functional and performance objectives

or b) designing and manufacturing new mobile terminals or selected modules to meet the functional and performance objectives.

Recurring cost shall be based upon production quantities specified in section 3.

All costs shall be quoted in 1981 Canadian dollars.

In respect to task a) the contractor shall submit a brief report identifying the existing radios and/or modules considered and describing the risk, nature and scope of any modifications to be made. The estimated cost of modification shall be broken down on the basis of each of the modules (functional elements) of the radio considered. These modules are specified at the end of this section.

In respect to task b) the contractor shall submit a brief report describing the new radio or module (functional element) design including a conceptual block and level diagram, a logic timing diagram showing the relationships between the various digital signals, a description of any special or innovative design feature which the contractor may consider to be necessary, and a cost breakdown based upon functional elements in the block diagram.

In respect to both tasks, the contractor shall identify the potential development schedules for all innovative or developmental work required. Such developmental work will be carried out in a manner conducive to mass production of the associated radio elements for commercial application.

Digital mobile radios currently available for military applications at lower or higher frequency bands can be considered as baselines for delta cost determination. Alternatively, one or more of the following modules (functional radio elements) may be selected for the analysis:

(i) Demand Assignment Multiple Acces (DAMA) protocol as controlled by a built-in microprocessor;

(ii) agile frequency synthesizer as controlled by the same microprocessor;

(iii) vocoder;

(iv) baseband signal processor and filters;

(v) IF section including pilot carrier and PLL circuits;

(vi) digital modem;

(vii) 800MHz RF transceiver excluding antenna but including front end receiver, power amplifier, and any signal conversion modifications employed at RF.

3. BACKGROUND

Background and a technical understanding of the MSAT concept may be obtained from the DOC publication attached as Annex A to this document.

From this it will be seen that it is the DOC intent to launch a demonstration spacecraft in 1986/87 followed by an operational spacecraft in 1993.

The mobile terminals considered in this document are required to be available in production quantities of up to 20,000 per year spaced over a 7 year period commencing in 1992.

In addition it is anticipated that radio terminals of a pre-production nature, would be required in quantities of 100 commencing 1986 for use in the demonstration system.

4. FUNCTIONAL OBJECTIVE

To the extent possible it is the intent that radio terminals, suitable for operation via satellite, should also be capable of operation within the planned terrestrial cellular systems. In the first instance therefore it is necessary to consider radios operating in the 800 to 890MHz band using NBFM modulation.

As an alternative, necessary to reduce power and spectrum loading on the satellite, other more efficient modulation techniques such as amplitude companded single sideband (ACSB) and narrow band digital voice will be considered.

In these two latter alternatives it is desirable that the mobile terminal should include an AMPS compatible FM modulation scheme.

The MSAT system will incorporate a DAMA channel allocation system similar to that proposed for AMPS. Hence the mobile terminal will contain a data modem and microprocessor controlled frequency synthesizer with equivalent capability. Minor changes in protocols and timing are detailed in Section 5.2, 5.10 and 5.11. The MSAT DAMA is described in more detail in Annex B.

The mobile terminal designed for public telephone service will operate in a quasi-full duplex mode with "toll" quality voice communications. The use of voice activation on the downlink from the satellite will require a carrier operated squelch circuit to mute receiver noise during pauses in speech. This feature may not be incorporated in existing cellular mobile design. A control head will provide a full "dialing" capability and will generate audio tones, bells etc. as appropriate to the telephone type service.

The mobile terminal designed for mobile radio dispatch services will normally operate in a half duplex, PTT, mode although the equipment will be inherently capable of full duplex or mobile repeater operation. Sub-toll quality communication will be acceptable and only limited dialing facilities will be provided.

Two frequency bands shall be considered

a) 20MHz Tx and 20MHz Rx with a Tx/Rx separation of 45MHz. This assumes that frequencies will be allocated for MSAT from within the proposed cellular bands.

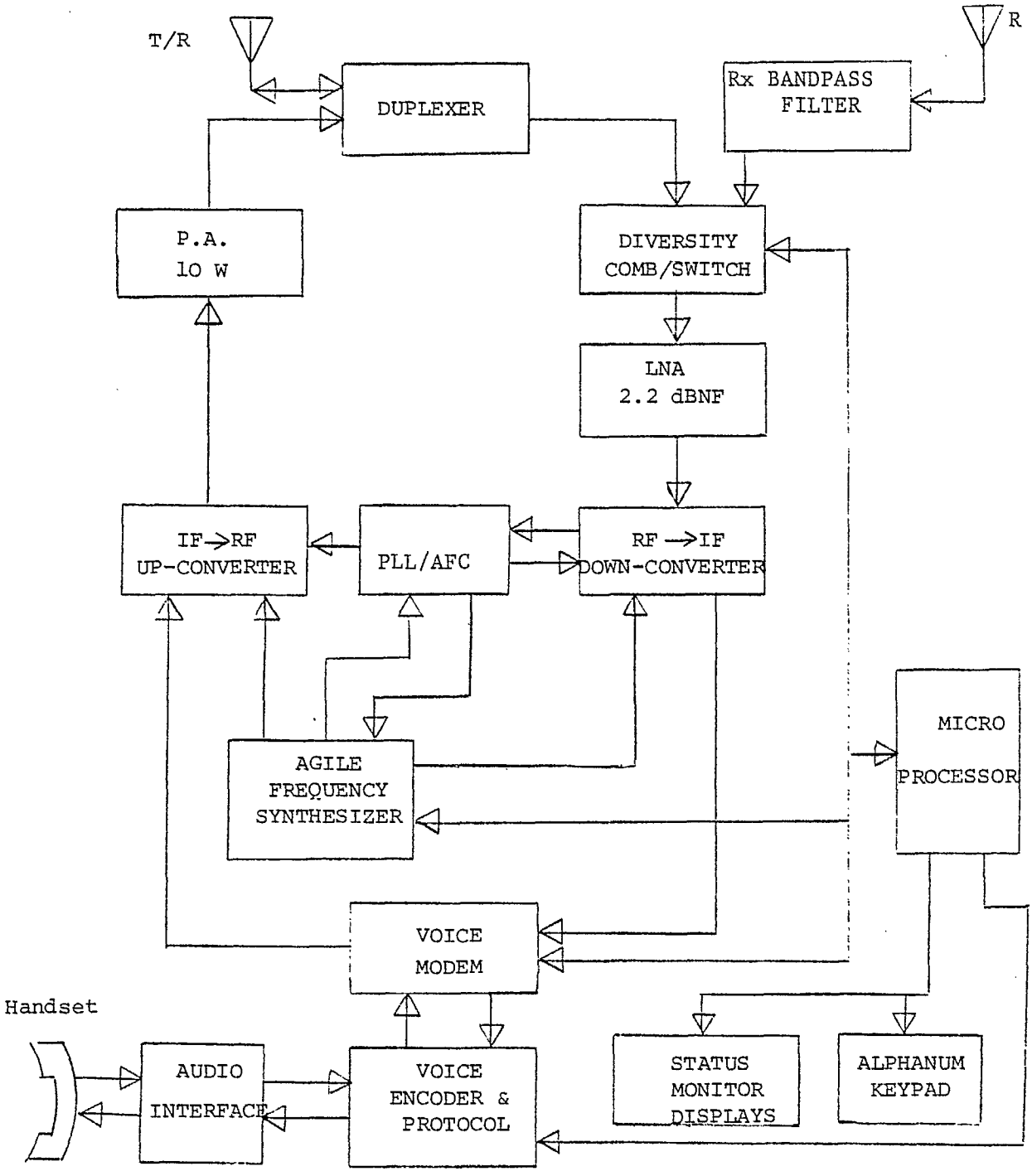
b) 25MHz Tx and 25MHz Rx also with a Tx/Rx separation of 45MHz. This assumes an allocation of 5MHz immediately adjacent to the proposed cellular bands.

5. SPECIFIC PERFORMANCE OBJECTIVES (DIGITAL)

5.1 GENERAL

When LPC or RELPC low bit rate speech encoding is combined in an all digital mobile radio employing MSK, DMSK or digital NBFM, a low satellite EIRP/channel, lowest bandwidth and lowest transponder linearity requirement results for an 800MHz MSAT communications system. Implementation of 2.4-4.8kbps LPC or 4.8kbps RELPC speech encoding will permit a UHF single channel per carrier (SCPC) width of 5KHz for satellite/mobile up and downlinks as compared to 30KHz for analog NBFM. This spectrum efficiency not only impacts on the cost of the spacecraft but also allows accommodation of the estimated number of users per UHF beam for Canada wide requirements in a smaller portion of the 806-890MHz band. Assuming a maximum of 1000 channel frequency pairs for Canada, only 5MHzx2 of spectrum would be needed for MSAT. Realization of more functional radio elements in LSI or VLSI would be possible in an all digital radio. When a TDMA scheme or a DAMA scheme is combined into both the radios and the central (Gateway) stations, more efficient useage of transponder capacity and power results.

A conceptual functional block diagram of a digital mobile is shown in Figure 5.1. For each functional block, performance objectives are described in the next few sections.



CONCEPTUAL FUNCTIONAL BLOCK DIAGRAM

DIGITAL MOBILE USING 1 MICROPROCESSOR

Figure 5.1

5.2 MICROCOMPUTER CONTROLLED LOGIC SUBSYSTEM (MCLS)

5.2.1

MCLS DEFINITION

The MCLS is the microprocessor based controlling element of the mobile terminal which will automatically control the signal processing circuits and handle the protocols and order wire signalling responses required as part of the system's Demand Assignment Multiple Access (DAMA) dynamic channel allocation. In addition, the MCLS will automatically monitor and report mobile terminal status information and control all facets of terminal operation.

5.2.2

MCLS CONFIGURATION

It is highly desirable that the MCLS be of modular design, containing all dedicated hardware, circuitry, firmware and software required to autonomously execute its functions so that it might be used in a "product family" of MSAT mobile terminals.

Execution of MCLS functions must be transparent to the terminal user, the other elements of the terminal and to the MSAT system.

Initiation of MCLS functions will be either automatic (self-or signal-initiated) or manual by the terminal user via keyboard entry or switch positioning. Processor systems and applications programs must be resident in non-volatile read-only memory.

Data, including user entries, may be stored in volatile memory if independent battery backup power (e.g. NICAD) is provided. Microprocessor architecture and throughput as well as program and data storage capacity for the AMPS/NBFM application must be adequate to accommodate both the AMPS functions and the additional MSAT functions. Since existing terrestrial mobile terminal equipment should accomodate all AMPS functions, expansion to include MSAT functions should only require additional memory and software. Alternatively, the MCLS may be housed within a separate control head.

A supervisory logic module, providing interface with and supervision of the other terminal elements can either be co-located with the transceiver circuits or form a part of the MCLS module.

Data communication between the terminal and the MSAT system over the 800MHz links is at a rate of 2.4 to 4.8 kpbs.

5.2.3 MCLS INTERFACE

The MCLS must interface with the following mobile terminal modules:

- Supervisory logic module (if not part of the MCLS)
- Transmitter module(s)
- Receiver module(s)
- Frequency synthesizer module(s)
- Power supply module
- Antenna module(s)
- User keyboard module
- User switch module
- Digital display module
- Status indicator module
- Hook switching module

5.2.4 MCLS FUNCTIONS

5.2.4.1 GENERAL

MCLS functions will include:

a) Automated monitoring and reporting of the status of the mobile terminal.

b) Automated response to user data entry via keyboard or switch positioning.

c) Automated control of mobile terminal functions not provided by other modules.

d) Automated channel acquisition and call processing as required by the AMPS radiotelephone service and the MSAT DAMA dynamic channel allocation protocols.

MCLS functions must be autonomously executed, independent of the operation of the other modules of the mobile terminal. Initiation of the functions will be either automatic, in response to stored program commands or to incoming data or on user demand in response to keyboard data entry or switch position.

5.2.4.2

MCLS ADDITIONAL MSAT FUNCTIONS

a) Modification of AMPS signal channels and call processing protocol:

- due to the increased signal transmission time in satellite communications the timing requirements for call set-up will be on the order of 1000 milliseconds which is a relaxation in comparison to the AMPS type DAMA system. The satellite propagation delay time is 266 x 2 milliseconds and it is assumed that the central computer switch, located in the Gateway station, will need up to 250 milliseconds to determine whether it is possible to set up the communication link between the mobile calling party and the called party.

In addition, it will take about 100 milliseconds for the mobile to receive and process an acknowledgement message from the Gateway and about 100 milliseconds for channel request and assignment message transmission. The one second call set up time may require protocol modification.

The DAMA channels (forward set-up and reverse request) can be assumed to be pre-assigned fixed frequency channels with 7-10 of each required for Canada wide operation. The remaining MSAT voice channels will be available in a pool for dynamic assignment by the Gateway on a demand basis.

A low data rate and/or tone modulation will be used with the pilot to conduct disconnect and priority incoming call warning type of functions while the mobile is busy. Cellular hand-off and re-assignment of channels during voice communication will not be required.

Request for assignment messages will be error correction encoded and have repeat redundancy. The typical message size will be 200 bits BCH encoded. The channel assignment messages from the Gateway will be similarly encoded into 40 bit BCH coded words including word repetition used for the reduction of miss and false interpretation probabilities. More background information on the MSAT DAMA system envisioned is provided in Annex B.

In general it will be seen that the MSAT protocol is related to the AMPS protocol.

b) Automatic frequency synthesizer tuning:
   - agile retuning of the synthesizer to the channel frequency allocated by the MSAT DAMA is required. The retuning time has been identified in Section 5.10.

c) Automatic selection of one of two diversity antennas in response to receiver detection of the strongest signal.

d) Automatic monitoring and reporting to the terminal user of terminal status, called terminal availability, paging and control messages, channel availability and channel allocation via status lights and/or an alphanumeric display.

e) Automatic reporting of terminal status and availability to the Gateway station including roam/home status.

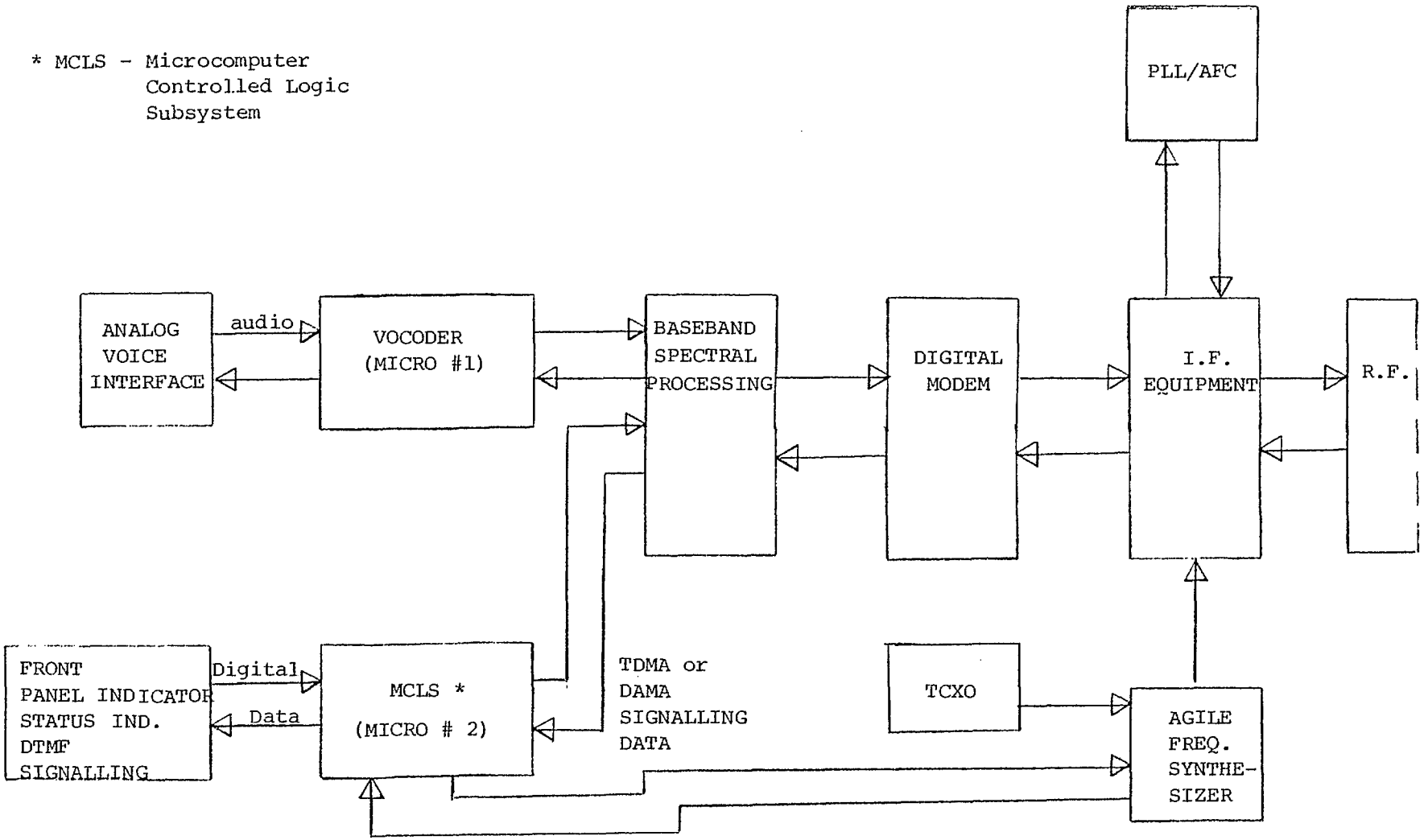
5.3 VOCODER

Current or planned equipment employing LPC at 2.4-4.8kbps and RELPC at 4.8kbps will be required to be miniaturized and realized in VLSI for mass production commencing in 1992. Field evaluation prototypes to be employed in 1987 in the demonstration MSAT may not have to be realized in VLSI but installation as robust mobile units in cars must be possible. Vocoder interfacing with the modulator will be via spectral shaping and processing circuits to allow AC coupling of the vocoder and to satisfy the more severe 60-80dB out of band spurious emission rejection requirement for SCPC mobile radio communications. Some pre-modulation baseband filtering may be required as described in Section 5.4. Modifications to the vocoder output port may thus be required to facilitate integration into the mobile.

Assuming that the vocoder contains a built-in microprocessor, two alternative configurations are currently envisaged:

1) Autonomous vocoder module interfacing with the baseband processing and direct digital modem stages and the MCLS. This implies two microprocessors housed within the mobile (see fig. 5.2).

* MCLS - Microcomputer
Controlled Logic
Subsystem



FUNCTIONAL BLOCK DIAGRAM

MOBILE RADIO USING SEPARATE MICROPROCESSORS

Figure 5.2

2) Since the vocoder functions probably require a more complex microprocessor as compared to that of the MCLS, some or all of the MCLS tasks may be absorbed by the vocoder module; the larger portion of MCLS tasks is executed when the vocoder microprocessor is idle. The MCLS, which controls the hardware as well as the DAMA/TDMA channel acquisition, call set-up and other protocol tasks, is busy prior to the voice communication and performs only a few housekeeping functions during conversation. The reverse is true for the vocoder. In addition, it is anticipated that MCLS tasks will largely consist of timing and binary decision functions. In comparison vocoders of current and future design necessarily perform complex algorithms and repetitive calculations. Therefore a configuration using a shared microprocessor performing both the vocoder and MCLS functions could be cost effective. The vocoder microprocessor should not require re-programming from scratch to include the MCLS functions particularly if the software is structured. MCLS tasks might be provided in PROM and executed on an as required basis. It can be assumed that call set up time (time taken for gateway to acknowledge channel assignment request and cause calling party and called party to retune to assignment) is on the order of 1 second. Average voice transmission durations will be in the 20-30 second range. MCLS tasks thus represent 3.3 - 5% of the total link time.

Other modifications required to the vocoder will stem from constraints to minimize battery current drain, to reduce degradation during background noise caused by vehicle speeds reaching 100km/hr (robustness) and compatibility requirements with more severe environmental and shock conditions. These parameters are specified in section 5.13. Military spec vocoders are not required. It is likely that the VLSI realization could achieve the current drain objective based upon the vocoder duty cycles if circuits are powered down during pauses in speech.

5.4 BASEBAND SPECTRAL PROCESSING AND DIGITAL MODEM

5.4.1 GENERAL TRANSMISSION REQUIREMENTS

The 5Khz channel separation for the SCPC narrowband digital voice transmission system is given by

$$f_s = B + 2 f$$

where B = transmission occupied bandwidth at RF

f = carrier frequency drift in each transmitter

Since $B \quad f_b/m$ where f_b = bit rate of vocoder

m = transmission efficiency

$$f_s = f_b/m + 2 f.$$

It is seen that narrow band digital voice can be achieved if the following 3 conditions are met:

1) low bit rate vocoding;
2) narrow band efficient digital modulation;
3) stabilization of carrier frequency.

Assigning MSAT objectives of 2.4 or 4.8kbps, 1bps/Hz, and ±400Hz for (1), (2) and (3) respectively channel separations of:

(a) 3.2KHz for the 2.4kbps, and

(b) 5.6KHz for the 4.8kbps vocoding rates are possible, ignoring adjacent channel spurious emission effects.

If the efficiency of the modulator were increased to 2bps/Hz, channel separations of:

(c) 2KHz for the 2.4kbps, and

(d) 3.2KHz for the 4.8kbps vocoding rates are possible, again ignoring adjacent channel spurious emission problems.

The value of m will thus have to be 2bps/Hz and current digital modems will need to be modified unless data rates were to be restricted to a maximum of 2.4 kbps or the 5 KHz channel separation requirement were to be relaxed.

Sideband splatter into the adjacent channels should be suppressed 60-80dB. To meet this requirement, both an IF filter and a baseband spectral shaping filter will likely be required.

5.4.2 DESIRABLE DIGITAL MODULATION SCHEMES

1) QPSK

The wide useage of QPSK and its good trade off performance between spectrum efficiency and transmit power economy makes this scheme a likely candidate for modem realization. However, sideband splatter problems result because of the power spectrum generated during the modulation process. Baseband or IF spectral manipulation may be used with post modulation filters to achieve the 60-80dB objective for sideband splatter in the adjacent channels.

2) DMSK/MSK

MSK is a continuous-phase frequency-shift keying scheme with a low modulation index. It is also known as fast FSK or FFSK. The low modulation index property is more amenable for narrow band digital FM operation such as that envisioned for MSAT.

Although MSK has the intrinsic property of a constant envelope and minimal spreading of the power spectrum, it does not satisfy the out-of-band spurious emission objective for an SCPC mobile environment. Post modulator filtering is still required.

5.5 POWER AMPLIFIER

Transmit Power: 10W

Output Stages : Class AB amplifiers to maintain linearity and minimize distortion;

Class C at discretion of contractor.

5.6 RECEIVER FRONT END AMPLIFIER

The high signal environment, typical in urban land mobile communication, requires the receiver to exhibit a high third-order intermodulation intercept point frequently at the expense of only a moderate noise figure. In certain cases an RF preamp is not used, and downconversion to the first IF is done from the antenna input with only passive RF filtering preceding the mixer. For MSAT a low noise figure is required and a lower third order intercept point may be accepted. This could be accomplished through a new amplifier which will precede existing stages.

The noise figure of the new amplifier should be 2.2dB maximum over the MSAT receive bands and the average gain should be 20dB (nominal).

5.7 DUPLEXER

For option 1 (i.e., frequency band (a)) a duplexer similar in design to those developed for 800MHz cellular radio products is anticipated.

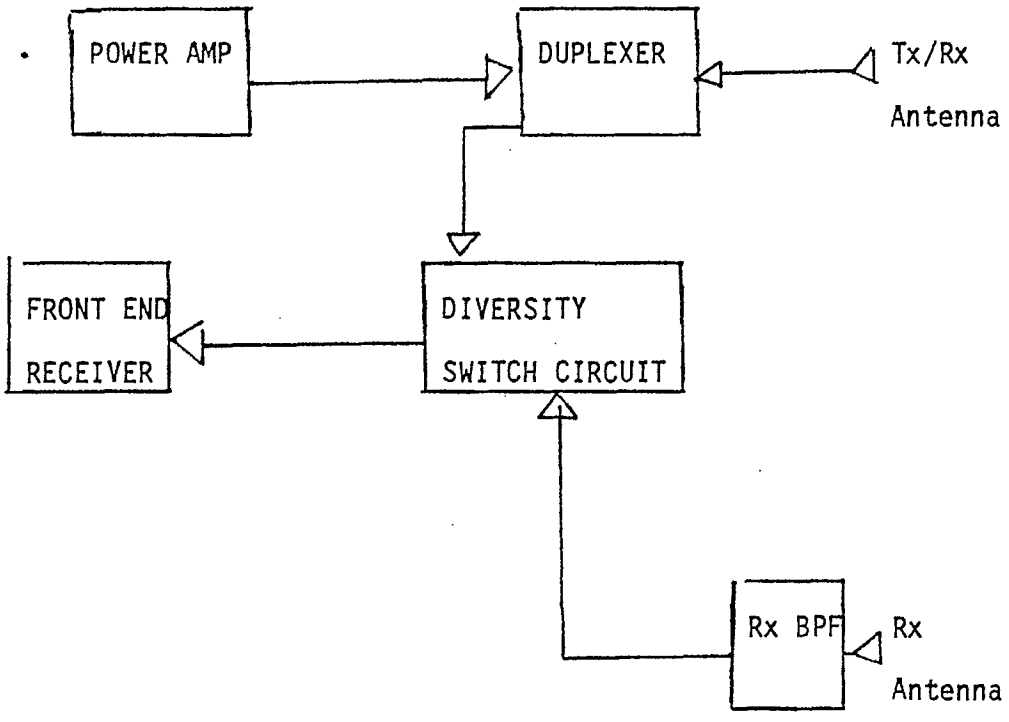
Depending upon the detailed design of the equipment, the out of band attenuation of transmitter broadband noise may need to be increased by up to 13dB to allow for the higher gain in the transmitter power amplifier and receiver front end.

Similiarly, an additional 13dB of out of band attenuation may be necesary in the receiver port to reject the high transmit carrier signal. The contractor shall determine the changes necessary in order to satisfy the 2.2dB receiver noise figure requirement with the transmitter operating at full rated power.

For option 2 (i.e. frequency band (b)) a more complex design will be necessary to achieve the wider passband in both transmit and receive ports.

5.8 DIVERSITY RECEIVER ELEMENTS

Figure 5.3 is a block diagram of a typical mobile radio space diversity receive system.



DIVERSITY FRONT END

FIGURE 5.3

1) RECEIVE BPF

In the satellite receiving mode the receive BPF should have the lowest insertion loss practically attainable with the response characteristic similar to that required in the duplexer receiver port. An insertion loss of 1.0dB maximum is suggested. Two passbands should be considered to cover option 1 and option 2.

2) DIVERSITY SWITCH CIRCUIT

Constant 50 Ohm impedance presented to the duplexer and receive BPF is important to maintain the receiver figure of merit (G/Ts ratio). Insertion loss for the receive path is to be 0.3dB max and for the receive/transmit path to be 0.6dB max. The transmit/receive isolation shall be 30dB minimum. Switchover to MSAT operation (under microcomputer or front panel control) shall allow the diversity path selector to operate with signal levels as low as -125dBM.

5.9 SIGNAL CONVERSION

Conventional designs should be adequate. The usual sideband filtering will be necessary however conventional transmitters may not reduce spurious and harmonic emissions to the required (minimum) level of -60dBc (dB referred to carrier level). This will likely require sharper roll-offs for the IF spectral BPF's particularly to clean up the input signal before amplification through the class AB transmitter. The pilot carrier will consist of a tone above the digitized voice spectrum and some 10-16dB down in level from the output of the transmitted signal. Pilot filtering at either IF or baseband will be needed to permit pilot signal recovery.

5.10 FREQUENCY SYNTHESIZER

A step size of 5KHz and a channel capacity of 666 QPSK or MSK channels as a minimum is required. The functional requirement is for all LO frequencies to be derived from this synthesizer including the transmitted pilot tone.

To avoid excessive adjacent channel interference in a 5KHz spacing system an overall stability of $\pm$500Hz will be necessary. The more significant requirement is the stability for proper receiver operation. For the MSAT application, a mobile receiver must track the transmit carrier frequency to within $\pm$30Hz.

There are a number of methods to obtain the required frequency synchronization between the transmitter and receiver. Since a pilot carrier will be used with each MSAT digital voice channel, a realistic approach would be to use a TCXO and a digitally controlled agile frequency sythesizer to obtain an initial reference signal stability of $\pm$400Hz supplemented by an AFC circuit locking to a steady pilot signal. This reference signal stability requirement can be met with a TCXO stable to within $\pm$0.5 PPM over the operating temperature range.

Up to 666 TX/Rx channel frequency pairs are required to be synthesised via front panel or internal (microprocessor) control in response to DAMA signalling information received on separate paging channels. The retune time (including synthesizer PLL lock up time) is to be on the order of 200-300 milliseconds.

Wideband synthesizer noise and spurious emissions should be reduced to the lowest level practical consistent with the requirements for duplex operation as per Sections 4, 5.11 and 5.12.

5.11 PILOT RECEIVE/TRANSMIT AND AFC ELEMENTS

The AFC circuit is required to lock on to a steady pilot signal in 100-200 milliseconds and the AFC PLL should have a lock-in range of $\pm$500Hz minimum. The basic LO will be stable to within $\pm$400Hz and the Doppler shift frequency on the received pilot will be as high as 100Hz with a vehicle speed of 100km/hr. Errors introduced by the satellite will be reduced to negligible values within the satellite Gateway stations.

Apart from the Doppler shift, the pilot tone will be subjected to chopping outages of up to 100 milliseconds. The PLL time constant must be suitable for accommodation of such outages.

The loop bandwidth should be narrow enough to provide the lock up time needed with noise and spurious emissions reduced to the lowest level practical consistent with the requirements for full-duplex operation and simultaneous pilot tone reception and transmission. In summary the prime functions of the pilot and the AFC circuit are listed as follows:

(a) compensate for TCXO long term drift;

(b) track received pilot tone;

(c) provide the capture range required on a per channel basis;

(d) permit demodulation of tone encoded signalling functions to allow the gateway to page the mobile while it is busy.

5.12 CONTROL FUNCTIONS

Operator control functions will include either a limited (less than 10 digit) dialing capability for MSAT mobile radio system (MRS) application or a full (10 digit) dialing capability for use in a MSAT mobile telephone system (MTS) and for compatibility with AMPS type cellular terrestrial MTS.

Execution of the control functions will result in generation of display of the number dialed, of dial tones, of status display and in activation of status lights.

For limited dialing MRS use, existing MTS compatible 10 digit dialing control units could either be modified to provide limited dialing only or, while retaining 10 digit dialing capability, provide (switch selectable) automatic insertion of pseudo digits complementing the set of limited dialing digits to a total of 10. Usual capabilities such as ANI and frequently dialled number storage will be required.

5.13 ENVIRONMENTAL PARAMETERS

a) Operating temperature: -30 to + 60 degrees C

b) Vibration and shock : current vehicular standards in use

c) Reliability : current mobile radio standards in use

5.14 POWER SUPPLY

13.6VDC; 10 to 16VDC range. Present FM (AMPS) radios draw 10A Tx and 1A on Rx/STBY.

This includes analogue voice to RF circuits and the MCLS.

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FUNCTIONAL PERFORMANCE

AND

TECHNICAL REQUIREMENTS

MODIFICATION OF SSB MOBILE RADIOS FOR USE WITH MSAT

COI-866
JANUARY 1982
AEW/cb

Authorized by: _____
A.E. Waltho, P.Eng.
Director of Engineering
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In respect to task a) the contractor shall submit a brief report identifying the existing radios considered and describing the risk, nature and scope of any modifications to be made. The estimated cost of modification shall be broken down on the basis of the various functional elements of the radio, for example receiver front end, duplexer, PA, harmonic filters etc.

In respect to task b) the contractor shall submit a brief report describing the new radio design including a conceptual block and level diagram, a description of any special or inovative design feature which the contractor may consider to be necessary and a cost breakdown based upon functional elements within the block diagram.

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b) 25MHz Tx and 25MHz Rx also with a Tx/Rx separation of 45MHz. This assumes an allocation of 5MHz immediately adjacent to the proposed cellular bands.

5. SPECIFIC PERFORMANCE OBJECTIVES (ACSB)

These are based upon modifications to current or planned mobile radios employing ACSB (A3j) modulation. A double superheterodyne transceiver is assumed as the baseline, unmodified radio. A space diversity antenna system will be employed in the receive mode.

5.1 POWER AMPLIFIER

Transmit Power: 50W PEP; 10W Average

Output Stages : Class AB amplifiers to maintain linearity and minimize distortion

Where isolators and transmit harmonic filters are used, their power handling capability shall be 50W peak and 10W continuous.

5.2 RECEIVER FRONT END AMPLIFIER

The high signal environment, typical in urban land mobile communication, requires the receiver to exhibit a high third-order intermodulation intercept point frequently at the expense of only a moderate noise figure. In certain cases an RF preamp is not used, and downconversion to the first IF is done from the antenna input with only passive RF filtering preceding the mixer. For MSAT a low noise figure is required and a lower third order intercept point may be accepted. This could be accomplished through a new amplifier which will precede existing stages.

The noise figure of the new amplifier should be 2.2dB maximum over the MSAT receive bands and the average gain should be 20dB (nominal).

5.3 DUPLEXER

For option 1 (i.e., frequency band (a)) a duplexer similar in design to those developed for 800MHz cellular radio products is anticipated.

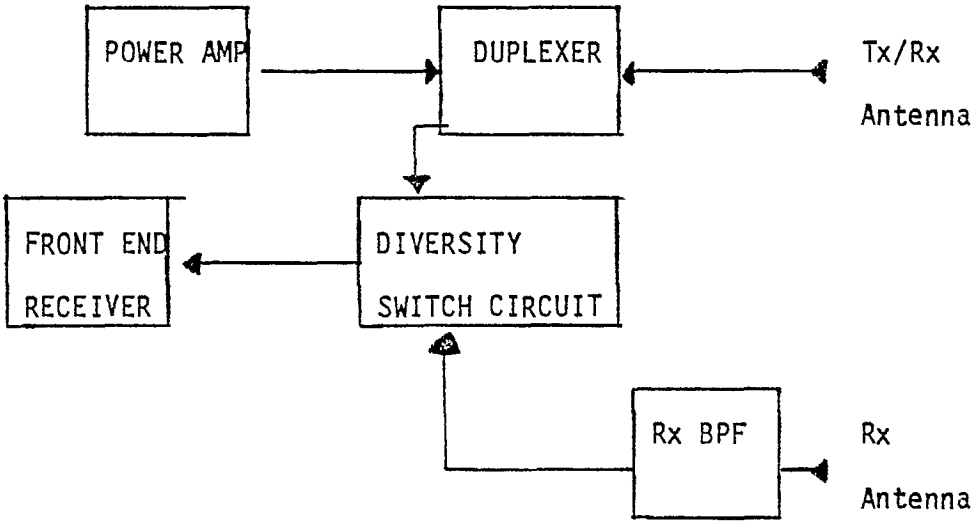
Depending upon the detailed design of the equipment, the out of band attenuation of transmitter broadband noise may need to be increased by up to 13dB to allow for the higher gain in the transmitter power amplifier and receiver front end.

Similarly, an additional 13dB of out of band attenuation may be necessary in the receiver port to reject the high transmit carrier signal. The contractor shall determine the changes necessary in order to satisfy the 2.2dB receiver noise figure requirement with the transmitter operating at full rated power.

For option 2, (i.e frequency band (b)) a more complex design will be necessary to achieve the wider passband in both transmit and receive ports.

5.4 DIVERSITY RECEIVER ELEMENTS

Figure 5.1 is a block diagram of a typical mobile radio space diversity receive system.



DIVERSITY FRONT END

FIGURE 5.1

1) RECEIVE BPF

In the satellite receiving mode the receive BPF should have the lowest insertion loss practically attainable with the response charactaristic similar to that required in the duplexer receiver port. An insertion loss of 1.0dB maximum is suggested. Two passbands should be considered to cover option 1 and option 2.

2) DIVERSITY SWITCH CIRCUIT

Constant 50 Ohm impedance presented to the duplexer and receive BPF is important to maintain the receiver figure of merit (G/Ts ratio). Insertion loss for the receive path is to be 0.3dB max and for the receive/transmit path to be 0.6dB max. The transmit/receive isolation shall be 30dB minimum. Switchover to MSAT operation (under microcomputer or front panel control) shall allow the diversity path selector to operate with signal levels as low as -125dBm.

5.5 SIGNAL CONVERSION

Conventional designs should be adequate. The usual sideband filtering will be necessary however conventional SSB transmitters may not reduce spurious and harmonic emissions to the required minimum level of -60dBc (dB referred to carrier level). This will likely require sharper roll-offs for the IF spectral BPF's particularly to clean up the input signal before amplification through the class AB transmitter. The pilot carrier will consist of a tone above the SSB voice signal and some 10-16dB down in level from the PEP output of the transmitted signal. Pilot filtering at either IF or baseband will be needed to permit pilot signal recovery.

5.6 FREQUENCY SYNTHESIZER

A step size of 5KHz and a channel capacity of 666 SSB channel as a minimum is required. The functional requirement is for all LO frequencies to be derived from this synthesizer including the transmittted pilot tone.

To avoid excessive adjacent channel interference in a 5KHz spacing system an overall stability of $\pm$500Hz will be necessary. The more significant requirement is the stability for proper receiver operation. For the MSAT application, a mobile receiver must track the transmit carrier frequency to within $\pm$30Hz.

There are a number of methods to obtain the required frequency synchronization between the transmitter and receiver. Since a pilot carrier will be used with each MSAT SSB channel, a realistic approach would be to use a TCXO and a digitally controlled agile frequency synthesizer to obtain an initial reference signal stability of ±400Hz supplemented by an AFC circuit locking to a steady pilot signal. This reference signal stability requirement can be met with a TCXO stable to within ±0.5 PPM over the operating temperature range.

Up to 666 Tx/Rx channel frequency pairs are required to be synthesized via front panel or internal (microprocessor) control in response to DAMA signalling information received on separate paging channels. The retune time (including synthesizer PLL lock up time) is to be on the order of 200-300 milliseconds.

Wideband synthesizer noise and spurious emissions should be reduced to the lowest level practical, consistent with the requirements for duplex operation as per Sections 4, 5.7 and 5.13.

5.7 PILOT RECEIVE/TRANSMIT AND AFC ELEMENTS

The AFC circuit is required to lock on to a steady pilot signal in 100-200 milliseconds and the AFC PLL should have a lock-in range of ±500Hz minimum. The basic LO will be stable to within ±400Hz and the Doppler shift frequency on the received pilot will as high as 100Hz with a vehicle speed of 100km/hr. Errors introduced by the satellite will be reduced to negligible values within the satellite Gateway stations.

Apart from the Doppler shift, the pilot tone will be subjected to chopping outages of up to 100 milliseconds. The PLL time constant must be suitable for accommodation of such outages.

The loop bandwidth should be narrow enough to provide the lock up time needed with noise and spurious emissions reduced to the lowest level practical, consistent with the requirements for full-duplex operation and simultaneous pilot tone reception and transmission. In summary the prime functions of the pilot and the AFC circuit are listed as follows:

(a) compensate for TCXO long term drift;

(b) track received pilot tone;

(c) provide the capture range required on a per channel basis;

(d) provide a reference for transmission;

(e) permit derivation of the AGC voltage;

(f) provide a carrier operated squelch function.

5.8 AGC

An AGC time constant of 20ms is known to allow the receiver to follow fading rates of up to 50Hz adequately at 175MHz and reasonably effectively at 450MHz. The fade rate at 800MHz is between 80-100Hz. A forward-feeding AGC is suggested with the voltage derived entirely from the pilot tone. The fade depth is not required to be considered.

5.9 PRE-EMPHASIS, DE-EMPHASIS, COMPANDING, AND SQUELCH

The amplitude companding factor required is 4:1. The pilot tone shall be injected after the first 2:1 compression stage to aid in the recovery of the SSB signal.

Pre and de-emphasis is required for the ACSB modulation scheme when using satellite links. The slope should be 12dB/octave.

A carrier operated squelch function shall be provided as discussed in Section 4. In this case the carrier is the pilot tone transmitted by the MSAT gateway station. Tone encoded squelch is not required.

5.10 VLSI IMPLEMENTATION OF ACSB "CONVENIENCE CIRCUITS"

Work done at the Stanford University Communication Satellite Planning Centre under contract to the FCC resulted in the development of a VLSI chip which performs a variety of functions using so called "convenience circuits". The following functions are combined on a single chip:

- amplitude companding
- AFC
- AGC
- selective calling
- pre-emphasis
- de-emphasis
- filtering (pilot tone recovery done at baseband)
- microphone level control
- automatic linearity control

It would be desirable to implement the AFC, AGC, pilot filtering (if done at baseband), pre-emphasis, de-emphasis and amplitude companding in VLSI. In this way, the differences at IF and baseband between MSAT and terrestrial mobiles, in a mass production environment, could be limited to a single VLSI chip and additional microprocessor logic and software.

5.11 MICROCOMPUTER CONTROLLED LOGIC SUBSYSTEM (MCLS)

5.11.1

MCLS DEFINITION

The MCLS is the microprocessor based controlling element of the mobile terminal which will automatically control the signal processing circuits and handle the protocols and order wire signalling responses required as part of the system's Demand Assignment Multiple Access (DAMA) dynamic channel allocation. In addition, the MCLS will automatically monitor and report mobile terminal status information and control all facets of terminal operation.

5.11.2

MCLS CONFIGURATION

It is highly desirable that the MCLS be of modular design, containing all dedicated hardware, circuitry, firmware and software required to autonomously execute its functions so that it might be used in a "product family" of MSAT mobile terminals.

Execution of MCLS functions must be transparent to the terminal user, the other elements of the terminal and to the MSAT system.

Initiation of MCLS functions will be either automatic (self-or signal-initiated) or manual by the terminal user via keyboard entry or switch positioning. Processor systems and applications programs must be resident in non-volatile read-only memory.

Data, including user entries, may be stored in volatile memory if independent battery backup power (e.g. NICAD) is provided. Microprocessor architecture and throughput as well as program and data storage capacity for the AMPS/NBFM application must be adequate to accommodate both the AMPS functions and the additional MSAT functions. Since existing terrestrial mobile terminal equipment should accomodate all AMPS functions, expansion to include MSAT functions should only require additional memory and software. Alternatively, the MCLS may be housed within a separate control head.

A supervisory logic module, providing interface with and supervision of the other terminal elements can either be co-located with the transceiver circuits or form a part of the MCLS module.

Data communication between the terminal and the MSAT system over the 800 MHz links is at a rate of 2.4 kbps.

5.11.3 MCLS INTERFACE

The MCLS must interface with the following mobile terminal modules:

- Supervisory logic module (if not part of the MCLS)
- Transmitter module(s)
- Receiver module(s)
- Frequency synthesizer module(s)
- Power supply module
- Antenna module(s)
- User keyboard module
- User switch module
- Digital display module
- Status indicator module
- Hook switching module

5.11.4 MCLS FUNCTIONS

5.11.4.1 GENERAL

MCLS functions will include:

a) Automated monitoring and reporting of the status of the mobile terminal.

b) Automated response to user data entry via keyboard or switch positioning.

c) Automated control of mobile terminal functions not provided by other modules.

d) Automated channel acquisition and call processing as required by the AMPS radiotelephone service and the MSAT DAMA dynamic channel allocation protocols.

MCLS functions must be autonomously executed, independent of the operation of the other modules of the mobile terminal. Initiation of the functions will be either automatic, in response to stored program commands or to incoming data, or on user demand in response to keyboard data entry or switch position.

5.11.4.2

MCLS ADDITIONAL MSAT FUNCTIONS

a) Modification of AMPS signal channels and call processing protocol:

- due to the increased signal transmission time in satellite communications the timing requirements for call set-up will be on the order of 1000 milliseconds which is a relaxation in comparison to the AMPS type DAMA system. The satellite propagation delay time is 266 x 2 milliseconds and it is assumed that the central computer switch, located in the Gateway station, will need up to 250 milliseconds to determine whether it is possible to set up the communication link between the mobile calling party and the called party.

In addition, it will take about 100 milliseconds for the mobile to receive and process an acknowledgement message from the Gateway and about 100 milliseconds for channel request and assignment message transmission. The one second call set up time may require protocol modification.

The DAMA channels (forward set-up and reverse request) can be assumed to be pre-assigned fixed frequency channels with 7-10 of each required for Canada wide operation. The remaining MSAT voice channels will be available in a pool for dynamic assignment by the Gateway on a demand basis.

A low data rate and/or tone modulation will be used with the pilot to conduct disconnect and priority incoming call warning type of functions while the mobile is busy. Cellular hand-off and re-assignment of channels during voice communication will not be required.

Request for assignment messages will be error correction encoded and have repeat redundancy. The typical message size will be 200 bits BCH encoded. The channel assignment messages from the Gateway will be similarly encoded into 40 bit BCH coded words including word repetition used for the reduction of miss and false interpretation probabilities. More background information on the MSAT DAMA system envisioned is provided in Annex B.

In general it will be seen that the MSAT protocol is related to the AMPS protocol.

b) Automatic frequency synthesizer tuning:
   - agile retuning of the synthesizer to the channel frequency allocated by the MSAT DAMA is required. The retuning time has been identified in Section 5.6.

c) Automatic selection of one of two diversity antennas in response to receiver detection of the strongest signal.

d) Automatic monitoring and reporting to the terminal user of terminal status, called terminal availability, paging and control messages, channel availability and channel allocation via status lights and/or a single line alphanumeric display.

e) Automatic reporting of terminal status and availability to the gateway station including roam/home status.

5.12 MODEM UNIT

A modem, optimized for reception of 2.4kbps data within the SSB channel bandwidth, shall be provided. The modem function may be incorporated into the microcomputer or be implemented as a separate hardware module. Bit and frame sychronization shall be obtained using a 38 bit preamble. It may be assumed that the pilot tone, used for AFC during analogue voice transmissions, will also be used for AFC during data transmission.

5.13 CONTROL FUNCTIONS

Operator control functions will include either a limited (less than 10 digit) dialing capability for MSAT mobile radio system (MRS) application or a full (10 digit) dialing capability for use in a MSAT mobile telephone system (MTS) and for compatibility with AMPS type cellular terrestrial MTS.

Execution of the control functions will result in generation of display of the number dialed, of dial tones, of status display and in activation of status annunciator lights.

For limited dialing MRS use, existing MTS compatible 10 digit dialing control units could either be modified to provide limited dialing only or, while retaining 10 digit dialing capability, provide (switch selectable) automatic insertion of pseudo digits complementing the set of limited dialing digits to a total of 10. Usual capabilities such as ANI and frequently dialled number storage will be required.

5.14 SUGGESTED REALIZATION

The ACSB convenience circuits, digital frequency synthesiser, low speed data modem and MCLS could all be housed within the control head as an alternative means for bringing about the modification of the IF and baseband portions of an SSB transceiver.

Appendix C to:

Final Report on
Survey and Technical Analysis
of Mobile Radio Terminal
Suitable for MSAT

FUNCTIONAL PERFORMANCE

AND

TECHNICAL REQUIREMENTS

MODIFICATION OF NBFM MOBILE RADIOS FOR USE WITH MSAT

COI-866
JANUARY 1982
AEW/cb

Authorized by: _____
A.E. Waltho, P. Eng.
Director of Engineering
ADGA Systems International Ltd

TABLE OF CONTENTS

1. INTRODUCTION

As part of a program to determine the technical and economic viability of a commercial nationwide mobile communications system via satellite (MSAT), the Canadian Dept. of Communications has initiated a study to determine the cost of mobile terminals suitable for operation via the satellite. This document describes the functional and performance requirements of the required mobile terminals and is to be used as a reference in determining the cost and risk of modifying existing mobile radios to meet these requirements.

2. STATEMENT OF WORK

The contractor shall examine the functional and performance requirements as described in sections 4 and 5, and shall estimate the recurring and non-recurring cost of

either a) modifying existing or planned radio mobile terminals to meet the functional and performance objectives

or b) designing and manufacturing new mobile terminals to meet the functional and performance objectives.

. Recurring cost shall be based upon production quantities specified in section 3.

All costs shall be quoted in 1981 Canadian dollars.

In respect to task a) the contractor shall submit a brief report identifying the existing radios considered and describing the risk, nature and scope of any modifications to be made. The estimated cost of modification shall be broken down on the basis of the various functional elements of the radio, for example receiver front end, duplexer, PA, harmonic filters etc.

In respect to task b) the contractor shall submit a brief report describing the new radio design including a conceptual block and level diagram, a description of any special or innovative design feature which the contractor may consider to be necessary and a cost breakdown based upon functional elements within the block diagram.

3. BACKGROUND

Background and a technical understanding of the MSAT concept may be obtained from the DOC publication attached as Annex A to this document.

From this it will be seen that it is the DOC intent to launch a demonstration spacecraft in 1986/87 followed by an operational spacecraft in 1993.

The mobile terminals considered in this document are required to be available in production quantities of up to 20,000 per year spaced over a 7 year period commencing in 1992.

In addition it is anticipated that radio terminals of a pre-production nature, would be required in quantities of 100 commencing 1986 for use in the demonstration system.

4. FUNCTIONAL OBJECTIVE

To the extent possible it is the intent that radio terminals, suitable for operation via satellite, should also be capable of operation within the planned terrestrial cellular systems. In the first instance therefore it is necessary to consider radios operating in the 800 to 890MHz band using NBFM modulation.

As an alternative, necessary to reduce power and spectrum loading on the satellite, other more efficient modulation techniques such as amplitude companded single sideband (ACSB) and narrow band digital voice will be considered.

In these two latter alternatives it is desirable that the mobile terminal should include an AMPS compatible FM modulation scheme.

The MSAT system will incorporate a DAMA channel allocation system similar to that proposed for AMPS. Hence the mobile terminal will contain a data modem and microprocessor controlled frequency synthesizer with equivalent capability. Minor changes in protocols and timing are detailed in Section 5.6, 5.9. The MSAT DAMA is described in more detail in Annex B.

The mobile terminal designed for public telephone service will operate in a quasi-full duplex mode with "toll" quality voice communications. The use of voice activation on the downlink from the satellite will require a carrier operated squelch circuit to mute receiver noise during pauses in speech. This feature may not be incorporated in existing cellular mobile design. A control head will provide a full "dialing" capability and will generate audio tones, bells etc. as appropriate to the telephone type service.

The mobile terminal designed for mobile radio dispatch services will normally operate in a half duplex, PTT, mode although the equipment will be inherently capable of full duplex or mobile repeater operation. Sub-toll quality communication will be acceptable and only limited dialing facilities will be provided.

Two frequency bands shall be considered

a) 20MHz Tx and 20MHz Rx with a Tx/Rx separation of 45MHz. This assumes that frequencies will be allocated for MSAT from within the proposed cellular bands.

b) 25MHz Tx and 25MHz Rx also with a Tx/Rx separation of 45MHz. This assumes an allocation of 5MHz immediately adjacent to the proposed cellular bands.

5. SPECIFIC PERFORMANCE OBJECTIVES (NBFM)

These are based upon modifications to current or planned mobile radios employing NBFM with a channel spacing of 30KHz and operable over the 806-890MHz band. Microprocessor controlled frequency agile cellular radiotelephones (which are AMPS compatible) or conventional trunked radios are candidates for modification. A space diversity antenna system will be employed in the receive mode.

5.1 POWER AMPLIFIER

This shall be modified to allow up to 60W output in the two optional bands of interest. Where isolators and transmit harmonic filters are used, their power handling capability shall be 60W continuous.

5.2 RECEIVER FRONT END AMPLIFIER

The high signal environment, typical in urban land mobile communication, requires the receiver to exhibit a high third-order intermodulation intercept point frequently at the expense of only a moderate noise figure. In certain cases an RF preamp is not used, and downconversion to the first IF is done from the antenna input with only passive RF filtering preceding the mixer. For MSAT a low noise figure is required and a lower third order intercept point may be accepted. This could be accomplished through a new amplifier which will precede existing stages.

The noise figure of the new amplifier should be 2.2dB maximum over the MSAT receive bands and the average gain should be 20dB (nominal).

5.3 DUPLEXER

For option 1 (i.e., frequency band (a)) a duplexer similar in design to those developed for 800MHz cellular radio products is anticipated.

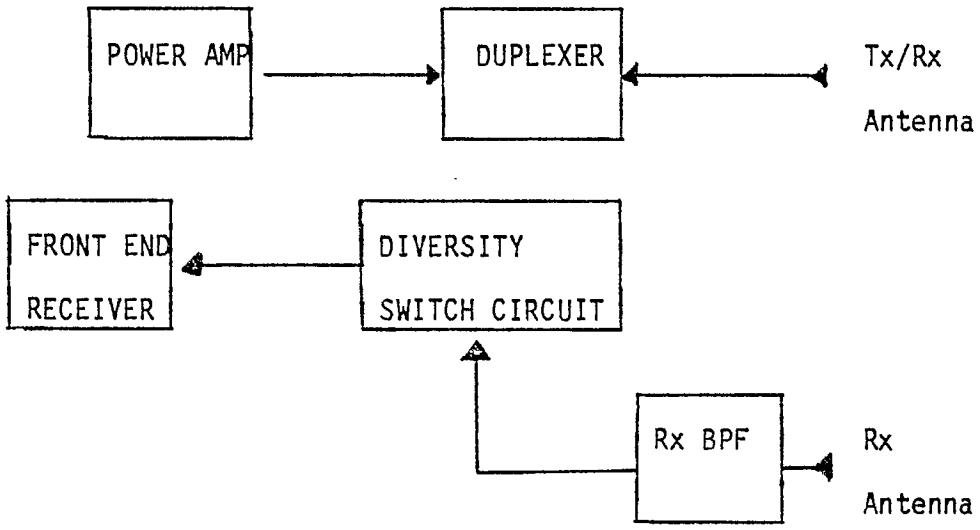
Depending upon the detailed design of the equipment, the out of band attenuation of transmitter broadband noise may need to be increased by up to 13dB to allow for the higher gain in the transmitter power amplifier and receiver front end.

Similarly, an additional 13dB of out of band attenuation may be necessary in the receiver port to reject the high transmit carrier signal. The contractor shall determine the changes necessary in order to satisfy the 2.2dB receiver noise figure requirement with the transmitter operating at full rated power.

For option 2 (i.e. frequency band (b)) a more complex design will be necessary to achieve the wider passband in both transmit and receive ports.

5.4 DIVERSITY RECEIVER ELEMENTS

Figure 5.1 is a block diagram of a typical mobile radio space diversity receive system.



DIVERSITY FRONT END

FIGURE 5.1

1) RECEIVE BPF

In the satellite receiving mode the receive BPF should have the lowest insertion loss practically attainable with the response charactaristic similar to that required in the duplexer receiver port. An insertion loss of 1.0dB maximum is suggested. Two passbands should be considered to cover option 1 and option 2.

2) DIVERSITY SWITCH CIRCUIT

Constant 50 Ohm impedance presented to the duplexer and receive BPF is important to maintain the receiver figure of merit (G/Ts ratio). Insertion loss for the receive path is to be 0.3dB max and for the receive/transmit path to be 0.6dB max. The transmit/receive isolation shall be 30dB minimum. Switchover to MSAT operation (under microcomputer or front panel control) shall allow the diversity path selector to operate with signal levels as low as -125dBm.

5.5 SIGNAL CONVERSION

Conventional designs should be adequate. The RF input for the 800MHz to 45MHz mixer may have to be modified to accommodate input power levels in the -120 to -110 dBm range.

5.6 FREQUENCY SYNTHESIZER

For option 1, no change is required. For option 2, the frequency synthesizer must generate a tuning capability over an additional 166 x 2 channels for a total of 832 x 2 channels. The TCXO stability for both options 1 and 2 can remain at the EIA/FCC compatible $\pm$2.5 PPM level.

For both options 1 and 2, the channel tuning time required for use with MSAT is in the order of 200-300 milliseconds.

5.7 IF SECTION

No changes to existing baseline NBFM equipment are required.

5.8 AF SECTION

Pre and de-emphasis circuits shall be provided. The slope should be 12dB/octave. A voice activated carrier will be transmitted from the Gateway stations to the mobiles. A means to mute the mobile receiver output during pauses in speech shall be provided. It would be desirable to implement these circuits in an IC chip which could be an add-on to current AF circuit designs.

5.9 MICROCOMPUTER CONTROLLED LOGIC SUBSYSTEM (MCLS)

5.9.1 MCLS DEFINITION

The MCLS is the microprocessor based controlling element of the mobile terminal which will automatically control the signal processing circuits and handle the protocols and order wire signalling responses required as part of the system's Demand Assignment Multiple Access (DAMA) dynamic channel allocation. In addition, the MCLS will automatically monitor and report mobile terminal status information and control all facets of terminal operation.

5.10 MODEM UNIT

The existing 10kbps FSK AMPS modem will be used for data communication in both transmit and receive mode. Error detection and correction will be implemented within the microprocessor separately from the modem.

5.11 CONTROL FUNCTIONS

Operator control functions will include either a limited (less than 10 digit) dialing capability for MSAT mobile radio system (MRS) application or a full (10 digit) dialing capability for use in a MSAT mobile telephone system (MTS) and for compatibility with AMPS type cellular terrestrial MTS.

Execution of the control functions will result in generation of display of the number dialed, of dial tones, of status display and in activation of status annunciator lights.

For limited dialing MRS use, existing MTS compatible 10 digit dialing control units could either be modified to provide limited dialing only or, while retaining 10 digit dialing capability, provide (switch selectable) automatic insertion of pseudo digits complementing the set of limited dialing digits to a total of 10. Usual capabilities such as ANI and frequently dialled number storage will be required.

APPENDIX D

MANUFACTURERS' DATA SHEETS

MANUFACTURERS' DATA SHEETS

Johnson

- Clear channel logic trunked MRS radio
- Transcom II conventional MRS radio
- Fleetcom II conventional MRS radio

Motorola

- Maxar 80 - 800 MHz MRS mobile
- EMX advanced mobile telephone system
- Syntor trunked MRS radio 800 MHz MRS mobile
- Micor 15/35 watt

Sideband Technology

- ACSB pioneer 1000 VHF MRS radio

OKI Advanced Communications

The direct line cellular mobile

FUJITSU

- Cellular radio

JOHNSON®

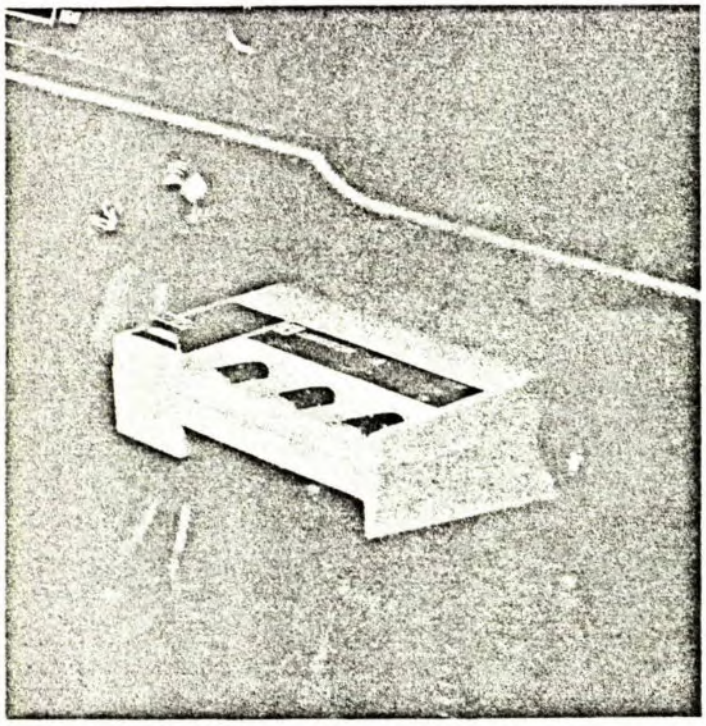
We're reinventing two way radio

CLEARCHANNEL LTR™

Logic Trunked Radio System

Mobile Transceivers

20 Channels — Digitally synthesized



- Fast system access
- User privacy
- 5 to 20 channels
- Automatic channel assignment
- Uncomplicated operation
- Space diversity antenna system

Johnson's new CLEARCHANNEL LTR™(Logic Trunked Radio) system is a revolutionary technological breakthrough utilizing logic controlled radio signalling technology. Mobile channel assignment is automatic, providing all individuals in your radio system with access to any of up to 20 pooled channels. Simplicity in operation combined with the latest advancements in microprocessor digital technology provides you with the privacy lacking in conventional radio systems.

Johnson's LTR mobiles are 25 watt simplex transceivers with a wide band digital synthesizer and a logic control assembly which limits any given radio to 20 programmed channels. Channel selection and squelch control functions are performed by the mobile logic and you only need to operate the volume control, ON-OFF switch and microphone "push-to-talk" button.

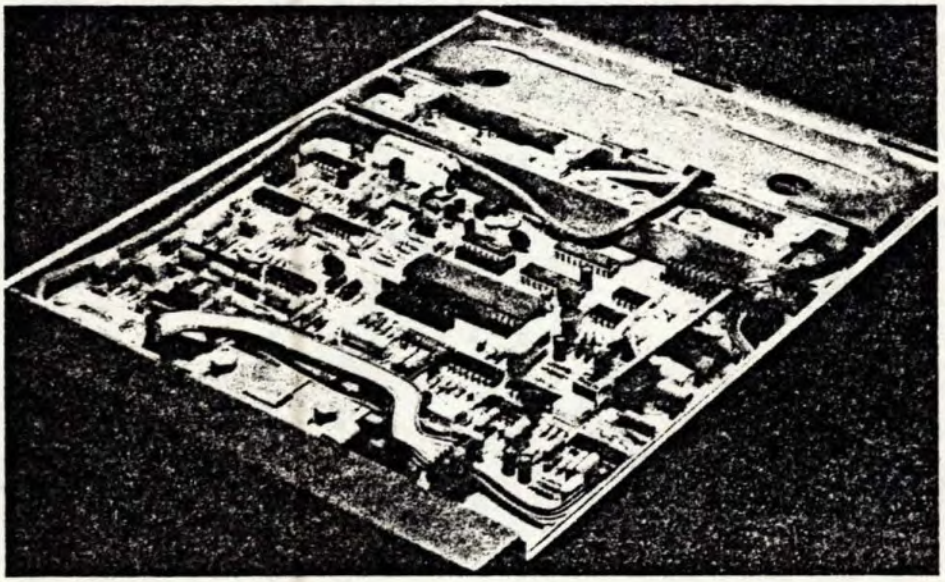
The Johnson 800 MHz trunked system uses an exclusive method of signal strength enhancement called "space diversity antennas," providing significantly improved system coverage and signal clarity over other trunked systems. The Johnson CLEARCHANNEL LTR™ is the best radio communications system available. There is nothing comparable. In effect, Johnson has reinvented two-way radio.

JOHNSON®

Features/Benefits

800 MHz Trunked Mobile Radio

Trunked operation pools several radio channels to provide access to these channels by any user on the system. In doing so, considerable radio spectrum efficiency results, providing a level of radio service far superior to that available in conventional systems. Your mobile unit is automatically assigned an available channel along with all the other members in your system, without the need to manually select a channel or monitor the channel before transmitting.



LTR user benefits

A Johnson CLEARCHANNEL LTR™ dispatch system provides numerous advantages over conventional shared repeater dispatch operations. These include fully automatic channel sharing with access to all channels allocated to a system for a superior level of service. Rapid channel acquisition, with absolute minimum waiting time for an open channel, alleviates the channel congestion associated with conventional systems.

Each user has complete privacy from other system users, transmissions cannot be monitored. Operation is simple, all pre-transmission channel monitoring requirements are eliminated, and the only controls necessary are on-off, volume, and the microphone push-to-talk transmit button. Simple operation and reliable, advanced technology combine to offer the maximum benefits realizable in trunked dispatch operation.

Privacy

As a radio operator on a Johnson LTR repeater system you have complete privacy from other users of the system. Only users in your own group can hear your conversation. All pre-transmission channel monitoring requirements are eliminated as is the capability to monitor the channel.

LTR signalling

Advanced microprocessor generated and controlled digital signalling in the mobile directs the independent operation of your unit. During mobile transmissions, the LTR repeater system is transmitting and receiving digital signals to and from all mobile units on the system. This data is transmitted continuously and simultaneously with voice transmissions in the subaudible portion of the voice spectrum. The advantages of subaudible data are:

- Minimal hardware. Sync, bit, and word detection are implemented in software. This means less complex, smaller, and lower cost logic packages with minimal current drain; all crucial to mobile operation.
- Redundancy. Date transmitted continuously with voice updates new mobiles entering service or mobiles lost due to out-of-range conditions.
- Spectrum efficiency. The ability to send data and voice simultaneously eliminates the need for a dedicated control channel. A five channel system provides five voice channels.

High performance specifications

The CLEARCHANNEL LTR™ mobile employs the uncompromising circuit design and component quality traditional with Johnson for over 50 years. The resultant excellent receiver performance combined with the transmitter's 25 watt RF output power assures dependable, reliable communications. Microprocessor digital signalling technology is utilized to insure fast, dependable system integrity. Digital systhesis provides access on up to 20 channels without the need for individual crystal channel elements.

Antenna diversity

Two antenna ports are provided for antenna diversity to insure continuous communications in a signal fading environment. The multipath characteristics of 800 MHz signal propagation can cause reduced communications reliability due to the effect of signal fading on voice quality. Space diversity antennas are used on the LTR receivers to compensate for this phenomenon, with each antenna experiencing independent propagation conditions. The diversity logic circuitry within the receiver automatically selects the antenna with the best signal. Overall performance is improved by several orders of magnitude. If only one antenna is desired, the diversity function may be disabled.

CLEARCHANNEL LTR™
Logic Trunked Radio System
Mobile Transceivers

Options/Benefits

Versatile mounting

The LTR 8800 is a dash or hump-mount unit with operator controls an integral part of the radio package. The LTR 8850 is a trunk or remote mount unit with an attractively styled control unit which interfaces with the radio by way of an eight foot or seventeen foot control cable.

Quality construction

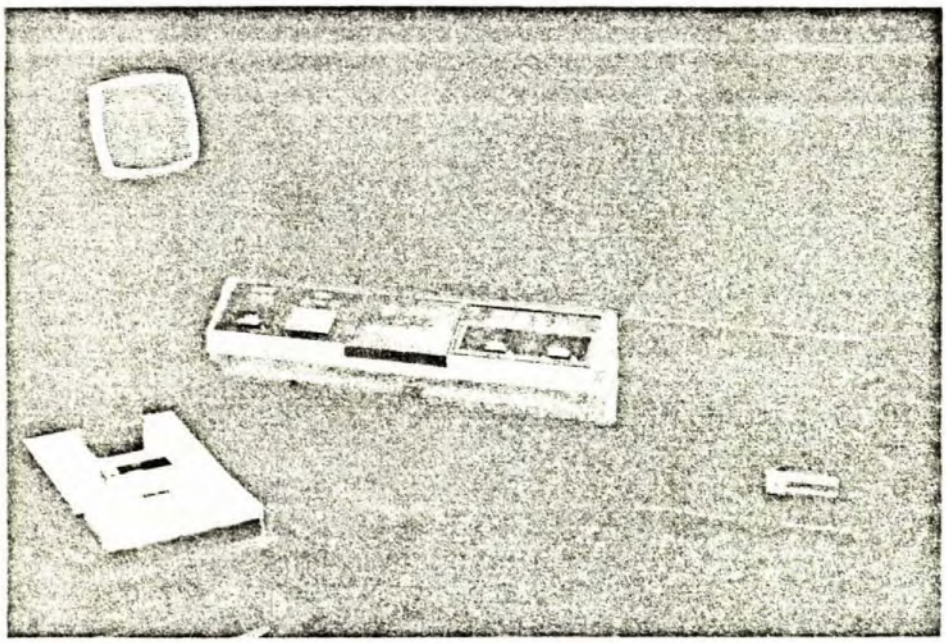
Advanced solid-state design permits modern construction techniques insuring quality, dependable operation. A unique, lightweight, one-piece die-cast aluminum chassis combines electrical stability with exceptional strength to withstand the most rugged mobile applications.

Full one-year warranty

All Johnson radios are backed by an exclusive one-year warranty on both parts and labor. This warranty is backed by an extensive network of domestic and international Johnson service centers.

Made in U.S.A.

Every CLEARCHANNEL LTR mobile is designed, developed and built in America to exacting standards. The workmanship is of exceptionally high caliber, a major contributing factor to their reliability.



Group/sub-group/selective call

The microprocessor in the Johnson LTR transceiver can be programmed to selectively communicate with specific groups, sub-groups or individual units in your fleet through the use of the "Group Call" option. Up to ten individual digital codes can be assigned. Each unit or group of units in your fleet is designated by a unique digital ID code.

Simple rotation of the "Group Call" switch selects the exact group, sub-group or individual ID code within your system you want to communicate with.

Control station

The control station consists of an LTR 8800 mobile transceiver mounted on an attractive pedestal power supply with self-contained speaker and desk top microphone. The antenna diversity function is disabled in the control station configuration to allow for the use of a single antenna.

"System Select"

The "System Select" option expands your transceiver's capability, capacity and flexibility. The unique characteristics of your particular mobile (radio channels, ID codes, area ID, etc.) are programmed into your radio in a programmable read-only-memory (PROM) integrated circuit. The "System Select" option includes a rotary four position switch which allows you to select any one of up to four individual PROMs. This can greatly expand your system's capability by adding ID code capacity, access to additional available LTR trunked systems for wider area coverage, and by varying other system parameters.

CLEARCHANNEL LTR™
Logic Trunked Radio System
Mobile Receivers

MODEL	MOUNTING	FREQUENCY	INPUT VOLTAGE	OUTPUT POWER
8800 8850	Dash/Hump Remote front/ trunk	816-821 MHz	13.8 VDC Negative Ground	25 watts Minimum

LTR 8800	LTR 8850
Number of Channels	
5-20	5-20
Dimensions	
Height	
Radio — 2.5"	Radio — 2.5"
Speaker — 4.5"	Speaker — 4.5"
	Control Unit — 1.75"
Width	
Radio — 9.06"	Radio — 9.06"
Speaker — 4.4"	Speaker — 4.4"
	Control Unit — 5.31"
Depth	
Radio — 13.9"	Radio — 12.82"
Speaker — 2.6"	Speaker — 2.6"
	Control Unit — 4.38"
Weight	
12 lbs.	12 lbs.
Duty Cycle	
20%	20%
T/R Separation	
45 MHz	45 MHz
FCC Compliance	
Parts 15 and 90	Parts 15 and 90
FCC Type Number	
242-8800	242-8850

LTR 8800	LTR 8850
RECEIVER (Measurements made per EIA Standard RS 204 B)	
Sensitivity	
12 dB SINAD — 0.35 μV	12 dB SINAD — 0.35 μV
20 dB Quieting — 0.50 μV	20 dB Quieting — 0.50 μV
Modulation Acceptance	
±7.5 kHz	±7.5 kHz
Selectivity	
−75 dB	−75 dB
Spurious Rejection	
−90 dB	−90 dB
Image Rejection	
−90 dB	−90 dB
Intermodulation	
−70 dB	−70 dB
Audio Power Output	
5 watts	10 watts
Distortion At Full Rated Audio	
5%	5%
Frequency Stability (−30 to +60°C)	
±0.00025%	±0.00025%
TRANSMITTER (Measurements made per EIA Standard 152 B)	
RF Power Output (Adjustable)	
12-25 watts	12-25 watts
Spurious and Harmonics	
−60 dB	−60 dB
Frequency Stability (−30 to +60°C)	
±0.00025%	±0.00025%
Modulation	
16F3, 15F2, 16F9	16F3, 15F2, 16F9
Audio Distortion	
Less than 5%	Less than 5%

JOHNSON®

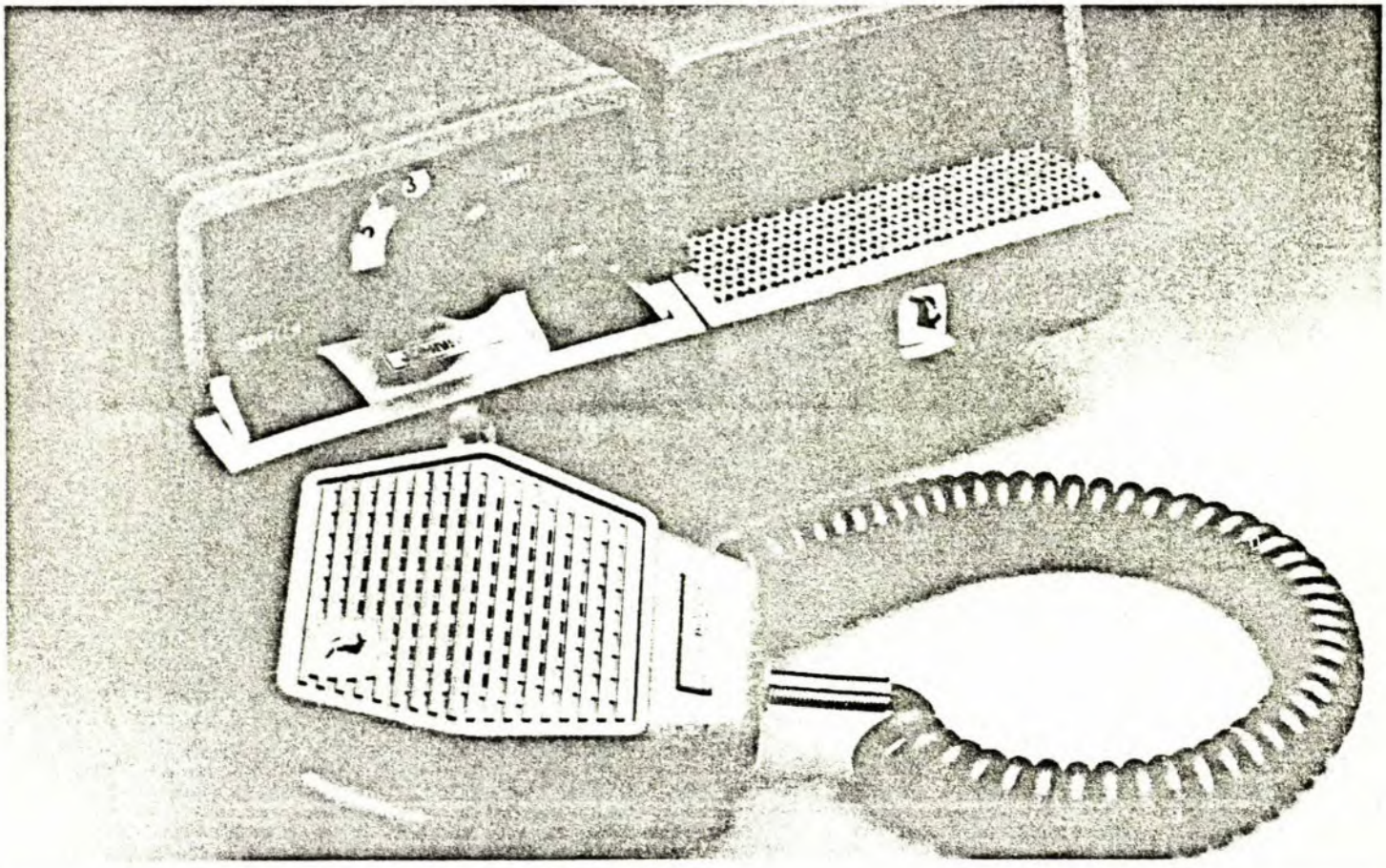
E. F. JOHNSON COMPANY, WASECA, MINNESOTA 56093

JOHNSON®

Transcom II

800 Mobile FM 2-way radio

806-821 MHz Transmit, 851-866 MHz Receive • 1-5 channels • 12 watts



- **High performance specifications**
- **5 channel capability**
- **One-piece chassis**
- **5 MHz transmit and receive channel spread**
- **±2.5 PPM frequency stability**

Johnson's Transcom II 800 FM two-way mobile radio takes you into the clear, congestion free era of 800 MHz radio communications. The Transcom II 800 provides 10 watts of talk power in a rugged package designed for both maximum reliability and optimum performance.

The completely transistorized Transcom II 800 mobile eliminates warm-up delayed communications and holds down current drain. Performance features of the Transcom II 800 include excellent receiver sensitivity, selectivity, adjacent channel rejection and intermodulation rejection. The transmitter features ±2.5 parts-per-million (PPM) frequency stability and 5 MHz channel spread. You are assured of clear on-frequency communications despite adverse environmental conditions.

Every Transcom II 800 radio is built in America to exacting standards, and each carries the exclusive Johnson full one-year warranty on both parts and labor. This warranty is backed by a network of domestic and international service centers.

Transcom II
800 Mobile FM 2-way radio

Features/benefits

800 MHz

ove up with the Transcom II 800 obile to the congestion free world of 800 MHz radio. Clear, interference free communications are assured, pecially when you qualify for your wn exclusive radio channel. Even when your channel is shared with her users, channel loading restrictions ean that the channel will never become overcrowded.

igh performance specifications

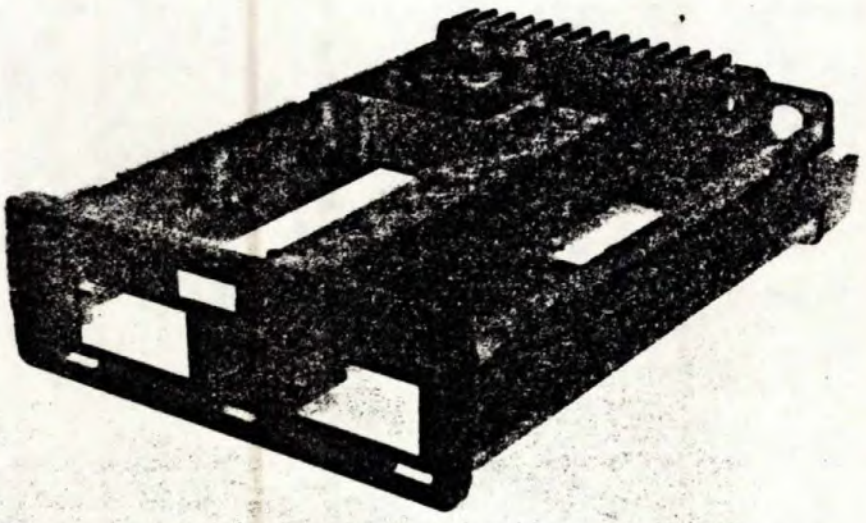
ne Transcom II 800 utilizes the uncompromising circuit design and component quality traditional with ohnson for over 50 years. The sultant excellent receiver sensitivity, selectivity, adjacent channel rejection and intermodulation ejection combined with the ansmitter's 10 watts of RF output power assures dependable, liable communications.

All solid-state construction

dvanced solid-state design offers high reliability and holds maintenance to an absolute minimum. Critical circuits are voltage regulated to ensure equency stability. Transmitter power transistors are protected against failure used by antenna malfunctions. No warm-up" time is required and there are no tubes to fail.

implified maintenance

A single test metering jack facilitates apid trouble shooting, and swing out ccessory boards permit fast accessory service.



One-piece chassis

A unique lightweight, one-piece die-cast aluminum chassis combines electrical stability with exceptional strength to withstand the most rugged mobile applications.

Low-profile styling

The low-profile radio housing, a mere 2 3/4" high, 8" wide, and 12 1/8" deep, is not only neat and compact but simplifies installation whether under dash or remote using the removable control head and speaker.

± 2.5 parts-per-million frequency stability

Only one high stability ±.00025% TCXO channel element is required per channel for on frequency communications under all operating conditions. Adding a channel is as simple as plugging in an additional TCXO.

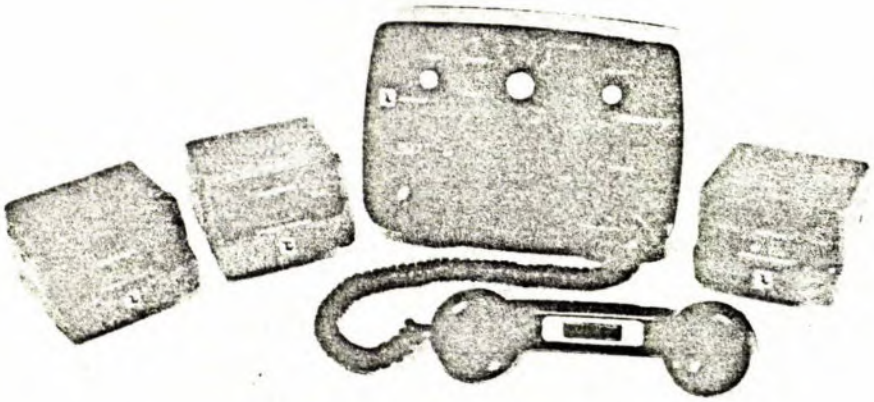
Full one-year warranty

All Johnson radios are backed by an exclusive one-year warranty on both parts and labor. This warranty is backed by a network of domestic and international service centers.

Made in U.S.A.

Every Transcom II 800 mobile is built in America to exacting standards. The workmanship is of exceptionally high caliber, a major contributing factor to their reliability.

Options/benefits



TRANSCOM II test set

Quick and easy routine testing is available with the optional TRANSCOM II test set connected to the test metering jack. The test set may be purchased through the E. F. Johnson Customer Service department.

Call Guard® tone squelch

Optional Call Guard® tone squelch keeps the receiver quiet until called by one of your own units. It greatly reduces missed calls, since the radio is activated only by radios within your system. Call Guard® is compatible with other continuous, subaudible tone squlelch systems.

Time-out-timer

This optional timer turns the transmitter off after a preset time to prevent accidental blocking of the channel. The operator is alerted by an audible tone.

Microphone option

The Johnson heavy duty microphone is standard with the Transcom II 800. For systems design flexibility a noise canceling microphone can be used in high ambient noise environments.

One to five channel capability

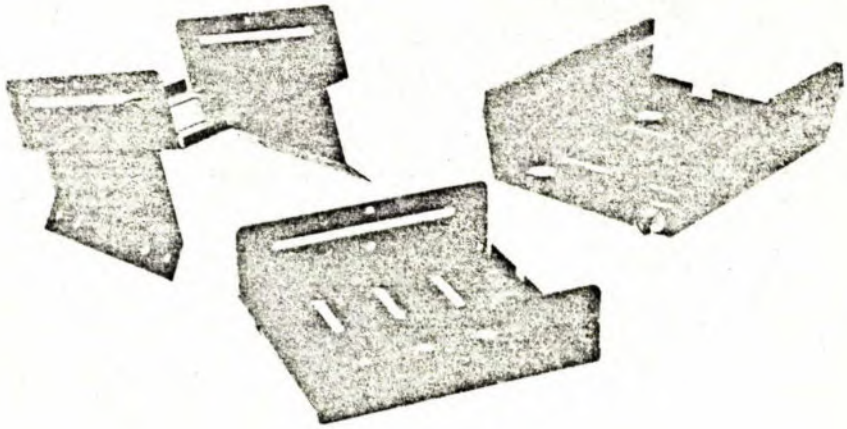
One to five channel capability permits system design flexibility. This multiple channel option facilitates selection of a clear frequency if radio traffic is heavy and also permits simple channel additions when system growth requires it. Only one plug-in TCXO channel element is required per channel. One, two, four, and five channel control heads are available as well as a four channel telephone style control head.

Mobile installation options

A number of versatile mounting configurations are available for mobile installation of the Transcom II 800. Included are a transmission hump mount for vehicles with limited under-dash space, a simple universal mount, and a locking mount. Trunk mount kits with 8' or 17' cables are also available.

Remote speakers

Two optional external speakers are available. One, a large 4" external speaker provides crisp, clear sound traditional with Johnson. The other is a 15 watt audio accessory speaker which uses a built-in solid-state amplifier. It is excellent for use in mobile situations where environmental noise is high or the operator is outside the vehicle.



Transcom II

800 Mobile FM 2-way radio

MODEL	FREQUENCY	POWER OUTPUT	INPUT VOLTAGE	CURRENT DRAIN	
				SQUELCHED	TRANSMIT
800	806-821 MHz Transmit 851-866 MHz Receive	10 watts	13.8 VDC Negative Ground	.6A at 13.8V	6A at 13.6V

umber of Channels	1, 2, 4, or 5	
imensions	**Control Head**	**Speaker**
Height:	3-3/8 inches (8.6 cm)	3-3/8 inches (8.6 cm)
Width:	4 inches (10.2 cm)	4 inches (10.2 cm)
Depth:	3¼ inches (8.3 cm)	3¼ inches (8.3 cm)
	Transmitter-Receiver (without control head)	
Height	2¾ inches (7.0 cm)	
Width	8 inches (20.3 cm)	
epth	12-1/8 inches (30.8 cm)	
eight	8 pounds (3.6 kg)	
Duty Cycle	20% (1 min. transmit, 4 min. receive per EIA)	
Channel Spacing	25 kHz	
R Separation	45 MHz	
ompliance	FCC Parts 15, 90	
FCC Type Number	242-0800	

eceiver (measurements made per EIA Standard RS 204B)

Sensitivity	
EIA 12 dB SINAD	.35μV
20 dB Quieting	.5μV
quelch Sensitivity	.25μV
Modulation Acceptance	±7.5 kHz
lectivity	−75 dB
urious Rejection	−80 dB
Intermodulation	−65 dB
Audio Power Output	5 watts <5% distortion
equency Stability	±.00025% from −30 to +60°C
hannel Spread	5 MHz

Transmitter (measurements made per EIA Standard RS 152B)

F Power Output	10 watts
Spurious & Harmonic Emissions	−60 dB
Frequency Stability	±.00025% from −30 to +60°C
lodulation	16F3: ±5 kHz for 100% at 1000 Hz; 15F2
udio Distortion	Less than 5% at 1000 Hz
Channel Spread	5 MHz
M Hum and Noise	−50 dB

Optional Accessories

Call Guard® tone squelch	**Time-out-timer**	***External speaker***
Various mounts	***Transcom II test set***	***Various microphones***
		Telephone style control head

JOHNSON®

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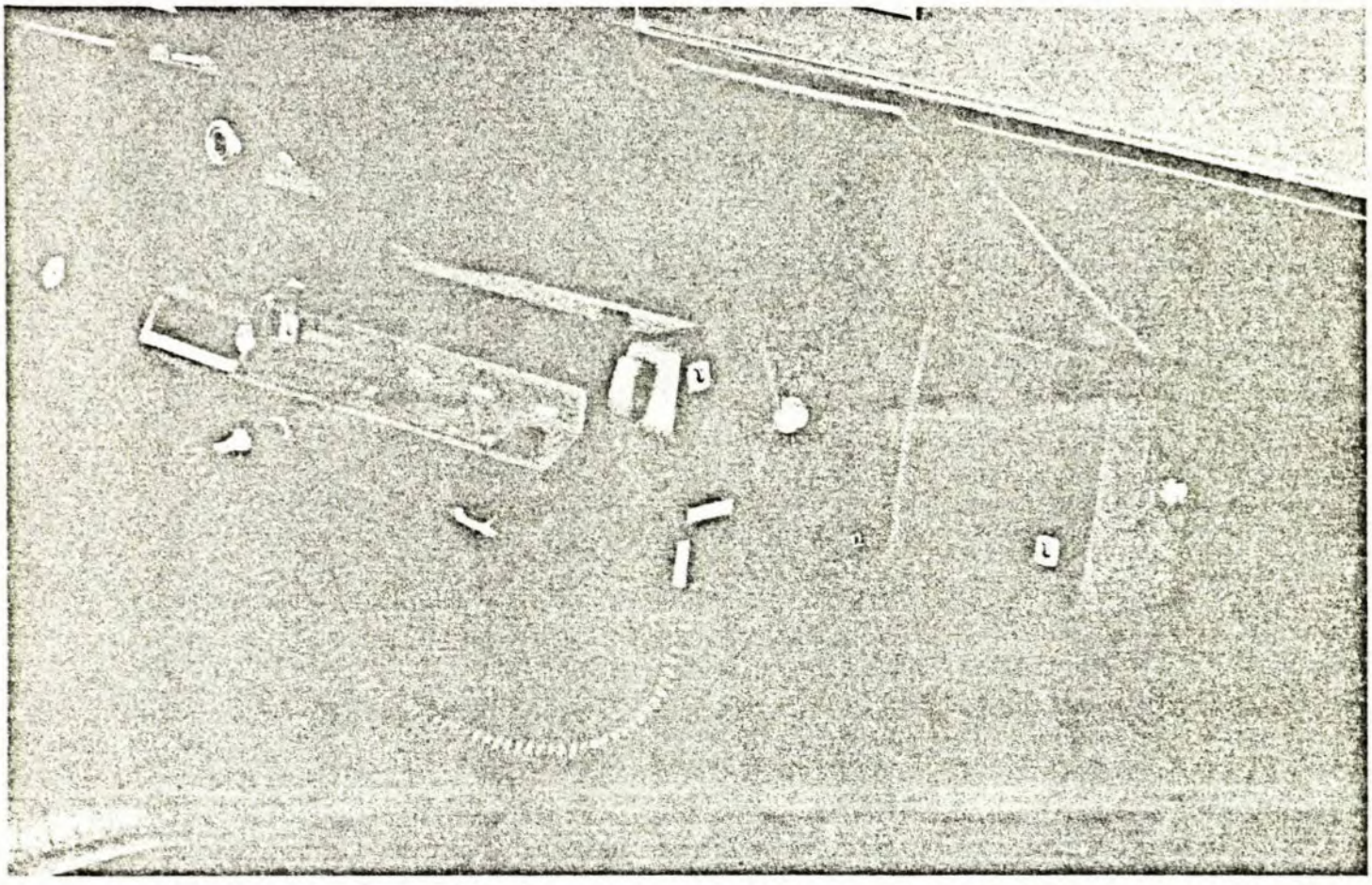
Specifications subject to change without notice

JOHNSON®

Fleetcom II

880 Mobile FM 2-way radio

806-825 MHz Transmit, 851-870 MHz Receive • 1-2 channels • 10 watts



- **High performance specifications**
- **2 channel capability**
- **One-piece chassis**
- **5 MHz transmit and receive channel spread**
- **±2.5 PPM frequency stability**

Johnson's **FLEETCOM II 880** FM two-way mobile radio takes you into the clear, congestion free era of 800 MHz radio communications. The **FLEETCOM II 880** provides 10 watts of talk power in a rugged package designed for both maximum reliability and optimum performance.

The completely transistorized **FLEETCOM II 880** mobile eliminates warm-up delayed communications and holds down current drain. Performance features of the **FLEETCOM II 880** include excellent receiver sensitivity, selectivity, adjacent channel rejection and intermodulation rejection. The transmitter features ± 2.5 parts-per-million (PPM) frequency stability and 5 MHz channel spread. You are assured of clear on-frequency communications despite adverse environmental conditions.

Every **FLEETCOM II 880** radio is built in America to exacting standards, and each carries the exclusive Johnson full one-year warranty on both parts and labor. This warranty is backed by a network of domestic and international service centers.

Fleetcom II

880 Mobile FM 2-way radio

Features/benefits

) 0 MHz

Move up with the **FLEETCOM II 880** mobile to the congestion free world of 0 MHz radio. Clear, interference free communications are assured, especially when you qualify for your own exclusive radio channel. Even when your channel is shared with other users, channel loading restrictions mean that the channel will never become overcrowded.

High performance specifications

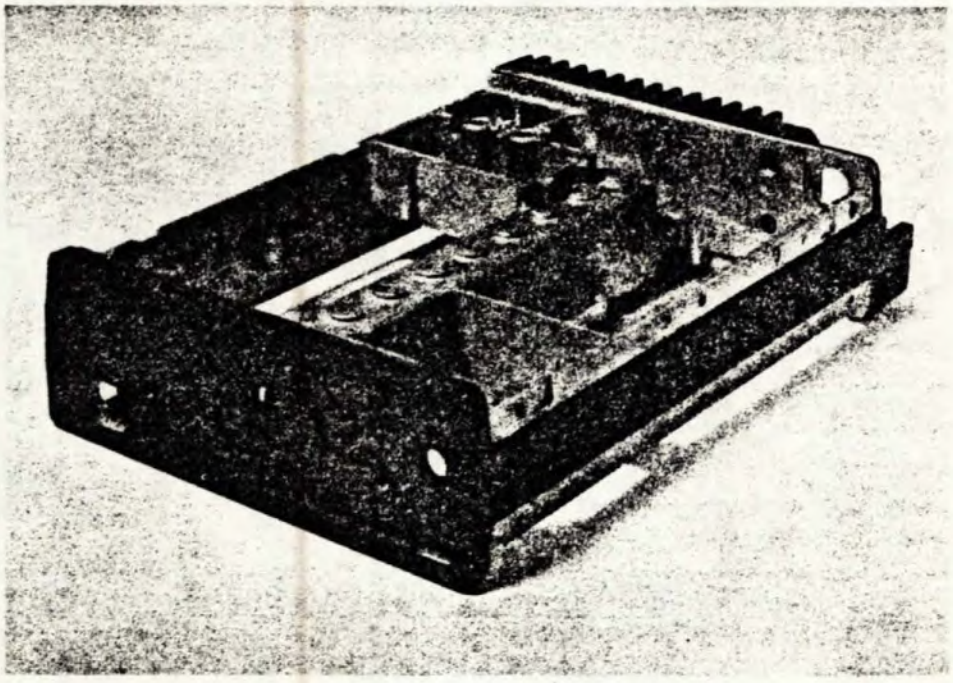
The **FLEETCOM II 880** utilizes the uncompromising circuit design and component quality traditional with Johnson for over 50 years. The resultant excellent receiver sensitivity, selectivity adjacent channel rejection and intermodulation rejection combined with the transmitter's 10 watts of RF output power assures dependable, reliable communications.

All solid-state construction

Advanced solid-state design offers high reliability and holds maintenance to an absolute minimum. Critical circuits are voltage regulated to ensure frequency stability. Transmitter power transistors are protected against failure caused by antenna malfunctions. No "warm-up" time is required and there are no tubes to fail.

Outstanding audio quality

A large 4" external speaker provides the crisp, clear sound traditional with Johnson. Loud and intelligible message reception is assured even in noisy environments.



One-piece chassis

A unique lightweight, one-piece die-cast aluminum chassis combines electrical stability with exceptional strength to withstand the most rugged mobile applications.

Full one-year warranty

All Johnson radios are backed by an exclusive one-year warranty on both parts and labor. This warranty is backed by a network of domestic and international service centers.

Low-profile styling

The low-profile radio housing, a mere 2 3/4" high, 8" wide, and 13 3/8" deep, is not only neat and compact it simplifies under dash installation. Weighs just eight pounds.

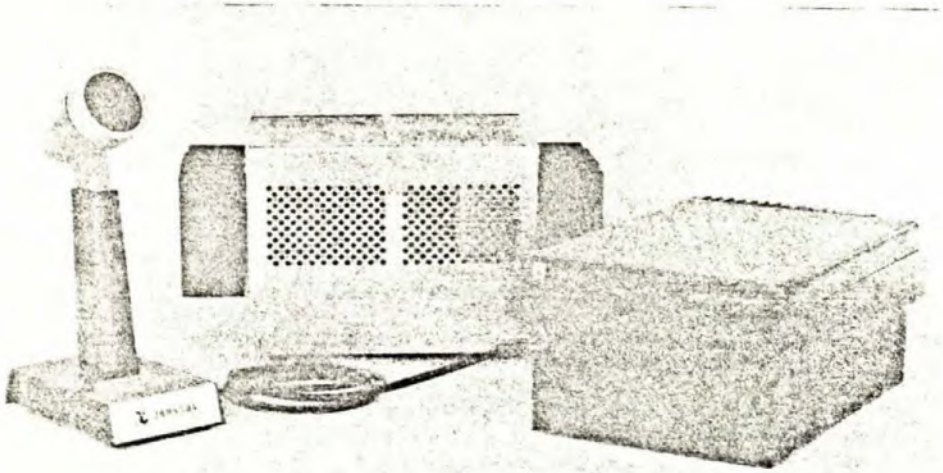
±2.5 parts-per-million frequency stability

Only one high stability ±.00025% TCXO channel element is required per channel for on frequency communications under all operating conditions. Adding a channel is as simple as plugging in an additional TCXO.

Made in U.S.A.

Every **FLEETCOM II 880** mobile is built in America to exacting standards. The workmanship is of exceptionally high caliber, a major contributing factor to their reliability.

Options/benefits



Fleetcom II 880 Control Station

Mobile/control station operation

An optional 117/234 VAC power supply allows the **FLEETCOM II 880** to be operated as a control station. The power supply is used with a desk top pedestal which includes a built-in speaker. Use of this power supply permits the transfer of the **FLEETCOM II 880** between mobile and control station without modification, assuring continuous system operation.

Remote speakers

Two optional **FLEETCOM II** external speakers are available.

A 15 watt audio accessory speaker, which uses a built-in solid-state amplifier, is excellent for use in mobile situations where environmental noise is high or the operator is outside the vehicle.

The remote speaker provides remote speaker and microphone functions for **FLEETCOM II** transceivers. It permits the radio to be at a remote location with the speaker and microphone conveniently close to the operator.

Mobile installation options

A number of versatile mounting configurations are available for mobile installation of the **FLEETCOM II**. Included are a transmission hump mount for vehicles with limited under-dash space, a simple universal mount, a locking mount, and a dash mount.

Call Guard® tone squelch

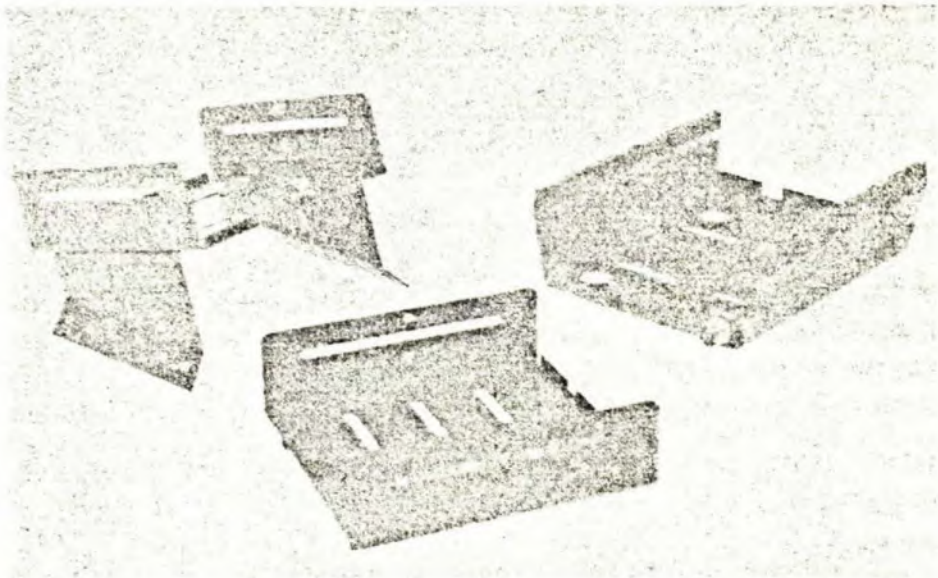
Optional Call Guard® tone squelch keeps the receiver quiet until called by one of your own units. Greatly reduces missed calls, since the radio is activated only by radios within your system. Call Guard® is compatible with other continuous, sub-audible tone squelch systems.

Two-channel capability

The two-channel option gives you the operational flexibility of selecting a clear frequency when radio traffic is heavy.

Microphone option

The Johnson heavy duty microphone is standard with the **FLEETCOM II 880**. For systems design flexibility a noise canceling microphone can be used in high ambient noise environments.



Fleetcom II

880 Mobile FM 2-way radio

MODEL	FREQUENCY	POWER OUTPUT	INPUT VOLTAGE	CURRENT DRAIN	
				SQUELCHED	TRANSMIT
880	806-825 MHz Transmit 851-870 MHz Receive	10 watts	13.8 VDC Negative Ground	.6A at 13.8V	7A at 13.6V

Number of Channels	1 or 2
Dimensions Height: Width: Depth:	 2-3/4 in. (7.0 cm) 8 in. (20.3 cm) 13-3/8 in. (34.0 cm)
Weight	8 pounds (3.6 kg)
Duty Cycle	20% (1 min. transmit, 4 min. receive per EIA)
Channel Spacing	25 kHz
T/R Separation	45 MHz
Compliance	FCC Parts 15, 89, 91, 93
FCC Type Number	242-0880

Receiver (measurements made per EIA Standard RS 204A)

Sensitivity EIA 12 dB SINAD 20 dB Quieting	 .35μV .5μV
Squelch Sensitivity	.25μV
Modulation Acceptance	±7.5 kHz
Selectivity	-75 dB
Spurious & Image Rejection	-80 dB
Intermodulation	-65 dB
Audio Power Output	5 watts <5% distortion
Frequency Stability	±.00025% from -30 to +60°C
Channel Spread	5 MHz

Transmitter (measurements made per EIA Standard RS 152B)

RF Power Output	10 watts
Spurious & Harmonic Emissions	-60 dB
Frequency Stability	±.00025% from -30 to +60°C
Modulation	16F3: ±5 kHz for 100% at 1000 Hz; 15F2
Audio Distortion	Less than 5% at 1000 Hz
Channel Spread	5 MHz
FM Hum and Noise	-50 dB

Optional Accessories

Call Guard® tone squelch
Various mounts
External speakers
Various microphones

JOHNSON®

Specifications subject to change without notice

E. F. JOHNSON COMPANY, WASECA, MINNESOTA 56093

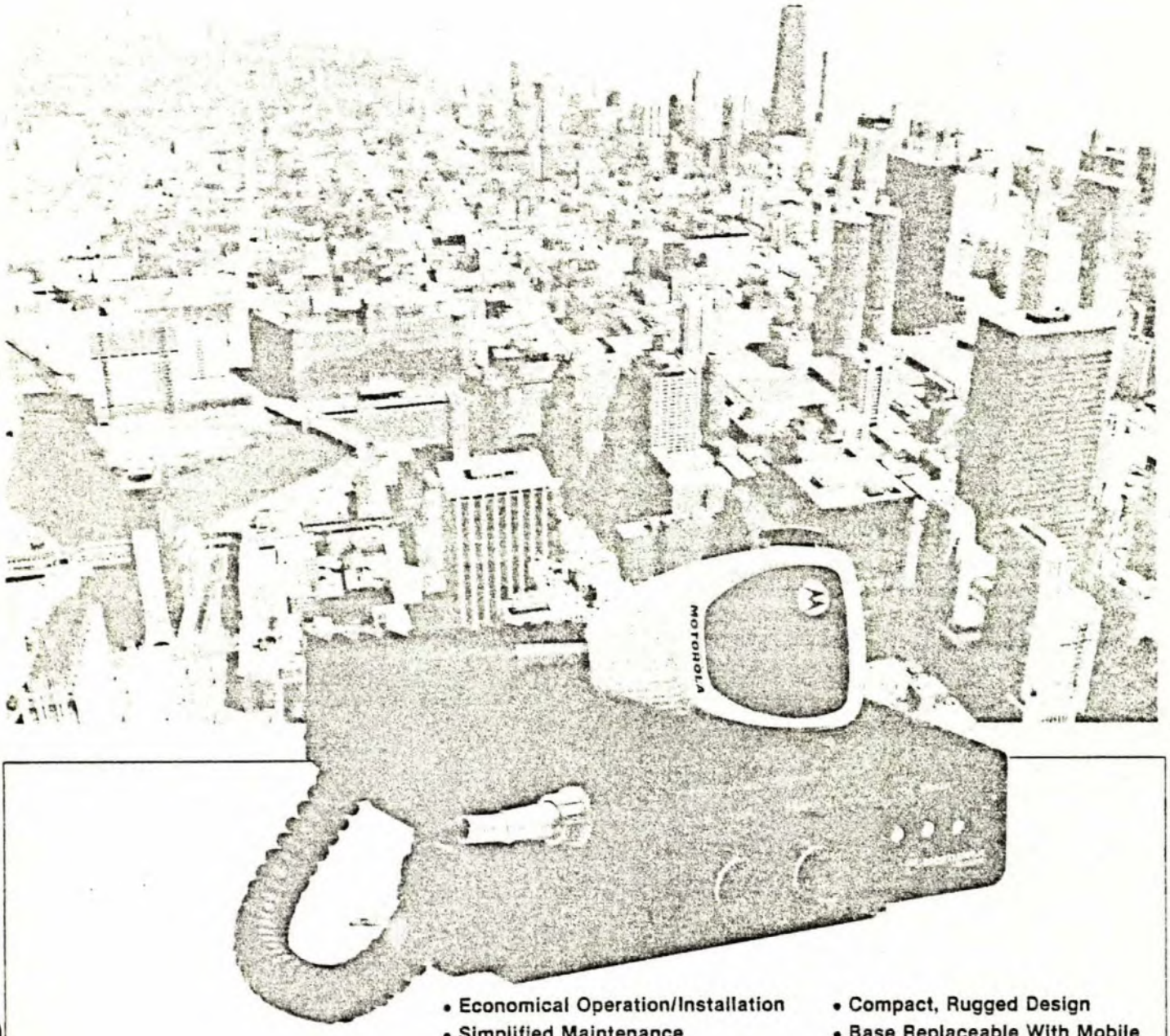
Eq Cat	Sec	Item
R3	1.1	70

MOTOROLA

MAXAR 80 FM Two-Way 800 MHz Mobile/Control Station Radios

10 Watts

Tx = 806-825 MHz
Rx = 851-870 MHz
12V dc/120V ac, 60 Hz



- Economical Operation/Installation
- Simplified Maintenance
- Outstanding Audio Quality
- Solid-State Reliability
- Compact, Rugged Design
- Base Replaceable With Mobile
- Popular Options
- Plug-in MIC

MAXAR 80 FM Mobile/Control Station Radios

Feature	Description	Benefits
Power	MAXAR 80 provides 10 watts of power in 800 MHz operation.	10 watts of power provides effective and dependable radio coverage over a large geographic area.
All Solid State	Transmitter and receiver are 100% solid state.	MAXAR 80 provides full rated transmit and receive power at turn-on. Cooler operation allows longer component life, resulting in minimum maintenance required.
Audio Output	MAXAR 80 radio has 3 watts of audio output. One and two frequency radios come standard with an internal speaker and a special acoustically designed grill.	Designed to receive messages loud and clear.
Reverse Burst	Standard on MAXAR 80 radios equipped with PRIVATE-LINE squelch.	Eliminates usual annoying noises heard on receiving end when push-to-talk button is released.
Variable Squelch	Exterior radio knobs for adjusting radio squelch.	Operator can set radio to achieve optimum operation under various environmental conditions.
Polarity Protection	Provides protection against equipment burn-out.	If radio is connected to wrong polarity during installation in a negative ground vehicle, it is protected against damage.
Rugged Styling	One piece, strong, molded Cycolac ABS radio housing has safety rounded edges. The MAXAR 80 radio color is Shadow Plum.	Lightweight, durable housing assures low maintenance.
Size	Lightweight, compact, under 165 cubic inches.	Fits easily in most locations.

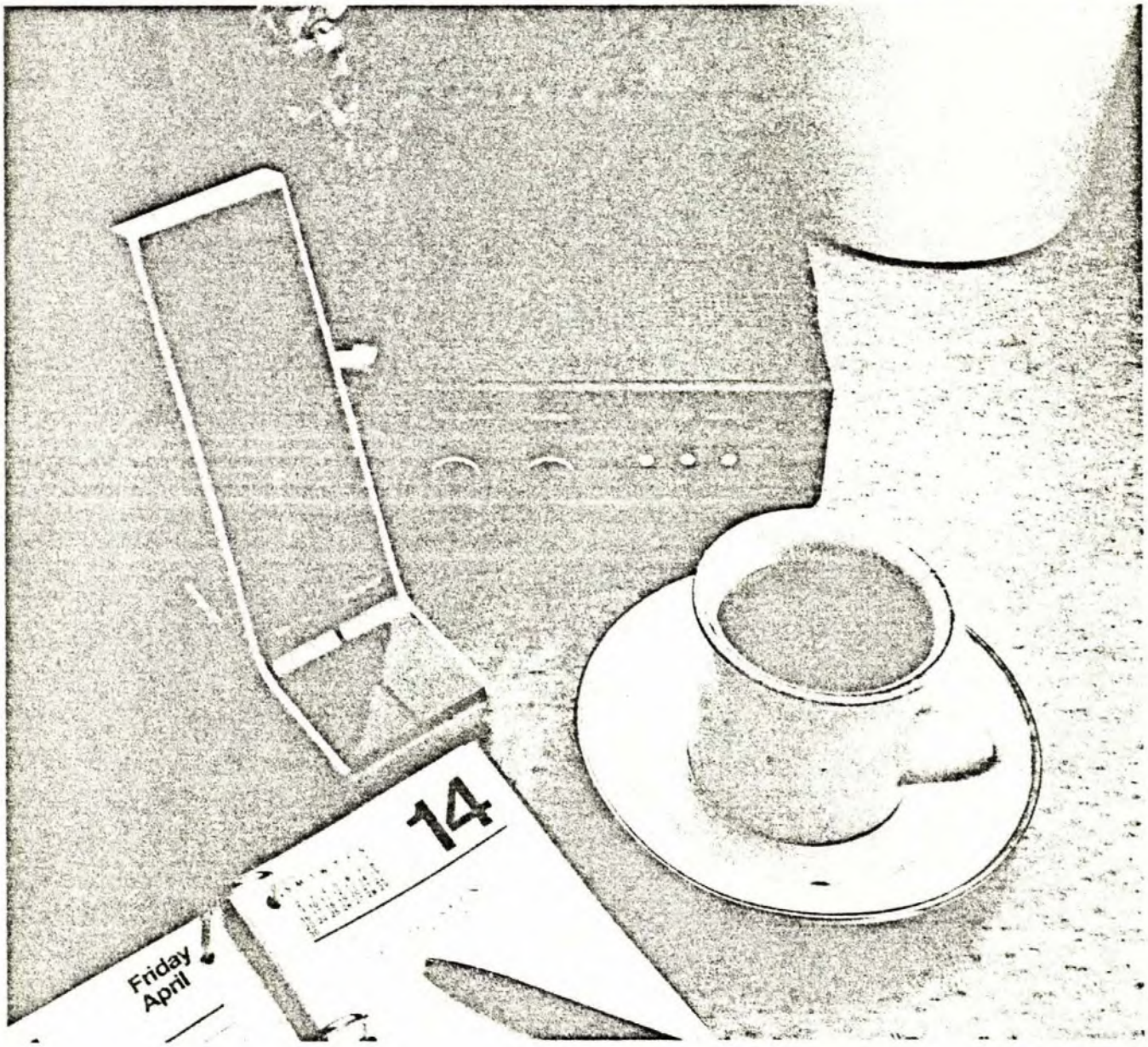
Feature	Description	Benefits
Back-Lit Graphics	MAXAR 80 has simplified non-glare graphics.	Easier control reading, day or night.
Key Lock Mount	Mounting tray with trunnion is permanently installed in vehicle.	Trunnion can be locked in place for increased security.
Control Station	Addition of power supply and desk microphone provides control station capability.	Modern styling and compact size allow use almost anywhere.
Mobile to Base Flexibility	MAXAR 80 mobile radio can also serve as a control station while station is being serviced.	Allows communications system to stay in operation at all times.
Two Channel Capability	A choice of one or two frequency operation is available.	Allows added versatility and more capacity for MAXAR 80 radio systems.
PRIVATE-LINE Squelch	Squelch circuit hears only those calls with a particular tone code.	Minimizes annoying message reception from other radio users on same channel. Circuit accepts only those signals with the proper tone code.
Digital PRIVATE-LINE Coded Squelch	Completely solid state, utilizes large scale integrated circuitry.	When a message is finished, receivers are muted until another unit in the same system originates a message. Eighty new and unique system codes assure system longevity.
Multiple Digital PRIVATE-LINE Squelch	Provides up to 4 codes to use with existing DIGITAL PRIVATE-LINE radios.	For accessing multiple repeaters or contacting selected groups within a large fleet.
Time-Out-Timer	Automatically shuts off transmitter after a one minute interval.	Prevents lock-up of a repeater, or tie-up of a channel, by prolonged keying of the transmitter. Emits an alert tone and shuts off the transmitter after the transmission exceeds 60 seconds. Resets transmitter instantly after the microphone button has been released.

Feature	Description	Benefits
Public Address	Used with mobile mic. Up to four 6 watt external speaker amplifiers can be used per radio installation. Operates from push-type external switch.	Provides a low cost, dependable PA system for making internal or external announcements from a vehicle.
QUIK CALL II Selective Signaling	Allows MAXAR 80 radio to be used as a special paging receiver using alerting tones, horn or light signals until call is acknowledged when driver is recalled to vehicle for the message.	Dispatchers can call an individual unit, special group or an entire fleet with only one radio transmission.
External Speaker	External speakers in 3 or 6 watts are available in Shadow Plum to match MAXAR 80 radio's color.	Provides ability to add louder audio capability in high noise level areas by positioning speaker closer to listener.
Inverted Escutcheon	Available for mounting MAXAR 80 radio in positions where a standard escutcheon might be difficult to read.	Provides greater ease of readibility for users.
Quick Disconnect Slide Mount	High quality, 16 ga. steel construction and 3-way spring form base tray and adjustable mount. Push button release disconnects radio cable connections from mount.	Enables operator to quickly remove radio when leaving the vehicle.
Handset with Hang-Up Box	Push-to-talk button is conveniently located on cradle for easy one hand operation. Dynamic element and transistorized pre-amplifier strengthen voice signal for improved clarity.	Provides the convenience of a telephone-type handset for crisp and clear communications, especially in high noise level areas.
Noise Canceling Microphone	The noise canceling microphone eliminates feedback and prevents outside noise from being transmitted.	Provides clear transmissions especially in high noise environments.

Quick Disconnect Slide Mount

Noise Canceling Microphone

Feature	Description	Benefits
Connections	All input and out connections, including AC power and antenna, are at the rear of the unit.	Connections are made without need for removing the housing. Servicing can be performed without disturbing the connections.
Metering	Full metering socket capability.	Simplifies tuning.
Single Board Construction	Compact construction means simplified servicing and maintenance.	Reduces maintenance time, labor and costs.



MAXAR 80 FM MOBILE/Control Station Radio

Performance Specifications

General

Model (Series)	Frequency	Minimum RF Power Output	Dimensions			Primary Input Voltage (3)	Weight(1)	Maximum Primary Power Input	
			H	W	L			Receive(2)	Transmit
D25TSA Mobile L35TSB Control	Tx = 806-825 MHz Rx = 851-870 MHz	10 watts	2⅜" (59 mm)	6½" (165 mm)	10½" (267 mm)	13.8V dc Neg. Grnd.	6.0 lbs. (2700g)	0.3A	5.0A
						120V ac 60 Hz	18 lbs. (8100g)	12W	95W

No. of Frequencies:	One or two frequency models.
Squelch Options:	PRIVATE-LINE tone coded squelch; DIGITAL PRIVATE-LINE coded squelch.
Maximum Power Supply Dimensions:	5¼"H x 5"W x 14"L (134 x 127 x 356 mm).
External Metering Socket:	A single scale 0-50 microampere meter or Motorola portable test set can be used to measure all circuits essential to tuning and checking.

Transmitter

Model Mobile/Control:	D25TSA/L35TSB
Spurious and Harmonic Emissions More Than:	−56 dB
Frequency Stability:	±.00025% from −30° to +60°C ambient (+25°C Reference)
Max. Frequency Separation:	2 MHz
Audio Distortion:	Less than 3% @ 1000 Hz ±3.0 kHz deviation
FM Noise:	55 dB below ±3.0 kHz deviation @ 1000 Hz
Output Impedance:	50 Ohms
Modulation:	15F2, 16F3, 16F9: ±5 kHz for 100% @ 1000 Hz

FCC Designation:

For FCC rules Parts 89, 91 and 93	
1 Frequency:	CC5015
2 Frequency:	CC5016

Notes: (1) Control models include weight of power supply
(2) Receiver squelched
(3) 120/220/240V ac, 50/60 Hz power supply is available upon request

Receiver

Model Mobile/Control:	D25TSA/L35TSB
Channel Spacing:	25 kHz
Sensitivity (20 dB Quieting):	0.4μV
(EIA Sinad):	0.3μV
Intermodulation (EIA Sinad):	−70 dB
Selectivity (EIA Sinad):	−70 dB
Spurious and Image Rejection:	−80 dB
Audio Output:	3 watts at less than 5% distortion
Frequency Stability:	±.00025% from −30° to +60°C ambient (+25°C Reference)
Max. Frequency Separation:	2.0 MHz
EIA Modulation Acceptance:	±7.0 kHz
Squelch Sensitivity:	.2μV (all squelch types)
Input Impedance:	50 Ohms

FCC Designation:

1 Frequency:	RC0283
2 Frequency:	RC0284

MOTOROLA
Communications and Electronics Inc.

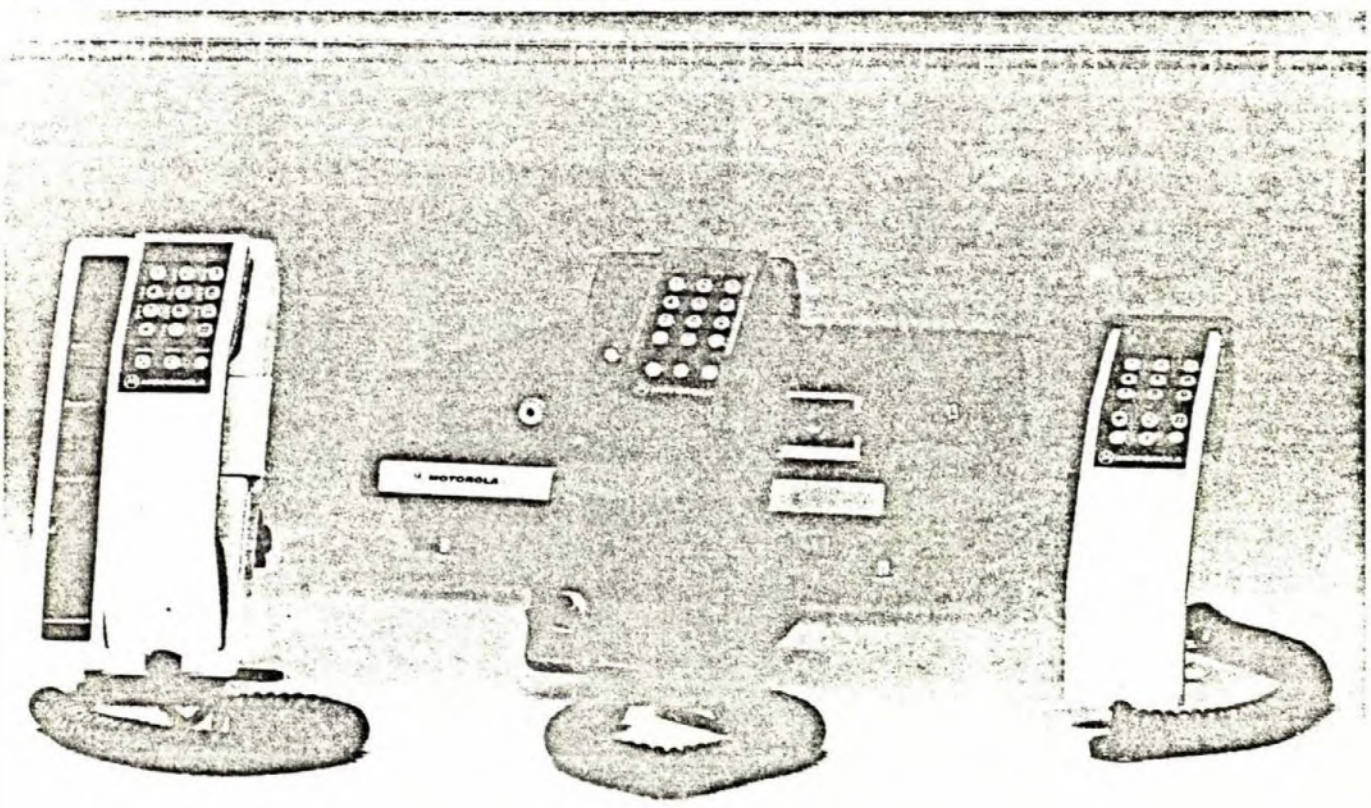
A Subsidiary of Motorola, Inc.
1301 East Algonquin Rd., Schaumburg, Illinois 60196
(312) 397-1000

Eq. Cat.	Sec.	Item
R0	1	62

MOTOROLA

EMX Advanced Mobile Telephone System

406-520 MHz
825-890 MHz



The control heads and radio pictured above are representative of Motorola mobile telephone systems.

The EMX Advanced Mobile Telephone System is a state-of-the-art, microprocessor-controlled, fully duplex car telephone system. It is compatible with major car telephone signalling systems accepted worldwide and fits small as well as large system applications. Employing state-of-the-art, modular construction, the EMX Advanced Mobile Telephone System has the following features:

- Microprocessor-controlled Duplex Radio
- Push Button Dialing
- LED Dialed Number Display
- Telephone Number Memory
- Repertory Dialing
- Extensive Synthesized Channel Capability
- Compander Speech System Processing
- On Hook Dialing

EMX Advanced Mobile Telephone System

Performance Specifications

General

Speech Operation:	Fully Duplex	
Switching:	Fully Automatic Dialing	
Service Area:	Small (UHF) to Large Metropolitan (UHF/800 MHz)	
Hand Off of Call in Progress:	Automatic	
Number of Subscribers Per Service Area:	22,000 Max. (UHF)/200,000 Max. (800 MHz)	
Radio System:	**UHF**	**800MHz**
Frequency:	406-520 MHz	825-890 MHz
Channels:	180 Max.	666 Max.
Modulation:	Narrow Band FM	Wide Band FM
Channel Spacing:	25 KHz	25/30 KHz
Transmitter Power:	15/25 Watts	5 Watts
Signalling:	Digital 1200 Baud	Digital 1200/10K Baud

MOTOROLA

Communications International Division

1301 E. Algonquin Road
Schaumburg, Illinois 60196 U.S.A.

Major facilities in Australia • Canada • Germany • Malaysia • Mexico • Puerto Rico • United Kingdom • And other countries.

R0-01-62

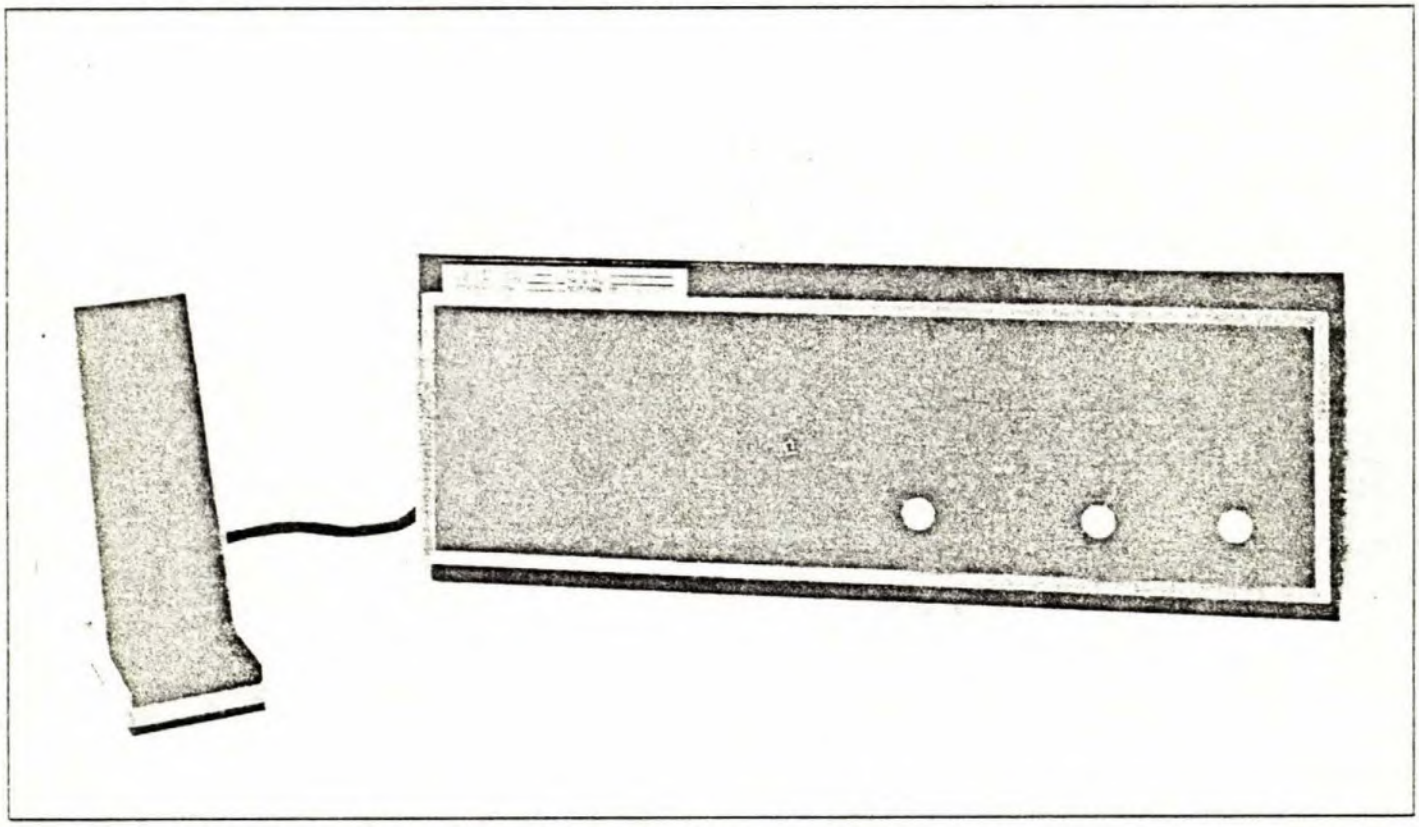
Eq. Cat.	Sec.	Item
R3	8.6	07

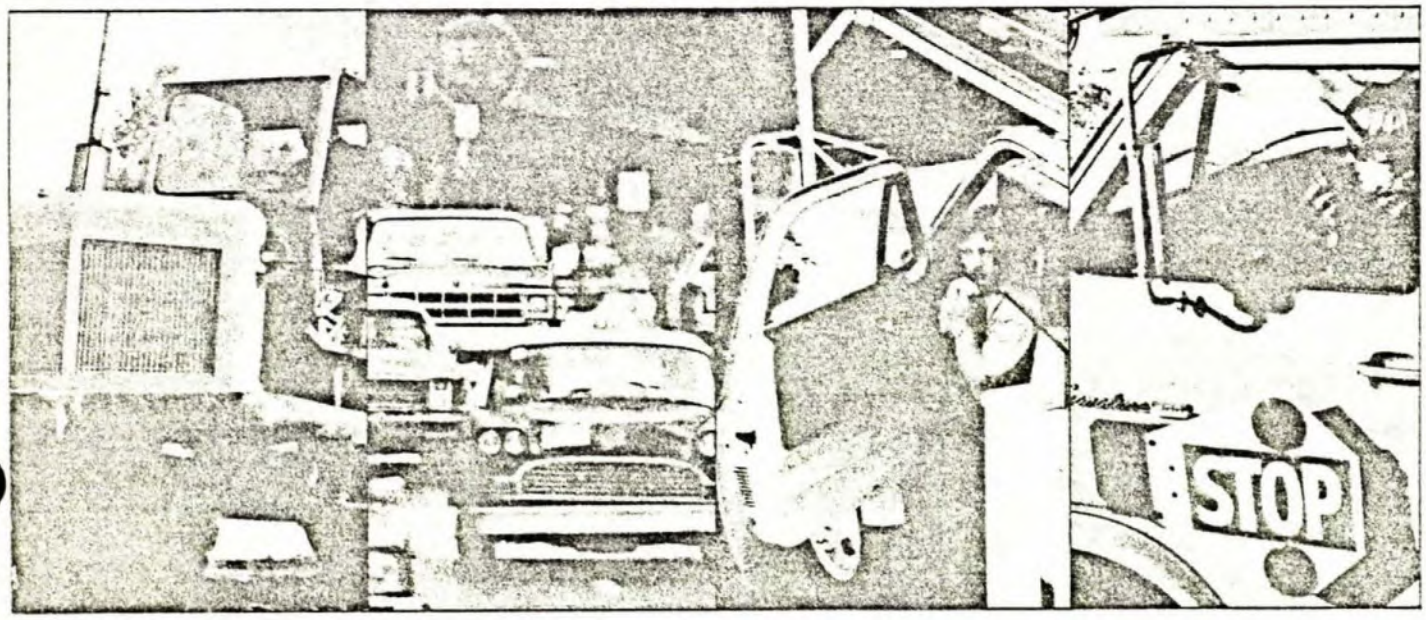
MOTOROLA

MOTOROLA
Technical communications supplier to the United States Olympic Committee

Trunked SYNTOR X
FM Radio Control Station

806-870 MHz
10 Watts





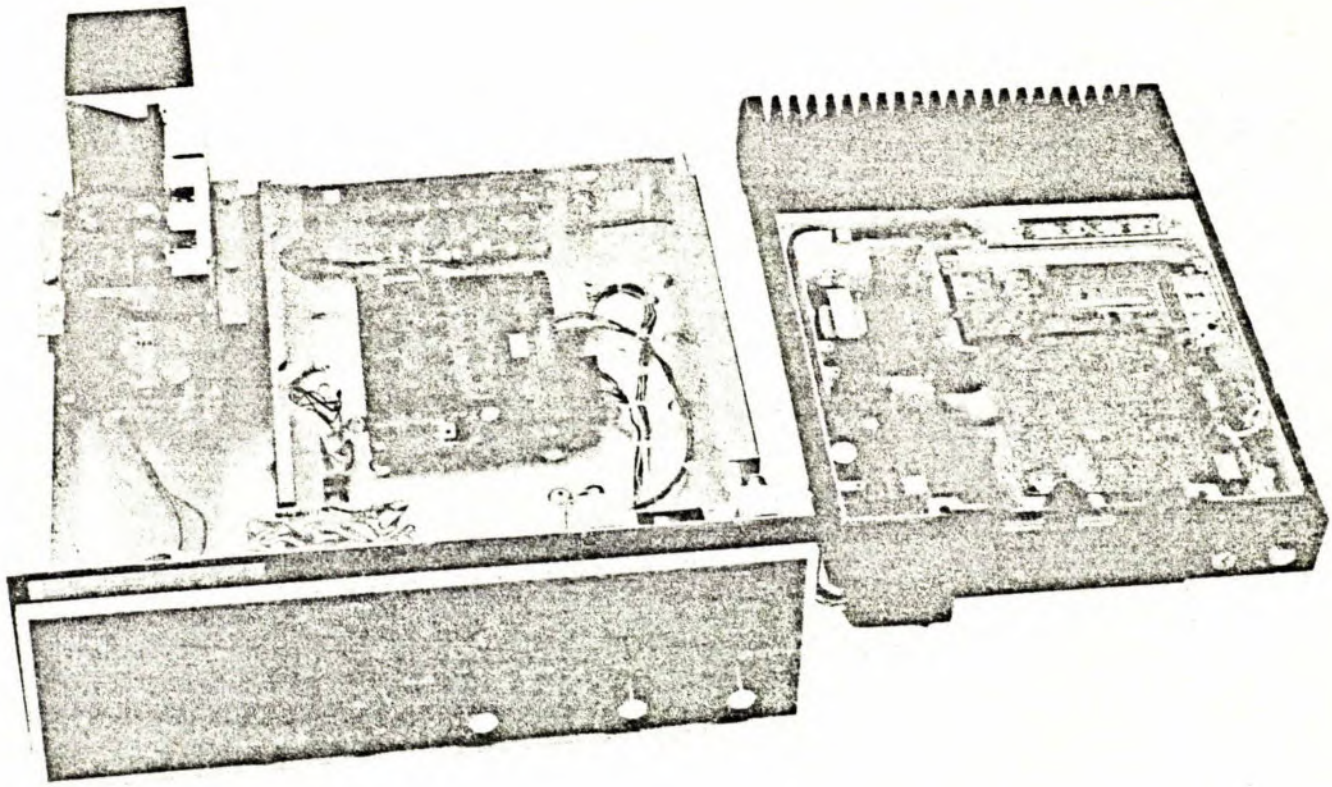
Trunked SYNTOR X FM Radio Control Station

Feature	Description	Benefits
Trunked System Operation	The Trunked Syntor X control station contains all the logic circuitry required to integrate this high performance radio into a fully automatic channel sharing trunked system.	Motorola's Trunked Systems result in simplified user operation through the elimination of frequency selection, squelch controls, and monitoring requirements. They provide privacy from other system users, and up to 20 channel operation.
20 Channel Operation	The Trunked Syntor X control station comes fully equipped with up to 20 channel operation.	20 channels expand communications capabilities by providing substantially more channels to handle call requests.
Fast-Lok Synthesizer	Specific RF Frequencies are created electronically rather than by individual crystals or channel elements. The synthesizer spans the entire 800 MHz spectrum.	No channel elements are required. Synthesizer operation eliminates the need to return the control station for servicing to implement additional channels when the system grows in its number of frequencies. The control station will respond automatically to system frequency growth.
Premium Performance Specifications	The Trunked Syntor X control station features less than 2% audio distortion with spurs and harmonics at —85 dB, and .0002 frequency stability at —30°C to +60°C.	Transmissions will be sharp and clear with a minimum of transmitter generated noise. Transmissions will remain on frequency regardless of extreme temperature conditions.
Receiver Excellence	The Trunked Syntor X control station receiver features —80 dB intermodulation protection, —80 dB selectivity at the first adjacent channel, and a built-in preamp providing sensitivity of .25 μv (EIA SINAD).	Provides a clear signal in high RF density areas. Adjacent channel interference is minimized. Receives even extremely weak transmissions for improved distance coverage.
Solid State	The Trunked Syntor X control station's transmitter, receiver, synthesizer, power supply and microprocessor control system are 100% solid state.	Solid state components provide greater reliability and equipment durability.
Operational Flexibility	Available in local and extended control configurations.	You can choose the configuration that best suits your dispatching needs.

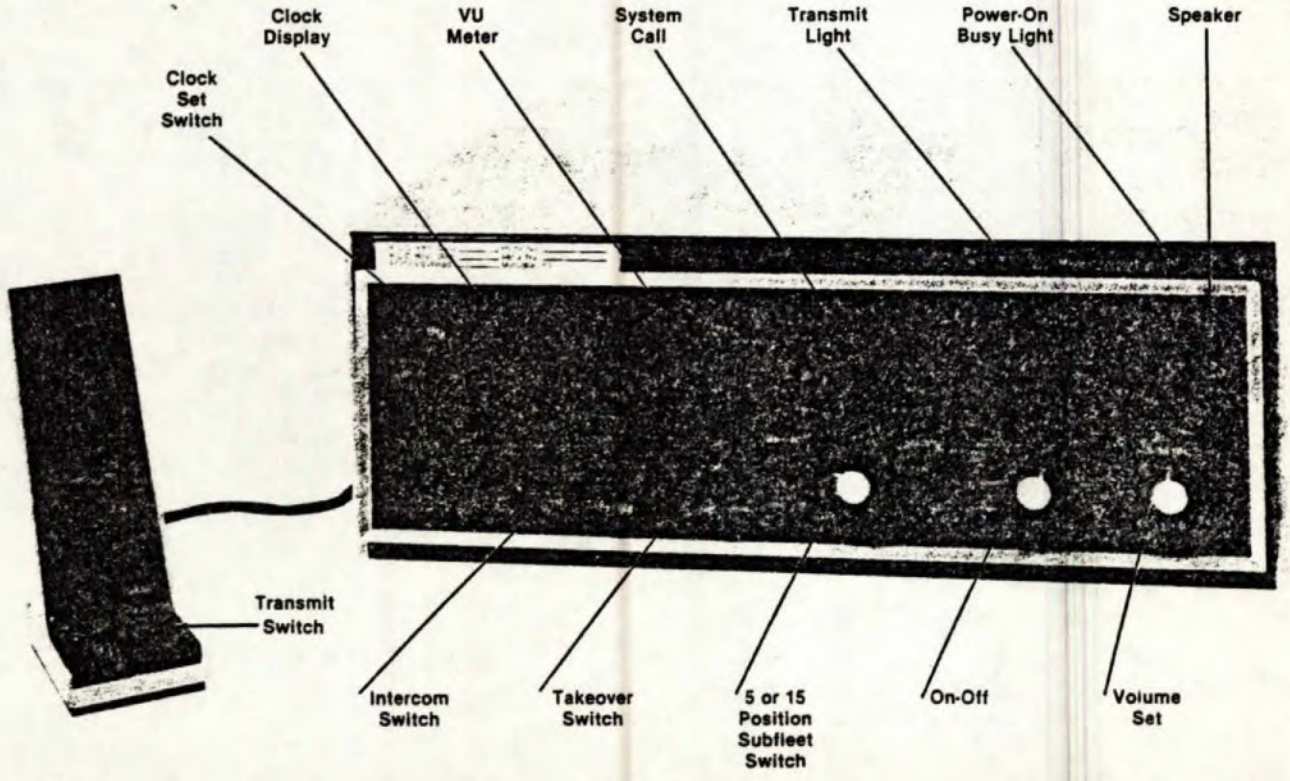
Local Control—for desktop installation, contains all control functions on the front panel. Matching desk microphone is provided.

Extended Local Control—use the standard desk microphone for local control or use the optional Series 80 Local Desk Set for extended local control to serve as radio "dispatch points" up to 100 cable feet from the control station.

Feature	Description	Benefits
Connections	All input and output connections, including AC power and antenna, are at the rear of the unit.	Servicing can be performed without disturbing the connectors.
Modular	The radio module can be lifted out of the station chassis for servicing while still connected.	Provides the technician with complete access to the unit while it is in operating condition.
Front Panel	The front panel can be pivoted down.	Provides access to all the local controls.
Metering	Full metering socket capability.	Simplifies tuning.
Service Intercom	Service intercom is available on an optional basis.	Provides communications between the station and its control point.

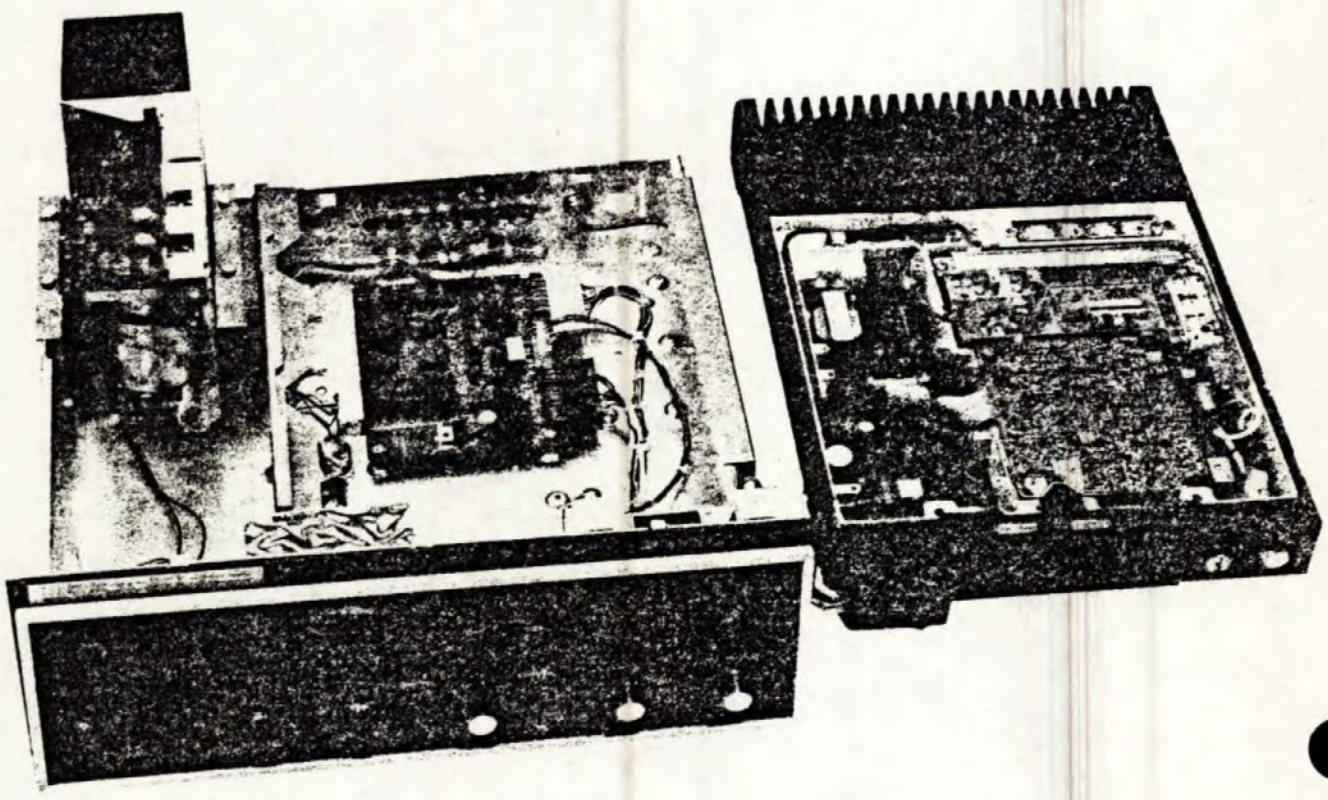


Feature	Description	Benefits
Code Plug Flexibility	The Trunked Syntor X control station fleet and subfleet configurations are contained in a code plug mounted in the Trunking Control Logic module.	This makes it possible to reassign a control station to a different fleet or subfleet by simple replacement of the code plug. No additional tuning or adjustment is required.
Time-Out Timer	Automatically shuts off the transmitter after a pre-determined period of time.	Prevents lock-up of a repeater, or the tie-up of a channel by the inadvertent or prolonged keying of the transmitter. Emits an audible tone in advance of shutting down the transmitter after the transmission has exceeded a preset time.
Busy Indication	Provided standard on all Trunked Syntor X control stations. Gives a visual indication that no voice channels are presently available. A flashing green on/off light indicates this condition.	Activation of this light alerts the operator that his call request has been placed in an ordered waiting line (queue) and he will automatically be called back once a channel becomes available.
Compact Stylish Design	The Trunked Syntor X control station is small, lightweight, and contemporary in its styling.	Makes it a welcome addition to the decor of any office. Can easily be installed on a desk, tabletop, or shelf.



Feature	Description	Benefits
ubfleet Selector	Choice of two subfleet selector options. One is a six-position selector which provides one fleet-call position and up to 5 subfleet positions. The second option is a 16 position selector switch which offers one fleet call position and up to 15 subfleets.	Provides maximum flexibility to structure and organize a customer's operation within a fleet and numerous subfleets for added segmentation.
System Call	A panel mounted switch allows the control station to transmit a message to virtually every unit of every fleet in its Trunked System. This option is reserved exclusively for the Trunked System owner.	Provides the system owner's dispatcher a means of disseminating urgent, important information to all users in the Trunked System.
Control Point and Intercom Kit	Provides the control point supervisory switch and intercom required by the FCC, between dispatch points and the Trunked control station.	The intercom option provides a convenient method of communications to additional dispatch points.
nel Mounted Operational cessories	Twelve or 24-hour digital clock with light emitting diode (LED) readouts, aids with station or message log; stylish adaptation to any office. VU meter provides instant identification of microphone audio levels, helps dispatcher maintain proper speaker distance.	These convenience options help the dispatcher optimize the efficiency of the system.
00/220/240 AC	The Trunked Syntor X control station can be operated from any of these additional power sources.	Ideal for applications where primary sources of AC power may vary.
DC Only Operation	Operates from 12V dc battery source, only.	Provides a cost-effective alternative when AC power is not available.

Feature	Description	Benefits
Connections	All input and output connections, including AC power and antenna, are at the rear of the unit.	Servicing can be performed without disturbing the connectors.
Modular	The radio module can be lifted out of the station chassis for servicing while still connected.	Provides the technician with complete access to the unit while it is in operating condition.
Front Panel	The front panel can be pivoted down.	Provides access to all the local controls.
Metering	Full metering socket capability.	Simplifies tuning.
Service Intercom	Service intercom is available on an optional basis.	Provides communications between the station and its control point.



Trunked SYNTOR X FM Radio Control Station

Performance Specifications

General

Model No.	Frequency MHz	Maximum RF Output Power	Input Voltage	AC Current Drain (@ 121V, 60 Hz)		DC Current Drain @ 13.6V	
				Standby	Transmit	Standby	Transmit
L35VBB5174AM	806-870	10W	120V ac @ 60 Hz (100/220/240V ac Opt.) (12V dc Opt.)	.25A	2A	1.2A	7A

No. of Frequencies:	Twenty.
Dimensions:	6⅞" high x 16¾" wide x 22¼" long. (175 x 425 x 565 mm)
Weight:	Approximately 53 lbs. (24 kg.) Shipping weight, including accessories: approx. 57 lbs. (28 kg.).

Transmitter 806-825 MHz

RF Power Output:	10 W Var to 3 W
Output Impedance:	50 ohms
Spurious and Harmonic Emissions:	—85 dB
Frequency Stability:	±.0002% from —30°C to +60°C ambient +25°C ref. ±15% primary voltage variation
Maximum Frequency Separation:	19 MHz
Modulation:	15F2 and 16F3: ±5 kHz for 100% @ 1000 Hz
Audio Sensitivity:	0.080 V ±3 dB for 60% max. deviation @ 1000 Hz
FM Noise EIA Method:	Companion Rcvr. Response —60 dB RS152B Response —50 dB
Audio Response:	+1, —3 dB of 6 dB/octave preemphasis characteristic from 300 to 3000 Hz
Audio Distortion:	Less than 2% @ 1000 Hz, 60% maximum deviation
FCC Designation:	CC5031—licensable under FCC Rules Part 90 for 15F2, 16F3 and 16F9 emission.

Receiver 851-870 MHz

Channel Spacing:	25 kHz
EIA Modulation Acceptance:	±7.5 kHz min.
Selectivity—EIA-SINAD:	±25 kHz: —80 dB ±100 kHz: —90 dB
Frequency Stability:	Within ±.0002% from —30°C to +60°C ambient, +25°C ref. ±15% primary voltage variation
Maximum Frequency Separation:	19 MHz
Input Impedance:	50 ohms
Sensitivity— 20 dB Quieting: EIA SINAD:	 .35 μV .25 μV
Intermodulation— EIA SINAD:	 —80 dB
Spurious & Image Rejection:	—100 dB
Audio Characteristics For Local Speaker Output: Response: Distortion: Hum & Noise:	 5W at (16 Ω) +2, —8 dB of 6 dB/octave deemphasis characteristic from 300 to 3000 Hz Less than 5% at 1000 Hz —50 dB
FCC Designation:	RC0246

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R3-8,6-07

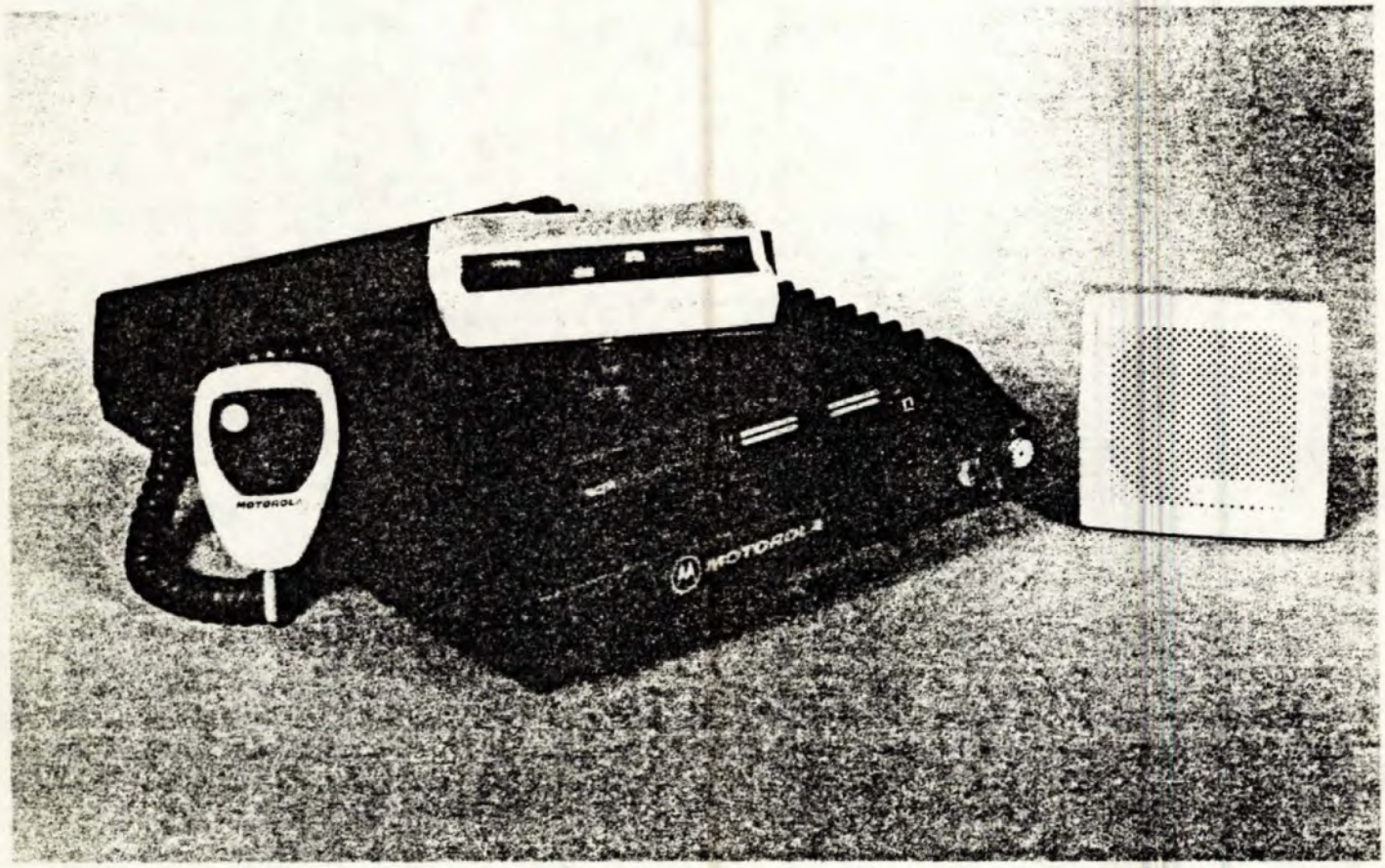
Eq. Cat.	Sec.	Item
R3	1.1	38B

MOTOROLA

MICOR

FM Two-Way Radio

806-821 MHz (Transmitter)
851-866 MHz (Receiver)
15/35 Watts



Features • Benefits

800 MHz MICOR Radio

The "Micor" radio's 15 and 35 watt transmitters feature built in reserve drive and the 35 watt model has a continuous duty rating. • Output power is maintained at the desired level, providing dependable performance in the congestion free 800 MHz band.

100% Solid State with Integrated Circuits — • No tubes to warm up or replace, and no power slump. The use of solid-state components maximizes system reliability, durability, and useful equipment lifetime. All solid-state means dependable, instant-on communications and low power consumption.

SENSITRON Receiver—The MICOR radio's Sensitron receiver provides 75 dB intermodulation protection, 80 dB selectivity, and sensitivity of .5 μV (20 dB quieting). • This gives the receiver the ability to select desired signals from among potentially interfering ones, and to receive even very weak transmissions. Enhanced and expanded communication is the result.

Low-Cost, Convenient System Expansion — • Only one channel element is required for each pair of transmit and receive frequencies. What's more, the five frequency model can be ordered with only those channel elements you need now. Additional plug-in channel elements can be added later as your system expands.

Lifetime Operation Antenna Switch— • Reed switch sealed in glass in a rugged housing provides the utmost in reliability. This switch has been proven capable of 200 million operations without failure.

800 MHz MICOR Mobile Radio

Performance Specifications

General

No. of Frequencies:	One and five frequency models available
Squelch Options:	Carrier Squelch—1000 series models "Private Line" tone-coded squelch—3000 series models "Digital Private-Line" coded squelch—6000 series models
Dimensions:	3⅜" H x 13" W x 17½" L (85 mm x 330 mm x 450 mm)
Weight:	Approx. 25 lbs. (11,4 kg) Ship Wt. approx. 50 lbs. (22,7 kg)
Metering:	A single-scale 0 to 50 microampere meter or Motorola Portable Test Set can be used to measure all circuits essential to tuning and checking.

Freq. (MHz)	Model Series	EIA Intermittent Minimum Rf Power Output	Cont. Duty Power Output	Operation	Max. Batt. Drain** Stdby. @ 13.8V	Rcvr. @ 13.8V	Transmit @ 13.6V
806-821TX/ 851-866RX	T45RTA	35W	30W	12V dc*	.6A	2.7A	13 amps @ 13.6V
	T35RTA	15W	N.A.	12V dc*	.6A	2.7A	5.5 amps @ 13.8V

adio supplied for operation with negative ground vehicles: optional kit available to permit interchangeable positive or negative ground operation.
* Add 0.1 amp for positive ground operation.

Transmitter

RF Power Output:	15/35 watts
Output Impedance:	50 ohms
Frequency Stability:	Chan. ele. maintains osc. stab. within ±.00025% from −30°C to +60°C ambient, +25°C ref. ±15% primary voltage variation
Spurious & Harmonics:	−70 dB / −80 dB
Modulation:	15F2 & 16F3, ±5 kHz for 100% @ 1 kHz
Audio Sensitivity:	0.080V ±3 dB for 60% max. deviation @ 1000 Hz
FM Noise:	55 dB below 60% max. deviation @ 1000 Hz
Audio Response:	+1, −3 dB of a 6 dB per octave pre-emphasis characteristic from 300 to 3000 Hz
Audio Distortion:	Less than 3% @ 1000 Hz, 60% max. deviation
Maximum Frequency Separation:	5 MHz
FCC Designation:	35W CC5010 15W CC5022 Licensable under FCC Rules Parts 89, 91 and 93 for 15F2, 16F3 emissions

Receiver

Channel Spacing:	SPLIT CHANNEL 25 kHz
Sensitivity— 20 dB Quieting:	.5 μV
EIA SINAD:	.35 μV
Selectivity: (EIA SINAD)	−80 dB
Intermodulation: (EIA SINAD)	−75 dB
Spurious and Image Rejection:	−100 dB min.
Squelch Sensitivity— Carrier Squelch: (adjustable)	6 dB quieting (.25 μV) or less at threshold
Coded Squelch: (fixed)	6 dB Sinad
EIA Modulation Acceptance:	±8 kHz minimum
Input Impedance:	50 ohms
Audio Output:	10 watts at less than 5% distortion (into an 8 ohm load at 1000 Hz)
Maximum Frequency Separation:	5 MHz
Frequency Stability:	Chan. ele. maintains receiver stab. within ±.0003% from −30°C to +60°C ambient, +25°C ref. ±15% primary voltage variation.

Speaker

Input Impedance:	8 ohms
Dimensions:	5" x 5" x 2½" excluding mounting bracket (127 mm x 127 mm x 63 mm)
Weight:	1½ lbs. (680g)

Control Head

Dimensions: exciuding mounting bracket	6⅞" W x 2" H x 3¾" D (175 mm x 51 mm x 95 mm)
Weight:	1 pound (454g)
Current Drain:	145 mA @ 13.8 V
Safety:	Meets or exceeds Federal Safety Standards FS-201 & SAEJ921

Transistorized Palm Type Microphone

Carrier Squelch Mounting:	Hang-up Brkt Included
"Digital Private-Line" & "Private-Line" Squelch Mounting:	Hang-up Box Included

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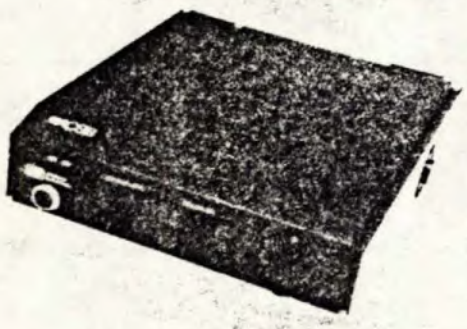
R3-1.1-38B

SIDEBAND TECHNOLOGY

ACSB™ PIONEER 1000 SERIES NARROWBAND MOBILE TWO-WAY RADIO



The STI ACSB™ PIONEER 1000 VHF narrowband mobile two-way radio represents the state-of-the-art in spectrum efficient mobile communications. Using the combination of simple, yet attractive, exterior design, combined with amplitude compandored sideband circuitry, the PIONEER 1000 will provide high quality land mobile communications with a spectrum occupancy of less than 5 kHz per channel.

Designed with advanced communication techniques in mind, the PIONEER 1000 uses single sideband suppressed carrier modulation combined with an Identity Carrier system to provide precision automatic tuning and gain control. A two stage companding system assures optimum performance in signal reproduction and fidelity, resulting in clear, intelligible, noise free communications. High receiver sensitivity is achieved while still maintaining superior selectivity and intermodulation performance. The transmitter operates at a peak envelope power output level of 25 watts.

Designed for "up front" mounting, the PIONEER 1000 provides up to 4 simplex channel operation. User operation is similar to contemporary VHF-FM units operating with 30 kHz channel spacing, the only controls being for volume, squelch and channel selection. Status indication is given by power on, transmit and channel busy indicator lights. No other user controls are necessary.

The unit measures only 9½" W x 2 5/8" H x 11" D and is constructed of rugged, high impact resistant materials to withstand shock and vibration encountered in typical heavy duty commercial and industrial applications. Housing interface points are sealed to prevent dust, dirt and moisture from affecting circuit integrity. High quality glass epoxy circuit boards are mounted on a single unit chassis and are easily accessible for testing and adjustment, or rapid removal for repair when needed. An internal speaker is provided with an external speaker as an option. The audio system is capable of producing a full 10 watt output. The PIONEER 1000 is powered from a standard 12 volt negative ground supply.

Features

- STATE-OF-THE-ART ACSB™ NARROWBAND OPERATION
- TWO-STAGE COMPANDING SYSTEM
- PRECISION "IDENTITY CARRIER" AUTOMATIC TUNING
- RUGGED COMMERCIAL/INDUSTRIAL CONSTRUCTION
- HIGH SENSITIVITY & SELECTIVITY RECEIVER
- 25 WATT PEP RF POWER OUTPUT
- 4 CHANNEL CAPABILITY
- 10 WATT AUDIO OUTPUT
- BUILT-IN SPEAKER

PRELIMINARY DATA

Performance Specifications for the Sideband Technology ACSB™ PIONEER 1000
VHF Narrowband Mobile Radio

GENERAL

Dimensions	9½" W x 2⅝" H x 11" D (241 x 67 x 280 mm)
Weight	5 Lbs. (2.27 kg)
Power Requirements	
Voltage	13.6 VDC + 20% Negative Ground
Current Drain	
Receive (Squelched)	400 ma
Receive (Max Audio Output)	1.5 A
Transmit (Avg. Speech)	3 A
Transmit (Peak)	7 A
Microphone	Heavy Duty Dynamic
Antenna Switching	Solid State - Pin Diode
Power Switching	Solid State
Frequency Range	150-174 MHz
Channels	4 Simplex, 2 Dual Frequency Simplex (Note: 4 dual frequency simplex channels may be accommodated if each of 2 pairs are on adjacent channels)
Squelch	Carrier Squelch Standard Tone Coded Squelch Optional

TRANSMITTER

Power Output	25 Watts PEP (Peak Envelope Power)
Frequency Stability	4 PPM Standard, 2 PPM Optional -30° to + 60° C
Modulation	3A3J with 3 kHz Identity Carrier
Audio Response	+1, -3 db, 300-2500 Hz
Modulation Distortion	Less Than 3%
Spurious/Harmonic Output	60 db Below PEP
Hum and Noise	-40 db
Channel Frequency Spread	2 MHz

RECEIVER

Sensitivity	.3 uv for 10 db S+N/N
Selectivity	60 db @ 5 Kz Channel Spacing 80 db @ 25 kHz Spacing
Intermodulation Distortion	80 db
Spurious/Image Rejection	85 db
Frequency Stability	4 PPM Standard, 2 PPM Optional -30° to +60°C
Audio Power Output	10 Watts @ 5% Distortion
Channel Frequency Spread	2 MHz

Printed in U.S.A.

Due to continual product improvements the above specifications are subject to change without notice

SIDEBAND TECHNOLOGY

SIDEBAND TECHNOLOGY, INC.
3000 WINTON RD. SOUTH, BLDG. E
ROCHESTER, NY 14623
Telephone: 716-244-5500

OKI
advanced
communications

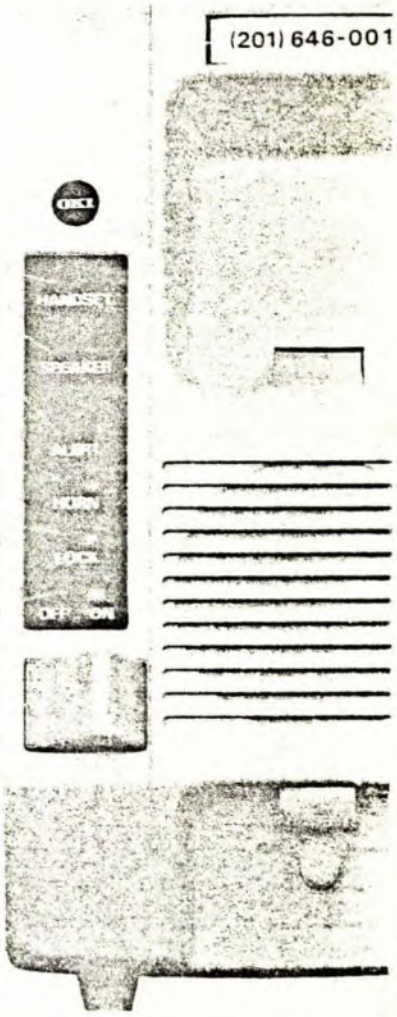
Coming or Going
The Best Phone on the Road

THE DIRECT LINE

OKI MOBILE TELEPHONE FOR CELLULAR SYSTEMS

INNOVATIVE TECHNOLOGY BA(

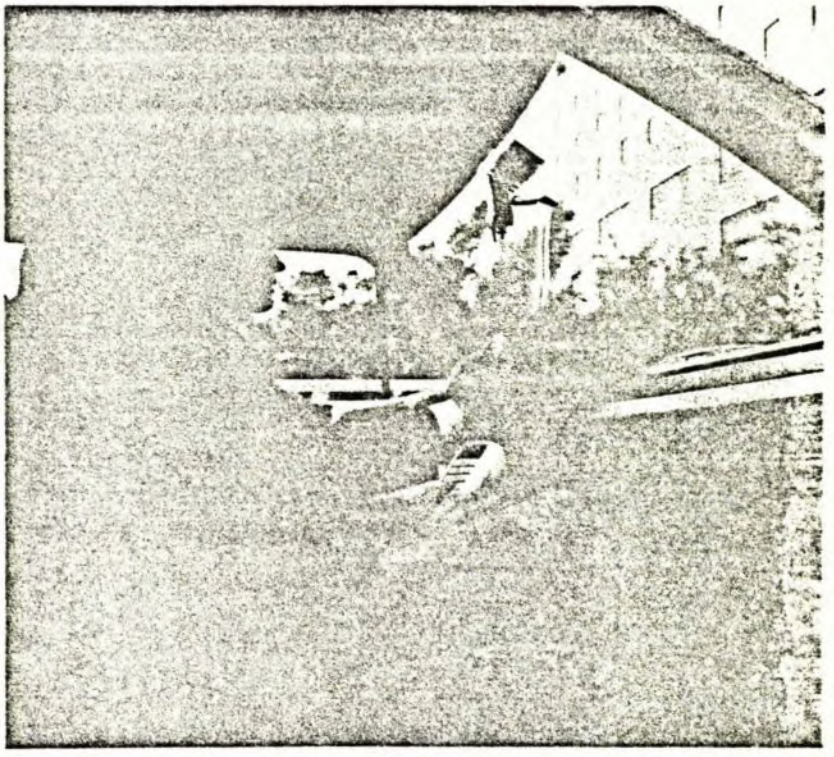
Making connections promptly and conveniently is essential to making it on today's fast track. The Direct Line mobile phone gives users full access to the nationwide telephone network with unsurpassed ease of use. For executives reacting to the fluid business environment, professionals on the move, and key people in any organization, the Direct Line meets your communications needs on the road. As a pioneer in the development of cellular mobile units with vast experience in electronics manufacturing and superior technological resources, Oki has developed a compact, highly reliable mobile telephone. Make connections anywhere. With the Direct Line from Oki.



User-Oriented Features

Emphasizing ease of operation and safety-oriented styling, the Direct Line offers features that make mobile phoning more convenient and reliable than ever before.

Pushbutton Dialing permits fast, easy dialing.
On-Hook Dialing enables calls to be placed or monitored with the handset in the cradle.
LCD Display provides highly visible readout of ten-digit dialed number.
Last Number Recall permits fast redialing.
Repertory Dialing allows user to store and recall any ten frequently dialed numbers (up to sixteen digits per number) for quick dialing.
Horn Alerting signals incoming calls when the user is away from the car.
Electronic Lock with three-digit code prevents unauthorized calls.
Modern Styling of the Direct Line control unit matches the interior of any vehicle.
Compact Size of the Direct Line control unit permits a wide range of mounting locations.



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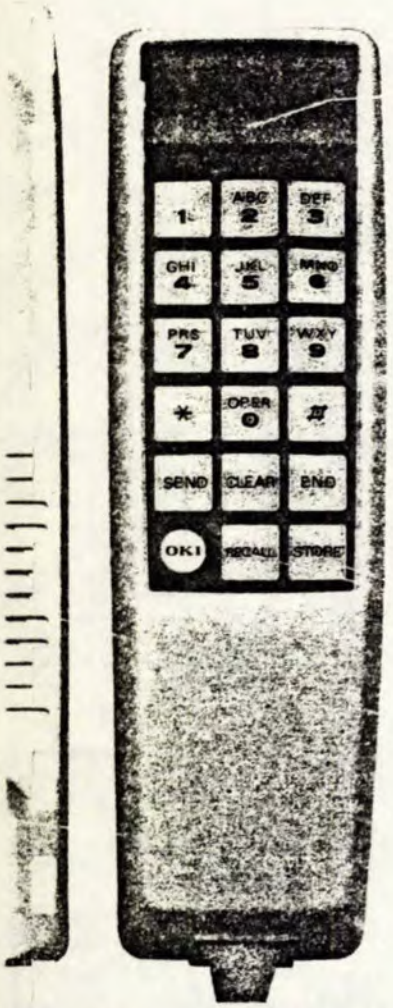
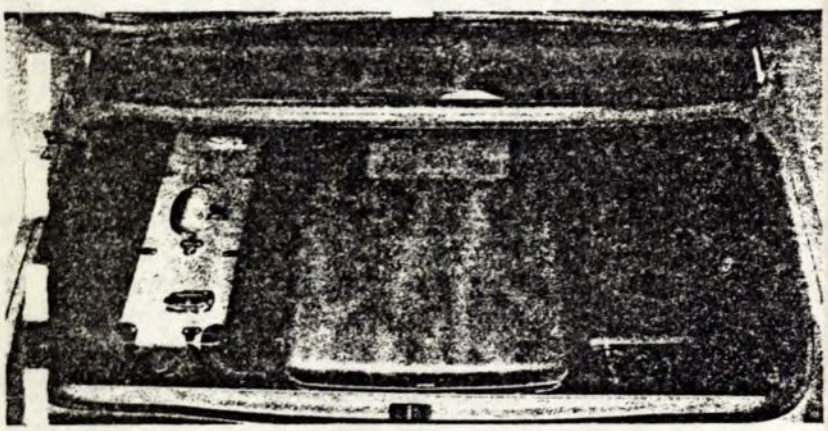
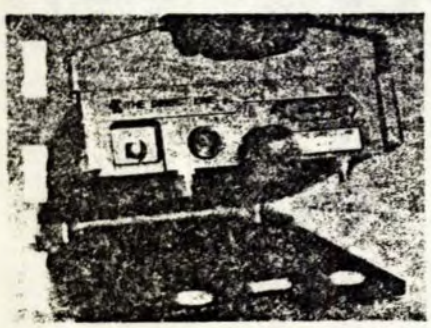


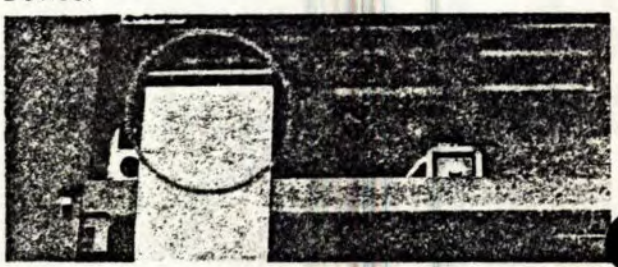




1 Mobile phoning in safety and comfort keynotes the stylish Direct Line.
2 The low-profile transceiver leaves plenty of trunk room for equipment or luggage.
3 The transceiver unit can be easily installed and securely key-locked in one simple operation.

Easy Installation and Maintenance

The transceiver unit of the Direct Line is lightweight and compact, so it occupies only a small space even in the trunk of compact cars. This leaves plenty of space for other equipment or luggage. Installation is accomplished in one easy operation by key-locking the transceiver on the mounting bracket secured to the vehicle's trunk floor.
The Direct Line is configured in easily replaced plug-in modules for prompt, simple maintenance should a malfunction ever occur. All of these modules are linked to a concentrated connector, so servicemen can instantly pinpoint and replace faulty modules by using Oki's Field Diagnostic Device.



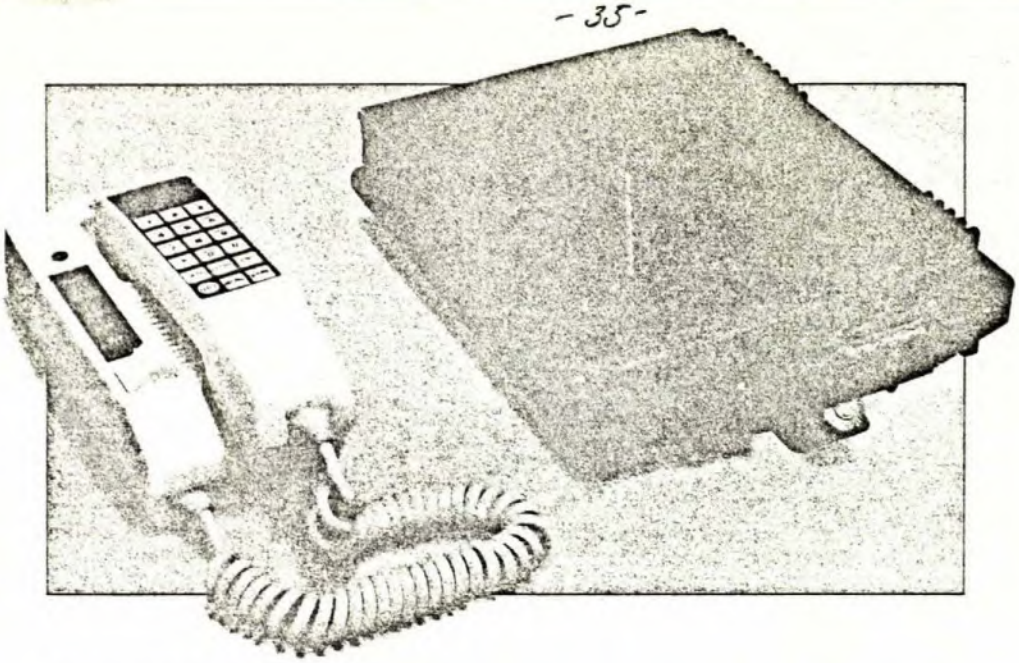
The Field Diagnostic Device plugs into the central connector of the transceiver to immediately trace the cause of any malfunction.

Sound Technology from Oki

One of the world's leading integrated electronics manufacturers, Oki has packed the Direct Line with the latest in technology and more than a century of experience in the telecommunications industry. All components are products of the most stringent reliability tests and quality controls developed anywhere. So the Direct Line provides around-the-clock communications dependability even under severe environmental conditions.

Principal Modules

- 800 MHz band direct synthesizer
- 800 MHz band direct FM modulator
- MIC power amplifier module
- 800 MHz band dielectric duplexer
- Integrated 45/10.7 MHz IF block
- 800 MHz band VCO



Specifications

Type	Cellular mobile telephone unit
Frequency Range	800 MHz band
RF Channels	666 ch, full duplex
T/R Separation	45 MHz
RF Output	3 W (with power control)
Frequency Stability	±2.5 ppm
Receive Sensitivity	−116 dBm (12 dB SINAD)
IF Frequency	1st: 45 MHz, 2nd: 10.7 MHz
Modulation/Demodulation	Voice: FM (with compander) Data: FM
Logic/Control	Stored program system (with microprocessor, RAM and ROM)
Battery Drain at 13.7 V DC	Standby: Approx. 1.8 A with control unit Transmit: Approx. 2.3 A
Operating Temperature Range	−29°F to +140°F (−34°C to +60°C)
Permissible Humidity	Up to 95% RH
Transceiver Dimensions	10.6H × 9.8W × 2.4D in. (27H × 25W × 5.9D cm)
Transceiver Weight	13 lbs (6 kg)

Specifications are subject to change without notice.

This equipment has not yet been approved by the FCC and therefore, is not currently offered for sale or lease.

OKI
Advanced Communications

Division of Oki Electric Overseas Corp.
One University Plaza, Hackensack, New Jersey 07601, U.S.A Tel: (201) 646-0011~0015 TWX 7109905004 OKI ELEC HAK

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Cellular Mobile Telephone Vehicular Equipment

FUJITSU

Introducing the latest in mobile telephone systems: Fujitsu's cellular equipment for vehicles. Comes with various built-in features for user convenience, and built tough for dependable service.

Slim-Line Transceiver Unit

- Fully meets the FCC Cellular System Mobile Station-Land Station Compatibility Specification.
- Capable of withstanding severe environmental conditions. For example, the unit has an operating temperature range of from −35°C to +70°C.
- Compact and ultra reliable thanks to the application of Fujitsu's sophisticated technology, such as a VLSI (very large scale integrated circuit).
- Negligible costs and downtime for maintenance, made possible by modular circuitry with no wiring connections between modules.

Fujitsu's 8 bit microprocessor

Backlit keypad for night operation

State-of-the-art mo communications fi

Choice Of Three Attractive Control Units

Type A **Compact one-piece control unit**

Low-priced, compact model providing the minimum basic functions.

Type B **One-piece control unit**

Full function model with a large, bright digital display.

Type C **Dial-in handset control unit**

Full function model, with major functions concentrated in the handset.

10-digit dialed number display	—	—	○
On-hook origination	○	○	○
Off-hook paging	○	○	—
Last number repeat	○	○	○
Repertory dial	—	—	○
Backlit keypad	—	○	○
Keypad illumination	○	—	—
Electronic lock	○	○	○
Power switch	—	—	○
Horn alert	—	○	○
Transmit audio gain control	—	○	○

(○ means available; — means not available)

***These devices have not been approved by the Federal Communications Commission.**

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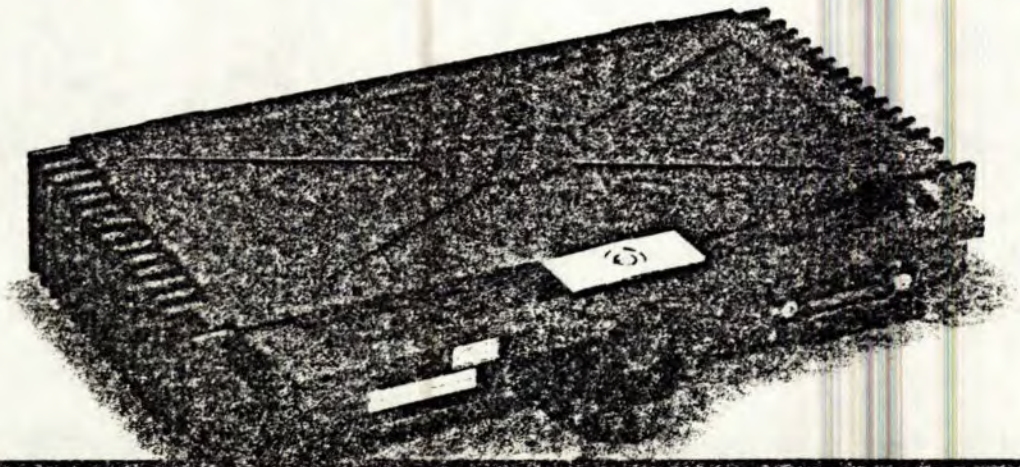

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Cellular 800 MHz Equipment

FUJITSU AMERICA, INC.
Communications Division
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Mgr Radio Communication

FUJITSU LIMITED
Communications and Electronics
6-1, Marunouchi 2-chome, Chiyoda-ku, Tokyo 100, Japan
Phone: National (03) 216-3211 International (Int'l Prefix) 81-3-216-3211 Telex: J22833 Cable: "FUJITSULIMITED TOKYO"

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