

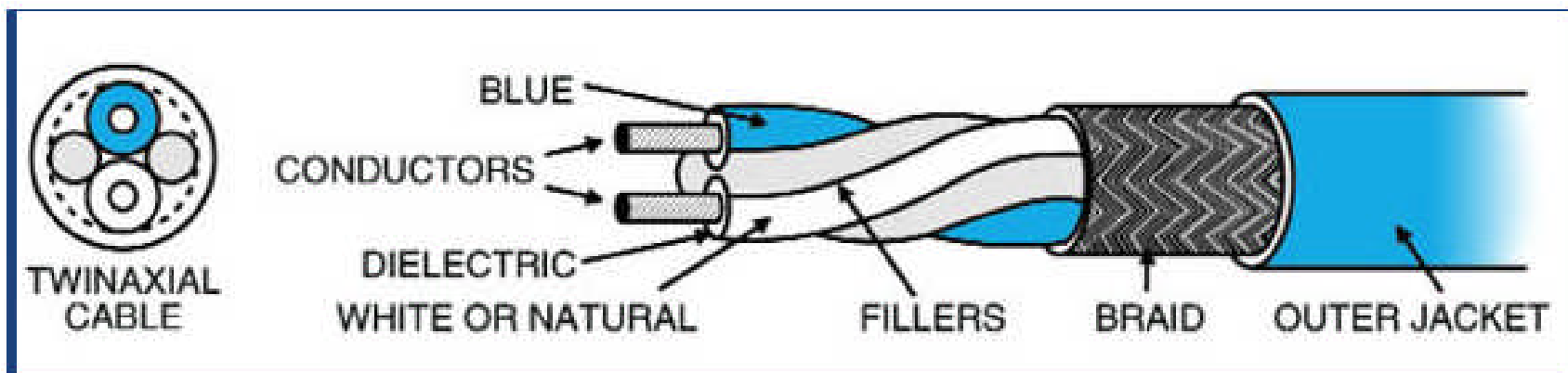


MIL-STD-1553 Protocol Overview



- MIL-STD-1553 Chronology
- 1553 Physical Layer and Bus Connections
- 1553 Protocol
 - Electrical Encoding
 - Word Types
 - Terminal Types
 - Message Types
 - Redundancy
 - Things to Remember

- 1973 – MIL-STD-1553 – USAF
- 1975 – MIL-STD-1553A – USAF, Army, Navy
- 1978 – MIL-STD-1553B – USAF, Army, Navy, and NATO
- 1980 – 1553B Notice 1 – USAF
- 1986 – 1553B Notice 2 – USAF, Army, Navy
 - RT Validation Test Plan first defined
- 1988 – MIL-HDBK-1553A
- 1995 – SAE AS15531 Commercial Standard
 - SAE AS4111 RT Validation Test Plan



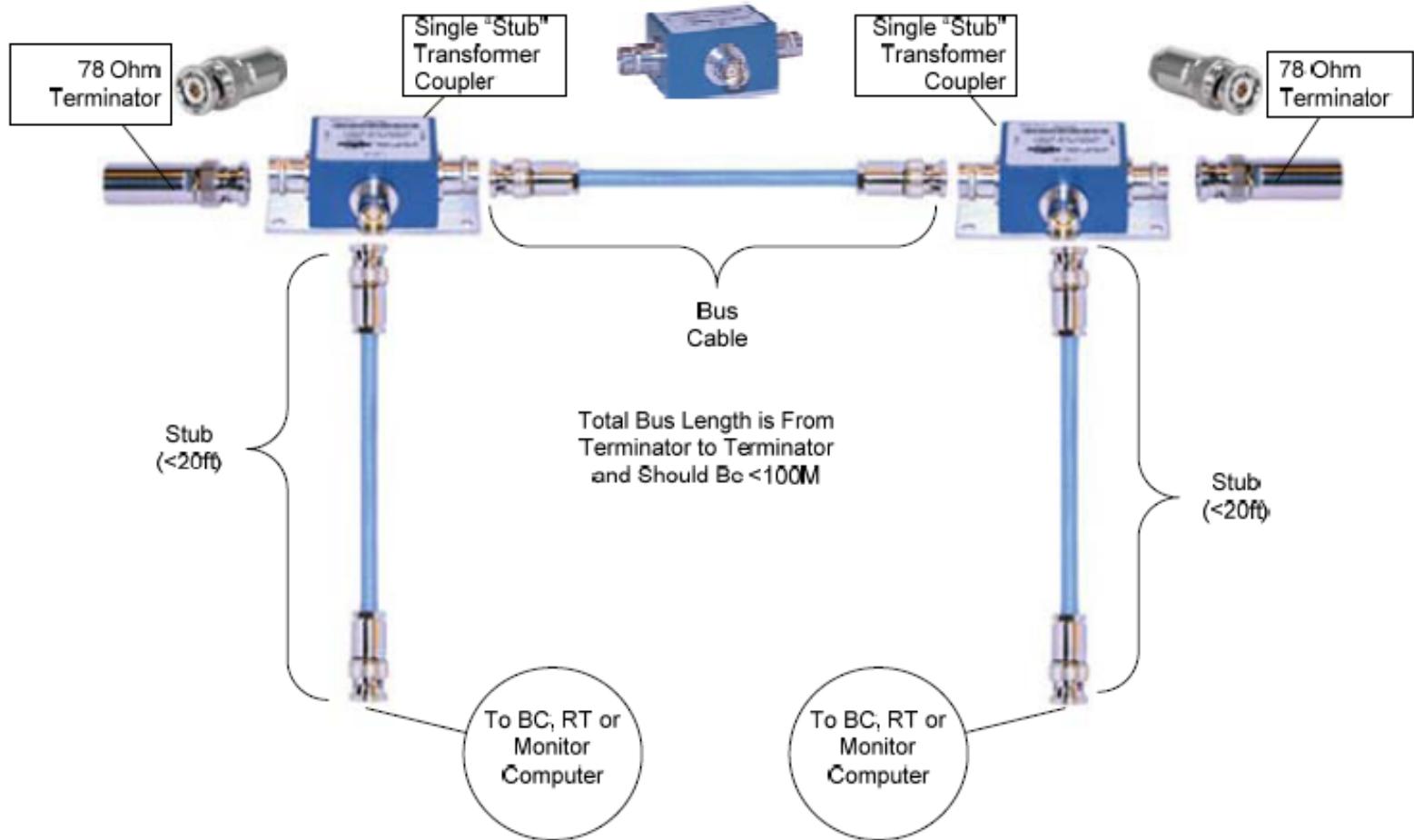
Shielded Twisted Pair

Blue wire is the Positive Signal

White wire is the Negative Signal

78 ohm characteristic impedance

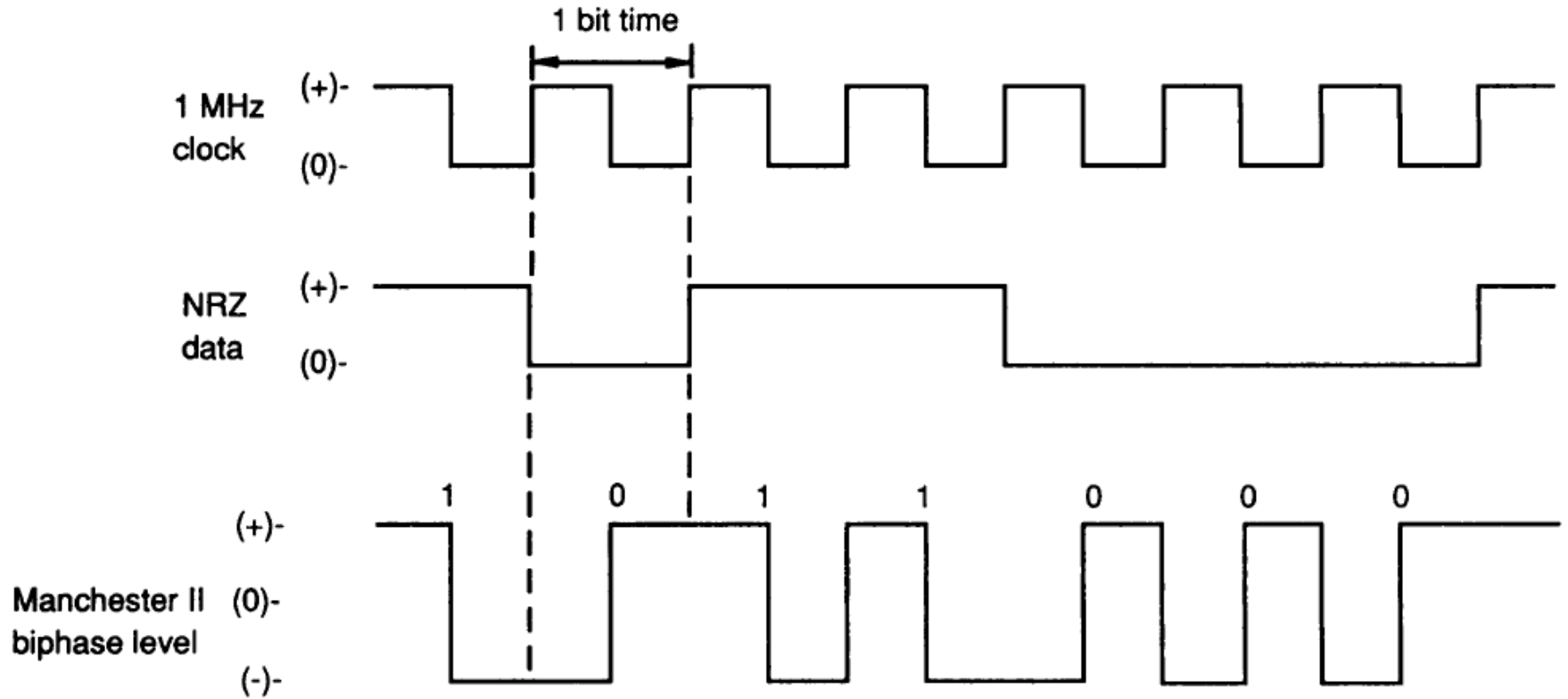
Transformer-Coupled Bus Connections



Innovation, Quality and Service
MIL-STD-1553 & ARINC-429

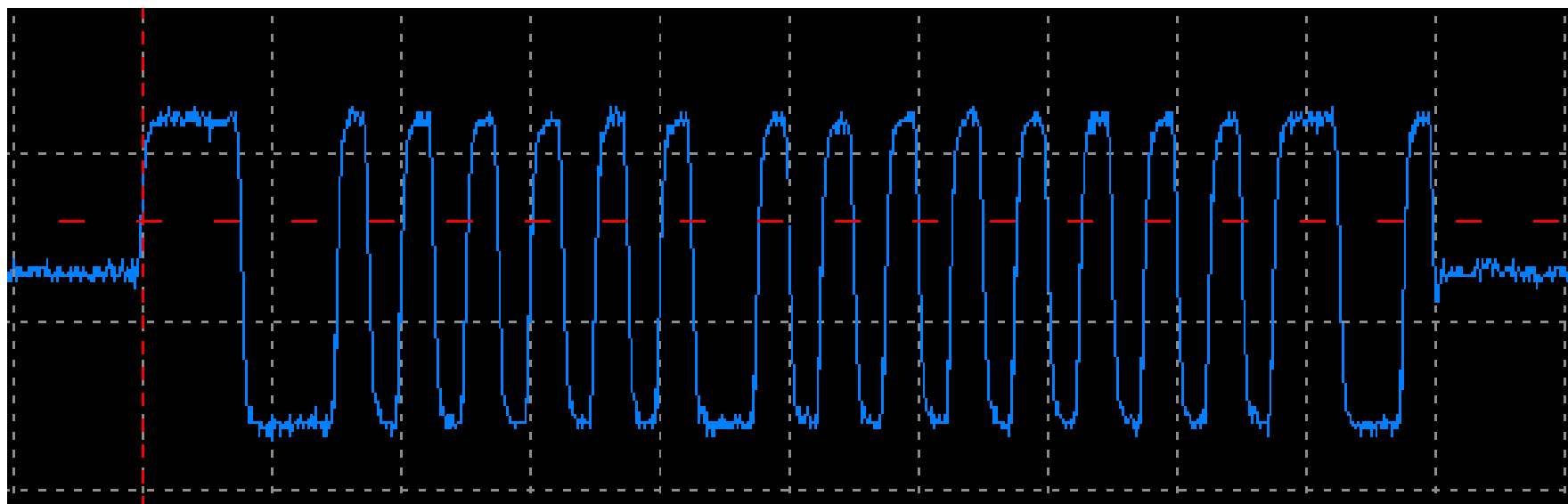
MIL-STD-1553 Protocol Summary

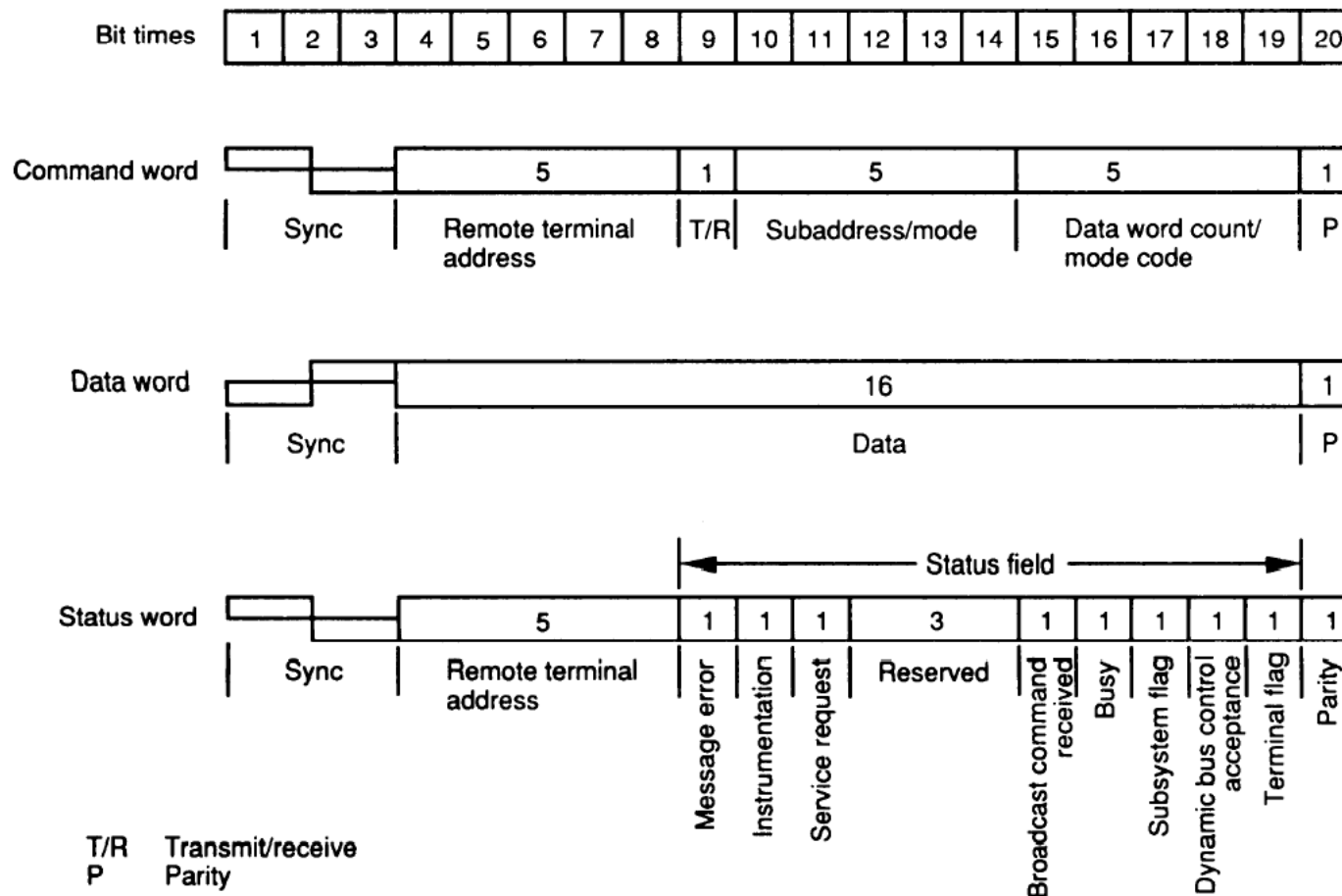
- Serial digital data, 1 Mbps (1us per bit)
- Self-clocking data (sync at the start of each word)
- Bi-phase (Manchester II) encoding
- Half-duplex
- Terminal Types – Bus Controller (BC), Remote Terminal (RT), Bus Monitor (BM)
- Word types – Command, Data, Status
 - BC sends Command and Data words
 - RT sends Status and Data words
 - BM does not transmit anything
- 20 bit-times per word (20us)
- Minimum of **4us** gap between messages
- RT must respond with status in **4us to 12us**
- BC allows **14us** for status response timeout



NRZ: non-return to zero

This is an example of a 1553 Command Word





- Three terminal types:
 - Bus Controller (BC)
 - Only ONE BC on the bus.
 - Only the BC can send command words.
 - Initiates ALL messages with a command word, may also send data words.
 - Remote Terminal (RT)
 - Up to 31 RTs on the bus (addresses 0-30)
 - Only an RT can send status words.
 - RTs only transmit in response to a command word – they send status words, may also send data words.
 - Bus Monitor (BM)
 - Only listens, does not transmit.

- BC to RT – Receive message
- RT to BC – Transmit message
- RT to RT – Receive to one RT, Transmit to other RT
- Mode Code without Data
- Mode Code with Receive Data
- Mode Code with Transmit Data

- Broadcast BC to RT
- Broadcast RT to RT
- Broadcast Mode Code without Data
- Broadcast Mode Code with Receive Data

An RT Address of 31 indicates BROADCAST

MIL-STD-1553B Assigned Mode Codes

T/R Bit	Mode Code	Function	Assoc. Data Word	Broadcast Command Allowed
1	00000 (0)	Dynamic Bus Control	No	No
1	00001 (1)	Synchronize (without Data)	No	Yes
1	00010 (2)	Transmit Status Word	No	No
1	00011 (3)	Initiate Self-Test	No	Yes
1	00100 (4)	Transmitter Shutdown	No	Yes
1	00101 (5)	Override Transmitter Shutdown	No	Yes
1	00110 (6)	Inhibit Terminal Flag Bit	No	Yes
1	00111 (7)	Override Inhibit Terminal Flag Bit	No	Yes
1	01000 (8)	Reset Remote Terminal	No	Yes
1	01001 (9)	Reserved	No	TBD
.
1	01111 (15)	Reserved	No	TBD
1	10000 (16)	Transmit Vector Word	Yes	No
0	10001 (17)	Synchronize (with Data)	Yes	Yes
1	10010 (18)	Transmit Last Command	Yes	No
1	10011 (19)	Transmit BIT Word	Yes	No
0	10100 (20)	Selected Transmitter Shutdown	Yes	Yes
0	10101 (21)	Override Selected Transmitter Shutdown	Yes	Yes
0 or 1	10110 (22)	Reserved	Yes	TBD
.
0 or 1	11111 (31)	Reserved	Yes	TBD

Required Mode Codes



MESSAGE #2 -----

(89)17:22:30.074.576.560 IM Gap: 15154.6us

BUS A - CMD:1820 (3-R-1-32) BCRT

9EF3 1D47 FB99 A306 5A18 CAC8 BFEE 607D

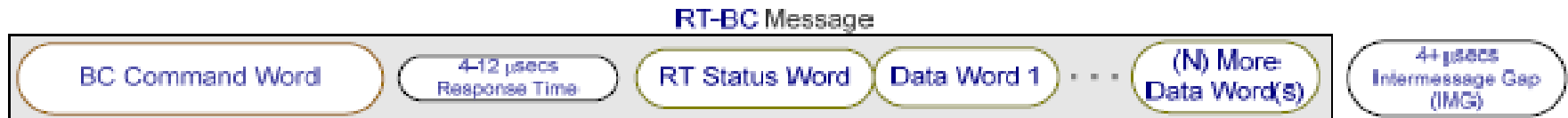
FB0C ED27 27C5 04A9 22CE 6B31 A22A C0AF

9C44 15FA 086B D872 0E5F 187E 08BC CFB1

92EB 038A 7152 1D6D 388F 6EF6 4325 C051

Rsp Time 7.7us STS:1800

Message Time = 685.7us



MESSAGE #3 -----

(89)17:22:30.090.935.360 IM Gap: 15674.5us

BUS B - CMD:1440 (2-T-2-32) RTBC

Rsp Time 10.3us STS:1000

49EB A931 E18C 9E5E E357 994E 92AE D1FC

75CB 6CCC 84A8 78D1 ECA7 2D91 6EF8 C0A9

A487 578D AC90 04A4 4B67 8674 148B 2BE8

101A 568D 5975 A281 27EE 8C15 AA01 6773

Message Time = 688.3us



MESSAGE #4 -----

```
(89)17:22:30.105.771.740    IM Gap: 14428.3us
BUS B - CMD:0870:1470 (1-R-3-16,2-T-3-16) RIRT
Rsp Time 5.7us STS:1000
2145 F8F9 DF23 FDE6 32A2 6F1D 45C4 3C63
A2B3 9BEF 4B08 1A1A 16E3 43C1 AE74 77E5
Rsp Time 10.3us STS:0800
Message Time = 412us
```


Mode Code (No Data) Message

Mode Code Without Data Word Message



MESSAGE #7 -----

(89)17:22:30.152.325.720 IM Gap: 15816.6us

BUS A - CMD:0C01 (1-T-0-1) MODE CODE

Synchronize Without Data

Rsp Time 5.7us STS:0800

Message Time = 43.7us

Mode Code (Receive Data) Message

Mode Code With Receive Data Word Message



MESSAGE #161 -----

(89)18:49:36.231.538.660 IM Gap: 98428.2us

BUS A - CMD:2811 (5-R-0-17) MODE CODE

Synchronize With Data

25A9

Rsp Time 8.6us STS:2800

Message Time = 66.6us

Mode Code (Transmit Data) Message

Mode Code With Transmit Data Word Message



MESSAGE #162 -----

(89)18:49:36.231.613.740 IM Gap: 10.6us

BUS A - CMD:1C10 (3-T-0-16) MODE CODE

Transmit Vector Word

Rsp Time 8.5us STS:1800

0000

Message Time = 66.5us

Broadcast BC to RT Message



MESSAGE #163 -----

(89)18:49:36.231.688.660 IM Gap: 10.6us

BUS A - CMD:F920 (31-R-9-32) BRDCST BCRT

F61A D948 A114 9625 294B 86CD BD20 7E4F

FAA4 856A 3A88 4F92 5A16 2070 4CEC 98A2

F809 78F0 13AA A101 5647 C9E8 42E6 C39C

C57E 836B 4654 679B 8FCB 0396 1953 488B

Message Time = 660us

Broadcast RT to RT Message

Broadcast RT-RT Message



MESSAGE #164 -----

(89)18:49:36.232.357.260 IM Gap: 10.7us

BUS A - CMD:FA20:2F00 (31-R-17-32,5-T-24-32) BRDCST RTRT

Rsp Time 8.8us STS:2800

25A9 0000 0000 0000 0000 0000 0000 0000

0000 0000 0000 0000 0000 0000 0000 0000

0000 0000 0000 0000 0000 0000 0000 0000

0000 0000 0000 0000 0000 0000 0000 0000

Message Time = 706.8us

Broadcast Mode (No Data) Message

Broadcast Mode Code Without Data Word Message

BC Command Word

4+ μ secs
Intermessage Gap
(IMG)

MESSAGE #702 -----

(89)19:32:30.751.531.260 IM Gap: 11.6us

BUS A - CMD:FC03 (31-T-0-3) BRDCST MODE CODE
Initiate Self Test

Message Time = 20us

Broadcast Mode (Rcv Data) Message

Broadcast Mode Code With Receive Data Word Message

BC Command Word

Data Word 1

4+ μ s
Intermessage Gap
(IMG)

MESSAGE #165 -----

(89)18:49:36.233.072.540 IM Gap: 10.6us

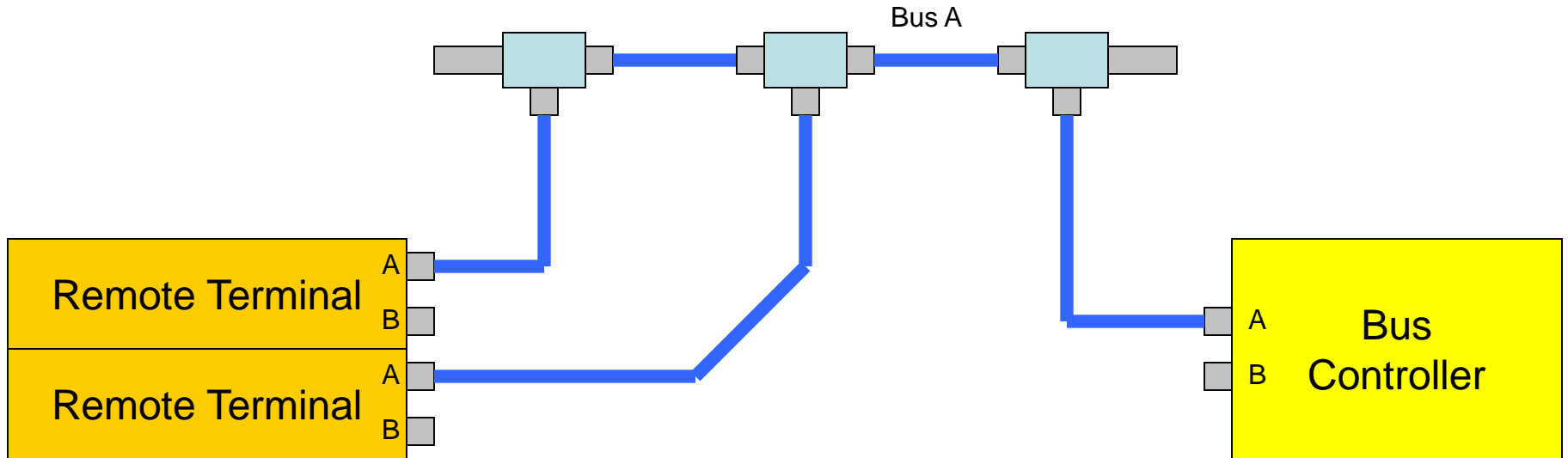
BUS A - CMD:F811 (31-R-0-17) BRDCST MODE CODE
Synchronize With Data

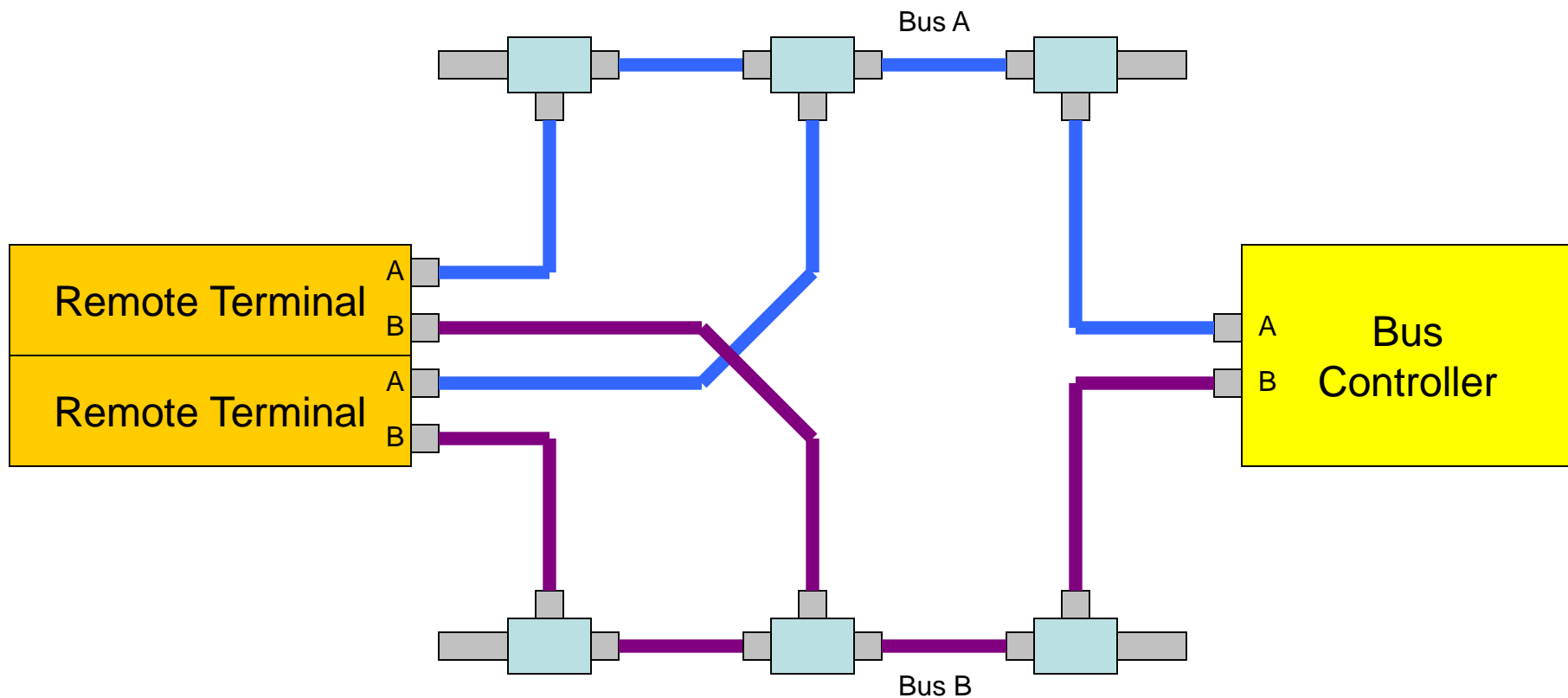
0000

Message Time = 40us

- 1553 can use a single bus or a dual-redundant bus.
- Dual-redundant bus:
 - Bus A (primary) and Bus B (secondary)
 - Bus Controller can send messages on either bus.
 - Remote Terminals respond on the bus where they saw the command word.
 - CANNOT have traffic on both busses at the same time.

Single Bus – No Redundancy





- 1553 is a 1Mbps serial data bus
 - Single or dual-redundant bus configurations
 - Transformer coupled (direct coupling should not be used)
- Three terminal types – BC, RT, BM
 - Bus Controller initiates everything
 - Only one BC on a bus
 - Only the BC can send command words
 - A message can have up to 32 data words
 - The BC should allow **14us** for the RT to respond with status
 - The BC must allow at least a **4us** gap between messages
 - Remote Terminals respond to commands from the BC
 - Only RTs can send status words, RT must respond with status in **4us to 12us**.
 - Up to 31 RTs on a bus (RT address 0-30)
 - RT address 31 is BROADCAST
 - Each RT can have 30 subaddresses (1-30)
 - Subaddresses 0 and 31 indicate MODE CODE
 - Bus Monitor only listens, never transmits

- **Bus Controller Implementations**
 - Message scheduling – Minor frames, major frames, aperiodic messages
 - Message retries and error recovery
 - Conditional Branching
 - Enabled and disabled (NOP) messages
- **Remote Terminal Implementations**
 - Mode Code handling – BIT word, vector word, etc.
 - Usage of Status Word bits – Busy, Service Request, etc.
 - MIL-STD-1760 power-up response and checksums
- **Bus Monitor Implementations**
 - Data processing, error checking, archiving
 - Backup Bus Controller

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