AEROFLEX

OPERATION MANUAL

429E
ARINC 429 TX/RX

MANUAL NUMBER:	06-1001-01 (Hard Copy)
	E6-1001-01 (CD-ROM)
REVISION:	00
DATE:	10/02/2006

ELECTROSTATIC DISCHARGE GENERAL WARNINGS FOR ALL EQUIPMENT

CAUTION: THIS EQUIPMENT MAY CONTAIN ELECTROSTATIC DISCHARGE (ESD) SENSITIVE COMPONENTS. TO PREVENT ESD SENSITIVE EQUIPMENT FROM POSSIBLE DAMAGE, OBSERVE THE FOLLOWING PRECAUTIONS WHEN HANDLING ANY ESD SENSITIVE COMPONENTS, OR UNITS CONTAINING ESD SENSITIVE COMPONENTS:

a.   Maintenance or service personnel must be grounded though a conductive wrist strap, or a similar grounding device, using a 1 MΩ series resistor for equipment protection against static discharge, and personal protection against electrical shock.

b.   All tools must be grounded (including soldering tools) that may come into contact with the equipment. Hand contact will provide sufficient grounding for tools that are not otherwise grounded, provided the operator is grounded through an acceptable grounding device such as a wrist strap.

c.   Maintenance or service of the unit must be done at a grounded, ESD workstation.

d.   Before maintenance or service of the equipment, disconnect all power sources, signal sources, and loads connected to the unit.

e.   If maintenance or service must be performed with power applied, take precautions against accidental disconnection of equipment components. Specifically, do not remove integrated circuits or printed circuit boards from equipment while the equipment has power applied.

f.   All ESD sensitive components are shipped in protective tubes or electrically conductive foam. The components should be stored using the original container/package when not being used or tested. If the original storage material is not available, use similar or equivalent protective storage material.

g.   When ESD sensitive components are removed from a unit, the components must be placed on a conductive surface, or in an electrically conductive container.

h.   When in storage or not being repaired, all printed circuits boards must be kept in electrically conductive bags, or other electrically conductive containers.

i.   Do not unnecessarily pick up, hold, or directly carry ESD sensitive devices.

Failure to comply with these precautions may cause permanent damage to ESD sensitive devices. This damage can cause devices to fail immediately, or at a later time without apparent cause.

REVISION HISTORY BY DRAWING NUMBER

MANUAL: 429E ARINC 429 TX/RX OPERATION

REVISION: 0 – October 2, 2006

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Safety and Regulatory Information

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate this equipment.

WARNING   The **WARNING** notice denotes a hazard. It calls attention to a procedure, practice, or the like, that, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** notice until the indicated conditions are fully understood and met.

CAUTION   The **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

Caution (refer to accompanying documents). Attention – refer to the manual. This symbol indicates that information about usage of a feature is contained in the manual.

Equipment Markings

The following markings may appear on this equipment:
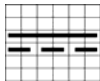
Direct current. This symbol indicates that the equipment requires direct current input.
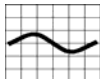
Alternating current. This symbol indicates that the equipment requires alternating current input.
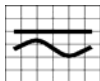
Both direct and alternating current. This symbol indicates that the equipment requires either ac or dc input at the same connector.
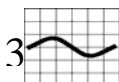
Three-phase alternating current. This symbol indicates that the equipment requires 3-phase ac input.
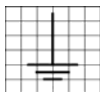
Earth (ground) terminal. This symbol indicates the ground (earth) terminal.
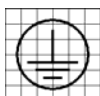
Protective conductor terminal. This symbol indicates the protective ground (earth) terminal.

Frame or chassis terminal. This symbol indicates the frame or chassis terminal for connection to ground.

Equipotentiality. This symbol indicates an equipotentiality terminal.

On (Supply). This symbol indicates that the power line switch is ON.
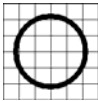
Off (Supply). This symbol indicates that the power line switch is OFF.
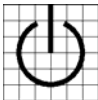
Standby. This symbol indicates that the power line switch is in STANDBY.
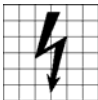
Caution, risk of electric shock. Danger – high voltage.
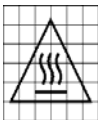
**Caution, hot surface.** Danger – high temperature surface.

Caution (refer to accompanying documents). Attention – refer to the manual. This symbol indicates that information about usage of a feature is contained in the manual.
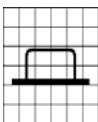
In-position of a bistable push control. This symbol indicates the in (on) position of a bistable push control.
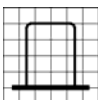
Out-position of a bistable push control. This symbol indicates the out (off) position of a bistable push control.

CE Mark. ™ of the European Community.

Fuse Symbol. To indicate a fuse.

Warnings

WARNING   Do not use the equipment in a manner not specified in this manual!

WARNING   Equipment should only be serviced by authorized personnel.

DO NOT OPERATE IN EXPLOSIVE ATMOSPHERES
      To avoid explosion, do not operate the equipment in an atmosphere of explosive gas.

WARNING   Keep the equipment dry to avoid electrical shock to personnel or damage to the equipment. To prevent damage, never apply solvents to the equipment housing. For cleaning, wipe the equipment with a cloth that is lightly dampened with water, mild detergent, or alcohol. Do not use aromatic hydrocarbons, chlorinated solvents, or methanol-based fluids.

WARNING   Equipment has a recharging circuit for rechargeable cells. Use only NiCad size "AA" cells.

WARNING   Equipment is not intended for wet locations. Miscellaneous liquids on or in the equipment could cause hazardous conditions.

WARNING TO SERVICE PERSONNEL
      Ensure that power is disconnected before removal of any covers.

JcAIR Test Systems

400 New Century Parkway
P.O. Box 9
New Century, KS 66031-0009
(800) 237-2831
(913) 764-2452
Fax: (913) 782-5104
http://www.jcair.com

Declaration of Conformity

DECLARATION OF CONFORMITY

Manufacturer's Name: JcAIR Test Systems

Manufacturer's Address: 400 New Century Parkway
New Century, KS 66031-0009
USA

Declares that the products

Product Name: 429E/429EX -- ARINC 429 TX/RX

Model Number(s):   01-1001-00/01-1001-05

Product Options: All options associated with listed models are covered.

Conform to the following product specifications and carry the CE-marking accordingly.

Low Voltage Directive 73/23/EEC: IEC 61010-1:1990 / EN 61010-1:1993

EMC Directive 89/336/EEC: EN 61326:1998
IEC 61326:1997

Date: 11/01 2002
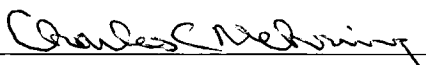
Chuck Nehring, Director
Quality Assurance/Customer Support

Aeroflex Maintenance Manual

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SECTION I
GENERAL INFORMATION

1.1 INTRODUCTION

This manual provides operational and maintenance information for the Aeroflex Model 429E ARINC 429 Transmitter/Receiver.

1.2 EQUIPMENT DESCRIPTION

The 429E provides avionics technicians, engineers and line maintenance personnel with a convenient, easy to use tool for testing and trouble-shooting ARINC 429 avionics systems.

Transmitter features:

- Data entry in Hexadecimal or Engineering Units
- Can transmit up to 10 labels simultaneously
- Individual screens for entry of data, rate, SDI and SSM
- Selectable (Lo or Hi speed) bit rate
- Selectable (Odd or Even) word parity
- Selectable (4 to 59998 ms) word rate
- LED display of transmitted word parity

Receiver features:

- Data display in Hexadecimal or Engineering Units
- Individual screens for display of data, rate, SDI and SSM
- Ability to trap and store up to 255 words
- Automatic scrolling of trapped data
- Selectable (Lo or Hi speed) bit rate
- LED display of received word parity

Other features:

- Liquid crystal display
- Portability
- Self-contained, rechargeable NiCad batteries
- "Low Battery" warning
- Available with either 110 V ac or 230 V ac battery charger
- Rugged, compact case
- Optional carrying case

1.3 TECHNICAL CHARACTERISTICS

Specification	Characteristic
ENVIRONMENTAL SPECIFICATIONS:	The environmental specifications are as follows.
OPERATING TEMPERATURE:	5 °C to 40 °C.
RELATIVE HUMIDITY:	Maximum of 80% for temperatures up to 31 °C decreasing linearly to 50% at 40 °C.
OPERATING ALTITUDE:	Up to 2 000 m.

IEC OVERVOLTAGE CATEGORY: II

POLLUTION DEGREE: 1

SIZE: 18.42 cm H x 11.43 cm W x 6.35 cm D
                             (7.25" H x 4.5" W x 2.5" D)

MASS (Weight)   1.36 kg (3 lbs.)

CABLES AND WIRES   Jumper cable assembly should be fabricated using 2-conductor twisted pair with braided shield. The shield should be folded back onto the insulation and the clamp on the connector should be crimped around the shielding. Also, once the shield is clamped, solder should be added to ensure a stable connection is made between the clamp and wire shield. Refer to figures X and Y.
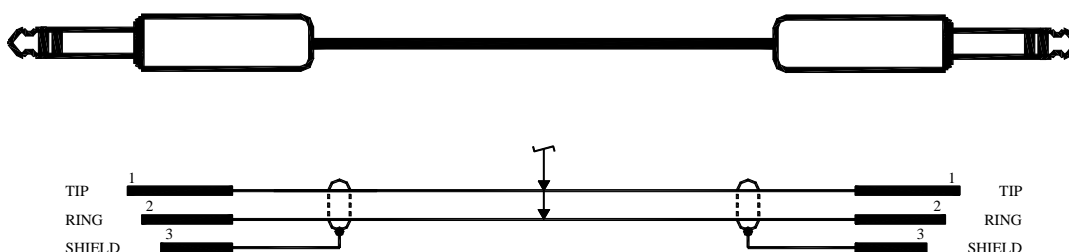
Figure X. Cable Assembly Schematic
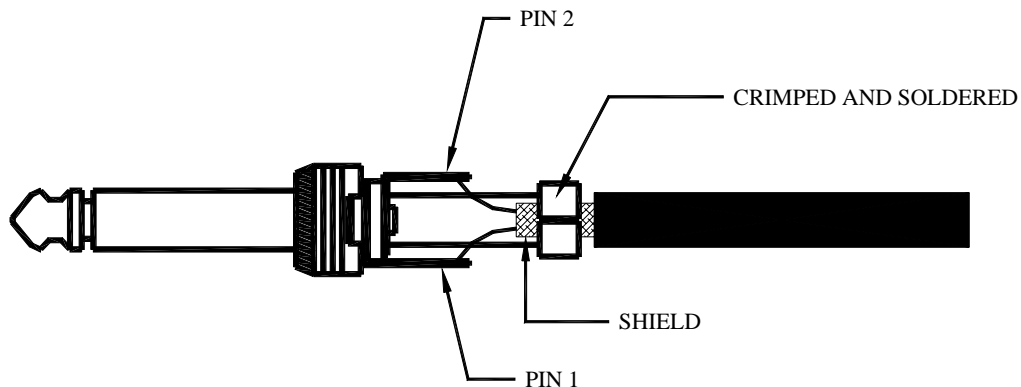
Figure Y. Phone Plug Termination

EQUIPMENT MEETS THESE LISTED STANDARDS

EN 61010-1 (IEC 61010-1)
EN 61326 (IEC 61326)
EN 55011 Class A
EN 50082-1

POWER REQUIREMENTS: 110 V/60 Hz/500 mA
                     OR
                               230 V/50 Hz/300 mA
                     OR
                               Six (6) internally mounted
                               AA size rechargeable NiCad cells

ARINC SPECIFICATION: Conforms to Mark 33 Digital Information Transfer
                               System (DITS) Specification 429-9 (Attachment 2)
                               unless otherwise specified.

ARINC 429 TRANSMITTER

Pulse Rise/Fall Times: Low Speed   10.0 ±5.0 μs
                               High Speed   1.5 ±0.5 μs

Voltage Levels (Line A to B): HI   +10.0 ±1.0 V dc
                               NULL   0.0 ±0.5 V dc
                               LO   -10.0 ±1.0 V dc

Output Impedance (Line A to B): 75 ±5 Ω
Bit Rate: Low Speed   12.5 kbps ±0.5%
                               High Speed   100.0 kbps ±0.5%

Word Rate: 4 to 59998 ms

Parity: ODD or EVEN

ARINC 429 RECEIVER

Voltage Levels (Line A to B): HI   +6.5 to +13.0 V dc
                               NULL   +2.5 to - 2.5 V dc
                               LO   -6.5 to -13.0 V dc

Bit Rate: Low Speed   8 to 20 kbps
                               High Speed   80 to 125 kbps

Word Rate: ±2 ms average

Input Impedance: 12 kΩ min. (balanced)

1.4 UNITS AND ACCESSORIES SUPPLIED

The Aeroflex Model 429E, PN: 01-1001-00, is supplied with either a 110 V ac battery charger or a 230 V ac battery charger. Two 3-conductor 1/4" phone plugs are included for fabrication
of cables to connect to the transmit and receive jacks of the unit. (See Section 1.3 for fabrication instructions.) The accessories provided are as follows:

Aeroflex P/N	DESCRIPTION
15-0009-00	Battery Charger 110 V ac to 9 V dc 500 mA
OR	
15-0009-01	Battery Charger 230 V ac to 9 V dc 300 mA
AND	
33-1032-00	3-Conductor 1/4" Phone Plugs
06-1001-00	429E Maintenance Manual

SECTION II
INSTALLATION

2.1 GENERAL INFORMATION

This section contains information relating to the unpacking and inspection of the unit. Also included is information concerning charging of the internal batteries and an explanation of the unit's self test.

2.2 UNPACKING AND INSPECTING EQUIPMENT

Carefully remove the Aeroflex 429E and accessories from the packing box. Visually inspect the units for any damage incurred during shipment. Should there be damage, save the packing box to show the shipping company when submitting your claim. It is generally a good idea to save the packing box should it become necessary to store or ship the unit.

2.3 EQUIPMENT INSTALLATION

2.3.1 BATTERY CHARGING

The batteries were fully charged when the unit was shipped from the factory. However, if the unit has been stored for an extended period of time, the batteries may have become discharged. Plug the charger into an appropriate voltage outlet (110 & 230 volt chargers are available). A four to five hour charge should refresh the batteries. The 429E may be operated while charging or with the charger disconnected. With fully charged batteries, the unit will operate for approximately four to six hours.

In the event that the batteries become discharged during use to a level approaching unreliable operation, the display will flash the message LOW BATTERY approximately every ten seconds. At this point, the unit should be reconnected to the charger to refresh the batteries.

*** CAUTION ***

To avoid possible damage to the battery charger, it is recommended that you do NOT have the charger connected to the wall outlet when connecting or disconnecting the charging plug to the 429E.

2.3.2 CONNECTION TO USER EQUIPMENT

Connect the Aeroflex 429E TX output jack to the input of the UUT and the Aeroflex 429E RX input jack to the output of the UUT using 3-conductor 1/4 inch phone plugs (see paragraph 1.4).

NOTE

On both the transmitter and receiver port jacks, the tip is the HI (A) side of the bus, the ring is the LO (B) side and the sleeve is GROUND.

2.4 POST INSTALLATION CHECK

2.4.1 UNIT SELF TEST

The Aeroflex 429E performs a self test routine on initial power up. The following tests are performed:

1. The red LEDs on the front of the unit will be lit for approximately 0.5 seconds each in the following order; EVEN and ODD Parity, TX and RX. For the remainder of the test, unless an error condition exists, the LEDs are extinguished. If one of the LEDs fails to light, the unit should still function properly, but the LED should be replaced at the earliest opportunity. If all LEDs fail to illuminate and the display is blank or displays random data, then a catastrophic unit failure has occurred or the batteries are completely discharged.

2. The EPROM is checked by summing all memory locations and comparing the result to the known checksum. If the checksums don't match, the unit will signal a checksum error by flashing the RX LED and will attempt to write CHECKSUM ERROR to the display. If the entire EPROM has failed, however, or if one of the locations in the check-sum subroutine is bad, the program will not be able to execute properly.

3. The 429E has RAM in two independent ICs. The unit tests each RAM section separately for data retention and address integrity. It begins by writing the lower 8 bits of the location address to the location. After writing to all locations of the section, it then reads each location and check its value. If all is correct, it will repeat this sequence with the exception that it will write the complement of the lower 8 bits of the location address to the location. It performs this sequence for each RAM section.

    If the first IC fails this test, the unit will flash the EVEN parity LED and attempt to write NSC RAM ERR to the display. This indicates that U5 has failed its test. If the second IC fails this test, the unit will flash the ODD parity LED and will attempt to write 6116 RAM ERR to the display. This indicates that U3 has failed its test. The PROGRAM will then loop indefinitely reading from the failed location.

4. The 429E has a loop back feature on the digital board to completely test the digital portion of the transmit and receive circuitry. The unit will turn on the loopback circuitry and transmit a word with a label of 0 and a data pattern of AA55AA (hex). After a brief pause, the unit will read its receive buffer and check the data against the transmitted data. If the data is not what is expected, the unit will flash the TX LED and attempt to write LOOP BACK FAILED to the display. No further operations will be possible until the cause of the failure is corrected.

    If all tests have been successfully completed, the unit will display SELF TEST OK for approximately 2 seconds and will then enter the operational receive mode and display the number of different labels currently being received (if any).

SECTION III
OPERATION

3.1 GENERAL OPERATION DESCRIPTION

The 429E is a single channel ARINC 429 transmitter and receiver. It can receive and display all ARINC 429 labels per ARINC Specification 429-9 (Attachment 2). It can simultaneously output up to ten ARINC 429 words. Data can be displayed and entered in either hexadecimal or engineering formats.

The transmitter and receiver can operate at either 100 kbps (HI Speed) or 12.5 kbps (LO Speed). Each mode's speed can be set independently of the other. The parity of the words being transmitted can be set for either ODD or EVEN. An LED indicator will show the parity selected for transmitted words in the TX mode or the parity of the currently displayed word if in the RX mode.

To minimize battery drain, the 429E has the capability to sense when there has been no activity (keypad, TX, RX) for at least 5 minutes. When this happens, the 429E will shut down some of its circuitry and go to "sleep". In this state, the 429E is fully functional, but is in a low current drain wait state. The LCD screen will blank, but either the TX or RX LED will be lit. Any keypad or RX activity will reawaken the 429E to its normal operational mode.

3.1.1 HEX MODE

The HEX mode allows entry and display of the data field in hexadecimal format. The data field is specified in up to 6 hex characters (000000-FFFFFF). The characters represent the hexadecimal equivalent of bits 32-9 (starting with bit 32) in six 4-bit nibbles. Each 4-bit nibble is derived from the BCD equivalent of the binary value.

For example: Data Field in Binary - 1001 0010 1111 0001 1010 0101

Equivalent Hex Value -   9   2   F   1   A   5

The 429E will display (from left to right), the label (bits 1-8) in three octal characters (001-377), followed by the SDI (bits 10-9) in two binary characters (00-11), the data field (bits 32-9) in six hex characters (000000-FFFFFF) and the SSM (bits 31-30) in two binary characters (00-11). The only other screen possible in DATA mode is the RATE screen.

3.1.2 ENG MODE

The ENG (Engineering) mode allows data entry and display in convenient engineering unit formats (feet, knots, MHz, etc.). The label definition will determine the number of screens required for display of all possible fields of the word. See Appendix A for a complete listing of the engineering conversion for each ARINC 429 label defined by the 429E.

3.1.3 TRANSMIT & RECEIVE MODES

There are two distinct modes of operation: TX (Transmit) mode and RX (Receive) mode. Selection of these modes and all other display operations are accomplished by keypad or slide switch entry as described in the following sections.

3.1.3.1 TX MODE

The transmitter is capable of outputting up to ten 32 bit words in ARINC 429 or 419 bipolar RZ (Return to Zero) format. The data for each individual word is easily edited. There is a unique screen for most individual fields of the word. Some words will have more screens than others.

The word rate for each transmitter slot can be set independently. The word rate can be as fast as 4 ms or as slow as 59998 ms. If the rate is not specified, the unit will set it to the default value as defined as the minimum word rate in the ARINC 429-9 (Attachment 2) specification.

If desired, the word output sequence can be synchronized to be transmitted in a particular order (see the ENT key description in section 3.2.1 for details).

To comply with ARINC standards, the transmitter automatically insures at least a 4 bit time (low speed) separation between adjacent words.

3.1.3.2 RX MODE

There are two modes of operation in the RX mode; NORMAL and TRAP. Each mode has a screen that shows the count of words received, the label and description, or the data field currently selected.

3.1.3.2.1 NORMAL Mode

NORMAL mode (default) is a dynamic mode that displays all unique labels received, the label and description currently selected, or the data field currently selected. In this mode, the screen is updated 4 times per second with the latest data received.

3.1.3.2.2 TRAP Mode

TRAP mode is a static mode of operation which captures and stores the data for detailed analysis.

TRAP data may be filtered in 1 of 4 combinations:

1. All Labels/All SDI

2. Specific Label/All SDI

3. All Labels/Specific SDI

4. Specific Label/Specific SDI

Words are received and stored in the trap buffer in their order of occurrence. They will remain in the buffer until the TRAP key is pressed again or until the unit power is turned off, even if disconnected from the user equipment. Up to 255 unique words may be stored. Once the trap buffer is full, all subsequent received words will be ignored. In this mode, the time that has elapsed since the previous word is stored as the rate.

3.1.4 MISCELLANEOUS

3.1.4.1 Speed and Parity Select/Display

The transmitter and receiver can operate at either 12.5 kbps (Lo Speed) or 100 kbps (Hi Speed). Each mode's speed can be set independently of the other. The parity of the words being transmitted can be set for either ODD or EVEN parity. The 429E will automatically correct the entered data to be transmitted if the data entered by the user is in conflict with the selected TX parity. An LED indicator will show the parity selected for transmitted words if in the TX mode or the parity of the currently displayed word if in the RX mode.

3.1.4.2 Power Saver Mode

To minimize battery drain, the 429E has the ability to sense when there has been no activity (keypad, TX, or RX) for at least 5 minutes. When this happens, the 429E will shut down some of its circuitry and go to "sleep". In this state, the unit is fully functional, but it is in a low current drain wait state. The LCD screen will be blank, but either the TX or RX LED will be lit. Any keypad or RX activity will reawaken the unit to its normal operation mode.

3.2 CONTROL FUNCTIONS

3.2.1 429E CONTROLS AND INDICATORS (Figure 3-1)

(1) TRAP Mode Key

Allows the operator to enter any one of four combinations for selection of received labels for display. A 255 word buffer is provided for receiving and storage of data for display. Access to TRAP mode is through selection of receiver mode via TX/RX key. Trapping a "0" label will trap ALL labels. Trapping on all SDIs is accomplished by entering ENT only when prompted for "SDI?".

(2) AUTO Mode Key

IN RX MODE. ON/OFF key for AUTO scrolling mode. Allows the operator to scroll through labels that have been received by TRAP mode. If in the LABEL mode, steps automatically through the word buffer and displays the number of trapped words as well as the engineering name of the label. If in the DATA mode, the AUTO mode steps to the same data menu for the next trapped word. Scroll keys (UP/DN Arrow keys) allow scanning direction to be selected.

IN EDIT MODE. Allows the hexadecimal value "C" to be entered.

(3) TX Parity Switch

Allows operator to select ODD or EVEN transmit word parity.

(4) TX SPEED Switch

Allows selection of HI (100 kbps) or LO (12.5 kbps) speed transmit bit rate.

(5) TX Output Port

Allows access to transmitter port using standard 3-conductor, 1/4" phone plug.

(6) RX Input Port

Allows access to receiver port using standard 3-conductor, 1/4" phone plug.

(7) SCROLL (UP/DOWN) Keys — Allows operator to scroll through display menus (10 transmitter slots, 255 receiver slots, or data menus). Allows selection of the scanning direction in AUTO mode. If editing data of an ISO Alpha label (356 or 357), the SCROLL keys will allow selection of the Alpha character to be entered (SCROLL to the desired character and press ENT to select the character).

(8) TX/RX Indicator — LED indicates that the system is in either the transmit (TX) or receive (RX) mode of operation for display and entry of data.

(9) PARITY Indicator — IN RX MODE. LED Indicates parity (ODD or EVEN) of word presently displayed.

IN TX MODE. LED Indicates selected transmit parity.

(10) HEX/ENG Switch — Allows selection of hexadecimal or engineering unit display and entry of data.

(11) TX/RX Key — Allows selection of TX or RX mode of operation for display and entry of data. After selection, initial display indicates the number of labels being transmitted or received. SCROLL keys should then be used for manual stepping through TX or RX slots. TX/RX LED indicators above display will indicate current mode of operation.

(12) RX SPEED Switch — Allows selection of HI (100 kbps) or LO (12.5 kbps) speed receiver bit rate.

(13) DATA ENTRY Keys — Allows operator to enter various data in hexadecimal or engineering formats. Keys 0 - 9 and the "." and "." keys are valid while in ENG mode. Keys 0-F are valid while in HEX mode. Hex mode will be forced regardless of switch position if the label is currently undefined by ARINC 429-9 Attachment 2 specifications or is a label not supported in ENG mode (Discrete data, Maintenance Data, etc.).

Keys 0 - 7 are valid for LABEL entry since all labels are entered in octal format.

The "0" and "1" keys allow clearing and setting, respectively, bits of discrete bit screens (SDI, SSM, RF management labels, frequency discretes and individual bit screens, etc.)

(14) LAB/DAT Key — Allows selection of either LABEL or DATA mode of display. LABEL mode displays octal number and engineering definition of labels being transmitted or received. DATA mode allows viewing of data of the currently selected label being transmitted or received.

(15) EDIT/DEL Key — Allows access to the data entry mode. If in the data entry mode, the DEL keys allows correction of errors during data entry.

(16) ON/OFF Key — Turns the unit ON or OFF.

(17) ENT (Enter) Key

DATA ENTRY MODE. Used to complete an entry sequence. Until the ENT key is pressed, an entry may be edited with the DEL key. If an entry is not allowed for some reason (out of range, illegal key), the old data will be retained.

TX WORD ORDER SYNCHRONIZATION. If not in the data entry mode and the transmitter is active, pressing the ENT key will reset the counters of each active label to their initial value. This allows the TX labels to be synchronized in their output order if all have the same word rate. They will be sent out in descending TX block order (10 through 1).

For example, you want to simulate an LRU that transmits 6 labels in bursts of 100 ms apart. You would enter the first label in the group in TX block 10 with word rate of 100. The second label would go in TX block 9 with a word rate of 100. This would continue for the remaining labels with the last label of the group being entered in TX block 5. Once all the data has been entered and you are ready to synchronize the labels, the ENT key should be pressed. There will be no visible indication that anything has occurred, but the words will have been synchronized and are being transmitted in bursts of 6, 100 ms apart. If any data is changed later, the ENT key must be pressed again to resynchronize the words.

(18) Battery Charging Jack

Allows the internal AA NiCad batteries to be charged by connecting to the battery charger furnished with the 429E.

*** CAUTION ***

To avoid possible damage to the battery charger, it is recommended that you do NOT have the charger connected to the wall outlet when connecting or disconnecting the charging plug to the 429E.

(19) Display Contrast Adj.

Allows adjustment of the liquid crystal display (LCD) for desired viewing angle.
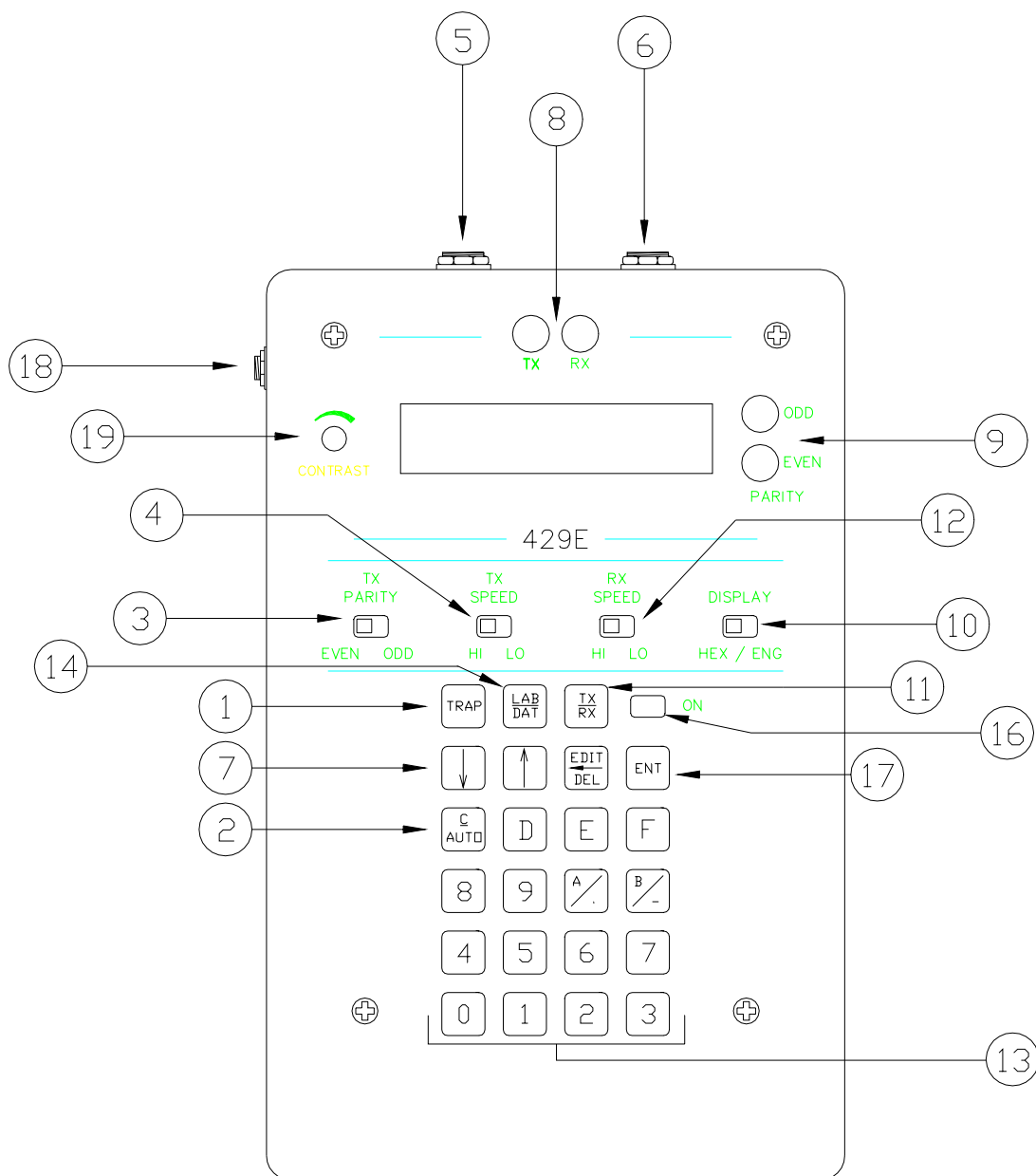
Fig. 3-1: Controls and Indicators

SECTION IV
THEORY OF OPERATION

4.1 GENERAL CIRCUIT THEORY

The Aeroflex Model 429E, ARINC 429 single channel transmitter and receiver consists of three board level sub assemblies and a battery pack. The three boards are:

1) Display Board (JPN: 20-6782-00)

2) Digital Board   (JPN: 20-6784-00)

3) Analog Board (JPN: 20-6783-00)

4.1.1 DISPLAY BOARD

The Display board performs the human interface function for the 429E. It has three major sections of circuitry:

1) Display circuits

2) Keypad circuits

3) Slide Switch circuits

The Display circuits output data in visual form. The display circuit consists of the liquid crystal display (DS1). The Keypad switches allow data to be input to the unit. The keypad circuits consist of 23 momentary contact switches (S1 - S23). The switches are arranged in an X/Y matrix and are decoded by the firmware on the digital board. The slide switches allow various I/O information (Parity, TX Baud, etc.) to be changed and to turn the unit on and off. The slide switch circuits consist of 5 SPST slide switches (S24 - S28) and various discrete components (resistors, transistors and capacitors).

4.1.2 DIGITAL BOARD

The Digital board contains the digital circuitry for the 429E. This circuitry has three major sections:

1) Control circuits

2) 429 Receive Buffer

3) 429 Generator

The Control circuits are the "Heart" of the system that controls and monitors all other circuits in the system. The control circuits consist of the following components

1) Micro-controller   (U1)

2) Firmware EPROM   (U2)

3) RAM   (U3)

4) Address Latch   (U4)

5) RAM IO   (U5)

The control circuits monitor the number of "bits" received and upon completion, will read the receive buffer.

The 429 Receive buffer stores the 429 bit stream data (Converted to TTL levels by the Analog board). The following components make up the 429 receive buffer.

1) Bit Latch   (1/2 U8)

2) Serial Register   (1/2 U6)

3) Mux   (U14)

The 429 Generator circuits send TTL level bit stream data to the Analog board, where it is converted to the correct levels for output. The Generator is loaded and started by the Control circuits. The Generator consists of the following components:

1) Digital drivers   (U9)

2) Serial Register   (1/2 U6)

3) Baud Clock/Bit Counter   (U5)

4) Driver Enable   (1/2 U8)

4.1.3 ANALOG BOARD

The Analog board contains the analog circuitry for the 429E. This circuitry has three major sections:

1) Power Circuits

2) 429 Receiver

3) 429 Driver

The Power circuits supply power to the system from one of two sources. If the battery charger is disconnected, the circuits supply power to the system from the battery pack. The battery voltage is monitored by the power circuits. Should the voltage drop to an insufficient level it is the power circuits that will indicate this to the control circuits. An indication of low power will be seen on the display board should the aforementioned conditions exist. If the charger is connected, the power circuits will supply power to the system from the charger and will also trickle charge the NiCad batteries. The power circuits consist of the following components:

1) Low Drop Out Regulator   (U5)

2) Voltage converter   (U6)

3) Monitor   (U7)

The 429 Receiver circuits convert ARINC 429 RZ transmitted signals form 10V levels (between A & B) to TTL level signals for use by the 429 Receiver Buffer on the Digital board. The 429 receiver circuits consist of a Comparator and a number of discrete components. The 429 driver circuits convert the TTL level signal from the digital board into 10V (between A and B) ARINC 429 compatible signal levels.

The 429 Driver circuits consist of the following components:

1) "1" Driver   (U2, Q1, Q2)

2) "0" Driver   (U3, Q3, Q4)

3) Speed Switch   (U1)

The battery Pack supplies power to the system and consists of the following components:

1) Battery Holder

2) Six (6) "AA" NiCad rechargeable batteries.

**SECTION V
MAINTENANCE**

5.1 INTRODUCTION

This section contains maintenance information for the Aeroflex 429E ARINC 429 Transmitter/Receiver.

5.2 TEST AND ALIGNMENT

5.2.1 ALIGNMENT AND CALIBRATION PROCEDURE

No alignment or calibration required.

5.3 BILLS OF MATERIAL, ASSEMBLY DRAWINGS, SCHEMATICS & TEST PROCEDURE

To assist in the maintenance of the 429E, bills of material, assembly drawings, schematics and test procedure are available in the 429E Maintenance Manual (P/N 06-1001-00 for hard copy, E6-1001-00 for CD) available separately from Aeroflex.

APPENDIX A

MODEL 429EX (VERS. 1.1): DEFINED LABELS AND DEFAULT DATA

LAB	DESCRIPTION	RANGE *	UNITS	DEFAULT RATE	HEX IDs
001	DIST TO GO	+-/3999.9	NAU MILE	100ms	2
002	TIME TO GO	0-399.9	MINUTES	100ms	2
003	X TRACK DIST	0-399.9	NAU MILE	100ms	2
004	RUNWAY DIST	0-79900	FEET	100ms	1
005	SPARE LABEL		HEX	200ms	
006	SPARE LABEL		HEX	200ms	
007	SPARE LABEL		HEX	200ms	
010	PRES POS LAT	180N-180S	DEG:MIN	250ms	2,4
011	PRES POS LNG	180E-180W	DEG:MIN	250ms	2,4
012	GROUND SPEED	0-7000	KNOTS	250ms	2,4,5,25
013	TRK ANG TRUE	0-359.9	DEGREES	250ms	2,4
014	MAG HEADING	0-359.9	DEGREES	168ms	4,5
015	WIND SPEED	0-799	KNOTS	250ms	2,4,5
016	WIND DIR TRU	0-359.9	DEGREES	250ms	4
017	SEL RNWY HDG	0-359.9	DEGREES	168ms	10,A0,B0
020	SEL VERT SPD	+/-6000	FT/MINUTE	100ms	20,A1
021	SEL EPR	0-3		100ms	2
022	SEL MACH	0-4	MACH	100ms	20,A1
023	SEL HEADING	0-359	DEGREES	100ms	20,A1
024	SEL COURSE 1	0-359	DEGREES	168ms	11,20,A1,B1
025	SEL ALTITUDE	0-50,000	FEET	100ms	20,A1
026	SEL AIRSPEED	30-450	KNOTS	100ms	3,20,A1
027	SEL COURSE 2	0-359	DEGREES	168ms	11,20,A1,B1
030	VHF COM FREQ	118-135.975	MHz	100ms	20.24,B6
031	BCN ATC CODE	0-7777	NUMERIC	100ms	20,B8
032	ADF FREQ	190-1750	KHz	100ms	12,20,B2
033	ILS FREQ	108-111.95	MHz	168ms	2,10,20,B0
034	VOR FREQ	108-117.95	MHz	168ms	2,11,20,B0
035	DME FREQ	108-135.95	MHz	100ms	2,9,20,A9
036	MLS FREQ		HEX	100ms	
037	HF COM FREQ	2.8-24	MHz	100ms	20,B9
040	SPARE LABEL		HEX	200ms	
041	SET LATITUDE	180N-180S	DEG:MIN	250ms	2,4,20,A4
042	SET LONGTUDE	180E-180W	DEG:MIN	250ms	2,4,20,A4
043	SET MAG HEAD	0-359	DEGREES	250ms	2,4,20,A4
044	TRUE HEADING	0-359.9	DEGREES	250ms	4
045	MIN AIRSPEED	0-259.9	KNOTS	064ms	3
046	ENG SER# LSD	0999	NUMERIC	500ms	33
047	ENG SER# MSD	0999	NUMERIC	500ms	33

LAB	DESCRIPTION	RANGE *	DEFAULT UNITS	RATE	HEX IDs
050	SPARE LABEL		HEX	200ms	
051	SPARE LABEL		HEX	200ms	
052	SPARE LABEL		HEX	200ms	
053	TRAK ANG MAG	0-359	DEGREES	250ms	4,5
054	SPARE LABEL		HEX	200ms	
055	SPARE LABEL		HEX	200ms	
056	ETA	0-2359.9	HOUR:MIN	250ms	2
057	SPARE LABEL		HEX	200ms	
060	LI TIRE PRES		HEX	050ms	
061	LO TIRE PRES		HEX	050ms	
062	RI TIRE PRES		HEX	050ms	
063	RO TIRE PRES		HEX	050ms	
064	NOSE TIRE		HEX	050ms	
065	GROSS WEIGHT	0-12000	LBS x100	100ms	3
066	LONG CG	0-100.00	% MAC	100ms	2
067	LAT CG	0-100.00	% MAC	100ms	
070	AC FREQ ENG	0-512	Hz	100ms	29
071	AC FREQ ALT	0-512	Hz	100ms	29
072	STAT VAN ANG	0-360	DEGREES	100ms	1C,2F
073	OIL QUANTITY	0-512	CC	100ms	1C
074	0 FUEL WEIGHT	1,310,720	LBS	100ms	2C
075	GROSS WEIGHT	1,310,720	LBS	100ms	2,3,2C,3E
076	AC VOLT BB	0-256	VOLTS	100ms	29
077	AC LOAD ENG	0-256	PERCENT	100ms	29
100	SEL COURSE 1	0-360	DEGREES	168ms	1,2,11,20,A1,B1
101	SEL HEADING	0-360	DEGREES	032ms	2,20,A1
102	SEL ALTITUDE	0-65536	FEET	100ms	2,20,A1
103	SEL AIRSPEED	0-512	KNOTS	100ms	1,2,03,20,A1
104	SEL VERSPEED	0-16384	FEET/MIN	100ms	1,2,20,2B,A1
105	SEL RNWY HDG	0-360	DEGREES	168ms	2,10,20,A1,B0
106	SEL MACH	0-4096	m MACH	032ms	2,A1
107	FLP/SLAT LEV	0-360	DEGREES	100ms	1B
110	SEL COURSE 2	0-360	DEGREES	168ms	1,2,10,11,20,A1
111	TEST WORD A		HEX	200ms	
112	RNWY LENGTH	0-20480	FEET	250ms	2
113	SPARE LABEL		HEX	200ms	
114	DESRD TRACK	0-360	DEGREES	032ms	2
115	WAYPOINT BRG	0-360	DEGREES	032ms	2
116	X TRACK DIST	0-128	NAU. MILE	032ms	2
117	VERT DEVIATN	0-2048	FEET	032ms	2

LAB	DESCRIPTION	RANGE *	UNITS	DEFAULT RATE	HEX IDs
120	RANGE TO ALT	0-512	NAU. MILE	026ms	2
121	HZ CMD SIGN	0-360	DEGREES	050ms	2
122	VER CMD SIGN	0-360	DEGREES	050ms	2
123	THROTTLE CMD	0-256	DEG/SEC	050ms	2
124	SPARE LABEL		HEX	200ms	
125	GMT	0-2400	HR/MN/SEC	100ms	31
126	PACK FLOW		HEX	200ms	
127	SLAT ANGLE	0-360	DEGREES	100ms	1B
130	FAN TTL TEMP	0-128	DEGREES C	100ms	1A,1C,2F,3F
131	FAN TTL PRES	0-32	PSI	100ms	1A,1C,2D,2F,33,35
132	EXH GAS PRES	0-32	PSI	100ms	1A,1C
133	THRUST LEVER	0-360	DEGREES	100ms	1A,2F,3F
134	POWER LEVER	0-360	DEGREES	100ms	1C
135	ENG VIBRAT 1	0-8	INCH/SEC	100ms	1C
136	ENG VIBRAT 2	0-8	INCH/SEC	100ms	1C
137	FLAP ANGLE	0-360	DEGREES	100ms	1B,2A
140	FLT DIR ROLL	0-360	DEGREES	050ms	1
141	FLT DIR PTCH	0-360	DEGREES	050ms	1
142	FAST/SLOW	0-32	KNOTS	032ms	2,3
143	FLT DIR YAW	0-360	DEGREES	050ms	1
144	ALT ERROR	0-8192	FEET	026ms	2B
145	DSCR DATA 8		HEX	200ms	
146	DSCR DATA 9		HEX	200ms	
147	DSCR DATA 10		HEX	200ms	
150	GMT	0-2400	HR/MIN/SEC	200ms	31
151	LOC BRG TRU	0-360	DEGREES	168ms	2
152	MLS ELEVAT 1		HEX	200ms	
153	MLS ELEVAT 2		HEX	200ms	
154	RNWY HDG TRU	0-512	NAU. MILE	084ms	2
155	MAINT DATA 6		HEX	200ms	
156	MAINT DATA 7		HEX	200ms	
157	MAINT DATA 8		HEX	200ms	
160	MAINT DATA 9		HEX	200ms	
161	MAINT DATA 10		HEX	200ms	
162	ADF BEARING	0-360	DEGREES	032ms	12
163	SPARE LABEL		HEX	200ms	
164	MDA	0-8192	FEET	500ms	2
165	RADIO HEIGHT	+/-7999.9	FEET	100ms	7
166	RALT CHPT DV	0-512	FEET	200ms	7
167	SPARE LABEL		HEX	200ms	

LAB	DESCRIPTION	RANGE *	UNITS	DEFAULT RATE	HEX IDs
170	DH SEL	0-7000	FEET	100ms	25
171	SPARE LABEL		HEX	200ms	
172	SPARE LABEL		HEX	200ms	
173	LOC DEV	0-0.4	DDM	034ms	10
174	GLS DEV	0-0.8	DDM	034ms	10
175	ECON SPEED	0-1024	NAU. MILE	064ms	3
176	ECON MACH	0-4096	m MACH	064ms	3
177	ECON FLT LEV	0-131072	FEET	032ms	3
200	DRIFT ANGLE	+/-180	DEGREES	100ms	4
201	DME DISTANCE	-1-399.99	NAU. MILE	084ms	9
202	DME DISTANCE	0-512	NAU. MILE	084ms	9
203	ALTITUDE	0-131072	FEET	032ms	6
204	BARD ALT #1	0-131072	FEET	032ms	6
205	MACH	0-4.096	MACH	064ms	6,1A
206	CMP AIRSPEED	0-1024	KNOTS	064ms	6
207	MAX AIRSPEED	0-1024	KNOTS	064ms	6
210	TRU AIRSPEED	0-2048	KNOTS	064ms	6
211	TTL AIR TEMP	0-512	DEGREES C	250ms	3,6,1A
212	ALTITUD RATE	0-32768	FEET/MIN	032ms	4,5,6
213	STAT AIR TMP	0-512	DEGREES C	250ms	6
214	SPARE LABEL		HEX	200ms	
215	IMPACT PRESS	0-512	MB	064ms	6,1A
216	SPARE LABEL		HEX	200ms	
217	STATIC PRESS	0-64	INCHES HG	064ms	6
220	BARO ALT. #2	0-131072	FEET	032ms	6
221	ANG ATACK AV	0-360	DEGREES	032ms	6
222	VOR BRG	0-360	DEGREES	050ms	11
223	ANG ATACK 1R	0-360	DEGREES	032ms	6
224	ANG ATACK 2L	0-360	DEGREES	032ms	6
225	ANG ATACK 2R	0-360	DEGREES	032ms	6
226	SPARE LABEL		HEX	200ms	
227	SPARE LABEL		HEX	200ms	
230	TRU AIRSPEED	100-599	KNOTS	250ms	6
231	TTL AIR TEMP	-060-099	DEGREES C	250ms	6
232	ALTITUD RATE	+/-20,000	FEET/MIN	032ms	4,5,6
233	STAT AIR TMP	099-060	DEGREES C	250ms	6
234	BARO (MB) #1	745-1050	MB	064ms	6
235	BARO (IN) #1	22-31	INCHES HG	064ms	6
236	BARO (MB) #2	745-1050	MB	064ms	6
237	BARO (IN) #2	22-31	INCHES HG	064ms	6

LAB	DESCRIPTION	RANGE *	UNITS	DEFAULT RATE	HEX IDs
240	SPARE LABEL		HEX	200ms	
241	COR ANG ATCK	0-360	DEGREES	032ms	6
242	TOTAL PRSUR	0-2048	MB	064ms	6,1A
243	SPARE LABEL		HEX	200ms	
244	FUEL FLOW ED	0-32768	LBS/HOUR	100ms	1C
245	MIN AIRSPEED	0-256	KNOTS	064ms	3
246	N1 (ENG DIR)	0-4096	RPM	100ms	1C
247	TOTAL FUEL	0-655,360	POUNDS	500ms	1F
250	PSEL FUEL QT	0-655,360	POUNDS	100ms	2C
251	BARO ALT. #3	0-131,072	FEET	032ms	6
252	BARO ALT. #4	0-131,072	FEET	032ms	6
253	GO-A EPR LMT	0-4		100ms	1E
254	CRUS EPR LMT	0-4		100ms	1E
255	CLMB EPR LMT	0-4		100ms	1E
256	FUEL QTY #1	0-131,072	POUNDS	500ms	2C,32
257	FUEL QTY #2	0-131,072	POUNDS	500ms	2C,32
260	DATE/FLT/LEG	31-12-9	NUMERIC	200ms	2,A2
261	FLIGHT	0-999	NUMERIC	200ms	2,A2
262	FUEL QTY #5	0-131,072	POUNDS	500ms	2C
263	FUEL QTY #6	0-131,072	POUNDS	500ms	2C
264	FUEL QTY #7	0-131,072	POUNDS	500ms	2C
265	FUEL QTY #8	0-131,072	POUNDS	500ms	2C
266	TEST WORD B		HEX	200ms	
267	THRTL POS CM	0-360	DEGREES	050ms	2B
270	DSCR DATA 1		HEX	200ms	
271	DSCR DATA 2		HEX	200ms	
272	DSCR DATA 3		HEX	200ms	
273	DSCR DATA 4		HEX	200ms	
274	DSCR DATA 5		HEX	200ms	
275	DSCR DATA 6		HEX	200ms	
276	DSCR DATA 7		HEX	200ms	
277	GEN TEST WD		HEX	200ms	
300	SPARE LABEL		HEX	200ms	
301	SPARE LABEL		HEX	200ms	
302	SPARE LABEL		HEX	200ms	
303	SPARE LABEL		HEX	200ms	
304	SPARE LABEL		HEX	200ms	
305	SPARE LABEL		HEX	200ms	
306	SPARE LABEL		HEX	200ms	
307	SPARE LABEL		HEX	200ms	

LAB	DESCRIPTION	RANGE *	UNITS	DEFAULT RATE	HEX IDs
310	PRES POS LAT	180N-180S	DEGREES	100ms	2,4
311	PRES POS LNG	180E-180W	DEGREES	100ms	2,4
312	GROUND SPEED	0-4096	KNOTS	026ms	2,4,5
313	TRK ANG TRUE	0-360	DEGREES	026ms	4
314	TRUE HEADING	0-360	DEGREES	026ms	4
315	WIND SPEED	0-256	KNOTS	050ms	2,4,5
316	WIND ANGLE	0-360	DEGREES	050ms	4
317	TRK ANG MAG	0-360	DEGREES	026ms	4,5
320	MAG HEADING	0-360	DEGREES	026ms	4,5
321	DRIFT ANGLE	0-360	DEGREES	026ms	4,5
322	FLT PATH ANG	0-360	DEGREES	026ms	4,5
323	FLT PATH ACL	0-4	G	010ms	4,5
324	PITCH ANGLE	0-360	DEGREES	010ms	4,5
325	ROLL ANGLE	0-360	DEGREES	010ms	4,5
326	BDY PITCH RT	0-128	DEG/SEC	010ms	4,5
327	BDY ROLL RT	0-128	DEG/SEC	010ms	4,5
330	BDY YAW RATE	0-128	DEG/SEC	010ms	4,5
331	BDY LNG ACCL	0-4	G	010ms	4,5
332	BDY LAT ACCL	0-4	G	010ms	4,5
333	BDY NRM ACCL	0-4	G	010ms	4,5
334	PLTFORM HDNG	0-360	DEGREES	020ms	4,5
335	TRK ANG RATE	0-32	DEG/SEC	010ms	4,5
336	INRT PTCH RT	0-128	DEG/SEC	010ms	4,5
337	INRT ROLL RT	0-128	DEG/SEC	010ms	4,5
340	EPR ACTUAL	0-4		100ms	3,1A,2D,33
341	EPR COMMAND	0-4		100ms	3,29
342	EPR LIMIT	0-4		100ms	3,29
343	EPR RATE	0-4		100ms	3
344	N2	0-256	%RPM	050ms	1A,1C,29,33
345	EGT	0-2048	DEGREES	100ms	1A,1C,33
346	N1 ACTUAL	0-256	%RPM	100ms	3,1A
347	FUEL FLOW	0-32768	LBS/HOUR	050ms	29
350	MAINT DATA 1		HEX	200ms	
351	MAINT DATA 2		HEX	200ms	
352	MAINT DATA 3		HEX	200ms	
353	MAINT DATA 4		HEX	200ms	
354	MAINT DATA 5		HEX	200ms	
355	ACKNOWLEDGE		HEX	200ms	
356	MAINT ISO #5		ISO ALPHA	200ms	
357	ISO ALPHA #5		ISO ALPHA	200ms	

LAB	DESCRIPTION	RANGE *	UNITS	DEFAULT RATE	HEX Ids
360	POT VERT SPD	0-32768	FEET/MIN	010ms	4
361	INR ALTITUDE	0-131,072	FEET	020ms	5
362	ATRK HZ ACCL	0-4	G	010ms	4
363	X TRACK ACCL	0-4	G	010ms	4
364	VERT ACCEL	0-4	G	010ms	4,5
365	INR VERT VEL	0-32768	FEET/MIN	020ms	4,5
366	N-S VELOCITY	0-4096	KNOTS	050ms	4
367	E-W VELOCITY	0-4096	KNOTS	100ms	4
370	DH SEL (EFI)	0-8192	FEET	100ms	25
371	SPARE LABEL		HEX	200ms	
372	WIND DIR-MAG	0-360	DEGREES	050ms	5
373	N-S VEL MAGN	0-4096	KNOTS	100ms	5
374	E-W VEL MAGN	0-4096	KNOTS	100ms	5
375	A HDG ACCEL	0-4	G	010ms	5
376	X HDG ACCEL	0-4	G	010ms	5
377	EQUIPMENT ID		HEX	200ms	

NOTES: * Ranges shown are those specified by ARINC 429-9, Attachment 2, and are provided for reference only. The 429E does not perform range checking to prevent over or under range entries. The user should insure that the ranges entered are within limits when making entries in the TX mode.