Physical Layer Comparison: MIL-STD-1553 vs RS-485

Characteristic	MIL-STD-1553	RS-485	Advantage/Benefit
Type of Signaling	Differential	Differential	**Even.** Both MIL-STD-1553 and RS-485 use differential signaling.
Signal Encoding Method	Manchester Bi-Phase	Not specified.	**N/A**
Transmit Voltage	Direct Coupled: 6.0 to 9.0 V_{PK-PK} Transformer Coupled: 18.0 to 27.0 V_{PK-PK}	Differential voltage = 1.5 to 5.0 volts = 3.0 to 10.0 V_{PK-PK}	**MIL-STD-1553.** For both direct and transformer-coupled configurations, MIL-STD-1553 provides a higher minimum bus voltage: 6.0 V_{PK-PK} direct-coupled, or 6.36 V_{PK-PK} transformer-coupled.
Rise/Fall Times (10% to 90%)	100 to 300 nS	≤0.3●UI	**MIL-STD-1553.** For MIL-STD-1553, a stream of all Manchester "1"s or "0"s results in rise/fall times in the range of 0.2●UI to 0.6●UI. For alternating "1"s and "0"s, the corresponding rise/fall times are 0.1●UI to 0.3●UI. MIL-STD-1553's upper limit is equivalent to that for RS-485. MIL-STD-1553's lower limit of 100 nS serves to minimize EMI and over/undershoots.
Transmitter Zero-Crossing Deviation	≤ ±25 nS	Not specified	**MIL-STD-1553.** MIL-STD-1553 specifies an upper bound on transmit jitter, thereby providing increased margin for distortion introduced by bus cabling and stubs.
Non-Transmitting Output Noise	Direct Coupled: ≤ 5 mV RMS line-to-line Transformer Coupled: ≤ 14 mV RMS line-to-line	Defines a maximum offset voltage in the range of -1.0 to +3.0 volts.	**MIL-STD-1553.** MIL-STD-1553's more stringent requirement for non-transmitting output voltage guarantees a lower maximum level of interference from inactive (non-transmitting) nodes.
Output Symmetry – Residual Voltage	Direct Coupled: ≤ 90 mV peak, line-to-line Voltage 2.5 µS after last mid-bit crossing Transformer Coupled: ≤ 250 mV peak, line-to-line Voltage 2.5 µS after last mid-bit crossing	Maximum common mode voltage is -3.0 to +1.0 volts. Maximum difference between positive and negative peak voltages must be ≤ 0.2 volts.	**MIL-STD-1553.** MIL-STD-1553's requirement for a maximum residual (or "tailoff") voltage 2.5 µS following the end of a transmission ensures non-interference with the subsequent transmission on the bus. In addition, RS-485's allowance for a DC offset voltage complicates the use of transformer isolation.
Node isolation.	Isolation transformers are required for all MIL-STD-1553 terminals.	Isolation is not required.	**MIL-STD-1553.** MIL-STD-1553's requirement for transformer isolation ensures a high degree of ground isolation, and lightning and common mode rejection.
Bus-to-Bus Isolation	≥ 45 dB	None	**MIL-STD-1553.** MIL-STD-1553 limits crosstalk between redundant buses.
Fault Isolation	Direct Coupled: 55 ohm Series Resistors in Each Terminal Leg	None	**MIL-STD-1553.** The requirement for isolation resistors prevents a short-circuited terminal or stub from taking the entire bus out of operation.

Characteristic	MIL-STD-1553	RS-485	Advantage/Benefit
	Transformer Coupled: 0.75●Z_0 Series Resistors in Each Stub Leg		
Bus Coupling Transformer	Turns Ratio: 1.4 to 1.0 (step-down, bus to stub)	N/A	**MIL-STD-1553.** The option for transformer coupling provides increased stub impedance, matched transmitter impedance, improved ground isolation, and provides a higher degree of lightning immunity.
	Open Circuit Impedance: ≥ 3,000 ohms, over 75 KHz to 1 MHz		
	Droop: ≤ 20%		
	Ringing: ≤ 1V peak		
	Common Mode Rejection: ≥ 45 dB		
Signal Level Delivered By Bus to Stub	Direct Coupled: 1.4 to 20 V_{PK-PK}, line-to-line	Not specified	**MIL-STD-1553.** MIL-STD-1553A specified a maximum cable distance of 300 feet. While MIL-STD-1553B dropped this requirement, it requires a minimum (and maximum) voltage to be presented to each terminal and/or stub on the bus. This forces implementers to design terminals, buses and stubs in such a way to ensure reliable network operation.
	Transformer Coupled: 1.0 to 14 V_{PK-PK}, line-to-line		
Receiver Signal Range	Direct Coupled: 1.2 to 20 V_{PK-PK}, line-to-line	-0.2V (peak) ≤ threshold voltage ≤ +0.2V (peak). This implies a receiver "threshold" of 0.0 to 0.4 volts peak-to-peak.	**MIL-STD-1553.** MIL-STD-1553 allows higher receiver thresholds than RS-485, thereby providing a lower bit error rate. Further, MIL-STD-1553 receivers must provide a "dead zone" of 0.28 V V_{PK-PK} = ±0.14 V_{PK} (direct coupled), or 0.2 V V_{PK-PK} = ±0.1 V_{PK} (transformer coupled), thereby providing improved noise immunity. In addition, this improves the capability for a 1553 receiver to be able to determine the end of a received signal transmission. For TTP, this enables shorter gap times between transmissions by individual nodes. RS-485's minimum receiver threshold of 0V can result in receiver output jitter when there is no received signal.
	Transformer Coupled: 0.86 to 14 V_{PK-PK}, line-to-line		
Receiver "No Response" Range	Direct Coupled: 0 to 0.28 V_{PK-PK}, line-to-line		
	Transformer Coupled: 0 to 0.2 V_{PK-PK}, line-to-line		
Receiver Zero-Crossing Distortion Tolerance	≥ ±150 nS	Not specified.	**MIL-STD-1553.** This 1553 requirement provides tolerance for phase shifts introduced by transmitters, bus cabling and stubs.
Receiver Common Mode Rejection	± 10 V_{PEAK}, line-to-ground, DC to 2 MHz	Receivers must operate over a common mode voltage range of -7V to +12V	**MIL-STD-1553.** MIL-STD-1553's common mode range is slightly higher, ±10V_{PK} = 20 V_{PK-PK} vs. RS-485's of +12/-7 V_{PK} = 19 V_{PK-PK}. In practice, MIL-STD-1553's requirement for transformer isolation

Characteristic	MIL-STD-1553	RS-485	Advantage/Benefit
	For transformer-coupled stubs, coupling transformers must have a common mode rejection ratio greater than 45.0 dB at 1.0 MHz.		provides a greater common mode rage than ±10V_{PK}. In addition, MIL-STD-1553's option for transformer coupling with a common mode rejection ratio of 45 dB for coupling transformers provides a further improvement in overall common mode rejection.
Noise Rejection (Word Error Rate)	Direct Coupled: ▪ 3.0 V_{PK-PK} Signal Level ▪ 200 mV RMS White Gaussian Noise, 1.0 to 4.0 MHz ▪ Word Error Rate < 10^{-7} Transformer Coupled: ▪ 2.1 V_{PK-PK} Signal Level ▪ 140 mV RMS White Gaussian Noise, 1.0 to 4.0 MHz ▪ Word Error Rate < 10^{-7}	No specified	**MIL-STD-1553.** MIL-STD-1553's noise rejection (bit error rate) test ensures the implementation of receiver filtering, thereby providing reliable operation in the presence of differential noise.
Terminal Input Impedance	Direct Coupled: ≥ 2,000 ohms, over 75 KHz to 1 MHz Transformer Coupled: ≥ 1,000 ohms, over 75 KHz to 1 MHz	Defines the concept of "unit load", in which a receiver's, transmitter's, or transceiver's DC resistance is approximately 8.7 KΩ to 12 KΩ. A receiver's, transmitter's, or transceiver's overall input impedance, including reactive (i.e., capacitive) components, is not specified. In addition, the input resistance can be either less than, equal to, or greater than one "unit load".	**MIL-STD-1553.** MIL-STD-1553's minimum values for terminal impedance provide a limitation of the bus voltage loading by individual terminals, and minimize distortion resulting from transmission line reflections.