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An Overview of

ARINC 429

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Introduction

Aeronautical Radio Incorporated (ARINC) is a corporation in which the US scheduled airlines are the principle stockholders. Other stockholders include air transport companies, aircraft manufacturers, aircraft equipment manufacturers and foreign flag airlines.

Amongst their activities ARINC sponsor the "Airlines Electronic Engineering Committee" (AEEC) to formulate standards for electronic equipment and systems for commercial airlines. One such standard is the "ARINC 429", Mark 33 Digital Information Transfer System (DITS).

The first revision "ARINC 429-1" was generated 11 April 1978, the current specification is "ARINC 429-10".

Architecture

ARINC 429 has a very simple architecture, almost point-to-point. The types of equipment employed on an ARINC 429 system are Transmitter (source), Receiver (sink), or Transmitter and Receiver. All data is transmitted over a single, twisted shielded, wire pair in one direction only. Figure 1 shows a simplified block diagram of an ARINC 429 system.

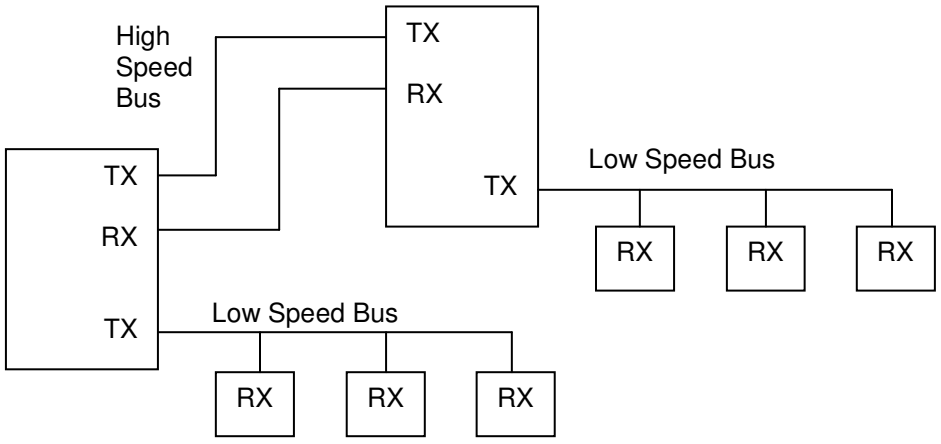

Figure 1 – Simplified ARINC 429 Architecture

A transmitter may "talk only" to a number of receivers, up to a maximum of 20, on one twisted wire pair. Each receiver would be continually listening for its applicable data, but does not acknowledge that it has received it.

Alternatively, a transmitter may require communicate with a receiver when large amounts of data are to be transferred. In this case the receiver is required to acknowledge that this data has been received. This form of handshaking is performed using a word style, as opposed to a hard wire form of handshaking, and will be described in more detail later. When this form of communication is required, two twisted wire pairs are necessary, one in each direction.

Electrical Characteristics

As described in the Architecture Section, the transmission bus is constructed using a shielded twisted pair. The shield must be grounded at each end and at all junctions along the transmission bus.

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Figure 2 illustrates the construction of a typical ARINC 429 transmission bus.

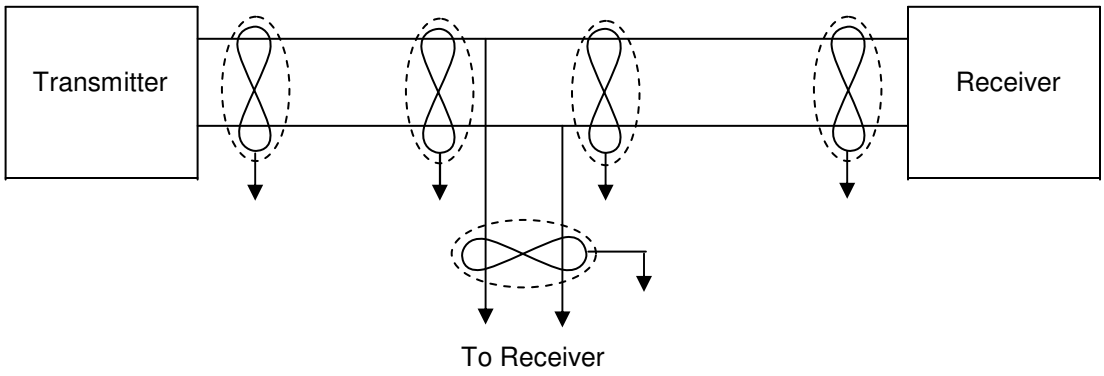

Figure 2 – Typical Transmission Bus Construction

The transmitter output impedance should be 75 +/- 5 ohms, divided equally between Line A and Line B to provide an impedance balanced output. This should correspond to the transmission bus characteristics.

Data is transmitted in Bi-Polar RZ format. This is a tri-level state modulation consisting of a “Hi”, “Null”, and “Lo” states. An example of Bi-Polar RZ encoding is shown in Figure 3.

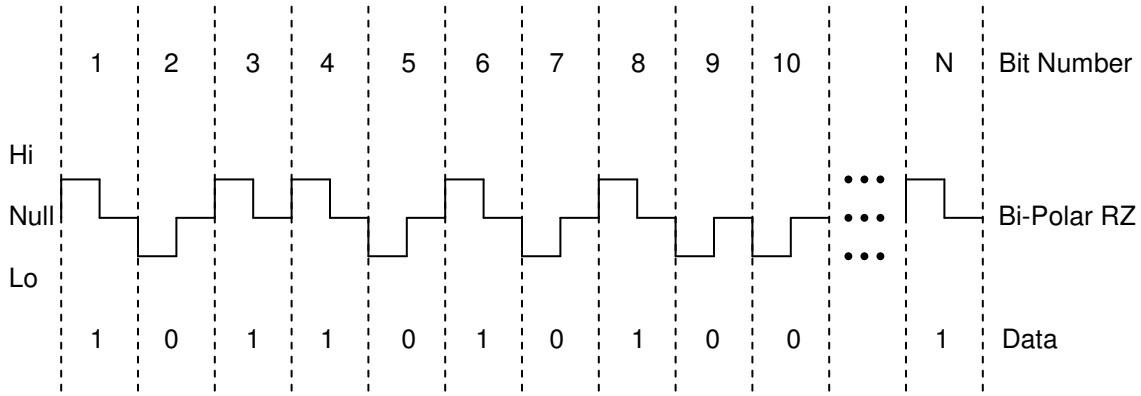

Figure 3 – Bi-Polar RZ (Return to Zero) Format Encoding

The transmitter has a differential output and the signal levels measured across the outputs terminals should be:

“Hi”	+10.0 ±1.0 volts
“Null”	0 +/- 0.5 volt
“Lo”	–10.0 ±1.0 volts

The differential voltage presented at the receiver input will be dependent upon line length, stub configuration and the number of receivers connected. Noise and pulse distortion will also effect

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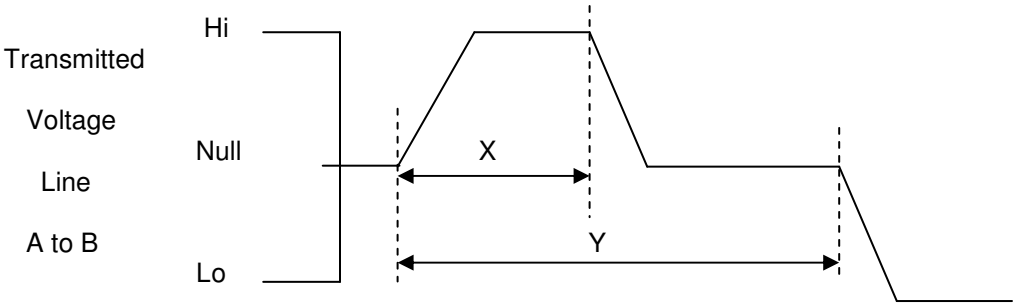
these voltage levels, therefore, receivers should be designed to accept the following voltage ranges for the three states:

"Hi"	+5.0V to + 13V
"Null"	+2.5V to –2.5V
"Lo"	–5.0V to –13V

There are two data rates associated with ARINC 429, 100 Kbits/s for high speed operation and 12.0 to 14.5 Kbits/s for low speed operation. The two data rates, however, cannot be used on the same transmission bus.

Transmitter output signal timing tolerances are illustrated in Figure 4.



Parameter	High Speed Operation	Low Speed Operation
Bit Rate	100Kbps ±1%	12 – 14.5Kbps
Time Y	10µsec ±2.5%	Z * µsec ±2.5%
Time X	5µsec ±5%	Y/2 ±5%
Pulse Rise Time**	1.5µsec ±0.5%	10 ±5 µsec
Pulse Fall Time**	1.5µsec ±0.5%	10 ±5 µsec

*Z = 1/R where R = bit rate selected from 12 – 14.5Kbps range.

** Pulse rise and fall times are measured between the 10% and 90% voltage amplitude points on the leading and trailing edges of the pulse and include permitted time skew between the transmitter output voltages A-to-Ground and B-to-Ground.

Figure 4 – Output Signal Specification

Word and Message Formats

The basic information element is a digital word containing 32 bits. Each word contains a Label, Data, and Parity; an example word is illustrated in Figure 5. The data field may also contain SDI and SSM bits.

There are five types of data word available in ARINC 429.

- Binary (BNR) data
- Binary Coded Decimal (BCD) data
- Discrete Data
- Maintenance Data (general) and Acknowledgement
- ISO Alphabet No 5 and Maintenance (ISO Alphabet No 5) data (AIM)

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Labels

Each word contains an Information Identifier in the form of an 8 bit label (Bits 1 to 8).

The label is normally expressed as 3 digit octal number and can have a number of different meanings depending upon the application.

Bit Number	8	7	6	5	4	3	2	1	
	LSB							MSB	
Octal Value	(1	2	4)	(1	2	4)	(1	2)	
Example	0	0	0	1	1	0	0	1	(230) True Airspeed

Receivers can be pre-programmed to accept up to 255 of these labels.

Source/Destination Identifier (SDI)

Bits 9 and 10 are normally reserved for SDI. However, SDI is not available when the data word contains alpha numerical data (ISO Alphabet No 5) or when the resolution of numeric data (BNR/BCD) necessitates the use of these bits for valid data.

The prime purpose of these SDI bits is to direct data words to a particular receiver.

Sign/Status Matrix (SSM)

The sign/status matrix (bits 30 and 31) are used to indicate plus, minus, north, south etc., of BCD numeric data; the word type (first, intermediate, control, last) for AIM data, and the status of the transmitter hardware.

The sign/status matrix of BNR numeric data words is encoded in bits 29, 30 and 31. Bit 29 for the sign and bits 30 and 31 being used as the status of the Transmitter (Failure Warning, No Computed Data, Functional Test, Normal Operation).

Data Types

As previously explained there are five types of data words: BNR, BCD, Discrete, Maintenance and AIM.

- BNR – binary data expressed in fractional 2's complement notation
- BCD – the numerical subset of ISO Alphabet No 5
- Discrete Data – are used in two ways:

  As part of a BNR or BCD data word
  Bits 11 to 15 to indicate data word (e.g., position 1, and bit's 17 to 29 to indicate data associated with Position 1)

  Or when using labels 270 to 276 the data field bits 11 to 29 are used for discrete data messages

- Maintenance Data (General Purpose) can be made up of BNR, BCD and Discrete data but will not contain ISO Alphabet No 5 data, and would use labels in the range 350 to 354.

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- AIM Data – (Acknowledge, ISO alphabet No 5 and Maintenance data). This type of data word is used when the "data package" contains more than 21 bits of information. The data package would be divided into data words, each word being identified using the SSM bits (i.e., initial word, intermediate word and final word). All these words would contain the same label in bits 1 to 8. The initial word would contain in bits 9 to 16, a binary representation of the number of words in the "data package".

Parity

Bit 32 of each word is encoded to give the word odd parity.

Data File Transfer

This type of transfer would be used when the terminal has the capability of both transmitting and receiving data. Each Data File can contain from 1 to 127 records, each of which can contain from 1 to 126 data words. The first word of a record would be the "initial" word, followed by "intermediate" words and ending with the "final" word, these words are identified using the SSM bits 30 and 31.

The parity, bit 32, of each word is encoded to give the word odd parity. This is then used for error detection, should an error be detected the receiver will respond accordingly. Therefore, when the "final" word has been received error free, the receiver will respond by sending the "Data Received OK" word to the transmitter.

There are eight types of initial word and are identified as 1, 0 in bits 30 and 31.

- **Request to Send** - (Tx and Rx) The data field would contain the binary count of the number of records to be sent.

- **Clear to Send** - (Rx to Tx) Indicates that the receiver is ready to accept the data. The data field would contain information as to the number of maximum length records or the number of 32 bit words the receiver can accept.

- **Data Received OK** - (Rx to Tx) The data has been received OK and informs the transmitter of the binary count of the number of words and record sequence number received.

- **Data Received Not OK** - (Rx to Tx) An error has occurred in the data received and informs the transmitter of the word count and the record sequence in which the error occurred.

- **Synchronization Lost** - (Rx to Tx) The receiver informs the transmitter that it is lost by sending zeros in bits 9-22.

- **Data Follows** - (Tx to Rx) After the receiver has informed the transmitter that erroneous data has been received, the data is then retransmitted using this initial word.

- **Header Information** - (Tx to Rx) Similar to request to send but without any commitment to send, or request the receiver to accept, the file itself.

- **Poll** - (Bi-directional) Can be used as a form of interrogation by the transmitter or receiver and can be interpreted as the message "I have nothing for you, do you have anything for me?"

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Data File Transfer words can contain any of the five previously described types of data (BNR, BCD, Discrete, Maintenance and AIM).

This type of data transfer is normally used when one system needs to talk to another system so that large amounts of data may be passed, and employs the high data transfer rate of 100K bits/sec/s.

Summary

Figure 5 provides examples of ARINC 429 data words.

32	31 30 29	28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11	10 9	8 7 6 5 4 3 2 1
P	SSM	MSB DATA FIELD LSB	SDI	LSB LABEL MSB
1	1 1 0	0 0 1 0 1 0 0 0 1 0 1 0 0 0 0 P P P	0 0	0 1 0 1 0 0 1 1

Example of BNR Data Word

Label = Ground Speed (312)
Data = 650 Knots

32	31 30	29 28 27	26 25 24 23	22 21 20 19	18 17 16 15	14 13 12 11	10 9	8 7 6 5 4 3 2 1
		MSB DATA FIELD LSB						LSB MSB
P	SSM	4 2 1	8 4 2 1	8 4 2 1	8 4 2 1	8 4 2 1	SDI	LABEL
0	0 0	1 0 1	0 1 1 0	0 1 0 1	P P P P	P P P P	0 0	0 0 0 1 1 0 1 0

Example of BCD Data Word

Label = True Airspeed (230)
Data = 565 Knots

Note: 'P' in Data Field denotes padding with binary '0' OR possible use for Discrete Data

32	31 30	29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11	10 9	8 7 6 5 4 3 2 1
P	SSM	DATA → ← PAD ← DISCRETE (MSB … LSB)	SDI	LABEL

Generalized BCD Data Word with Discrete Data

Figure 5 – Examples of ARINC 429 Data Words

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