

Yellow highlighted text indicates refinement is needed

Turquoise highlighted text indicates where the text was original pulled from

**The section pulled from clause 72.7**

130.7 5GBASE-KR electrical characteristics

130.7.1 Transmitter characteristics

Transmitter characteristics at TP1 are summarized in Table 130–6 and detailed in 130.7.1.1 through 130.7.1.11.

**Table 130-6-Transmitter characteristics for 5GBASE-KR**

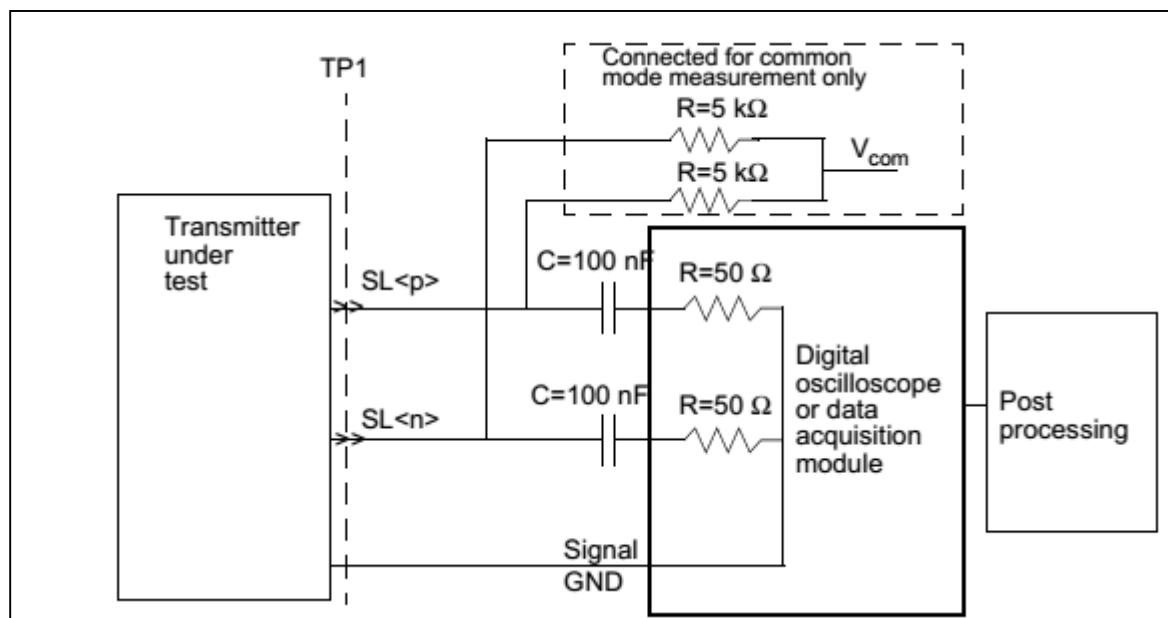
Parameter	Sub clause reference	Value	Unit
Signaling speed	130.7.1.3	5.15625±100 ppm	GBd
Differential peak to peak output voltage(max)	130.7.1.4	1200	mV
Differential peak to peak output voltage(max) with TX disabled	130.6.5	30	mV
Common mode Voltage Limits	130.7.1.4	0 to 1.9	V
Common mode voltage deviation(max) during LPI	130.7.1.4	150	mV
Differential output return loss (min)	130.7.1.5	See the equation 130-4	dB
Common-mode output return loss (min.)	130.7.1.6	See the equation 130-5	dB
Transition time (20%-80%)	130.7.1.7	20 to 60	ps
Max output jitter (peak-to-peak)	130.7.1.9		
Random Jitter		0.15	UI
Deterministic Jitter		0.12	UI
Duty Cycle Distortion		0.035	UI
Total jitter		0.30	UI

Jitter is specified at BER 10<sup>-12</sup>

Duty Cycle Distortion is considered part of deterministic jitter distribution

### 130.7.1.1 Test fixture

The test fixture of Figure 130–7 or its functional equivalent, is required for measuring the transmitter Specifications described in 130.7.1, with the exception of return loss.



**Figure 130-7-Transmitter test fixture for 5GBASE-KR**

### 130.7.1.2 Test fixture impedance

The differential load impedance applied to the transmitter output by the test fixture depicted in Figure 130–7 shall be 100 Ω. The differential return loss, in dB with  $f$  in MHz, of the test fixture shall meet the requirements of Equation (130–2) and Equation (130–3).

$$\begin{aligned} \text{RL}(f) &\geq \text{RL min} = 20 \\ \text{For } 100\text{MHz} \leq f < 2.579\text{GHz} \end{aligned} \quad (130-2)$$

$$\begin{aligned} \text{RL}(f) &\geq \text{RL min} = 20 - 26.55 \log_{10}(f/2.579\text{GHz}) \\ \text{For } 2.579\text{GHz} \leq f < 5\text{GHz} \end{aligned} \quad (130-3)$$

### 130.7.1.3 Signaling speed

The 5GBASE-KR signaling speed shall be 5.15625 GBd  $\pm$  100ppm

### 130.7.1.4 Output amplitude

The differential output voltage is constrained via the transmitter output waveform requirements specified in 130.7.1.10. For a 1010 pattern, the peak-to-peak differential output voltage shall be less than 1200 mV, regardless of equalization setting. The transmitter output voltage shall be less than 30mV peak-to-peak, when disabled. The differential output voltage test pattern shall consist of no fewer than eight symbols of alternating polarity.

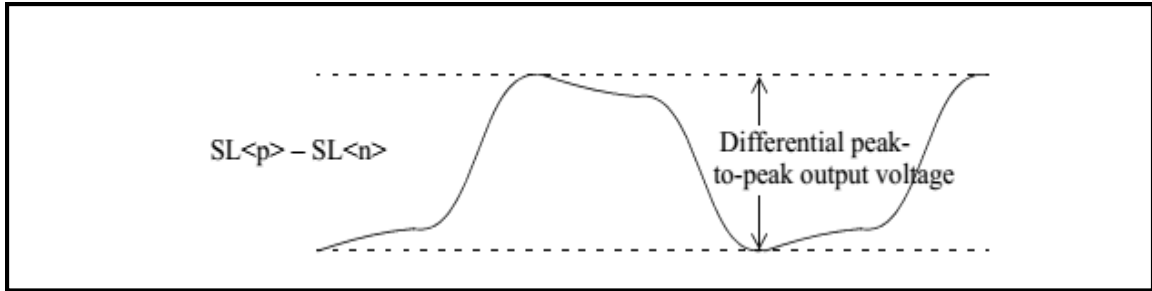


FIGURE-130-8-Transmitter peak-to-peak output voltage definition

NOTE 1—See Figure 130–8 for an illustration of the definition of differential peak-to-peak output voltage. DC-referenced voltage levels are not defined since the receiver is AC-coupled. The common-mode voltage of SL<p> and SL<n> shall be between 0 and 1.9V with respect to signal ground as measured at Vcom in Figure 130–7.

For EEE capability, the transmitter’s differential peak-to-peak output voltage shall be less than 30 mV within 500 ns of tx\_mode being set to QUIET and remain so while tx\_mode is set to QUIET. Furthermore, the transmitter’s differential peak-to-peak output voltage shall be greater than 720 mV within 500 ns of tx\_mode being set to ALERT. The transmitter output shall be fully compliant within 5s after tx\_mode is set to DATA. During LPI mode, the common-mode shall be maintained to within  $\pm 150$  mV of the pre-LPI value.

#### 130.7.1.5 Differential output return loss

For frequencies from 100 MHz to 3750 MHz, the differential return loss, in dB with  $f$  in MHz, of the transmitter shall meet the requirements of Equation (130–4) and Equation (130–5). This output impedance requirement applies to all valid output levels. The reference impedance for differential return loss measurements shall be 100  $\Omega$ .

$$\begin{aligned} &RL(f) \geq RL_{min} = 10 \\ &\text{For } 100 \text{ MHz} \leq f < 1.289\text{GHz} \end{aligned} \quad (130-4)$$

$$\begin{aligned} &RL(f) \geq RL_{min} = 10 - 13.275 \log_{10}(f/1.289\text{GHz}) \\ &\text{For } 1.29\text{GHz} \leq f \leq 3.75\text{GHz} \end{aligned} \quad (130-5)$$

The minimum differential output return loss is shown in Figure 130–9.

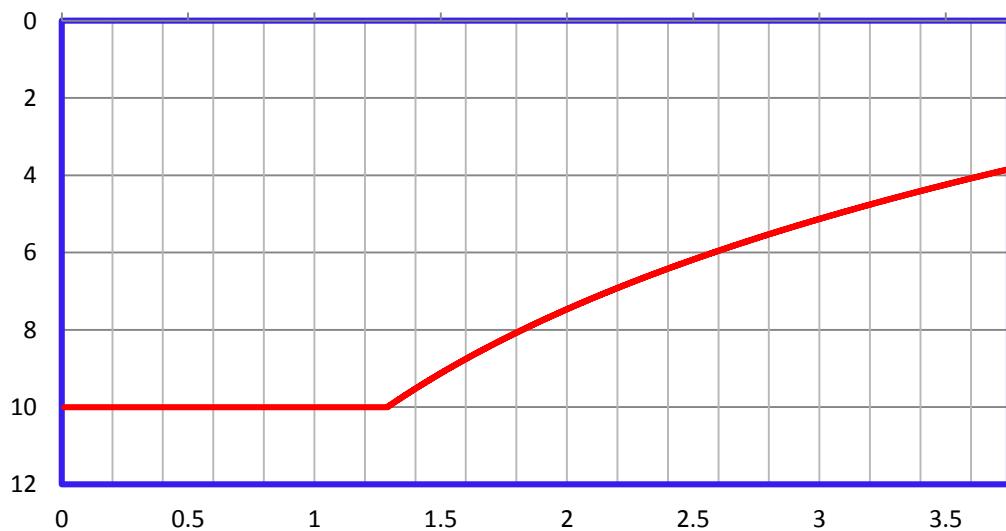


Figure 130-9: Transmit output differential mode return loss

#### 130.7.1.6 Common-mode output return loss

The transmitter common-mode return loss shall meet the requirements of Equation (130–6) and Equation (130–7). The reference impedance for common-mode return loss measurements is 25Ω.

$$\begin{aligned} \text{RL}(f) &\geq \text{RL min} = 7 \\ \text{For } 100 \text{ MHz} \leq f < 1.25 \text{ GHz} \end{aligned} \quad (130-6)$$

$$\begin{aligned} \text{RL}(f) &\geq \text{RL min} = 7 - 13.275 \log_{10}(f/1.25 \text{ GHz}) \\ \text{For } 1.25 \text{ GHz} \leq f \leq 3.75 \text{ GHz} \end{aligned} \quad (130-7)$$

The minimum common-mode output return loss is shown in Figure 130–10.

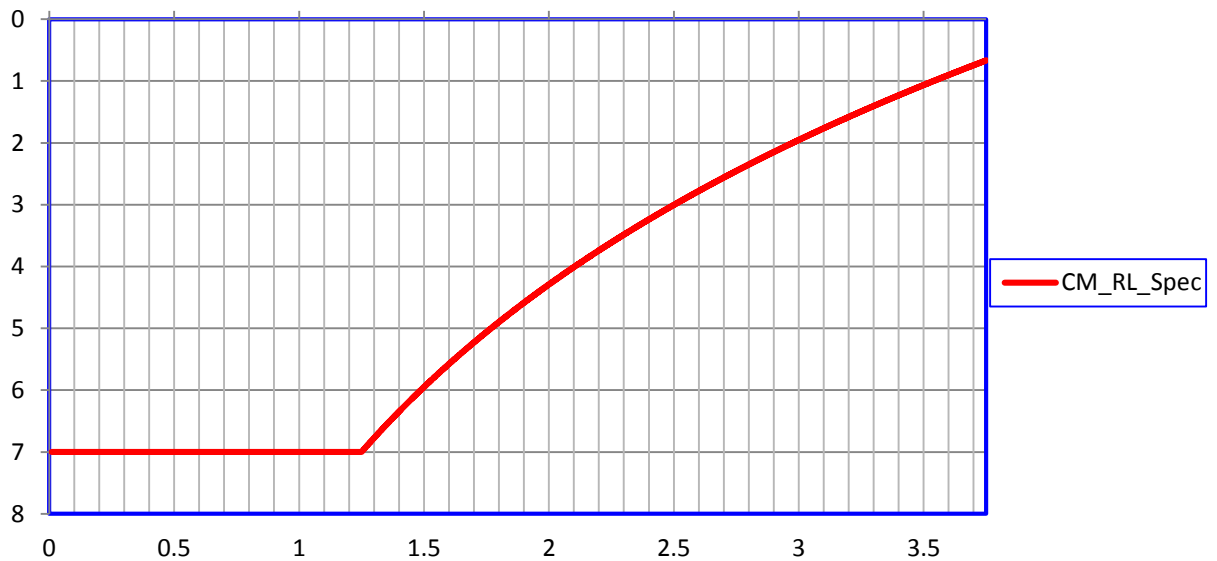


Figure 130-10-Transmit Common mode output return loss

#### 130.7.1.7 Transition time

The rising and falling edge transition times shall be between 20 ps and 60 ps as measured at the 20% and 80% levels referenced to  $v_2$  and  $v_5$  as defined in 130.7.1.11. Measurement is done using the square wave test pattern defined in 52.9.1.2, with no equalization and a run of at least eight consecutive ones. Transmit equalization may be disabled completely during this testing.

#### 130.7.1.8 Transmit jitter test requirements

Transmit jitter is defined with respect to a test procedure resulting in a BER bathtub curve such as that described in Annex 48B.3. For the purpose of jitter measurement, the effect of a single-pole high-pass filter with a 3 dB point at 4 MHz is applied to the jitter. The data pattern for jitter measurements shall be test patterns 2 or 3 as defined in 52.9.1.1. Crossing times are defined with respect to the mid-point (0V) of the AC-coupled differential signal. Equalization shall be off during jitter testing.

The duty cycle distortion test pattern shall consist of no fewer than eight symbols of alternating polarity.

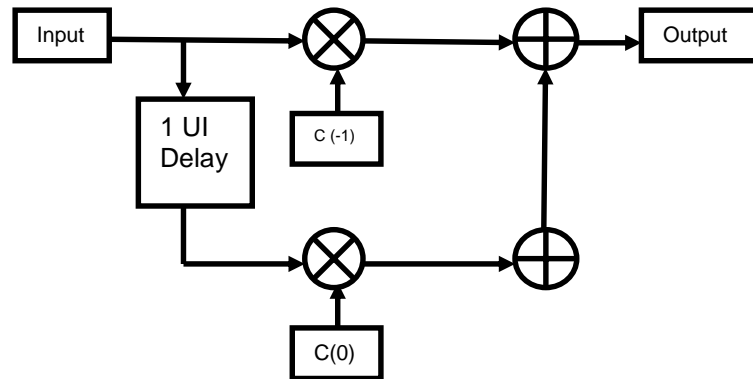
#### 130.7.1.9 Transmit jitter

The transmitter shall have a maximum total jitter of 0.30 UI peak-to-peak, composed of a maximum deterministic

Component of 0.12 UI peak-to-peaks and a maximum random component of 0.15 UI peak-to-peak. Duty cycle distortion (DCD) is considered a component of deterministic jitter and shall not exceed 0.035 UI peak-to-peak. The peak-to-peak duty cycle distortion is defined as the absolute value of the difference in the mean pulse width of a 1 pulse or the mean pulse width of a 0 pulse (as measured at the mean of the high- and low-voltage levels in a clock-like repeating 0101 bit sequence) and the nominal pulse width. Jitter specifications are specified for BER  $10^{-12}$ . Transmit jitter test requirements are specified in 130.7.1.8.

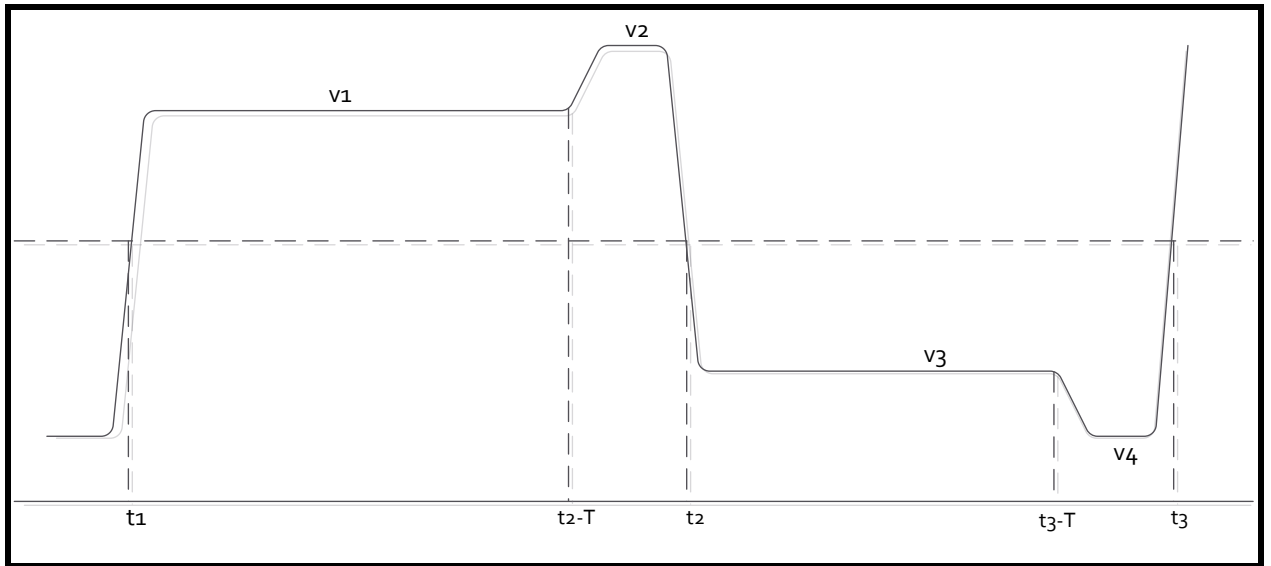
#### **130.7.1.10 Transmitter output waveform**

The 5GBASE-KR transmitter includes pre-emphasis to compensate for frequency-dependent loss in the backplane channel and facilitate data recovery at the receiver. This equalization may be accomplished with a two-tap finite impulse response (FIR) structure as shown in Figure 130–11



#### 130.7.1.11 Transmitter output waveform requirements

The test pattern for the transmitter output waveform is the square wave test pattern defined in 52.9.1.2, with a run of at least eight consecutive ones. The transmitter output waveform test is based on the voltages  $v_1$  through  $v_4$ , which shall be measured as shown in Figure 130–12 and described below.



$T$  = Symbol period

$t_1$  = zero crossing of the first rising edge of AC coupled signal

$t_2$  = Zero crossing of the falling edge of the AC coupled signal

$t_3$  = Zero crossing of the second rising edge of the AC coupled signal

$v_1$  = positive steady state voltage measured as the average voltage in the interval  $t_1$  to  $t_2 - T$

$v_2$  = maximum voltage measured in the interval of  $t_2 - T$  to  $t_2$

$V_3$  = negative steady state voltage measured as the average voltage in the interval of  $t_2$  to  $t_3 - T$

From these voltages, the pre equalization ratio  $R_{pre}$  is derived from the equation (130-8)

$$R_{pre} = v_2/v_1 \quad (130-8)$$

### 130.7.2 Receiver characteristics

Receiver characteristics at TP4 are summarized in Table 130–9 and detailed in 130.7.2.1 through 130.7.2.5.

**Table 130–9-Receiver characteristic of 5GBase-KR**

Parameter	Subclause reference	Value	Unit
Bit error ratio	130.7.2.1	$10^{-12}$	
Signaling speed	130.7.2.2	$5.15625 \pm 100$ ppm	GBd
Receiver coupling	130.7.2.3	AC	
Differential input peak to peak amplitude(maximum)	130.7.2.4	1200 <sup>a</sup>	mV
Differential output return loss (min)b	130.7.2.5	See the equation 130-4	dB

a:The receiver shall tolerate amplitudes up to 1600mV without permanent damage

b:Relative to 100 ohm differential

#### **130.7.2.1 Receiver interference tolerance**

The receiver interference tolerance shall consist of two separate tests as described in Annex 130B with the Parameters specified in Table 130–10. The data pattern for the interference tolerance test shall be the test Patterns 2 or 3 as defined in 52.9.1.1. The receiver shall satisfy the requirements for interference tolerance specified in Annex 130B for both tests

**Table 130–10- 5GBase-KR Interference Tolerance Parameter**

Parameter	Test 1 Values	Test 2 Values	Units
Target BER	$10^{-12}$	$10^{-12}$	
Mtc (min)	1.0	0.5	
Amplitude of broadband noise (min. RMS)	10.2	16	mV
Applied Transition time	60	60	ps
Applied Sinusoidal jitter (min peak to peak)	0.12	0.12	UI
Applied Random Jitter( min. peak to peak)	0.12	0.12	UI
Applied Duty Cycle Distortion (min. peak-to-peak)	0.035	0.035	UI

Mtc is defined in equation (130A-6) of Annex 130B

Applied random jitter is specified at a BER of  $10^{-12}$

#### **130.7.2.2 Signaling speed range**

A 5GBASE-KR receiver shall comply with the requirements of Table 130–9 for any signaling speed in the range  $5.15625 \text{GBd} \pm 100$  ppm.

#### **130.7.2.3 AC-coupling**

The 5GBASE-KR receiver shall be AC-coupled to the backplane to allow for maximum interoperability between various 5 Gb/s components. AC-coupling is considered to be part of the receiver for the purposes of this specification unless explicitly stated otherwise. It should be noted that there may be various methods for AC-coupling in actual implementations.

NOTE—It is recommended that the maximum value of the coupling capacitors be limited to 100 nF. This will limit the inrush currents to the receiver that could damage the receiver circuits when repeatedly connected to transmit modules with a higher voltage level.

#### ***130.7.2.4 Input signal amplitude***

5GBASE-KR receivers shall accept differential input signal peak-to-peak amplitudes produced by compliant transmitters connected without attenuation to the receiver, and still meet the BER requirement specified in 130.7.2.1. Note that this may be larger than the 1200 mV differential maximum of 130.7.1.4 due to the actual transmitter output and receiver input impedances. The input impedance of a receiver can cause the minimum signal into a receiver to differ from that measured when the receiver is replaced with a 100 ohm test load. Since the channel is AC-coupled, the absolute voltage levels with respect to the receiver ground are dependent on the receiver implementation.

#### ***130.7.2.5 Differential input return loss***

For frequencies from 100 MHz to 3750 MHz, the differential return loss, in dB with  $f$  in MHz, of the receiver shall be greater than or equal to Equation (130–4) and Equation (130–5). This return loss requirement applies at all valid input levels. The reference impedance for differential return loss measurements is 100  $\Omega$ .



