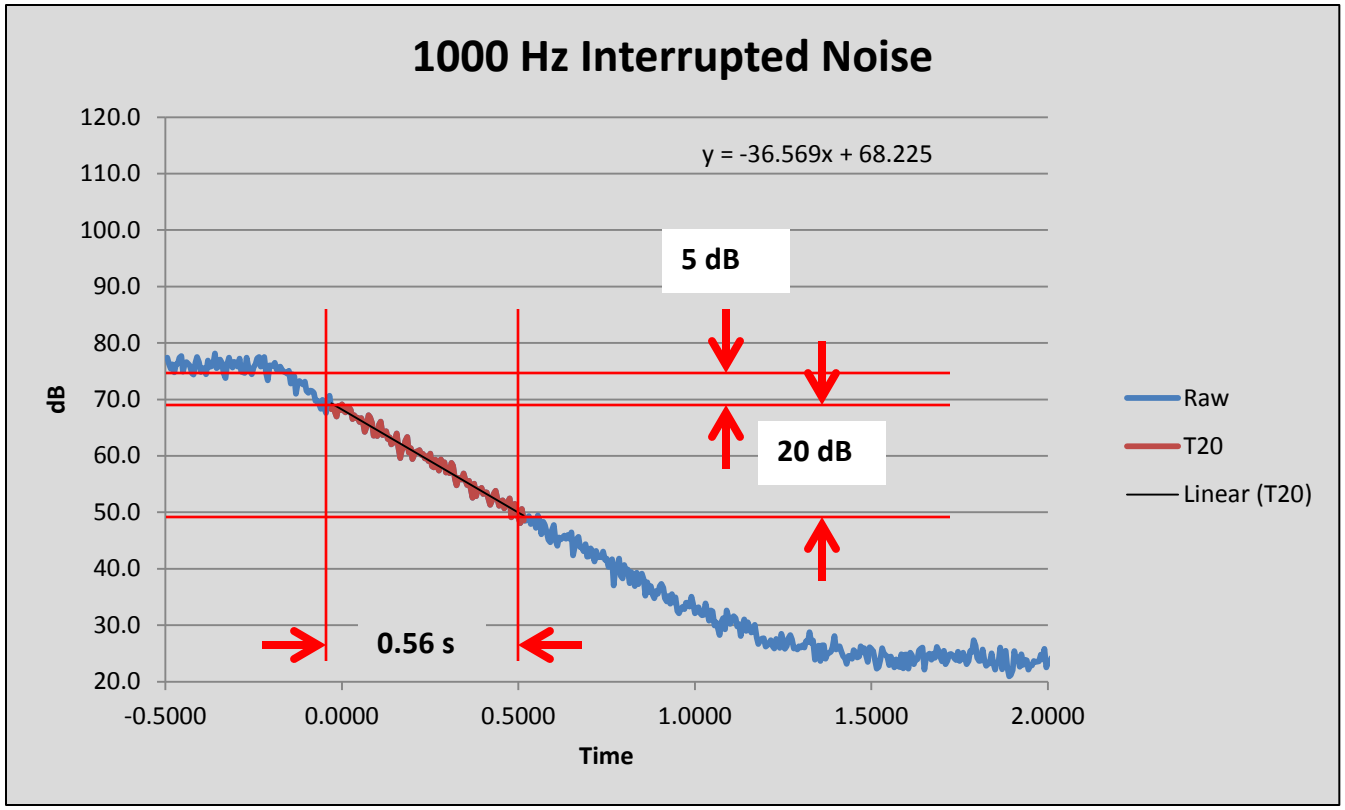
Model 831
Reverb time metrics
(831-RT)

Ken Cox

Reverb Time – T20

- RT60 = time for sound to decay 60 dB
- T20 = RT60 time based upon the first 20 dB of decay
  - Start @ -5 dB
  - Linear interpolate from -5 dB to – 25 dB and compute slope
  - T60 = 60/slope (3 X the time to decay 20 dB)



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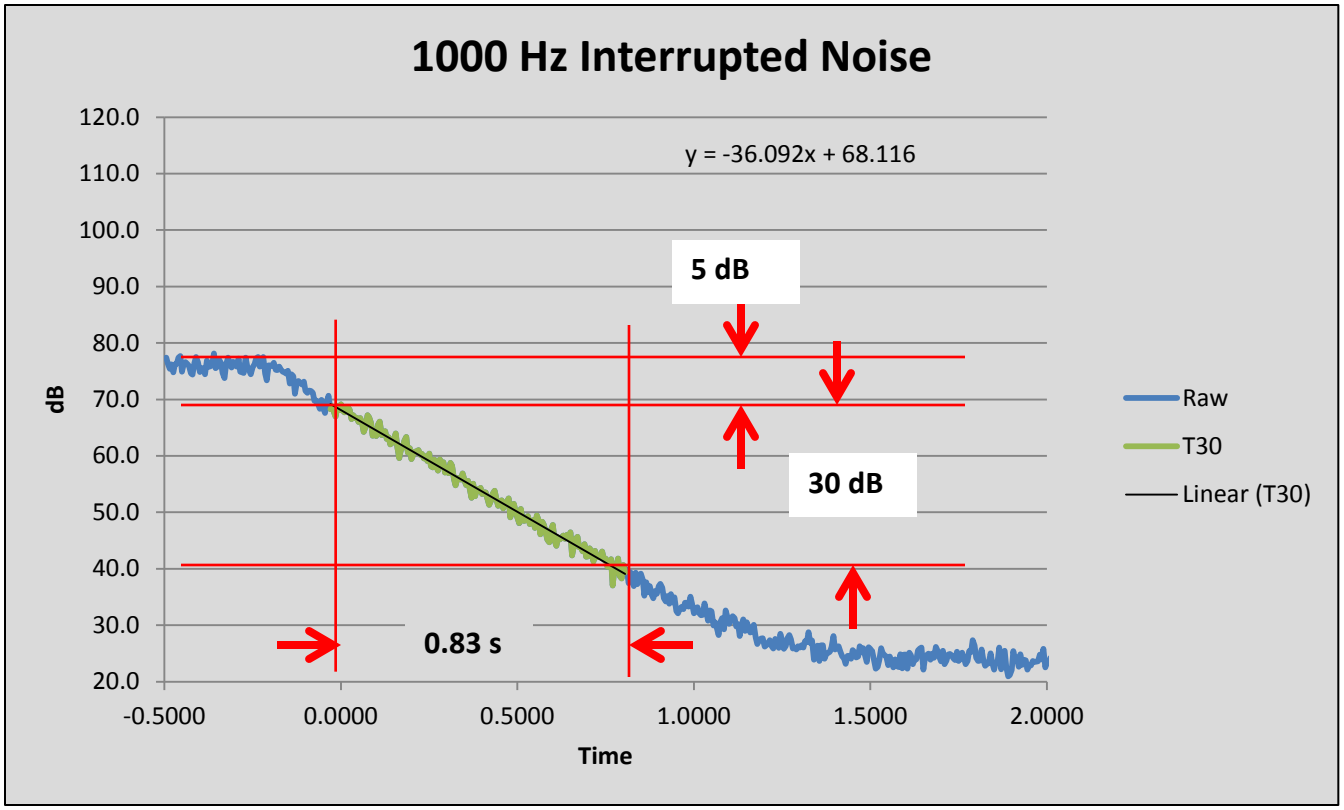
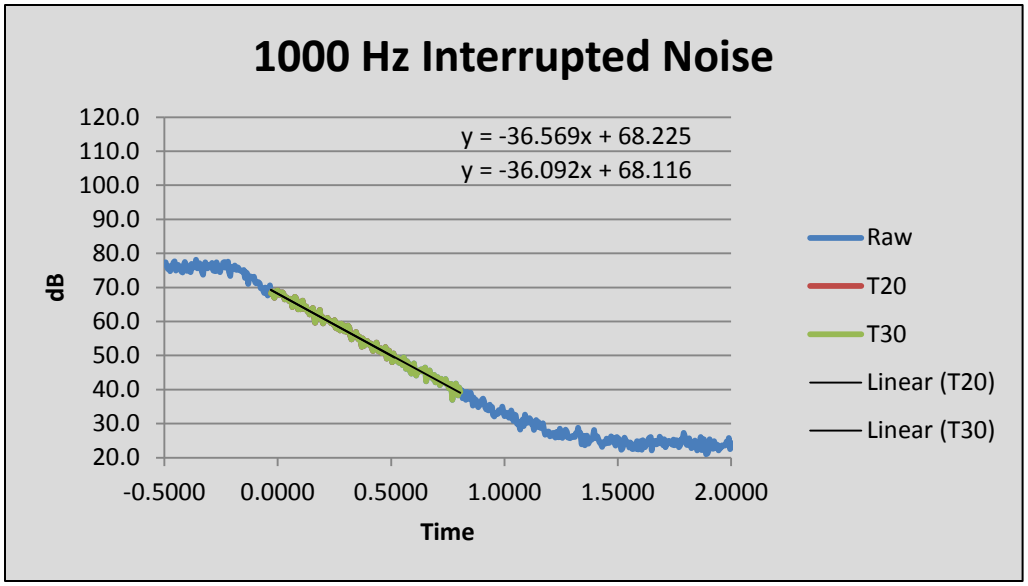
Reverb Time – T30

- RT60 = time for sound to decay 60 dB
- T30 = RT60 time based upon the first 30 dB of decay
  - Start @ -5 dB
  - Linear interpolate from -5 dB to – 35 dB and compute slope
  - T60 = 60/slope (2 X the time to decay 30 dB)



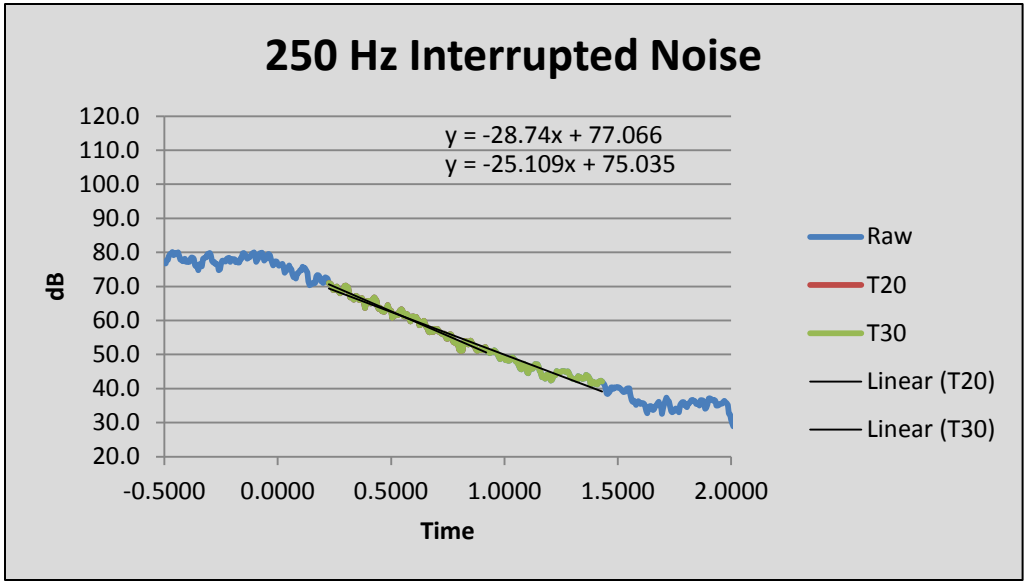
Reverb Time – T20 & T30 Comparison



Good Match

T20 = 1.641 s

T30 = 1.662 s



Not as Good Match

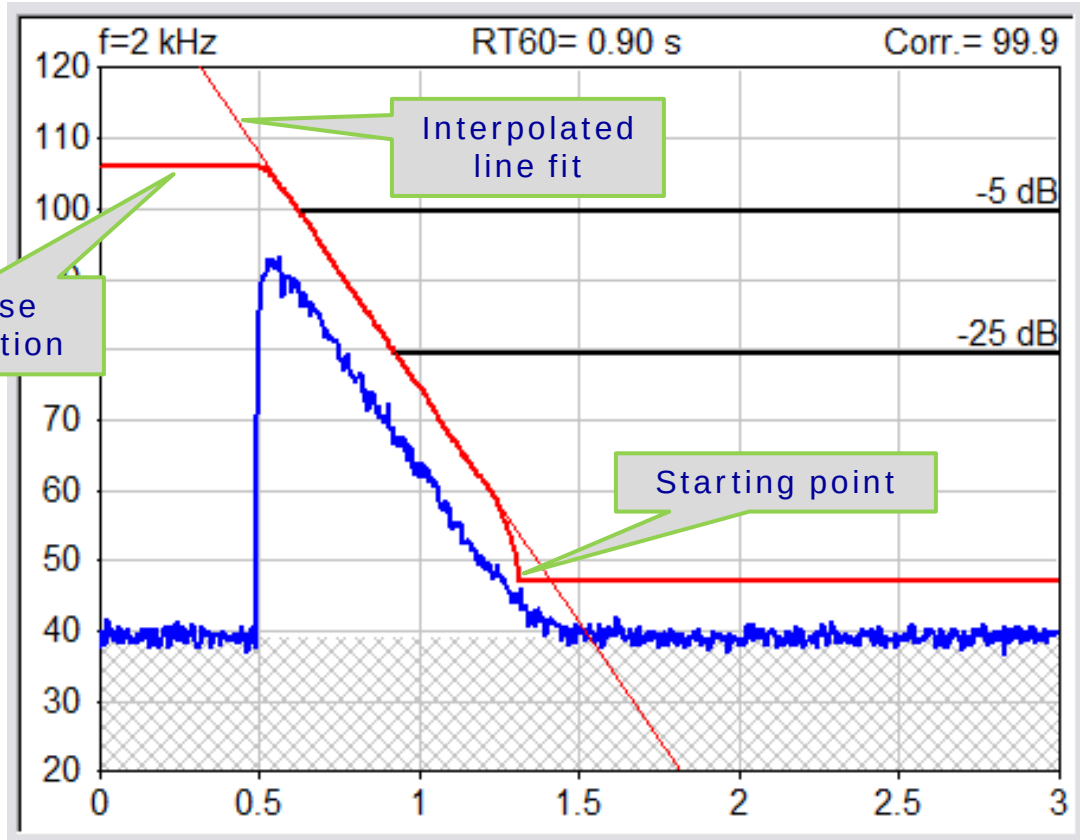
T20 = 2.088 s

T30 = 2.390 s

Reverb Time – Reverse Integration (Schroeder)

Reverse Integration (Schroeder integration) is applied to impulsive measurements

- Start near the end of the decay and integrate backwards in time
  - “smooths” the decay and provides clean max level

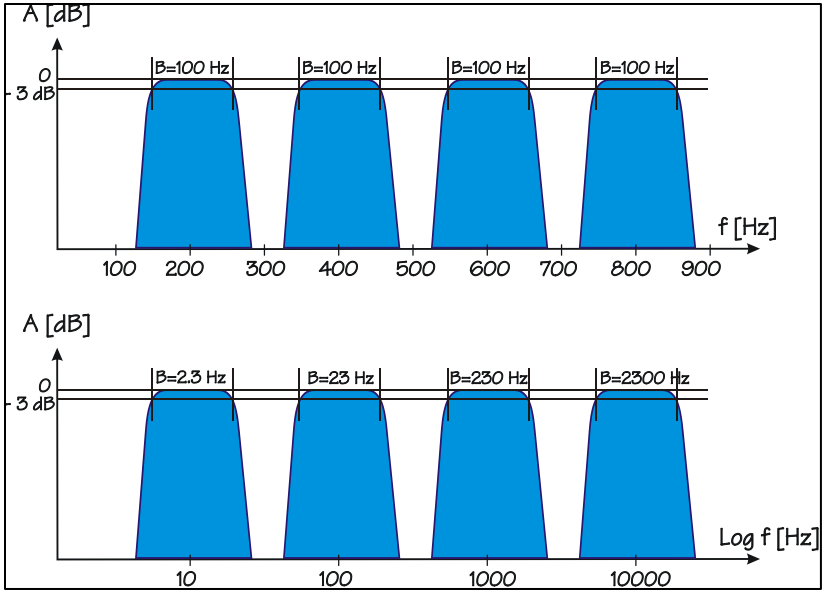


Reverb Time – BT (Bandwidth Time)

BT = (Filter Bandwidth) * (RT60 time)

- Verify measured decay is acoustic, not instrumentation

BT > 16 & T > TR



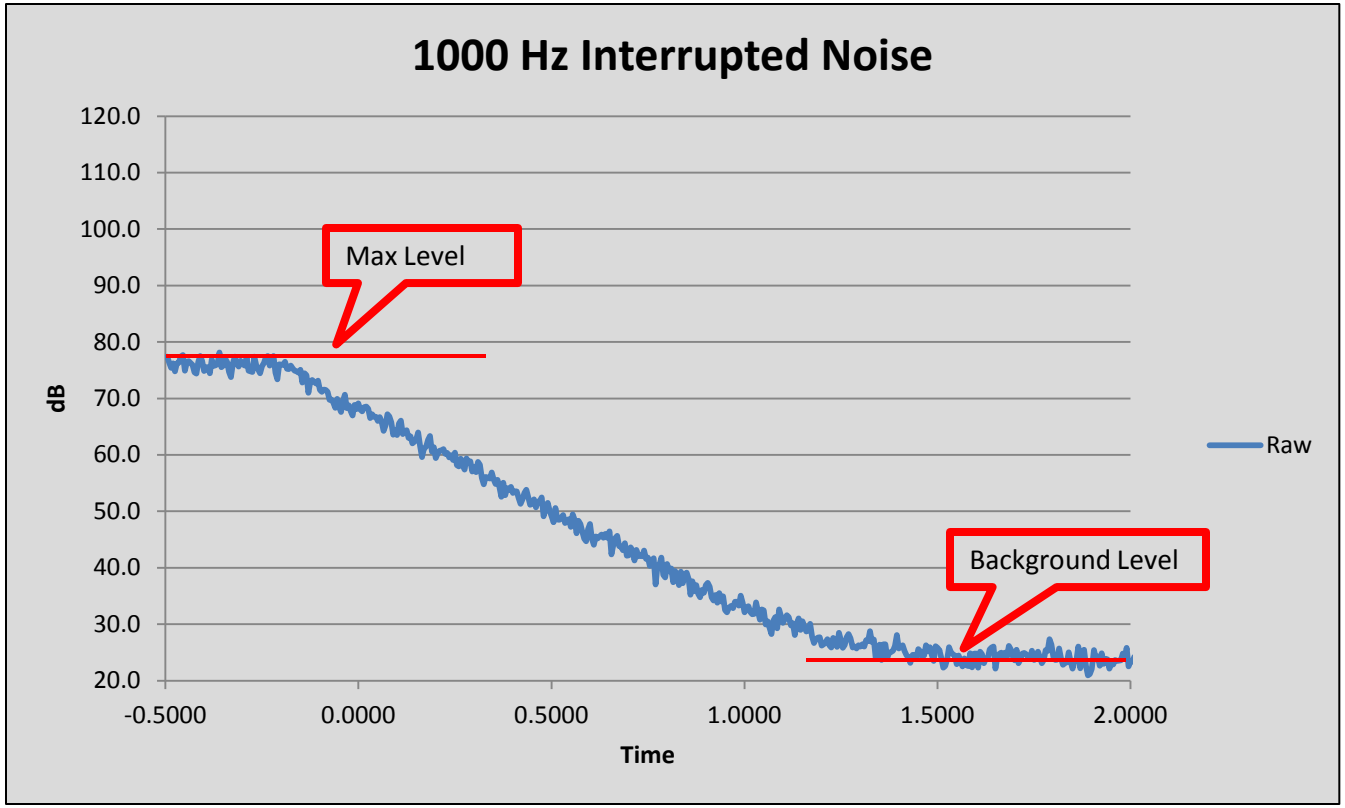
ISO 3382-2(2008) 7.3

Frequency	1/3 Octave		1/1 Octave	
	TR (ms)	BT	TR (ms)	BT
50.0 Hz	378	4.37		
63.0 Hz	301	4.38	160	7.12
80.0 Hz	216	3.96		
100 Hz	181	4.18		
125 Hz	153	4.43	86	7.63
160 Hz	119	4.34		
200 Hz	94	4.32		
250 Hz	75	4.36	40	7.10
315 Hz	55	4.04		
400 Hz	43	3.93		
500 Hz	37	4.26	16	5.62
630 Hz	29	4.18		
800 Hz	24	4.44		
1000 Hz	13	3.11	8	5.56
1250 Hz	17	4.97		
1600 Hz	16	5.85		
2000 Hz	12	5.38	6	8.87
2500 Hz	11	6.30		
3150 Hz	11	6.30		
4000 Hz	10	9.45	5	13.63
5000 Hz	8	9.42		
6300 Hz	5	7.27		
800 Hz	10	18.69	5	28.50
10000 Hz	7	17.05		

Table A-22 Model 831 Manual

Reverb Time – BK (Background or SNR)

- Background noise level impact on decay calculation
  - T20 good when (Max Level) – (Background Level) ≥ 35 dB
  - T30 good when (Max Level) – (Background Level) ≥ 45 dB



ISO 3382-2(2008) 5.2.1

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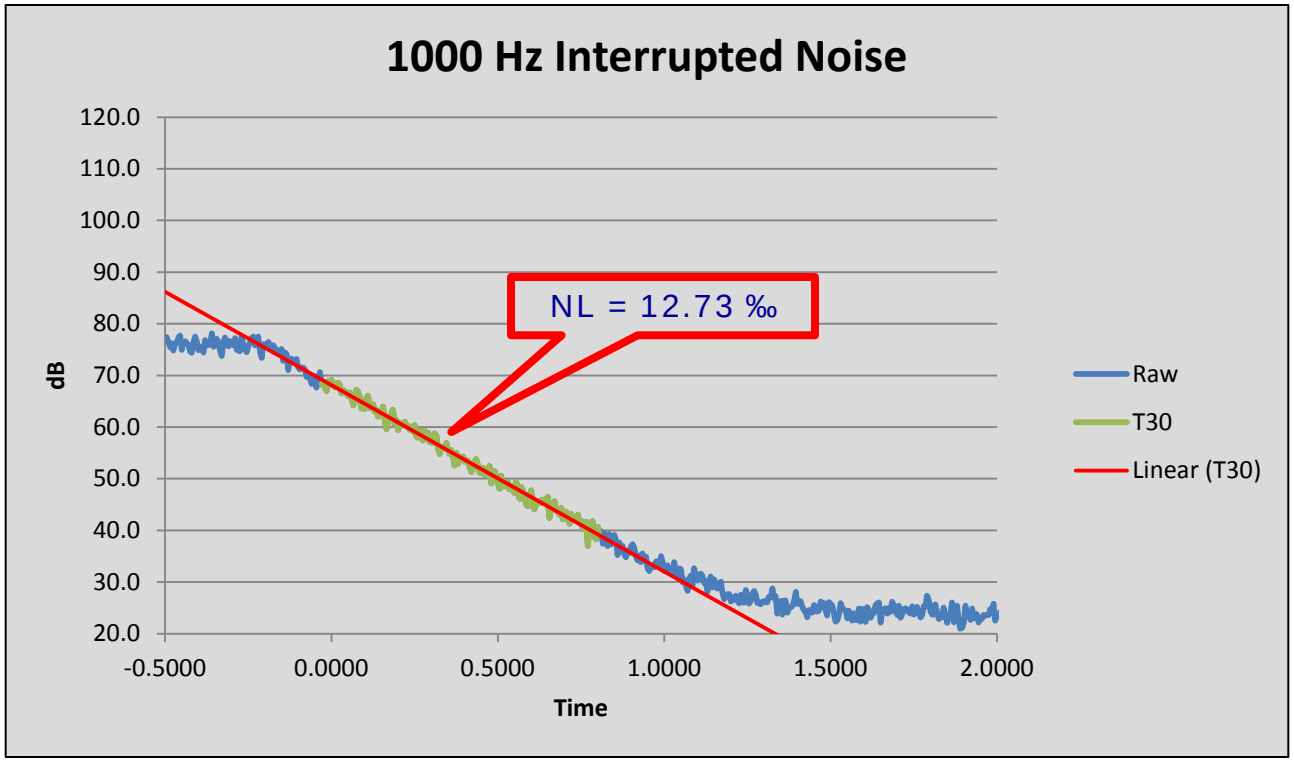
Reverb Time = NL (Non-Linearity)

- Measures how well the decay follows a straight line
  - Curved decays indicate mixed modes
- NL = 1000*(1-r^2) where r^2 is the correlation coefficient squared
  - Straight line = 0‰
  - Good = 0‰ to 5‰



ISO 3382-2(2008) 6 & Annex B

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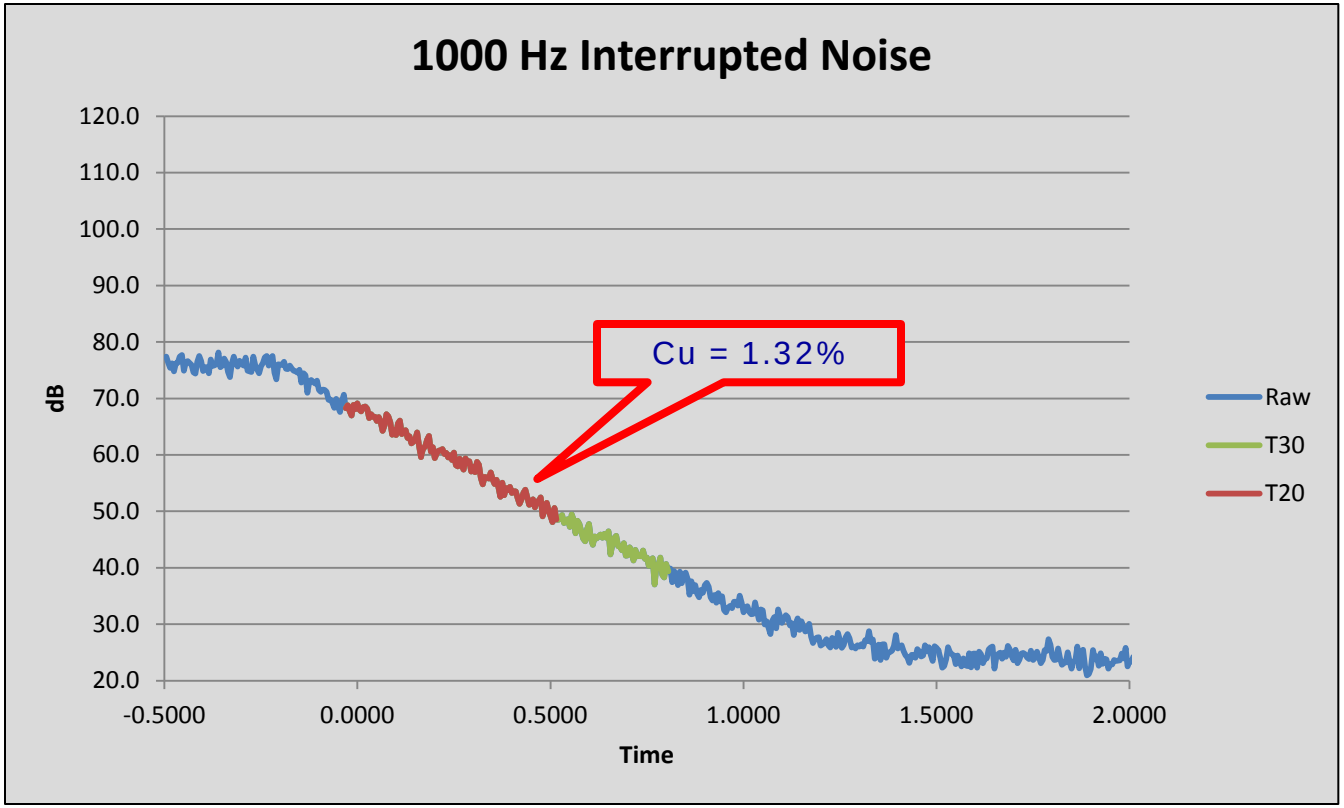
Reverb Time – Cu (Curvature)

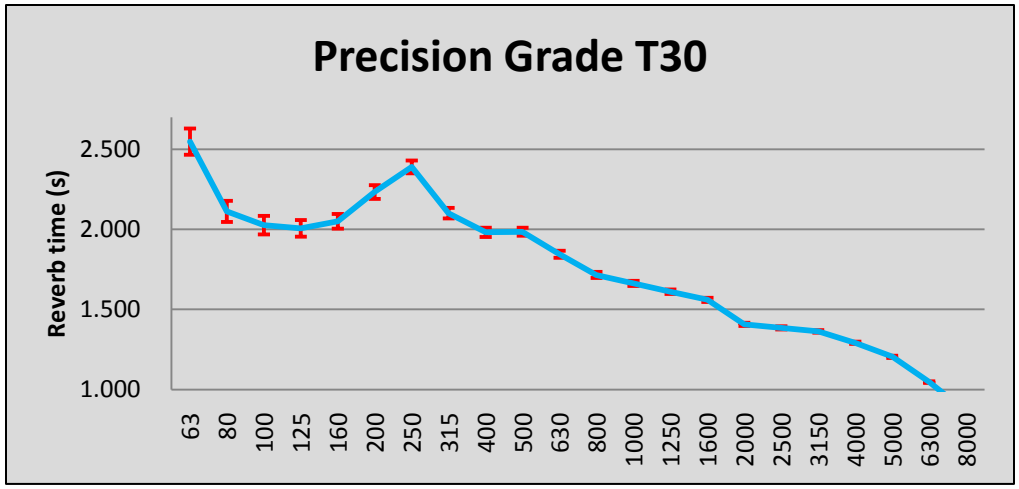
- Compared T30 to T20 decay times
  - Evaluate if decay times change as level decreases
- Cu = 100 * (T30/T20 – 1)
  - Good = 0% to 5%



ISO 3382-2(2008) 6 & Annex B

Reverb Time = SD (Standard Deviation)

- Estimate of uncertainty due to number of averages
  - For T20, $SD = 0.88 * T_{20}\sqrt{\frac{1+1.90/n}{N*B*T_{20}}}$ in seconds
  - For T30, $SD = 0.55 * T_{30}\sqrt{\frac{1+1.52/n}{N*B*T_{30}}}$ in seconds
    - B = filter bandwidth in Hz
    - n = number of decays at each position
    - N = number of independent measurement positions
  - Model 831 report coefficient of variation = SD/RT as a percentage



Example

Precision grade T30 measurement

- 12 positions (N)
- 3 measurement / position (n)

ISO 3382-2(2008) 7.1

Reverb Time – Spatial Averaging

Due to varying geometries and different acoustic absorption rates of materials, decay times can vary depending upon source and microphone location.

Table 1 — Minimum numbers of positions and measurements

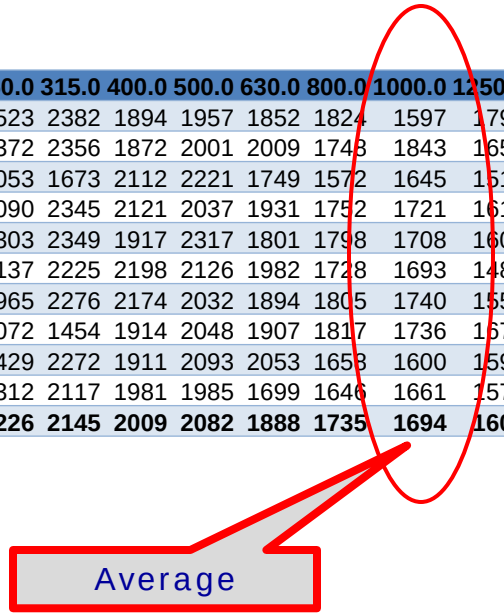
	Survey	Engineering[a]	Precision
Source-microphone combinations	2	6	12
Source-positions[b]	⩾ 1	⩾ 2	⩾ 2
Microphone-positions[c]	⩾ 2	⩾ 2	⩾ 3
No. decays in each position (interrupted noise method)	1	2	3

ISO 3382-2(2008) 4.3.1

Reverb Time – Arithmetic Averaging

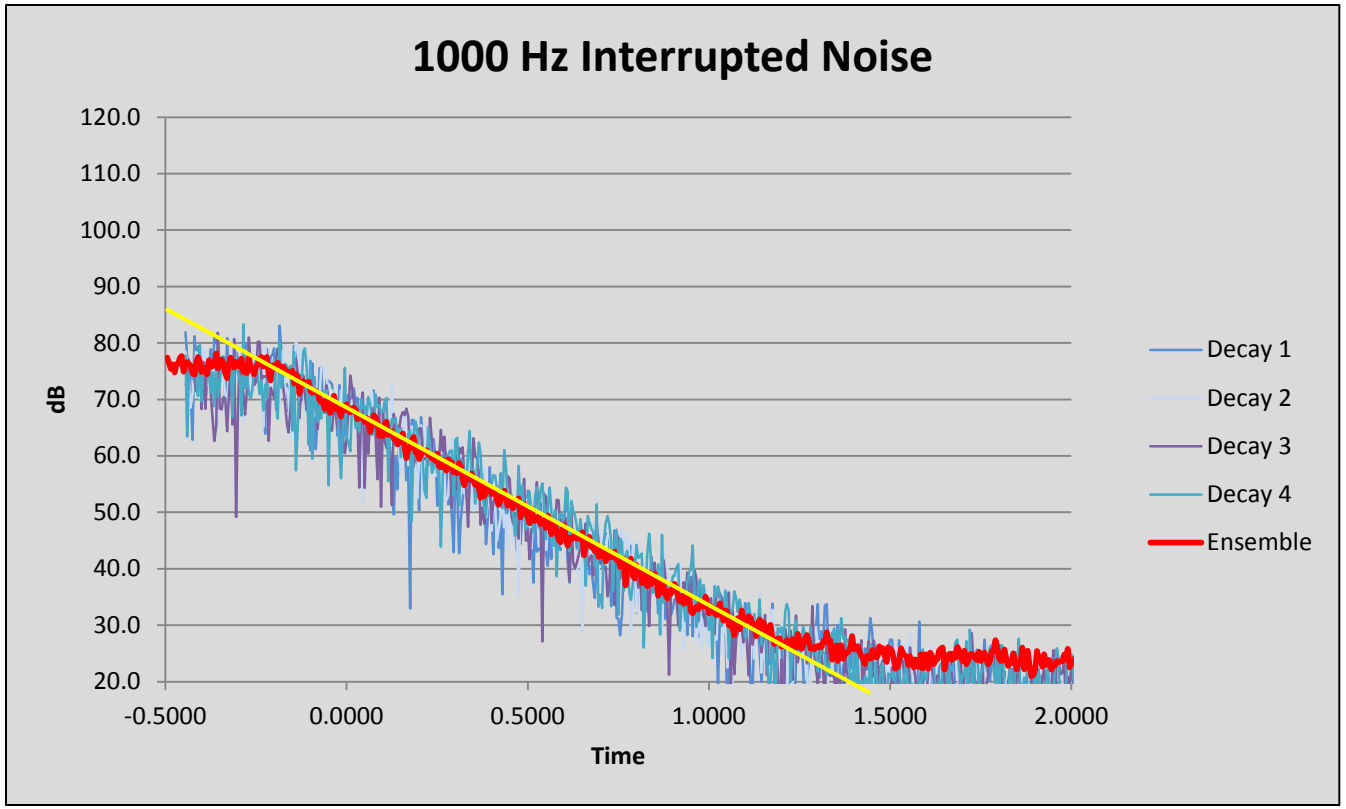
RT60 for room = arithmetic average of individual decay times

Frequency	63.0	80.0	100.0	125.0	160.0	200.0	250.0	315.0	400.0	500.0	630.0	800.0	1000.0	1250.0	1600.0	2000.0	2500.0	3150.0	4000.0	5000.0	6300.0	8000.0
Decay 1	412	2043	1512	2244	1877	2365	2523	2382	1894	1957	1852	1824	1597	1799	1571	1453	1314	1332	1291	1249	1033	860
Decay 2	2953	1881	2642	8027	2487	1946	2372	2356	1872	2001	2009	1748	1843	1654	1480	1448	1373	1365	1302	1191	1020	896
Decay 3	3475	1669	2771	3259	2342	2770	2053	1673	2112	2221	1749	1572	1645	1519	1661	1360	1376	1355	1262	1235	1056	842
Decay 4	4045	2524	2195	2155	2089	2457	2090	2345	2121	2037	1931	1752	1721	1612	1563	1471	1342	1452	1292	1157	1050	878
Decay 5	2037	2192	1796	2083	2184	3164	2303	2349	1917	2317	1801	1798	1708	1600	1613	1394	1334	1394	1273	1197	1047	849
Decay 6	1597	1920	1992	1936	1747	2718	2137	2225	2198	2126	1982	1728	1693	1483	1483	1343	1394	1319	1294	1214	1011	848
Decay 7	1951	2619	1497	2193	2163	2402	1965	2276	2174	2032	1894	1805	1740	1557	1547	1315	1348	1317	1337	1214	1017	858
Decay 8	2360	2025	2258	1870	1953	2407	2072	1454	1914	2048	1907	1817	1736	1675	1505	1405	1341	1302	1298	1221	1047	846
Decay 9	19347	2245	2108	2411	2367	2026	2429	2272	1911	2093	2053	1653	1600	1592	1566	1385	1344	1311	1299	1189	1057	857
Decay 10	10	2330	2136	1876	1869	2175	2312	2117	1981	1985	1699	1646	1661	1574	1638	1358	1367	1359	1251	1178	1076	855
Average	**3819**	**2145**	**2091**	**2806**	**2108**	**2443**	**2226**	**2145**	**2009**	**2082**	**1888**	**1735**	**1694**	**1607**	**1563**	**1393**	**1353**	**1350**	**1290**	**1204**	**1041**	**859**



Reverb Time – Ensemble Averaging

Individual decay beginnings are synchronized and the discrete sound pressure samples at each time interval are energy averaged



ISO 3382-2(2008) 5.2.2 (Preferred method)

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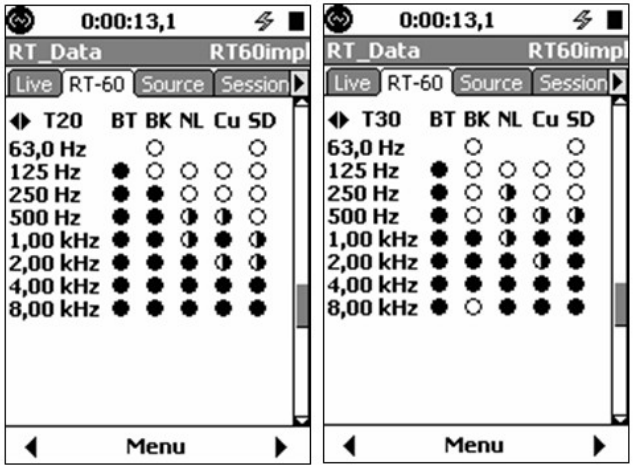
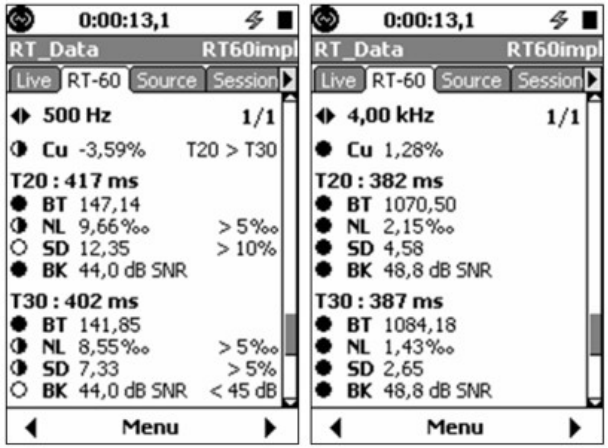
Model 831 – Quality Indicators

Quality Indicator	Good = ●	Fair	Poor = ○
BT	BT > 16	n/a	BT ≤ 16
BK	T_{20} ≥ 35 dB T_{30} ≥ 45 dB	n/a	T_{20} < 35 dB T_{30} < 45 dB
NL	NL ≤ 5‰	5‰ < NL ≤ 10‰	NL > 10‰
Cu	0% ≤ Cu ≤ 5%	5% < Cu ≤ 10% -5% < Cu < 0%	Cu > 10% Cu ≤ -5%
SD	SD ≤ 5%	5-% < SD ≤ 10%	SD > 10%





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Thank You

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