

**Table 5.1 Key Data Transmission Terms**

<b>Term</b>	<b>Units</b>	<b>Definition</b>
Data element	Bits	A single binary one or zero
Data rate	Bits per second (bps)	The rate at which data elements are transmitted
Signal element	Digital: a voltage pulse of constant amplitude  Analog: a pulse of constant frequency, phase, and amplitude	That part of a signal that occupies the shortest interval of a signaling code
Signaling rate or modulation rate	Signal elements per second (baud)	The rate at which signal elements are transmitted

**Table 5.2 Definition of Digital Signal Encoding Formats**

**Nonreturn to Zero-Level (NRZ-L)**

- 0 = high level
- 1 = low level

**Nonreturn to Zero Inverted (NRZI)**

- 0 = no transition at beginning of interval (one bit time)
- 1 = transition at beginning of interval

**Bipolar-AMI**

- 0 = no line signal
- 1 = positive or negative level, alternating for successive ones

**Pseudoternary**

- 0 = positive or negative level, alternating for successive zeros
- 1 = no line signal

**Manchester**

- 0 = transition from high to low in middle of interval
- 1 = transition from low to high in middle of interval

**Differential Manchester**

- Always a transition in middle of interval
- 0 = transition at beginning of interval
- 1 = no transition at beginning of interval

**B8ZS**

- Same as bipolar AMI, except that any string of eight zeros is replaced by a string with two code violations

**HDB3**

- Same as bipolar AMI, except that any string of four zeros is replaced by a string with one code violation

**Table 5.3 Normalized Signal Transition Rate of Various Digital Signal Encoding Schemes**

	<b>Minimum</b>	<b>101010. . .</b>	<b>Maximum</b>
NRZ-L	0 (all 0s or 1s)	1.0	1.0
NRZI	0 (all 0s)	0.5	1.0 (all 1s)
Bipolar-AMI	0 (all 0s)	1.0	1.0
Pseudoternary	0 (all 1s)	1.0	1.0
Manchester	1.0 (1010 . . .)	1.0	2.0 (all 0s or 1s)
Differential Manchester	1.0 (all 1s)	1.5	2.0 (all 0s)

**Table 5.4 HDB3 Substitution Rules**

Polarity of Preceding Pulse	Number of Bipolar Pulses (ones) since Last Substitution	
	Odd	Even
–	000–	+00+
+	000+	–00–

**Table 5.5 Data Rate to Transmission Bandwidth Ratio for Various Digital-to-Analog Encoding Schemes**

	$r = 0$	$r = 0.5$	$r = 1$
<b>ASK</b>	1.0	0.67	0.5
<b>FSK</b>			
Wideband ( $\Delta F \gg R$ )	$\sim 0$	$\sim 0$	$\sim 0$
Narrowband ( $\Delta F \approx f_c$ )	1.0	0.67	0.5
<b>PSK</b>	1.0	0.67	0.5
<b>Multilevel signaling</b>			
$M = 4, b = 2$	2.00	1.33	1.00
$M = 8, b = 3$	3.00	2.00	1.50
$M = 16, b = 4$	4.00	2.67	2.00
$M = 32, b = 5$	5.00	3.33	2.50