

**PUBLICATION TSM 20-311**

**TECHNICAL MANUAL  
20 WATT UHF AMPLIFIER  
FOR MX20U SERIES  
TV TRANSMITTER/TRANSLATOR**

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Cadco M-369 Manual

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## MX Series - 20 Watt UHF AMPLIFIER

### NOTICES, ETC.:

**THIS EQUIPMENT USES STATIC-SENSITIVE CMOS INTEGRATED CIRCUITS.** Observe proper handling precautions (indicated in Maintenance Sections) at all times when working with this equipment.

#### **TOXIC MATERIALS NOTICE... IMPORTANT...**

Effective thermal management in certain semiconductor devices in this equipment is possible only through the use of Beryllium Oxide ceramic materials. This equipment contains devices made with Beryllium Oxide!

*Beryllium and its compounds is a POISON if taken into the body in any manner.*

**To reduce your risk, remember: In case of accidental breakage of any kind of semiconductor device, DO NOT INHALE THE DUST, and AVOID GETTING DUST IN YOUR MOUTH; *it could contain Beryllium.* DO NOT LET BERYLLIUM DUST INTO YOUR BLOODSTREAM THROUGH CUTS OR OPEN WOUNDS!**

*Seek and obtain IMMEDIATE medical attention if the dust enters your body in any manner.*

**Avoid cuts by wearing gloves while picking up the pieces. Wash your hands thoroughly after replacing devices. Dispose of defective devices only through approved toxic waste disposal facilities.**

**Remember too, after cleaning up an accidental breakage, avoid inhaling the dust while replacing or emptying vacuum cleaner filter bags, and wash your hands well after servicing the vacuum cleaner.**

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Trademarks are the property of their respective owners and are mentioned in the text for discussion purposes; any such mention is not necessarily an endorsement of the trademark or its owner. Parts lists may also contain trademarked vendor names as an aid in procurement of spare parts. We apologize for any inadvertent omission of trademark acknowledgement; any such omission was completely accidental.

Although the following pages contain as much information about the 20W UHF Amplifier as it is reasonably possible to provide, nevertheless we must state that these instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with its installation, operation, or maintenance. It is assumed that fully competent technical personnel will be responsible for the maintenance and repair of the equipment that is described in this manual. Should further information be desired, or should particular problems arise which are not covered sufficiently herein for the purchaser's purposes, or should replacement parts be required, the matter should be referred to us.

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## **MX Series - 20 Watt UHF AMPLIFIER**

### **TRANSMITTER SAFETY PRECAUTIONS:**

#### ***AC VOLTAGES USED FOR THE OPERATION OF THIS EQUIPMENT ARE DANGEROUS TO HUMAN LIFE!***

This instruction manual has been written for the general guidance and information of operation, maintenance and service personnel who are aware of, and are familiar with, the hazards of working with high powered electronic circuits.

This manual does not purport to detail all of the safety precautions that should be observed when servicing this or any other electronic equipment. Servicing by inadequately trained or inexperienced personnel may expose such personnel to serious risks that could result in personal injury or death, and/or damage to this equipment. All personnel concerned with the servicing of this equipment should be thoroughly familiar with standard first aid procedures for the treatment of electrical burns and shock.

The equipment has been designed to protect operating personnel from accidental contact with voltages dangerous to human life, either by means of distance (where it is necessary to deliberately reach to make contact with live terminals) or with shielding. It is therefore of prime importance that any protective covering devices are kept in place at all times.

While all practical safety precautions have been adopted to safeguard personnel from possible injury, in times of off-air emergency there is often a strong tendency to act without due regard for normal caution; for this reason, both supervisory and operating personnel are urged to **ENSURE THAT THE SAFETY RULES DETAILED BELOW ARE FOLLOWED AS AN ESTABLISHED ROUTINE** at all times.

#### **1. KILL THE AC POWER BEFORE IT KILLS YOU**

Under no circumstance should any person reach within the cabinets for the purpose of servicing or adjusting the equipment without first disconnecting the AC power, or without the immediate presence of another person capable of rendering aid. Use of the buddy system is encouraged for transmitter work.

#### **2. DO NOT TAMPER WITH INTERLOCKS OR SAFETY SHIELDS**

Under normal circumstances no safety shield should be removed.

#### **3. REMOVE PERSONAL JEWELRY WHEN WORKING ON THE EQUIPMENT**

The 48 volt power supply in this transmitter, although overload protected, is able to deliver currents capable of heating metallic tools or personal jewellery such as a watchband, bracelet, or ring. Accidental short circuits from such metallic objects can cause them to heat sufficiently to result in serious personal injury.

#### **4. KNOW FIRST AID, AND KEEP FIRST AID SUPPLIES AVAILABLE**

Illustrated first aid instructions for the treatment of electrical shock and burns should be displayed in a prominent location adjacent to the equipment. In rendering first aid, the timeliness and effectiveness of the treatment are vitally important to the recovery of the injured person.

Without exception, all personnel should thoroughly familiarize themselves with the procedures involved. One person, whose regular duties place him or her at the transmitter site often, should be delegated and given the complete responsibility and authority to ensure that first aid supplies are kept on site and maintained fresh and up to date.

Prominently display a list of emergency telephone numbers. This list should include the telephone numbers of the nearest ambulance, hospital, doctor, and fire department paramedics; and the public works (highways or county roads) department in case the former persons need access to the site during inclement weather.

## **MX Series - 20 Watt UHF AMPLIFIER**

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### HEALTH WARNINGS:

1. Non-metallic coverings of some coaxial cables used in this equipment are **FLAMMABLE** and may transmit fire when ignited. Other wire coverings are not capable of supporting combustion, but any non-metallic covering when heated sufficiently may emit dense smoke and acid gases which can be highly **TOXIC** and often **CORROSIVE**.
2. Be careful when replacing RF power transistors. Thermal transfer properties in these devices are achievable only by the use of Beryllium Oxide ceramics. We stated it earlier but we will emphatically repeat it again and again, **Beryllium Oxide is a TOXIC substance**. If the ceramic or other encapsulation is opened, crushed, broken or abraded, the Beryllium Oxide dust can be hazardous if taken into the body in any manner. Use caution in replacing these devices.
3. Solvents such as alcohol, ketones, aliphatic or aromatic hydrocarbons, halogenated hydrocarbons, etc. as found in glues, paints, paint thinners, paint removers, and/or cleaning fluids, may emit **TOXIC VAPOURS** and some may be **FLAMMABLE**. Read and understand the directions on their containers, and ensure that they are used only in well-ventilated locations.

### GENERAL SERVICE INFORMATION

#### 1. Parts List Layout - EXPLAINED

Parts lists for manuals are computer-generated out of the LARCAN materials management database. They are presented in hierarchical or family tree order.

The computer is input with the parent parts list number, in this case the amplifier model 40D2238G1 which it designates as level 0. The computer first checks the parent list for major subassemblies, then each subassembly list for more subassemblies, etc., and arranges these lists in order of hierarchy beginning with level 0, then 1, then 2, etc., then prints each in the order in which they were found. In these booklets which together describe the PARTS of the amplifier, we have used the computer's electronic data output to allow us to more easily integrate the relevant parts list with the text.

The line of text immediately above the horizontal line on the first page of each list provides the number and name of the relevant assembly that the list represents.

An "R" followed by a dash and a number indicates revision status. This information is meaningful to our Renewal Parts and/or Customer Service people, and in order that these people can be most helpful, they should be advised of this revision number especially if renewal parts are needed.

#### 2. Interpreting LARCAN Drawing Numbers

Engineering drawings at LARCAN are based on the concept that an assembly or subassembly is simply a GROUP of component parts, thus when a **G** appears on a list, it means an "assembly". Thus a circuit board loaded with parts may be referenced in this manual as "21B1389G1". In this example, G1 is the amplifier used in the IPA2 stage while G2 is the amplifier used in the PA stage. Furthermore, the 'P' in 21B1389P1 indicates that this is a part in itself (a printed circuit board) with no parts in it. In this case this part is called up in 21B1389G1 parts list. The 'S' in 21B1389S indicates that this is a schematic diagram. In some cases the schematic diagram may be a completely different number.

## MX Series - 20 Watt UHF AMPLIFIER

### GENERAL SERVICE INFORMATION

#### 2. Interpreting LARCAN Drawing Numbers (continued).

Other assemblies may be shown as a number of separate assemblies (Parts 1, 2, 3, 4, or 5), on several sheets of a single drawing. The drawing "parts" all are assembled the same way, but vary in quantity and type of components.

For vendor components such as resistors and capacitors, often a generic drawing describing basic specifications, but having many "parts", will be used.

As an example, Drawing 3R152: Resistor, composition, ¼ watt. Drawing 3R152 describes a ¼ W resistor, but the drawing PART number calls for the value and tolerance of the resistor wanted. The first two digits after the "P" are the first two significant figures of the resistance, the third digit is the number of following zeroes in the resistance value, and a J is 5% tolerance, or K is 10% tolerance. Some example part numbers are: 47 Ω, ±10%, ¼W, is "3R152P470K"; and "3R152P243J" specifies 24 kΩ, ±5%, ¼W. For resistance values between 1 Ω and 10 Ω, a letter "R" will appear in the part number to indicate the decimal place; for instance a 5.6 Ω, ±5%, ¼W resistor will be designated as "3R152P5R6J".

Often the letter "R" appears on schematics or in parts lists where it specifies the decimal place when referring to resistances, such as "51R" or "75R" or "5R6", and sometimes the letter "k" will appear in the same context, such as "3k3". This practice is deplored by old-timers in our midst who attended North American tech schools and therefore learned about component values that are specified with the use of decimal notation, but schematics drawn this way are common in other parts of the world. In a parts list, moreover, an R followed by a dash and a number indicates a revision, but you will be able to recognize the difference from the layout framework of the list.

#### 3. The LARCAN Assembly Prefix Numbering System

Because a transmitter is a complex device, a referencing system for unique identification of component parts reduces the chaotic situation that would otherwise result from the natural numbering system found in every parts list, in which the first capacitor is designated C1 and the first resistor is likewise designated R1, but when several assemblies using capacitors or resistors appear together, the entire question then becomes "*which* C1 or R1 are we talking about?"

The LARCAN prefixing system and its "undocumented features" represent a beginning and evolving solution to some of these problems. It begins by assigning a distinct assembly prefix number to each subassembly.

Prefix 2, the amplifier heatsink assembly, has other subassemblies, which are uniquely prefixed such as the metering board, which is prefixed 5. This sub assembly could have a C1, an R1, etc. Identification of each component in full is done by simply adding the prefix number to the component designator, thus 5C1, 5R1, etc.

Prefix designation is great for written communications such as letter or FAX, but when talking about it during a phone conversation, it is probably more natural to simply say "C1 in the preamp board" or "R7 in the output amplifier" than to go through the routine of looking up the prefix number.



## MX Series - 20 Watt UHF AMPLIFIER

### GENERAL SERVICE INFORMATION

#### 4. List of Assembly Prefixes

	Prefix 1	Main Amplifier Chassis Assembly
Sub-assembly	Prefix 2	Heatsink Assembly
“	“	2A1 Front End Module
“	“	2A2 IPA Module
“	“	2A3 PA Module
“	“	5 Metering Board
“	“	7 Directional Coupler
Sub-assembly	Prefix 3	Power Supply (B+)
Sub-assembly	Prefix 4	Control Board
Sub-assembly	Prefix 8	Control Power Supply

#### 5. Production Changes

From time to time, it may become necessary that changes be made in the equipment described in this manual. Such changes are usually made either to provide improved performance, or to accommodate component substitutions necessitated by vendor product availability. A revision letter or number may follow the model or group number marked on the nameplate, chassis, or circuit board; or on the parts list (where it is an "R" followed by a dash and a number). Whenever a revision letter or number appears, it should be quoted in any correspondence or communication regarding the equipment.

## **MX Series - 20 Watt UHF AMPLIFIER**

### **GENERAL DESCRIPTION**

#### **INTRODUCTION**

This manual describes the LARCAN 20 watt UHF amplifier which is designed to operate on channels 14 through 69. This solid state 20 W UHF amplifier was designed to operate conservatively at 20W peak sync visual RF power, and 2W average aural carrier RF power, with superb performance, reliability and operating economy. This amplifier accepts an on-channel internally diplexed (in a 10:1 ratio Vis to Aur) composite driving signal of about 6mW peak visual RF as input to its RF chain.

The 20W amplifier and channel processor chassis' are designed to fit in a single 19" customer-provided cabinet rack, and require 7.0" (4RU) of vertical panel space for a complete transmitter or translator system. Alternatively, a 19" customer-provided tabletop cabinet could be substituted if the site requires it.

The RF amplifier heatsink has its own integral cooling fans, and other sub-assemblies are convection cooled. The simplicity of design, the deployment of all modular and other subassemblies, and the use of standard readily available components, also enhances serviceability.

Peak forward and reflected power are displayed on an analog percent power meter located on the front panel of the amplifier unit.

#### **AMPLIFIER CHAIN**

The internally diplexed composite RF output of the channel processor or exciter is fed to a conservatively designed broadband solid-state Front-End amplifier. This amplifier requires no tuning or adjustment. Simplicity of operation, reduced maintenance costs and increased reliability are a few of the major benefits derived from this amplifier.

The amplifier chain consists of three stages of amplification. These are the Front End, IPA, and PA stages. The first two stages operate in class A and the one in class AB. The overall gain of the system is about 35dB.

The Front-End module acts as a pre-amplifier as well as an RF level control of the RF chain. It accepts control voltages from the AGC and VSWR cutback circuits for maintaining and power cutback purposes respectively. The 20W transmitter uses a single RF chain, consequently quadrature phasing and combining are not needed, however, if the need arises the Front End module also has gain and quadrature phasing controls that can be made available.

The next stage is the IPA module. It is based on the MRF181 transistor. This broadband amplifier delivers about 2W sync peak to the PA module. This amplifier does not require optimizing in the system, which means that it is not frequency dependent at the RF level it is operating.

The PA module operates in class AB and has a gain of about 10dB. Under RF operation the overall bias on the PA module is adjusted to optimize the overall intermodulation products and differential gain.

#### **TRANSMITTER CONTROL**

Interlocking in the 20W simply consists of a jumper as a default connection. The terminals are marked INTRK on 1TB1. Antenna or dummy load interlock can be substituted for this jumper. All control wiring of the transmitter passes through a control circuit board (prefix 4), and facilities can be provided on this board for telemetry, and control connections to and from a remote control system.

A thermostat is provided in the PA heatsink to open the interlock chain and shut down the power supply should an unlikely overheating condition occur.

## MX Series - 20 Watt UHF AMPLIFIER

### GENERAL DESCRIPTION ELECTRICAL AND MECHANICAL SPECIFICATIONS

#### NTSC

Power Output: ..... Visual 20 W peak, Aural 2W  
Diplexing: ..... internal, 10:1 V to A  
Frequency Range: ..... 470-806 MHz (channels 14 thru 69)  
Amplifier Output Impedance: ..... 50  $\Omega$   
Output Connector: ..... type N  
Amplifier Input Impedance: ..... 50  $\Omega$   
Output Regulation: ..... 3% (black-white picture)  
Output Variation: ..... 2% (over 1 frame)  
Amplitude/Frequency Response  
-0.75 MHz to +4.75 MHz (Relative to Visual Carrier) ..... +0.5/-1.0 dB  
Harmonic Radiation: ..... -60 dB  
Spurious Emission (fv-4.5MHz, fv+9.0 MHz) without a Bandpass Filter: ..... -30 dB  
Intermodulation Distortion: ..... -50 dB

### ELECTRICAL AND MECHANICAL SPECIFICATIONS

#### ELECTRICAL

AC Line Input: ..... 120VAC  
Power Consumption, black picture + 10% aural: ..... 340VA (typical)

#### ENVIRONMENTAL

Ambient Temperature: ..... 0°C to +45°C  
Humidity: ..... 0% to 90%  
Altitude: ..... 7500 ft.

#### COOLING

Two 4" muffin fans push air into the heatsink and through the front panel perforations.

#### DIMENSIONS

The amplifier, a standard channel processor chassis' are standard 19" rack wide units;  
Amplifier height is 5.25" (3U); channel processor is 1.75" (1RU); for a TOTAL HEIGHT of 7.0" (4RU).  
Depth is 22" including an allowance for connectors.

The MX20U series amplifier is marketed on the assumption that the customer prefers to provide the cabinet or enclosure for it.

#### SHIPPING WEIGHT

Amplifier only:...Approximately 40 lbs.

## **MX Series - 20 Watt UHF AMPLIFIER**

### **GENERAL DESCRIPTION ABOUT THIS MANUAL**

It will be observed that this manual consists of a collection of separate publications, each one of which describes its own module or section of the equipment. Parts lists, applicable alignment instructions, and illustrations which generally consist of assembly diagrams and schematics are included in each of these booklets, which are identified by a "PUB" number and revision.

These mini-publications represent our attempt to assure quality of our documentation and at the same time maintain the material as current as possible. In the usual large manual or handbook, a change made to a single module might require a sentence or even several paragraphs be added, with the result that all text following the change will shift, consequently requiring renumbering of all pages and subsequent reprinting. These operations create an undesirable delay between the release of the revision to the equipment and the re-issue of its manual, despite our extensive use of computers. It is our hope that this republication delay will be reduced because revisions are nearly always done on one module at a time, and a few pages pertinent to one module are obviously simpler to revise and reprint than the many pages of a handbook.

Each section or module of the equipment is described in its own booklet. For each booklet, the format generally consists of a block diagram where applicable, then the relevant specifications, then the circuits are described, then test/alignment procedures are defined, and then the parts list is presented. Finally, the Figures (illustration drawings in 11" x 17" size) complete the booklet.

The Parts Lists in all booklets have been compiled by, and then extracted from, the LARCAN materials management computer system, and are current as of the date of issue of the booklet.

We have attempted to present our circuit descriptions in such a way that they would be meaningful to the competent technician whose main objective is to look after the equipment. We have therefore minimized the inclusion of material usually found in engineering textbooks, professional papers, and doctoral theses, because much of the information from such sources, although meaningful to the EE, can be too heavy and overdone for the beleaguered technician who is desperately trying to put a transmitter back on the air.

3-ring binders are used for LARCAN manuals as a courtesy to our customers because a 3-ring binder enables assembly drawings and/or equipment schematics to be temporarily extracted and used in a more convenient place when necessary. (Before their joining LARCAN, several of our staff technical people were previously broadcast station engineering technicians, whose custom was to temporarily tape their schematics to the transmitter cabinet doors for convenient reference when working inside the equipment).

Drawings whose numbers begin with 30C, 31C, 40D, 41D, 50E, or 51E may have been reduced in size or even split into several sheets to fit into the booklet's 11" x 17" format. Should any reduced drawings as presented in our manuals be found difficult to read, full size engineering blueprints are available at no charge by simply writing, calling or FAXing our Customer Service department and requesting the referenced drawing and revision wanted.

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## **MX Series - 20 Watt UHF AMPLIFIER**

### **GENERAL DESCRIPTION**

Notes: