Installation Notes for Correctional Institutions

Progressive Concepts 305 South Bartlett Road, Streamwood, IL 60107

These informational notes are applicable to the following devices:

FMX-A: FMX circuit card with antenna connector.
FMX-EA: FMX circuit card w/antenna connector installed in an enclosure.
FMX-W: FMX circuit card with attached wire antenna.
FMX-EW: FMX circuit card with wire antenna installed in an enclosure.
FMX-EAD: FMX circuit card w/antenna connector & Digital inputs in enclosure.
FMX-EWD: FMX circuit card with wire antenna & Digital inputs in enclosure.

These devices are limited range FM oscillator/transmitters. The microprocessor, crystal stabilized, phase-locked-loop circuitry is the same as used by commercial FM broadcast stations to maintain frequency stability for "no drift" operation. The radio frequency output circuit is protected against accidental shorts. The input DC power is protected against accidental polarity reversal. The broadcast frequency is selected by rotary switches in increments of 100kHz from 87.9 MHz to 107.9MHz. If the DC power is lost for any reason, the device will return to its set frequency when power is restored. The audio input requirement is the "line level" output typical of TV, VCR, CD and tape machines. Digital models accept digital audio from coaxial or TOSLINK type outputs.

Page: Subject

Specifications:

Frequency:	87.9 MHz to 107.9 MHz in 100 kHz increments (FM Band)
RF Output:	ACC100: < 1mW; FMX: 5mW, optional 50mW
Harmonics:	-40dB across band, specific frequency tunable to -50dB
Frequency Select:	On-board direct-reading rotary switches
Frequency Lock:	1.5 seconds maximum after power-up
Frequency Reset:	Resets to pre-set frequency at power-up or loss of lock
Lock Indicator:	On-board LED
Audio Response:	40Hz to 20kHz (mono) 75uS pre-emphasis
Audio Input:	Accepts speaker & line sources or Digital Audio on "D" models
Audio Connector:	Analog Models: RCA jack or 2-pin header. Digital Models: Coax or Toslink
Audio Level:	-30dBm minimum, accepts PA or TV speaker output levels
Supply Voltage:	12-14Vdc, 100mA (on-board rectifier/filter/regulator) 2.1mm jack
Circuit Board:	Military type 2-sided epoxy-glass.
Size & Weight:	ACC100/FMX:5.5"x4.25"x1.25",13Oz. FMX-A/FMX-W: 2.5"x3.9"x1.2", 4 Oz
Antenna:	ACC100/FMX-W: 24" insulated wire, FMX-A/FMX-E: Type "F" connector

Setting the Operating Frequency

These devices are capable of transmitting on any frequency between 87.9MHz and 107.9MHz in 100 kHz steps. Standard FM channels fall on ODD numbered frequencies such as 1, 3, 5, 7, and 9. Example: 88.1, 88.3, 88.5, 88.7, and 88.9. Even numbered frequencies may be used if desired; however, *some* digital FM receivers may not be programmed for ODD frequencies. No problem for analog tuned radios.

Changing frequency requires switching off DC power for a few seconds after setting switches. This instructs the circuit to reset itself to the newly selected frequency.

When the frequency has "locked" the on-board red LED will glow brightly.

(See photo on page 9 for Frequency Selection Switches and Lock Indicator)

Frequency Selection:
There are 3 rotary switches with numbers 0 to 9. The first switch on the left determines the "10's" of the number, such as 8 = 80, 9=90, 0=100.The center switch determines the "1's" and the right end switch determines the ".1's".

Any frequency selected which is outside of the FM band, either lower than 87.9 MHz or higher than 107.9 MHz results in these devices defaulting to 88.1 MHz.

Examples:

	Switch Setting			Frequency in MHz
	(10's)	(1's)	(.1's)	
Invalid channel	7	9	9	88.1 default (79.9 not valid)
Standard channel	8	7	9	87.9
"	8	8	3	88.3
"	9	1	5	91.5
"	0	7	9	107.9
Even channel	9	1	6	91.6 (not standard channel)
Invalid channel	0	8	0	88.1 default (108 not valid)

Multiple audio sources (i.e., Several TV's in one room):

Each device should be set to a frequency different from the others in the vicinity, and if possible, at least 3 channels removed from the others. Example: 88.3, 88.9, 89.3, 89.9, 90.3 or better, 88.3, 89.1, 89.9, 90.7, 91.5, etc. The greater the frequency separation the less likely interference may result and makes the channel easier to find on the receiver.

The Antenna

The ACC100 and FMX-W Circuit Card: These already have an attached 24 inch insulated wire antenna.

Only radiate as much RF energy as required to do the job. Simply shorten the effective length of the antenna wire by winding it into a loop or coil to shorten the range.

The rest of this page applies only if your device has an antenna connector.

Prepare you antenna from a piece of coaxial cable with a type F mating connector. The coax may be as long as is required to get the "radiating" part of the antenna to where it needs to be. Up to 30 inches of the coax shield is then removed from the open end of the cable to expose the insulated inner conductor. **Do not remove the insulation from the center conductor.** This exposed length of insulated inner conductor is your antenna.

Distribution Antenna: This consists of a long length of coaxial cable with "T" connectors at appropriate intervals. The main cable could run along a corridor, air conditioning chase or other pathway that passes through, or near, each cell or area to be served. A "T" connector is placed on the cable at the appropriate location. A 12 to 24 inch insulated wire antenna is then connected to the center pin of the "T" to radiate signal to that area. The cable minimizes signal loss and possible interference with other transmissions while putting the signal exactly where it is needed. Such a system could be used for distances of 200 feet or more. Because the FMX uses a type "F" coax connector, you will want to employ an "F" to "BNC" or "UHF" adapter. The adapter, BNC and UHF "T" connectors, and coax are available at Radio Shack stores.

For greater line-of-sight range, such as across an exercise yard, you may need a more efficient antenna than those described above. (See our Simple Coaxial Antenna information sheet)

Digital Audio Models

Units with the suffix "D" in the model number have Digital Audio Inputs. The connector type is either coaxial (RCA) or Toslink (Fiber Optic). Toslink cables are sold seperately in various lengths to suit your needs. Contact Progresive Concepts for these fiber optic cables. Some TV sets or other audio sources are encoded in Dolby Digital 5.1 or higher, if this is the case, you will want to go into the menu system of the associated device (TV or other source) and turn Dolby Digital to the "OFF" position. This will allow the digital audio to operate normally on the transmitter.

DC Power Connections

(See photo on page 9 for location of the DC power jack)

These devices require 100 mA of current at 12 Volts DC through a 2.1mm barrel plug inserted into the circuit board's DC jack. The input is not polarity sensitive. On-board circuitry automatically corrects input polarity.

We recommend our T2 wall-adapter power supply, however, any good 12 Volt DC source with an output of 100 mA or better will suffice. The AC power to the wall-adapter supply should be switched on/off with the associated TV receiver.

FMX-A and FMX-W Circuit Cards: The installer should not solder directly to the circuit card for connection to a DC power source. A 2.1mm barrel plug and cable should be used instead. This allows easy removal of the card if necessary and minimizes risk of damage to the card which would not be covered under warranty. Contact your vendor to purchase dc power plugs and cables.

Some installers, when installing the circuit card within a TV's enclosure, tap into the DC supply of that TV. However, you must assure that supply is well filtered and does not exceed 14 Volts nor is less than 10 Volts. A higher supply voltage could damage the circuit card's on-board voltage regulator. A lower voltage could cause instability. To protect the TV, the technician should assure the TV's supply will tolerate the additional current load without damage. ***CAUTION: this is not advised for "hot" chassis TV receivers. If the FMX circuit card is connected to the TV's power supply, the card itself becomes as hazardous as the TV chassis. Touching either could result in a fatal shock.***

How to determine if a TV has a "hot" Chassis

Test for AC and DC voltages between the TV chassis and an external grounded object such as a water pipe or the "ground" lug of an AC wall outlet. If the TV's power cord can be inserted either way in the AC outlet, reverse it and do the test again. If any voltage level is found you may have a "hot" chassis. TV's with large power transformers are generally "safe". Those that do not have a power transformer may have one side of the AC line connected to the chassis or circuit "ground".

External clues: Plastic or wood cabinet. No RCA audio output jack. No external speaker connectors. Any of these should prompt testing of the TV's internal metal structures.

If you must deal with a "hot" chassis, refer to Audio Connections on how to isolate the audio from the circuit "ground" of the FMX circuit card.

Audio Connections

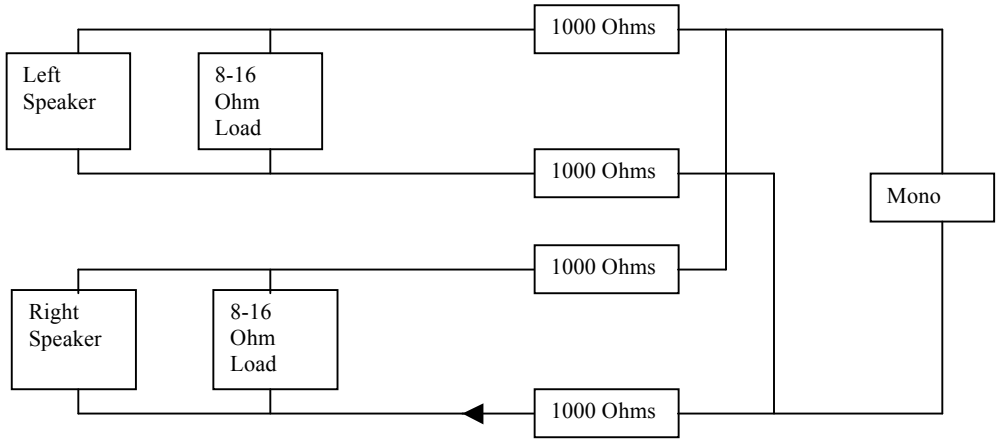
(See photo on page 9 for location of the audio level adjustment and input header pins)

Circuit Cards Only: Two Audio connection wires approximately 5" long are furnished with the card. Use this cable to splice to your RCA cable, screw connections, speaker output terminals, etc. These wires permit a "floating" connection (neither side is grounded) when required. **Soldering audio wires directly to the circuit card may void your warranty.**

The audio input level is your typical "line output" connection. Audio may also be taken from speaker or earphone outputs. When audio is taken directly from internal speakers you may want to disconnect the speakers to keep the noise level down. However, speaker audio levels may be higher than "line level". If a mid-range volume setting results in distortion during transmission you can adjust the level as shown on page 9. **For difficult installations ask your vendor about the "AI2" (Audio Interface) which includes speaker termination resistors and a separate volume control.**

Some stereo TV's allow you to set them in "mono" mode. This should be done to receive the full sound for transmission. If this option is not available then you can try "Y" audio connectors to combine the left and right channels. Dependent on the audio source circuitry a "Y" connector may not operate properly. Instead you may make a "Summing Junction". This is simply resistors in series with both left and right channels and then connected together. All grounds are connected together.

If you take your audio from the speaker circuit, and remove the speaker, you may want to provide a "termination" to take the place of the speaker impedance. This is simply a 5 to 10 watt, 8 to 16 Ohm resistor. Most new TV's will not require a termination; however, if audio distortion is present the termination is probably required. The following circuit illustrates stereo speaker source terminations and a level reducing summing junction.



Circuit Card Installation

(This section does not apply to the ACC100 or FMX-E devices)

When securing the FMX circuit card in an enclosure or TV receiver, you must avoid "shorting out" the circuit board against any metal or conductive surface.

Use the corner 4-40 clearance holes of the circuit card for mounting in your own enclosure. A quarter inch spacer is required at each corner. Regular size 4-40 nuts should not be used to avoid possible contact with circuit components – use extra small nuts instead. The head of the mounting screw should be on the outside of the enclosure, the ¼ spacer fitted onto the screw, the circuit card next and then secured with the small nuts at each corner. An installation kit containing (4) 4-40 x 5/8" screws, (4) 4-40 small hex nuts and (4) quarter inch spacers is available from your device vendor. Metal enclosures are best.

Circuit cards with a Type "F" antenna connector: The circuit card may also be mounted in a TV receiver or your own enclosure by means of its "F" antenna jack. A 3/8th inch hole could be drilled in the back cover of the TV receiver, or your own metal enclosure. The circuit card is secured with the supplied 3/8th inch washer & nut. A short antenna is then connected to the jack and hangs down on the outside of the TV receiver.

Other possibilities:

Double-sided carpet tape or double-sided weather striping may be placed between the solder side of the circuit card and any flat surface, such as the inside of a plastic or metal TV cabinet. The circuit board can then be easily removed if required.

The circuit card could also be slipped into a "pocket" formed from duct tape stuck to the inside of a TV cabinet. While duct tape could be applied directly to the circuit card, it is not recommended, as it might be difficult to remove after it ages a bit.

A couple of dabs of silicone sealant could also be used. The sealant should not be allowed to touch any of the solder points as it would be very difficult to remove if repairs are required. If sealant is used it should only be applied to the edge of the card at, or near, the corner mounting holes.

For that matter, the circuit board can be hung from a string inside a TV cabinet. Or, it may be secured with a plastic "fast-tie" to a strut or other plastic or metal support within a TV cabinet. A piece of insulation material, such as Styrofoam, or other soft plastic of at least ¼" thick must be used on the circuit side of the card to avoid shorts. Care must be taken that the circuit card will not touch any of the TV circuitry if the cabinet were to move. Serious damage to the TV could result.

Radio Frequency Propagation & Interference (Broadcast Range)

Concrete and metal reflect radio signals. Under some conditions they can also absorb signals. Antenna placement which is near, or surrounded by, these materials can therefore give varied radio signal strengths. The space between the antenna and the reflective materials can, therefore, be an advantage or a disadvantage. For example: When the antenna is spaced one-quarter wavelength from a reflective material the radio signal is reinforced in the direction opposite to the reflector. Think of the antenna as a light bulb in front of a mirror. The light being reflected from the mirror enhances the light radiating from the side of the bulb away from the mirror. This makes the antenna "directional" because the radiated signal is stronger in the direction opposite the reflector. But this apparent gain of signal in one direction is the result of less signal in the direction of the reflector. Other spacing between an antenna and a reflector results in various degrees of signal strength ranging from enhancement to attenuation. A single radio signal can be strengthened or weakened as it interferes with itself by "bouncing" off reflective walls, producing "hot" and "dead" zones. These conditions are lessened the farther away the antenna is from reflective materials.

Quarter wavelength = 2925 / frequency in MHz. Example: 2925/100MHz = 29.25 inches

Polarization:
Vertical bars would have the greatest affect on signals when the antenna is also in a vertical position. If you experience "directivity", "hot" or "dead" zones, you might experiment with placing the antenna horizontal.

Comparative Receiver Sensitivity:
"Pocket FM radios" are usually not very sensitive. As a rule, the cheaper radios have the worst sensitivity. Typically these radios require signal strength of 10 microvolts or more for their proper operation. On the other hand, Two-way radios, as might be used in correctional facilities, are up 100 times more sensitive at .1 microvolt sensitivity.

Comparative Transmitter Power Output:
The FMX broadcaster has an RF signal output of 2 to 20 milliwatts. The ACC100 is less than 1 milliwatt. Compare this with the output of, say, a 5 Watt two-way radio. Five watts is equal to 5000 milliwatts. These broadcasters, therefore, are up to 5000 times LESS powerful than a 5-Watt transmitter.

Comparative Field Strength:
While we may not know the signal field strength produced by a particular transmitter, we can compare the relative strengths for two different transmitters. Relative field strength is calculated by taking the square root of the power ratio between the two transmitters.

Assuming a broadcaster output of 1mW versus 5000mW of a two-way radio we have a power ratio of 5000:1. The square root of 5000 is 71. Therefore, the field strength at any given distance from these broadcasters is 71 times LESS than a 5-Watt Two-way radio.

Comparative Range:
From **Comparative Receiver Sensitivity** above we see that Pocket FM radios can be 100 times less sensitive than two-way radios. From **Comparative Field Strength** above we see that these low power broadcast devices produce 71 times LESS strength than two-way radios. From this we can assume these broadcasters have a range of 7100 (71x100) times LESS a 5-Watt two-way radio.

RF Output Power Option:
The FMX is normally configured for an RF power output of 5 milliwatts or less. It is advisable to broadcast with only as much signal strength as you need to do the job. Where the need for a greater range is required, say across an exercise yard, AND there is a minimal chance of interference with other radio services, you have a choice to do so. The output can be increased to about 50 milliwatts by first UNSOLDERING the "LPJ" (low power jumper), and then soldering across the "HPJ" (high power jumper) on the FMX pc board. See diagram on page 9 for position of jumper. (NOTE: failure to first unsolder the LPJ jumper will result in permanent damage to the board which will void the warranty). Signal strength, and therefore range, would increase as the square-root of the power ratio. In this case 50/5 = 10 and the square-root of 10 is 3.16. Range should, therefore, increase 3.16 times. The range of the ACC100 can also be extended about 3 times, but to do so would void its FCC certification. Contact technical support for more information.

Conclusions:
While two-way radios used in correctional facilities may penetrate concrete walls, these low power broadcasting devices would find it difficult. Line-of-sight range of these broadcasters is generally less than 100 feet. Chances of interference between two-way radios and these low power devices are extremely low.

The best operation of these devices should be realized in open spaces, (line-of-sight) of a hundred feet or less. This may be achieved with a relatively short antenna of 24 to 30 inches, or less if less range is required. Greater penetration of concrete walls and greater distances may be realized by using a more elaborate antenna. This could be a longer wire or take the form of a simple coaxial dipole (requires antenna connector).

If broadcast coverage is required on the other side of a concrete wall, it is recommended that an antenna wire be passed through the wall to radiate on the other side. If that is not feasible then the antenna should be placed near an opening, or window, which has a view of the other side of the wall.

Warranty & Repairs

These broadcasting devices are warranted against defects of materials and workmanship for a period of 1 year from the date of purchase. Failure or damage of components due to physical or electrical abuse is not covered by this warranty. Warranty repairs may consist of repairing the failed broadcaster or replacing it entirely at the manufacturer's option.

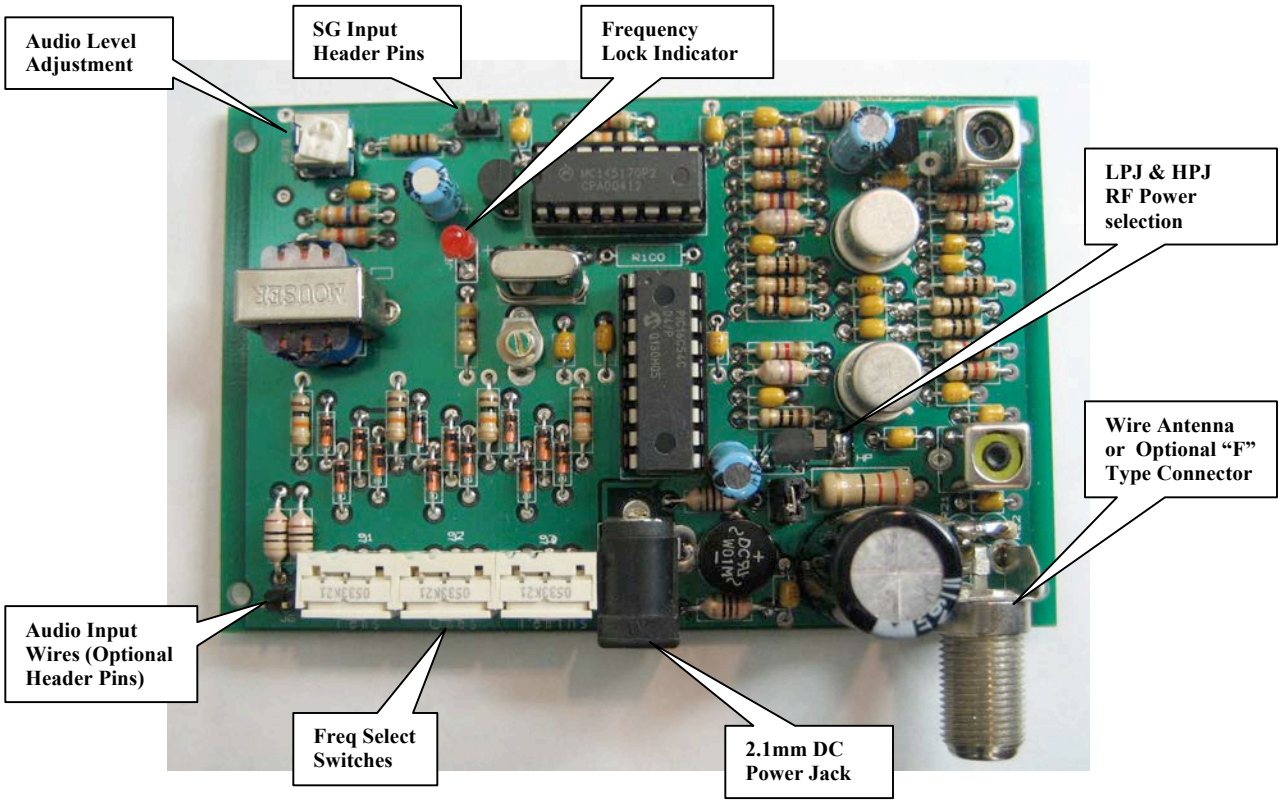
Do not attempt repair of any of these devices. Any attempt to repair or modify the unit without authorization may void your warranty and/or FCC certification.

Technical Support: (630) 736-9822 support@progressive-concepts.com

Notify your vendor if you believe you have a failed broadcasting device. If our technician cannot make it operable by telephone, fax, or email discussion, it may be sent in for repair. Ask your vendor for a "repair return authorization" and a shipping address.

Out-of-warranty repairs costs are typically less than $80.00 plus return shipping.

This photo is of an FMX-A (with F-Type RF Jack) circuit card. The ACC100 internal circuit card is identical with the exception of 3 component value changes to meet FCC certification and the ACC100 uses a fixed wire antenna instead of the F-Type RF jack.



Alternative Audio Connections

The following a simple circuit which may be used with "RCA" type audio output connectors or with an earphone output jack. These output circuits have a common "ground" which permits using only three resistors to combine Left and Right channels into a single monophonic signal.

The values of R1 and R2 must be the same to maintain stereo balance.

The output level depends on the ratio of R3 divided by one half the value of R1 (or R2) providing the source impedance is low and the transmitter input impedance is high. However, the source impedance may vary and the transmitter input impedance is 600 Ohms. To avoid trying to calculate for different circumstances it may be best to simply adjust the value of R3 until you have a level that sounds good without distortion.

Typical values would be R1, R2 = 1000 Ohms, R3 = 100 Ohms

R3 could be a potentiometer for a precision adjustment of volume.