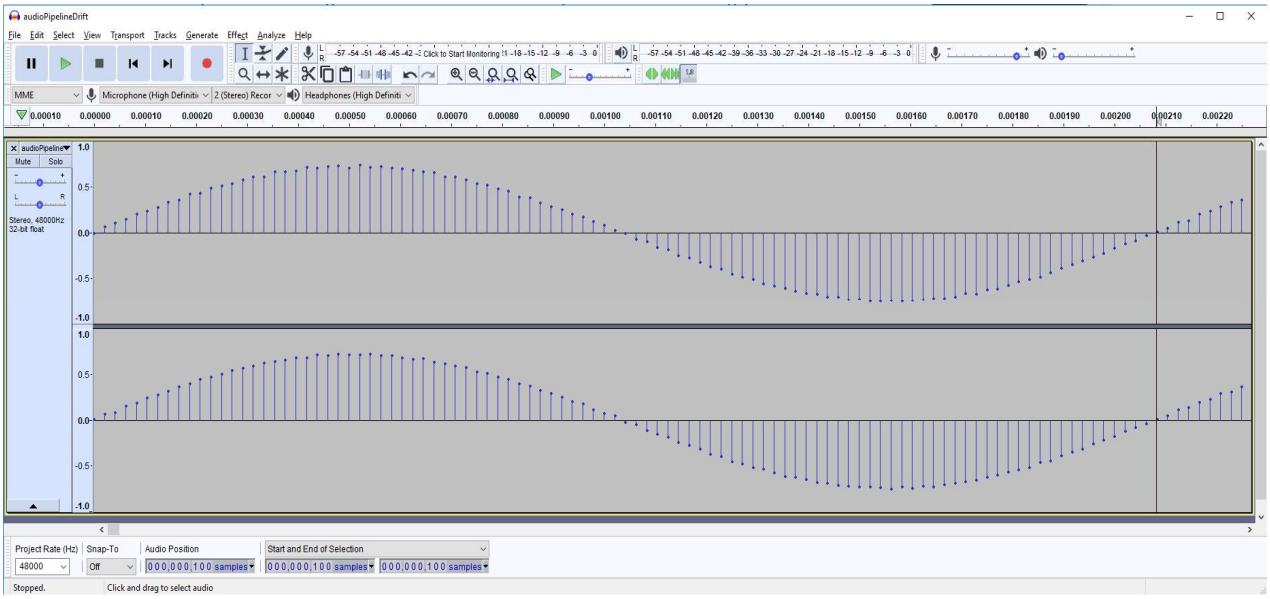
MRM PreQual Test for i.MX7D

Test results for the MRM Pre Qualification Test for i.MX7D

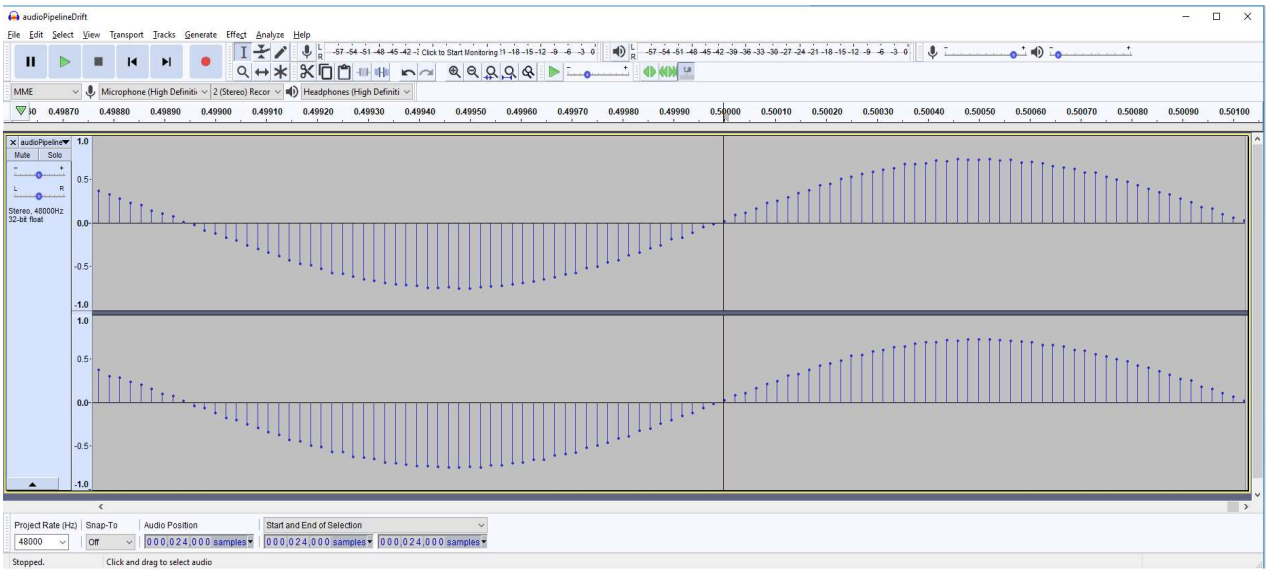
TEST 1: AUDIO PIPELINE DRIFT

Results

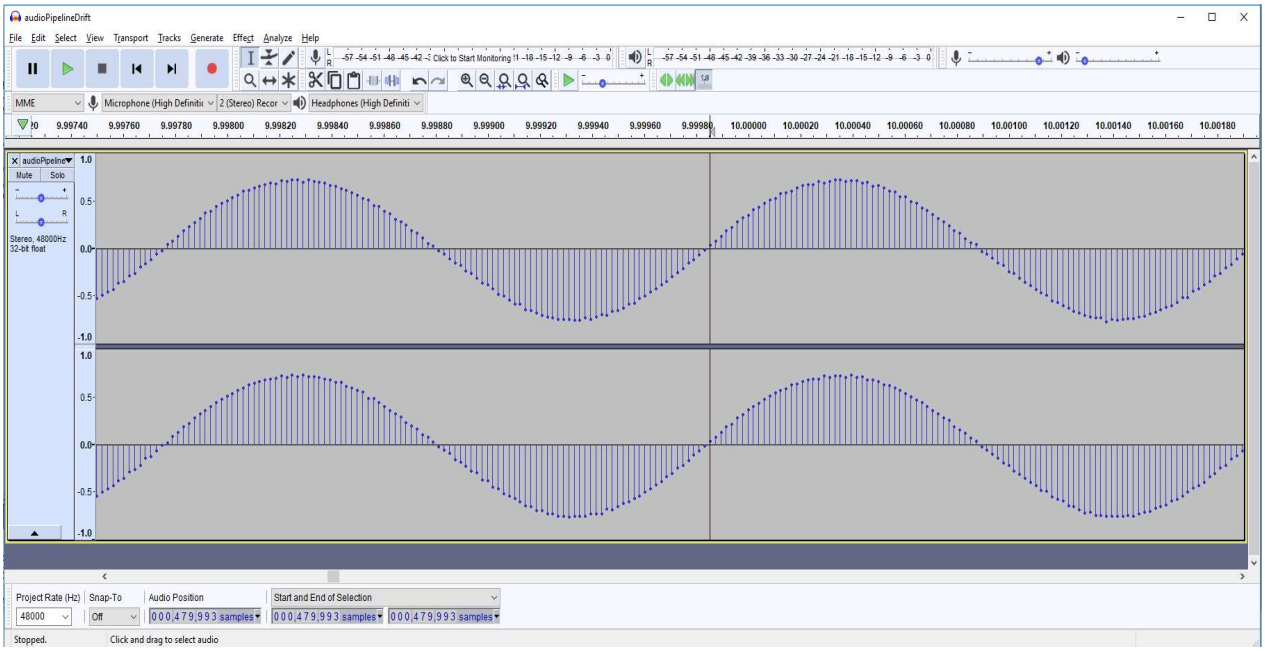
Observing a 1 cycle of the sine wave we can see there is exactly 100 samples per period



On a t = 0.5 seconds the upward-going zero crossing sample is at exact multiple of 100



However in a more significant t = 10s, the drifting is now visible.



Doing the calculations with: S1=0, S2=479993, T1=0s, T2=9.99985s

```
wavFileFrequency = 480
sampleRate = 48000
samplesPerPeriod = sampleRate / wavFileFrequency = 100
error_samples = (479993 - 0) – 100 * round((479993 - 0)/100) = 7
deltaT = T2-T1 = 9.99985 - 0 = 9.99985
error_PPM = 1.0E6 * (7 / 48000) / 9.99985 = 14.58
```

ERROR PPM = **14.58** which is < 20 PPM, so

TEST is PASSED

TEST 2: HIGH-RESOLUTION TIMER

Results

Test PASSED from observing console output

Sample Output Evidence

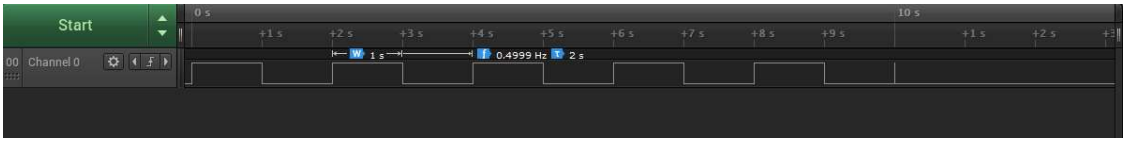
```
root@imx7d-pico:~/mrm_prequaltest_mx7d# ./preQualTest --gtest_filter="HRT.*"
sh: line 0: echo: write error: Device or resource busy
PreQualification for device: 'Technexion PICO-IMX7 Dual/Solo', IPaddr:
192.168.1.127, run: 2018-04-26T23:37:21Z

Note: Google Test filter = HRT.*
[==========] Running 2 tests from 1 test case.
[----------] Global test environment set-up.
[----------] 2 tests from HRT
[ RUN      ] HRT.SlowAccessTest
Ensures that HRT increments at about the right rate (~1E9 ns/sec)

HRT1_ns,HRT2_ns,delta_ns,result
973553772375,974553935625,1000163250,PASS
974553999875,975554157750,1000157875,PASS
975554208375,976554353500,1000145125,PASS
976554397875,977554549625,1000151750,PASS
977554593375,978554745750,1000152375,PASS
978554788750,979554944000,1000155250,PASS
979554997250,980555141875,1000144625,PASS
980555187000,981555334875,1000147875,PASS
981555378500,982555529375,1000150875,PASS
982555572500,983555717750,1000145250,PASS
983555760750,984555897375,1000136625,PASS
984555953625,985556090000,1000136375,PASS
985556135500,986556285000,1000149500,PASS
986556330000,987556481500,1000151500,PASS
987556524750,988556677250,1000152500,PASS
988556720000,989556874125,1000154125,PASS
989556916750,990557058625,1000141875,PASS
990557102125,991557236000,1000133875,PASS
991557278250,992557432000,1000153750,PASS
992557475000,993557620625,1000145625,PASS
993557663375,994557779875,1000116500,PASS
994557822250,995557955000,1000132750,PASS
995557996750,996558129375,1000132625,PASS
996558172375,997558325375,1000153000,PASS
997558367500,998558522000,1000154500,PASS
[       OK ] HRT.SlowAccessTest (25005 ms)
[ RUN      ] HRT.FastAccessTest
Ensures that the HRT can be accessed quickly (<=3us, 1 failure allowed)
```

```
HRT1_ns,HRT2_ns,delta_ns,result
998558807000,998558808375,1375,PASS
998558825750,998558826500,750,PASS
998558841875,998558842750,875,PASS
998558857500,998558858375,875,PASS
998558873125,998558874000,875,PASS
998558888750,998558889500,750,PASS
998558904250,998558905125,875,PASS
998558919875,998558920625,750,PASS
998558935500,998558936250,750,PASS
998558951125,998558952000,875,PASS
998558966750,998558967625,875,PASS
998558982375,998558983250,875,PASS
998558998000,998558998875,875,PASS
998559013625,998559014500,875,PASS
998559029250,998559030000,750,PASS
998559044750,998559045625,875,PASS
998559060375,998559061125,750,PASS
998559076000,998559076875,875,PASS
998559091625,998559092500,875,PASS
998559107125,998559108000,875,PASS
998559122750,998559123625,875,PASS
998559138250,998559139125,875,PASS
998559153875,998559154625,750,PASS
998559169500,998559170375,875,PASS
998559185000,998559185875,875,PASS
[       OK ] HRT.FastAccessTest (0 ms)
[----------] 2 tests from HRT (25006 ms total)

[----------] Global test environment tear-down
[==========] 2 tests from 1 test case ran. (25006 ms total)
[  PASSED  ] 2 tests.
```

TEST 3: GPIO VALIDATION

Results

Test PASSED by observing Logic Analyzers graphics the width of slow pulses are = 1s, while small pulses are 0.32us (< 1us)



Gpio Slow Pulses

Gpio Short Pulses

Sample Output

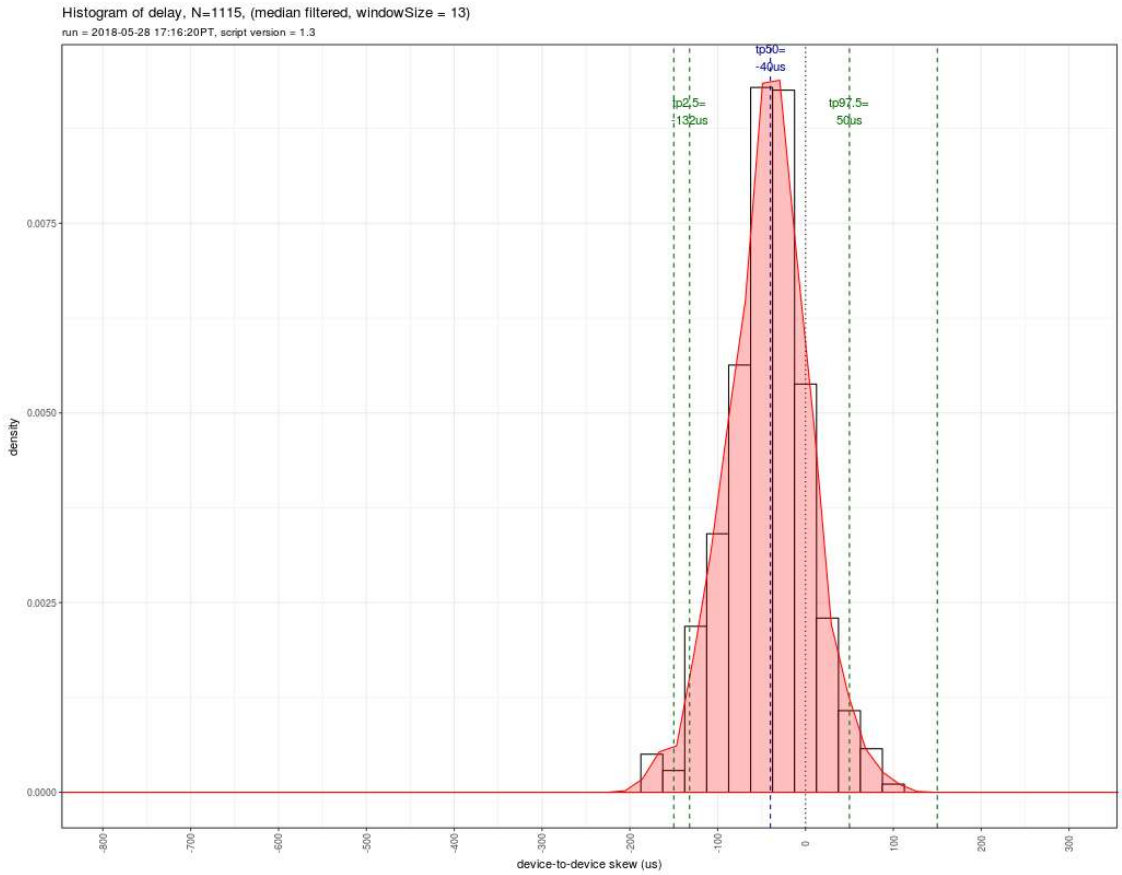
```
root@imx7d-pico:~/mrm_prequaltest_mx7d# ./preQualTest --gtest_filter="GPIO.*"
sh: line 0: echo: write error: Device or resource busy
PreQualification for device: 'Technexion PICO-IMX7 Dual/Solo', IPaddr:
192.168.1.127, run: 2018-04-27T01:08:03Z

Note: Google Test filter = GPIO.*
[==========] Running 2 tests from 1 test case.
[----------] Global test environment set-up.
[----------] 2 tests from GPIO
[ RUN      ] GPIO.SlowAccessTest
Ensures that GPIO can be toggled

Start recording on the logic analyzer.
GPIO high
GPIO low
GPIO high
GPIO low
GPIO high
GPIO low
GPIO high
GPIO low
GPIO high
GPIO low
Stop recording on the logic analyzer.
[       OK ] GPIO.SlowAccessTest (10002 ms)
[ RUN      ] GPIO.FastAccessTest
Ensures that the GPIO can be toggled quickly (<1us)

Start recording on the logic analyzer.
```

```
GPIO transitioning 20 times.
Stop recording on the logic analyzer.

TODO: Manually check the logic analyzer output.
      Slow pulses should have H/L time of ~1s.
      Fast pulses should have H/L time of <1us.
      Duration of fast pulse section should be <20us.
[       OK ] GPIO.FastAccessTest (0 ms)
[----------] 2 tests from GPIO (10002 ms total)

[----------] Global test environment tear-down
[==========] 2 tests from 1 test case ran. (10002 ms total)
[  PASSED  ] 2 tests.
```

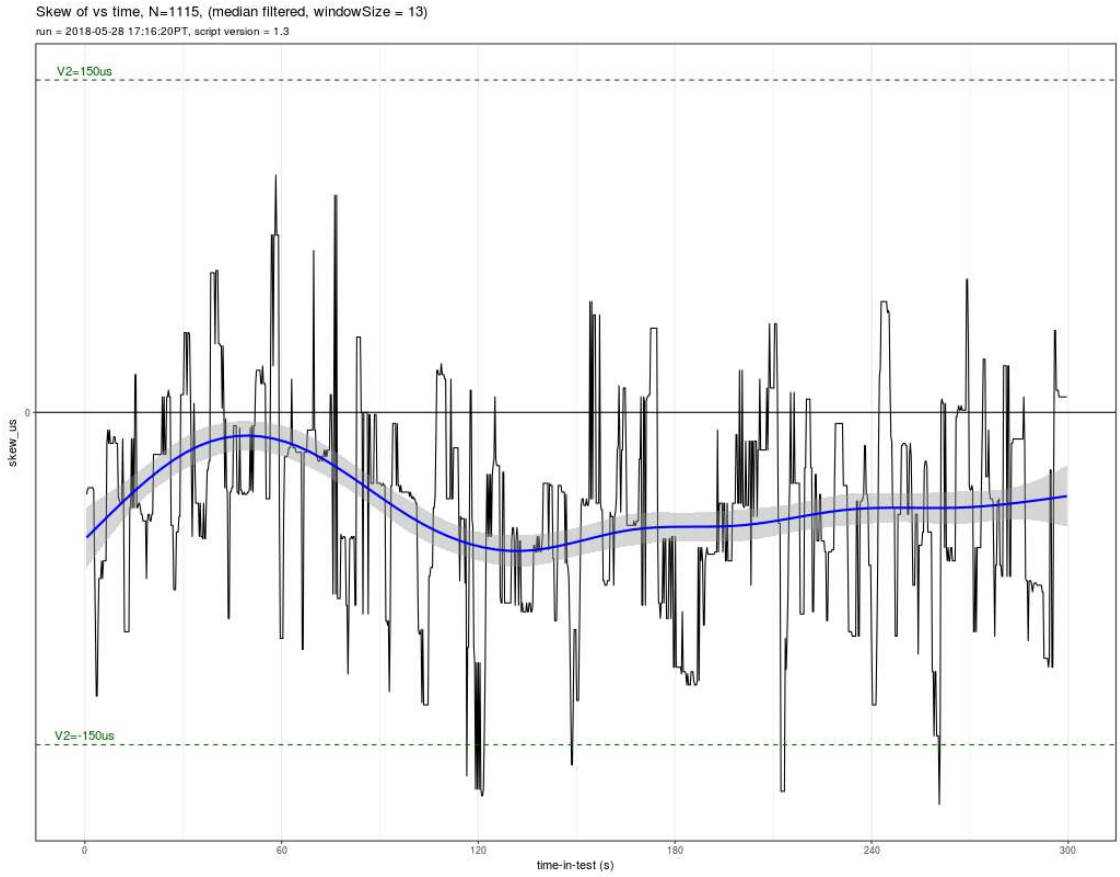
TEST4: TIME SYNCHRONIZATION

Results

Test PASSED from graphics obtained from Logic Analyzer(TimeSync3.test.csv) it can be observed that The TP95 is around **90us** of the median (TP50) line. (Application note marked as PASSED if within 150us)



Plot with 2 i.MX7D - Device to Device TimeSync delay



Plot with 2 i.MX7D - Device to Device TimeSync Skew vs Time

TEST 5: AUDIO PLACEMENT

Results Using Alsa Device as HW:2,0

Sample Output from RScript results

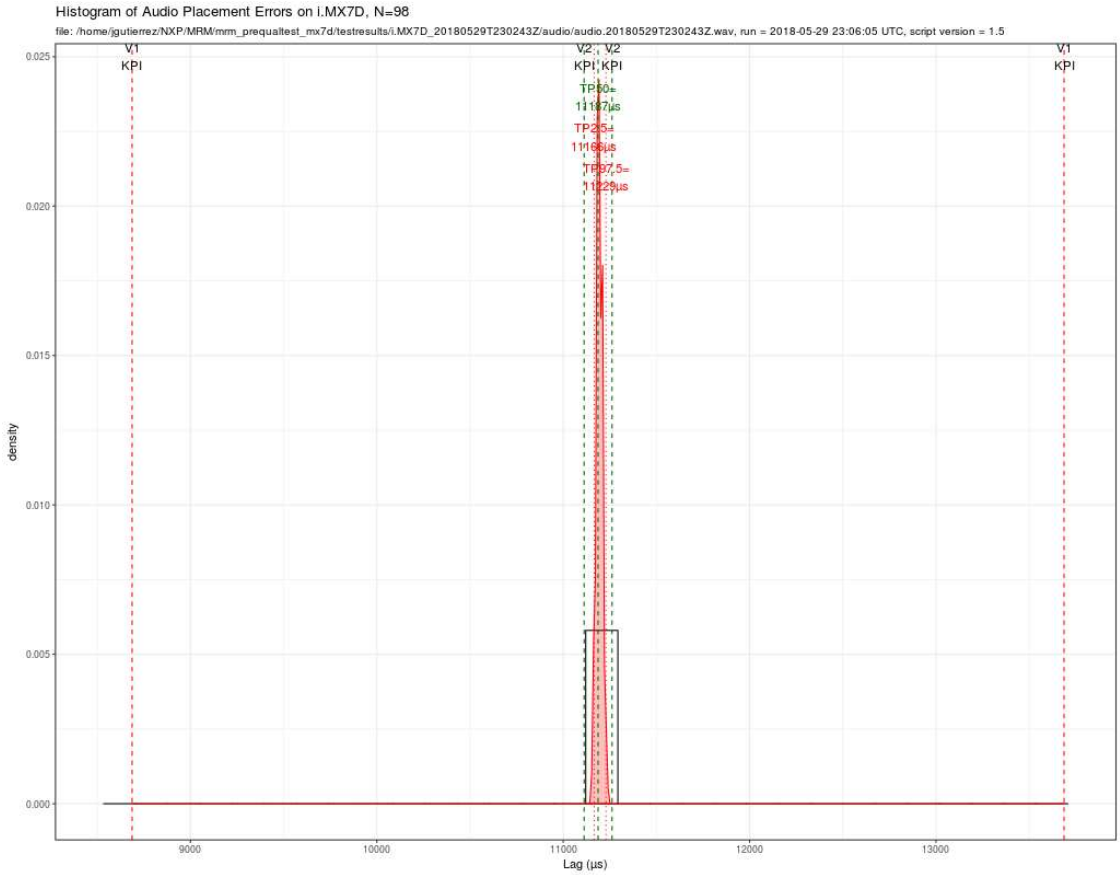
Test PASSED by inspecting report_i.MX7D.txt file

```
+-----------------------------------------------------+
| AUDIO PLACEMENT FOR i.MX7D                          |
| run = 2018-05-29 23:06:05 UTC, script version = 1.5 |
+-----------------------------------------------------+
N (number of samples) = 98

TP0 (min)    = 11166 µs = TP50 - 21 µs
TP2.5        = 11166 µs = TP50 - 21 µs
TP50         = 11187 µs
TP97.5       = 11229 µs = TP50 + 42 µs
TP100 (max)  = 11229 µs = TP50 + 42 µs

NOTE: always manually check the audio file, too.

+-------------------------------------+
| Level 1 KPI compliance (Multi-room) |
+-------------------------------------+
KPI1a (TP95 spread  < 5000µs) = 63µs: PASS
KPI1b (TP100 spread < 5000µs) = 63µs: PASS
     Samples outside V1 TP100 KPI: 0 out of 98 = ~0%

+----------------------------------+
| Level 2 KPI compliance (LR Stereo) |
+----------------------------------+
KPI2a (TP95 spread  < 150µs)= 63µs: PASS
KPI2b (TP100 spread < 150µs) = 63µs: PASS
     Samples outside V2 TP100 KPI: 0 out of 98 = ~0%

+----------------------+
| Audio Placement Data |
+----------------------+

Assume constant (correctable) lag is TP50(lag_µs): 11187 µs

        sn burstStartSN lag_µsec uncorrected_lag_µsec V1_KPI V2_KPI
1   286069       334606    11187                    0      .      .
2   357246       405782    11166                  -21      .      .
3   502561       551098    11187                    0      .      .
4   574213       622751    11208                   21      .      .
5   643678       692215    11187                    0      .      .
6   713044       761581    11187                    0      .      .
```

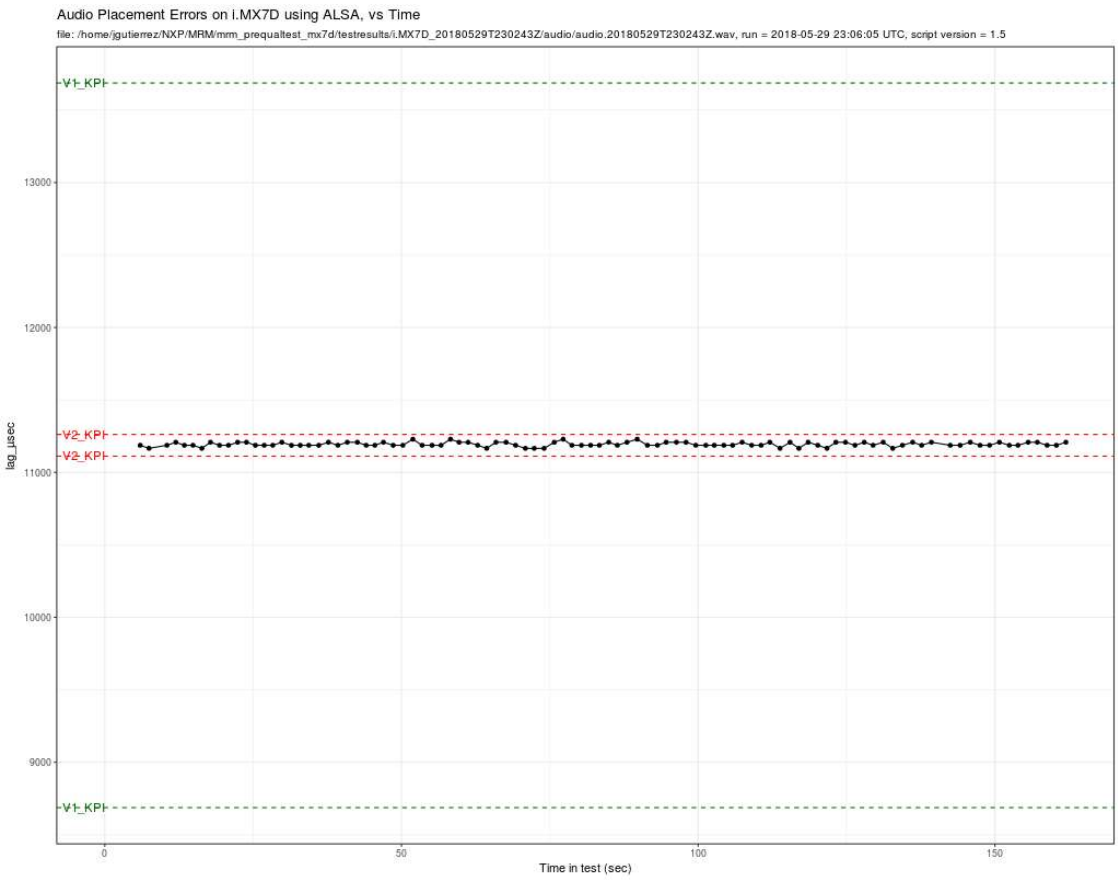
7	785604	834140	11166	-21	.	.
8	854858	903396	11208	21	.	.
9	928081	976618	11187	0	.	.
10	1000572	1049109	11187	0	.	.
11	1074433	1122971	11208	21	.	.
12	1146217	1194755	11208	21	.	.
13	1217971	1266508	11187	0	.	.
14	1289437	1337974	11187	0	.	.
15	1358639	1407176	11187	0	.	.
16	1432161	1480699	11208	21	.	.
17	1510067	1558604	11187	0	.	.
18	1580817	1629354	11187	0	.	.
19	1649803	1698340	11187	0	.	.
20	1731033	1779570	11187	0	.	.
21	1809037	1857575	11208	21	.	.
22	1885218	1933755	11187	0	.	.
23	1961302	2009840	11208	21	.	.
24	2043074	2091612	11208	21	.	.
25	2114371	2162908	11187	0	.	.
26	2184685	2233222	11187	0	.	.
27	2254103	2302641	11208	21	.	.
28	2333045	2381582	11187	0	.	.
29	2410838	2459375	11187	0	.	.
30	2492093	2540632	11229	42	.	.
31	2566612	2615149	11187	0	.	.
32	2646930	2695467	11187	0	.	.
33	2719543	2768080	11187	0	.	.
34	2796428	2844967	11229	42	.	.
35	2865428	2913966	11208	21	.	.
36	2938920	2987458	11208	21	.	.
37	3016595	3065132	11187	0	.	.
38	3089521	3138057	11166	-21	.	.
39	3163707	3212245	11208	21	.	.
40	3246034	3294572	11208	21	.	.
41	3322915	3371452	11187	0	.	.
42	3402399	3450935	11166	-21	.	.
43	3473521	3522057	11166	-21	.	.
44	3553576	3602112	11166	-21	.	.
45	3635957	3684495	11208	21	.	.
46	3707724	3756263	11229	42	.	.
47	3778342	3826879	11187	0	.	.
48	3855679	3904216	11187	0	.	.
49	3929576	3978113	11187	0	.	.
50	4001040	4049577	11187	0	.	.
51	4076609	4125147	11208	21	.	.
52	4145583	4194120	11187	0	.	.
53	4224200	4272738	11208	21	.	.
54	4307047	4355586	11229	42	.	.
55	4389162	4437699	11187	0	.	.
56	4470496	4519033	11187	0	.	.

57	4540641	4589179	11208	21	.	.
58	4624073	4672611	11208	21	.	.
59	4701388	4749926	11208	21	.	.
60	4780742	4829279	11187	0	.	.
61	4862004	4910541	11187	0	.	.
62	4930819	4979356	11187	0	.	.
63	5007515	5056052	11187	0	.	.
64	5078396	5126933	11187	0	.	.
65	5155571	5204109	11208	21	.	.
66	5232684	5281221	11187	0	.	.
67	5308482	5357019	11187	0	.	.
68	5380345	5428883	11208	21	.	.
69	5461831	5510367	11166	-21	.	.
70	5543304	5591842	11208	21	.	.
71	5614512	5663048	11166	-21	.	.
72	5689907	5738445	11208	21	.	.
73	5767858	5816395	11187	0	.	.
74	5841601	5890137	11166	-21	.	.
75	5914056	5962594	11208	21	.	.
76	5991437	6039975	11208	21	.	.
77	6068362	6116899	11187	0	.	.
78	6142820	6191358	11208	21	.	.
79	6214559	6263096	11187	0	.	.
80	6296826	6345364	11208	21	.	.
81	6373743	6422279	11166	-21	.	.
82	6452467	6501004	11187	0	.	.
83	6535085	6583623	11208	21	.	.
84	6607644	6656181	11187	0	.	.
85	6686233	6734771	11208	21	.	.
86	6838884	6887421	11187	0	.	.
87	6919081	6967618	11187	0	.	.
88	7000827	7049365	11208	21	.	.
89	7080431	7128968	11187	0	.	.
90	7157023	7205560	11187	0	.	.
91	7237018	7285556	11208	21	.	.
92	7316894	7365431	11187	0	.	.
93	7387194	7435731	11187	0	.	.
94	7469522	7518060	11208	21	.	.
95	7543560	7592098	11208	21	.	.
96	7622372	7670909	11187	0	.	.
97	7697538	7746075	11187	0	.	.
98	7774862	7823400	11208	21	.	.

Graphics



histogram of audio placement inaccuracy



audio placement inaccuracy vs Time

Results using Alsa plug:dmix

Sample Output from RScript results

Test PASSED by inspecting report_i.MX7D_dmix.txt file

```
+-----------------------------------------------------+
| AUDIO PLACEMENT FOR i.MX7D                          |
| run = 2018-05-30 21:58:46 UTC, script version = 1.5 |
+-----------------------------------------------------+
N (number of samples) = 121

TP0 (min)    = 10791 µs = TP50 - 42 µs
TP2.5        = 10791 µs = TP50 - 42 µs
TP50         = 10833 µs
TP97.5       = 10854 µs = TP50 + 21 µs
TP100 (max)  = 10874 µs = TP50 + 41 µs

NOTE: always manually check the audio file, too.

+-----------------------------------+
| Level 1 KPI compliance (Multi-room) |
```

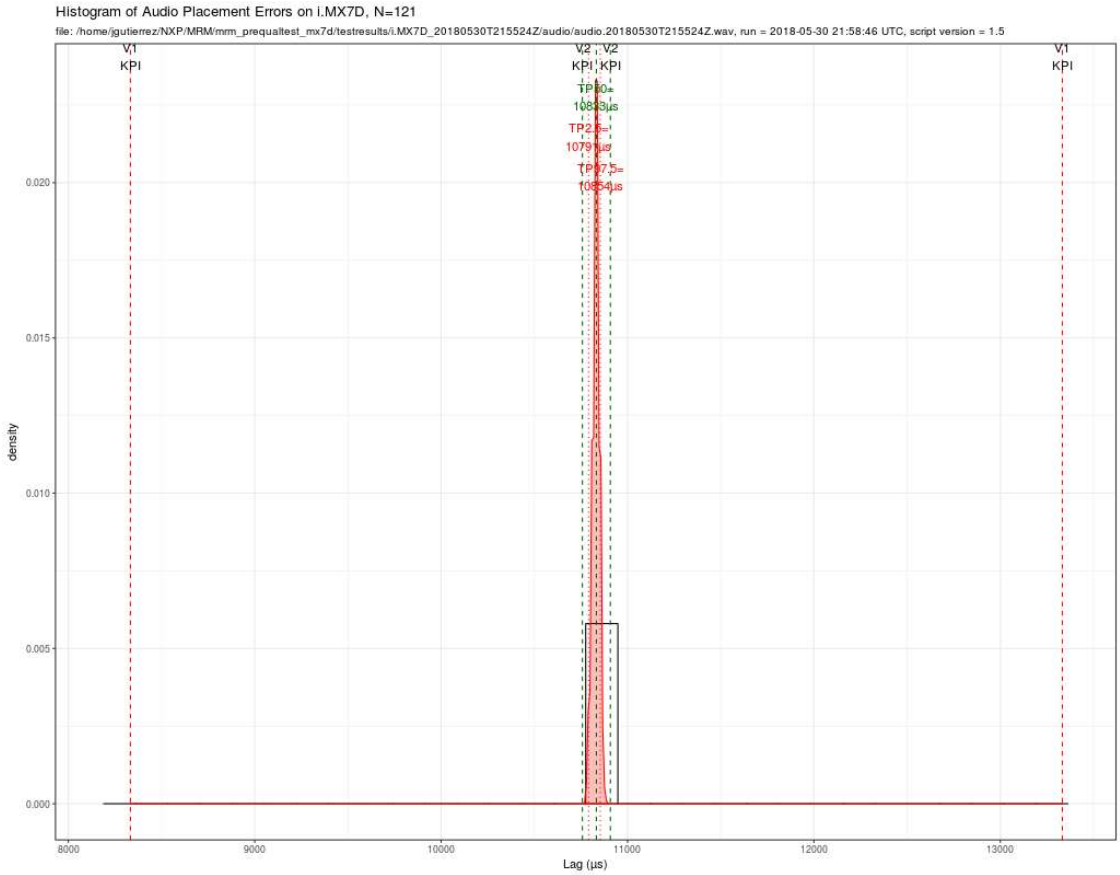
```
+-----------------------------------+
KPI1a (TP95 spread  < 5000µs) = 63µs: PASS
KPI1b (TP100 spread < 5000µs) = 83µs: PASS
     Samples outside V1 TP100 KPI: 0 out of 121 = ~0%

+-----------------------------------+
| Level 2 KPI compliance (LR Stereo) |
+-----------------------------------+
KPI2a (TP95 spread  < 150µs)= 63µs: PASS
KPI2b (TP100 spread < 150µs) = 83µs: PASS
     Samples outside V2 TP100 KPI: 0 out of 121 = ~0%

+----------------------+
| Audio Placement Data |
+----------------------+

Assume constant (correctable) lag is TP50(lag_µs): 10833 µs
```

	sn	burstStartSN	lag_µsec	uncorrected_lag_µsec	V1_KPI	V2_KPI
1	270063	318582	10812	-21	.	.
2	342450	390970	10833	0	.	.
3	417978	466498	10833	0	.	.
4	490126	538647	10854	21	.	.
5	562898	611419	10854	21	.	.
6	633527	682048	10854	21	.	.
7	704039	752559	10833	0	.	.
8	777753	826272	10812	-21	.	.
9	848209	896730	10854	21	.	.
10	922589	971109	10833	0	.	.
11	996261	1044781	10833	0	.	.
12	1071301	1119821	10833	0	.	.
13	1144239	1192759	10833	0	.	.
14	1217148	1265667	10812	-21	.	.
15	1289799	1338319	10833	0	.	.
16	1360197	1408716	10812	-21	.	.
17	1434879	1483399	10833	0	.	.
18	1513971	1562492	10854	21	.	.
19	1585860	1634379	10812	-21	.	.
20	1656020	1704540	10833	0	.	.
21	1738399	1786918	10812	-21	.	.
22	1817601	1866120	10812	-21	.	.
23	1894945	1943466	10854	21	.	.
24	1971952	2020470	10791	-42	.	.
25	2054896	2103415	10812	-21	.	.
26	2127338	2175859	10854	21	.	.
27	2198798	2247318	10833	0	.	.
28	2269379	2317899	10833	0	.	.
29	2349492	2398012	10833	0	.	.
30	2428403	2476921	10791	-42	.	.

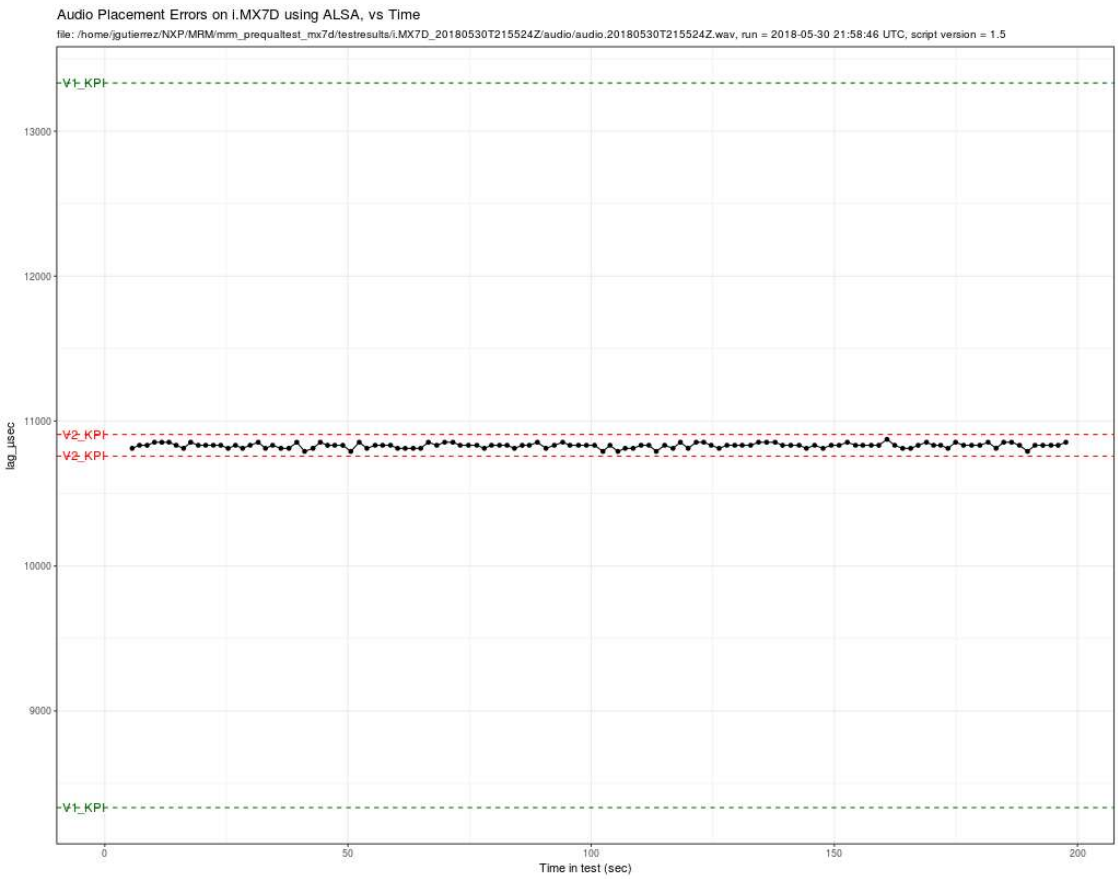
31	2510796	2559317	10854	21	.	.
32	2586493	2635012	10812	-21	.	.
33	2667981	2716501	10833	0	.	.
34	2741772	2790292	10833	0	.	.
35	2819846	2868366	10833	0	.	.
36	2890031	2938550	10812	-21	.	.
37	2964722	3013241	10812	-21	.	.
38	3043587	3092106	10812	-21	.	.
39	3117720	3166239	10812	-21	.	.
40	3193116	3241637	10854	21	.	.
41	3276605	3325125	10833	0	.	.
42	3354681	3403202	10854	21	.	.
43	3435329	3483850	10854	21	.	.
44	3507593	3556113	10833	0	.	.
45	3588809	3637329	10833	0	.	.
46	3672392	3720912	10833	0	.	.
47	3745325	3793844	10812	-21	.	.
48	3817105	3865625	10833	0	.	.
49	3895608	3944128	10833	0	.	.
50	3970700	4019220	10833	0	.	.
51	4042889	4091408	10812	-21	.	.
52	4119635	4168155	10833	0	.	.
53	4189749	4238269	10833	0	.	.
54	4269553	4318074	10854	21	.	.
55	4353562	4402081	10812	-21	.	.
56	4436844	4485364	10833	0	.	.
57	4519332	4567853	10854	21	.	.
58	4590680	4639200	10833	0	.	.
59	4674813	4723333	10833	0	.	.
60	4753280	4801800	10833	0	.	.
61	4833800	4882320	10833	0	.	.
62	4916213	4964731	10791	-42	.	.
63	4986196	5034716	10833	0	.	.
64	5064058	5112576	10791	-42	.	.
65	5136124	5184643	10812	-21	.	.
66	5214464	5262983	10812	-21	.	.
67	5292741	5341261	10833	0	.	.
68	5369734	5418254	10833	0	.	.
69	5442764	5491282	10791	-42	.	.
70	5525399	5573919	10833	0	.	.
71	5608015	5656534	10812	-21	.	.
72	5680400	5728921	10854	21	.	.
73	5756958	5805477	10812	-21	.	.
74	5836088	5884609	10854	21	.	.
75	5910992	5959513	10854	21	.	.
76	5984592	6033112	10833	0	.	.
77	6063103	6111622	10812	-21	.	.
78	6141204	6189724	10833	0	.	.
79	6217716	6266236	10833	0	.	.
80	6290621	6339141	10833	0	.	.

81	6374058	6422578	10833	0	.	.
82	6452161	6500682	10854	21	.	.
83	6532046	6580567	10854	21	.	.
84	6615844	6664365	10854	21	.	.
85	6689546	6738066	10833	0	.	.
86	6769327	6817847	10833	0	.	.
87	6852255	6900775	10833	0	.	.
88	6924345	6972864	10812	-21	.	.
89	7005724	7054244	10833	0	.	.
90	7088655	7137174	10812	-21	.	.
91	7169399	7217919	10833	0	.	.
92	7247150	7295670	10833	0	.	.
93	7328346	7376867	10854	21	.	.
94	7409384	7457904	10833	0	.	.
95	7480872	7529392	10833	0	.	.
96	7564396	7612916	10833	0	.	.
97	7639637	7688157	10833	0	.	.
98	7719667	7768189	10874	41	.	.
99	7796030	7844550	10833	0	.	.
100	7874567	7923086	10812	-21	.	.
101	7953084	8001603	10812	-21	.	.
102	8027900	8076420	10833	0	.	.
103	8109059	8157580	10854	21	.	.
104	8179984	8228504	10833	0	.	.
105	8249785	8298305	10833	0	.	.
106	8321731	8370250	10812	-21	.	.
107	8396501	8445022	10854	21	.	.
108	8475078	8523598	10833	0	.	.
109	8555345	8603865	10833	0	.	.
110	8636006	8684526	10833	0	.	.
111	8717709	8766230	10854	21	.	.
112	8797246	8845765	10812	-21	.	.
113	8871838	8920359	10854	21	.	.
114	8949291	8997812	10854	21	.	.
115	9028445	9076965	10833	0	.	.
116	9107017	9155535	10791	-42	.	.
117	9180069	9228589	10833	0	.	.
118	9258016	9306536	10833	0	.	.
119	9338911	9387431	10833	0	.	.
120	9409193	9457713	10833	0	.	.
121	9485907	9534428	10854	21	.	.

Graphics



histogram of audio placement inaccuracy for dmix



audio placement inaccuracy vs Time for dmix

TEST 6: AUDIO DISTRIBUTION

Results

Test PASSED from observing console output

Sample Output Evidence

Master

```
root@imx7d-pico:~/mrm_prequaltest_mx7d#
bution.Master 192.168.1.126altest_mx7d# ./preQualTest --
gtest_filter=AudioDistri
PreQualification for device: 'Technexion PICO-IMX7 Dual/Solo', IPaddr:
192.168.1.127, run: 2018-04-26T23:24:03Z

Note: Google Test filter = AudioDistribution.Master
[==========] Running 1 test from 1 test case.
[----------] Global test environment set-up.
[----------] 1 test from AudioDistribution
[ RUN      ] AudioDistribution.Master
Audio Distribution Unicast MASTER
Slave devices:
Slave #0: 192.168.1.126
Trying to connect to Slave #0 at '192.168.1.126'...CONNECTED.
master: now connected to 192.168.1.126 on port 1234....
DONE.
[       OK ] AudioDistribution.Master (1846 ms)
[----------] 1 test from AudioDistribution (1846 ms total)

[----------] Global test environment tear-down
[==========] 1 test from 1 test case ran. (1846 ms total)
[  PASSED  ] 1 test.
```

Slave

```
root@imx7d-pico:~/mrm_prequaltest_mx7d#
bution.Slaveico:~/mrm_prequaltest_mx7d# ./preQualTest --
gtest_filter=AudioDistri
PreQualification for device: 'Technexion PICO-IMX7 Dual/Solo', IPaddr:
192.168.1.126, run: 2018-04-27T01:06:26Z

Note: Google Test filter = AudioDistribution.Slave
[==========] Running 1 test from 1 test case.
[----------] Global test environment set-up.
[----------] 1 test from AudioDistribution
[ RUN      ] AudioDistribution.Slave
Audio Distribution Unicast: SLAVE
slave: waiting for connections...
slave: got connection from 192.168.1.127
```

```
Each report below = ~1000000 bytes received.
incrMbps,cumuMbps
31.097,31.097,0.000
43.388,36.211,0.000
41.805,37.902,0.000
50.485,40.417,0.000
45.563,41.353,0.000
52.957,42.918,0.000
49.401,43.741,0.000
55.178,44.899,0.000
47.760,45.201,0.000
58.714,46.267,0.000
slave: recv -- Master disconnected
[       OK ] AudioDistribution.Slave (30040 ms)
[----------] 1 test from AudioDistribution (30040 ms total)

[----------] Global test environment tear-down
[==========] 1 test from 1 test case ran. (30041 ms total)
[  PASSED  ] 1 test.
```