RF-Orchestra Linear Transmitter Product Specification

System Description

Motorola is proud to present the RF-Orchestra! (RF-O!), the industry's most advanced transmitter for your two-way voice and data paging needs. The RF-O! offers efficient spectrum management in the new 50-kHz channels at 900 MHz operation. It provides the outbound wireless communications link to ReFLEX and InFLEXion pagers, and meets all modulation and performance requirements for Narrowband PCS services.

Motorola's RF-O! is offered as a single-or double-channel transmitter. By adding more linear amplifiers and power supplies, and by the addition or replacement of a combiner, each channel expands to support a maximum of four ReFLEX or InFLEXion subchannels. As more subscribers are added to a system, capacity is increased by having properly spaced transmitters operating on the same frequency and transmitting different messages at the same time on different subchannels.

System Features

The RF-O! uses linear technology to maximize the greatest spectrum efficiency in the Narrowband PCS channels. It allows a single PA to provide multiple channel operations within a bandwidth of 50 kHz while maintaining rapid channel switch time and superior performance. The modular design maintains an average power level for the ReFLEX or InFLEXion protocol despite varying power levels. This is accomplished by multiple channels utilizing frequency re-use techniques.

Expansion

Modular PA building blocks create a platform that is easily expanded. Messaging capacity is added by increasing the number of supported subchannels. Any RF-O! in the 83-inch cabinet can migrate to up to four subchannels by adding PAs and power supplies and replacing the combiner and / or other peripherals while still maintaining a 75-W average power.

Smart Power Control

Depending on capacity requirements, the Smart Power Control advantage allows the RF-O! to modulate one or two channels at 75 watts each. This feature also allows the RF-O! to maintain maximum power output under the most adverse conditions.

Smart Power Control offers the ability to automatically shut off an individual malfunctioning PA. Thus, with Motorola's paralleled architecture, if one PA goes down, information is still transmitted.

System Components

The RF-O! consists of the following components:

- An Orchestra Control Chassis, containing the following modules:
  - Orchestra Control Module (OCM)
  - RF exciter
  - DC/DC converter
- AC distribution panel
- Power amplifier
- AC power supply (s)

Optional components available for the RF-O! are as follows:

- RF peripherals
- Transmitter peripheral broadband 13-MHz package
- Transmitter peripheral 200-kHz package
- Transmitter peripheral 1-MHz package
- RF-Baton! (RF-B!) transmitter controller without Global Positioning System (GPS)
- RF-B! transmitter controller with GPS
- Battery revert
- RF-A!
- RF-A! peripheral
- Combined InFLEXion and ReFLEX protocol software
- Network peripheral options

The following diagram shows each component in a two-channel system, and the following paragraphs provide a brief description of each component of the RF-O!.

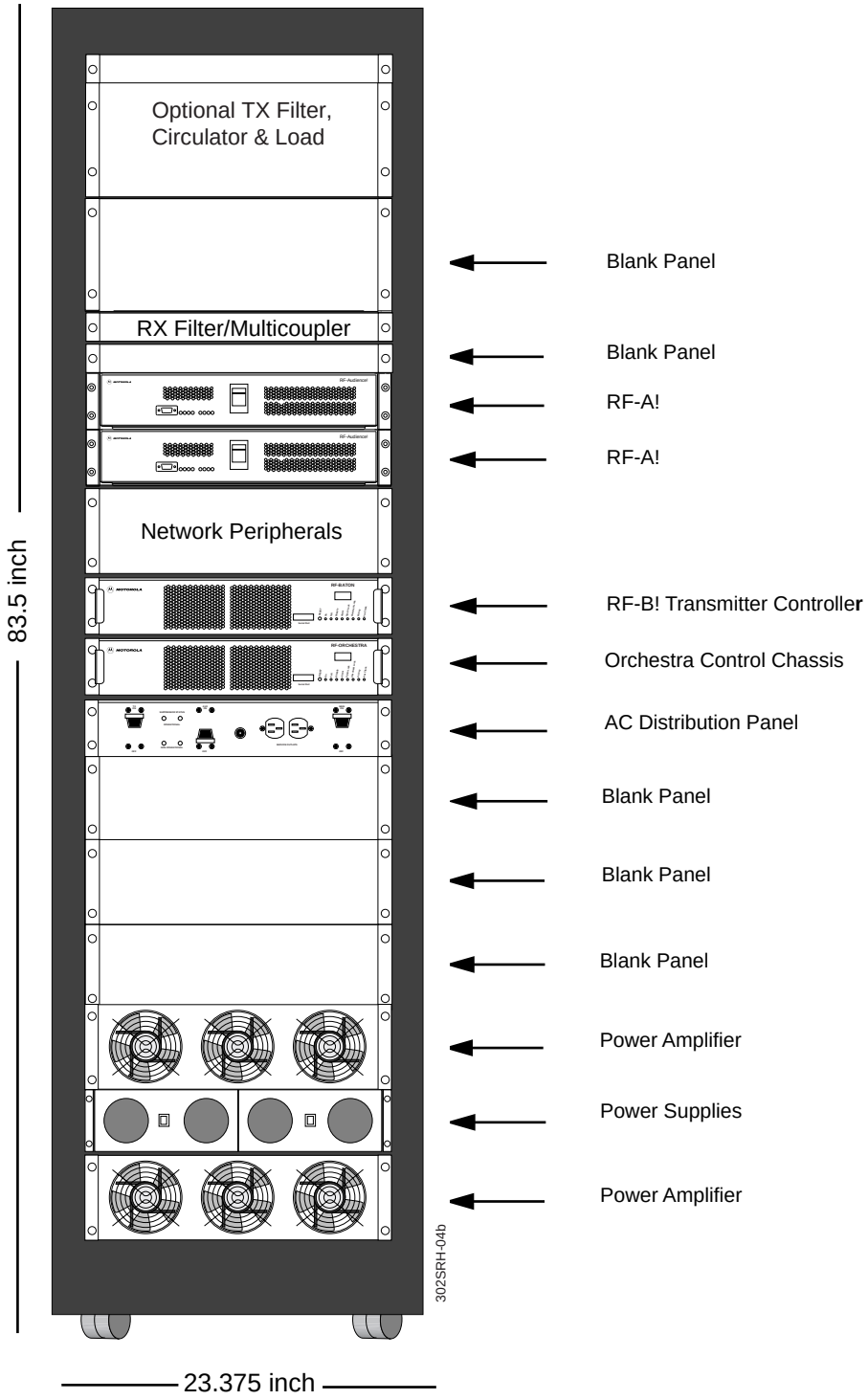

Figure 1: RF-O! Two-channel Transmitter

Hardware Configuration

Orchestra Control Chassis

The Orchestra Control Chassis contains an Orchestra Control Module (OCM), exciter, module, and a DC / DC converter. This RF-shielded enclosure interconnects the OCM, exciter, and DC / DC converter with all other station modules through the backplane interconnect board.

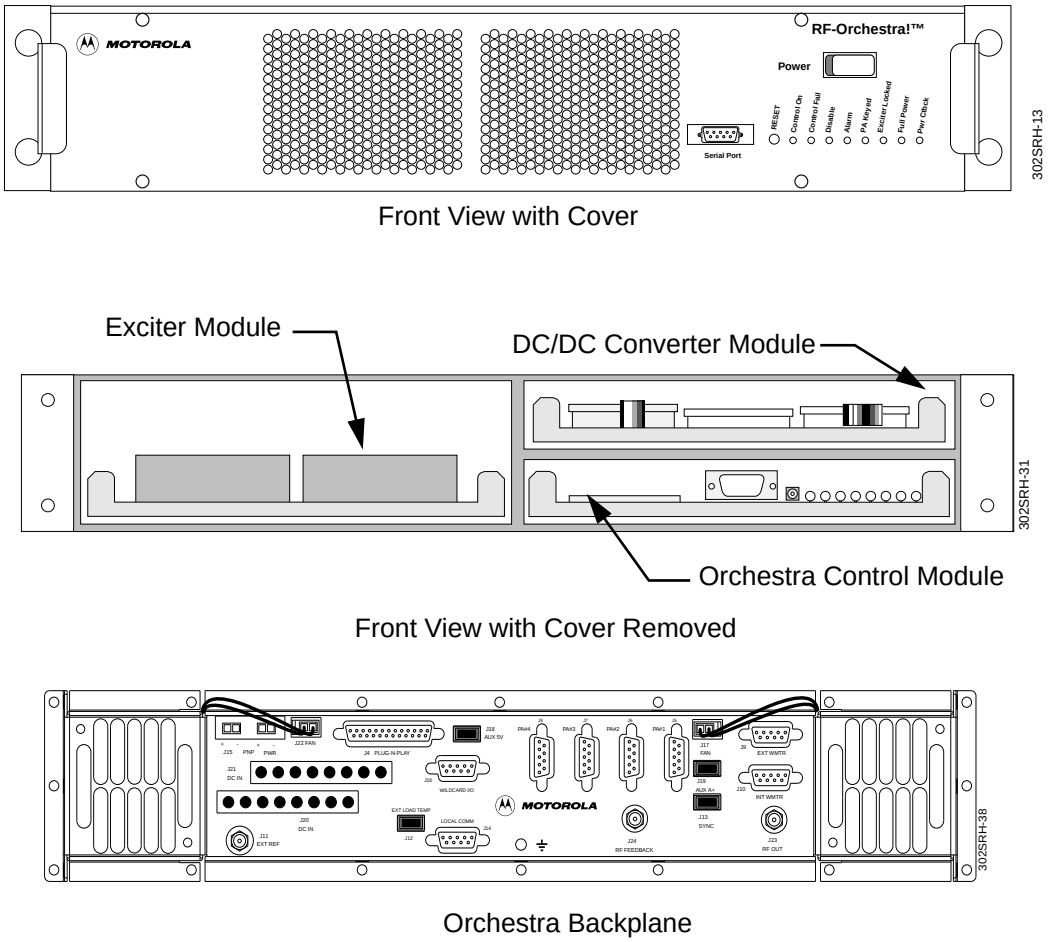

Figure 2: Orchestra Control Chassis

Orchestra Control Module

Located within the Orchestra Control Chassis, the OCM is a microprocessor / digital-signal processor based board that responds to RF-B! commands. The OCM transmitter controller is a 19-inch, rack-mounted module that is two EIA rack units high (3.5 in.). The OCM directly controls the exciter module to maintain proper RF modulation and time synchronization for protocol operation. Additionally, the OCM monitors proper operation in the exciter and the PA through a serial peripheral interface bus. The OCM design meets all requirements for interface with the RF-B!.

The Orchestra Control Module has a serial port located on the front panel for a local or remote interface. The serial port uses RS-232 signaling with a DB-9 connector. Using Motorola's Friendly Interface Protocol System (FIPS), an operator can access all station parameters and diagnostic information.

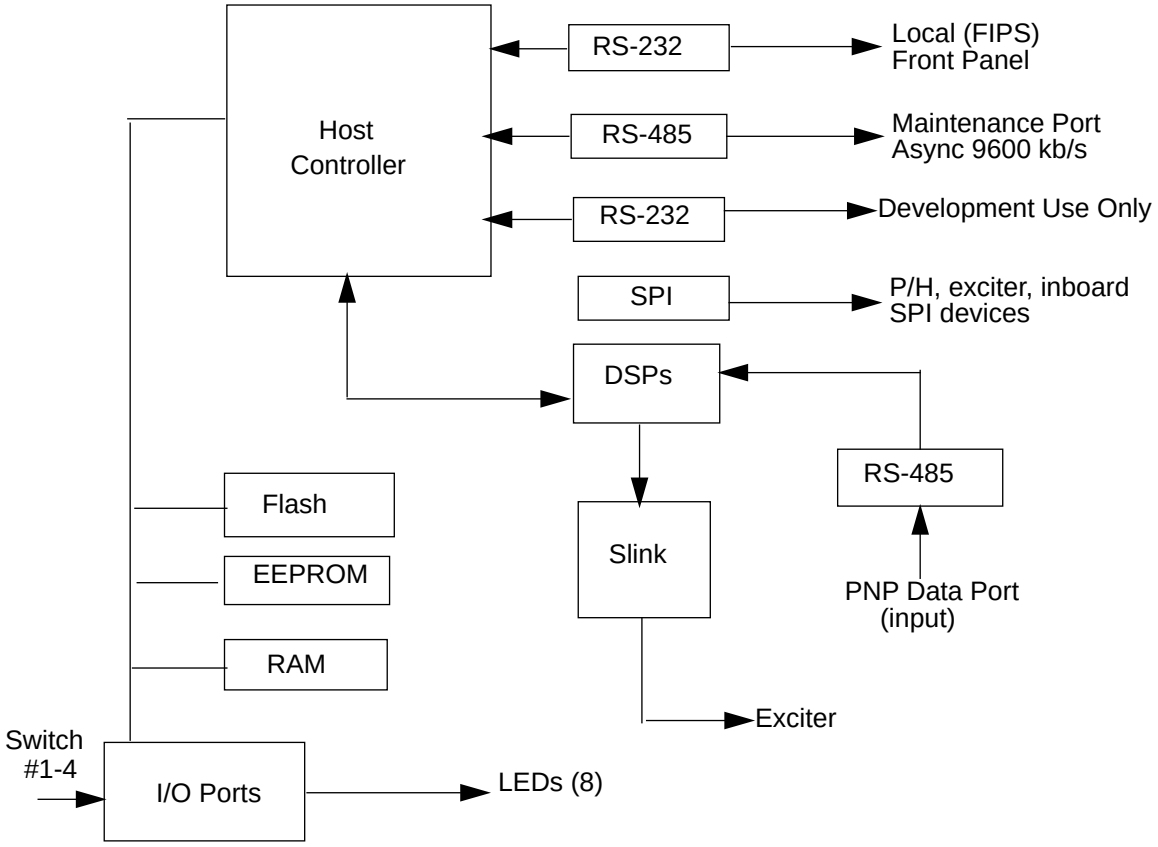

Figure 3: OCM Block Diagram

RF Exciter Module

The RF exciter module converts high-speed, digital baseband data generated by the OCM into selected RF frequencies. A custom linearization IC with a built-in inphase and quadrature digital modulator accurately shapes waves for broadcasting messages. The output of the exciter is the station carrier frequency and contains the appropriate modulation for message delivery.

Depending on the final RF output from the power amplifier(s), as measured by the internal wattmeter sensor, the RF level output from the exciter is variable during the active keyed state.

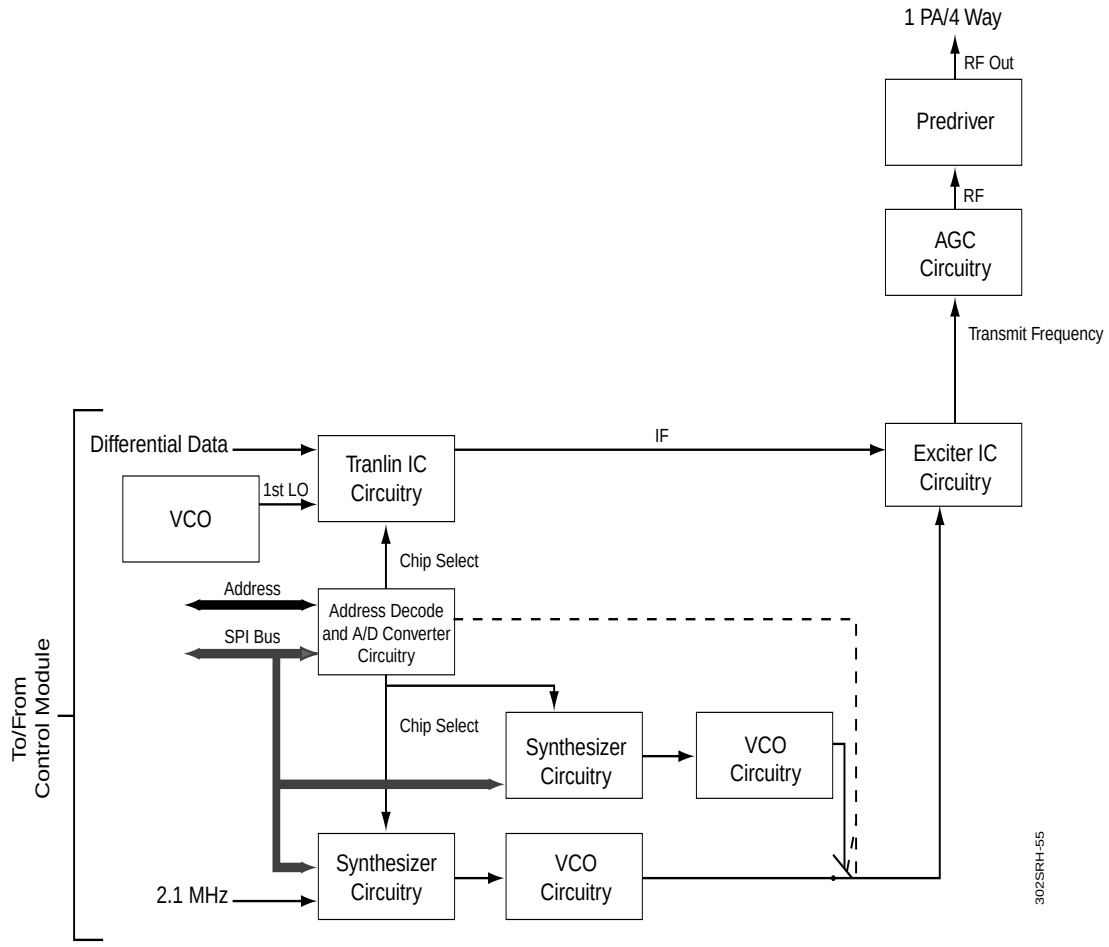

Figure 4: Exciter Block Diagram

DC/DC Converter

The DC / DC converter provides the OCM and exciter with +5-V and +14-V regulated DC voltages. These voltages are taken from the +28-V secondary output from the power supplies.

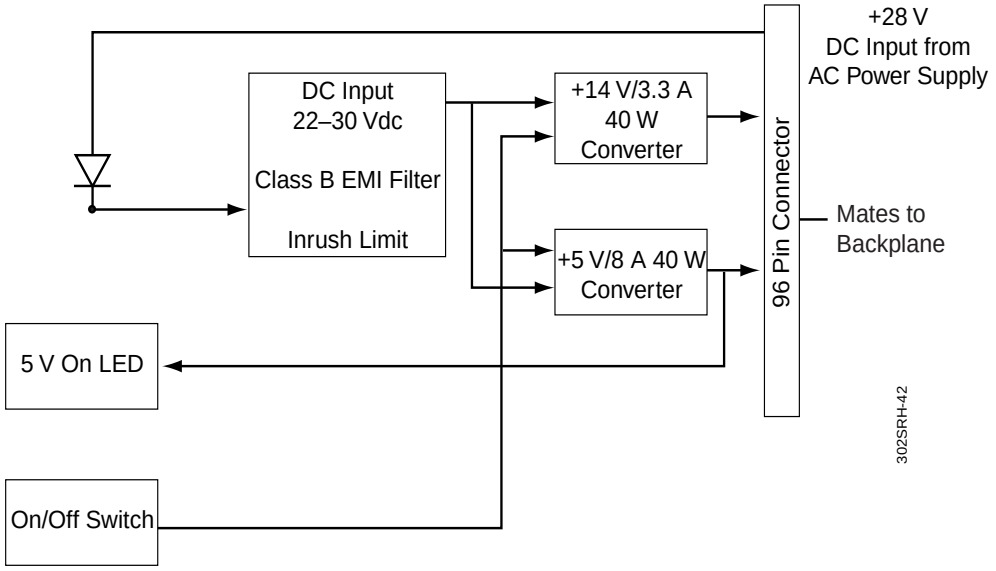

Figure 5: DC/DC Converter Block Diagram

AC Distribution Panel

The AC distribution panel provides the main AC power input to the transmitter and all AC-powered modules. The panel has silicone diode surge protection and distributes 220 Vac and 120 Vac as required in the cabinet.

The panel includes two 120-V service outlets located on both the front and the rear of the unit.

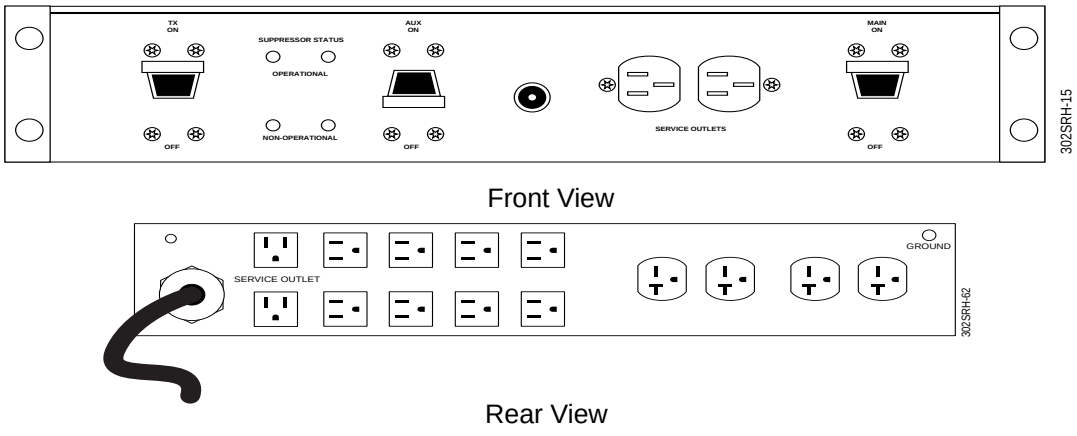

Figure 6: AC Distribution Panel

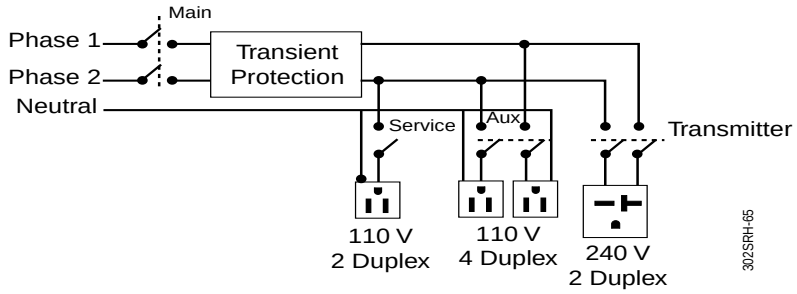

Figure 7: AC Distribution Panel Block Diagram

A 10-foot line cord with a NEMA L14-30P plug exits from the top of the cabinet. The main circuit breaker switch connects or disconnects AC power to all AC plugs on the panel. This breaker switch (located on the right of the panel) prevents injury when inserting or removing the AC plug.

The transmitter circuit breaker switch connects or disconnects the four 240-Vac receptacles on the back of the right side. This breaker switch connects or disconnects AC power to all RF-O! power supplies (two, three, or four units).

The auxiliary circuit breaker switch connects or disconnects all the 120-Vac duplex outlets, except the service duplex outlet on the back and front of the AC distribution panel. Positioning this switch to OFF powers down any optional RF-A!s and any AC-powered network modules for the RF-O! and RF-A!(s).

The main circuit breaker, which can be reset, provides the service outlets with 120-Vac power. This circuit breaker only requires resetting after a high current is detected and pops the button out of the breaker.

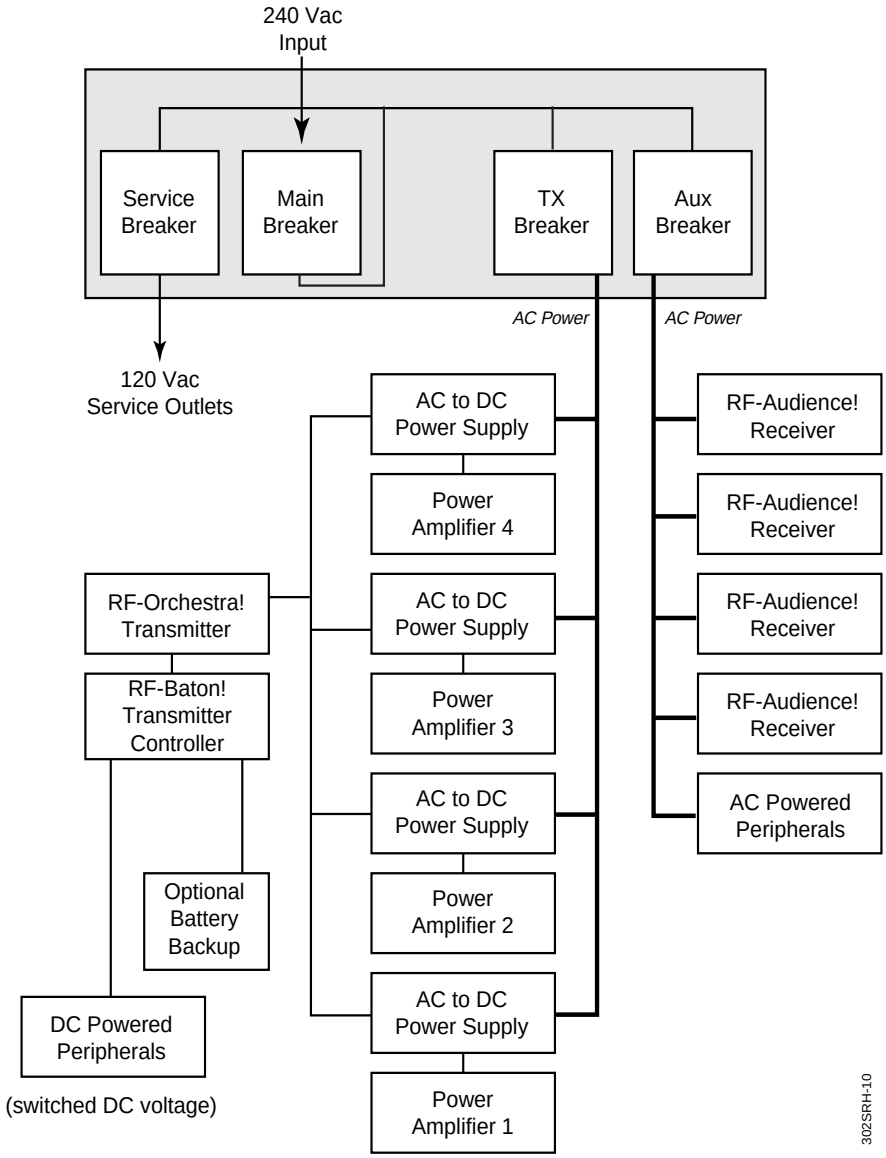

Figure 8: Power Connections Block Diagram

Power Amplifier

The power amplifier (PA) is a linear RF gain module that amplifies the exciter output to the required amplitude for proper system operation.

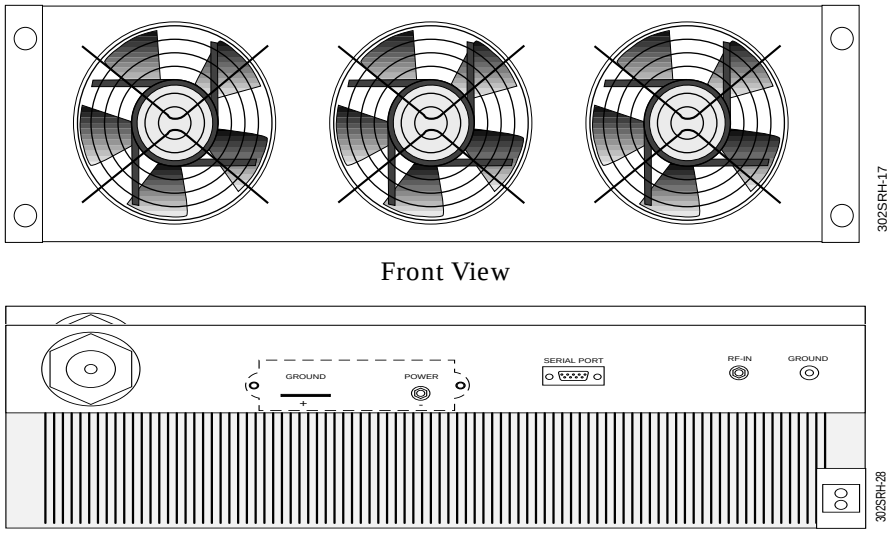

Figure 9: Power Amplifier Chassis Front And Rear View

The PA module accomplishes amplification in three distinct stages. These stages are similar in operation and connected serially.

The first stage is the predriver power amplifier (PPA). This stage receives its RF input from the exciter module located in the OCM and amplifies the RF to a higher level required for the second stage. The driver power amplifier (DPA) is the next stage. The DPA output is split into three equal amplitude signals for the final stage.

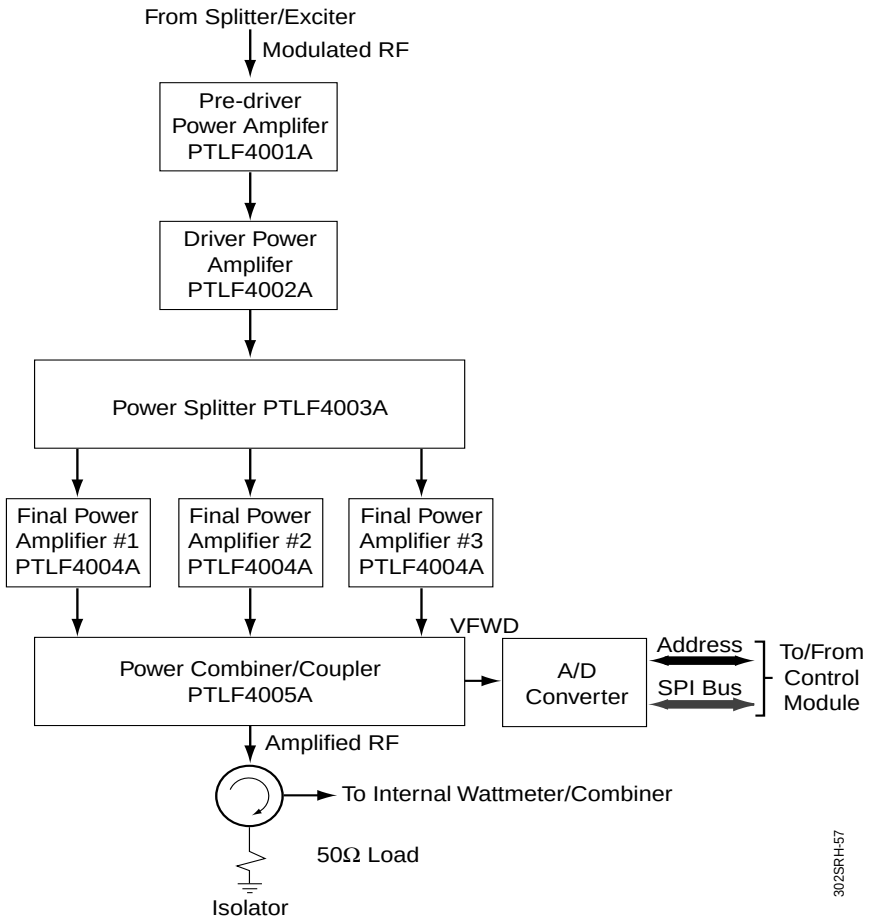

Figure 10: Power Amplifier Block Diagram

The third and final amplification stage has unique performances for high-power RF generation. This stage uses three final power amplifier (FPA) modules in parallel. Each FPA amplifies the input signal and outputs the RF signal into a combiner module. The combiner reconstructs a single output that is fed to the PA output. The high-power output level is then monitored by a forward power detector and is isolated from any external RF load variation by a circulator with an internal high-power load.

The PA is equipped with AC fans to provide front-to-rear airflow. Front-to-rear airflow provides the heat sink with the lowest ambient air temperature available.

AC Switching Power Supply

The AC switching power supply receives 220-V input from the AC distribution panel and provides +28-Vdc power required by other modules in the transmitter. Inputs and outputs are filtered to meet FCC Part 15, Class B operation. Power supply operation meets UL and CSA agency approval.

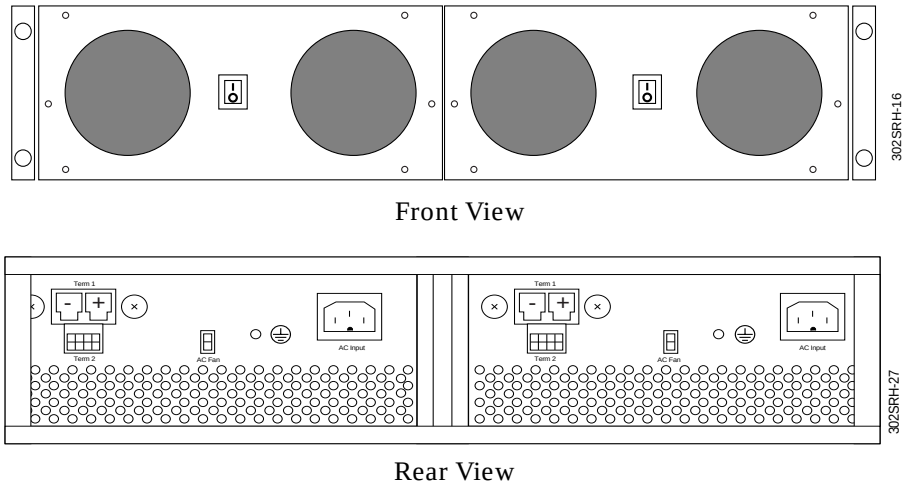

Figure 11: AC Power Supply Chassis Front And Rear View

This switching power supply is built to react quickly to the large power variations existing in the InFLEXion voice protocol. The power converter starts with power factor correction circuitry that maintains near-zero phase shift between the input voltage and the current. The second power conversion drops the high voltage to +28 V. Input current rush is limited to less than 120 amps in 10 ms. Two power supplies, rated at 1200 watts, are required for the single- and two-channel RF-O!.

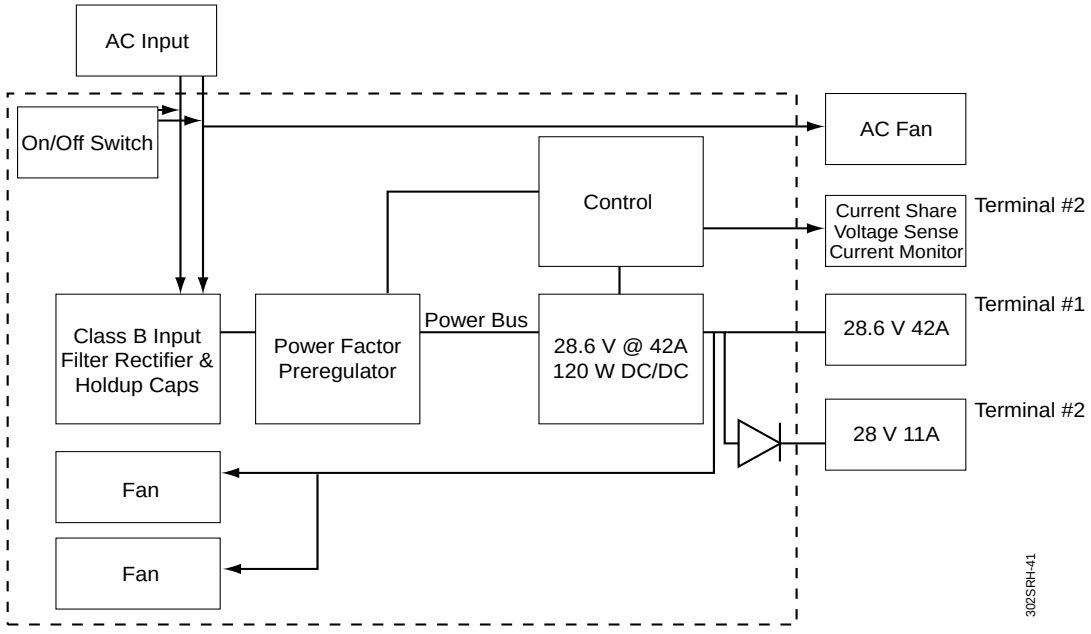

Figure 12: AC Power Supply Block Diagram

The RF-O! receives AC service from the AC distribution panel. The 240V / 120V is supplied from a center tapped transformer. Each RF-O! configuration is at 75-W average RF output for each subchannel.

If the preferred service is not available, a 3-phase, 120-V (phase-to-neutral) service can be substituted. This service is limited to 20 amps.

Operations

Control Distribution Links

The RF-Controller! manages the operation of the RF-O! through the RF-B!. The controller assigns tasks such as transmitter keying and frequency assignment, queuing, packetization, delivery of messages, station status reporting and/or system diagnostics. The control path interface between the RF-C! and the RF-B! is either by VSAT or Digital Data Service (DDS).

Subsystem Diagnostics

Each RF-O! module contains diagnostic abilities that assess subsystem operational failures to the level of the Field Replaceable Unit (FRU) modules. Remote diagnostic monitoring is supported through a computer software emulation program.

The following critical alarm points are supported:

- Paging is disabled - caused by pendulum reference, high-stability reference failure or exciter synthesizers out of lock.
- Station reset - issued upon any reset or power-up.
- OCM transmitter power output - caused by low forward power or high reflected power detected on the OCM.
- OCM transmitter power cutback - caused by an intentional power cutback on the OCM due to power supply failure, PA high temperature, or power clip.
- OCM transmitter paging disabled - when paging is disabled
- OCM transmitter reset - OCM software reset occurred.
- OCM transmitter control error - A PnP control command was invalid.
- OCM transmitter data error - A PnP symbol data command was invalid.

Orchestra Control Chassis

The front panel of the Orchestra Control Chassis includes the on/off switch, a serial port for interfacing with a remote terminal, and all operating indicators. The following paragraphs describe each of these items in further detail.

The Orchestra Control Chassis front panel includes:

- Power button: powers the RF-O! up or down
- Reset switch: re-initializes RF-O! operation
- Eight LEDs: display critical system information
- Serial port: nine-pin connector that interfaces with the FIPS system

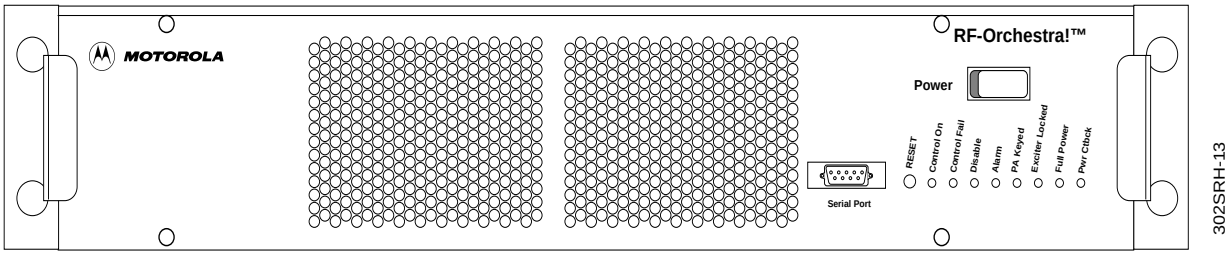

Figure 13: Front View Of The Orchestra Control Chassis

LEDs

The initial two seconds of OCM power-up turns on all eight LEDs to verify operational conditions. After the initial two seconds, all LEDs turn off for five seconds. Beyond the first seven seconds, each LED indicates the functions shown in the table, until powered down or a manual reset.

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Table 1: Orchestra Control Module LED Definitions and Standard Operating Conditions

LED	Function	Color	Normal Condition
Control On	ON when the control module is operating successfully after completing a power up or reset.	Green	ON
Control Fail	ON when a control module fatal failure is detected.	Red	OFF
Disable	ON when normal paging activity is disabled.	Red	OFF
Alarm	ON after a station alarm is detected.	Red	OFF
PA Keyed	ON when the station is transmitting.	Green	ON
Exciter Locked	ON when the station is locked on transmit frequency.	Green	ON
Full Power	ON when all PAs have full power.	Green	ON
PWR Ctbck	ON when any PA is not operating at full power.	Yellow	OFF

Optional Components

The options available for the RF-O! are:

- RF peripheral options
- Transmitter peripheral package (13-MHz broadband cavity)
- Transmitter peripheral package (200-kHz bandpass / Hi Q)
- Transmitter peripheral package (1-MHz bandpass cavity)
- RF-B! Transmitter Controller without GPS
- RF-B! Transmitter Controller with GPS
- Battery revert
- RF-A!
- RF-A! required and optional packages

RF Peripheral Options

To minimize interference with other communications equipment, several transmit filtering options are available. Filtering requirements are determined by site and customer system requirements. Options include a single-stage isolator, bi-directional coupler with linear detector, and a thermal switch integrated in an isolator load.

The filter / isolator package provides transmitter noise suppression, IM protection, and post-filter power metering, which protects the transmitter from high reflected RF power levels. The RF-O! offers three transmitter peripheral packages to meet most site and customer needs.

Transmitter Peripheral Package (13-MHz Broadband Cavity)

This package includes a wide passband (928-941 MHz) filter that is extremely versatile for ReFLEX and InFLEXion applications. The filter offers low insertion loss across the band, attenuates over 85dB in the 901-902MHz band, and allows customers to use both bands (930-931 and 940-941) of the narrowband PCS spectrum. The package includes an external wattmeter / detector, an isolator, and cabling.

Transmitter Peripheral Package (200-kHz Bandpass/Hi Q)

This popular package includes a waveguide designed dual bandpass cavity filter that offers extremely high selectivity in the 928-941 MHz range. The narrow bandpass of the filter (~100 kHz) allows it to be used for customers with 100 kHz or less of bandwidth. At 1 MHz away from the center, the filter offers over 25dB of attenuation. This filter meets Motorola site standards and is highly recommended for reducing transmitter noise and IM interference at congested sites. The package includes an external wattmeter / detector, an isolator, and cabling.

Transmitter Peripheral Package (1-MHz Bandpass Cavity)

This narrowband cavity offers a 1-MHz resolution filter that is fixed tuned at either the 930 MHz band or the 940 MHz band. It covers customer applications that require a wider bandpass than the bandpass cavity option, and require some selectivity in the 928-941 MHz band. The package includes an external wattmeter / detector, an isolator, and cabling.

RF-B! Transmitter Controller without GPS Receiver

When the RF-B! is integrated with the transmitter, it decodes incoming signals sent from the RF-C!. It also performs secondary voice processing for InFLEXion paging, accepts remote software downloads, and transfers software downloads to the OCM. The RF-B! is a 19-inch, rack-mounted module that is two EIA rack units high (3.5 in.). A laptop computer, interfacing with the RS-232 FIPS port on the RF-B!, can be used to program transmitter parameters and run diagnostic traces.

Note: The RF-B! must be connected to an external GPS receiver that the customer provides. The software is set up to work with the Trimble Accutime II GPS Receiver and the Motorola UT Oncore Remote GPS receiver.

RF-B! Transmitter Controller with GPS Receiver

This option is the same as above but includes the Motorola GPS receiver. The GPS receiver detects signals from the US Department of Defense NAV STAR GPS satellites. The GPS receiver is used for time synchronization and optimal simulcast performance.

Battery Revert

The battery revert option includes the batteries, cables, and tray to operate the RF-B! and network modems in the event of a power failure. It provides four hours of battery revert.

RF-A!

Transmitter sites can consist of an RF-O! station and a co-located RF-A!. A maximum of four RF-A!s can be co-located in the 83-in. RF-O! cabinet.

RF-A!s are required for receiving inbound messages. These messages include registration, location, and acknowledgments from the pagers. After processing by the RF-A!, inbound messages are sent to the RF-C!. A receiver site can be co-located with the transmitter sites, although some stand-alone receiver sites may be required, depending on coverage requirements.

Each RF-A! is a 19-in. rack-mount chassis that is two rack units (3.5 in.) high. Each RF-A! only receives signals on a single 12.5-kHz inbound channel. The receiver uses diversity antennas to maximize signal gain in multipath environments. The RF-A! also uses advanced DSP demodulation techniques for inbound frequency shift keying messages at 800 and 1600 bps. Whether co-located or stand-alone, all RF-A!s support remote software downloads.

RF-A! Required and Optional Packages

The RF-A! uses GPS synchronization for inbound message transmission. The GPS receiver may be located on the reference module in the RF-B! chassis or may be external to the RF-B! module. For sites with co-located transmitters and receivers, the receivers monitor the GPS time and the one pulse-per-second timing from the GPS receiver in the RF-B!. For sites with stand-alone RF-A!s, a separate GPS receiver and antenna are required.

This package provides the software required for the InFLEXion protocol (voice messaging) and the ReFLEX protocol (two-way data messaging), and is required when ordering an RF-O!.

Optional Rx filtering is available to minimize interference by RF generating sources in the receiver's range.

An optional multicoupler allows for more than one RF-A! to interconnect to the receiver diversity antenna lines. The receiver multicoupler contains a low noise amplifier and a splitter to distribute the receive signals to each RF-A!.

Optional network peripheral packages are offered with the RF-O! for connection to a network TELCO / DDS service. A typical network configuration of peripheral equipment may consist of a Network Router, a Network CSU / DSU and a Network V.34. The particular complement of network interface equipment is defined by the paging system provider at the time of purchase.

Specifications

Environmental Specifications

Table 2: Environmental Specifications

Specification	Value
Operating Temperature	-30˚C to +60˚ (-22˚F to +140˚F)
Operating Humidity	0 to 95% relative @ 50˚C per TIA-603
Lightening Protection	Optionally available
Mechanical Shock	Motorola shipping specification 12M80973A04
Dust	Airborne particles must not exceed 90mg/m3
Electrostatic Discharge	Per ETSI 300.279
Vibration	TIA-603
AC Line Transients	IEEEC62.41 location cat. B

Specifications by Model Number

Table 3: Specifications by Model Number

Model	Frequency	Power Output (w/Standard Single Circulator)	Dimensions (Rack Mount) (in inches) (HxWxD)	Weight (lb)[1]	AC Input Source (Vac)	AC Input Power (max)
PT1052A	929-941	Single Channel RF-O!: 1 chan InFLEXion: 75W 1 chan ReFLEX: 400W 2 chan ReFLEX: 125W per channel 3 chan ReFLEX: 55W per channel	9.25 x 19 x 24	420	200-265	3000 W
PT1054A	929-941	2-Channel RF-O!: 2 chan InFLEXion: 75 W per channel 1 chan ReFLEX: 285W 2 chan ReFLEX: 145W per channel 3 chan ReFLEX: 95 W per channel	24.5 x 19 x 24	470	200-265	3000 W
PT1052 with RF-B!: FCC Designation PT 24 LX696FC4001						
PT1054 with RF-B!: FCC Designation PT 24LX696FC4001						

1. The dimensions and weight are specified using a 43 RU cabinet and includes RF-A!s, and network and RF peripheral equipment. Weight and size can change depending on the cabinet configuration.

General Specifications

Table 4: General Specifications (Sheet 1 of 2)

Input Power	Power supply type	Switching
	AC power	196-254 Vac @ 47-63 Hz nominal; 30 A; load sharing sized per PA
	Battery revert	Control only

Table 4: General Specifications (Sheet 2 of 2)

Transmitter Frequency (transmit bandwidth varies by model)	Channel switch time	Exceeds InFLEXion protocol specifications
	Frequency generation	Synthesized -6.25 kHz step
	Channel spacing	50-kHz NPCS channels
	Conducted spurious	Less than -80 dBc
	Harmonic emissions	Less than -100 dBc
	Adjacent channel noise	Exceeds FCC mask; part 24
	Frequency deviation (2/4 level)	Per ReFLEX and InFLEXion specifications
	Frequency offsets and deviation adjust	±5000 Hz, programmable in 1 Hz steps
	Frequency stability (UHSO)	±.005 ppm -30˚C to +60˚C
	Isolation (built-in circulator)	20 dB standard, 3 choices of transmitter peripherals to meet site needs
	FM hum and noise	-40 dB; 300 to 3000 Hz
	Emissions designators	6K25B8E, 600F1D
	Deviation accuracy	±1 Hz
Transmitter Modulation	Pager signaling	2-level and/or 4-level binary FSK-NRZ FLEX, ReFLEX, and InFLEXion codes
	Modulator	Advanced DSP Technology
	Maximum paging data rates	2-level: 2400 or 3200 bps; 4-level: 6400 bps
Transmitter Output Power	Power output	Continuous duty and selectable on a per-channel basis
	Antenna connector	7/16 DIN
Control	Remote system control	RF-Conductor! controller or RF-Plug-n-Play transmitter controller
	Station programming	Local or remote, laptop or Choreographer!
	Software	Version OCM 1.0, BCM 1.20

Table 5: RF-O! Linear Transmitter Power

Model No.	Number of		FLEX Channels (#Watts)						InFLEXion Channels (#Watts)			
	PAs	PSs	One		Two		Three		One		Two	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
PT1052A	1	2	100	400	30	125	15	55	40	75	---	---
PT1054A	2	2	70	290	35	145	25	95	65	150	40	75

Electrical Requirements

All electrical wiring for the site must meet the requirements of the National Electrical Code and all applicable local codes. All conductors must be made of copper (designated Cu). Electrical requirements for the InFLEXion protocol are shown (see Table 6). Electrical requirements for the ReFLEX protocol are shown (see Table 7).

Table 6: InFLEXion Electrical Requirements

Configuration	Ac Amps[1]	Btu/hour Heat Load (Maximum)
Model PT1052 Single channel RF-O!	6.4	5.611
Model PT1054 Two channel RF-O!	11.2	6.860
Model PT1052 Single channel RF-O! with single co-located RF-A! Receiver	6.7	5,400
Model PT1054 Two channel RF-O! with two co-located RF-A! Receivers	11.8	7,230

1. AC amps maximum steady-state operation is current at 195 Vac input. Each RF-O! configuration is at 75-W average RF output for each subchannel operation. AC amps start-up is 120 amps; duration less than five milliseconds for four subchannel operation.

Table 7: ReFLEX Electrical Requirements

Configuration	Ac Amps[1]	Btu/hour Heat Load (Maximum)
Model PT1052 Single channel RF-O!	9.8	6000
Model PT1054 Two channel RF-O!	14.1	8,640
Model PT1052 Single channel RF-O! with single co-located RF-A! Receiver	10.1	6,190
Model PT1054 Two channel RF-O! with two co-located RF-A! Receivers	14.7	9.005

1. AC amps maximum steady-state operation is current at 195 Vac input.

Acronyms

For a detailed list of abbreviations and acronyms, see Abbreviations for Terms Used in Electronics, published by the Standards Council of the Society for Technical Communications.

Table 8: Acronyms

Term / Acronym	Abbreviation or Definition
ac / AC	Alternating Current
AM	Amplitude Modulation
ampere(s)	A
ampere-hours	Ah
ASIC	Application Specific Integrated Circuit
assembly	assy
audio frequency	af
AWG	American Wire Gage
British thermal unit	Btu
decibel(s)	dB
direct current	DC (when used alone), dc (when used with a value)
DSP	Digital Signal Processor
EIA	Electronics Industries Association
FCC	Federal Communications Commission
FIPS	Friendly Interface Protocol Specification
FRU	Field Replaceable Unit
FSK	Frequency Shift Keying
GPS	Global Positioning System
I / O	Input / Output
IPA	Intermediate Power Amplifier
LED	Light-Emitting Diode
OTA	Over-the-Air
PA	Power Amplifier
RF	Radio Frequency

Table 8: Acronyms

Term / Acronym	Abbreviation or Definition
SPI	Serial / Parallel Interface OR Serial Peripheral Interface
TCP / IP	Transmission Control Protocol / lnternet Protocol
TELCO	Telephone Company
VCO	Voltage Controlled Oscillator
VSWR	Voltage Standing Wave Ratio