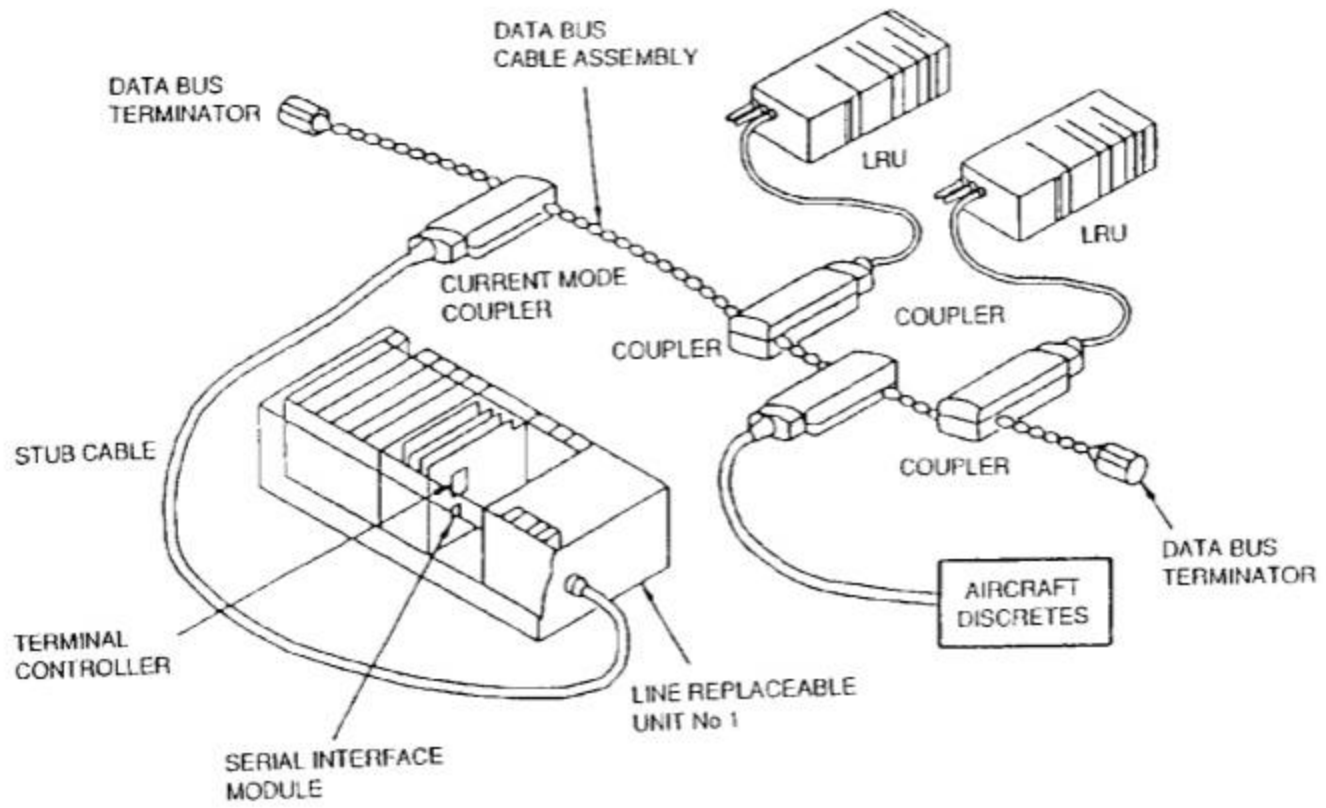# ARINC 429

Data bus for Civil Aircraft

Prepared
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- This presentation is about ARINC 429 Data bus which is commonly used in all civil aircrafts.

- ARINC- stands for "Aeronautical Radio INC"

- ARINC is a private corporation organized in 1929 comprises of a airlines, aircraft manufacturers and avionics equipment manufacturers to produce specifications and standards for avionics equipment.

- ARINC 429 is a standard for requirements for transfer of digital data between avionics systems on **commercial aircraft**.

- ARINC 429 is also known as the Mark 33 DITS (Digital Information Transfer system) Specification.

TYPICAL PHOTOGRAPHIC OF ARINC 429

High Speed Data Cables

DATA BUS CABLE ASSEMBLY

DATA BUS TERMINATOR

LRU

LRU

CURRENT MODE COUPLER

COUPLER

COUPLER

COUPLER

STUB CABLE

DATA BUS TERMINATOR

AIRCRAFT DISCRETES

TERMINAL CONTROLLER

LINE REPLACEABLE UNIT No 1

SERIAL INTERFACE MODULE

- ARINC 429 uses simplex, twisted shielded pair data bus.

- It consist of one transmitter and multiple receiver (up to 20 receiver connected to one twisted pair of wire).

- It does not have Bus monitor, Remote terminal or Bus controller as like that of 1553B data Bus.

- A transmitter may 'talk only' to a number of receivers on the bus, up to 20 on one wire pair, with each receiver continually monitoring for its applicable data, but does not acknowledge receipt of the data.

- A transmitter may require acknowledgement from a receiver when large amounts of data have been transferred. This handshaking is performed using a particular word style, as opposed to a hard wired handshake. When this two way communication format is required, two twisted pairs constituting two channels are necessary to carry information back and forth, one for each direction.

- Communication on 429 data bus uses 32 bit words with odd parity. The wave form uses is bipolar return to zero with each bit lasting either 70 or 83 microsec+_2.5 percent or 10microsec+_2.5 percent depends on operating speed of bus.

- ARINC-429 data bus operate in two speeds
  - Low speed (12.5 kHz)
  - High speed (100kHz)

- Low speed bus is used for general purpose low critical application .

- High speed bus is used for transmitting large quantities of data's or flight critical applications.

- Transmission from the source LRU is comprised of 32 bit words containing a 24 bit data portion containing the actual information, and an 8 bit label describing the data itself.

- LRUs have no address assigned through ARINC 429, but rather have Equipment ID numbers which allow grouping equipment into systems, which facilitates system management and file transfers.

- Sequential words are separated by at least 4 bit times of null or zero voltage.

- Transmission rates may be at either a low speed – 12.5 kHz – or a high speed – 100kHz.
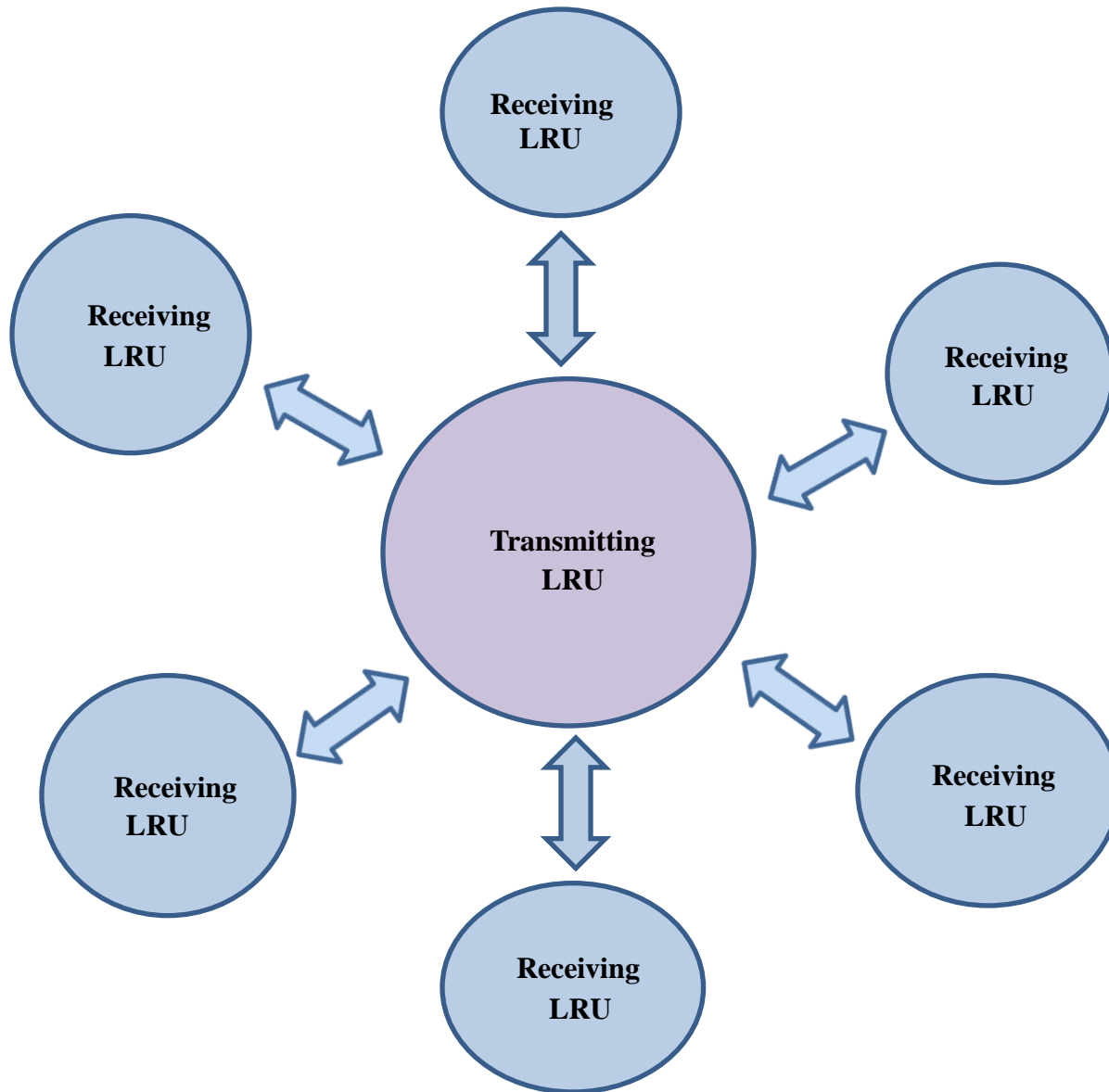
BUS DROP TOPOLOGY
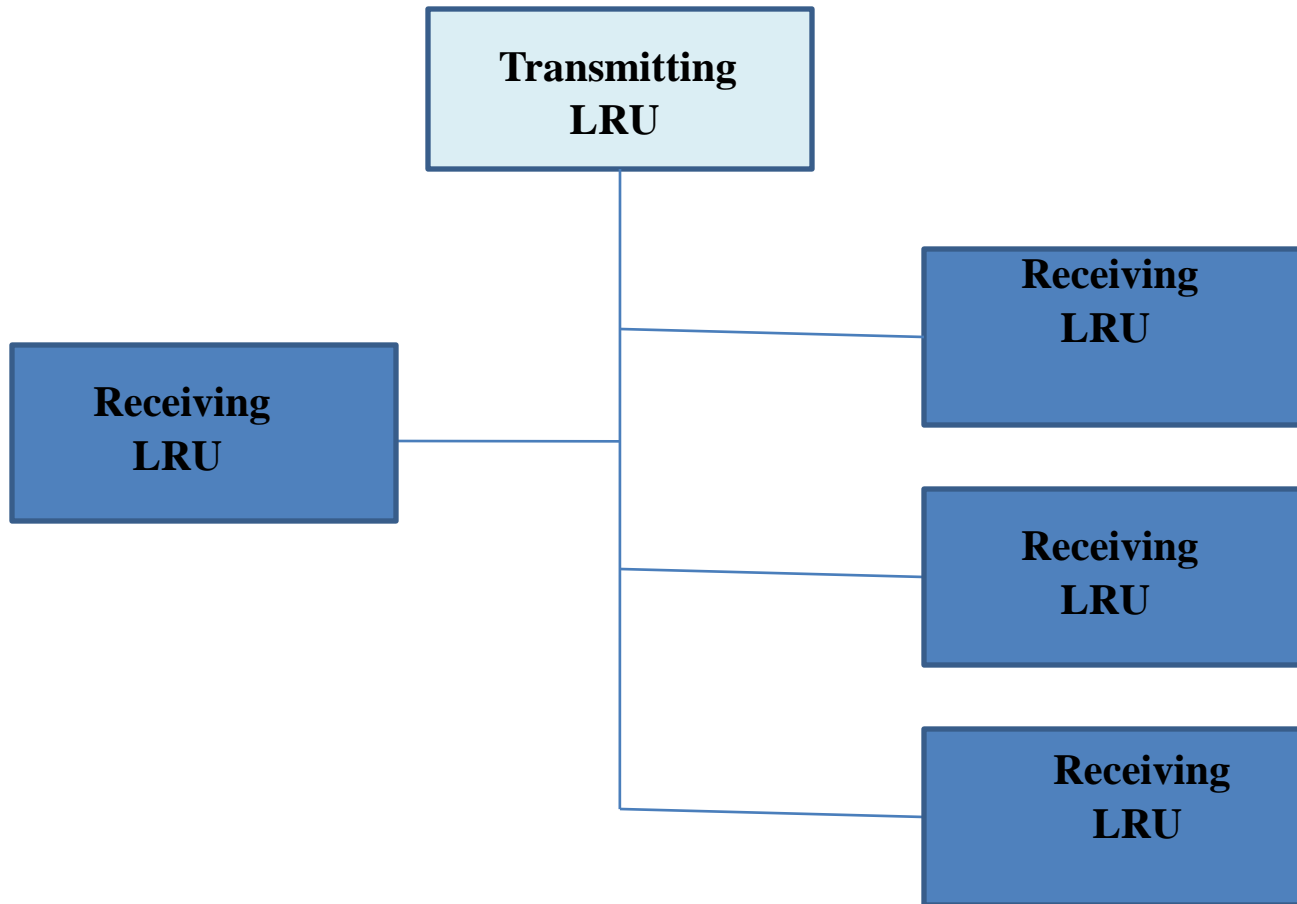
MULTIPLE BUS DESIGN TOPOLOGY
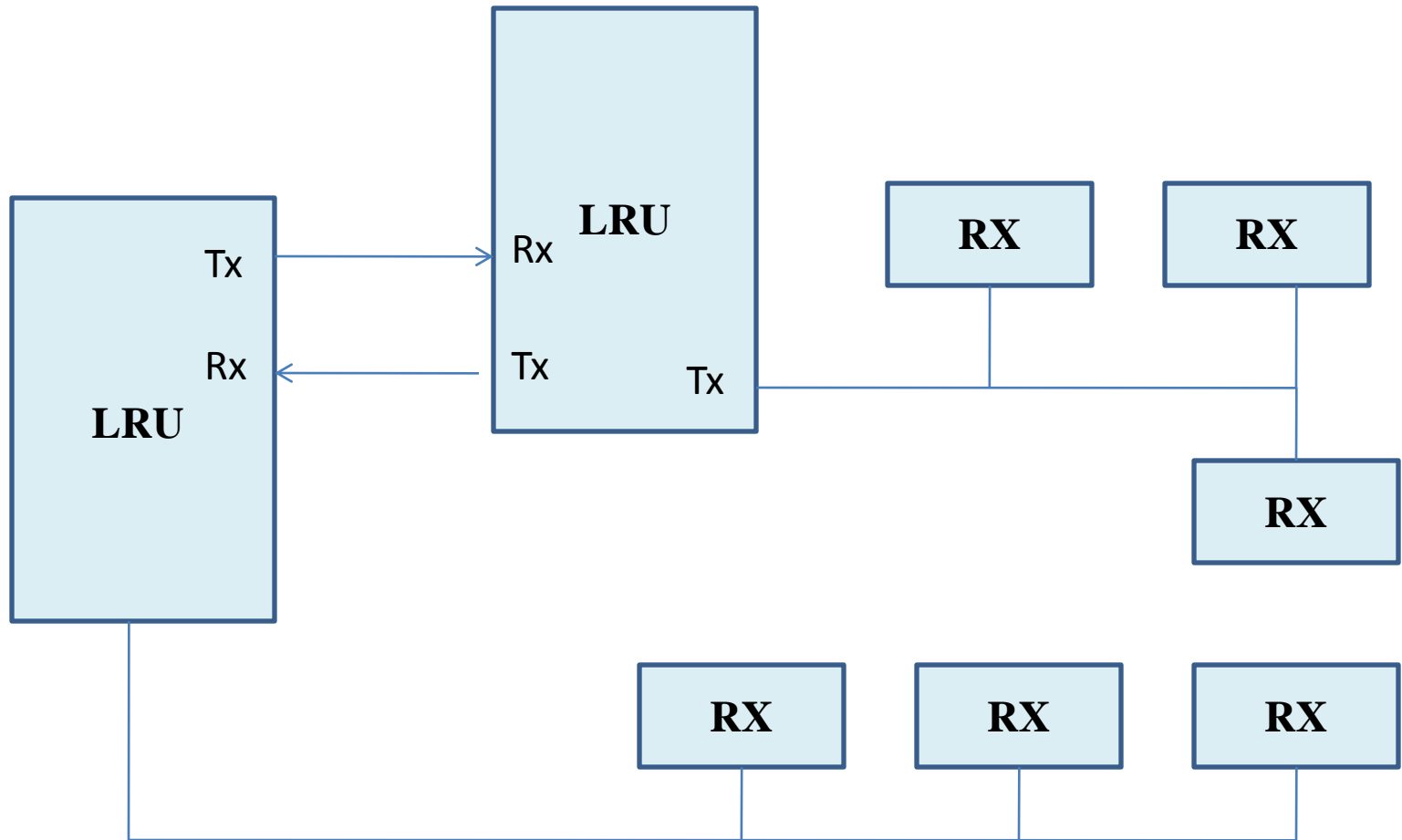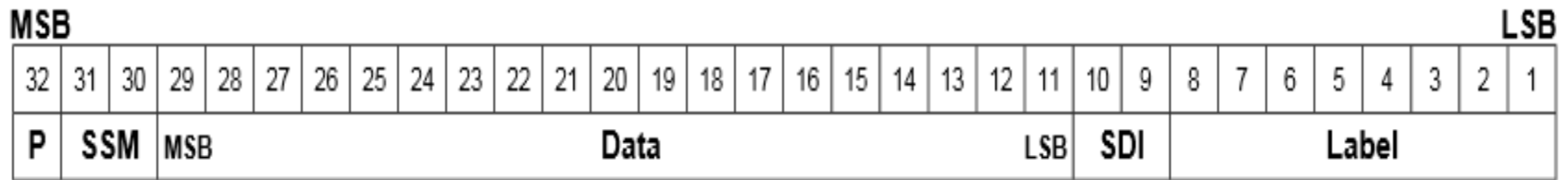
ARINC 429 32 bit Word Format

- ARINC 429 data words are 32 bit words made up of five primary fields:
- Parity – 1 bit
- Sign/Status Matrix (SSM) – 2 bits
- Data – 19 bits
- Source/Destination Identifier (SDI) – 2 bits
- Label – 8 bits

PARITY BIT

- Parity bit helps to Detect Error in the receiving words.

- ARINC 429 uses odd parity as error check to insure accurate data reception.

- The number of Logic 1s transmitted in each word is an odd number. The receiver checks the received words having odd logic or not.

- Odd logic 1s - accept the word
- Even logic 1s- reject the word

ARINC 429 DATA TYPES

- BNR Word Format (Signed Binary Number)
  - Encoded and transmitted by using 2s complement fractional binary notation

- BCD Word Format (Binary coded Decimal)

- Discrete Data-combination of Both BNR and BCD
  - Combination of BNR, BCD or individual bit representation

- Maintenance data and Acknowledgement Data-Requires two way communication
  - Alphanumeric Data encoded

- File data transfers by using Williamsburg/Buckhorn Protocol – A bit-oriented protocol.

ARINC BNR WORD FORMAT

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									LSB	SDI				Label					

ARINC 429 BNR Word Format

- It represent the entire data as Binary Number using 2s complement method.
- BIT 29 is used to represent as a signed number.
- Bit 29 with 1 indicating a negative number – or South, West, Left, From or Below.
- Bit 28 is MSB used to represent half the maximum value of data.
- Bit 27 is half the value of Bit 28.
- Bit 26 is half the value of Bit 27.

ARINC BCD WORD FORMAT

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		Digit 1			Digit 2				Digit 3				Digit 4				Digit 5				SDI		Label							

ARINC 429 BCD Word Format

- It uses 4 data field bits to represent each decimal digit.

- 5 subfields are used to represent decimal value. Among 5 data fields. MSB Digit 1 only have 3 data field bits (for maximum binary value of 7).IF MSB digit is greater than 7 bit 29-17 are padded with zero and second subfield become MSB allowing 4 data field instead of 5data field to represent the data.

DISCRETE DATA WORD FORMAT

P	SSM	BCD CH #2			BCD CH #2				BCD CH #3				BCD CH #4				BCD CH #5				SDI		8	7	6	5	4	3	2	1
		4	2	1	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1										
0	0 0	0	1	0	0	1	0	1	0	1	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	1
Example		2			5				7				8				6						DME DISTANCE (201)							

BCD Word Format Example (No Discretes)

- Discrete data can be made up of BNR and/or BCD data, or as individual bits representing specific equipment conditions. Pass/Fail, Activated/Non-Activated and True/False conditions relating to system or subsystem operational activity can be represented by setting or clearing predefined bits in the word data field.

MAINTENANCE DATA AND ACKNOWLEDGEMENT

- It can only employ or access by using Duplex or Two way communication between source and the sink (receiver).

- Since ARINC 429 only uses one way simplex transmission.

- Two ARINC channels are required for an LRU to send and receive maintenance, Acknowledgement and sequence of messages.

WILLIAMSBURG/BUCKHORN PROTOCOL

- Williamsburg/Buckhorn is a bit oriented protocol used to File Transfer across an ARINC bus.

- It is updated version of AIM data (Acknowledge, ISO Alphabet NO.5 and Maintenance Data) which was used in earlier version of ARINC 429.

- File transfer are necessary when more than 21 bits of data are required to transmitted.

- When initiating a file transfer – the source and receiver need to establish first.

- Followed by source initiate a predefined code to determine compatibility with receiver units.

- A request to send word (RTS) is Transmitted containing a destination code and word count.

- The receiver responds with a Clear to send word (CTS) retransmitting back to the destination and word count information.

- Upon confirmation of CTS, the source begins the file transfer.

- Files are transferred in Link Data Units (LDUs) format. Means, the entire file is divided into 3 to 255 words of length depends upon size of the file.

- File transfer begin with a Start of Transmission word (SOT) which includes file sequence number, general format identifier(GFI), and LDU sequence Number.

- After the SOT ,the data words are sent, followed by end of transmission (EOT).

- The EOT includes a CRC and LDU position in the file being sent. The receiver decodes the files depends upon their LDU position.

SIGN/STATUS MATRIX

- BIT 31-30 are assigned for Sign/Status Matrix or SSM

- Depending upon the word labels(1-8 bit),the SSM provides Different information about status of subsystem and status of the word.

- For BCD ,the SSM can be used to indicate Sign or Direction of the data contained in the ARINC word.

SSM FOR BCD WORD

BIT 31	BIT 30	Decoded Information
0	0	Plus, North, East, Right, To Above
0	1	No Computed Data
1	0	Functional Test
1	1	Minus, South, West, Left, From, Below

- Use of sign function for BCD is optional

- NO Computed Data Code (01) is used to identify a source system that is not able to produce reliable data

- Functional code is transmitted along with an Instruction command code to perform a test on receiver unit. The data received back from the receiver contains result of the test

SSM FOR BNR WORD

BIT 31	BIT 30	Decoded Information
0	0	Failure warning
0	1	No Computed Data
1	0	Functional Test
1	1	Normal Operation

BIT 29	Decoded Information
0	Plus, North, East, Right, To Above
1	Minus, South, West, Left, From, Below

- Failure warning code (00) indicates a transmitter or source system is failure that could not produce an reliable data.
- NO Computed Data Code (01) is used to indicate unreliable data output by a condition other than system failure.
- Functional code (10)- indicates the word data containing results of the Functional test.
- Bit 29 is optional in BNR word Format.

SSM FOR DISCRETE WORD

BIT 31	BIT 30	Decoded Information
0	0	Verified Data, normal operation
0	1	No Computed Data
1	0	Functional Test
1	1	Failure warning

- Use of sign function for BCD is optional.

- NO Computed Data Code (01) is used to identify a source system that is not able to produce reliable data.

- Functional code is transmitted along with an Instruction command code to perform a test on receiver unit. The data received back from the receiver contains result of the test.

SOURCE/DESTINATION IDENTIFIER

- The source/Destination identifier (SDI) utilizes the bit 9-10.Its is optional bit used to identify the source which is transmitting the data or multiple receiver to identify which receiver the data is meant for.

- For Higher resolution file transmission the BIT 9 and 10 may be used instead of SDI.

LABEL

Code No. (Octal)	Eqpt. ID (Hex)			Transmission Order Bit Position								Parameter	Data				Notes & Cross Ref. to Tables in Att. 6
				1	2	3	4	5	6	7	8		BNR	BCD	DISC	SAL	
1 0 2	0	0	2	0	1	0	0	0	0	1	0	Selected Altitude	X				6-27
	0	0	B	0	1	0	0	0	0	1	0	VDOP	X				
	0	2	0	0	1	0	0	0	0	1	0	Selected Altitude	X				
	0	2	9	0	1	0	0	0	0	1	0	DC Current (Battery)	X				
	0	5	6	0	1	0	0	0	0	1	0	Selected Altitude	X				
	0	6	0	0	1	0	0	0	0	1	0	Selected Altitude	X				
	0	A	1	0	1	0	0	0	0	1	0	Selected Altitude	X				

- BIT 1-8 contains the ARINC Label also known as Information Identifier.

- The label is expressed as a 3 Digit octal number.

- The label is used to identify the word data type whether it is BNR, BCD, Discrete word and also contains instruction or Data reporting information.

- Label may be extend by utilizing the Bits 11-13, as an Equipment Identifier to identify the bus transmission source. Equipment IDs are expressed in hexadecimal values.

CABLE CHARACTERISTIC
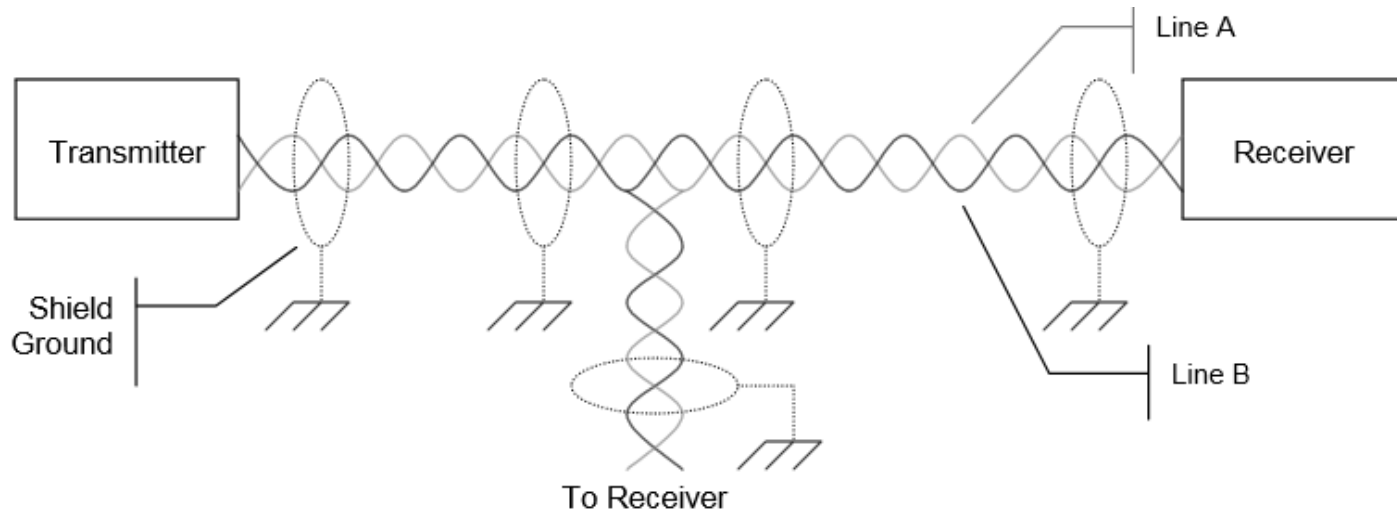
- The transmission bus media uses 78 Ω shielded twisted pair cable. The shield must be grounded at each end as well as all junction along the bus.

- The transmitting source output impedance should be 75 Ω ± 5 Ω divided equally between Line A and Line B. This balanced output should closely match the impedance of the cable.

- The receiving sink must have an effective input impedance of 8kΩ minimum.

- Maximum length is not specified, as it is dependent on the number of sink receivers, sink drain and source power.

- Most systems are designed for under 150 feet, but conditions permitting, can extend to 300 feet and beyond.

TRANSMISSION CHARACTERISTIC
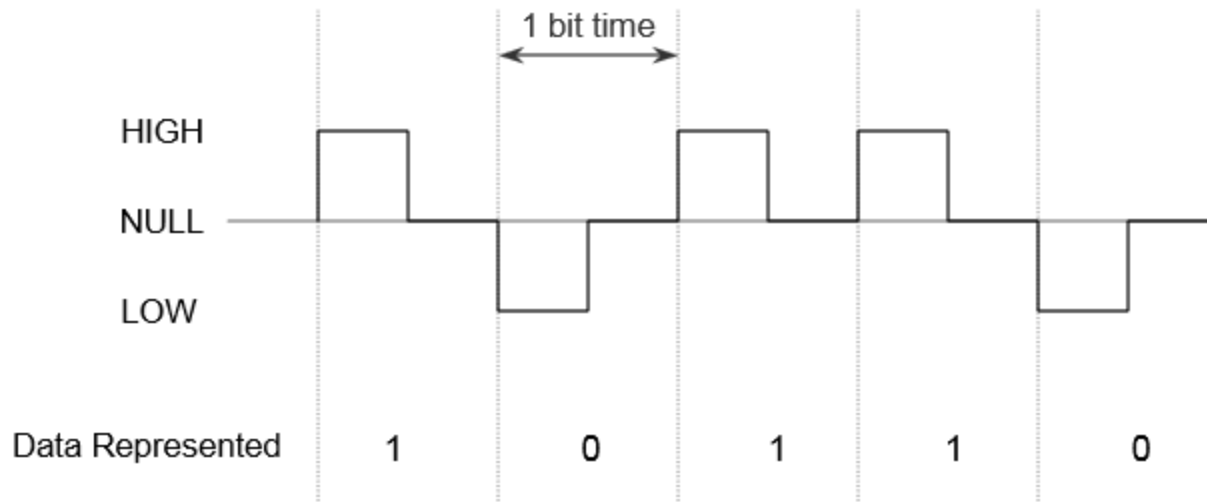
| 1 bit time |
| HIGH |
| NULL |
| LOW |

| Data Represented | 1 | 0 | 1 | 1 | 0 |

TRANSMIT	STATE	RECEIVE
+10.0 V ± 1.0 V	HIGH	+6.5 to 13 V
0 V ± 0.5V	NULL	+2.5 to -2.5 V
-10.0 V ± 1.0 V	LOW	-6.5 to -13 V

- Data is transmitted in a bipolar, Return-to-Zero format.

- This is a tri-state modulation consisting of HIGH, NULL and LOW states.

- Voltages presented across the receiver input will be dependent on line length, stub configuration and the number of receivers connected.

- Transmission voltages are measured across the output terminals of the source

EXAMPLE ARINC 429 DATA FORMAT

Code No. (Octal)	Eqpt. ID (Hex)			Transmission Order Bit Position								Parameter	Data				Notes & Cross Ref. to Tables in Att. 6
				1	2	3	4	5	6	7	8		BNR	BCD	DISC	SAL	
3 6 0	0	0	2	1	1	1	1	0	0	0	0	Flight Information	X				6-33
	0	0	4	1	1	1	1	0	0	0	0	Potential Vertical Speed	X				
	0	0	5	1	1	1	1	0	0	0	0	Potential Vertical Speed	X				
	0	3	8	1	1	1	1	0	0	0	0	Potential Vertical Speed	X				
	0	3	D	1	1	1	1	0	0	0	0	N1 Rotor Imbalance Angle	X				
	0	5	6	1	1	1	1	0	0	0	0	Flight Information	X				
	0	6	0	1	1	1	1	0	0	0	0	Flight Information	X				
	1	0	A	1	1	1	1	0	0	0	0	Throttle Rate of Change	X				
	1	0	B	1	1	1	1	0	0	0	0	Throttle Rate of Change	X				
	1	4	2	1	1	1	1	0	0	0	0	RAIM Status Word	X				
				1	1	1	1	0	0	0	0	ACESS - System Address Label				X	See Attachment 11
3 6 1	0	0	4	1	1	1	1	0	0	0	1	Altitude (Inertial)	X				
	0	0	5	1	1	1	1	0	0	0	1	Altitude (Inertial)	X				
	0	3	8	1	1	1	1	0	0	0	1	Altitude (Inertial)	X				
	0	3	D	1	1	1	1	0	0	0	1	LPT Rotor Imbalance Angle (737 only)	X				
	1	0	A	1	1	1	1	0	0	0	1	Derivative of Thrust vs. N1	X				
	1	0	B	1	1	1	1	0	0	0	1	Derivative of Thrust vs. N1	X				
				1	1	1	1	0	0	0	1	EFIS - System Address Label				X	See Attachment 11

P	SSM	BCD CH #2			BCD CH #2				BCD CH #3				BCD CH #4				BCD CH #5				SDI		8	7	6	5	4	3	2	1
		4	2	1	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1										
0	0 0	0	1	0	0	1	0	1	0	1	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	1
Example		2			5				7				8				6						DME DISTANCE (201)							

BCD Word Format Example (No Discretes)

P	31 30 SSM	29 11	SDI	8 7 6 5 4 3 2 1
		PAD		LABEL
		1/2 1/4 1/8 1/16 1/32 1/64 1/128 etc		
0	1 0	0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0	0 1 1 0 1 1 1 1
Example:		512 Knots (i.e., 1/8 x 4096 where 4096 is entry in range column of Table 2, Att. 2)		N-S VELOCITY (366)

BNR Word Format Example (No Discretes)

Eq. ID	Equipment Type
001	Flight Control Computer (701)
002	Flight Management Computer (702)
003	Thrust Control Computer (703)
004	Inertial Reference System (704)
005	Attitude and Heading Ref. System (705)
006	Air Data system (706)
007	Radio Altimeter (707)
008	Airborne Weather Radar (708)
009	Airborne DME (709)
00A	FAC (A310)