

**OPERATING AND MAINTENANCE
INSTRUCTION MANUAL**

MODEL 710

RDS/RBDS RADIODATA ENCODER



INOVONICS
INCORPORATED

— USER'S RECORD —

Model 710 - Serial No. _____

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INSTRUCTION MANUAL**

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RDS/RBDS RADIODATA ENCODER

December, 1996



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TABLE OF CONTENTS

Section I - INTRODUCTION

Model 710 Product Description	5
General - <i>STATIC</i> Mode Defined - Factory and Field Re- Programming - <i>DYNAMIC</i> Operation - Features	
Model 710 Technical Specifications	6
Block Diagram	7

Section II - The Radio Data System

RDS in Europe	8
The RDS System	8
RDS Applications Supported by the Model 710	9
PI - PS - PTY - TP - TA - AF - DI - M/S - PIN - RT - IH - CT	
Applications Not Supported	11
EON - LN - RP - EWS - TMC - PTYN - MBS/MMBS	
Universal Encoder Communication Protocol	12

Section III - Installation and Basic Operation

Unpacking and Inspection	13
Mounting	13
Rack Requirements - Heat Dissipation	
AC (Mains) Power	13
As Delivered - Voltage Selector - Power Cord	
Radio Frequency Interference (RFI)	14
Location - Ground Loops	
Encoder "Loop-Through" Mode	14
Loop-Through Operation - Gain and Impedance Jumpering - Jumpering Verification	
Encoder "Outboard" Mode	16
Setting the RDS Injection Level	17
Selecting The <i>Static</i> Data Frames	19
Front-Panel Manual Selection - Frame #15: TA Flag - Remote Manual Selection - Rear-Panel Connections	

Section IV - *Dynamic* Encoder Operation

Dynamic Operation Considerations	21
Installing the Software	21
Utilities Overview	22
Drop-Down Menus	
Dynamic Programming Tutorial	23
Programming the Memories (PS, PI, MS, DI, RT, PTY, CT, Travel, Frequencies, IH, PIN, Dynamic) - Copying the Memories	
Editing Memories	26
Saving RDS Data	26
Computer-to-Encoder Connection	27
Selecting Memories for Transmission	27
Editing RDS Data On-Line	27
Scheduling Events	27

Section V - Programming *Static* EPROM “Frames”

Introduction	29
Types of Memory - Equipment Required	
Preliminary Recommendations	29
Similarity to <i>Dynamic</i> Encoder Operation	
Installing the Software	30
Utilities Overview	30
Drop-Down Menus	
EPROM Programming Tutorial	31
Programming Static Memory “Frames” (PS, PI, MS, DI, RT, PTY, Group 2/6, Travel, Frequencies, IH, PIN) - Copying Frames - Exiting PRO-EPM - Naming Files	
Editing Frames	34
Loading Files - Editing - Important Special Instructions! - Saving Edits	
Managing RDS Files	35

Section VI - Circuit Descriptions

Combining and Line-Drive Amplifiers37
 Mode and Input Termination Jumpering - Combining Stage,
 Gain Jumpering and Output Circuitry

Encoder Clock38
 Pilot Recovery - Crystal Oscillator Default

Static Message Frame Selection38
 “GAL” Integrated Circuits - Local Frame Selection - Remote
 Frame Selection

RDS Data Transfer39
 Static Data Transfer - *Dynamic* Data Input - Differential
 Encoding

Generating the RDS Waveform40

Power Supplies40

Encoder Calibration Procedures41
 C19: Timebase - R78: 19kHz PLL - R87 and R99: 57kHz Band-
 Pass Filter - R98: Pilot Filter and RDS Phase

Section VI - Appendix

Parts Lists - Schematics - Warranty43

Section I

INTRODUCTION

MODEL 710 PRODUCT DESCRIPTION

- General** Inovonics' Model 710 offers a simple and inexpensive means of implementing the Radio Data System, generally referred-to worldwide as RDS. In the United States, this same service is known as the Radio *Broadcast* Data System, or RBDS. The more "generic" and established term, RDS, will be used throughout this Manual.
- The 710 owes its simplicity and low cost to its development primarily as a *static* radio data encoder. A parallel data port does, however, permit limited, on-line *dynamic* control when the Encoder is used with a dedicated IBM-compatible host computer.
- STATIC Mode Defined** In the *static* operating mode, the 710 can selectively transmit the full range of data which is loaded beforehand into 15 non-volatile PROM-based memories. Each of the 15 memories constitutes a "frame" of RDS data, a frame comprising a complete set of station and service IDs, traffic and other "flags," and scrolling radiotext messages.
- When the factory receives an order for a Model 710, we send the user a fill-in form for entering the various RDS data options. He completes this self-guiding form and returns it to us. The data are then programmed into the EPROM by factory technicians, and the unit delivered with all data loaded. By this means, no computer or programming expertise is required of the user.
- Factory and Field Re-Programming** Though initial PROM-programming is performed at the factory before shipment, a qualified computer professional can easily re-program the 710 with the aid of software included on the diskette supplied with the Encoder. In addition to this software, the programmer must have access to an "EPROM Eraser" and an "EPROM Programmer." The Inovonics 710 uses the popular and inexpensive Type 2764 EPROM, and spares may be kept on-hand for fast and efficient data updates.
- Alternatively, the user can always call on the factory for his RDS data update needs. He can supply revised filled-in data forms, and a programmed EPROM will be sent to replace the EPROM in service. Factory re-programming incurs a charge based on materials (the EPROM integrated circuit) and labor (the prevailing Inovonics "hourly shop rate")
- DYNAMIC Operation** A rear-panel parallel data port permits *dynamic* (on-line) computer control of RDS flags and messages. The *dynamic* operating mode is most useful for station promotions, advertising campaigns, contests, song titles, etc. Radiotext (scrolling text) messages typed into the controlling computer appear instantly on the listener's radio display

panel. (In the interest of highway safety, this display is not made available on automobile receivers.)

The menu-driven software required for *dynamic* operation is a separate file on the diskette supplied with the 710. Almost any IBM-compatible PC may be used. The only item *not* supplied is the cable to interconnect the computer's parallel (LPT1) port with the PARALLEL DATA INTERFACE "DB-25" connector on the rear panel of the 710 Encoder.

Features Features of the Inovonics 710 include:

- Easy installation with unity-gain, loop-through operation and fail-safe bypass.
- Automatic phase-lock to the FM stereo pilot with default to an internal crystal timebase.
- Front-panel button or remote message frame selection. The Encoder automatically sequences through selected message frames.
- Free initial factory programming of the "static" message frames; menu-driven EPROM programming software supplied.
- No additional hardware is required for computer-controlled "dynamic" operation, and necessary software is supplied.

MODEL 710 TECHNICAL SPECIFICATIONS

Standards Supported:

European CENELEC and United States NRSC standards supported through appropriate software versions.

RDS Groups Supported:

Static Mode:

0A, 1B, 2A, 6A, 15B.

Dynamic Mode:

1A, 1B, 2A, 4A, 6A, 10A,
15A, 15B.

Applications Supported:

PI, PS, PTY, TP, AF, TA, DI, M/S, PIN, RT, IH, CT. (A more detailed explanation of these applications begins on Page 9.)

Composite Loop-Through Level:

Unity-gain; 1V-10Vp-p, relative to 100% (± 75 kHz) carrier modulation.

Composite Input:

Unbalanced-bridging, 600-ohm-terminating, or 75-ohm-terminating; selected by internal jumpering.

Composite Output:

"Zero-impedance" voltage source, 75-ohm source impedance, or 600-ohm source impedance; selected by internal jumpering.

(continued next page)

RDS Subcarrier Injection Level:

Continuously adjustable between 1% and 10% of total carrier modulation.

Remote Data Frame Selection:

Encoder accepts TTL logic, NPN transistor saturation, or switch contact closure to ground to add selected frame(s) to the auto-sequence routine.

Dynamic Data Interface:

The 1-byte-wide parallel data bus (DB-25 connector) may be cabled directly to the LPT (parallel) port of an IBM-compatible computer for *dynamic*, on-line control of the 710 Encoder.

Power Requirements:

105–130VAC or 210–255VAC, 50/60Hz; 15 watts.

Size and Weight:

1¾”H x 19”W x 7”D (1U);
7 lbs (shipping).

BLOCK DIAGRAM

A simplified Block Diagram of the Model 710 is shown in Figure 1, below. Encoder circuitry is explained in detail in the Circuit Descriptions section beginning on Page 37. Circuit Descriptions reference the Schematic Diagrams found in the Appendix.

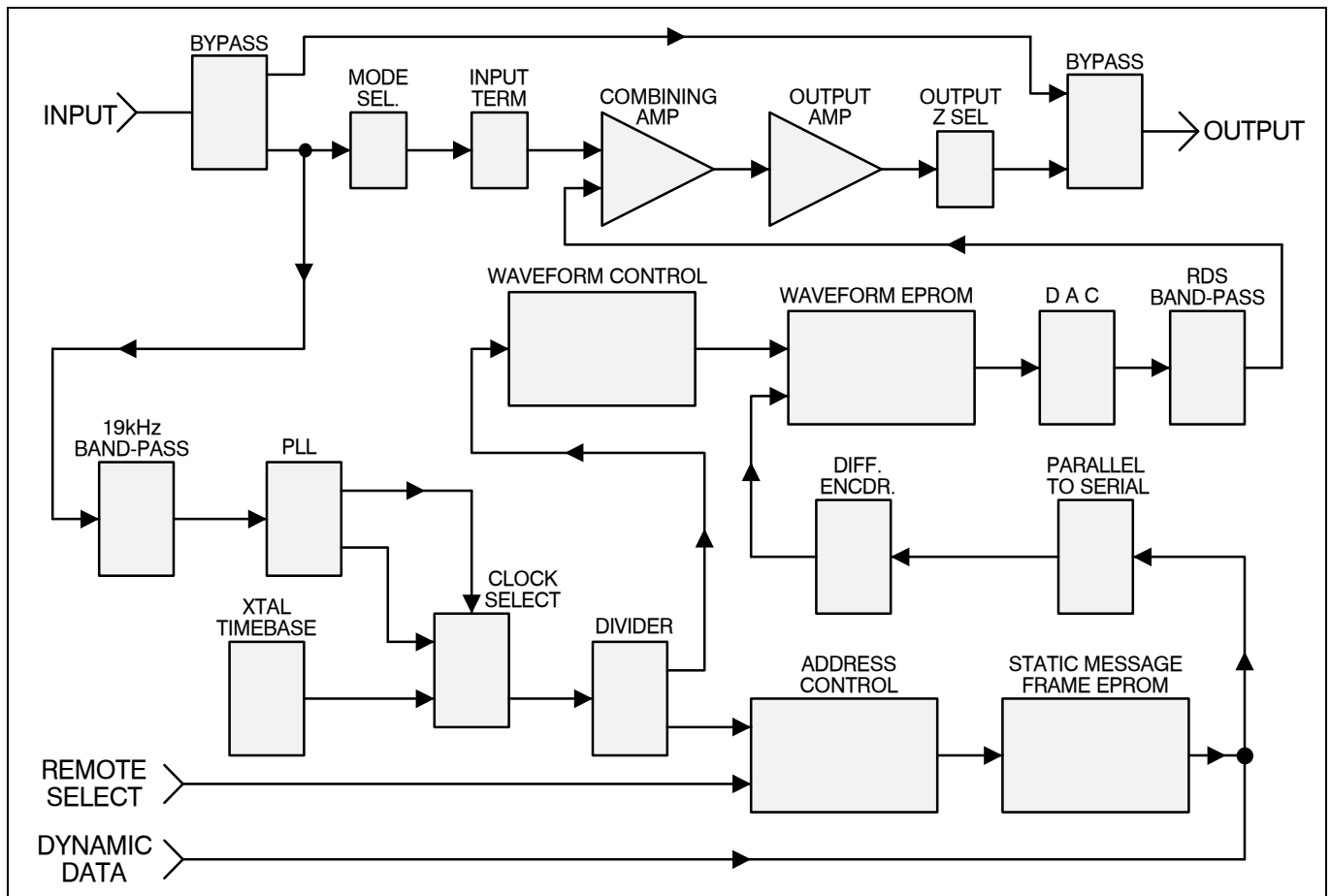


Figure 1 - Block Diagram, Model 710 RDS Encoder

Section II

THE RADIO DATA SYSTEM

RDS IN EUROPE

The concept of “Radio Data” was developed by the European Broadcasting Union (EBU) and its member countries. The European RDS specification, generally referred to as CENELEC Standard EN50067, was originally published in 1984. It was revised in 1986, 1990, 1991 and 1992.

RDS has grown in use throughout Europe, beginning with initial adoption of the Standard. At the time of this writing, RDS is nearly universal; it is almost impossible to find a European FM broadcasting station which does *not* carry a radio data subcarrier.

The popularity of RDS in Europe, as contrasted with current (1996) reluctance on the part of US broadcasters to embrace this technology, can be ascribed to material differences in broadcasting practices. Almost without exception, FM broadcasting in the United States is independent; that is, each station originates its own programming. One exception might be America’s “National Public Radio”; though for most of the broadcast day, even NPR stations originate, or at least schedule, their own programming.

In many respects, much of European broadcasting is similar to the “network” radio prevalent in the US prior to about 1950. A central program originator may have transmitting facilities, frequently of modest power, located throughout the country. The European disposition toward lower-power transmitters can be found on the “local radio” level as well, with “relay” (re-broadcast) repeater transmitters at several different frequencies to blanket a designated service area.

The European concept of a *service area* equates to a US broadcaster’s *market*. The subtle difference between these designations further characterizes broadcasting practices. RDS benefits the European broadcaster through an almost altruistic endeavor to be of *service* to his listeners; the US broadcaster is *marketing* his programming, and is mainly interested in how he can make additional profits from RDS.

THE RDS SYSTEM

RDS is a digital data channel transmitted as a low-level subcarrier above the range of the composite stereo program signal in the FM baseband. The data transmission (baud) rate is modest, yet it is “robust” because of data redundancy and error correction.

It is not within the scope of this Manual to cover the details of RDS subcarrier coding and modulation. For this the reader is directed to the Specification appropriate to his location, either the CENELEC EN50067 Specification for Europe, or the United States NRSC Specification. It is presupposed that the user has some familiarity with the concept of RDS, since the balance of this Manual will deal with specific implication of RDS implemented with the Inovonics Model 710 Encoder.

RDS APPLICATIONS SUPPORTED BY THE MODEL 710

Listed here are the RDS applications which are fully supported by the Model 710. Applications which are supported only in the *dynamic* mode (under computer control) are so identified. This listing is followed on Page 11 with specific applications which *are not supported* by the 710 in any operating mode.

In this listing, the standardized RDS application acronym (abbreviation) is followed by an expansion of the application name, then a short explanation of the function.

- PI Program Identification:** This block of data identifies the broadcast station with a numerical code. It becomes the “digital signature” of the station. The code is calculated from the station’s location (the country and more specific geographic information), and from a numerical encoding of station call letters. The PI code is processed by the receiver to assist automatic tuning features (station memories), and to prevent false switching to alternative frequencies which might be shared by different broadcasters.
- PS Program Service Name:** This is the “street name” of the station which will show on the receiver’s front-panel alphanumeric display. The PS can be as simple as the station’s call letters, or a slogan such as “NEWSTALK” or “LIVE-95.” Since the Program Service Name is constantly displayed, even on automobile receivers, it must remain static; that is, it must not alternate between different entries since this might well prove a distraction to the driver. *This requirement is specifically written into US and European RDS Specifications!* Though violation of this regulation is technically feasible, and is infrequently practiced, it is not impossible that, in our litigious society, a broadcaster could be held liable for creating a distraction which results in a motor accident!
- PTY Program Type:** The PTY data block identifies the station format from one of several pre-defined categories. Many RDS receivers can be listener-programmed to seek a particular station format. Thus a car radio can automatically switch from a fading station to a stronger one which carries similar programming. The PTY function of RDS is one of those which helps a broadcaster catch transient audience share.
- TP Traffic Program Identification:** The TP “flag” identifies the station as one which routinely broadcasts traffic bulletins for motorists as part of

its normal, everyday programming. The TP “flag” is not only displayed by the receiver, but an automobile radio which has been programmed by the driver to search for traffic bulletins will keep track of those stations which offer this service.

- TA Travel Announcement:** This “flag” is temporarily added to the RDS data stream when a traffic bulletin is actually on-air. RDS automobile receivers can be set to search for traffic bulletins among various “TP” stations (see above), even while remaining tuned to a listener’s preferred program, or even playing a tape or CD. Then when any TP station broadcasts a traffic bulletin, the receiver temporarily switches over to receive it. When the bulletin is completed, the receiver switches back to the original program, tape or CD.
- AF List of Alternative Frequencies:** A “network” broadcaster, or one with re-broadcast, “relay” facilities to extend his coverage, can include a list of all frequencies which carry the identical program. These can even be mixed FM and AM frequencies. The RDS receiver, particularly the automobile radio, constantly searches for the best signal which carries the same program. When a better signal is found, the radio re-tunes with hardly any interruption. The principal utility for this RDS function is with European radio networks.
- DI Decoder Information:** This is a “flag” which tells whether the broadcast is monaural, or is broadcast in any of several methods of stereo or binaural broadcasting. As many as 16 encoding options may be accommodated! This becomes rather esoteric; for typical situations, only *mono* or *stereo* is of present concern.
- M/S Music / Speech Switch:** This “flag” simply indicates whether music or speech is being broadcast. The purpose of this function is not well explained in the respective Standards (!).
- PIN Program Item Number:** A data option identifying a particular program by encoding the scheduled program time and day of the month. It can be used, for example, in actuating a recorder to save the program for later playback.
- RT Radiotext:** A 64-character block of plain text for visual display on the front panel of any (non-automobile) RDS receiver. Most receivers have limited alphanumeric display capability, so the 64 characters are “scrolled” across the screen, marching across the front-panel like news bulletins above Times Square.

In the *static* mode, each of the 15 frames can be programmed with a separate 64-character radiotext message. This might give the telephone number for music requests, advertise a sponsor’s product, promote various programs heard in different time periods, or give “we have a winner” or other “reusable” contest results. *Dynamic* operation of the 710 allows radiotext data to be entered, simply by typing it into the computer. This lends immediacy to the text, which can announce song titles, run special promotions or contests, or broadcast specific sponsor’s messages.

IH In-House Application: This is a special 64-character string of ASCII text reserved for proprietary station intercommunications. The channel is not secure, but consumer radios have no provision for decoding it. Data may be used to identify a particular transmitter, to perform switching or remote control functions, or for paging station staff.

In the *static* mode, any message frame may be programmed with 64 characters of radiotext, *or* 64 characters of in-house text. A *static* frame holds only 64 ASCII characters, so each message must be earmarked for RT or IH use. Under *dynamic* operation, the 710 can transmit both the radiotext *and* the in-house groups.

CT Clock Time and Date: (*Dynamic Mode Only*) Running under computer control, the 710 encodes and transmits the current date and time of day including a proper time zone offset, if applicable. Bear in mind, however, that the accuracy of this function is only as good as the computer's internal real-time clock. Personal computers are notoriously bad at timekeeping, so be sure to check clock accuracy before entering the *dynamic* mode, and occasionally during extended operation.

APPLICATIONS NOT SUPPORTED

The Inovonics 710 was engineered as a simple, low-cost RDS Encoder. Within the confines of this innovative, PROM-based design, most of the important RDS applications have been addressed. Nevertheless, there are applications which are *not within the capability* of the 710.

Modification of the Model 710, to include those RDS applications which are *not* supported by the present design, is neither simple nor cost-effective, and not considered practicable. We, the proud manufacturers, are first to recommend purchase of a more fully-featured Encoder if any RDS application in the following listing is deemed immediately essential. Of course the 710 may be used until such applications are required, then relegated to secondary service.

EON Enhanced Other Networks: This is a feature which can update the information stored in a receiver concerning program services *separate* from the one being received. Data transmitted in this group includes: PS, PTY, TP, TA, AF and PIN. The BBC in England, who maintain several, non-competitive networks, probably use this feature.

LN Location and Navigation: This block of data gives detailed information regarding exact station location, including the city and state, latitude and longitude, and data for use by (future) navigational systems.

RP Radio Paging: A "revenue-generating" RDS application. A broadcaster could lease part of the RDS data stream to a paging service. The paging data arrives by telephone line or microwave link and is embedded within the transmitted RDS data. Special paging receivers can then deliver short messages to paging service subscribers.

- EWS** **Emergency Warning System:** Both the US and the CENELEC standards are vague on the use of this application, citing “national security” as a reason why details cannot be divulged. At our own risk of imprisonment (or worse!), might we suggest that the basic idea is to encode warning messages which could alert listeners to impending disasters: hurricanes, nuclear attacks, invading Amway distributors?
- At this writing, the dual-audio-tone Emergency Warning System used in the United States for many years is being replaced by a more sophisticated Emergency Alert System (EAS). EAS, however, utilizes dedicated hardware, rather than a tie-in with RDS encoding equipment.
- TMC** **Traffic Message Channel:** This group is still undefined, but is reserved for some sort of coded motor traffic information.
- PTYN** **Program Type Name:** Similar to PTY, but enables the receiver to display the name of the format being received instead of the Program Service Name. This group is for display and is not used by the receiver to search for a particular format.
- MBS / MMBS** **Mobile Search / Modified Mobile Search:** The MBS application is specific to the Swedish Telecommunications Administration and their proprietary scheme for a Public Radio Paging System. MMBS is used in the United States and elsewhere for similar radio-paging schemes..

UNIVERSAL ENCODER COMMUNICATION PROTOCOL

A worldwide specification has been adopted for serial-data interface between RDS encoders and the “outside world.” Many applications, such as Radio Paging, GPS (error correction for the Global Positioning System) and other navigational applications, roadside message billboards, radios which print and eject “coupons,” stock market updates, etc., all require continuous, on-line access to the RDS encoder by one or more service providers. Generally, these applications are the ones which promise additional revenue to the station. The Inovonics 710 RDS Encoder *does not incorporate* the SPB 490 Universal Encoder Communications Protocol. Though it might be possible to emulate this protocol using a dedicated computer and special software, it is Inovonics’ recommendation that an RDS encoder specifically suited to these applications would prove a better solution.

Section III

INSTALLATION AND BASIC OPERATION

UNPACKING AND INSPECTION

Immediately upon receipt of the equipment, inspect carefully for any shipping damage. If damage is suspected, notify the carrier at once, then contact Inovonics.

It is recommended that the original shipping carton and packing materials be set aside for future reshipment. In the event of return for Warranty repair, shipping damage sustained as a result of improper packing for return *may invalidate the Warranty!*

IT IS VERY IMPORTANT that the Warranty Registration Card found at the front of this Manual be completed and returned. Not only does this assure coverage of the equipment under terms of the Warranty, and provide some means of trace in the case of lost or stolen gear, but the user will automatically receive specific **SERVICE OR MODIFICATION INSTRUCTIONS** should they be issued by Inovonics.

MOUNTING

Rack Requirement

The Model 710 Encoder mounts in a standard 19-inch equipment rack and requires only 1¾ inches (1U) of vertical rack space. The use of plastic “finishing” washers is recommended to protect the painted finish around the mounting holes.

Heat Dissipation

Consuming far less power than the obligatory EXIT sign in a dimly-lit movie theater, the 710 itself generates insignificant heat. The unit is specified for operation within an ambient temperature range extending from freezing to 120°F/50°C. Because adjacent, less efficient equipment may radiate substantial heat, be sure that the equipment rack has sufficient ventilation to keep internal temperature below the specified maximum.

AC (MAINS) POWER

As Delivered

Unless specifically ordered for export shipment, the Model 710 is set at the factory for operation from 115V, 50/60Hz AC mains. The rear-panel designation next to the fuseholder will confirm both the mains voltage selected and the value of the fuse supplied.

Voltage Selector

A mains voltage selector switch is located beneath the top cover of the unit, adjacent to the AC mains connector on the circuit board. *With primary AC power disconnected*, you may slide the red actuator with a small screwdriver so that the proper mains voltage designation (115 or 230) shows. Be certain always to install an appropriate fuse, and check that the rear-panel voltage/fuse designation is properly marked. It is factory practice to cross-out the *inappropriate* designation with an indelible black marking pen. You can remove this strikethrough with lacquer thinner or a similar noxious solvent to redesignate.

BE SURE that the mains voltage selector setting and primary fuse value are appropriate for the mains supply before plugging the 710 Encoder into the wall outlet.

Power Cord

The detachable IEC-type power cord supplied with the Encoder is fitted with a North-American-standard male plug. Nevertheless, the individual cord conductors are *supposed* to be color-coded in accordance with CEE standards; that is:

BROWN = AC “HOT” BLUE = AC NEUTRAL GRN/YEL = GROUND

If this turns out *not* to be the case, we offer our apologies (cord vendors sometimes lie to us) and advise that US color coding applies:

BLACK = AC “HOT” WHITE = AC NEUTRAL GREEN = GROUND

RADIO FREQUENCY INTERFERENCE (R F I)

Location

Although we have anticipated that the 710 may be installed in the immediate proximity of broadcast transmitters, you should practice care in locating the unit away from *abnormally* high RF fields.

Ground Loops

Because the Model 710 INPUT and OUTPUT are unbalanced connections, a mains frequency or RF ground loop may be formed between the input or output cable shield grounds and the AC power cord ground in some installations. This situation usually manifests itself as a low-level hum, audible during periods of low audio modulation. Use of a “ground-lifting” AC adapter will probably remedy this situation, though the chassis somehow must be returned to earth ground for safety. Generally, being screwed-down in the equipment rack will satisfy the safety requirement.

ENCODER “LOOP-THROUGH” MODE

The 710 Encoder may be operated in either a loop-through mode (with fail-safe, relay bypass), or as an “outboard” signal source, with or without phase-lock with the 19kHz FM stereo pilot. A discussion of the options and their respective jumpering configurations follows.

Loop-Trough Operation

In the loop-through mode, the model 710 is simply connected in-line with the composite, multiplex signal between the output of the FM stereo generator and the input of the FM exciter. This guarantees automatic phase-lock of the RDS subcarrier to the 19kHz stereo pilot. A bypass relay removes the 710 from the circuit should Encoder power be interrupted.

Figure 1, below, diagrams loop-through connection. In the loop-through mode, it is important to match the input and output characteristics of the 710 Encoder match those of the FM exciter and the stereo generator, respectively. The 710 includes a combining stage and line-drive amplifier which must be properly configured to yield overall unity gain. Gain and impedances must match to ensure that there is no level shift when the bypass relay operates.

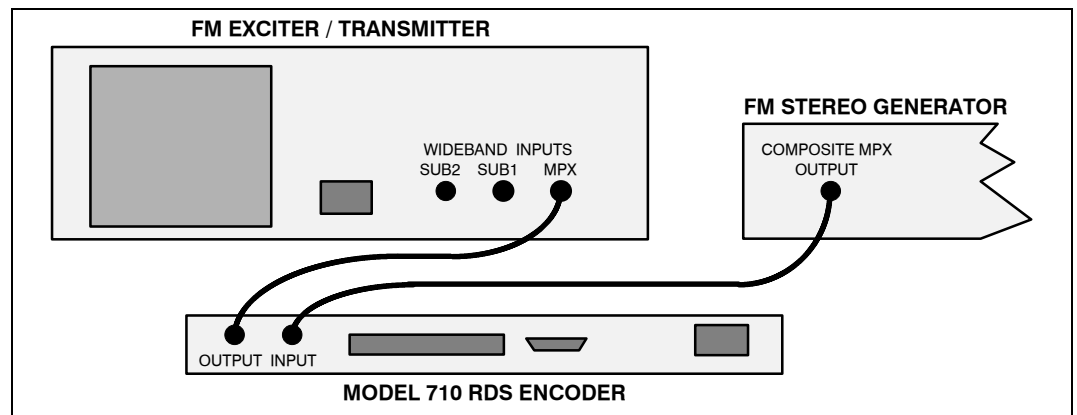


Figure 2 - Loop-Through Connection

Gain and Impedance Jumpering

Several jumpering options allow matching the gain and the input and output impedance of the 710 Encoder with the rest of the broadcast air chain. This matching is particularly critical when the Encoder is operated in the loop-through mode.

The Model 710 input characteristic may be jumpered for high-impedance, no-load *bridging* of the input signal, or for a 600-ohm or 75-ohm *terminating* input. Similarly, the output impedance of the 710 can be jumpered as a “zero-impedance” voltage source, or with a series 600-ohm or 75-ohm buildout resistor.

When connected between equal source and load impedances; that is, when the stereo generator has a source (build-out) impedance which feeds an equal load (terminating) impedance in the FM exciter, the combining stage of the 710 must be jumpered for these same impedances, and for a gain of 2, to retain an overall system gain of unity.

Some early stereo generators conformed to the 600-ohm impedance convention of the day. Contemporary, enlightened practice is to employ either a lower, 75-ohm characteristic for composite, multiplex signals, or to use voltage-source outputs feeding bridging inputs and ignore impedance matching for short cable runs.

The following matrix of impedance, gain and jumpering options will satisfy nearly all loop-through installation situations. Jumper locations are shown in Figure 5 on Page 18.

STEREO-GEN OUTPUT Z	EXCITER INPUT Z	INPUT TERM. JUMPER (JP3)	GAIN JUMPER (JP6)	OUTPUT Z JUMPER (JP5)
ZERO	BRIDGING	OPEN	X1	ZERO
ZERO	600 OHMS	600 OHMS	X1	ZERO
ZERO	75 OHMS	75 OHMS	X1	ZERO
75 OHMS	BRIDGING	OPEN	X1	75 OHMS
75 OHMS	600 OHMS	600 OHMS	X2	600 OHMS
75 OHMS	75 OHMS	75 OHMS	X2	75 OHMS
600 OHMS	BRIDGING	OPEN	X1	600 OHMS
600 OHMS	600 OHMS	600 OHMS	X2	600 OHMS
600 OHMS	75 OHMS	75 OHMS	X2	75 OHMS
MODE JUMPER (JP4) IN "LOOP THROUGH" POSITION FOR ALL OPTIONS				

Jumpering Verification

Once the impedance and gain jumpers have been set, and the 710 Encoder installed in-line between the stereo generator and FM exciter, check for normal operation and minimum gain offset. This test should be performed with the front-panel SUBCARRIER INJECTION control fully counter-clockwise; that is, *with no RDS subcarrier transmitted*. Under this condition, carrier deviation from the normal program signal should not change by more than a few percent when power to the encoder is turned off and on.

ENCODER "OUTBOARD" MODE

As an alternative to loop-through operation, the Model 710 may be used in its "outboard" mode as an independent subcarrier signal source. This mode has the added advantage of not requiring source and load impedance matching, and it assures that the composite, multiplex signal is not compromised by passing through the Encoder's circuitry.

For "outboard" connection, the output of the Encoder is fed directly into an FM exciter input intended for subcarrier signals. A sample of the composite, multiplex output from the stereo generator is fed to the input of the Model 710 using a "T" connector. The Encoder recovers the 19kHz stereo pilot from this sample to phase-lock the RDS subcarrier. Jumpering options for "outboard" operation are given below. A connection diagram is shown in Figure 4 at the top of the following page.

INPUT TERM. JUMPER (JP3)	MODE JUMPER (JP4)	GAIN JUMPER (JP6)	OUTPUT Z JUMPER (JP5)
OPEN	OPEN	X1	75 OHMS

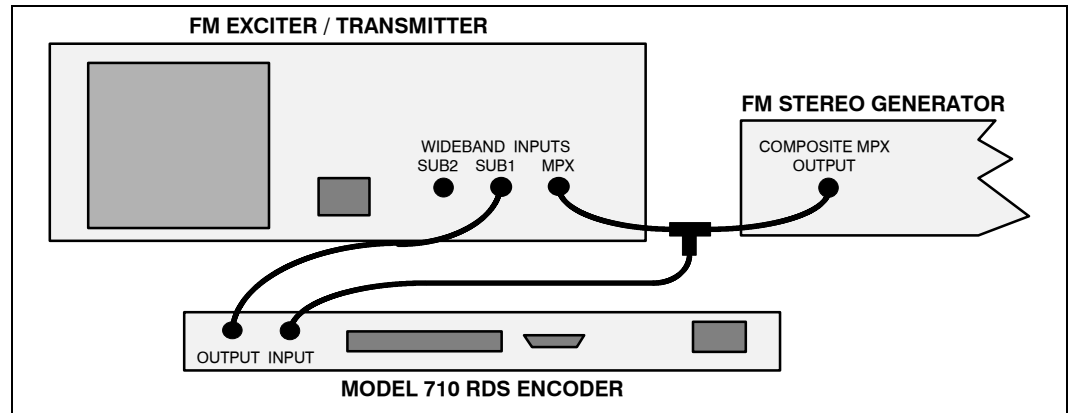


Figure 4 - "Outboard" Encoder Connection

SETTING THE RDS INJECTION LEVEL

The typical FM modulation monitor cannot make independent measurements of the injection level of the 57kHz RDS subcarrier. For this, the monitor would require a special subcarrier measurement filter, similar to the one sometimes provided for SCA channel measurements, but tuned for the 57kHz RDS operating frequency.

Inovonics manufactures two products specifically designed to make these measurements: the Model 510 RDS Decoder/Reader, and the Model 540 Subcarrier Monitor/Demodulator. Both of these are compatible with any mod-monitor.

Nonetheless, the conventional mod-monitor may be used alone to set injection by temporarily interrupting the audio program during a maintenance period.

With the 710 Encoder on, and with the modulation monitor showing total carrier modulation at the accepted 100% figure for program peaks, *turn off* the audio program, the 19kHz stereo pilot, and any other (SCA or high-speed data) subcarriers. (The SUBCARRIER INJECTION level control on the 710 front panel should still be set fully counterclockwise. Note that this is a 15-turn control to give good adjustment resolution.) As the mod-monitor is downranged to its most sensitive scale, only system noise should be indicated; hopefully an off-scale indication. At this point the SUBCARRIER INJECTION level control may be advanced slowly in a clockwise direction. The mod-monitor will begin to register the RDS subcarrier, which may then be set to the desired injection level, usually about 3% of total carrier modulation ($\pm 2.25\text{kHz}$ carrier deviation).

When the normal program audio and any other subcarriers are turned back on, a very slight increase in total carrier modulation may be noted on program peaks. In order for the RDS subcarrier to remain at 3% of total modulation, and for any other subcarriers to maintain their normal injection ratios, the output of the stereo generator (that is, the

audio program) may have to be adjusted slightly downward so that total modulation is once again at the desired "full value" level.

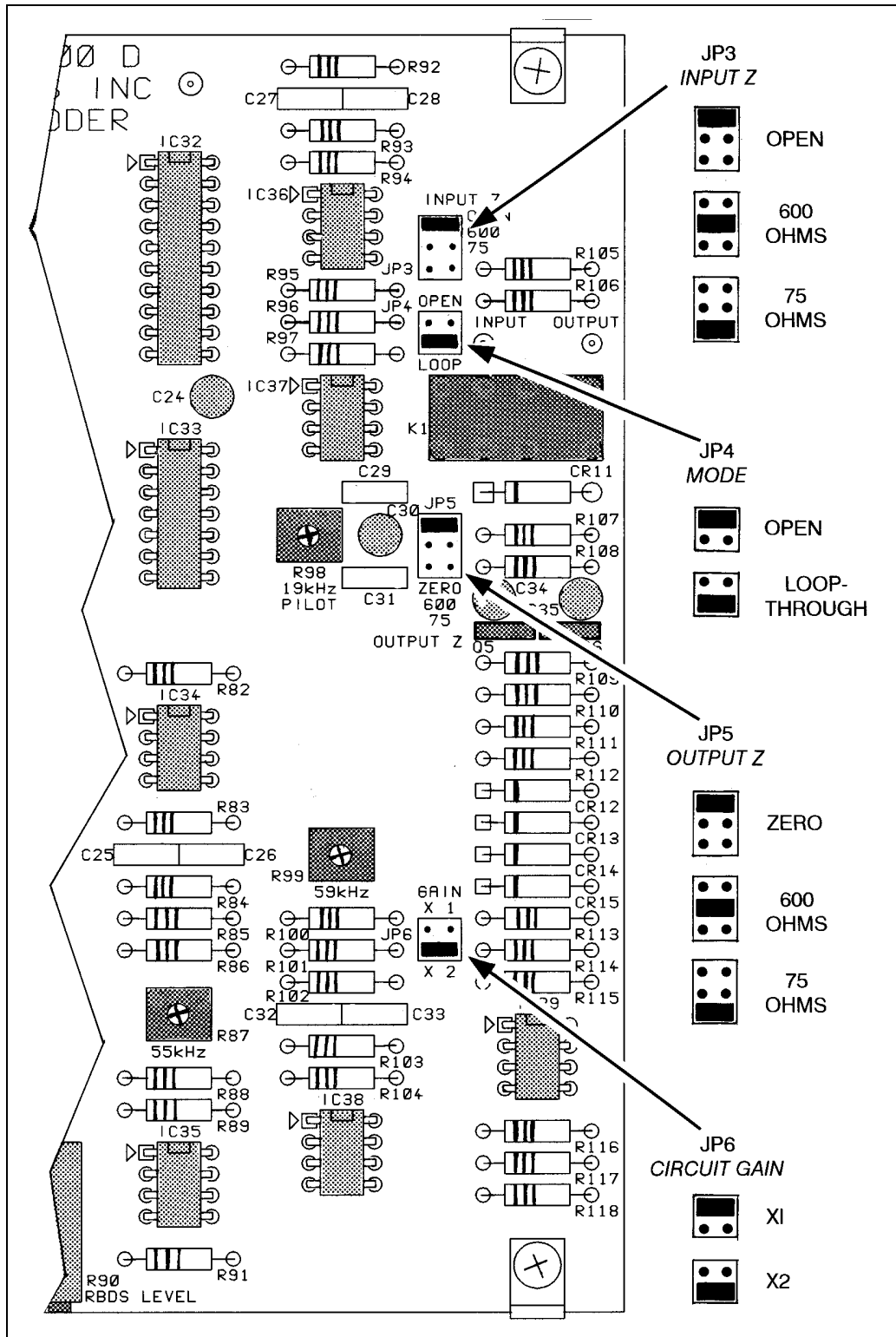


Figure 5 - Model 710 Encoder Jumpering Options

SELECTING THE *STATIC* DATA FRAMES

Front-Panel Manual Selection

The most obvious means of selecting the pre-programmed *static* RDS data for transmission is by cycling through the frames with the front-panel SELECT button. As this button is repeatedly pressed, the MESSAGE FRAME indicator LEDs will advance through the 15 data frames.

Cycle the SELECT button until the MESSAGE FRAME indicator reaches the desired RDS frame for transmission. A few seconds after the button is released, the corresponding MESSAGE FRAME indicator will begin to blink. A solid light indicates a frame which has been *selected*, a blinking light shows which frame is being *broadcast*. The blinking frame will continue to be transmitted until another frame is manually called-up.

Frame #15: TA Flag

Frame number 15 transmits the Travel Announcement (TA) flag. If the station is normally identified with a TP flag, as a station which broadcasts travel announcements, as soon as the TA flag is sent a receiver will immediately switch from another station (or tape/CD player) and stand-by for the anticipated travel bulletin. This frame should be selected *only just before* a travel announcement is broadcast, and should be de-selected *immediately after* the bulletin has aired. We suggest that Frame 15 is best selected by remote control through the indicated rear-panel terminal. This gives it priority over any other front-panel or remote frame selection, and even over *dynamic* (computer) operation. (See instructions under “Rear-Panel Connections” on the following page.)

Remote Manual Selection

Note that as the frames are manually cycled, a gap follows number 15, just as if there were a 16th frame. This 16th selection actually lights the REMOTE SELECT indicator to the left of the button. When this LED is lighted, the 710 will respond to rear-panel remote commands.

Remote selection is made with connections to rear-panel MESSAGE FRAME SELECTION barrier strip terminals. When the 710 is left in the “16th frame” REMOTE SELECT position, a ground applied to any *one* barrier strip terminal will immediately select that data frame. When *two or more* terminals are grounded, the 710 will cycle among those pre-selected frames, transmitting each frame for approximately one minute before cycling to the next.

All remotely pre-selected frames will show as *steadily lighted* MESSAGE FRAME indicators. The one actually being transmitted at the moment will be *blinking*. The sequence may be interrupted at any point by manually cycling the SELECT button to a desired data frame. The sequence will resume when the SELECT button is cycled back to the REMOTE SELECT position.

IT IS VERY IMPORTANT that at least one barrier strip terminal remain grounded at all times, even if the front-panel SELECT button will be used exclusively for frame selection, and even when the

Encoder is under *dynamic* (computer) control. As received from the factory, terminal number 1 is tied to ground.

Rear-Panel Connections

The rear-panel MESSAGE FRAME SELECTION barrier strip unplugs from the chassis. *Just grab the black plastic part and pull!* This makes wiring easier and affords quick-disconnect for servicing.

Connections to the rear-panel barrier strip may be hard-wired to a switch within reach of the console. This may be a simple rotary switch for one-at-a-time frame selection, or a series of push-on / push-off buttons for remote *sequence* programming. All 15 lines may be taken to this switch, or only the few required in routine operation. The GND. (ground) lead from the barrier strip must be carried to the switch as well. When a remote switch is wired, remember to provide a ground for one of the command lines (a chosen “default” frame) even when the switch is in the “off” position.

Because the number 15 “TA” frame has priority over the other *static* frames (and over *dynamic* operation as well), a separate switch is recommended for sending Travel Announcements. A TA flag will be broadcast immediately when terminal 15 is grounded. Normal *static* sequencing (or *dynamic* control) will resume when the ground is lifted.

If remote programming for *static* data frame sequencing is not necessary, the barrier strip may simply be strapped, daisy-chain style, so that a ground is applied continuously to the terminals representing message frames desired for routine transmission. A front-panel REMOTE SELECT command will then initiate the automatic sequencing of the grounded terminals. Front-panel SELECT button choices always override the rear-panel barrier strip programming, except that a frame 15 (TA) barrier strip closure to ground overrides everything.

Section IV

DYNAMIC ENCODER OPERATION

Dynamic operation of the 710 Encoder necessitates full-time use of an external computer. Any IBM-compatible with a 286-or-higher processor and VGA monitor may be used. Since the processing requirement is minimal, and the application is DOS-based, an older computer which has been retired from more demanding service makes the ideal and inexpensive “host” for *dynamic* Encoder control.

DYNAMIC OPERATION CONSIDERATIONS

When (and *only* when) *dynamic* operation is desired, the computer’s LPT1 printer port is cabled to the PARALLEL DATA INTERFACE connector on the Model 710 rear panel. A DB-25 parallel data cable of suitable length can be purchased at any computer supply store. Since data transfer is *parallel*, rather than *serial*, there is no baud rate or other transfer protocol to contend with.

It would be wise to equip the computer with a *parallel port data switch* to disconnect the 710 when the computer is turned off, or when it is used for any other purpose. Connecting the computer to the Model 710 automatically switches the 710 from *static* to *dynamic* operation. The computer must be connected to the 710 only after the dynamic control software has been loaded and the program is running. Similarly, the computer must be disconnected before the program is halted and the computer turned off.

INSTALLING THE SOFTWARE

Software required for *dynamic* operation may be found on the diskette supplied with the 710 Encoder. The program runs only on an IBM-compatible computer, and only under DOS. Windows[®] and any of its applications must be closed before the program is loaded, and any time when the *dynamic* program is run.

This installation loads several files. ENCODER.EXE and its supporting files are for *dynamic* Encoder operation. Other files are for the PROM (*static* memory) programming utility. Total space required for all files is just under 500K bytes.

At the C:\> DOS prompt, copy the Encoder software to the computer hard drive by typing A:INSTALL (assuming that the diskette is running on the A drive). Once the Encoder utilities are resident on the hard

drive, change to the RBDS directory (C:\> CD RBDS), then type RBDS at the C:\RBDS> prompt to run the program.

The *dynamic* control program is menu-driven and more-or-less self-explanatory. Ident codes, flags, radiotext, etc. are typed into indicated fields on the computer screen. A final F10 command downloads the entire frame of data to the Encoder and out over the air. This frame will repeat while another frame of data is being typed in, and until the F10 command is given for the new RDS update.

UTILITIES OVERVIEW

Drop-Down Menus

The opening screen shows four headings: Files, eVents, Off Line Edit and On Line Edit. Press the ↓ cursor key to show the menu items under the Files heading, then the → and ← cursor keys to see all items under each of the other headings. Under any main heading, the ↑ and ↓ cursor keys highlight the various subheadings, and the Enter key chooses the selected item. The highlighted key letter in each heading and subheading may also be used to navigate and select. Use the Esc button to return to previous screens, and to return to the desktop.

A brief description of each menu item is listed below. This is followed by a tutorial on entering and managing *dynamic* data.

Files

The Quit & Save option preserves all data that has been manually entered during a *dynamic* programming session. The next time the program is restarted, this same data will be reloaded. Quit No Save exits the program without saving any of the data entered.

Copy Code Table and Character Sets Info “Special” characters, such as ñ or å, may be inserted into radiotext messages, simply by holding-down the ALT key while typing-in the numerical value of the desired special character on the computer’s 10-key number pad. The numerical value for each special character is given in code table “Figure E1” of the RDS/RBDS Standard. (Figure E1 shows displayable characters per ISO Norm 646, “EBU common core” characters, and the “complete Latin-based repertoire.” Additional code tables, Figures E2 and E3, cover Cyrillic, Greek, Arabic and Hebrew characters.) The numerical value is calculated directly from a matrix arranged by bit address. The numerical value for ö is 151. The bit address is 10010111.

The special character transmitted will always be true to the code table, though the character shown on the computer screen may not. The two utilities (Copy Code Table and Character Sets Info) permit the user to re-map the computer’s video ROM, making the character shown on the screen match the character transmitted. This is an involved process requiring some degree of programming expertise. Please contact the factory for additional instructions should this be of interest.

eVents

The Scheduler utility allows the operator to program a date and time to automatically transmit the pre-loaded *dynamic* memories.

Copy Memory is a useful feature in the initial programming of the ten *dynamic* memories. Once the first memory (Memory 0) has been programmed, that same data may quickly be copied to all other memories. Then the various memories may be *edited*, rather than having the mostly redundant data *re-entered* in each.

The Select TX Memory utility chooses which of the pre-programmed *dynamic* memories will actually be broadcast over the air. The screen shows which memory is currently on-air, and lets the operator choose another to replace it.

The IRQs and Port options allow a change in the interrupt and port assignments from the normal, default settings (LPT1, interrupt 7).

Off Line Edit

This is the editing mode for those *dynamic* memories which are *not* on the air at the moment. Data may be entered into any of the idle memory fields. The program will not allow you to change data in the memory which is being transmitted.

On Line edit

As the name implies, this mode is for editing *dynamic* data which is currently being broadcast. It is most useful for typing-in song titles, contest results, or other information for immediate transmission.

DYNAMIC PROGRAMMING TUTORIAL

Programming the Memories

This tutorial, as well as actual memory programming, is most safely done with the computer *disconnected* from the Model 710 Encoder. All warning screens may be disregarded when there is no connection.

Under the eVents menu, select Select TX Memory. Bypass the warning screen with the F1 command. Note that the ↑ and ↓ cursor keys permit selection of any of the ten *dynamic* memories, labeled Memory 0 through Memory 9. With Memory 0 highlighted, press Enter.

Next, select On Line edit, and bypass the warning screen with the F1 command. With the first RBDS Feature highlighted (PS, PI, MS, DI), press Enter.

PS The cursor will be blinking in the first (PS) field. Type in the eight-letter Program Service name. This is the station's "street name" which will be displayed on the listener's radio. Though you may use any combination of capital and lower-case letters, all-caps are most easily

read. (Some radios may display only capital letters.) When the PS

entry is complete, press Enter for the next field.

- PI** Type in the station's call letters; for instance, KWOW. Then press Enter; this will take you to the PI calculation field, seemingly asking you to enter the call letters again. *Don't do this!* Simply press the spacebar and the PI code will be calculated automatically. For instance, for call letters KWOW, the PI code is 4B9A. The code you see after you press the spacebar is the "digital signature" PI code for your station. Press Enter for the next field.
- MS** Use the PgUp and PgDn keys to toggle the Music Speech switch. Set this to represent your station's programming. Remember that each of the *dynamic* memories has the option of setting MS (and other "flags") independently. If programming varies during the day, a different MS "flag" can be set for each programming segment. Once the Music Speech switch is properly set, press Enter.
- DI** Again, use the PgUp and PgDn keys to toggle the Audio Decoder Information between Monophonic transmission and Stereophonic transmission. For most stations, this will be set for conventional stereo operation. In the event that your station does have monaural programming segments, this "flag" may be set to Monophonic transmission, though the receiver will probably still remain in the stereo mode unless the 19kHz stereo pilot is *turned off* during mono programming.
- RT** Type-in up to 64 characters of radiotext. Again, as this information scrolls across the front-panel of (non-automobile) receivers, you may wish to use all-caps for best readability. When the radiotext message is complete, press Enter.
- PTY** Use the PgUp and PgDn keys to select one out of a possible 32 categories of program types, or formats. Depending on the software version, the complete range of choices may not be available. As more PTY categories are added, software updates will be available. Press Enter for the next field.
- CT** When your controlling computer is set to local time, leave the entry at 0.0, indicating *no* time offset. If, on the other hand, your computer is set to Universal Coordinated Time, or is in a different time zone from the primary service area, you will have to enter an offset number. This can be any number between zero and ± 12 hours. (QUIZ: Why "in the world" has provision been included for decimal fractions of hours, and why, then, are fractional hours automatically rounded to the nearest half-hour?) Think about this a bit, then press Enter.
- Travel** The PgUp and PgDn keys cycle through four choices for travel announcement options. These are:
- 1) No Travel On This Station. This is a proper setting if your station *does not* carry traffic information for motorists as a regular feature.
 - 2) This station carries Travel Announcements. If you routinely *do* supply

travel and traffic information, and wish to signal special bulletins with a TA “flag” (so that radios switch to your frequency to receive them), this setting ensures that receivers keep your station on their “list” of available travel stations. The TA “flag” is set manually by grounding the proper terminal on the rear panel of the 710 Encoder (see Page 20).

- 3) Travel Announcement being Broadcast Now. The Model 710 Encoder has the option for raising a TA “flag,” either by grounding a rear-panel connection, or by programming one or more of the dynamic memories for TA service. A switch closure is the sure-fire and quickest means of initiating the TA “flag,” even when the Encoder is under *dynamic* control. This alternate *dynamic* option (Travel Announcement being Broadcast Now) is a more cumbersome means of accomplishing the task and is recommended only for special circumstances.
- 4) Travel on this station is By EON. This option is primarily for use by “network” stations. If you think this could possibly apply to your situation, consult the appropriate RDS or RBDS Standard for a full explanation of how EON is used.

When Travel flags & status has been set, press Enter, then F10 to return to the RBDS features menu. Next, enter the Frequencies field.

Frequencies

Up to eight AF (Alternative Frequency) selections may be entered. These may include AM frequencies as well, but only if your station carries the *identical programming* on its AM facility. (Unlikely, but possible.) Type in the first frequency, then press Enter. This will take you to the next, and so-on. Be sure to include the *primary station frequency* on this list as well.

Frequency entries may be erased or voided by typing-in an invalid entry, such as a single digit. (The program will automatically insert a FILLER or an Empty designation in unused frequency positions as the data are saved.)

When the Frequencies field is complete, press F10 to return to the RBDS Features menu. Next, enter the PIN, IH field.

IH In-House data are entered identically to radiotext (RT). This data string is for proprietary station use, and can carry telemetry or local paging information. (See Page 11.) Enter takes you to the PIN area.

PIN The Program Item Number identifies a particular program by encoding its scheduled program time and day of the month. As mentioned earlier, this feature can actuate a recorder to save a program for later playback.

If you do not broadcast PIN information, enter a zero in the first PIN field. Otherwise, any number corresponding to the day of the month, between zero and 31, may be entered. Similarly, enter a zero, or any

hour between zero and 23 in the second PIN field. The last PIN field

should be a zero, or any minute between zero and 59.

When the PIN, IH page is complete, press F10 to return to the RBDS features menu. Finally, enter the Dynamic field.

Dynamic

This field is associated with the Travel options field which was programmed earlier. Unless there is a specific reason to use dynamic programming to set the TA “flag,” leave this field’s switch set to: Follow the dynamic port for TA. This is the factory recommendation; you may wish to consult with our engineers if you believe that another option has merit for your use.

Use the Enter and F10 commands to return to the RBDS features menu, then the Esc key to clear the screen.

Copying the Memories

The next procedure is to copy the one dynamic memory just programmed into the other nine memories. This will obviate the need for entering all the RDS data nine more times. It also provides a safety factor since some form of valid data will be sent even if an empty memory is inadvertently transmitted.

Under eVents, select Copy Memory. This will bring up the Copy memory Contents screen.

The cursor will be blinking after: Memory number to copy from >. Type 0 (a zero) here. That will take the cursor to: Copy to the memory number >. Type 1 here, then Enter. This will clear the screen. Now repeat this procedure, copying memory 0 (zero) to memories 2 through 9. This will place memory 0 data in all *dynamic* memories.

EDITING MEMORIES

The nine memories which have been loaded with the Memory 0 data may be edited individually. This allows each to be customized: to update the PTY code for changing station formats, or to selectively transmit specific radiotext advertising or promotional messages.

Under Off Line Edit, any memory which is *not* currently on-air may be selected using the ↑ and ↓ cursor keys, or by entering the memory number. The selected memory will be verified at the bottom of the screen, along with the memory which is currently being transmitted. Once the selection is made, the RBDS features menu will appear. Any RDS field may be changed, simply by re-typing new information over the existing (Memory 0) data which will appear in all fields. Use the Enter and F10 keys to confirm and save new entries.

SAVING RDS DATA

Dynamic memory RDS data must be saved upon exiting the program, otherwise all freshly-programmed information will be lost. Always exit through the Files / Quit & Save menu option. The only instance when this

might *not* be a proper procedure, is when temporary changes are made. The Quit No Save exit will retain data previously saved, and will discard any changes made in the current programming session.

COMPUTER-TO-ENCODER CONNECTION

The LPT1 (printer) port of the computer is cabled to the DB-25 connector on the rear panel of the Model 710 Encoder.

VERY IMPORTANT: The Model 710 Encoder automatically goes into the *dynamic* mode as soon as the host computer is connected. It is *essential* that the RDS dynamic program is loaded and running *before* the connection is made. (See “*Dynamic Operation Considerations*” on Page 21.)

SELECTING MEMORIES FOR TRANSMISSION

Manual selection of memories is made under the eVents heading, choosing the Select TX Memory menu option. The warning screen is bypassed with the F1 command.

The programmed memory is selected for immediate transmission, either with the ↑ and ↓ cursor keys, followed by Enter, or by directly typing-in the memory number. The selection screen may be kept active until the selection is made. You also may elect to keep this screen active for keeping track of which memory is actually on-air.

EDITING RDS DATA ON-LINE

If, for example, you wish to update a radiotext message, this is done with the active, on-air memory through the On Line Edit feature. Bypass the warning screen with the F1 command, and select the RT, PTY, CT, Travel option from the menu. The cursor will be positioned in the radiotext field; simply type-in the new message and press Enter. Now give an F10 command, and the new radiotext message will be broadcast. This procedure may be used for any of the RDS fields, but updating radiotext messages with song titles, contest results, one-time promotions, etc. will probably be the most frequent use of On Line Edit.

If the changes made under On Line Edit are only temporary, be sure to exit the dynamic program with the Quit No Save option. Otherwise, the new, updated radiotext message (or other RDS field modification) will permanently replace the pre-programmed data in that memory.

SCHEDULING EVENTS

This feature lets the operator enter the date and time for transmission of a particular, pre-programmed *dynamic* memory.

Under the eVents heading, select and enter the Scheduler option and study the screen. Scheduled events are added to a “pool” by entering the date, time and memory number. Proper formatting is important. Note the format of the current date and time at the blinking cursor. You can compare formatting with the current date and time at the bottom of the screen. Though this display remains frozen at the instant the Scheduler feature was enabled, it can serve as an example when typing-in pool items.

Type the 2-digit day for the first pool item, followed by a hyphen, the month (Caps and lower-case; eg: Mar), another hyphen, and the 4-digit year. Follow the date entry with a single space, then the time in hours, minutes and seconds (separated by colons, as shown) for the pool item to start. Your entry should be formatted exactly like the “frozen” date and time shown below it. Press Enter to confirm the formatting and to move to the memory field.

Enter the number of the *dynamic* memory which you wish transmitted on the date and at the time you have just entered. Then press Enter, and finally F10 to add the item to the pool.

A scheduled pool item will be transmitted until it is replaced by the next pool item. The software has no provision to remove an item from the pool. To correct a scheduling error, simply schedule an alternative item to start *one second* after the unwanted pool item is scheduled to begin.

Pool items are listed in order on the screen, along with the number of items in the pool. This information is saved to disk when the program is exited under the Files / Quit & Save option. As each pool item transmission begins, it will be removed from the pool. The pool listing always shows future events.

Section V

PROGRAMMING STATIC EPROM “FRAMES”

INTRODUCTION

Static operation of the Model 710 Encoder involves “burning” the RDS information into PROM memory. The fifteen “frames” of static memory are then called-up by front-panel pushbutton selection, or by remote switching. *Static* memory selection is detailed on Pages 19 and 20.

Types of Memory

The 710 Encoder can use either of two types of PROM memory: the C-MOS “EPROM” (Erasable, Programmable Read-Only Memory), generic designation: 27C64, or the C-MOS “EEPROM” (Electrically-Erasable, Programmable Read-Only Memory), generic designation: 28C64. The EEPROM has the programming advantage that an ultra-violet EPROM “eraser” is not required to clear it of existing data before new information can be loaded.

Memory ICs are available with various “speed” classifications. Because of the comparatively slow data rate of the RDS system, speed is not a consideration; even the slowest PROM may be used to retain the Encoder’s *static* memory.

Equipment Required

“Burning” a PROM of either type requires an “EPROM Programmer.” This generally takes the form of a circuit “card,” which installs into a PC-compatible computer, and a “head,” or “adapter module,” which accepts the plug-in memory chip and connects to the computer card by a cable. Programmers are moderate in cost and useful in a host of IC programming applications. If occasional use won’t justify the purchase of a Programmer, one can usually be borrowed from a computer “hacker,” or fervid digital-circuit experimenter.

If the popular and universally-available EPROMs are used for *static* memory storage, an EPROM “Eraser” will be required. Data stored in EPROMS is erased by exposing them to a source of intense, ultraviolet light. A hobbyist-grade EPROM Eraser can be obtained at low cost. The only advantage afforded by more expensive, “professional” models is the time required for erasure, and the number of EPROMs which can be erased at once. Neither factor should handicap Encoder *static* memory management.

PRELIMINARY RECOMMENDATIONS

The PROM Programmer comes with its own software for translating the files created by Encoder software into PROM programming

language. It will be necessary for the operator to become familiar with the PROM Programmer and the software supplied with it.

PROM programming is not difficult; it is one of the first skills mastered by digital experimenters. You may wish to avail yourself of the services of a digital hobbyist (computer “geek”) to help in understanding and learning the fundamentals of programming.

**Similarity to
Dynamic Encoder
Operation**

The software for creating RDS *static* memory files is very similar to the program for *dynamic* operation of the 710 Encoder. Many of the menus and facilities for entering RDS data are identical. We emphatically recommend that Section IV, “*Dynamic Encoder Operation*,” starting on Page 21, be studied and mastered before the user attempts to program the *static* memory PROMs.

INSTALLING THE SOFTWARE

Software files required for PROM programming are among those on the diskette supplied with the 710 Encoder. PRO-EPM.EXE and supporting files contain this utility. The program runs only on a 286-or-better IBM-compatible computer, and only under DOS. Windows[®] and any of its applications must be closed before the program is loaded, and any time the program is run.

If the factory-supplied disk has already been loaded to enable *dynamic* Encoder operation, all files are already resident on the computer’s hard drive. If, on the other hand, a separate computer is used for PROM-burning, the files must be transferred again as follows.

At the C:\> DOS prompt, copy the Encoder software to the computer hard drive by typing A:INSTALL (assuming that the diskette is running on the A drive). Once the Encoder utilities are resident on the hard drive, change to the RBDS directory (C:\> CD RBDS), then type PRO-EPM at the C:\RBDS> prompt to run the program.

UTILITIES OVERVIEW

**Drop-Down
Menus**

The opening screen shows four headings: Files, Duplicate, Edit Memory and About 710 RBDS. Press the ↓ cursor key to show the menu items under the Files heading, then the → and ← cursor keys to see all items under each of the other headings. Under any main heading, the ↑ and ↓ cursor keys highlight the various subheadings, and the Enter key chooses the selected item. The highlighted key letter in each heading and subheading may also be used to navigate and select. Use the Esc button to return to previous screens, and to return to the desktop.

A brief description of each menu item is listed on the next page. This is followed by a tutorial on creating the *static* memory “frames.”

Files

Load File brings previously-generated *static* memory frames back into the PRO.EPM program for editing. Each set of 15 *static* memory frames comprises a file named: <NAME>.INI. The file is named by the operator once all RDS data has been entered, edited and verified.

Save File may be used at any time during the entering of RDS data. It ensures that data entered to that point will be saved to the named file. Because RDS data entry for all 15 frames may be a lengthy procedure, use the Save File command as propriety demands, or when intuition suggests an imminent power outage.

Quit & Save exits PRO-EPM, saving the data entered. Quit No Save exits the program without saving data. (This is useful when you begin to change a file, but change your mind instead.)

NOTE: Both the Save File and the Quit & Save commands will prompt for a file name. See “Naming Files” on Page 34.

Duplicate

Copy Memory is a useful feature in the initial programming of the fifteen *static* memory frames. Once the first frame (Memory 1) has been programmed, that same data may quickly be copied to all other memories. Then the various memories may be *edited*, rather than having to *re-enter* the mostly-redundant data for each one.

Copy Code Table (A utility for non-standard characters. See the complete explanation under a similar heading on Page 22.)

Edit Memory

This is the primary utility for entering all RDS data. Each static memory frame may be accessed and independently edited.

About 710 RBDS

Information 710 is a read-me screen giving a brief overview of the PRO-EPM features. Similarly, Character Sets gives information on entering “extended” characters which do not appear on the computer keyboard.

EPROM PROGRAMMING TUTORIAL

Programming Static Memory “Frames”

Under the Edit Memory menu, select Edit RBDS features. The 15 memories will be listed, Memory 1 should be highlighted. Press Enter.

The RBDS features menu will appear, with the first option (PS, PI, MS, DI) highlighted. Press Enter.

PS

The cursor will be blinking in the first (PS) field. Type in the eight-letter Program Service name. This is the station “street name” which will be displayed on the listener’s radio. Though you may use any combination of capital and lower-case letters, all-caps are most easily

read. (Some radios may display only capital letters.) When the PS entry is complete, press Enter for the next field.

PI Type in the station's call letters; for instance, KWOW. Then press Enter; this will take you to the PI calculation field, seemingly asking you to enter the call letters again. *Don't do this!* Simply press the spacebar and the PI code will be calculated automatically. For instance, for the call letters KWOW, the PI code is 4B9A. Press Enter.

MS Use the PgUp and PgDn keys to toggle the Music Speech switch to represent your station's programming. Remember that each frame has the option of setting this (and other "flags") independently. If programming varies during the day, a different MS "flag" can be set for each programming segment. Once the Music Speech switch is properly set, press Enter for the next field.

DI Again, use the PgUp and PgDn keys to toggle the Audio Decoder Information between Monophonic transmission and Stereophonic transmission. For most stations, this will be set for conventional stereo operation. If your station does have monaural programming segments, the DI "flag" may be set to Monophonic transmission, though the receiver will remain in the stereo mode unless the 19kHz stereo pilot is *turned off* during mono broadcasts.

When the DI "flag" has been set, press Enter, then press F10 to go back to the RBDS features menu. Use the cursor keys to highlight the next set of features (RT, PTY, Flag, Travel), and press Enter.

RT Under *static* operation, each frame may contain *either* a radiotext message, *or* a proprietary, "in-house" communications or control message, but *not both*. Since most *static* memory frames will be relegated to radiotext messages, enter a 64-character "default" message in this field. Again, as this information scrolls across the front-panel of (non-automobile) receivers, you may wish to use all-caps for best readability. When the radiotext message is complete, press Enter.

PTY Use the PgUp and PgDn keys to select one out of a possible 32 categories of programming. Depending on the software version, the range of choices may be limited. As more PTY categories are added, software will be updated. Use the Enter key to reach the next field.

Group 2/6 Since the *static* memory frame can transmit either a radiotext message or an in-house communication, but not both, the Group 2/6 switch selects the option for that frame. Again, as radiotext will be the predominant choice, set the switch for: Group 2 Radio Text - No In house data. Press Enter for the Travel field.

Travel The PgUp and PgDn keys cycle through four choices for travel announcement options. These are:

- 1) No Travel On This Station. This is proper if your station *does not* carry traffic information for motorists as a regular feature.
- 2) This station carries Travel Announcements. If you routinely *do* supply

travel and traffic information, and wish to signal special bulletins with a TA “flag” (so that radios switch to your frequency to receive them), this setting adds your station to the radio’s “list” of available travel stations. The TA “flag” is set manually by grounding the proper terminal on the rear panel of the 710 Encoder (see Page 20).

- 3) Travel Announcement being Broadcast Now. Memory 15 (only) will be edited to include the TA “flag.” Do not choose this option now.
- 4) Travel on this station is By EON. This option is primarily for use by “network” stations. If you think this could possibly apply to your situation, consult the appropriate RDS or RBDS Standard for a full explanation of how EON is used.

When Travel flags & status has been set, press Enter, then F10 to return to the RBDS features menu. Next, select the Frequencies field.

Frequencies

Up to eight AF (Alternative Frequencies) selections may be entered. These may include AM frequencies too, but only if your station carries the *identical programming* on its AM facility. Type-in the first frequency, then press Enter. This will take you to the next, and so-on. Be sure to include your station’s own *primary frequency* on this list as well.

Frequency entries may be erased or voided by typing-in an invalid entry, such as a single digit. The program will automatically insert a FILLER or an Empty designation in unused frequency positions as the data are saved.

When the Frequencies field is complete, press F10 to return to the RBDS Features menu. Next, enter the PIN, IH field.

IH This field is pre-loaded with a “filler.” Because the Group 2/6 switch has been set for Group 2 radiotext, the filler will be ignored. Later, when *static* memories are individually edited, In-House data may be entered identically to, and in lieu of, radiotext (RT). The IH data string is for proprietary station use, and can carry telemetry or local paging information. (See Page 11.) Enter takes you to the PIN area.

PIN The Program Item Number identifies a particular program by encoding its scheduled broadcast time and day of the month.

If you *do not* broadcast PIN information, enter a zero in the first PIN field. Otherwise, any number between zero and 31, corresponding to the day of the month, may be entered. Similarly, enter a zero, or any hour between zero and 23 in the second PIN field. The last PIN field should be a zero, or any minute between zero and 59.

When the PIN, IH page is complete, press F10 to return to the RBDS Features menu, then Esc to clear the screen.

Copying Frames

The next procedure is to copy the one *static* frame just programmed into the other fourteen frames. This will obviate the need for entering all the RDS data fourteen more times, and provides a safety factor as

well; that is, it ensures some form of valid data will be sent even if an empty frame is inadvertently transmitted.

Under the Duplicate menu, enter the Copy Memory utility. In the Copy From listing, Memory 1 will be highlighted. Press Enter. This will bring-up the Copy To memory list.

Use the ↑ and ↓ cursor keys to highlight Memory 2 in the Copy To column. Then press Enter. RDS data in static frame 1 will be copied to frame 2.

The Copy To listing will have disappeared, but Memory 1 in the Copy From column will still be highlighted. Again press Enter to bring up the Copy To listing. Use the cursor to highlight Memory 3 under Copy To and press Enter, transferring the RDS data into the third frame.

Repeat this process until the RDS data from Memory 1 has been copied to all 15 memories. When this is complete, press Esc to return to the desktop.

If you've had enough of this for now, exit the program as described below. Digital Masochists may skip the exit routine, but a Save File command under the Files menu would not be a bad move at this time.

**Exiting
PRO-EPM**

Naming Files

When exiting the PRO-EPM program, always use the Quit & Save option under the Files menu to retain the work in process. When prompted, assign a name to the file you're working on, if it hasn't already been named. Use any combination of letters and numbers up to eight characters. It's handy to use a name which readily identifies the file, perhaps using the date the file is generated; ie: 12MAR96. Type in a name, press Enter, and then F10 to confirm and exit the program.

EDITING FRAMES

The 15 *static* "frames" (memories), which have been loaded with identical RDS data from frame 1, may now be edited individually. This allows each to be customized with an alternate PTY code (if station format changes during the day), with different radiotext messages, and with other changes in any of the RDS fields as may be required to suit and support day-to-day station operation.

If you are still in the initial programming session, skip the Loading Files instruction, below.

Loading Files

If you have exited the program properly, naming and saving earlier work, you may return to PRO-EPM and edit the RDS data. Under the Files menu, choose Load File. All RDS data files will be shown as <NAME>.INI. Using the ↑ and ↓ cursor keys, highlight the file to edit and press Enter. This will clear the screen, but the selected file will be loaded into the PRO-EPM program.

Editing

Choose Edit RBDS Features under the Edit Memory menu. The selected file will be verified by name at the bottom of the screen. Any

individual *static* memory frame may then be selected using the ↑ and ↓ cursor and Enter keys. Once the selection is made, the RBDS features menu will appear. Any RDS field may be changed, simply by re-typing new information over existing data. Use this utility to enter alternative PTY codes and radiotext messages, to set the TP status, or to substitute IH (In-House) information for radiotext in one or more of the message frames. NOTE: If In-House messages are programmed to replace radiotext, the Group 2/6 switch for that frame must be changed as well.

**Important
Special
Instructions!**

1) The PS (Program Service Name) must remain identical for all fifteen static memory frames. The importance of this is discussed under “PS” on Page 9.

2) Travel flags and status should be set as follows:

If your station *does carry* information for motorists as a routine service throughout the day, set Travel flags & status in frames 1 through 14 for: This station carries Travel Announcements. In frame 15, set the Travel flags & status option for: Travel Announcement being Broadcast Now.

If the station *does not* provide routine motorist information (profit-driven, all-music format with no public conscience or community spirit), set *all 15 frames* for: No Travel On This Station.

Each edited item in an RDS field is confirmed with an Enter command. After each RDS field has been edited, an F10 command will return you to the RBDS Features menu. When all fields for a particular frame have been edited, press Esc to activate the list of memories for another frame selection. After all frames have been edited, use the Esc command to clear the screen.

Saving Edits

When all *static* RDS frames have been edited to the operator’s satisfaction, use the Quit & Save option under the Files menu to leave the program, or the Save File option to save all edits and to remain in PRO-EPM. Either option will prompt for a file name, or confirm a name already assigned. For Quit & Save, make sure the file has been properly named, then enter an F10 command to exit the program.

MANAGING RDS FILES

From a C:\RBDS> prompt, type DIR. This will list all files in the RBDS directory which are resident on the computer’s hard drive.

Program files will have an .EXE or .PIF extension. Files generated when the RDS data were entered will be identified by: <NAME>.INI. From the .INI files, PRO-EPM automatically generates a “HEX” file labeled: <NAME>.RDS. The HEX file is in the language and form to be used by EPROM-programming hardware and software to “burn” the *static* memory chip.

During the “burning” process, and depending on the particular programmer hardware and software, you will be asked for the location and name of the file to load into the empty (erased) PROM. This should be entered: C:\RBDS\

NOTE: The re-programmed PROM chip is the “data” PROM, IC8. Be sure that it is plugged into the IC8 socket and is facing the proper direction.

Section VI

CIRCUIT DESCRIPTIONS

This section details circuitry of the Inovonics Model 710 RDS Encoder, and also includes procedures for the comparatively few calibration adjustments. Circuit descriptions refer to the three pages of Schematic Diagrams contained in the Appendix, Section VII, Pages 47, 48 and 49.

COMBINING AND LINE-DRIVE AMPLIFIERS (Schematic Sheet 1)

Mode and Input Termination Jumpering

When jumper JP4 is in the LOOP position, a multiplex signal applied to the rear-panel INPUT connector is routed through the Encoder and mixed with the 57kHz RDS subcarrier to appear at the OUTPUT. When JP4 is jumpered OPEN, input signals pass only to the 19kHz filter and pilot recovery circuits. The output signal consists *only* of the 57kHz RDS subcarrier in this case.

DPDT relay K1 is arranged to bypass the Encoder in the event that the Encoder's primary power should fail. When the Encoder is used in the loop-through mode, this fail-safe feature ensures that the program signal will not be interrupted.

Jumper JP3 applies a termination resistance to the output of the stereo generator, or to an STL receiver or other equipment which feeds the Model 710 Encoder. A 75-ohm or 600-ohm resistor, or no terminator at all, may be chosen. The selected resistance should match the input characteristic of the FM exciter or other equipment which the Encoder feeds. (See discussion and jumpering table on Pages 15 and 16.)

Combining Stage, Gain Jumpering and Output Circuitry

If the Encoder is used in the loop-through mode, the stereo program signal is combined with RDS data by IC39A. The level of the RDS data is adjusted with R90, the SUBCARRIER INJECTION LEVEL control.

Jumper JP6 sets gain stage IC39B for unity gain, or for a gain of two. X2 gain is selected when the Encoder must operate in an impedance-matching installation; that is, the Encoder terminating a source, and the output of the Encoder terminated in a similar load.

IC39B is buffered by output transistors Q5 and Q6. These provide additional current capability and assure circuit stability when driving long cables or other complex-impedance loads. This is particularly important when JP5 is jumpered for the voltage-source, "zero" output impedance. JP5 can alternatively select a 600-ohm or a 75-ohm "buildout" resistor.

ENCODER CLOCK (Schematic Sheet 1)

- Pilot Recovery** Whether the Encoder is used in the loop-through mode, or connected just to bridge and monitor the multiplex signal, a portion of the composite program is coupled to an active band-pass filter comprising IC36B, IC36A and IC37B. This high-Q filter is tuned by R98 to the 19kHz stereo pilot, and then fine-tuned to bring RDS subcarrier phase into proper relationship with the stereo pilot.
- IC27 is a “tone-decoder” PLL which locks to the 19kHz stereo pilot and outputs a clean 19kHz squarewave. IC27 logic toggles the front-panel PILOT LOCK and FREE RUN indicators, and controls the SPDT data switch which is part of IC14. When a recovered stereo pilot signal is available, it is selected by IC14; otherwise, Encoder circuitry defaults to 19kHz derived from crystal oscillator/divider IC18.
- Crystal Oscillator Default**
- Recovered or regenerated 19kHz is fed to phase-locked loop IC20. IC16, dividing-by-six in the feedback path, multiplies the 19kHz to the 114kHz Encoder master clock rate.

STATIC MESSAGE FRAME SELECTION (Schematic Sheet 3)

- “GAL” Integrated Circuits** The Inovonics 710 uses several Generic Array Logic (GAL) integrated circuits which are factory-programmed to perform counting, gating and other simple logic functions. Use of these programmable LSI circuits reduces the parts count and simplifies the circuitry.
- The GALs are IC14, IC19, IC21 and IC25. *These are individually configured and must not be interchanged!*
- Local Frame Selection** The front-panel SELECT button, S2, cycles 4-bit counter IC10. IC7B debounces the switch contacts, and IC7A clears the counter on initial power-up.
- The 4-bit address from IC10 is decoded by logic in IC14 to light LOCAL SELECT indicator I2 whenever the count is between 1 and 15. During this count sequence, data selector IC13 routes the 4-bit address to data latch IC12. This message frame address is also decoded by the GAL array (IC19, IC21 and IC25), and displayed as a lighted MESSAGE FRAME indicator on the front panel.
- Transistor Q1 is turned on whenever the SELECT button is pressed. This charges C11 to initiate a delay of two or three seconds. IC14 waits for this delay, and for the completion of any data-in-process as determined by the state of the data *bit* rate counter, IC4, IC5 and IC6. Only then is the 4-bit address clocked through IC12 to select a corresponding frame of RDS data held in EPROM IC8. The actual transmission of the selected data frame is indicated by *flashing* the lighted MESSAGE FRAME indicator at about a 2Hz rate. Logic to flash the LED is derived from a 19kHz clock by divider IC17, the Q14 output pulsing LED driver IC15.

Remote Frame Selection

A 16th-count address (actually a “zero” address) from IC10 lights REMOTE SELECT indicator I3, and enables the rear-panel MESSAGE FRAME SELECTION connector. Data selector IC13 is also switched to route an alternate 4-bit frame address from counter IC26.

GAL devices IC19, IC21 and IC25 are programmed to perform a variety of functions. First, a ground applied to any rear-panel MESSAGE FRAME SELECTION terminal will light the corresponding MESSAGE FRAME indicator on the front panel. As many indicators will be lighted as terminals are grounded.

Also, the three GALs *compare* rear-panel grounds with the 4-bit address from counter IC26. IC26 is clocked at approximately 600Hz from the Q5 output of IC17. When a ground is sensed, IC14 interrupts the 600Hz clock, holding the 4-bit address for that particular frame. IC15 flashes the selected frame indicator, all other LEDs associated with grounded terminals remain lighted.

IC14 clocks the frame address into latch IC12 and enables counter IC22 which is clocked at 2Hz. After approximately one minute, the Q7 output goes high. This restarts the 600Hz clock, and the GAL array seeks the next grounded terminal in sequence. The process repeats continuously, sequencing selected (grounded) message frames in order, over and over again.

The only interruption to this sequencing of selected message frames occurs when a ground is applied to MESSAGE FRAME SELECTION terminal 15. This instantly jams a frame address of 15 through the system to transmit the TA flag..

RDS DATA TRANSFER (Schematic Sheet 2)

Static Data Transfer

“Frames” of RDS data are held in EPROM IC8. The four, most-significant address bits select the *frame* to be transmitted, and the frame *data* is shifted-out as 8-bit, parallel bytes by counters IC6, IC5 and IC4. These counters are clocked at the 1187.5-baud RDS data rate. Parallel data emerges at 1/8 of this frequency, or at 148.4375Hz.

Dynamic Data Input

When a computer LPT (printer) port is connected to the rear-panel PARALLEL DATA INTERFACE connector, transistor Q2 lights the front-panel DYNAMIC DATA indicator and drives the Output Enable pin of EPROM IC8 high. This sends the eight output address lines of the EPROM to a high-impedance state, permitting *dynamic* information from the computer to replace *static* RDS data. Timing information *to* the computer is buffered by Q3, and RDS data *from* the computer is properly formatted for the Model 710 by the supplied software.

Differential Encoding

The eight-bit, parallel RDS data byte, which represents either *static* or *dynamic* information, is converted to a serial bit stream by shift-register IC11. The register is clocked at the 1187.5(Hz) baud rate. A second shift register, IC31, and exclusive-OR gate IC23C differentially-

encode the data per the RDS Specification. Jumper strip JP2 is normally arranged to pass RDS data, but may be jumpered to instead transmit a continuous string of data zeroes or ones to help with system setup under some circumstances.

GENERATING THE RDS WAVEFORM (Schematic Sheet 2)

The RDS system employs a 57kHz suppressed-carrier subcarrier, amplitude-modulated by a biphas-coded data stream. Data is differentially coded and transmitted at a rate corresponding to 1/48 of the 57kHz subcarrier frequency, or 1187.5 baud.

EPROM IC28 is programmed with a code which represents instantaneous values of the double-sideband, suppressed-carrier RDS waveform. The 114kHz master clock cycles counters IC29 and IC30 through a routine which develops the basic waveshape, and differentially-coded RDS data from IC31 provides an additional modulating component which carries the RDS information.

IC32 latches the 8-bit waveform byte from the EPROM to ensure that it is free from address-change discontinuities. Jumper JP1 and ex-OR gate IC23D determine “coarse” subcarrier phase. Subcarrier zero-crossings are normally coincidental with 19kHz stereo pilot zero-crossings, but may be offset by 90 degrees if required in some installations. “Fine” phase adjustment is afforded by careful trimming of R98, the tuning control for the 19kHz band-pass filter.

IC33 is a monolithic D-to-A converter which changes the 8-bit waveform data byte into an analog output signal. A two-section, band-pass output filter removes waveshape segmentation and switching noise. The first filter section, IC34B and IC35A, is tuned to 55kHz, or slightly below the mean subcarrier frequency. The second section, IC35B and IC38A, is tuned to 59kHz, symmetrically above 57kHz. The band-passed output is fed to combining amplifier IC39A.

POWER SUPPLIES (Schematic Sheet 1)

To maintain sufficient headroom in the composite/multiplex signal path, combining and line-drive stages operate from a bipolar 12-volt supply. Positive and negative sources are regulated by linear “three-terminal” IC voltage regulators: IC1 for the +12-volt supply, IC2 for the -12-volt supply.

Encoder digital circuitry requires a +5-volt supply capable of delivering significant current. IC3 is a “switchmode” regulator. Operating like a “step-down transformer at DC,” it can deliver more *current* (at the lower voltage) than it actually draws from the positive raw supply.

The 710 power transformer has dual primary windings which may be switched in parallel or in series for 115V or 230V mains, respectively.

ENCODER CALIBRATION PROCEDURES

Routine alignment of the Model 710 Encoder is never necessary, circuitry inherently being very stable. There are too few internal adjustments to justify a separate section for calibration procedures, only five trimmer controls can be found beneath the top cover of the Encoder.

To verify Encoder alignment, you will need a frequency counter; a dual-trace oscilloscope with two 10:1, high impedance probes; two short BNC cables; an FM stereo generator; and an audio generator (oscillator) good to 100kHz.

C19: Connect the frequency counter to pin 10 of IC18 using one of the 10:1 'scope probes; the end of R75 nearest IC18 is a convenient place to clip the probe. Adjust C19 for a reading of exactly 1,216,000Hz.

R78: This adjustment must be made with the Encoder *disconnected* from the Stereo Generator; that is, with *no stereo pilot input* to lock-up to.

Connect a frequency counter to pin 5 of IC27 using a 10:1 'scope probe. Adjust R78 for a reading as close as possible to 19,000Hz.

R87 and R99: Remove A-to-D converter IC33 from its socket. Clip-lead the output from the audio generator across 100K resistor R82. The "hot" lead from the generator should go to the end of R82 closest to pin 1 of IC34, the ground lead from the generator to the end of the resistor closest to pin 8. Also bridge the generator output with the frequency counter. Set the generator level to approximately 1-volt r.m.s., or 3 volts peak-to-peak.

Monitor pin 1 of IC38 with the oscilloscope using the 10:1 probe. The end of R104 closest to pin 1 is a convenient point to clip onto.

Set the generator to exactly 55kHz and adjust R87 for an amplitude peak. Then reset the generator to exactly 59kHz and adjust R99 for an amplitude peak. As the generator is tuned from 50kHz to 65kHz, the amplitude response should be fairly flat in the vicinity of 57kHz.

Remove the test leads and replace IC33

R98: This adjustment is made with the Encoder in the "outboard" mode, rather than for loop-through operation. The Encoder INPUT should be connected to the output of a stereo generator which is set to supply *only* the 19kHz stereo pilot; that is, *without* program material present.

With a 19kHz stereo pilot (only) feeding the Encoder INPUT, check that the Encoder acknowledges the 19kHz stereo pilot with a front-panel PILOT LOCK indication. Monitor pin 1 of IC36 with the oscilloscope using the 10:1 probe. You may clip the probe to the end of R97 closest to pin 1 of IC37.

Adjust R98 for an amplitude peak at 19kHz. Set R98 carefully *at* the peak, not down from the peak on either side.

Next, be sure that JP1 is jumpered for “zero” phase offset. This is the normal jumpering for JP1.

Monitor the INPUT and the OUTPUT of the Encoder on oscilloscope channels 1 and 2, respectively. These should be *direct* connections, not with the probes. Use a BNC “T” connector to bridge the Encoder INPUT.

Set the ‘scope to give a 3- or 4-division vertical display of both waveforms. Trigger the ‘scope from channel 1, the 19kHz stereo pilot, using a timebase of $5\mu\text{s}/\text{div}$ to display a single pilot cycle. A *positive-going*, zero-crossing of the 19kHz stereo pilot should be near the center of the display. Center the pilot waveform vertically so that the zero-crossing is smack-dab on the graticule centerline. (If the central zero-crossing of the pilot is negative-going, change the ‘scope trigger selector.)

You should also observe three 57kHz DSB cycles. These will look like six, “double-humped” waveforms, and will be modulated with biphas-coded RDS data. Because of the nature of the DSB waveform, it will be easy to center it vertically, bringing the co-incident zero-crossings to the graticule centerline.

Note the zero-crossings of both the stereo pilot and the RDS waveform. The positive-going pilot zero-crossing should be very close to an RDS zero-crossing. *Carefully* adjust R98 to bring the RDS zero-crossing into perfect alignment with the pilot zero-crossing. *Slowly* turn R98 in whichever direction brings the waveforms in phase with minimum rotation of the control.

Section VII

APPENDIX

The following section of this Manual contains Parts Lists and Schematic Diagrams for the Model 710 RDS Encoder, and an explanation of Inovonics' Warranty Policy.

PARTS LIST

EXPLANATION OF PARTS LISTINGS

This section contains listings of component parts used in the Inovonics 710 RDS Encoder. These are listed either *en-masse*, or by schematic component reference designation. The listing may, or may not, specify a particular manufacturer. When no manufacturer is called-out, the term “open mfr.” advises that any manufacturer’s product is acceptable, so long as it carries the proper generic part number.

If a particular component is not listed at all, this means that we do not consider it a typical replacement item. Should you need to order an unlisted part, call, write or FAX the factory with a brief description. We’ll do our best to figure out what you need and get it on its way to you quickly.

PARTS LISTING

Unless specifically noted by component reference designation below, **capacitors** are specified as follows:

- a) **Under 100pF** are the “dipped,” or “silver” mica type; DM-15 (or CM-05 military series) size designation; “P” value is picofarads, $\pm 5\%$, 200VDC; (open mfr.).
- b) **100pF to 0.47 μ F** are of the metalized mylar or polyester variety. Whole number “P” values are picofarads, decimal values are microfarads, $\pm 5\%$, 50VDC or better. The style used in the 710 is the “minibox” package with a lead spacing of 0.2 inch. **Preferred part:** Wima MKS-2 or FKC-2 series. **Alternates:** CSF-Thompson IRD series, or Roederstein KT-1808 or KT-1817 series.
- c) **1.0 μ F and above** are radial-lead electrolytics, value per schematic, 25VDC; (open mfr.).

C1,2	Capacitor, Ceramic Disc “Safety” Mains Bypass, .0047 μ F, 440VAC; Murata/Erie DE7150 F 472M VA1-KC (preferred)
C3,4	Capacitor, Electrolytic, axial leads, 1000 μ F, 35VDC; (open mfr.)
C8	Capacitor, Electrolytic, radial leads, 1000 μ F, 6.3VDC; (open mfr.)
C19	Capacitor, Variable, 5-50pF; Mouser 24AA024
C22,26,28	Capacitor, “High-Q,” .0033 μ F, 2.5%, 100VDC; Wima FKC-2 (Polycarbonate) preferred, any equivalent <i>must</i> have identical characteristics.
CR1-6,11	Diode, Silicon Rectifier; (open mfr.) 1N4005
CR7	Diode, Schottky; (open mfr.) 1N9412
CR8-10,12-15	Diode, Silicon Signal; (open mfr.) 1N4151 or equiv.
F1	Fuseholder, PC-mounting; Littlefuse 345-101-010 with 345-101-020

	Cap for ¼-inch (U.S.) fuses, or 345-121-020 Cap for 5mm (European) fuses. (Fuse is normal “fast-blow” type in value specified on rear panel with reference to mains supply.)
I1	LED Indicator, diffused pastel red, T-1 package; Stanley MVR 3378S
I2,4-17,19	LED Indicator, diffused pastel green, T-1 package; Stanley MPG 3878S
I3,18,20	LED Indicator, diffused yellow, T-1 package; Stanley MAY 3378S
IC1	Integrated Cct.; (open mfr.) LM317-T (Uses Aavid 574602 B03700 Heat Fin)
IC2	Integrated Cct.; (open mfr.) LM337-T (Uses Aavid 574602 B03700 Heat Fin)
IC3	Integrated Cct., Switching Regulator; National Semi. LM2575-5 (Uses Aavid 574602 B03700 Heat Fin)
IC4-6,29,30	Integrated Cct.; (open mfr.) 74
IC7	Integrated Cct.; (open mfr.) CMOS 4093B
IC8,28	Integrated Cct.; <i>SPECIAL FACTORY-PROGRAMMED EPROM</i> , type 27C64. Order by designation, reference Model 710.
IC9,24	Integrated Cct.; (open mfr.) 74HC132
IC10,26	Integrated Cct.; (open mfr.) 74HC193
IC11	Integrated Cct.; (open mfr.) 74HC166
IC12	Integrated Cct.; (open mfr.) 74HC174
IC13	Integrated Cct.; (open mfr.) 74HC157
IC14,19,21,25	Integrated Cct.; <i>SPECIAL FACTORY-PROGRAMMED “GAL”</i> , type 22V10. Order by designation, reference Model 710.
IC15	Integrated Cct.; (open mfr.) 74HC154
IC16	Integrated Cct.; (open mfr.) CMOS 4018B
IC17,18	Integrated Cct.; (open mfr.) CMOS 4060B
IC20	Integrated Cct.; (open mfr.) CMOS 4046B
IC22	Integrated Cct.; (open mfr.) CMOS 4040B
IC23	Integrated Cct.; (open mfr.) 74HC86
IC27	Integrated Cct.; National Semi. LM567C
IC31	Integrated Cct.; (open mfr.) 74HC164
IC32	Integrated Cct.; (open mfr.) 74HC273
IC33	Integrated Cct.; Plessey ZN429
IC34-39	Integrated Cct.; (open mfr.) LF353N
J1	AC Mains Connector, PC-mounting; Switchcraft EAC303
J2	25-pin “D-Sub” Male; Amphenol 617-C025P-BF221, or Berg 86857-325
J3	16-Position Barrier Block; PCD Co. ELFH16210 PC-mounting header with ELFP116210 plug-in screw-terminal block.
J601,602	Connector, chassis-mounting male “BNC”; Amphenol 31-221
JP1-6	Shorting “Shunt” for 0.1-inch header strip (open mfr.)
K1	Relay, DPDT; Takamisawa RY-12W-K
L1	Inductor, switching regulator; Renco RL1952
Q1	Transistor, NPN; (open mfr.) 2N3906
Q2,3,4	Transistor, PNP; (open mfr.) 2N3904
Q5	Transistor, NPN; (open mfr.) MJE340
Q6	Transistor, PNP; (open mfr.) MJE350

All resistors are specified as follows:

- a) **Fixed resistors** with values carried to decimal places implying a 1% tolerance (*example*: 3.01K, 10.0K, 15.0K, 332K) are ¼-watt, 1% metal film type.
- b) **Fixed resistors** with values typical of 5% tolerance (*example*: 220, 3.3k, 10K, 270K) are ¼-watt, 5% carbon film type.
- c) **Multi-Turn Trimming Potentiometers** (front-panel adjustable) are Tokos RJC097P series, Beckman 89PR series, or equivalent “cermet” types.
- d) **Single-Turn Trimmers** (circuit board) are Tokos GF06U1 series or Beckman 91AR series.

S1	Switch, DPDT Slide, Voltage Selector; C&K V202-12-MS-02-QA
S2	Switch, SPDT Momentary Pushbutton; C&K 8125-S-D9-A-B-E, with 8018-BLK cap
S3-6	Switch, 2-position SPDT Miniature Toggle; C&K 7101-M-D9-A-B-E
S501	Switch, Power Rocker; Carling RA 911-RB-O-N
T1	Power Transformer, PC-mounting; Signal LP-34-340 or direct cross-reference
Y1	Crystal 1.216MHz; <i>SPECIAL - Inovonics Part No. 1242</i>

MAIL-ORDER COMPONENT SUPPLIERS

The following electronic component distributors have proven themselves reputable suppliers of both large and small quantities of parts. Any semiconductor, IC, capacitor, resistor or connector used in the Model 710 is *probably* available from one or more of these firms. Each supplier publishes a full-line catalog, available free for the asking. Minimum-order restrictions may apply; and export orders may be difficult.

Mouser Electronics — Call (800) 346-6873

Digi-Key Corporation — Call (800) 344-4539

ACTIVE (div. of Future Electronics) — Call (800) 677-8899

Allied Electronics (div. of Avnet) — Call (800) 433-5700

INOVONICS WARRANTY

- I **TERMS OF SALE:** Inovonics products are sold with an understanding of “full satisfaction; that is, full credit or refund will be issued for products sold as new if returned to the point of purchase within 30 days following their receipt, provided that they are returned complete, and in an “as shipped” condition.
- II **CONDITIONS OF WARRANTY:** The following terms apply unless amended *in writing* by Inovonics, Inc.
 - A. Warranty Registration Card supplied with product *must* be completed and returned to Inovonics within 10 days of delivery.
 - B. Warranty applies only to products sold “as new.” It is extended only to the original end-user and may not be transferred or assigned without prior written approval by Inovonics.
 - C. Warranty does not apply to damage caused by misuse, abuse or accident. Warranty is voided by unauthorized attempts at repair or modification, or if the serial identification has been removed or altered.
- III **TERMS OF WARRANTY:** Inovonics, Inc. products are warranted to be free from defects in materials and workmanship.
 - A. Any discrepancies noted within 90 days of the date of delivery will be repaired free of charge, or the equipment will be replaced, at the option of Inovonics.
 - B. Additionally, parts for repairs required between 90 days and one year from the date of delivery will be supplied free of charge. Labor for factory installation of such parts will be billed at the prevailing “shop rate.”
- IV **RETURNING GOODS FOR FACTORY REPAIR:**
 - A. Equipment will not be accepted for Warranty or other repair without a Return Authorization (RA) number issued by Inovonics prior to its return. An RA number may be obtained by calling the factory, and should be prominently displayed on the outside of the shipping carton.
 - B. Equipment must be shipped prepaid to Inovonics. Shipping charges will be reimbursed for valid Warranty claims. Damage sustained as a result of improper packing for return to the factor is not covered under terms of the Warranty, and may occasion additional charges.