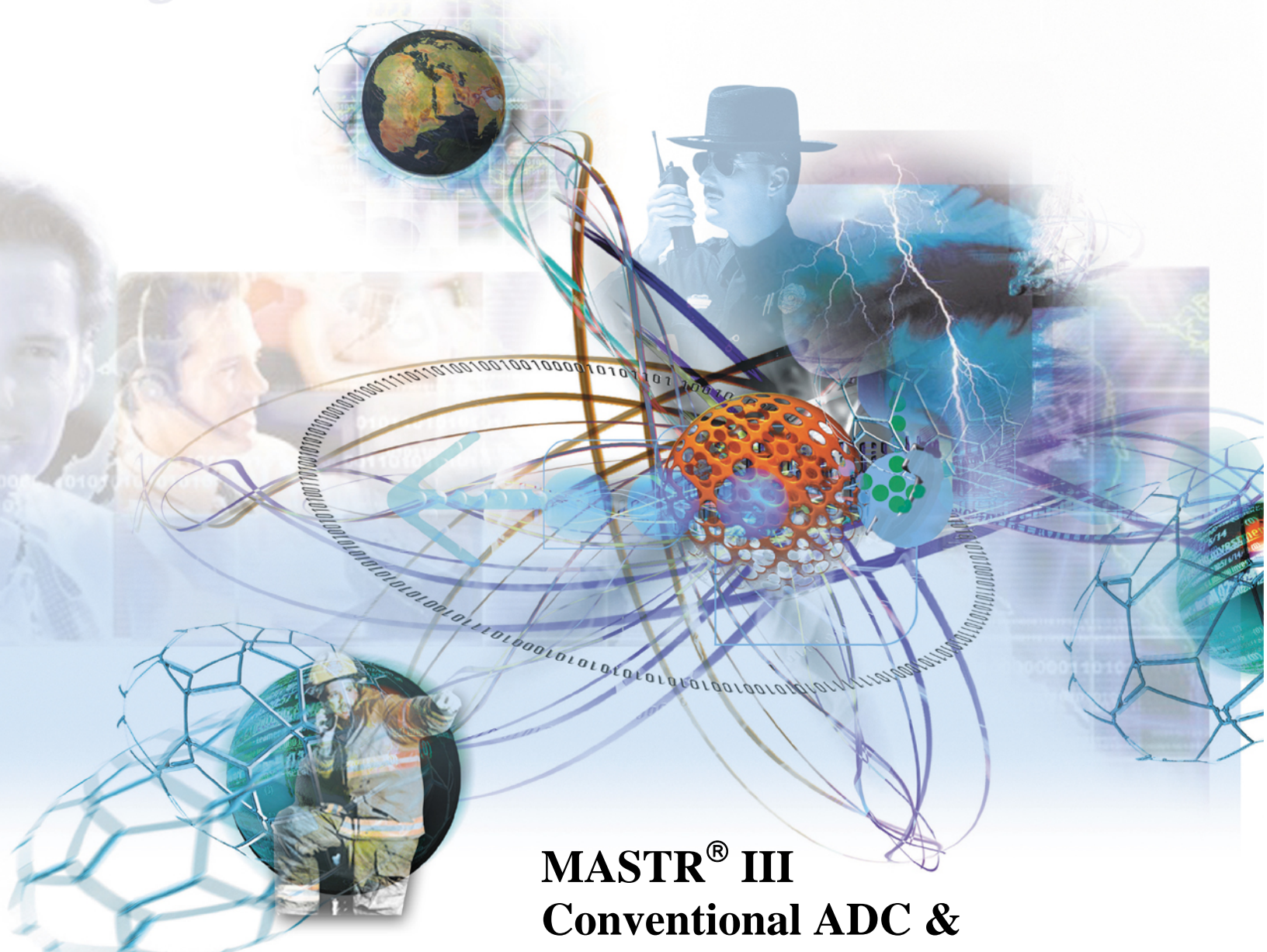


future
The Future of Mobile Radio



**MASTR[®] III
Conventional ADC &
P25 Conventional Base Stations**

MANUAL REVISION HISTORY

REV	DATE	REASON FOR CHANGE
R1A	Jul/06	Initial Release.

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or e-mail us at: techpubs@tycoelectronics.com

ACKNOWLEDGEMENTS

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1 REGULATORY AND SAFETY INFORMATION

1.1 MAXIMUM PERMISSIBLE EXPOSURE LIMITS

DO NOT TRANSMIT with this base station and antenna when persons are within the **MAXIMUM PERMISSIBLE EXPOSURE (MPE) Radius** of the antenna. The MPE Radius is the minimum distance from the antenna axis that **ALL** persons should maintain in order to avoid RF exposure higher than the allowable MPE level set by the FCC.



FAILURE TO OBSERVE THESE LIMITS MAY ALLOW ALL PERSONS WITHIN THE MPE RADIUS TO EXPERIENCE RF RADIATION ABSORPTION, WHICH EXCEEDS THE FCC MAXIMUM PERMISSIBLE EXPOSURE (MPE) LIMIT. IT IS THE RESPONSIBILITY OF THE BASE STATION OPERATOR TO ENSURE THAT THE MAXIMUM PERMISSIBLE EXPOSURE LIMITS ARE OBSERVED AT ALL TIMES DURING BASE STATION TRANSMISSION. THE BASE STATION OPERATOR IS TO ENSURE THAT NO BYSTANDERS ARE WITHIN THE RADIUS LIMITS.

1.2 DETERMINING MPE RADIUS

THE MAXIMUM PERMISSIBLE EXPOSURE RADIUS is unique for each site and is determined during site licensing time based on the complete installation environment (i.e. co-location, antenna type, transmit power level, etc.). Determination of the MPE distance is the responsibility of the installation license. Calculation of the MPE radius is required as part of the site licensing procedure with the FCC.

1.3 SAFETY TRAINING INFORMATION



YOUR M/A-COM MASTR® III BASE STATION GENERATES RF ELECTROMAGNETIC ENERGY DURING TRANSMIT MODE. THIS BASE STATION IS DESIGNED FOR AND CLASSIFIED AS “OCCUPATIONAL USE ONLY” MEANING IT MUST BE USED ONLY IN THE COURSE OF EMPLOYMENT BY INDIVIDUALS AWARE OF THE HAZARDOUS RF ENERGY AND THE WAYS TO MINIMIZE EXPOSURE. THIS BASE STATION IS NOT INTENDED FOR USE BY THE “GENERAL POPULATION” IN AN UNCONTROLLED ENVIRONMENT. IT IS THE RESPONSIBILITY OF THE LICENSEE TO ENSURE THAT THE MAXIMUM PERMISSIBLE EXPOSURE LIMITS ARE OBSERVED AT ALL TIMES DURING TRANSMISSION. THE BASE STATION OPERATOR IS TO ENSURE THAT NO BYSTANDERS COME WITHIN THE RADIUS OF THE LIMITS

When licensed by the FCC, this base station complies with the FCC RF exposure limits when persons are beyond the MPE radius of the antenna. In addition, your M/A-COM base stations installation complies with the following Standards and Guidelines with regard to RF energy and electromagnetic energy levels and evaluation of such levels for exposure to humans:

FCC OET Bulletin 65 Edition 97-01 Supplement C, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

American National Standards Institute (C95.1 – 1992), IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

American National Standards Institute (C95.3 – 1992), IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave.



TO ENSURE THAT YOUR EXPOSURE TO RF ELECTROMAGNETIC ENERGY IS WITHIN THE FCC ALLOWABLE LIMITS FOR OCCUPATIONAL USE, DO NOT OPERATE THE BASE STATION IN A MANNER THAT WOULD CREATE AN MPE DISTANCE IN EXCESS OF THAT ALLOWABLE BY THE FCC.

1.4 REGULATORY APPROVALS

Table 1-1: Regulatory and Standards Approval List

TX Frequency Range (MHz)	Power Output (Adjustable) (W)	FCC ID Number	Applicable FCC Rules (47CFR)	Industry Canada Certification Number	Applicable Industry Canada Rules	CE MARK
136-174	10-110	OWDTR-0032-E	22, 90	3636B-0017	RSS-119	N/A
403-450	10-100	OWDTR-0038-E	90	3636B-0038	RSS-119	UHF-L (403-430 MHz)
450-512	10-100	OWDTR-0039-E	22, 90	3636B-0039	RSS-119	UHF-H (450-470 MHz)
806-870	10-100	OWDTR-0036-E	90	3636B-0036	RSS-119	N/A

1.5 SAFETY SYMBOL CONVENTIONS

The following conventions are used to alert the user to general safety precautions that must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere violates safety standards of design, manufacture, and intended use of the product. M/A-COM, Inc. assumes no liability for the customer's failure to comply with these standards.



WARNING

The **WARNING** symbol calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** symbol until the conditions identified are fully understood or met.



CAUTION

The **CAUTION** symbol calls attention to an operating procedure, practice, or the like, which, if not performed correctly or adhered to, could result in a risk of danger, damage to the equipment, or severely degrade the equipment performance.



NOTE

The **NOTE** symbol calls attention to supplemental information, which may improve system performance or clarify a process or procedure.



The **ESD** symbol calls attention to procedures, practices, or the like, which could expose equipment to the effects of Electro-Static Discharge. Proper precautions must be taken to prevent ESD when handling circuit modules.



The **electrical hazard** symbol is a **WARNING** indicating there may be an electrical shock hazard present.

2 PREFACE

2.1 ABOUT THIS MANUAL

This manual is written for the communications professional responsible for maintaining MASTR III Advanced Digital Capable (ADC) Conventional or P25 Conventional base station equipment.

This manual provides specifications and an overview of the MASTR III ADC Conventional and P25 Conventional base station, and introduces the suite of manuals that provide installation and maintenance instructions for the MASTR III Conventional base stations.

69" Cabinet Installation



37" Cabinet Installation



Figure 2-1: Examples of MASTR III Conventional Base Stations

2.2 GLOSSARY OF TERMS

The following is a list of terms and acronyms used in this manual:

Table 2-1: Glossary of Terms

ADC	Advanced Digital Capable
AES	Advanced Encryption Standard
AGC	Automatic Gain Circuit
AME	Adaptive Multi-band Encoding
AMPF	Adaptive Multi-path Pop Filter
CAI	Clear Air Interface
CAS	Carrier Activity Sensor
CCT	Carrier Control Timer
CFR	Code of Federal Regulations
CG	Channel Guard
CIU	Console Interface Unit
COR	Carrier Operated Relay
CTCSS	Continuous Tone Coded Squelch System
CTI	Centralized Telephone Interconnect
CUE	Customer Unique Encryption
DCG	Digital Channel Guard
DES	Data Encryption Standard
DES	Digital Encryption Standard
DODT	Drop Out Delay Timer
DSP	Digital Signaling Processor
DSP	Digital Signal Processing
DTMF	Dual Tone Multi Frequency
DVIU	Digital Voice Interface Unit
E/D	Encode/Decode
EIA	Electronic Industries Alliance
FCC	Federal Communications Commission
FM	Frequency Modulation
GETC	Generic EDACS Trunking Card
GMSK	Gaussian Minimum Shift Keying
ID	Identification
IF	Intermediate Frequency
IMBE	Improved Multi-Band Exciter
LED	Light Emitting Diode

LO	Local Oscillator
NRZ	Non-Return to Zero
P25	Project 25
PA	Power Amplifier
PC	Personal Computer
PLL	Phased Lock Loop
PTT	Push-to-Talk
RF	Radio Frequency
RU	Rack Unit
RX	Receive
STE	Squelch Tail Elimination
T/R	Transmitter/Receiver
TAC	Technical Assistance Center
TIA	Telecommunications Industry Association
TX	Transmit
UHF	Ultra High Frequency, refers to the 370-512 MHz Band
VG	Voice Guard®
VGE	Voice Guard Encryption
VGS	Voice Guard Standard
VHF	Very High Frequency, refers to the 136-174 MHz Band

2.3 CUSTOMER SERVICE

2.3.1 Technical Support

M/A-COM's Technical Assistance Center (TAC) resources are available to help you with overall system operation, maintenance, upgrades, and product support. TAC is your point of contact when you need technical questions answered.

Product specialists, with detailed knowledge of product operation, maintenance, and repair, provide technical support via a toll-free telephone number (in North America). Support is also available through mail, fax, and e-mail.

For more information about technical assistance services, contact your sales representative, or call the Technical Assistance Center directly at:

North America: 1-800-528-7711

International: 1-434-385-2400

FAX: 1-434-455-6712

E-mail: tac@tycoelectronics.com

2.3.2 Customer Resource Center

If any part of the system equipment is damaged on arrival, contact the shipper to conduct an inspection and prepare a damage report. Save the shipping container and all packing materials until the inspection and the damage report are completed. In addition, contact the Customer Resource Center to make arrangements for replacement equipment. Do not return any part of the shipment until you receive detailed instructions from a M/A-COM representative.

Contact the Customer Resource Center at:

North America:

Phone Number: 1-800-368-3277 (toll free)
Fax Number: 1-800-833-7592 (toll free)
E-mail: customerfocus@tycoelectronics.com

International:

Latin America & Asia Pacific: 1-434-455-9217
Europe, Middle-East & Canada: 1-434-455-9219
Fax Number: 1-434-455-6685
E-mail: InternationalCustomerFocus@tycoelectronics.com

3 SPECIFICATIONS

3.1 CABINET

	INDOOR CABINET (Floor Mount)			OPEN RACK
	<u>37-inch</u>	<u>69-inch</u>	<u>83-inch</u>	<u>86-Inch</u>
Dimensions [in. (cm)]:				
Height:	37.0 (94.0)	69.1 (175)	83 (209)	85.5 (217)
Width:	21.5 (55.0)	23.1 in. (59)	23-3/16 (59)	21 (53.3)
Depth:	18.25 (46.0)	21.0 in. (53.3)	21.0 (53.3)	21 (53.3)
Weight (with max. number of channels)				
Continuous Duty:	121 lbs (55 kg)	576 lbs (261 kg)	693 lbs (314 kg)	
Packed, Domestic Shipping:	136 lbs (62 kg)	606 lbs (275 kg)	729 lbs (331 kg)	
Rack Units (RU) (1 RU = 1.75 in.)				
Cabinet capacity	17 RU	33 RU	41 RU	46 RU
Maximum Radio Units: (using 1-RU power supplies)	2	4	5	5

3.2 SOURCE POWER DRAIN

		VHF	UHF	800
TX Frequency Range (MHz)		136-174	380-512	851-870
RX Frequency Range (MHz)		136-174	370-512	806-825
AC Input Power		5A @ 120 VAC or 3A @ 230 VAC		
DC Input Power (A)	<u>VDC</u>			
Tx	13.8	2	2	2
Rx only	13.8	2	2	2
Tx (full/half power)	26.4	12/8	12/8	12/8
Rx only	26.4	0.5	0.5	0.5

3.3 STATION

General:	One RF Station Occupies 8-RU (includes T/R Shelf, RF PA, & 1-RU Power Supply)
Service Speaker:	1 watt at 8 ohms
Service Microphone:	Transistorized Dynamic
Duty Cycle (EIA) Continuous:	Transmit and Receive at 100%
Operating Temperature:	-22°F to +140°F (-30°C to +60°C)
Humidity (EIA):	90% at 122°F (50°C)
Input Power Source:	120 VAC ($\pm 20\%$), 47-63 Hz
Optional Input Power Source:	230 VAC ($\pm 15\%$), 47-63 Hz
Standby Battery Source:	26.4 VDC, 50 AHR (min.)
Antenna Connections:	Type N
Length of AC Power Cable:	10 ft (3048 mm)
Metering:	Provided through Handset or TQ0619 Software
Altitude:	
Operating:	Up to 15,000 ft (4,570 m)
Shippable:	Up to 50,000 ft (15,250 m)

3.4 INTERFACE

Line Interface:	2-wire or 4-wire (<i>software selectable</i>)
Line Cancellation:	(2-wire) 20 dB amplitude only (<i>software controllable</i>)
Audio (line to transmitter):	
Line Terminating Impedance:	600 ohms (2-wire or 4-wire)
Line Input Level (adjustable):	-20 dBm to +7 dBm
Frequency Response:	± 3 dB @ 300 to 3000 Hz
Tone Remote Control:	
Function Tones (Hz):	1050, 1150, 1250, 1350, 1450, 1550, 1650, 1750, 1850, 1950, & 2050
Secur-it Tone and Transmit Tone:	2175 Hz
Permissible Control Line loss @ 2175 Hz:	27 dB

Audio (receiver to line):	
Audio Amplifier Input Impedance:	10K ohms
Input Level:	1 Vrms (for 5 kHz Deviation)
Output Impedance to Line:	600 ohms (2-wire or 4-wire)
Output Level to Line (1 kHz ref.):	+7 dBm (adjustable)
Tone (1 kHz ref.):	+7 dBm (Reference 7 dBm)
Frequency Response:	+1 and -3 dB @ 300 to 3000 Hz
Hum and Noise, Noise Squelch:	-55 dBm (Reference 7 dBm)
Tone Squelch:	-30 dBm (Reference 7 dBm)
DC Remote Control Currents:	-2.5 mA, ± 6.0 mA, ± 11.0 mA
Line Loop Resistance (maximum):	11K ohms (includes 3K ohm termination)

3.5 TRANSMITTER

	VHF ANALOG	VHF P25 DIGITAL	UHF ANALOG	UHF P25 DIGITAL	800 MHz ANALOG	800 MHz P25 DIGITAL
Frequency Range (MHz)	136 - 174	136 - 174	380 - 512	380 - 512	851 - 870	851 - 870
Rated Power Output (W) ¹	10 - 110	10 - 110	10-100	10-100	10 - 100	10 - 100
RF Output Impedance (Ω)	50	50	50	50	50	50
Conducted Spurious and Harmonic Emission	-36 dBm	-70 dBc	-36 dBm	-70 dBc	-36 dBm	-70 dBc
Frequency Stability (ppm) ²	± 1.0	± 1.0	± 1.0	± 0.5 external freq. std.	± 1.0	± 0.15 external freq. std.
Modulation Deviation (kHz)						
Wideband	0 to ± 5	N/A	0 to ± 5.0	N/A	0 to ± 5.0	N/A
Narrowband	0 to ± 2.5	2.83 kHz nominal per TIA 102 CAAB	0 to ± 2.5	± 2.83 nominal per TIA 102 CAAB	N/A	2.83 kHz nominal per TIA 102 (CAAB)
FM Noise (dB)	-55	N/A	-55	N/A	-55	N/A

¹ Rated power output is measured at the transmitter power amplifier output connector per FCC Certification information. Any customer-required optional items such as power measuring devices and/or duplexers will introduce loss between the transmitter output connector and the station cabinet output connector. This loss will reduce the available power at the station connector.

² Frequency stability is relative to the stability of the Reference Oscillator. Unless otherwise specified, the value shown in this table is relative to the internal Reference Oscillator signal which is provided by the corresponding Receiver Synthesizer Module.

	VHF ANALOG	VHF P25 DIGITAL	UHF ANALOG	UHF P25 DIGITAL	800 MHz ANALOG	800 MHz P25 DIGITAL
Channel Spacing (kHz)	12.5/25/30	12.5	12.5/25	12.5	25 12.5 (NPSPAC)	25
Frequency Step Size (kHz)	1.25	1.25	1.25	1.25	6.25	6.25
Frequency Spread Full Spec (MHz)	2	1.5	2	1.5	0.5	0.5
Audio Distortion (@ 1 kHz)	Less than 3%	To Mask 47CFR90.2 10d	Less than 3%	To Mask 47CFR90.21 0d	Less than 3%	TX Mask 47CFR90.210 d
Number of Channels (Conventional)	Up to 12	Up to 12	Up to 12	Up to 12	Up to 12	Up to 12
Audio Response (pre-emphasis)	Within +1/- 3 dB of 6 dB/octave, 300 to 3000 Hz per EIA	Mod Fidelity <5%	Within +1/- 3 dB of 6 dB/octave, 300 to 3000 Hz per EIA	Mod Fidelity <5%	Within +1/- 3 dB of 6 dB/octave, 300 to 3000 Hz per EIA	Mod Fidelity <5%

3.6 RECEIVER

	VHF ANALOG*	VHF P25 DIGITAL	UHF ANALOG*	UHF P25 DIGITAL	800 MHz ANALOG*	800 MHz P25 DIGITAL
Frequency Range (MHz)	136 - 174	136 - 174	370 - 512	370 - 512	806 - 825	806 - 825
RF Input Impedance (Ω)	50	50	50	50	50	50
Channel Spacing (kHz)	12.5/25/30	12.5	12.5/25	12.5/25	25 12.5 (NPSPAC)	25 12.5 (NPSPAC)
Sensitivity (dBm) EIA	-116 (12 dB SINAD) (0.35 μ V)	-116 (5% BER) (0.35 μ V)	-116 (0.35 μ V)	-116 (5% BER) -108 faded	-118 (0.28 μ V)	-116 (5% BER) -108 faded
Threshold Squelch (dBm)	-119 (0.25 μ V)	N/A	-119 (0.25 μ V)	-119 (0.25 μ V)	-121 (0.18 μ V)	N/A

	VHF ANALOG*	VHF P25 DIGITAL	UHF ANALOG*	UHF P25 DIGITAL	800 MHz ANALOG*	800 MHz P25 DIGITAL
Selectivity 2- Signal						
12.5 kHz	≥75 dB	≥60 dB Dig ACR	≥75 dB	≥60 dB Dig ACR	≥20 dB (NPSPAC)	≥80 dB
25 kHz	≥85 dB	N/A	≥85 dB	N/A	≥80 dB	N/A
30 kHz	≥90 dB	N/A	N/A	N/A	N/A	N/A
Frequency Stability (ppm)	±1.0	±1.0	±1.0	±0.5	±1.0	±0.15 external freq. std.
Signal Displacement Bandwidth (kHz)						
12.5 kHz	±1.0	±1.0	±2	N/A	±1.6 (NPSPAC)	±1.0
25 kHz	±2.0	N/A	±1	±1	±2	N/A
Intermodulation (dB)						
12.5 kHz	≥75	≥80	≥75	≥80	N/A	≥80
25 kHz	≥80	N/A	≥80	N/A	≥80	N/A
30 kHz	≥80	N/A	N/A	N/A	N/A	N/A
Spurious and Image Rejection (dB)	≥90	≥90	≥90	≥90	≥90	≥90
Full Specs. (MHz)	2.0	2.0	2.0	2.0	0.5	0.5
Audio Output @ 1000 Hz, 25/30 kHz Channel (W)	1 @ <3% distortion	N/A	1 @ 3% distortion	N/A	1 @ 3% distortion	N/A

* **Audio Response (de- emphasis):** Within +2/-8 dB of 6 dB/octave (@ Local Speaker), 300 to 3000 Hz per EIA
Within +1/-3 dB of 6 dB/octave (@ Line Output), 300 to 3000 Hz per EIA.

3.7 INDIVIDUAL EQUIPMENT WEIGHTS

UNIT OR ASSEMBLY	WEIGHT	
	Lbs	kg
69-inch cabinet w/ doors and fan assembly	176	80
Power Supply 19A149978	38	17
Switching Power Supply PS103010	8.91	4.04
T/R Shelf (without plug-in modules)	9.6	4.35
T/R Shelf (with plug-in modules)	22.25	10.21
System Module	1.5	0.68
Power Module	1.8	0.82
TX Synthesizer	1.9	0.86
RX Synthesizer	2.15	0.93
RX Front End Module	2.35	1.07
RX IF Module	1.75	0.79
Blank module panel	0.4	0.18
Power Amplifier, 19D902797	20.8	9.43
Power Amplifier, EA101292	9.8	44.45
SureCall Test Unit (with radio)	20	9.07

4 GENERAL INFORMATION

4.1 REFERENCE MANUALS

It may be necessary to consult one or more of the following manuals. The manuals listed in Table 4-1 may provide additional guidance if you encounter technical difficulties during the installation or testing process.

Table 4-1: Reference Manuals

DESCRIPTION	MANUAL NUMBER
MASTR III Base Station	
MASTR III ADC Base Station Installation Manual	MM102554V1
MASTR III ADC Application and Assembly Diagrams	MM102555V1
MASTR III ADC T/R SHELF	MM102244V1
System Module (19D902590G6)	LBI-39176
Power Module (19D902589G2)	LBI-38752
MASTR III RF PACKAGE: VHF (136 - 174 MHZ)	MM102557V1
Transmit Synthesizer Module (EA101685V1, V2)	MM102174V1
Receive Synthesizer Module (EA101684V1, V2)	MM102819V1
Receiver Front End Module (19D902782G1, G2)	LBI-38642
Receiver IF Module (EA101401V1)	MM101886V1
Power Amplifier (EA101292V10, V11, & V12)	MM101383V2
MASTR III RF PACKAGE: UHF (380 - 512 MHZ)	MM102557V2
Transmit Synthesizer Module (EA101685V11, V12, V13)	MM102174V2
Receive Synthesizer Module (EA101684V11, V12, V13)	MM102819V2
Receiver Front End Module (19D902782G6, G8, G9, G10, G11, & G12)	LBI-39129
Receiver IF Module (EA101401V1)	MM101886V1
Power Amplifier (EA101292V21, V22)	MM101292V3
MASTR III RF PACKAGE: 800 MHz	MM102557V3
Transmit Synthesizer Module (EA101685V5)	MM102147V3
Receive Synthesizer Module (EA101684V5)	MM102819V3
Receiver Front End Module (19D902782G5)	LBI-39028
Receiver IF Module (EA101794V1)	MM102407V1
Power Amplifier, 100 Watt (EA101292V1)	MM101383V1

OPTIONS AND ACCESSORIES		
MASTR III Adaptive Multi-path POP Filter (AMPF), Option SXDE9C: Installation Manual: Maintenance Manual:		AE/LZT 123 3244/1 AE/LZB 119 3149/1
MASTR III Data Module, Option SXDE5B:	19D904558G1 Rev. 1 and earlier: 19D904558G1 Rev. A and later:	LBI-38918 MM-008429-001
Site Grounding and Protection Guidelines		AE/LZT 123 4618/1
Tower Requirements and General Specifications		LBI-39185
Base Station Switching Power Supply Maintenance Manual (PS103010V120)		MM22315
AC Outlet Strip Maintenance Manual		LBI-4841
Blower Kit Maintenance Manual		LBI-4842
MASTR III Fuse Panel (12/24 Volt) Maintenance Manual		LBI-30246
TEST AND PROGRAMMING		
RF Module Test Fixture (TQ0650)	- Model TS101285V11 - Model 344A4153P1	MM101885V1 LBI 38805
MASTR III Programming Guide (TQS3353)		MM102518V1

4.2 MASTR III ADC STATION OPTIONS

The MASTR III ADC Conventional base station is available in the following configurations and may be combined with the options listed. A brief description of individual modules, hardware and features listed below can be found in later sections of this manual.

Table 4-2: MASTR III ADC Pre-Configured Conventional Station Packages

PRE-CONFIGURED STATION PACKAGES	
OPTION	DESCRIPTION
UNENCRYPTED MASTR III STATIONS, PRE-CONFIGURED MODELS IN 37" CABINET	
SXHMC1	STATION, CONVENTIONAL MASTR III PACKAGE, 150.8-174 MHZ, 110W Includes power supply, 37-inch cabinet, antenna switch and mounting hardware.
SXUMC1	STATION, CONVENTIONAL MASTR III PACKAGE, 450-470 MHZ, 100W Includes power supply, 37-inch cabinet, antenna switch and mounting hardware.
UNENCRYPTED MASTR III STATIONS (CONFIGURED WITH T/R SHELF AND RF PA ONLY) (Cabinet, Power Supply, Antenna Switch, Mounting Hardware and other options must be ordered separately)	
SXGMCX	STATION, CONVENTIONAL MASTR III, 136-150.8 MHZ, 110W
SXHMCX	STATION, CONVENTIONAL MASTR III, 150.8-174 MHZ, 110W
SX8MCX	STATION, CONVENTIONAL MASTR III, 806-870 MHZ, 100W

SXUMCX	STATION, CONVENTIONAL MASTR III, 450-470 MHZ, 100W
SXWMCX	STATION, CONVENTIONAL MASTR III, 492-512 MHZ, 90W
SXVMCX	STATION, CONVENTIONAL MASTR III, 470-494 MHZ, 90W
SXTMCX	STATION, CONVENTIONAL MASTR III, 425-450 MHZ, 90W
SXPMCX	STATION, CONVENTIONAL MASTR III, 410-430 MHZ, 90W
SXRMCX	STATION, CONVENTIONAL MASTR III, 403-425 MHZ, 90W
AEGIS™/VOICE GUARD OPTIONS (FOR UNENCRYPTED MASTR III STATIONS ONLY) END-TO-END ENCRYPTION	
SXVG3F	KIT, GETC, AEGIS/VOICE GUARD, END-TO-END REMOTE/REPEATER With modem (for tone remote or tone remote/repeater stations with end-to end encryption). NOTE: No encryption or decryption occurs in the Aegis Station shelf.
SXVG3E	KIT, GETC™, AEGIS/VOICE GUARD, END-TO-END (For standalone repeaters.) NOTE: No encryption or decryption occurs in the Aegis Station shelf.
ENCRYPTED MASTR III STATIONS, (INCLUDES CONFIGURED T/R SHELF AND RF PA ONLY) (Cabinet, Power Supply, Antenna Switch, Mounting Hardware and other options must be ordered separately)	
SXGMCXE	STATION, 64-BIT ENCRYPTION, CONVENTIONAL MASTR III, 136-150.8 MHZ, 110W
SXHMCXE	STATION, 64-BIT ENCRYPTION, CONVENTIONAL MASTR III, 150.8-174 MHZ, 110W
SXGMCXE	STATION, 64-BIT ENCRYPTION, CONVENTIONAL MASTR III, 136-150.8 MHZ, 110W
SX8MCXE	STATION, 64-BIT ENCRYPTION, CONVENTIONAL MASTR III, 806-870 MHZ, 100W
SXUMCXE	STATION, 64-BIT ENCRYPTION, CONVENTIONAL MASTR III, 450-470 MHZ, 100W
SXWMCXE	STATION, 64-BIT ENCRYPTION, CONVENTIONAL MASTR III, 492-512 MHZ, 90W
SXVMCXE	STATION, 64-BIT ENCRYPTION, CONVENTIONAL MASTR III, 470-494 MHZ, 90W
SXTMCXE	STATION, 64-BIT ENCRYPTION, CONVENTIONAL MASTR III, 425-450 MHZ, 90W
SXPMCXE	STATION, 64-BIT ENCRYPTION, CONVENTIONAL MASTR III, 410-430 MHZ, 90W
SXRMCXE	STATION, 64-BIT ENCRYPTION, CONVENTIONAL MASTR III, 403-425 MHZ, 90W
MASTR III PAGING STATIONS (FOR TRANSMIT ONLY APPLICATIONS) (Cabinet, Power Supply, Mounting Hardware and other options must be ordered separately)	
SXUMDX	TRANSMITTER, CONVENTIONAL MASTR III, 450-470 MHZ, 100W
SXHMDX	TRANSMITTER, CONVENTIONAL MASTR III, 150.8-174 MHZ, 110W
SXGMDX	TRANSMITTER, CONVENTIONAL MASTR III, 136-150.8 MHZ, 110W

Table 4-3: MASTR III ADC Conventional Station Options and Accessories

OPTIONS AND ACCESSORIES	
OPTION	DESCRIPTION
ENCRYPTION/DECRYPTION MODE FOR REMOTE OR REMOTE/REPEATER (ENCRYPTED MASTR III STATIONS ONLY)	
SXVG3D	KIT, DES 1027 ENCRYPTION SHELF (INCLUDES GETC). Same as Option SXV1N except uses DES algorithm.
SXVW1J	KIT, DES ENCRYPTION SHELF (INCLUDES GETC). Same as Option SXV1N except uses DES algorithm.
SXV1N	KIT, VGE ENCRYPTION SHELF (INCLUDES GETC). Provides encryption/decryption in a tone remote/repeat station. Module is remotely controlled using function tones. VGE algorithm version.
REMOTE OR REMOTE/REPEATER (FOR UNENCRYPTED MASTR III STATIONS ONLY)	
SXV1S	KIT, AEGIS UNENCRYPTED SHELF (INCLUDES GETC). Provides non-encrypted Aegis digital communications in a tone remote/repeat station. Module is remotely controlled using function tones.
HARDWARE, OPTIONS AND ACCESSORIES	
SXCA1U	CABINET, 83 IN.
SXCA1D	CABINET, 69 IN.
SXCA1S	CABINET, 37 IN.
SXMR1D	OPEN RACK, 86 IN.
SXCA1X	CABINET, 45 IN., OUTDOOR
SXMN2B	OPTION, NO CABINET
SXFN1A	FAN, 120 VAC, Must be included when installing more than 1 repeater in a 69- or 83-inch cabinet.
SXFA1L	FAN, 230 VAC, Must be included when installing more than 1 repeater in a 69- or 83-inch cabinet.
SXFA1N	FAN, 12 VDC, Must be included when installing more than 1 repeater in a 69- or 83-inch cabinet.
SXCN1Z	OUTLET STRIP, 120 VAC
SXMN9H	COVER, CABINET TOP, 69/83 IN. CABINET (CONVENTIONAL)
SXMN7F	KIT, MOUNTING HARDWARE, 37 IN. CABINET
SXMN3Y	KIT, MOUNTING HARDWARE, 69/83/86 IN. CABINET/RACK
SXMN9C	COVER, SCREEN, T/R SHELF

OPTIONS AND ACCESSORIES	
OPTION	DESCRIPTION
SXCH1M	CHARGER, UHF ONLY, BATTERY STANDBY, 230 VAC, 50 HZ, Same as SXCH1L except 230 VAC/50 Hz.
SXPS5Y	POWER SUPPLY, 230 VAC, 50 HZ, 12/24 VDC, 3/15A For 800 MHZ and VHF applications
SXPS9R	POWER SUPPLY, 120 VAC, 60 HZ, 12/24 VDC, 6/15A Output
SXCL5Z	CABLE, CHARGER TO BATTERY, For use with SXPS9R
SXCL6A	KIT, GEL CELL SHELF WITH COVER AND CABLE, For use with SXPS9R
SPK0501	KIT, GEL CELL SHELF CABLES, Kit, contains cables only
SXPD1M	PANEL, FUSE, 12/24 VDC
2401	BATTERY, UHF ONLY, GEL CELL, 12 VDC, 26 AH, For use in battery shelf option. Order 4 units per base station.
SXSU3A	KIT, ANTENNA SWITCH
SXSU3J	KIT, ANTENNA SWITCH, RAIL MOUNTED
SXDU1K	DUPLEXER, Factory Installed, 162-174; 2-12 MHZ MAXIMUM SEPARATION Band pass/Band reject, 162-174 MHz 2-12 MHz Rx/Tx separation, maximum insertion loss 1.5 dB.
SXDU1J	DUPLEXER, Factory Installed, 150-162; 2-12 MHZ MAXIMUM SEPARATION Band pass/Band reject, 150-162 MHz 2-12 MHz Rx/Tx separation, maximum insertion loss 1.5 dB.
SXDU1M	DUPLEXER, Factory Installed, 450-470 MHZ, 5-30 MHz Rx-Tx sep.
SXDE5B	KIT, TX DATA, Provides Voice/Data mode selection. In the data mode, the module will accept NRZ (non-return to zero) digital input (single polarity or dual polarity in the range of -25 to +25 volts) at speeds up to 9600 bits/sec. (VHF/UHF only, 25 kHz channel only)
SXMK3J	KIT, RADIO LINK APPLICATION, Modifies a standard base station into a radio link repeater. Provides harness and programming to change a simplex tone remote station into a radio link repeater. Used in conjunction with option applied to another standard base station to complete the Radio Link application.
SXSU3D	KIT, SOR RELAY, Provides relays and hardware for SOR and Auxiliary Control.
SXMC3B	MICROPHONE, MOBILE (SERVICE)
SXMK3S	KIT, SETUP, MASTR III STATION WITH MIII AUXILIARY RX, Provides cabling and hardware for MASTR III Auxiliary Receiver. Limited to one RX frequency on base stations.
SXSF1W	FEATURE, VOTING TONE (1950 HZ), Includes 4-wire audio.
SXSF3J	FEATURE, 4 WIRE AUDIO Enable remote station to operate with 4-wire control.

OPTIONS AND ACCESSORIES	
OPTION	DESCRIPTION
SXMK3K	INSTRUCTION, BACK-TO-BACK REPEATER/STATION #2, This option is applied to a 2nd standard base station and is used in conjunction with SXMK3J which is applied to the 1st station.
SXMF5H	PROGRAMMING, 12.5 KHZ CHANNEL, Factory configured station for narrowband operation (UHF/VHF Conventional FM Voice Only).

Table 4-4: MASTR III ADC Programming, Test and Alignment Tools

PROGRAMMING, TEST AND ALIGNMENT	
OPTION	DESCRIPTION
TQS3353	MASTR IIE/MIII PROGRAMMING SOFTWARE, Provides capability of changing radio's functions and features. Includes TQ0619 Utility Programming Software.
TQS0653	MASTR IIE/MASTER III MSEDIT SOFTWARE, Provides access to special programming features.
SPK9024	UTILITY HANDSET
TQ3356	MASTR IIE/MIII PROGRAMMING CABLE
TQ0650	MODULE ALIGNMENT AND TEST KIT
EA24877-0001	EXTENDER BOARD, For "EA" Series RF Modules
188D5338G1	EXTENDER BOARD, System, Control and Power Modules
193D1094G1	Multi-Purpose Module

5 OPERATION

The MASTR III ADC station is a RF synthesized computer programmable, Frequency Modulated (FM) transceiver capable of wideband (25 kHz) or narrowband (12.5 kHz) operation. The MASTR III ADC station combines modular design and state-of-the-art technology to deliver superior performance and reliability. MASTR III ADC station incorporates fully shielded and removable modules, front-mount controls, and remote diagnostics. The station is capable of 100% transmitter duty cycle with simultaneous receive capability allowing repeater operation.

The MASTR III ADC station hardware may be installed in 19" rack mount cabinets or 19" open racks. Equipment cabinets are equipped with front and rear doors for full equipment access, key lock security and available in 37", 69" and 83" heights. The 86" open-rack is designed to be floor mounted and allows full accessibility to all sides of the equipment.

Power Supply options for the MASTR III ADC station include 120 VAC or 240 VAC input at 47 Hz to 63 Hz, battery backup options and DC Power Distribution equipment.

The MASTR III ADC station may be equipped with an antenna switch relay for stand-alone base station configurations, antenna duplexers for stand-alone repeater configurations, or transmitter combiners and receiver multi-couplers for multi-station installations.

The MASTR III ADC station may be configured as a Conventional Analog or P25 Conventional station.

5.1 CONVENTIONAL STATION CONFIGURATIONS

The MASTR III ADC station is available in Conventional VHF, UHF, and 800 MHz versions and can be configured to operate as any of the following:

- Conventional Base Station (2-wire or 4-wire audio)
- Conventional Repeater (Stand-alone, no wire line)
- Conventional Repeater (with wire line control)
- Remote-to-Repeater
- Transmit Only (Paging or other Data Applications)

5.1.1 Conventional Base Station

When configured as a Conventional Base Station, the MASTR III ADC station may be further configured to operate with 2-wire or 4-wire controllers, providing access to many remote control features including up to twelve (12) selectable RF channels. Each channel can be individually programmed for either simplex operation (common TX and RX frequency) or half-duplex operation (different TX and RX frequency). Each channel may be programmed for any combination of standard sub-audible tone Channel Guard or Digital Channel Guard.

In standard DC control applications, up to 2 RF channels, RX Channel Guard Disable (monitor) and scan features may be controlled using loop currents of +6 mA, +11 mA, -6 mA, -11 mA and -2.5 mA. E&M control is a feature of DC control.

In standard Tone Remote control applications, up to four (4) channels may be accessed via Tone Remote Control. Other features such as RX Channel Guard Disable (monitor), Scan and Repeater Enable may also be tone controlled.

Additionally, Dual Tone Multi Frequency (DTMF) signaling sent via the wire line connection can be used in conjunction with DC or Tone Remote control to allow control of up to twelve (12) selectable channels.

DTMF tones are sent to the station via the wire line interface where the System Module decodes the tones as channel assignment information. The DC or Tone Remote signaling then controls the TX/RX operations of the station on the channel selected by the DTMF signaling.

5.1.2 Conventional Repeater

When configured as a Conventional Repeater, the MASTR III ADC station provides full duplex (different TX and RX frequencies operating simultaneously) operation as a single channel repeater station. The repeater may be programmed for any standard Channel Guard, Digital Channel Guard or Type-90 tone.

MASTR III ADC stations configured for repeater operation may also be configured for DC or Tone Remote control. Console TX and RX, Channel Guard disable and repeater enable are common features available using 2-wire or 4-wire remote control.

5.1.3 Remote-to-Repeater

When configured as a Remote-to-Repeater station, the MASTR III ADC station provides full duplex repeater operation just like Conventional Repeaters, with extended capability to share TX, RX and control operations via 4-wire interfacing with another MASTR III ADC station operating as a Remote Base. The Remote Base station can be co-located or remotely located at another site.

5.1.4 Transmit Only

MASTR III ADC stations operating as Transmit Only stations provide the necessary equipment to operate as a One-Way Paging Station or other similar Data transmitters. Only transmitter related modules and components are provided with the station T/R shelf.

A Data Module is provided for 9600 bps NRZ TX data capability. The Data Module provides the required 12.8 MHz reference oscillator signal to the TX Synthesizer, thus meaning no RX Synthesizer is required (the usual source for the 12.8 MHz reference oscillator signal).

5.2 ENCRYPTED STATION CONFIGURATIONS

MASTR III ADC stations equipped with external encryption equipment may be configured one of two ways:

- End-to-End Encryption
- RF Only Encryption/Decryption

5.2.1 End-to-End Encryption

With end-to-end encryption, the voice encryption occurs at the dispatch center or originating radio and remains encrypted all the way to the properly equipped mobile or portable radio. External encryption equipment is located at or nearby the dispatch center and connected to the MASTR III ADC station via four-wire interconnection. This method of operation provides the highest level of system security.

However, four-wire interconnection with one or more consoles is always in the clear mode. This assumes that the dispatch center is secure and that the console interconnection will be by short, local cable runs that are adequately secure.

With end-to-end encryption, Cryptographic key information is not required at the MASTR III ADC station is located. All key loading occurs at the dispatch center or originating radio where the external encryption equipment is located.

5.2.2 RF-Only Encryption/Decryption

In RF-Only Encryption/Decryption (E/D) stations, external encryption equipment is connected directly to the MASTR III ADC station. The voice signal is always delivered clear (unencrypted) from the dispatch center to the base station where it can then be encrypted and sent over the radio path to properly equipped mobiles and portables. One or more station consoles operate in a standard clear mode, tone control configuration.

In an RF only E/D station, the working cryptographic key must reside in the external encryption equipment co-located at the MASTR III ADC station site. The external encryption equipment is remotely controlled to select for CLEAR or GUARDED modes of operation at the start of each transmit PTT, receive mode selection is automatic. Four-wire control is still a requirement but only a voice grade (not data grade) circuit is required.

5.3 MODES OF OPERATION

Options are available for conventional MASTR III ADC stations to provide the following modes of communication:

- Analog FM (Clear Voice)
- Data (Paging and other externally generated NRZ Data formats)
- Digital Voice (unencrypted AEGIS)
- Digital Voice Encryption (Encrypted Voice Guard or encrypted AEGIS)

5.3.1 Analog FM

When operating in conventional analog mode, the MASTR III ADC station communicates via traditional FM modulation schemes. Narrowband (12.5 kHz) bandwidth is available on the VHF and UHF stations while Wideband (25 kHz) bandwidth is available on the VHF, UHF and 800 MHz bands.

Both the TX and RX audio circuitry is designed to provide extremely clear audible speech characteristics from 300 Hz to 3000 Hz, with sub-audible tone capability for Channel Guard requirements.

5.3.2 Data

The MASTR III ADC station may be equipped with a Data Module capable of delivering up to 9600 bps Non-Return-to-Zero (NRZ) serial data transmissions. This mode of operation provides the necessary digital interfacing required for paging and other externally generated data formats.

5.3.3 Digital Voice

The MASTR III ADC station may be equipped with an external Digital Voice Interface Unit (DVIU) capable of encoding and decoding digital signaling. Stations equipped with the external DVIU can provide one of several digital voice formats, each having certain types of encrypted or unencrypted services available. The formats and types are as follows:

- Voice Guard (DES and VGE)
- AEGIS (Unencrypted AEGIS, Encrypted with DES, VGE or VGS)
- P25 Conventional (Unencrypted P25, Encrypted with DES and AES)

5.3.3.1 Voice Guard

Voice Guard is the first generation digital voice format available only as an encrypted signal. Voice Guard signals use Gaussian Minimum Shift Keying (GMSK), running at 9600 bps, two level FM modulation, Non-Return-to-Zero (NRZ), serial data. This means that the data is a serial train of two-state data bits (i.e., ones and zeros) occurring at the rate of 9600 bits per second. The NRZ characteristic means that the duration of each data bit is a full clock period (approximately 104 microseconds) instead of returning to zero before the next bit time starts.

Voice Guard is available in two types of encryption provided by either of two different algorithms. These algorithms are:

- Data Encryption Standard (DES)
- Voice Guard Encryption (VGE)

These algorithms are the mathematical manipulations used to scramble the digitized voice bit pattern. Both algorithms offer the user a higher level of voice security by virtue of the extremely large number of available cryptographic keys. The availability of encryption devices are subject to national and international export laws.

5.3.3.2 AEGIS

AEGIS is a second generation digital voice format, available in both encrypted and unencrypted formats. AEGIS uses Adaptive Multi-band Encoding (AME). AME offers enhanced voice quality characteristics over Voice Guard technology. AEGIS operates at 9600 bps, two level FM, with encryption provided by DES or VGE algorithms.

5.4 ENCRYPTION FORMATS

5.4.1 Data Encryption Standard (DES)

DES is a public domain encryption system. DES employs a 64 bit cryptographic key, 56 bits of which are used for encryption and the remaining eight bits are parity bits. This results in 7.2×10^{16} unique cryptographic keys being available. The security of a DES equipped system is a result of the extremely large number of available keys.

5.4.2 Voice Guard Encryption (VGE)

The VGE algorithm is a very secure, proprietary, encryption algorithm which was developed to meet the security needs of international and domestic customers. The encryption algorithm utilizes highly complex non-linear data spreading and iterative key scheduling to insure the security of encrypted voice data.

The VGE algorithm utilizes a 64-bit cryptographic key, and thus offers the security of 1.8×10^{19} permutations of keys. It also utilizes a key scheduling algorithm, bit permutations, and non-linear product transformations to provide a very high level of bit spreading.

Unlike DES, the VGE algorithm offers an additional level of security, in the form of Customer Unique Encryption (CUE). The programming of a second 64-bit CUE code (16hex characters) allows a user increased security. Even if two parties use the same cryptographic key, their equipment will not communicate unless they use the same CUE. This, effectively, increases the number of key and CUE permutations to 3.4×10^{38} , equivalent to 128-bit encryption.

VGS is a customer unique, customer specific encryption algorithm that works very similar to VGE.

5.4.3 Advanced Encryption Standard

Advanced Encryption Standard (AES) is a block cipher format approved for use as an encryption standard by the U.S. government. AES is fast in both software and hardware, is relatively easy to implement, and requires little memory. AES is currently used in conjunction with the P25 technology.

Unlike DES, AES operates as a substitution-permutation network. AES utilizes fixed blocks of data formed into tables. AES has a fixed block size of 128 bits and a key size of 128, 192 or 256 bits. AES uses a process of shifting data in a table. The bit shifting techniques are known as AddRoundKey, SubBytes, ShiftRows and MixColumns. This combination of block data, bit shifting and unique key driven encryption methodologies provide much further advanced encryption capabilities than DES or VGE.

5.5 P25 CONVENTIONAL CONFIGURATIONS

VHF and UHF MASTR III ADC stations may be equipped with a DSP Module to allow operation as a Project 25 (P25) Conventional station. P25 compliant stations use four-level FM modulation (C4FM), and are backward compatible with traditional analog FM radios. P25 Conventional technology supports the following modes of communication:

- P25 Conventional Base Station (4-Level FM)
- P25 Conventional Repeater
- P25 Conventional Repeater with Console Control

P25 is an Industry Standard developed to bring Interoperability between different manufacturers, and users of their respective digital communications equipment. P25 technology uses a standardized digital format known as Common Air Interface (CAI). CAI incorporates various system information and a digital voice format into one digital transmission.

While the DSP card located in the MASTR III ADC station provides the P25 formatting, external equipment is required to encrypt the voice product delivered to the station. External encryption equipment for P25 Conventional systems is available for three types of encryption:

- DES
- VGE
- AES

The encryption formats are discussed in Section 5.4.

5.5.1 P25 Conventional Station Operation

MASTR III ADC stations operating in P25 Conventional mode utilize additional circuitry in the RX IF Module to provide the properly filtered and amplified signal required by the DSP Module to decode the signal. The DSP Module also provides the encoded C4FM signaling for the transmitter.

In the 21.4 MHz RX IF module (VHF and UHF stations), the 455 kHz four-level FM signal passes through additional IF filtering, a differential amplifier, and a buffer to the 455kHzIF lines on the backplane. Unlike 2-level signals, the signals present on the 455kHzIF lines are not demodulated. These lines connect to the DSP Module input where the DSP captures the data signal and processes it as necessary.

During TX operations, the DSP Module encodes the inbound audio or digital signal into the P25 compliant C4FM modulation scheme and routed via the backplane to the TX Synthesizer Module.

5.5.2 P25 Conventional Repeater Station Operation

In the P25 Repeater mode, the DSP Module uses the Delay PTT In line and the Remote PTT to communicate with the System Module. After the DSP Module demodulates a four-level FM signal, it asserts a Delay PTT In signal to the System Module, indicating a P25 call is being received. While the Delay PTT In line is applied, the System Module keys the External PTT and disables the Channel Guard circuitry, preventing further processing of the 455 kHz signal on the VOL-SQ HI line.

The four-level FM signal is passed onto the System Module on the EXT HSD line. The System Module processes the signal and sends it to the TX Synthesizer Module on the TX Audio Hi line. The External PTT also keys the transmitter and the signal is re-transmitted. The DSP module continues to assert the Delay PTT In line until the P25 Terminating Data unit is transmitted.

While the External PTT is keyed, the DSP passes the demodulated analog audio to the System Module on the MDM Line TXD. The System Module routes the audio to the landline interface for monitoring by the Console.

5.5.3 P25 Conventional Station with Console

5.5.3.1 Console Transmit

The MASTR III P25 Conventional Base Station also supports analog remote control through the base station's 2- or 4- wire landline interface. When communication is initiated by a remote console, the analog audio is routed through the Interface Card to the System Module. The System Module routes the audio on MDM Line RXD to the DSP Module. The System Module also sends a Remote PTT signal to the DSP Module, initiating the four-level FM modulation process.

The DSP Module asserts a Delay PTT In signal to the System Module, indicating a P25 is being sent. The System Module executes an External PTT, this keys the transmitter and the signal is transmitted. The modulated four-level FM signal is passed on to the System Module on the EXT HSD line. The System Module processes the signal and sends it to the TX Synthesizer Module on the TX Audio Hi line. The DSP module continues to assert the Delay PTT In line until the call is complete and the P25 Terminating Data unit is transmitted.

5.5.3.2 Console Preempt

The Console Preempt feature allows a dispatcher's call to preempt a radio call already in progress. This means the dispatcher's call is heard by all radios and the transmitting radio is still heard by the dispatcher. The Console Preempt feature assumes a P25 call is in process (see section 4.2). When the console initiates a call, the analog audio is routed through the Interface Card to the System Module. The System Module routes the audio on MDM Line RXD to the DSP Module and sends a Remote PTT signal to the DSP Module.

The DSP Module initiates the four-level FM modulation process of the console audio. It then switches from sending the P25 call to sending the four-level FM modulated console audio to the System Module on the EXT HSD line. The System Module processes the signal and sends it to the TX Synthesizer Module on the TX Audio Hi line. The System Module continues executing an External PTT, keying the transmitter and transmitting the console signal.

At the end of the console call, the DSP Module sends the P25 Terminating Data unit. If the P25 Repeat call still exists, the DSP Module continues to assert the Delay PTT In line until the call is complete and the P25 Terminating Data message is transmitted.

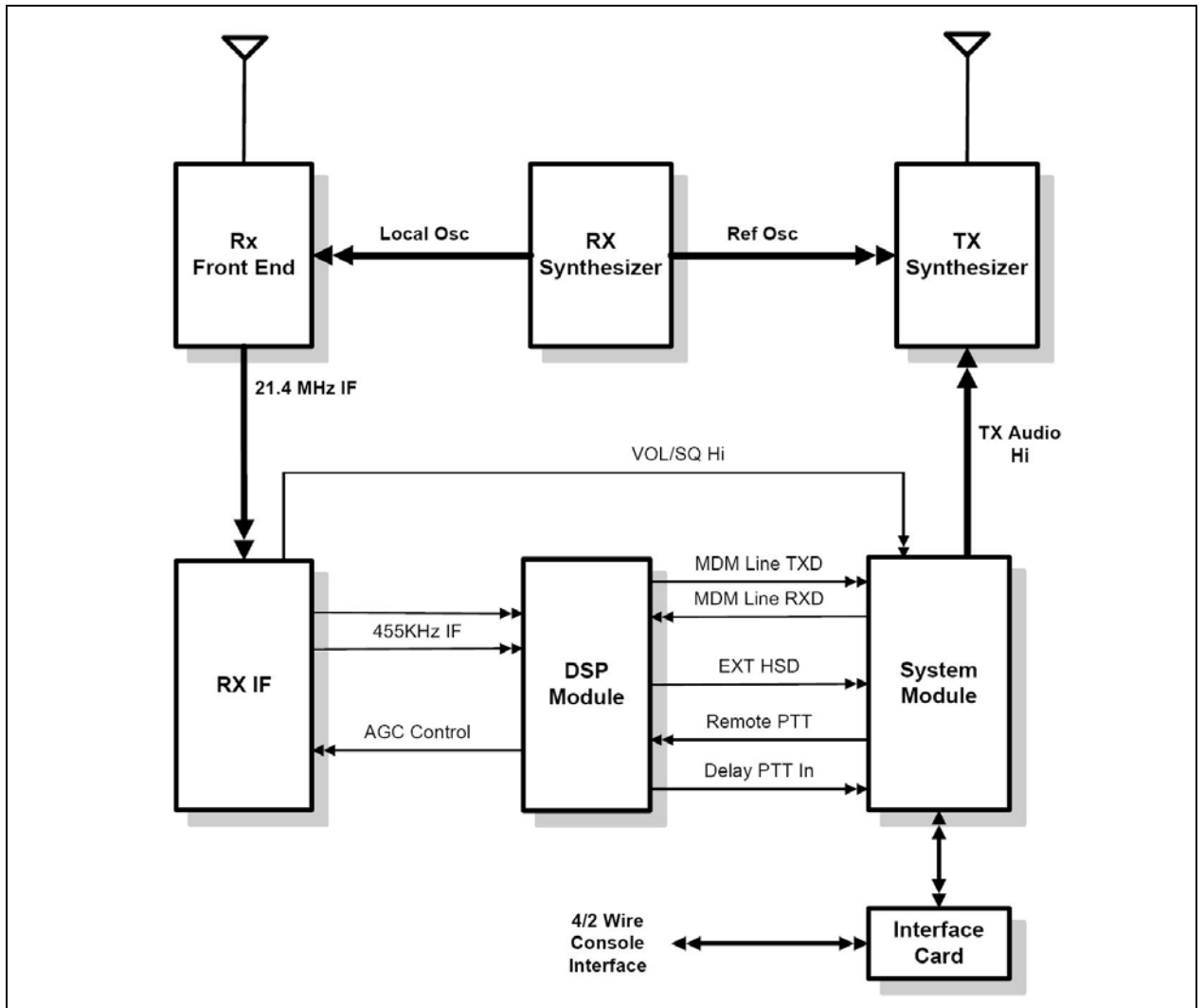


Figure 5-1: MASTR III P25 Conventional Station Functional Diagram

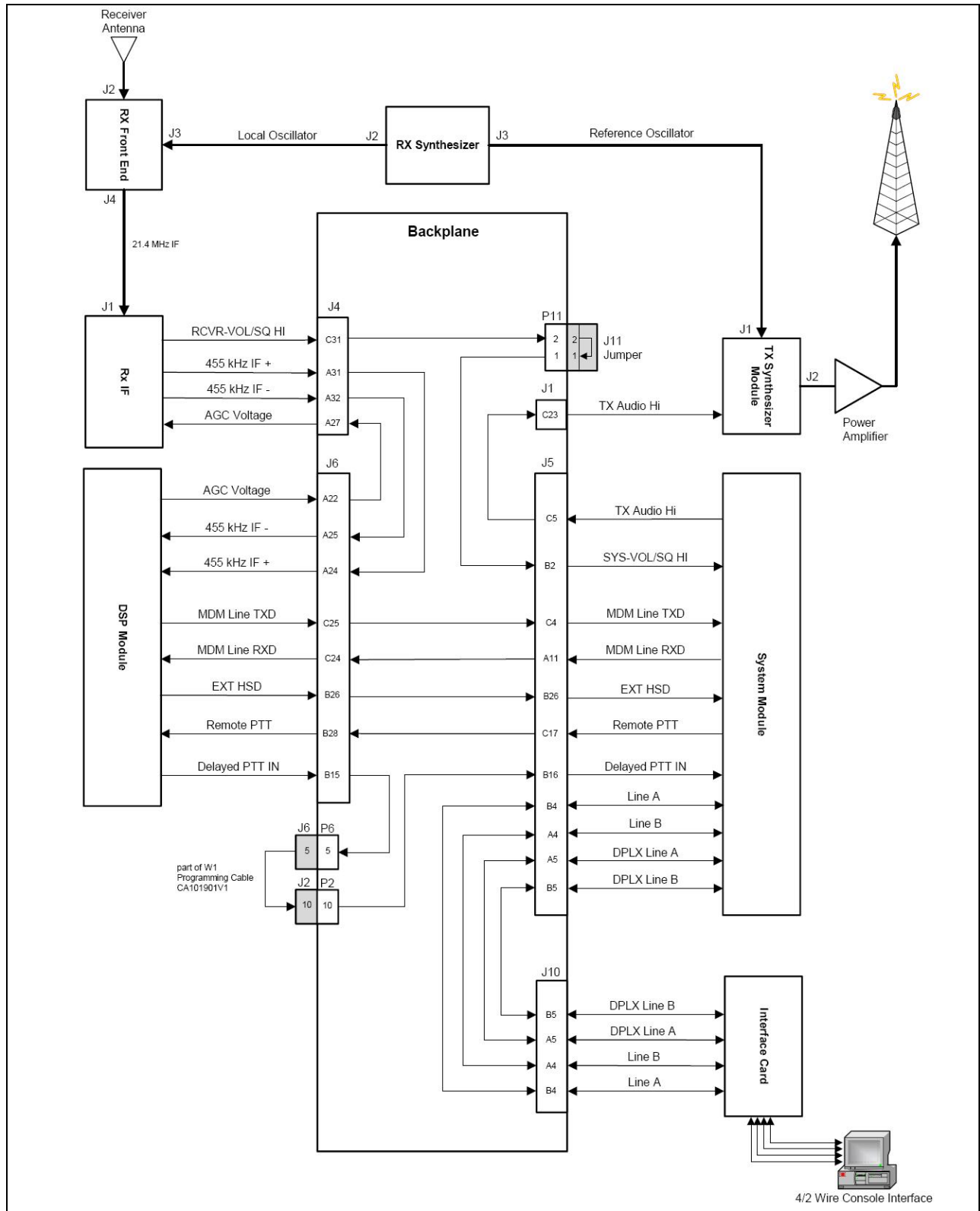


Figure 5-2: MASTR III P25 Conventional Simplified Interconnect Diagram

5.6 PROGRAMMABLE FEATURES FOR CONVENTIONAL STATIONS

Most MASTR III ADC station features may be accessed using a PC compatible computer and the latest version TQS3353 Programming Software. Station configurations discussed in Section 5 require features to be properly set via programming software.

Most MASTR III ADC feature programming is stored in the Station's System Module. This section of the manual is written to describe the programmable features of the MASTR III ADC station and how they apply to Conventional and P25 Conventional base and repeater station operation.



NOTE

When programming a MASTR III ADC station, it is advisable to read and save (archive) the personality from the station before attempting to program features. Always save (archive) any programming changes to a different filename to preserve the original personality in case the changes you have made are unsuccessful.

Programmable features discussed in this section include the following:

- Conventional Stations (Setup)
 - No Remote
 - DC Remote
 - Tone Remote
 - Type 90
 - DTMF
- Main Station Data (New)
 - Transmit and Receive Frequency
 - Channel Guard
 - TX Pot
 - CG Pot
 - RF Simplex and Rpt
 - PA Power
- Push-to-Talk Options (PTTs)
 - Repeat PTT
 - Remote PTT
 - Local PTT
 - External PTT
 - Morse Code ID PTT
- Potentiometer Settings (Pots)
- More Features (Additional)
 - Carrier Control Timer
 - Squelch Tail Elimination
 - Drop Out Delay Timer
- Control Shelf (Options)
 - Morse Code ID
 - Battery Alarm
 - Logic Standby
 - Intercom
 - Bandwidth
 - Receiver Channel Scan
- Station Remote Control
 - Two-Wire/Four Wire Operation
 - DC Remote Control
 - Tone Remote Control
 - Auxiliary Control Relays
 - Squelch Operated Relay
 - Channel Guard Monitor
 - System Module - DSP

5.6.1 Conventional Stations (Setup)

The initial *Setup* screen in the TQS3353 software allows the station to be defined as one of several Conventional station types include: No Remote, DC Remote, Tone Remote, Type 90 and DTMF.

Other station types appear in the *Setup* screen however only the above are applicable to Conventional stations. The other station types are: Simulcast, Trunked and Multi-Receiver.

5.6.1.1 No Remote

This type of station configuration is typically selected when the station will be operating as a stand-alone repeater. As the name implies, no remote control features will be activated during this mode.

5.6.1.2 DC Remote

Base, Repeater, and Transmit-only stations may be controlled remotely via 2-wire or 4-wire telephone line connections using DC Remote control signaling. DC Remote control uses a DC loop current placed on the phone line to remotely control certain preprogrammed station features such as TX PTT, channel selection and CG Enable/Disable. Further information on 2-wire and 4-wire operation may be found in Section 5.6.9.1, and further information about DC Remote control may be found in Section 5.6.9.2

5.6.1.3 Tone Remote

Similar to DC Remote control, Tone Remote control uses audible control tones sent via the phone line to remotely access certain preprogrammed station features such as TX PTT, channel selection and CG Enable/Disable. Further information may be found in Section 0.

5.6.1.4 Type 90

With Type 90 (T90) signaling, a station is setup to accept a burst of single-tone transmitted by a mobile or portable at the beginning of a transmission which activates certain base or repeater station functions such as CG Disable or Repeater Enable.

For example: when T90 is used to control the Repeater Enable function and the System Module detects the proper T90 signal, the repeater is keyed and operates in carrier squelch, CG or DCG tone mode until one of three things occur: the repeater's receiver is squelched, the repeater's Drop Out Delay Timer is reset, or the repeater Time Out Timer un-keys the station and the repeater is disabled until the next valid T90 tone is received.

There are ten (10) different T90 tones available: 1050 Hz, 1200 Hz, 1350 Hz, 1500 Hz, 1650 Hz, 1800 Hz, 1950 Hz, 2100 Hz, 2250 Hz, and 2400 Hz.

5.6.1.5 DTMF

When DTMF is selected, the station is setup to function as a repeater and uses over-the-air DTMF signaling to enable or disable the repeater and to make channel selections when multiple receive or transmit frequencies are assigned during special applications.

5.6.2 Main Station Data

Main station data may be programmed using the *New*, *Change* or *Read* tabs in the TQS3353 programming software. The *New* tab allows the programmer start with a clear database thereby requiring all parameters and features to be properly programmed from scratch. The *Change* tab allows the programmer to modify an existing data file previously stored to hard drive. The *Read* tab allows the programmer to read and save the station personality while directly connected to the station's Data port.

The main programmable station data parameters include Transmit and Receive frequency, Channel Guard, TX Pot settings, CG Pot settings, RF Simplex/Rpt and PA Power settings. The following sections include a brief description of each parameter.

5.6.2.1 Transmit and Receive Frequency

The System Module is programmed with most of the station's features including transmit and receive frequency assignment. Once the correct control station type has been defined, up to twelve (12) channels may be programmed into one station (16 channels in models with previous vintage System Modules).

5.6.2.2 Channel Guard

A Channel Guard (CG) is a sub-audible (below 300 Hz) tone, used to control one or more functions of a base or repeater station. CG tones may be used to open (or un-mute) the station's receiver audio circuit, provide PTT signaling to stations in repeater mode, or provide control of other station functions. There are two types of Channel Guard (CG) available:

- Tone Channel Guard (CG)
- Digital Channel Guard (DCG)

The System Module, located in the MASTR III ADC T/R Shelf, can encode CG or DCG tones (generate tones to be used by the transmitter) or decode received CG or DCG tones. The System Module may be programmed with different CG or DCG tones on each channel. Each individual channel may also have a different transmit and receive CG or DCG tone; including a mix, such as DCG for transmit and a CG for receive.

For DC or Tone Remote controlled stations, the CG Disable (monitor) function, controlled by DC or Tone Remote control signaling, may override the receiver CG or DCG decoding by un-muting the receiver and allowing all on-frequency activity to be monitored. When CG or DCG tones are used to key repeater stations, the transmitter is activated only when the proper CG or DCG tone is decoded, regardless of the CG Disable condition.

On the System Module, setting the CG MONITOR switch in the UP position (LED indicator lit), causes the receiver to un-mute and operate in the carrier squelch mode. This has no effect on repeater stations using DC or DCG tones to signal a PTT request to the transmitter. The transmitter is activated only if the proper CG or DCG tone is present on the received signal.

5.6.2.2.1 Tone Channel Guard

The industry standard Continuous Tone Coded Squelch System (CTCSS) or CG tones range from 67 Hz to 210.7 Hz. Extended CG tones above 210.7 Hz are available, but can cause some degradation in specifications.

The System Module monitors the station's receive demodulated audio output for a CG tone and signals the station when the proper CG tone is received. Once the proper receive CG tone has been detected, the System Module un-mutes the receive audio and causes other pre-programmed actions to occur.

In addition, the System Module generates any TX CG tones programmed on a channel and routes the audio to the TX Synthesizer card to modulate the carrier. A 135-degree phase shift in the CG tone is also generated at the end of a transmission for 160 milliseconds after the transmitter is un-keyed (PTT button released) to initiate STE in the receiving station, if equipped with STE.

5.6.2.2 Digital Channel Guard

The System Module also encodes and decodes Digital Channel Guard (DCG) tones. There are 83 digital codes available. Any of the digital codes can be assigned to any transmit or receive channel.

DCG functions much like CG however provides many more user codes. The encoding function provides continuous, repetitive digital word modulation to the transmitter. The decode function controls receiver muting to eliminate all calls that are not digitally coded with the assigned CG code.

5.6.2.3 TX Pot

The TX Pot value is used to set the main transmitter deviation limit. There is a unique TX Pot setting for each channel. The value has a range of 0 (min) to 255 (max), with a software default of 71.

5.6.2.4 CG Pot

The CG Pot value is used to set the main CG deviation level. There is a unique CG Pot setting for each channel. This value has a range of 0 (min) to 255 (max), with a software default of 69.

5.6.2.5 RF Simplex and Rpt

The RF Simplex and Rpt features on the Channel Data screen allow the programmer to define whether the associated channel operates in full-duplex or Simplex. Setting RF Simplex to *Yes* will automatically cause the Rpt to be set to *No* and the channel operates in simplex mode.

Setting RF Simplex to *No* and Rpt status to *Yes* defines the channel as full-duplex repeater operation. Setting both RF Simplex and Rpt status to *No* defines the station as full-duplex capable, 4-wire, non-repeater channel.

5.6.2.6 PA Power Pot

The RF Power Amplifier (PA) output power level may be set using the TQS3353 software programming tool. Control signaling occurs between the RF Power Amplifier and the T/R Shelf. Pre-programmed PA Power settings use this signaling to control the level of RF output power and manage PA alarm conditions. There is a unique PA Power Pot setting for each channel. Settings range from 0 to 99, with 99 corresponding to full power output.

5.6.3 Push-to-Talk Options

The System Module allows individual programming of Repeater PTT, Remote PTT, Local PTT, External PTT and Morse Code ID PTT functions with regard to CCT and DODT signaling as well as CG Encode options. Each type PTT signal may be defined to allow or exclude CCT, DODT or CG Encode functions.

5.6.4 Other Potentiometer Settings

Most of the MASTR III ADC station audio level settings are software programmable. Software programmable Pots are used for Line Out, Repeater Gain, Line In, DSP Cancel, DSP In, DSP Compressor, DSP Compressor Threshold and Squelch Pot. These settings are global (not assigned to any specific channel) and therefore apply to the overall station operation

5.6.5 Carrier Control Timer

The MASTR III ADC station may be pre-programmed for a Carrier Control Timer (CCT). Programming of the CCT will prevent the station for transmitting long durations. Use of a CCT may be a regulatory requirement by some agencies, and a means to prevent unwanted transmissions in the event of system failures or accidental keying of remote controllers or terminal devices in repeater applications.

5.6.6 Squelch Tail Elimination

Squelch Tail Elimination (STE) eliminates the burst of squelch noise heard when the received carrier drops immediately and the CG circuit is still un-muted. When using STE, the transmitter remains keyed for a short duration when the PTT is released.

When STE is enabled during CG tone signaling, STE directs the CG tone to be phase shifted by 135-degrees. If the CG detector in the receiving station is equipped with STE, the detected phase shifted CG signal will cause the receiver to mute the audio path before the carrier ends.

When STE is enabled during DCG signaling, STE directs the DCG tone circuit to encode a square wave when the PTT is un-keyed, which continues until the end of the carrier transmission. When detected by the receiving station, the square wave interrupts the DCG signal pattern and mutes the receive audio before the received carrier ends thus eliminating any burst of squelch noise.

5.6.7 Drop Out Delay Timer

The Drop Out Delay Timer (DODT) clocks the time after a PTT un-keys till the carrier ends. When set, the transmitter remains keyed after all PTT signals are finished for the specified time duration. This timer may be set from 0 to 10 seconds, in 10 millisecond increments.

5.6.8 Control Shelf Options

The System Module also provides programming for certain Control Shelf options. These options include Morse Code ID, Voting, Battery Alarm, Aux RX, Logic Standby, Intercom, RX IF Bandwidth and receiver channel scan.

5.6.8.1 Morse Code ID

A Morse Code ID may be programmed into each channel defined in the personality. This feature may also be enabled or disabled on a per-channel basis. Up to twelve (12) consecutive characters from any of the standard 26 letters of the English alphabet, numbers 0 through 9 and the “/” forward slash bar may be entered as a part of a CW ID. No spaces may be programmed within the twelve consecutive characters.

The Morse Code ID is sent at a rate of 20 words-per-minute and may be programmed for intervals of 5 to 30 minutes, defaulted to thirty minutes, with a wait time interval (pause time after CAS or line signal ends) of 0 to 10 seconds in 100 millisecond steps. The ID may be programmed to send either with or without Channel Guard encoding.

5.6.8.2 Battery Alarm

During battery stand-by power conditions, the station power supply applies a battery standby signal to the T/R shelf backplane. The signal is passed to the System Module which generates a default 1200 Hz alert tone and adds it to the transmit audio. The 1200 Hz tone may also be sent down the wire line to any remote control unit in the system (see note).

A battery stand-by condition will not force the station to key or send a PTT. Rather, over-the-air transmission of the alert tone occurs only when the station is keyed by normal operations. This prevents unnecessary battery drain caused by the high current requirement of the station during transmit.

The repetition rate and on-time rate are programmable. The repetition rate sets the time from the beginning of a tone to the beginning of the next tone, and is programmable from 0 to 25 seconds in increments of 1 second. The on-time rate sets the duration of the tone burst, and is programmable from zero 0 to 1 second, in increments of 100 milliseconds.



For Battery Alarm tones to be passed down the wire line, it may be necessary to install R112 on the System Module. Refer to the System Module schematic for installation instructions.

5.6.8.3 Logic Standby

When enabled, Logic Standby will restore certain station features in the event of a power failure or station reset. The features that will be restored are: CG Monitor, Remote PTT, Scan, Priority Scan, Aux Relay Settings, Morse Code ID, Main Receiver, 2nd Receiver, External PTT and Voice Guard.

5.6.8.4 Intercom

When enabled, the intercom feature built into the T/R shelf programming may be set to define the specific combination of line audio, receiver audio and handset audio that is routed to the station speaker. This is a useful tool for the service technician and other on-site operations. After enabling the feature in software by selecting *Yes*, refer to the software *Help* screens for detailed programming configuration information.

5.6.8.5 Bandwidth

The MASTR III ADC shelf is capable of transmitting and receiving signals modulated by two different bandwidths: 12.5 kHz and 25 kHz. This allows the station to meet regulatory and technical requirements of the many different digital and analog and channel spacing/frequency allocation schemes.

5.6.8.6 Receiver Channel Scan

The station may be enabled to scan selected receiver frequencies. Once enabled, each channel programmed in the main programming screen may be added to a scan list by selecting *Yes* or *No*. The scan option may be configured for certain features using MASTR Station Editor (MSEDIT) programming software. Features such as Scan Enabled on Power-up, Priority Scan, Revert Scan, Search Rate and Hang Time are just a few configuration features available through MSEDIT.

5.6.8.7 Voting

The MASTR III ADC station may be configured for voting operation. Voting is the practice of using a Voting Selector with satellite receivers to form a receiver voting system. The satellite receivers are located so that one or more of the receivers will receive a good quality signal from a Personal or Mobile two-way radio transmitting from anywhere in a specified operating area. Each receiver output is connected to a centrally located Voting Selector by an RF link, a Tone or a DC control line, or an E&M pair. The Voting Selector provides continuous voting for the satellite receivers and selects the receiver with the best audio quality.

5.6.9 Station Remote Control

The System Module in the T/R Shelf can be remotely controlled by DC Remote control or Tone Remote control. DC Remote and Tone Remote control signals may allow a user to initiate a transmission, disable RX Channel Guard, listen to received audio, select between two operating channels, and select or deselect certain T/R Shelf functions.

Configuration and operational features for Two-wire, Four-wire, DC Remote control and Tone Remote control signaling are described in the following sections.

5.6.9.1 Two-Wire/Four-Wire Operation

Two-wire describes a single pair of dedicated metallic wires in the form of discrete 600 ohm telephone wire provided by a customer, 600 ohm dry (quiet line only) telephone line provided by a telephone company, or the multiplexed equivalent provided by customer or telephone company owned equipment. This type of circuit will support the bi-directional transmission of audio signals in the nominal 300 to 3000 Hz frequency range. Switched or multiplexed circuits generally will not pass DC Remote control signaling. Support of DC control signals is available only with physical or metallic equivalent circuits and may not be available in some areas.

Four-wire describes two pair of (usually) multiplexed dedicated telephone circuits with one pair going each way. Each pair will support uni-directional transmission of audio signals in the nominal 300 to 3000 Hz frequency range. One pair is usually designated as the SEND pair while the other is designated as the RECEIVE pair. DC signaling and control is usually not available. These circuits may be obtained for voice only or for voice and/or data applications.

5.6.9.2 DC Remote

Control current signaling in a DC Remote Control system is achieved when a DC Remote Controller applies current levels on a wire pair having end-to-end DC continuity. The wire pair may be provided by the customer or a commercial wire line carrier, such as a telephone company. The overall circuit resistance of the wire line between the console controller and the station must not exceed the maximum loop resistance that the controller can support.

The six control current levels recognized by the remote T/R Shelf are:

-11 milliamperes	0 milliamperes
-6 milliamperes	+6 milliamperes
-2.5 milliamperes	+11 milliamperes

Station functions which can be controlled by these control currents are:

- Repeater Disable
- Channel Guard Monitor
- Transmit Frequency Selection
- Receive Frequency Selection
- Scan
- Receiver Selection (Auxiliary Receiver stations)

Please note that when leasing a wire line from a local wire line carrier, not all leased line services support DC control applications.



NOTE

Not all leased line services support DC control applications. Please check with your wire line carrier before attempting DC control on a leased line.

5.6.9.3 Tone Remote

In tone remote applications, the T/R Shelf uses the System Module and its onboard Digital Signal Processor (DSP) to interface with a Tone Remote control unit through a two-wire or four-wire phone line. A MASTR III ADC station may be programmed to allow Tone Remote control of the following functions:

- Repeater Enable (disable)
- Channel Guard Decode Enable (disable)
- Channel Guard Monitor
- Transmit Frequency Selection
- Receive Frequency Selection
- Scan
- Receiver Selection (Auxiliary Receiver selection)
- Auxiliary Output Enable (disable) (Auxiliary Control)

Signaling from a Tone Remote control unit consists of a high level **Secur-it** tone, followed by the appropriate medium level function tone (as well as a hold tone if the transmitter is keyed). The tone control sequence is shown in Figure 5-3.

The Secur-it tone is a +10 dB, 2175 Hz tone that is present for 125 milliseconds. The Secur-it tone is followed by a 40 millisecond, 0 dB Function tone. The Function tone can be followed by a 2175 Hz Hold tone at -20 dB level if PTT is selected. The Hold tone is present as long as the PTT is pressed.

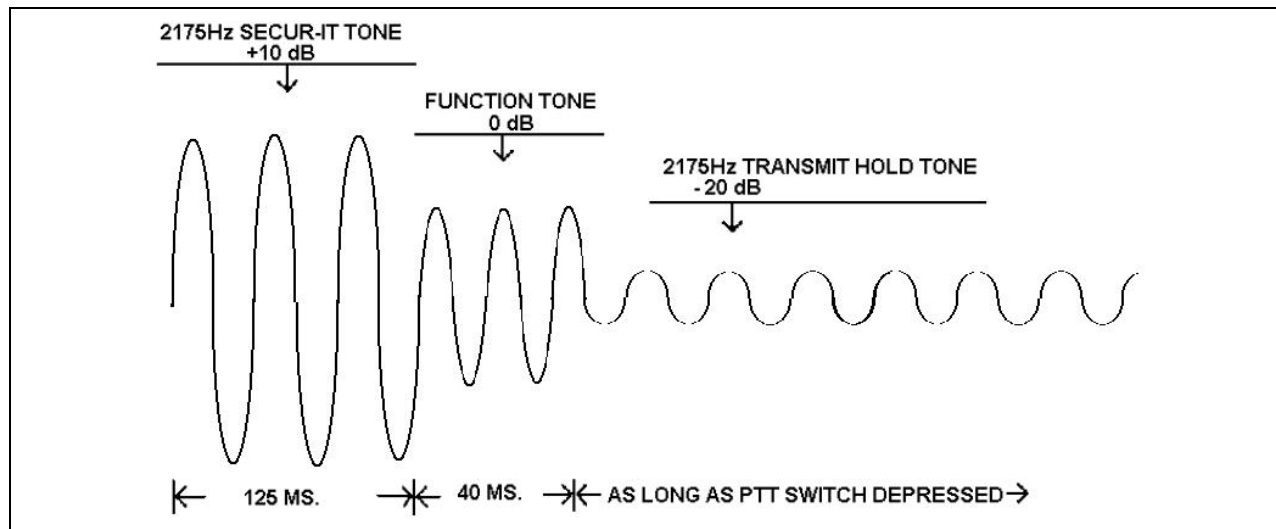


Figure 5-3: Tone Remote Control Signaling

The frequency of the Function tone determines the function selected by a tone remote control unit. Function tones range from 1050 Hz to 2050 Hz, and are spaced 100 Hz apart.

Table 5-1: Typical* Tone Functionality for Tone Remote Control Signaling

TONE (Hz)	FUNCTION	TONE (Hz)	FUNCTION
2175	SECUR-IT / TX Hold	1550	Channel Guard Decode or Repeater Enable
2050	RX Channel Guard Disable (Reset by PTT)	1450	Channel Guard Decode OFF or Repeater Disable
1950	TX Freq. No. 1	1350	TX-Freq. No. 3 or Aux. Function 1 ON
1850	TX Freq. No. 2	1250	TX-Freq. No. 4 or Aux. Function 1 OFF
1750	TX Freq. No 1 or Receiver No. 1	1150	Repeater Enable**
1650	TX Freq. No 2 or Receiver No. 2	1050	Repeater Disable** or Scan Simultaneous Monitor

* The functionality listed for each tone is typical, however may differ for some installations.

** Repeater Enable and Repeater and disable are 1150 Hz and 1050 Hz only when Channel Guard ON/OFF is present.

5.6.10 Auxiliary Control Relay

The MASTR III ADC T/R shelf may be equipped with up to two optional auxiliary relay kits, identified as K1 and K2. Assignment of control functions for each relay may be performed using MSEDIT Programming software.

AUX1 relay (K1) and AUX2 relay (K2) each contain two Form-C contacts and operate under remote control. When AUX1 function is started, the system microprocessor sets signal RXF3/AUX1 to logic high which switches K1. When AUX2 function is started, the system microprocessor sets bit 4 of output register U106 high which switches K2. When the AUX functions are stopped, the control bits are toggled, and the relay coil drops out. Detailed installation instructions may be found in Installation Manual MM102554V1.

5.6.11 Squelch Operated Relay

The MASTR III ADC T/R shelf may be equipped with an optional Squelch Operated Relay (SOR), identified as K3. The SOR (K3) contains four form "C" contacts and is rated for 2 amps at 20 VDC. The relay operates under control of signal RX_1_MUTE, which is derived from the Carrier Activated Squelch (CAS) signal. Detailed installation instructions may be found in Installation Manual MM102554V1.

5.6.12 Channel Guard Monitor

When the CG Monitor function DC control current or tone is received from a remote control unit, the T/R Shelf does not require the correct CG before un-muting the receiver. This allows received audio to be passed down the line to a remote control unit regardless of CG content, allowing the remote operator to monitor all frequency activity prior to transmitting. For repeater stations, the correct CG tone(s) are still required to key the station in repeat mode. This function is automatically reset when a remote control unit keys the transmitter.

5.6.13 System Module - Digital Signal Processing

The System Module also employs a State-of-the-Art audio Digital Signal Processing (DSP). Audio DSP is used to improve audio clarity, provide consistent audio leveling and enhanced tone generation and decoding for more flexible and reliable control functions.

The DSP provides line cancellation used during 4-wire mode to prevent unwanted signaling on the line, notch filtering during voted applications and line audio level processing employing compression and threshold settings.

6 MASTR III ADC STATION DESCRIPTION

The MASTR III ADC base station may be equipped to operate in the VHF, UHF or 800 MHz band. The station equipment is designed to install into a 19 inch wide rack mount equipment cabinet or rack. The station can be equipped with a wide range of modules and accessories to meet a diverse range of system requirements including simplex, half duplex, duplex and transmit-only frequency operation. Modulation schemes include Frequency Modulated (FM) analog and digital modulation. Stations may be equipped as a single stand-alone unit or as a multiple station installation including antenna combining and multiplexing techniques.

The basic set of MASTR III ADC base station equipment consists of the following:

- MASTR III ADC T/R Shelf
- RF Power Amplifier

MASTR III ADC base stations are available with various combinations of the following equipment:

- Station Power Supply
- Antenna Switch
- TX/RX Antenna Duplexer
- TX Combiners and RX Multicouplers
- 37" and 83" Cabinets, and 86" Open Rack

6.1 MASTR III ADVANCED DIGITAL CAPABLE T/R SHELF

The ADC Transmitter/Receiver (T/R) Shelf provides housing and interconnection for the RF and control modules. Figure 6-1 shows a typical MASTR III ADC T/R shelf with the basic set of modules required for basic Conventional FM transmit and receive applications. Additional modules are available for TX Data requirements, RX audio multi-path filtering, and Conventional P25 applications.

The T/R Shelf is comprised of a 19 inch rack mountable enclosure, an Interface board and a Backplane board to interconnect each module. The T/R shelf may be populated with various TX, RX, power and control modules. The function of each module is briefly described in the following sections.

The plug-in modules available for Conventional applications include:

- TX Synthesizer Module
- RX Synthesizer Module
- RX Front End Module
- RX IF Module
- Power Module (DC)
- System Module
- Adaptive Multi-Path Filter Module
- Data Module
- DSP Module

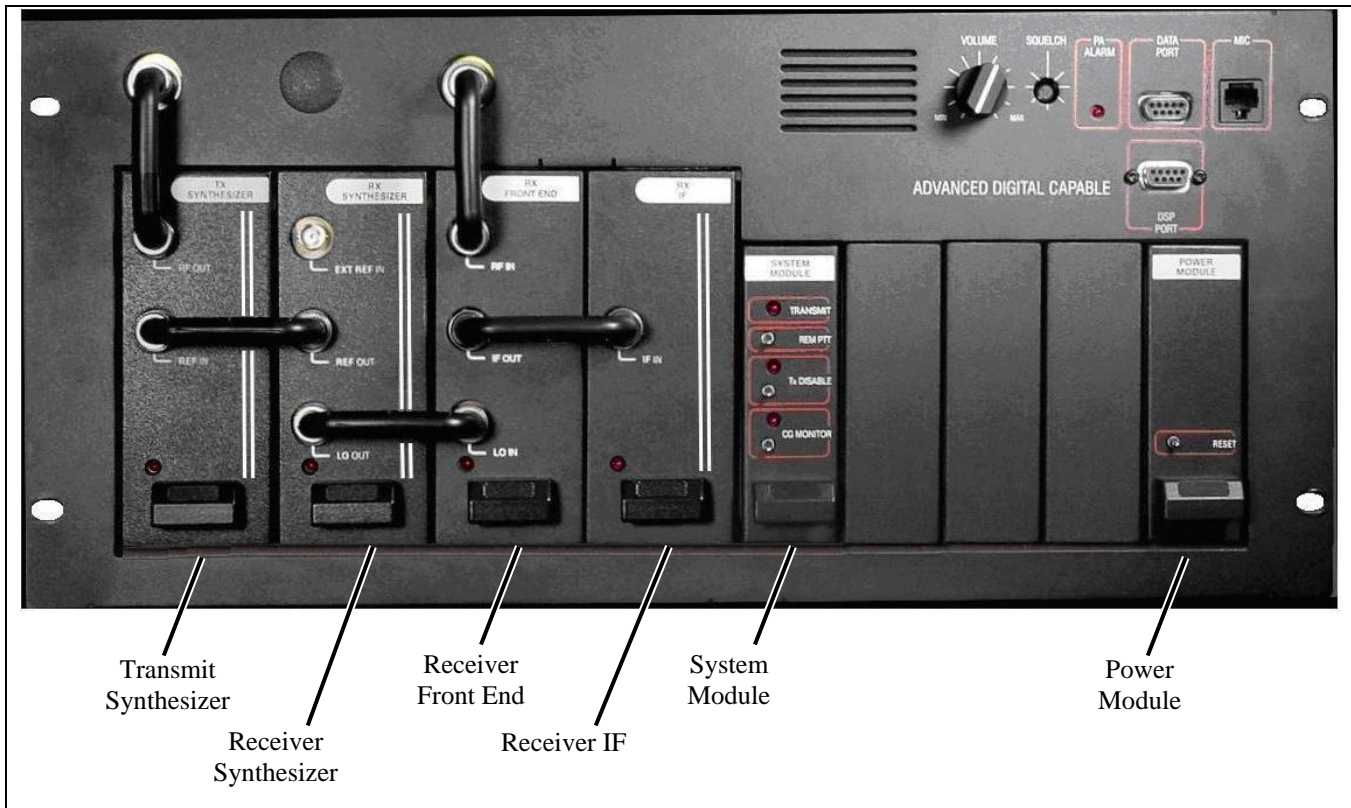


Figure 6-1: Advanced Digital Capable T/R Shelf (Equipped for Conventional FM)

6.1.1 Interface Board

The Interface Board 19D902975, shown in Figure 6-2, is mounted in the top of the ADC T/R shelf and provides the interface between the System Module and the RF Modules, and performs the following functions:

- Control Interface from System Module to RF Modules.
- Telephone line interface with current level detection for remote control.
- Audio PA for local speaker.
- Transmitter power output level and control.
- Manual adjustment with front panel access of receiver squelch and local speaker volume.
- LED indication of PA Alarm.
- Various connectors including RS232 programming port and Mic/Handset port.
- Alarm and monitor junctions of PA output power for MASTR III applications.

6.1.2 Backplane

The Backplane Board CB101126V1, shown in Figure 6-2, is used to interconnect power, low level audio, IF and data signaling between the MASTR III RF, Power and System Modules.

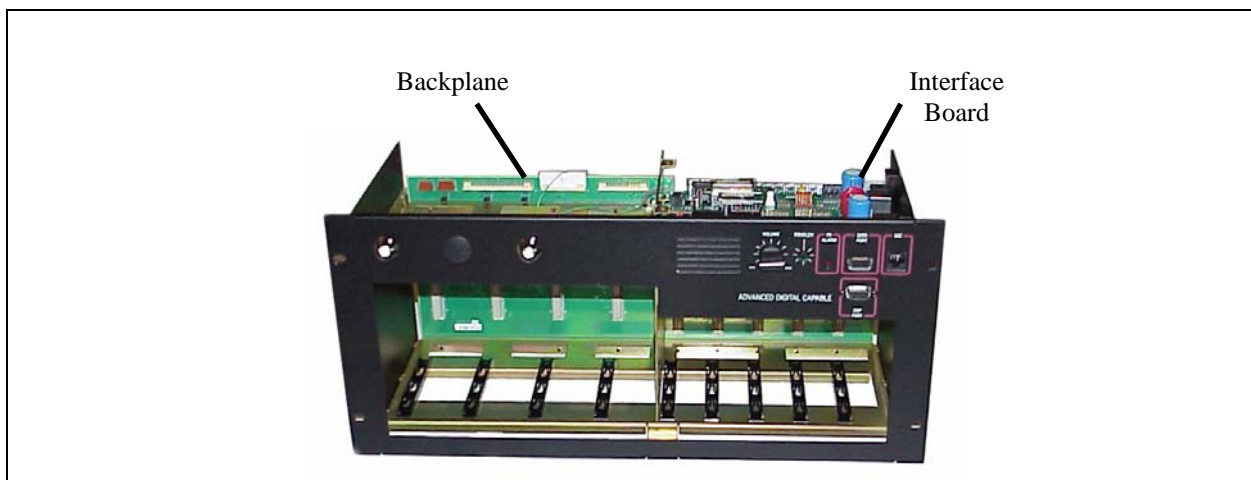


Figure 6-2: MASTR III ADC T/R Shelf Backplane and Interface Board

6.1.2.1 Transmitter Synthesizer Module

The Transmitter Synthesizer Module (TX SYN) model EA101685, shown in Figure 6-3, provides the RF excitation for the input of the base station RF Power Amplifier.

The output of the TX synthesizer is a Frequency-Modulated (FM) signal and derives its reference oscillator signal from either the Receiver Synthesizer Module or Data Module in Transmit-Only base stations.



Figure 6-3: Transmitter Synthesizer Module

6.1.2.2 Receiver Synthesizer Module

The Receiver Synthesizer (RX SYN) module EA101684, shown in Figure 6-4, generates a Phase Locked Loop (PLL) Local Oscillator (LO) signal used by the Receiver Front End Module in the ADC T/R Shelf.

The Synthesizer Module follows operational and frequency determining instructions from the System Module to select between an external or internal reference oscillator which provides a highly stable reference for the PLL to operate. The Receiver Synthesizer Module also provides the selected reference oscillator signal to the Transmitter Synthesizer Module.



Figure 6-4: Receiver Synthesizer Module

6.1.2.3 Receiver Front End Module

The Receiver Front End (RxFE) Module 19D902782, shown in Figure 6-5, provides Front End band pass tuning capable of passing the desired receiver frequency while providing first L.O. image rejection and L.O. signal isolation at the antenna port. The RxFE also mixes the RF signal from the band pass circuit with the Receiver Synthesizer signal to create the First Intermediate Frequency (IF) signal, 21.4 MHz for VHF and UHF systems, and 70.2 MHz for 800 MHz systems. Finally, the First IF signal is passed to the receiver IF module.



Figure 6-5: Receiver Front End Module

6.1.2.4 Receiver IF Module

The Receiver IF (RX IF) module models EA101401V1 (21.4 MHz for VHF and UHF stations) and EA101794V1 (70.2 MHz for 800 MHz stations), shown in Figure 6-6, provides IF filtering, amplification, and demodulation of the IF signal.

Output signals from the IF modules include a balanced 455 kHz IF output for data applications and a demodulated audio output for analog audio applications. The IF Module also provides AGC for the 455 kHz IF signal and includes the receiver squelch circuitry.



Figure 6-6: Receiver IF Module

6.1.2.5 System Module

The System Module 19D902590G6, shown in Figure 6-7, uses programmable microcomputer technology to control the base station's transmitter, receiver, and audio processor. This module contains a Digital Signal Processor (DSP) used for audio processing, tone generation and detection.

The System module can be programmed for up to twelve (12) channel operation during local control or programmed for remote control applications. DC remote control features can control up to two (2) transmit and receive frequencies, while Tone remote control can control up to four transmit and receive frequencies.

Options provided by the Control Section include a transmitter Drop-Out Delay (DOD) timer, Carrier Control Timer (CCT), Channel Guard (CG), and Squelch Operated Relay output (SOR). The CCT is programmable from zero to 10 minutes. The DOD is programmable from zero to 10 seconds. Additional station options include:

- Battery alarm tone
- Type 90 or DTMF tone decoding
- 2/4 wire audio
- Morse code station identification
- Auxiliary control



Figure 6-7: System Module

6.1.2.6 Data Module

Data Module 19D904558, shown in Figure 6-8, allows the MASTR® III Base Station to transmit Non Return to Zero (NRZ) data such as those produced by paging systems.

The Data Module accepts data with rates up to 9600 baud within a range of -25V to +25V. The Data Module produces two corresponding outputs; a modulated 12.8 MHz reference signal to drive the Reference Input of the Transmit Synthesizer, and filtered audio data that modulates the audio input of the Transmit Synthesizer. Together these modulation sources produce a clean data pattern resulting in reliable data transmissions.



Figure 6-8: Data Module

6.1.2.7 AMPF Module

AMPF Module KRG 101 56/1, shown in Figure 6-9, is a self-contained DSP-based plug-in module capable of filtering audible low frequency pops out of the base station's received audio signal.

The module executes a proprietary DSP algorithm that reduces the audible pops primarily caused by the reception of reflected or multi-path RF signals because of an affect known as Rayleigh distribution or Rayleigh fading.



Figure 6-9: AMPF Module

6.1.2.8 Power Module

The Power Module 19D902589G2, shown in Figure 6-10, provides power to the T/R shelf and modules. It contains switching regulators for the +5V, +12V, and -12V DC supplies. The output of the +12V and -12V supplies are further regulated to provide +5V and -5V required by the analog components.



Figure 6-10: Power Module

6.1.2.9 DSP Module

The DSP Module EA101800V1, shown in Figure 6-11, The DSP Module provides the necessary processing to generate and decipher the outbound and inbound P25 signaling.

The DSP module extracts P25 intelligence from the 455 kHz Receiver IF data output and forms it into two outputs, the High Speed Data (HSD) output and a serial output. The HSD output is passed to the System Module for re-transmission and the serial data is routed to a Station SitePro for conversion to IP packets or other formats for remote applications.

The DSP Module also encodes incoming data from the Station SitePro and analog inputs into P25 data and passes it to the System Module. The DSP Module allows the MASTR III P25 station to support the TIA 102 P25 Clear Air interface (CAI) protocol.



Figure 6-11: DSP Module

6.2 STATION EQUIPMENT

6.2.1 Station Power Supply

The MASTR III ADC station is available with either of two models switching power supply. The PS103010 (120 VAC input), shown in Figure 6-12, and the PS24043-0001 (240 VAC input), shown in Figure 6-13, are Multi-Output; AC to DC Switching Power Supplies housed in a metal chassis with built-in dual cooling fans. The supplies replace the previous model 19A149979 series 120V and 240V power supplies.

Both the PS103010 and PS24043-0001 switching power supplies are 600 Watt continuous duty power supply with two independent voltage outputs for full station operation, and includes a built-in battery back-up system. A 27.2 VDC output at 15 Amperes provides power to the RF Power Amplifier while a 13.6 VDC output at 6 Amperes provides power to the MASTR III ADC system (T/R) shelf. The battery back-up circuit includes a built-in battery charging circuit to maintain maximum battery performance. The supply incorporates features for over-voltage and over-current protection, 24V status signaling, and a forced-air cooling system for optimal system performance.



Figure 6-12: 120 VAC Switching Power Supply



Figure 6-13: 240 VAC Switching Power Supply

6.2.2 DC Power Distribution Panel

A DC Power Distribution panel is available for the MASTR III ADC station. This DC panel provides a high current 24 VDC input connection, and a low current 12 VDC input connection from external DC power sources. The panel includes safety fuses for each power source and the necessary distribution points to power station equipment.

6.2.3 RF Power Amplifier Assembly

The RF Power Amplifier (PA) Assembly EA101292, shown in Figure 6-14, amplifies the exciter output to rated output power level. This module contains a power module, amplifier drivers and power control circuitry required for power amplification.

The Power Amplifier Assembly is a continuous duty, solid state, wide-band RF power amplifier. Its main function is to amplify the 10 mW FM signal from the Transmitter Synthesizer to the rated RF output at the antenna port. The output of the Power Amplifier Assembly is typically 110 Watts for VHF (adjustable from 10 to 110 Watts) and 100 Watts for UHF and 800 MHz (adjustable from 10 to 100 Watts) as measured at the PA output port.



Figure 6-14: RF Power Amplifier

6.2.4 RF Antenna Switch Assembly

An RF Antenna Switch assembly, shown in Figure 6-15 is available for conventional MASTR III ADC stations operating in the simplex or half-duplex base station mode.

The Antenna Switch is available with or without mounting hardware and cabling. Mounting hardware options are available for mounting the Antenna Switch either directly to the RF PA assembly or as a 19" rail mounted device.



Figure 6-15: Antenna Switch

6.2.5 Cabinet Enclosures and Open Rack Assembly

MASTR III ADC station equipment is typically installed in a steel cabinet or rack, however may be ordered without a cabinet or rack. Cabinet enclosures include front and rear doors for full station access. Also available is an indoor open rack and a weatherproof outdoor cabinet.

The following list defines the available cabinet sizes, styles, and number of MASTR III ADC stations that can be installed into each type of cabinet or rack, dependent upon the hardware options installed in conjunction with each station:

- 37" Indoor Cabinet (1 station per cabinet)
- 45" Weatherproof Outdoor Cabinet (1 station per cabinet)
- 69" Indoor Cabinet (1-4 stations per cabinet)
- 83" Cabinet (1-5 stations per cabinet)
- 86" Open Rack (1-5 stations per rack)

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