



1305 Fair Avenue • Santa Cruz, CA 95060
Tel: (831) 458-0552 • Fax: (831) 458-0554
————— www.inovon.com —————

**OPERATING AND MAINTENANCE
INSTRUCTION MANUAL**

MODEL 701

RDS/RBDS “MINI-ENCODER”



TABLE OF CONTENTS

Section I - INTRODUCTION.....	1
Product Description - Product Features - Product Specifications	
Section II - THE RADIO DATA SYSTEM	3
What is RDS? - US vs. Europe	
Section III - INSTALLATION AND SETUP	4
Unpacking and Inspection - Mounting - AC Mains Power - Radio Frequency Interference (RFI) - Front Panel Indicators - Rear Panel Connectors, etc. - Connecting the Encoder - Stereo Pilot Requirement - Setting the RDS Injection Level	
Section IV - PROGRAMMING THE ENCODER.....	9
Computer Requirements - Entering RDS Data - Saving the Data - Sending Data to the Encoder - Miscellaneous Keyboard Commands - Alternate Characters	
Section V - CIRCUIT DESCRIPTIONS	15
Schematic Diagram Notes - 114kHz Clock - RDS Waveform Generator - Encoder Programming - Power Supply - Parts Listing - Mail-Order Component Suppliers - Schematic Diagrams - Warranty (inside back cover)	

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 shipment, provided that they are returned complete, and in "as shipped" condition.
- II **CONDITIONS OF WARRANTY:** The following terms apply unless amended in writing by Inovonics, Inc.
- A. The Warranty Registration Card supplied with the product must be completed and returned to the factory within 10 days of delivery.
 - B. The Warranty applies only to products sold "as new." It is extended only to the original end-user and may not be transferred or assigned
 - C. The Warranty does not apply to damage caused by misuse, abuse or accident. The Warranty is automatically voided by unauthorized attempts at repair or modification, or if the serial identification tag 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 Inovonics' prevailing "shop rate."
- IV **RETURN OF 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 marked 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 factory is *not* covered under terms of the Warranty and may occasion additional charges.

Section I

INTRODUCTION

Product Description

Inovonics' Model 701 is a low-cost digital "radio-data" data encoder. It gives the broadcaster easy implementation of the more important features of the *Radio Data System*, generally referred-to as "RDS" the world over. The very-nearly-identical system in the United States has been chauvinistically renamed "RBDS," standing for *Radio "Broadcast" Data System*, though one does wonder how *radio* data might be distributed except by *broadcasting*. The name difference notwithstanding, the 701 Encoder supports both European and US standards. In the interest of clarity, this Manual will hereafter use the more popular and generic term "RDS."

Product Features

Features of the Inovonics 701 include:

- Stand-alone operation — the Encoder does not require a dedicated host computer.
- Messages are held in non-volatile memory — the Encoder is easily programmed with a PC using the supplied, menu-driven software.
- Locks to the 19kHz stereo pilot from an MPX sample — no special stereo generator "sync" port is needed.

Product Specifications

Standards Supported: European CENELEC and United States NRSC.

RDS Applications Supported: Groups 0A and 2A which include the following RDS features:

- PS Program Service Name** - the station identification actually displayed on the front panel of the radio. This can either be call letters or the station's "street name" such as "LIVE 95."
- PI Program Identification** - identifies the station with a unique numerical code calculated from station call letters. This becomes the station's "digital address."

- PTY Program Type** - identifies the station format from one of 31 categories. The PTY code automates a “smart” radio’s search for the listener’s preferred programming.
- AF Alternative Frequency List** - identifies up to seven translators or other sources of the identical program. This helps the RDS radio automatically re-tune to the best possible signal.
- RT Radiotext** - a 32-character block of plain text which scrolls across the front panel of RDS radios with a text display mode. This may be used for promos, contests, or advertising.
- M/S Music/Speech Switch** - indicates music or speech-only transmission.
- DI Decoder Identification** - identifies the transmission as monaural or stereo.

RDS Applications NOT Supported: Please appreciate that the very simple and inexpensive nature of the Model 701 Encoder renders it virtually useless for “revenue-generating” RDS applications such as Radio Paging (RP, MBS and MMBS) and Location and Navigation (LN), including GPS correction; as well as Traffic and Travel (TP, TA and TMC), Program Type Name (PTYN), Program Item Number (PIN), Clock Time and Date (CT), In-House (IH) applications and the Emergency Warning System (EWS). The Inovonics 701 Encoder *does not* conform to the SPB 490 *Universal Encoder Communications Protocol* or other facility for serial, on-line “dynamic” data transmission.

RDS Output: Adjustable between zero and 1-Volt p-p; output impedance is 150 ohms or less.

MPX Sample Input: Unbalanced, 30k-ohm bridging; requires 0.5V p-p to 5V p-p composite signal sample. (This figure references 100% modulation, or $\pm 75\text{kHz}$ carrier deviation.)

Programming Port: A rear-panel “DB-25” parallel data port connects to the LPT (printer) port of an IBM-compatible computer. Programming software is provided.

Power Requirement: 12VAC at 500mA. A “wall-transformer” power supply is provided.

Size and Weight: 2”H x 6”W x 8”D; 4 lbs. (shipping).

Section II

THE RADIO DATA SYSTEM

What is RDS?

RDS is a digital data channel transmitted as a low-level, double-sideband, suppressed-carrier “subcarrier” at 57kHz. This is 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 RDS coding and modulation details. For this the reader is directed either to the CENELEC EN50067 or the United States NRSC Specification. The balance of this Manual deals specifically with the certain RDS implementations afforded by the Inovonics 701 Encoder.

US vs. Europe

The concept of “Radio Data” was developed by the European Broadcasting Union (EBU) and its member countries. The European RDS specification was first published in 1984 and subsequently revised in 1986, 1990, 1991 and 1992.

Following its mid-80s introduction, RDS quickly grew in use throughout Europe. By the late 1990s it was nearly universal; that is, there was hardly a European FM station which did *not* carry a radio data subcarrier.

The popularity of RDS in Europe reflects a “network” approach to broadcasting. A disposition toward multiple, lower-power transmitters can be found both at the national network and “local radio” levels. “Relay” (re-broadcast) repeater transmitters at scattered frequencies are used to blanket a designated service area.

The European concept of a *service area* equates to a US broadcaster’s *market*. The semantic difference between these designations further delineates 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 more concerned in how he can make additional profits from RDS and other subcarriers.

Section III

INSTALLATION AND SETUP

Unpacking and Inspection

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

We recommend that you set the original shipping carton and packing materials aside for possible reuse. 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 you complete and return the Warranty Registration Card found at the front of this Manual. 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

The Model 701 RDS Encoder is packaged in a plastic box with rubber feet. No provision has been made for rack-mounting the 701. The unit may simply be set on top of a convenient rack-mounted chassis, so long as at least 2U of panel space *above* the rack-mounted “host” is left open to access the Encoder. As the programming port is on the rear panel of the Model 701, interconnect cabling should have sufficient length to permit turning the Encoder around to access the rear-panel PROGRAMMING PORT connector.

AC Mains Power

The Model 701 is supplied with a “wall-mounted transformer” power supply suited to the destination mains voltage. The actual power delivered to the Encoder is 12 volts AC at about 500mA. Though the input power to the Encoder is well defined, we recommend that you use the supplied “wall wart.”

Radio Frequency Interference (RFI)

Though we anticipate 701 installation in the immediate proximity of a broadcast transmitter, please do practice some care in locating the unit away from *abnormally* high RF fields. Because the OUTPUT and MPX SAMPLE input are unbalanced connections, there is a chance that an RF ground loop could be formed, though the lack of a chassis or mains-lead ground lessens this possibility.

Front Panel Indicators

- | | |
|------------|--|
| POWER | This LED lights only when the proper AC voltage is delivered to the 710 Encoder. An input somewhat below the required 12VAC will cause the indicator to go out, though the Encoder may appear to function properly. |
| PILOT LOCK | This indicator shows that the 57kHz RDS subcarrier has phase-locked to the 19kHz stereo pilot tone. When pilot is absent, data output from the 701 Encoder is inhibited and the output is muted. |
| PRO-GRAM | This LED lights as new RDS data is downloaded from a computer to the Encoder's non-volatile memory. During this process, RDS data output is inhibited and the Encoder output is muted. RDS data may be interrupted for a period of one to two minutes, depending on the speed of the programming computer. |
| DATA | This indicator flashes as RDS data is actually transmitted. The flash rate has been made intentionally much slower than the actual data baud rate. |

Rear Panel Connectors, etc.

- | | |
|--------------------|--|
| PRO-GRAM-MING PORT | This DB-25 connector accepts parallel data from the LPT (printer) port of an IBM-compatible PC. The printer port must be <i>bi-directional</i> , and you will need to supply an appropriate cable to interconnect the Encoder with your computer. Be sure that the cable is certified for <i>parallel</i> data transfer; a serial cable may have too-few conductors. |
|--------------------|--|

POWER (12 VAC)	The “wall-mounted” power transformer included with the Model 701 Encoder has a cord with a mating plug for this connector. Make sure that the AC mains side of the adapter is matched to the nominal mains voltage. Be particularly suspicious if the adapter’s AC mains plug is <i>not</i> the same style as the wall outlet. Do not use a “travel” adapter to mate the power supply to the outlet.
MPX SAMPLE	This BNC connector <i>must</i> receive a feed of the composite-MPX signal from the stereo generator. The Encoder <i>will not generate the RDS subcarrier</i> without an MPX sample feed.
RDS OUTPUT	Cable this BNC connector directly to a spare wideband input of the exciter.
OUTPUT LEVEL	This 15-turn adjustment sets the RDS subcarrier output level. Refer to the setup procedure on Page 8.

Connecting the Encoder

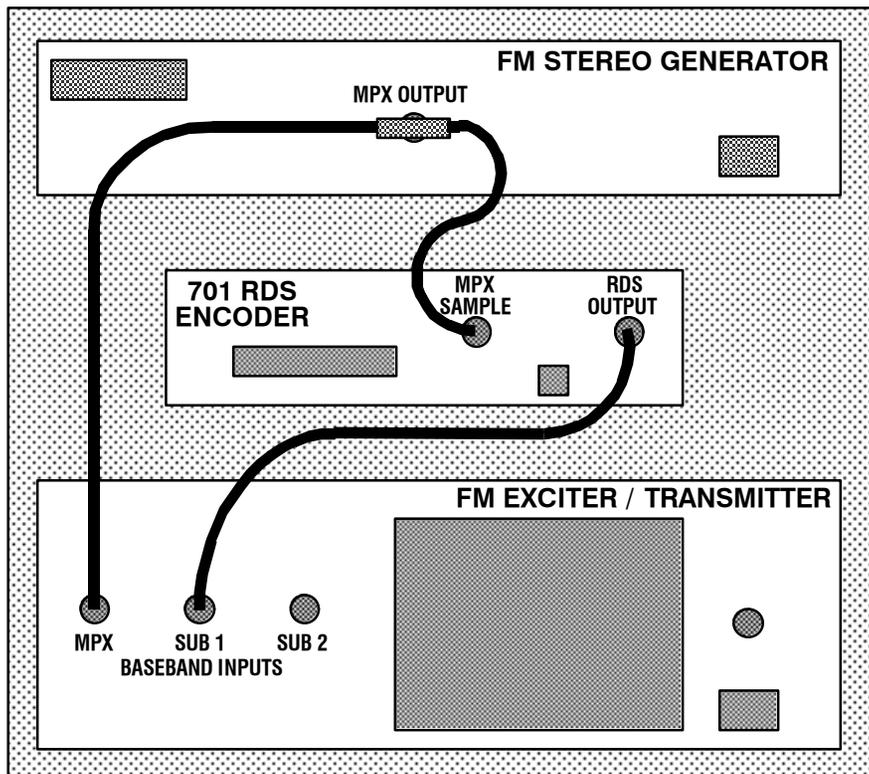
The Model 701 operates in a fail-safe “direct feed” mode rather than as a “loop through” device. Simply connect the RDS OUTPUT to any auxiliary subcarrier input of the FM exciter. Assuming a short cable run, the low output impedance of the 701 Encoder can directly feed any wideband exciter input without regard to impedance matching.

The MPX SAMPLE input of the 701 bridges the composite signal output from the stereo generator to phase-lock RDS to the 19kHz stereo pilot. This is most easily done with a BNC “T” connector. The high input impedance characteristic will not load or otherwise compromise the stereo baseband feed to the exciter, even if power to the Encoder becomes disconnected.

A typical Encoder installation is diagramed at the top of the next page.

Stereo Pilot Requirement

The 701 Encoder *does not* include an internal clock for free-run operation — it *must* sample the composite baseband signal and lock to the 19kHz stereo pilot. **The Encoder will not generate the RDS subcarrier without a stereo MPX sample!** (See *MPX Sample Input* Specification on Page 2.)



Encoder Connection Diagram

Setting the RDS Injection Level

Most FM modulation monitors are unable to make an independent measurement of the 57kHz RDS subcarrier injection level. For this the Monitor would require a special subcarrier measurement filter, similar to the one which optionally may be provided for SCA channel measurements, but tuned for the 57kHz RDS subcarrier frequency.

Fortuitously, Inovonics does manufacture two sterling products which simplify RDS measurements: the *Model 510 RDS Decoder/Reader* and the *Model 540 Subcarrier Monitor/Demod.* Both products are compatible with practically any FM mod-monitor in common use, including our own, highly esteemed *Model 530 FM Mod-Monitor.*

Nonetheless, the conventional mod-monitor may be used to set RDS injection with reasonable accuracy, though this requires a

temporary interruption of the audio program, perhaps best done during a maintenance period. Here is the procedure:

1. With the Model 701 Encoder *disconnected* from the exciter, check that the mod-monitor shows total carrier modulation at the accepted 100% figure for program peaks.
2. *Disconnect* the stereo generator and any SCA or other sub-carrier generators from the exciter. Do make sure, however, that the stereo-gen maintains a composite-MPX feed to the Model 701 MPX SAMPLE input.
3. Turn the RDS LEVEL control on the rear panel of the Model 701 fully counterclockwise (this is a 15-turn control), then connect the RDS OUTPUT of the Model 701 to a spare wide-band subcarrier input of the exciter. As the mod-monitor is downranged to its most sensitive scale, only system noise should be indicated. This should be a negligible, preferably off-scale, reading.
4. Slowly advance the RDS LEVEL control clockwise. The mod-monitor will begin to register the RDS subcarrier. Set this to the desired injection level, usually about 3% of total modulation ($\pm 2.2\text{kHz}$ carrier deviation).

NOTE: Some mod-monitors change from a *peak* to an *averaging* response on sensitive scales. Check the Operator's Manual to verify response of your mod-monitor on the range used for this RDS injection measurement. If response is *averaging*, RDS injection will measure about 4dB *lower* than the actual peak value. In this case set injection for an *indicated* 1.9% modulation ($\pm 1.4\text{kHz}$ carrier deviation). This equates to a proper *peak* injection level.

5. *Re-connect* the stereo-gen and SCA or other subcarrier generators to the exciter. You may note a very slight increase in total modulation on program peaks. In order for RDS and any other subcarriers to maintain their proper injection ratios, the output of the stereo generator (the audio program level) may have to be turned down slightly so that total modulation is once again at the desired "full value" figure.

REMEMBER: the 701 Encoder has been factory-programmed with "default" RDS data to confirm operation prior to shipment. Be sure to enter your own RDS data before placing the 701 in actual service. The next section, *Section IV*, guides you through this procedure.

Section IV

PROGRAMMING THE ENCODER

Computer Requirements

Software provided with the Model 701 RDS Encoder runs under DOS on any IBM-compatible computer with a 286-or-better processor. Programming the Encoder through Windows® will slow this operation, so it's best to re-start the computer in its DOS mode before running the software.

The computer is connected to the 701 Encoder with a DB-25 interconnect cable specifically intended for *parallel* data transfer. This connection may be left in place while data is being entered, since no data transfer will take place until the appropriate command is given. Encoder programming is self-checking, thus it is essential that the computer's parallel (LPT) port be a *bi-directional* port. You do not want to disconnect the programming cable whenever the computer is not being used for this particular operation as other programs could interrupt RDS transmissions.

Encoder software is supplied on a 3½-inch floppy diskette. Copy this to the computer's hard drive. Two methods are given here:

1. Insert the diskette in the computer's A drive. At the **C:\>** DOS prompt, type: **a:** to access the diskette drive and change to an **A:\>** prompt. At the new prompt type: **install**. This will create a C-drive directory labeled **701RDS**, and will copy all files to the hard drive.
2. Under Windows®, invoke the **Run** command under the **Start** utility. On the **Open:** line type: **a:\install**. This will create a C-drive directory labeled **701RDS**, and will copy all files to the hard drive.

Entering RDS Data

With the computer running in its DOS mode, at the **C:\>** prompt type: **cd\701rds**. When the prompt changes to **C:\701RDS>**, type: **701** to start the program.

An initial welcome will give-way to the data-entry screen. You move between the various fields with the keyboard

keys, and use the **[PgUp]** and **[PgDn]** keys to choose predetermined options in certain fields. The **[Enter]** key accepts the information which has been either typed-in or selected for each data entry field. The arrow keys can bring you back to any field to correct or to update information.

It's probably best to use all-capital letters when entering RDS information. Capital letters are the default display on many RDS radios, and may prove much easier for the listener to read on those displays which offer both uppercase and lowercase letters.

The flashing underline cursor will be in the **PS** field when the program first loads. Using capital letters, type the station call letters or station "street name" into this field. Up to eight characters (including spaces) may be entered. These are the characters which will be displayed on RDS radio front panels. Some examples might be: **KJBW-FM** or **LIVE 105** or **GOLD 92**. Correct any errors using the **[BkSp]** or cursor keys, then press **[Enter]** to accept the data. This will take you to the next field.

The **PTY** code identifies your station's format. Pre-assigned identifiers are dictated by the appropriate *RDS Standard*. Use the **[PgUp]** and **[PgDn]** keys to scroll through the proffered options, and **[Enter]** to accept the chosen format identifier.

The **DI** flag toggles between **Monophonic Transmission** and **Stereophonic Transmission**. Since the Model 701 is useful only with stereophonic broadcasts, that flag will be your obvious choice. **[Enter]** moves you to the next field.

The **MS** flag offers only a **Music** or a **Speech** option. An all-talk, all-news or all-sports station might decide to set this to **Speech**, though **Music** will be the setting of choice for most FM stations. Press **[Enter]** to continue.

Up to 32 characters (including spaces) of Radiotext may be entered in the **RT** field. This is where you enter a promo or advertising message. Some examples: **THE MORNING SHOW IS COOL ON KJBW** or **SHOP BERT'S LIQUORS AND SAVE BIG** or **KJBW CONTEST LINE - 800 234 5678**. When your message is complete, press **[Enter]**. Your message will scroll across the face of RDS radios (except for car radios, for obvious safety reasons) when the listener selects the text display mode.

| The RDS system has provided for "alternate" characters in |
| the PS and RT fields. These are characters which may not |

appear on the computer keyboard. Some are accented letters, such as ô or ñ. If you need to use these, please consult the Alternate Characters listing at the end of this section.

US broadcasters may simply type their station call letters into the **PI** field. Encoder software will automatically convert these into your station's official and unique hex-code "digital address." Users in other countries must type-in an identification hex code decided by local authorities and calculated from *Annex D* of the CENELEC Standard. Press **[Enter]** to continue.

A total of seven "alternative frequencies" may be entered in the **AF** field. List only those frequencies which carry the *very same programming* as your station's main dial location. Most likely these will be your translator frequencies. *It is important to include your station's main frequency as well*, since "smart" radios will need to know where to re-tune to the primary signal once the listener drives back into its range from an area served by a translator. Though it is a rare situation, AM dial settings may also be included, though each AM frequency requires two FM positions. (A maximum of five FM and one AM, for instance.) When alternative frequencies have been listed, press **[Enter]**. Software may automatically add a **FILLER** in unused **AF** positions.

Saving the Data

The **[F3]** command will prompt you to name the file you have just created or modified. Press **[Enter]** to keep the default **RDS.INI** name, or add one of your own. The file name can assume any alphanumeric combination up to 8 characters. This can reference a date (**030496**) or an ad (**CARS**) or promo (**MORNING**). Avoid punctuation and symbols. The program will warn you when a suggested file name is invalid. Once the file has been named, a **.INI** extension will be added automatically when you press **[Enter]**.

Any data file which has been saved can be called-up with the **[F2]** command. A list of the saved files will appear, and the **[↑]****[↓]** keys may be used to select from the list. **[Enter]** brings the selected file to the screen where it can be edited or sent to the 701 Encoder for transmission. Obsolete files may be edited and renamed, or they may be deleted. To delete an obsolete file, use the appropriate DOS command at the **C:\701RDS>** prompt, or use Windows Explorer[®], a "shell" or similar utility. When deleting old files, delete both the **.INI** and **.RDS** file components.

Sending Data to the Encoder

The current file displayed on the computer screen may be sent to the Model 701 Encoder with the **[F8]** command. Of course the Encoder and computer must be properly interconnected as already explained, and the data transfer process may take a minute or two. While data is being transferred, the Encoder's front-panel PROGRAM indicator will light and the on-air RDS message will be interrupted. The computer screen shows file transfer progress and indicates successful completion. At that point the new message will begin transmitting.

Miscellaneous Keyboard Commands

Encoder programming uses several of the keyboard "function" keys. These are menu-driven and should be self-explanatory. **[F1]** gives a general information screen. **[F2]** (loading files), **[F3]** (saving files) and **[F8]** (sending data to the Encoder) have been covered in the programming instructions. **[F4]** exits the data entry program *without saving* any of the RDS data entered or modified on the screen. **[F5]** also exits the program, but first prompts for a file name under which the on-screen RDS data will be saved for later recall and downloading to the Encoder. **[F6]** allows the user to change from the default LPT1 (printer) parallel port assignment to an alternative parallel port, if provided, and **[F7]** brings up an information screen concerning the "alternate" characters which may be inserted in the PS and RT fields.

Alternate Characters

Each of the special "alternate" RDS characters has an assigned numerical value. For example, the numerical value for ö is 151. This is derived from the binary address 10010111 given in code table *Figure E1* of the *RDS Standard*. Two additional code tables, *Figure E2* and *Figure E3*, cover Cyrillic, Greek, Arabic and Hebrew characters.

Locate an alternate character you wish to transmit in the appropriate code table of the published *RDS Standard*. Calculate the numerical value from the binary address by *adding* the appropriate numerical values for each binary "1" in the code table matrix. (b8=128, b7=64, b6=32, b5=16, b4=8, b3=4, b2=2, b1=1. Thus 10010111 becomes 128+0+0+16+0+4+2+1=151.) Now hold down the keyboard's **[Ctrl]** and **[Alt]** keys and type-in this number *using the 10-key number pad*. When

the **Ctrl** and **Alt** keys are released, the alternate character will be entered into the Radiotext message.

When RDS alternate characters are entered in the PS and RT fields, the symbol *displayed* on the computer screen may not be the same as the RDS symbol *entered*. The proper character will be transmitted, however, except that alternate characters are not universally displayed by all RDS radios. For example, radios manufactured for use in Brazil will not likely display the Cyrillic alphabet. Nonetheless, all three code tables have *ISO Norm 646* characters (the basic Roman alphabet) in common.

We have generated a table of the more common alternate characters from *Figure E1* (EBU/Latin) of the *RDS Standard*. Their actual numerical values have already been calculated. Find the desired character and enter the corresponding number in the PS and RT fields per the instructions.

Á	192	á	128	Â	208	â	144
À	193	à	129	Ä	209	ä	145
É	194	é	130	Ê	210	ê	146
È	195	è	131	Ë	211	ë	147
Í	196	í	132	Î	212	î	148
Ì	197	ì	133	Ï	213	ï	149
Ó	198	ó	134	Ô	214	ô	150
Ò	199	ò	135	Ö	215	ö	151
Ú	200	ú	136	Û	216	û	152
Ù	201	ù	137	Ü	217	ü	153
Ñ	138	ñ	154	Ã	224	ã	240
Ç	139	ç	155	Å	225	å	241
¼	178	£	170	\$	171	©	162
½	179	Ø	231	ø	247	~	126
¾	180	‰	163	°	177		124

Refer to the appropriate *RDS Standard* for additional alternate characters from the *Figure E1* table, and for those specific to certain regions from code tables *Figure E2* and *Figure E3*. If in

doubt as to which code table applies, consult your appropriate local governing authority.

Section V

CIRCUIT DESCRIPTIONS

Schematic Diagram Notes

This explanation of circuit operation refers to the several pages of schematic diagram which follow Circuit Description text.

Schematic component reference designations may at first appear to be annotated in a somewhat haphazard manner. Rather than annotate the *schematic* in a logical sequence, we have instead chosen to designate the *components on the circuit board* following their physical placement, top-to-bottom, left-to-right. It is our expectation that this practice will prove the more useful during troubleshooting, making it easier to locate the physical part or test point from an analysis of the circuitry.

114kHz Clock

The composite/MPX signal is sampled by a band-pass filter to isolate the 19kHz stereo pilot. The filter comprises IC2B, IC2A and IC1A, and includes tuning trimmer R2. This trimmer additionally provides fine adjustment of the phase relationship between the RDS subcarrier and the stereo pilot.

The output of the band-pass filter is coupled to PLL “tone-decoder” chip IC3. R16 sets the free-run frequency to 19kHz when no input signal is present. The PLL then quickly locks to the stereo pilot and furnishes additional filtering and logic-level translation. Once lock is acquired, a separate “lock” output from IC3 lights PILOT LOCK indicator I2, and also inhibits the clock and the RDS data output when no stereo pilot is present.

IC5 is a second PLL which includes counter IC4 in the digital side of the loop. IC4 divides by six, effectively multiplying the PLL output to 114kHz.

RDS Waveform Generator

IC7 is an electrically-erasable memory chip, or EEPROM. During the Encoder programming process, IC7 is loaded with a segmented, Walsh-function representation of the actual data-encoded DSB waveform. IC7 is clocked at a 114kHz rate by counters IC8 and IC9, along with various steering and gating

functions performed by Generic Array Logic (GAL) chip IC10. The counting routine steps IC7 through 239,616 counts. Each step yields an 8-bit output byte which represents an instantaneous value of the data-modulated RDS waveform. As the counting sequence repeats, one of the address lines flashes the front-panel DATA indicator to confirm normal operation.

A binary-weighted resistor network translates the 8-bit digital output of IC7 into the analog RDS subcarrier. An L/C band-pass reconstruction filter removes waveform segmentation and restores a sinusoidal property. Gain stage IC1B buffers the filtered signal. Rear-panel OUTPUT LEVEL control R1 may be used to adjust RDS injection level.

Encoder Programming

The rear-panel DB-25 PROGRAMMING PORT parallels the eight IC7 I/O lines. Once RDS data has been entered on the computer screen, an [F8] command transfers this data to the Encoder. When this command is given, pin 16 of the DB-25 connector is pulled low by the computer. This turns on Q3 and Q4, lighting the PROGRAM indicator and applying a +12-volt “programming” voltage to IC7. This changes the eight I/O lines from data outputs to programming inputs. Concurrently, the 114kHz clock is inhibited, counters IC8 and IC9 are reset, and output stage IC1B is biased to inhibit the RDS output signal.

The computer program presents RDS data to the eight I/O lines one byte at a time. Each byte is written to a data location within IC7 when pin 17 of the DB-25 is strobed low. Programming locations in IC7 are addressed by counters IC8 and IC9, incremented by clock pulses from the computer on pin 1 of the DB-25. As data is written to IC7, the computer checks each location with an interrogation command on pin 14 of the DB-25. (Hence the requirement for a bi-directional parallel port.)

Power Supply

A “wall-mounted” power transformer delivers 12 volts AC to the rear-panel POWER connector. This is rectified, filtered and regulated to +5 volts by “three-terminal” regulator IC6. A zener-stabilized +12-volt supply is buffered by Q2. Q1 lights the front-panel POWER indicator as long as incoming AC voltage supplies sufficient regulator margin.

Parts Listing

Component parts used in the 701 Encoder are listed either *en-masse*, or individually by schematic component reference designation. The listing may, or may not, specify a manufacturer by name. When no manufacturer is called-out, the term “open mfr.” advises that any manufacturer’s product is acceptable, as long as it carries the requisite generic part number.

If a component is not listed at all, this means that we do not consider it a typical replacement item. Should you need to identify or order an unlisted part, call, write or fax us with a brief description. We’ll do our best to figure out what you need and how to get it to you.

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

- a) **100pF to 0.47μF** are metalized mylar or polyester. Whole number “P” values are picofarads, decimal values are microfarads; ±5%, 50VDC or better. The style used in the 701 is the “minibox” package with a lead spacing of 0.2 inch. (Wima MKS-2 or FKC-2 series, CSF-Thompson IRD series, of Roederstein KT-1808 or KT-1871 series.)
- b) **1.0μF and above** are radial-lead electrolytics, 25VDC; (open mfr.)
 - C6,23,24, 25,26,28 Capacitor, Monolithic Ceramic, 0.1μF, 50V; (open mfr.)
 - CR1,2,3,4,6 Diode, Silicon Rectifier; (open mfr.) 1N4005
 - CR5 Diode, Zener, 12V; (open mfr.) 1N5242B
 - I1,2 LED Indicator, diffused pastel green, T-1 package; Stanley MPG 3878S
 - I3 LED Indicator, diffused pastel red, T-1 package; Stanley MVR 3378S
 - I4 LED Indicator, diffused pastel yellow, T-1 package; Stanley MAY 3378S
 - IC1,2 Integrated Cct.; (open mfr.) LF353N
 - IC3 Integrated Cct.; Signetics NE567N
 - IC4 Integrated Cct.; (open mfr.) CMOS 4018B
 - IC5 Integrated Cct.; (open mfr.) CMOS 4046B
 - IC6 Integrated Cct.; (open mfr.) LM317-T (Uses Aavid 574602 B03700 Heat Fin)
 - IC7 Integrated Cct.; AMD AM28F020
 - IC8,9 Integrated Cct.; (open mfr.) 74HC4040

- IC10 Integrated Cct.; *SPECIAL FACTORY-PROGRAMMED "GAL,"* type 22V10;
Order by designation, reference Model 701.
- IC11 Integrated Cct.; (open mfr.) 74HC14
- J1 Connector, Power Input; Mouser 163-5004
- J2 Connector, "DB-25" Male;
Amphenol 617-C025P-BF221
- J601,602 Connector, "BNC" male, chassis-mounting;
Amphenol 31-221
- L1,2,3 Inductor, 1mH; J.W. Miller 9220-28
- Q1,2,3 Transistor, NPN; (open mfr.) 2N3904
- Q4 Transistor, PNP; (open mfr.) 2N3906
- R1 Resistor, variable, multi-turn, 500 ohms;
Tokos RJC097P or Beckman 89PR series
- R2 Resistor, variable, single-turn, 500 ohms;
Tokos GF06U1 or Beckman 91AR series

All fixed resistors are 1/4-watt, 5% carbon film type, value per schematic diagram.

- T1 Power Transformer, wall-mounted,
12.0 VAC @ 0.5A; Jameco 101258

Mail-Order Component Suppliers

Certain mail-order electronics 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 701 is *probably* available from one or more of these firms. Each supplier publishes a full-line catalog available free for the asking.

Mouser Electronics — Call (800) 346-6873

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

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

Schematic Diagrams

The following pages contain a complete schematic diagram of the Model 701 RDS Encoder. The original drawing has been disassembled and reduced to fit the diminutive format of this Manual. The presbyopia-challenged may obtain a full-size diagram, simply for the asking, by sending a self-addressed 9-by-12-inch envelope to Inovonics.

NOTES AND DOODLES

