APPLICATION NOTE

AN_6513_025 FEBRUARY 2006

71M6513 Standards Compliance Test Report

Introduction

The Teridian 71M6513 device has been evaluated to provide metering compliance tests for accuracy and performance as per IEC and ANSI standards. Test titles are all based on the standard test titles for easy understanding. The compliance tests that have not been performed are more limited to the enclosure and the meter manufacturers production issues and not based on the IC itself.

Test Plans and Tools Used

The Teridian 71M6513 demonstration boards have been used along with the calibration test equipment by Rotek and Weco Engineering for meter performance and accuracy testing. Temptronic thermal stream equipment and Tenney temperature chambers have been used to test and verify temperature performance as per IEC 62053 part1 1 and part 22 and ANSI C12.20 class 0.2.

Power consumption:

Circuit Type	ANSI/IEC Standard	6513 demo board
Voltage circuit	2 W or 10VA	30mW
Current circuit	5VA	<2.4VA

Starting Current

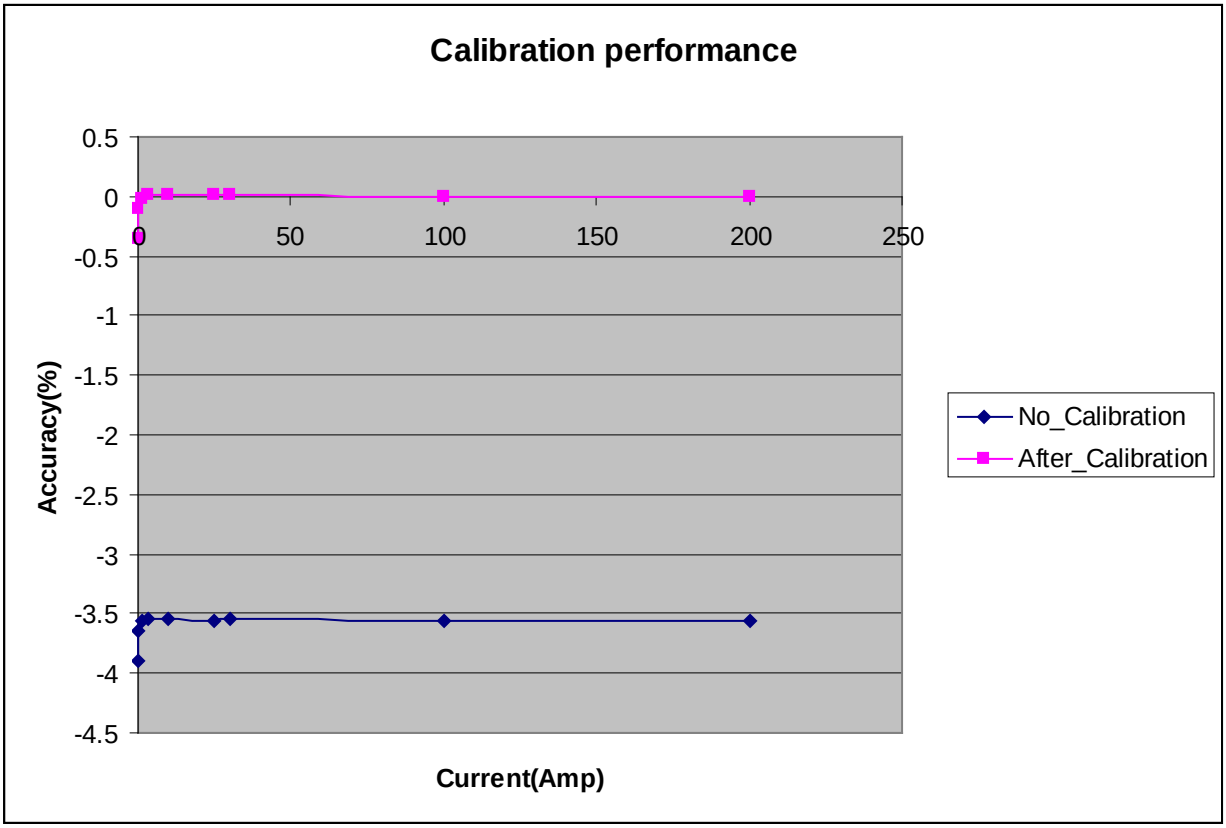
The starting current for measurement is really up to the current sensor's capability and as well the MPU firmware design thru the CREEP register provided on our demo code. For example, with a shunt meter that can measure 125A to 0.1A with 0.2% accuracy, can also measure 1mA of current. The minimum analog input voltage for having a bit of information change is 357 nanovolts. Also, one has to be careful of not sensing noise.

Summary of 71M6513 demo board performance with and without calibration.

step	element	volt	amp	phase_angle	No_calibration	Calibration
1	A	120	30	0	-3.6296	-0.0212
2	A	120	30	0	-3.6011	0.0083
3	A	120	30	60	-3.5186	-0.0181
4	A	120	30	60	-3.5083	-0.0026
5	A	120	30	300	-3.763	-0.0464
6	A	120	30	300	-3.7678	-0.0589
7	B	120	30	0	-3.4473	-0.0061
8	B	120	30	0	-3.4276	0.0177
9	B	120	30	60	-3.3553	-0.0075
10	B	120	30	60	-3.3289	0.0209
11	B	120	30	300	-3.5493	-0.017
12	B	120	30	300	-3.5692	-0.0409
13	C	120	30	0	-3.6519	0.0015
14	C	120	30	0	-3.632	0.0295
15	C	120	30	60	-3.5424	0.0029
16	C	120	30	60	-3.5404	0.0093
17	C	120	30	300	-3.7792	-0.043
18	C	120	30	300	-3.791	-0.0707
19	S	120	30	0	-3.5689	-0.0123
20	S	120	30	0	-3.5717	-0.0101
21	S	120	30	60	-3.4641	-0.0043
22	S	120	30	60	-3.4409	0.0062
23	S	120	30	60	-3.4293	0.0228
24	S	120	30	60	-3.4116	0.0366
25	S	120	30	300	-3.6791	-0.0455
26	S	120	30	300	-3.6963	-0.0622
27	S	120	30	300	-3.6428	-0.0103
28	S	120	30	300	-3.6682	-0.0231

240V test with and without calibration:

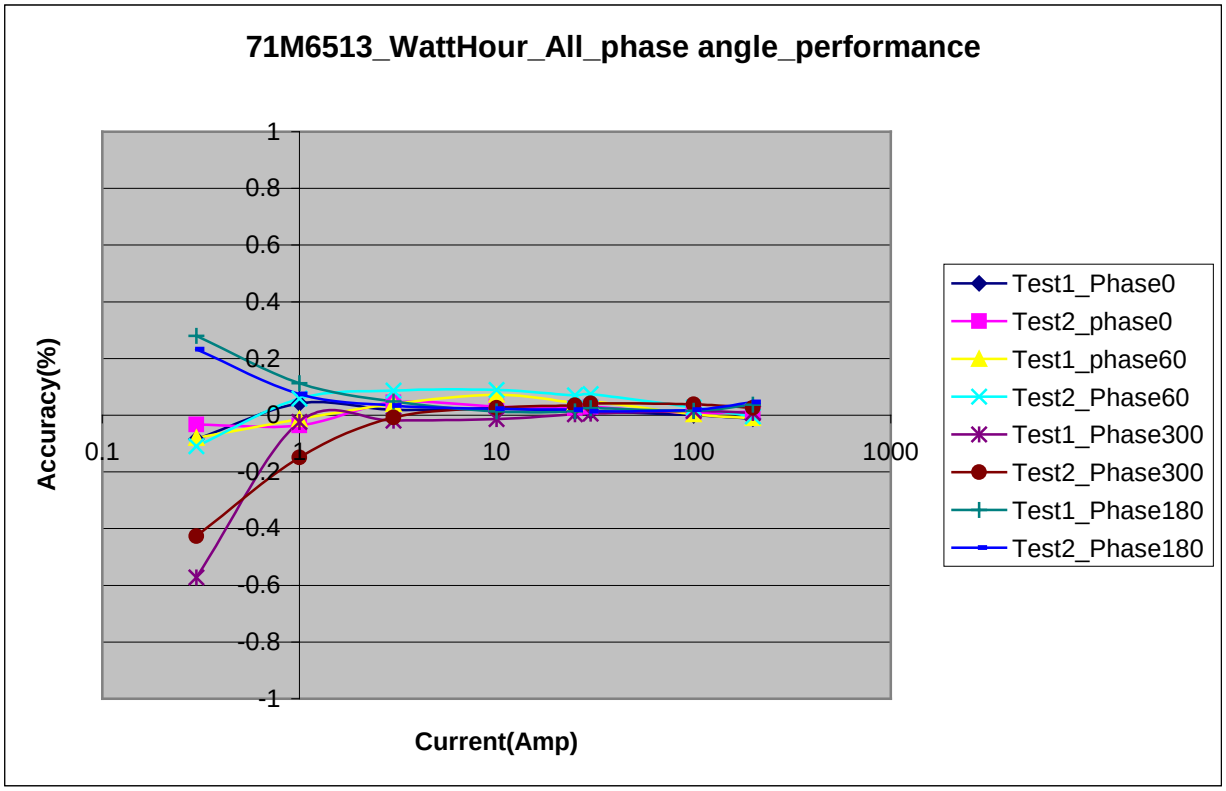
step	volt	amp	No_calibration	Calibration
1	240	200	-3.5661	-0.0037
2	240	100	-3.562	-0.0011
3	240	30	-3.5518	0.0099
4	240	25	-3.554	0.0114
5	240	10	-3.5496	0.0145
6	240	3	-3.5463	0.0148
7	240	1	-3.563	-0.0129
8	240	0.3	-3.6503	-0.0993
9	240	0.1	-3.8932	-0.3554



Power Factor variation test

71M6513 all phase angle performance

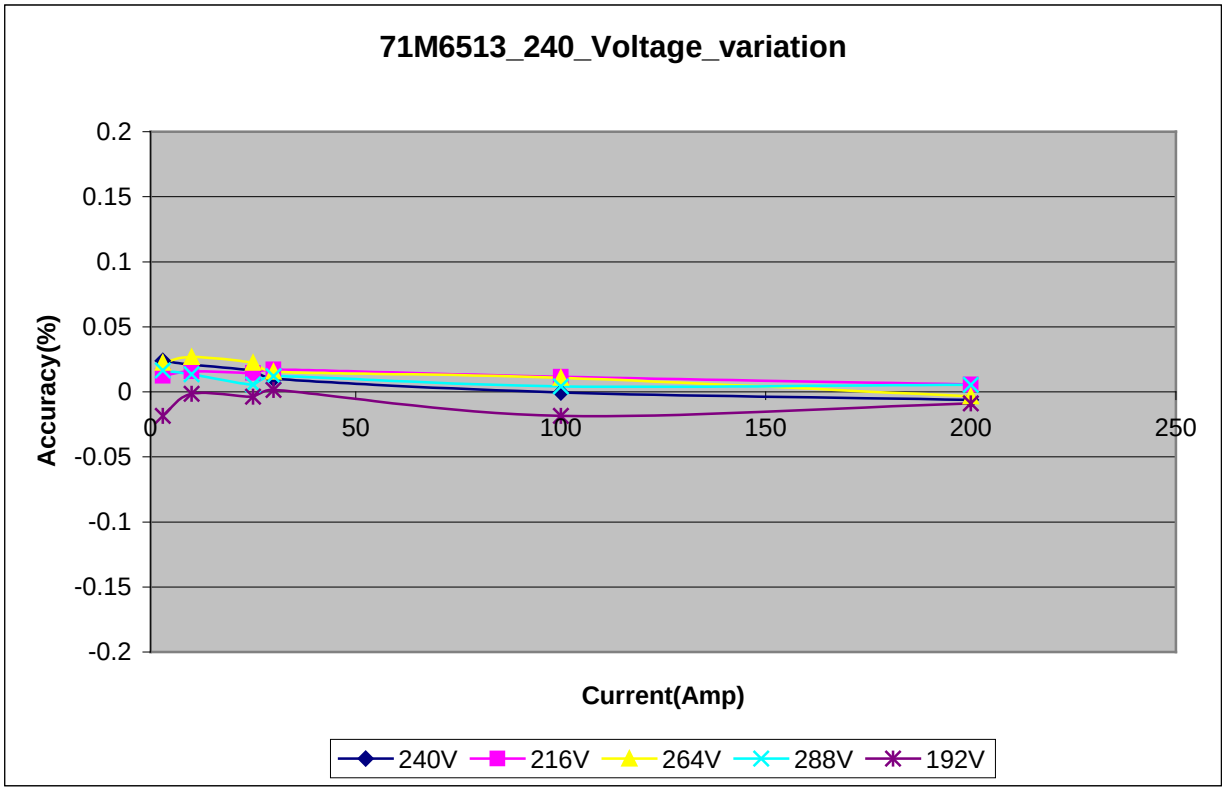
step	volt	amp	freq	Test1_0	Test2_0	Test1_60	Test2_60	Test1_300	Test2_300	Test1_180	Test2_180
1	120	200	60	-0.0129	0.0132	-0.0106	-0.0048	0.0078	0.026	0.0377	0.0464
2	120	100	60	0.0002	0.0083	0.0037	0.0273	0.0145	0.0386	0.0156	0.0187
3	120	30	60	0.0131	0.0294	0.0494	0.075	0.0061	0.0412	0.0253	0.0141
4	120	25	60	0.0121	0.0246	0.0442	0.0697	0.0039	0.0352	0.013	0.0195
5	120	10	60	0.0239	0.0308	0.072	0.0894	-0.014	0.0262	0.0135	0.0225
6	120	3	60	0.0195	0.0453	0.0392	0.0865	-0.0197	-0.0079	0.0481	0.0334
7	120	1	60	0.0419	-0.0363	-0.0135	0.0588	-0.0235	-0.1492	0.1126	0.0741
8	120	0.3	60	-0.0847	-0.0325	-0.0803	-0.1093	-0.5725	-0.4271	0.2799	0.2324



Voltage Variation Test

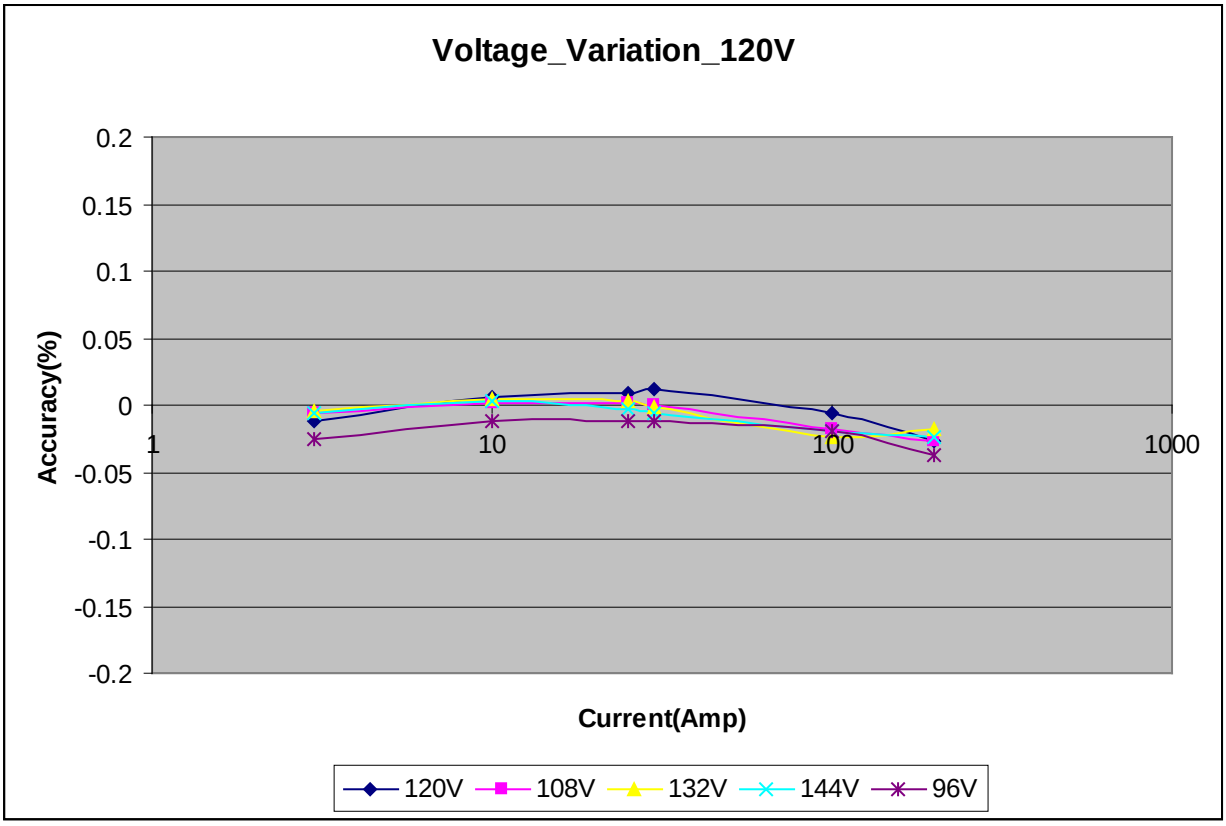
71M6513 240V voltage variation test

step	amp	240V	216V	264V	288V	192V
1	200	-0.0061	0.0057	-0.0035	0.0055	-0.0088
2	100	-0.0006	0.0115	0.0108	0.0043	-0.0185
3	30	0.0102	0.0171	0.0155	0.012	0.0014
4	25	0.0163	0.0144	0.0225	0.0056	-0.0038
5	10	0.0209	0.0157	0.0269	0.0135	-0.0014
6	3	0.0239	0.0123	0.0225	0.0164	-0.0184



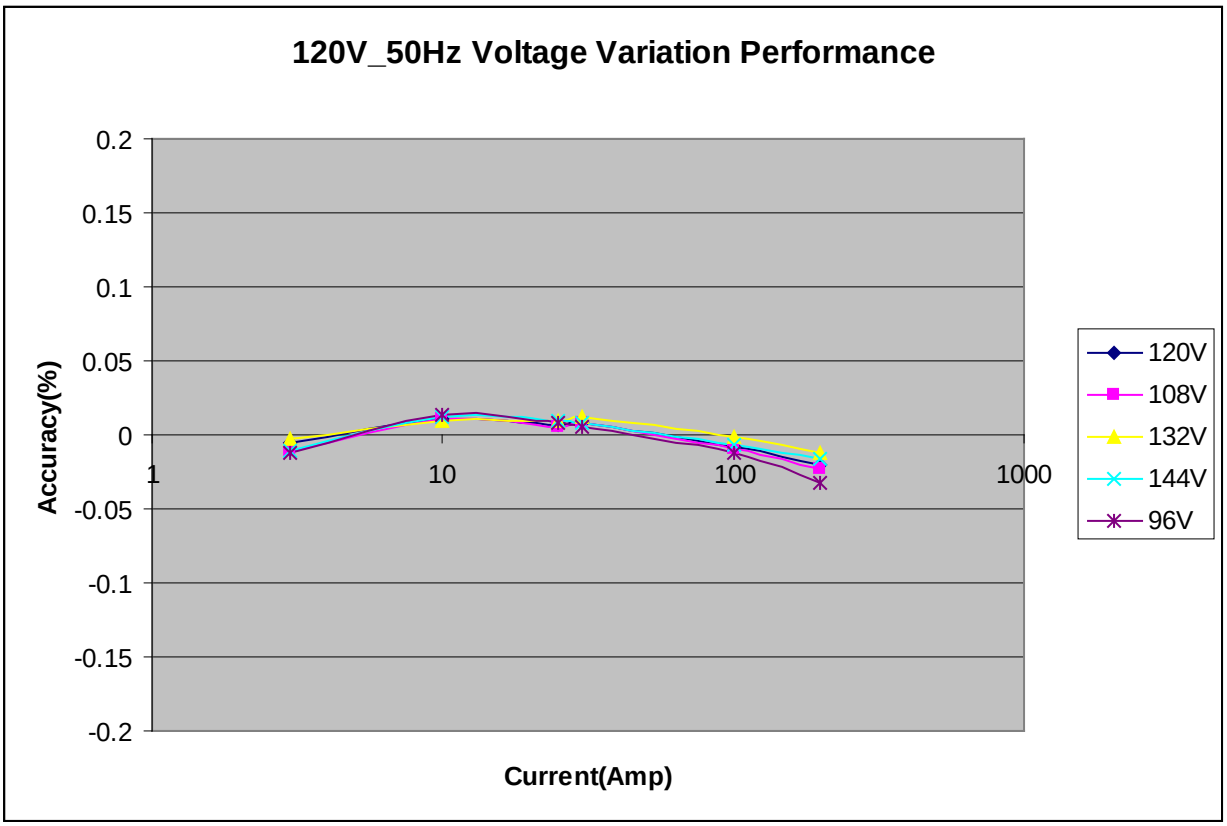
71M6513 120V 60Hz voltage variation testing

step	amp	120V	108V	132V	144V	96V
1	200	-0.0276	-0.0263	-0.0184	-0.0244	-0.0376
2	100	-0.0067	-0.0177	-0.0236	-0.0195	-0.0197
3	30	0.0115	-0.0004	-0.0016	-0.0059	-0.0112
4	25	0.0083	0.001	0.003	-0.0032	-0.0122
5	10	0.0062	0.0018	0.0045	0.0029	-0.0113
6	3	-0.0114	-0.0055	-0.0044	-0.0063	-0.0251



71M6513 50Hz Voltage variation test

step	Amp	120V	108V	132V	144V	96V
1	200	-0.0203	-0.0232	-0.0117	-0.0166	-0.0322
2	100	-0.0077	-0.0088	-0.0016	-0.0072	-0.012
3	30	0.008	0.0077	0.0118	0.0075	0.0054
4	25	0.007	0.0056	0.0093	0.0089	0.0075
5	10	0.0108	0.0112	0.0088	0.0118	0.014
6	3	-0.0048	-0.0108	-0.0027	-0.0113	-0.0119

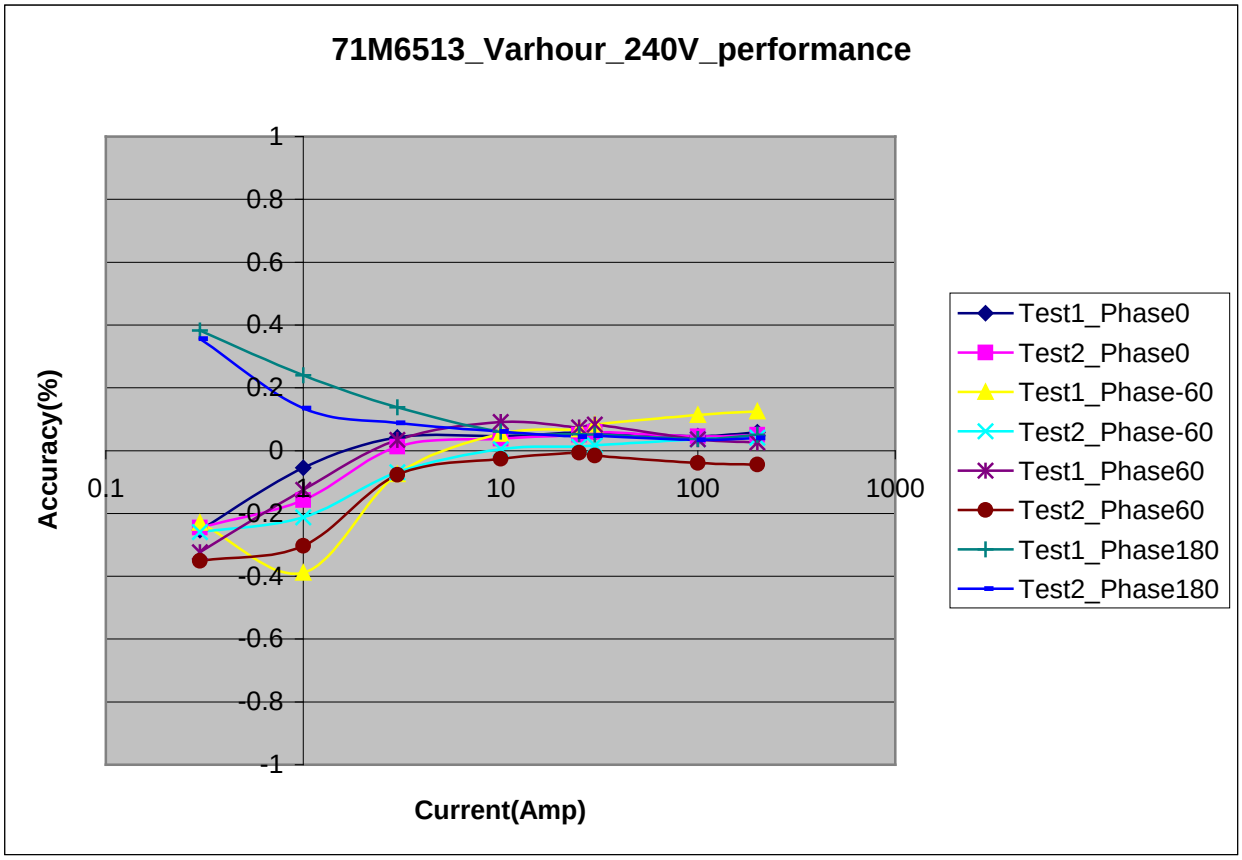


Varhour Performance

71M6513 240V 60Hz Varhour test performance

step	Amp	Test1_Phase0	Test2_Phase0	Test1_Phase-60	Test2_Phase-60
1	200	0.0585	0.05	0.1252	0.0408
2	100	0.0466	0.0449	0.1131	0.0366
3	30	0.058	0.0595	0.0828	0.0164
4	25	0.0581	0.0506	0.0678	0.0132
5	10	0.0466	0.0379	0.0536	0.0045
6	3	0.0425	0.0123	-0.0752	-0.0689
7	1	-0.0547	-0.1573	-0.389	-0.2128
8	0.3	-0.2535	-0.2448	-0.2295	-0.259

Test1_Phase60	Test2_Phase60	Test1_Phase180	Test2_Phase180
0.0258	-0.0439	0.05	0.0404
0.0359	-0.039	0.0369	0.0342
0.083	-0.0162	0.0519	0.0471
0.0739	-0.0069	0.0523	0.0448
0.0908	-0.0257	0.0611	0.0602
0.0343	-0.0766	0.1378	0.0879
-0.1249	-0.3033	0.24	0.1352
-0.3237	-0.351	0.383	0.356



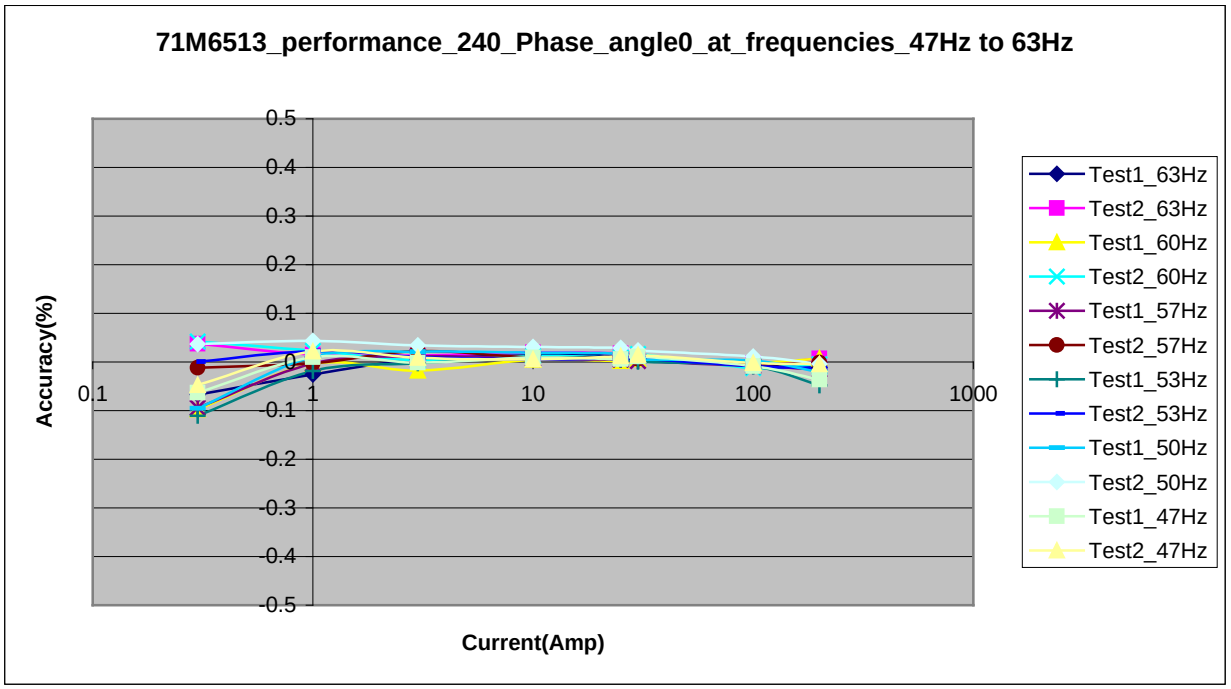
Frequency variation Test

71M6513 Variation of Frequency:

Phase_Angle 0

step	amp	Test1_63Hz	Test2_63Hz	Test1_60Hz	Test2_60Hz	Test1_57Hz	Test2_57Hz
1	200	-0.011	0.0075	0.0075	-0.0045	-0.0153	-0.0016
2	100	-0.0064	-0.0026	-0.0011	-0.0128	-0.0083	-0.0038
3	30	0.0069	0.0128	0.0061	0.0163	0.0022	0.0064
4	25	0.0123	0.018	0.0019	0.0095	0.0049	0.0096
5	10	0.0138	0.0199	0.0046	0.0124	0.0065	0.0091
6	3	0.005	0.0131	-0.0175	0.0034	0.0121	0.0223
7	1	-0.0257	0.015	-0.0041	0.0228	-0.0032	-0.0025
8	0.3	-0.0669	0.0375	-0.0972	0.0419	-0.0944	-0.0116

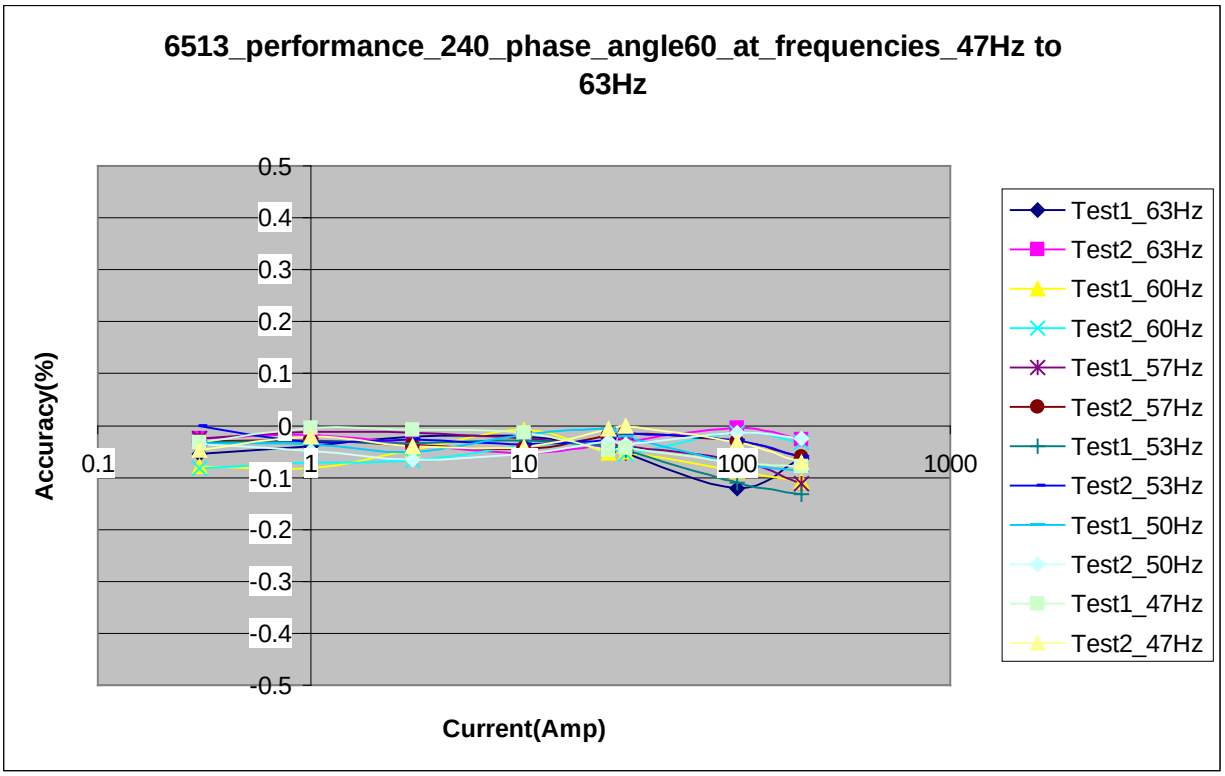
Test1_53Hz	Test2_53Hz	Test1_50Hz	Test2_50Hz	Test1_47Hz	Test2_47Hz
-0.0478	-0.0123	-0.0213	-0.0037	-0.0363	-0.0048
-0.0091	-0.0086	0.0026	0.0111	-0.0087	-0.0022
0.0009	0.0072	0.0053	0.0236	0.0111	0.0147
0.0054	0.007	0.0169	0.0288	0.0059	0.0117
0.0091	0.0052	0.0188	0.0309	0.0093	0.0053
-0.0025	0.0103	0.0211	0.0344	-0.0011	0.0086
-0.0182	0.0222	0.0106	0.0431	0.01	0.0218
-0.1103	0.0006	-0.0956	0.0369	-0.0632	-0.0472



Phase_angle 60

step	amp	Test1_63Hz	Test2_63Hz	Test1_60Hz	Test2_60Hz	Test1_57Hz	Test2_57Hz
17	200	-0.0633	-0.0274	-0.1089	-0.0329	-0.1125	-0.06
18	100	-0.1206	-0.0048	-0.087	-0.0145	-0.0676	-0.0309
19	30	-0.0524	-0.0311	-0.0502	-0.0537	-0.0397	-0.0143
20	25	-0.0412	-0.0366	-0.0532	-0.0344	-0.0382	-0.0187
21	10	-0.0217	-0.0526	-0.0079	-0.0401	-0.0245	-0.0456
22	3	-0.0215	-0.0358	-0.0463	-0.068	-0.0146	-0.0376
23	1	-0.0394	-0.0175	-0.0816	-0.0719	-0.0119	-0.0284
24	0.3	-0.0542	-0.0257	-0.0792	-0.0821	-0.0243	-0.0298

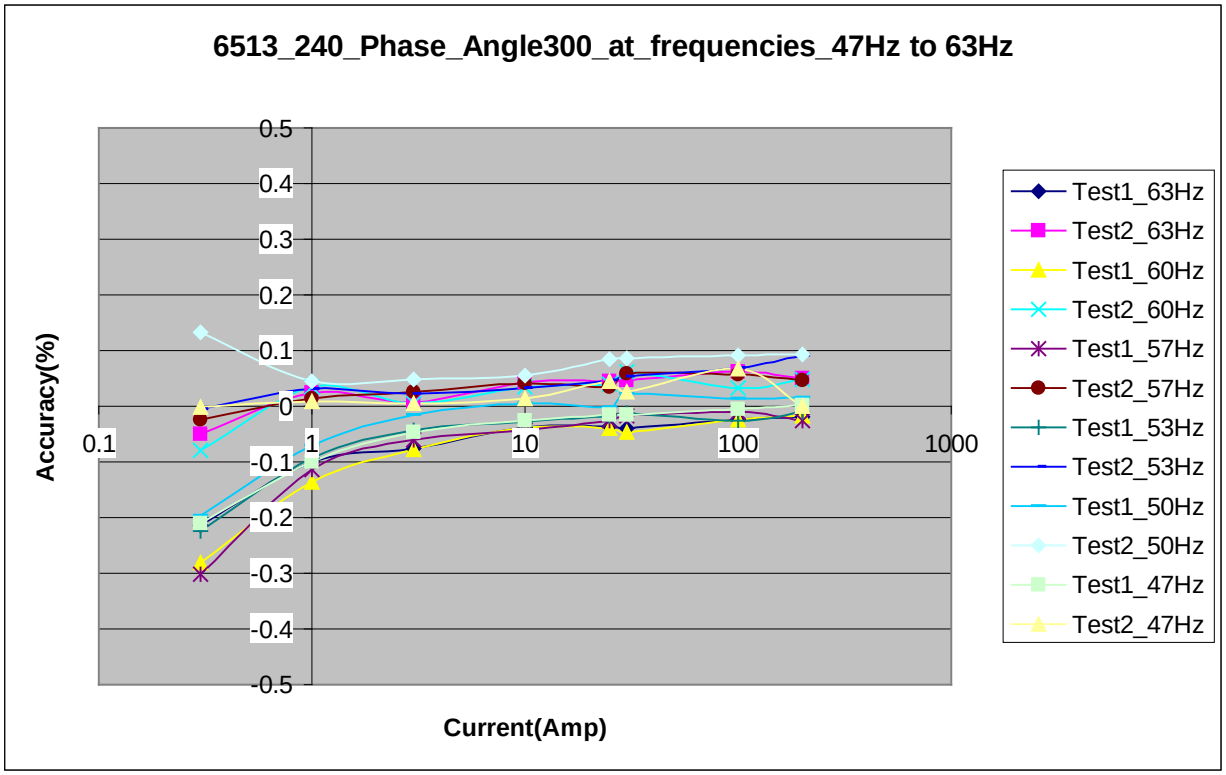
Test1_53Hz	Test2_53Hz	Test1_50Hz	Test2_50Hz	Test1_47Hz	Test2_47Hz
-0.1319	-0.0592	-0.0878	-0.0255	-0.0779	-0.0713
-0.1093	-0.0287	-0.0724	-0.013	-0.0703	-0.0326
-0.0479	-0.0163	-0.0213	-0.0362	-0.0437	-0.0018
-0.0406	-0.0277	-0.0058	-0.0307	-0.0479	-0.0061
-0.028	-0.0356	-0.0174	-0.0552	-0.0143	-0.0418
-0.0347	-0.0275	-0.0502	-0.0658	-0.0079	-0.04
-0.0297	-0.0315	-0.0359	-0.0481	-0.0038	-0.0218
-0.0329	-0.0006	-0.0346	-0.0369	-0.032	-0.047



Phase_angle 300

step	amp	Test1_63Hz	Test2_63Hz	Test1_60Hz	Test2_60Hz	Test1_57Hz	Test2_57Hz
33	200	-0.0197	0.05	-0.0175	0.0487	-0.0254	0.0471
34	100	-0.0247	0.0629	-0.0245	0.0329	-0.0111	0.0569
35	30	-0.0388	0.0457	-0.0464	0.0616	-0.0164	0.0586
36	25	-0.0358	0.045	-0.0393	0.0393	-0.0251	0.0348
37	10	-0.0378	0.0435	-0.0376	0.0347	-0.0425	0.0407
38	3	-0.0767	0.0065	-0.078	0.0056	-0.0596	0.0261
39	1	-0.0997	0.0237	-0.1361	0.0344	-0.1137	0.0143
40	0.3	-0.2131	-0.05	-0.2818	-0.0797	-0.3023	-0.0247

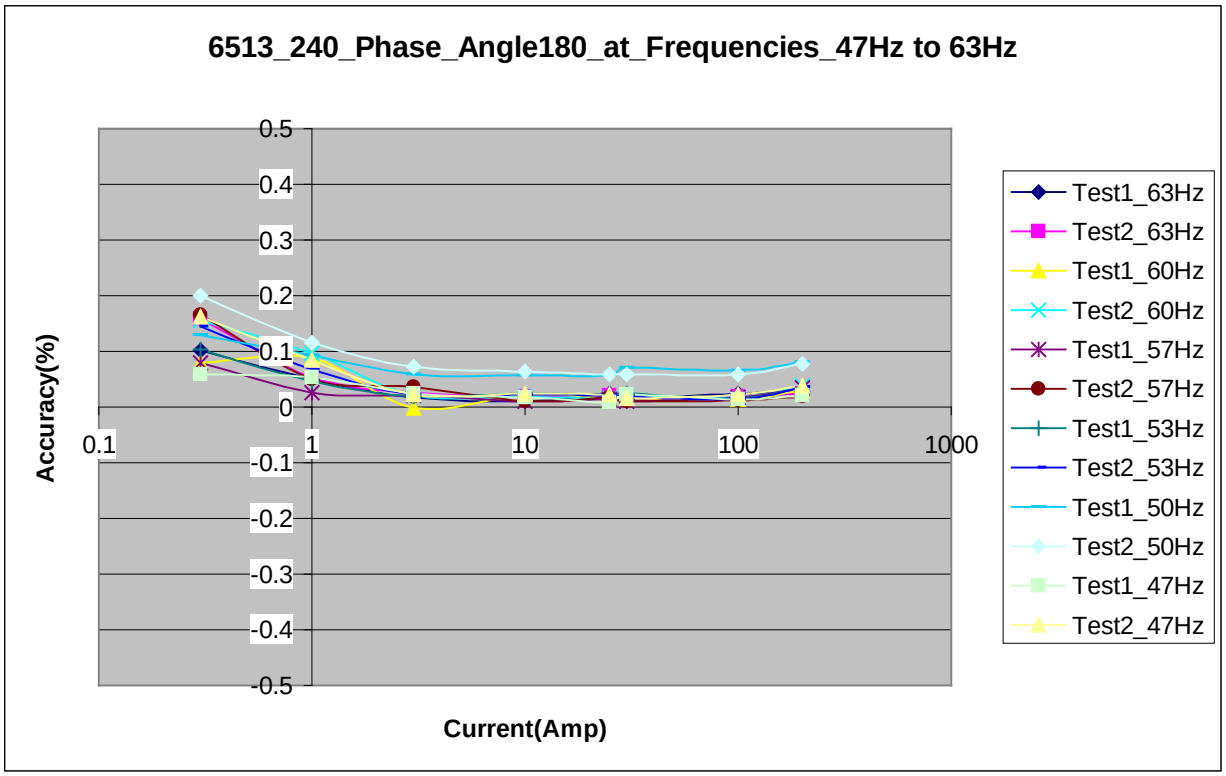
Test1_53Hz	Test2_53Hz	Test1_50Hz	Test2_50Hz	Test1_47Hz	Test2_47Hz
-0.0096	0.0911	0.0157	0.0929	0.001	-0.0005
-0.0266	0.0685	0.0137	0.0907	-0.0057	0.0664
-0.0115	0.0539	0.0228	0.087	-0.0154	0.0259
-0.0179	0.0459	-0.0014	0.0843	-0.0162	0.0448
-0.0275	0.0327	0.0045	0.0551	-0.026	0.0137
-0.0429	0.0229	-0.0149	0.0483	-0.0458	0.0051
-0.0928	0.0306	-0.071	0.045	-0.0994	0.0081
-0.2249	-0.0044	-0.196	0.1333	-0.2103	-0.0025



Phase_angle 180

step	amp	Test1_63Hz	Test2_63Hz	Test1_60Hz	Test2_60Hz	Test1_57Hz	Test2_57Hz
49	200	0.0282	0.0243	0.0301	0.0382	0.0339	0.0182
50	100	0.0235	0.0185	0.0132	0.0174	0.0168	0.0126
51	30	0.0136	0.0121	0.0151	0.0208	0.0098	0.01
52	25	0.0236	0.0215	0.0162	0.0157	0.0135	0.018
53	10	0.0104	0.0197	0.0231	0.0186	0.0109	0.0105
54	3	0.0175	0.0254	-0.0021	0.0206	0.0204	0.0359
55	1	0.0497	0.0528	0.0879	0.097	0.0253	0.0494
56	0.3	0.101	0.1584	0.08	0.1549	0.0791	0.165

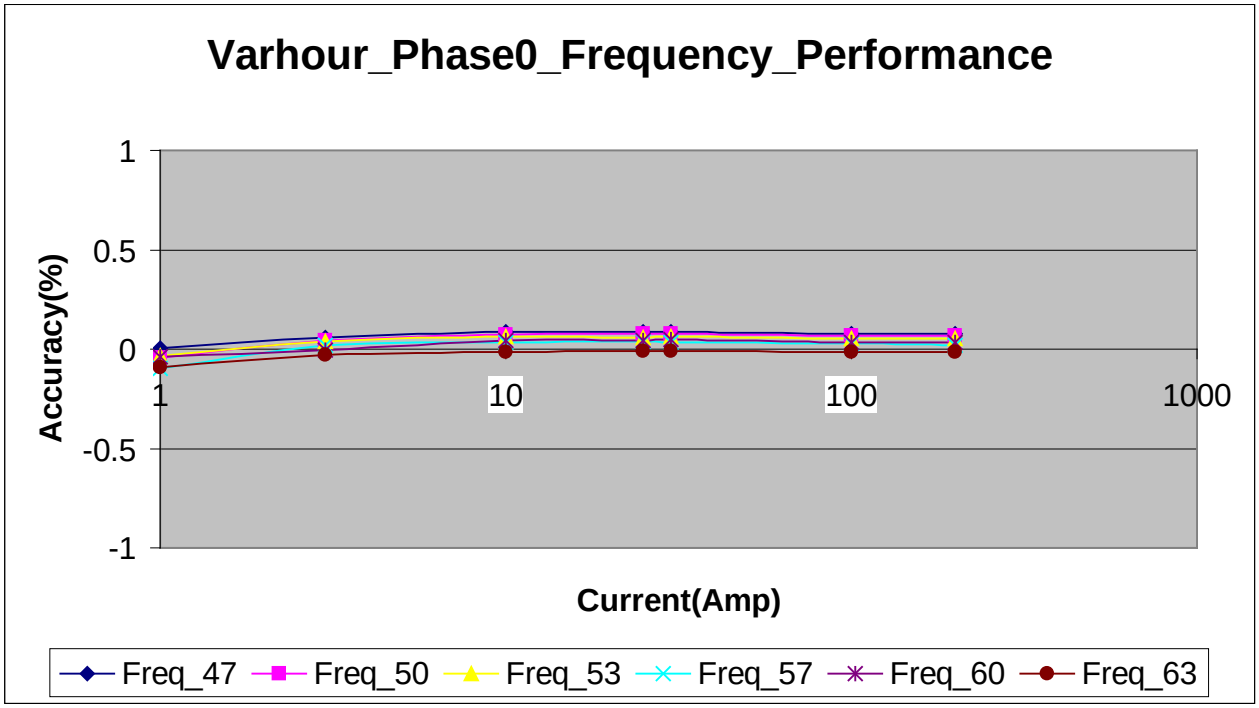
Test1_53Hz	Test2_53Hz	Test1_50Hz	Test2_50Hz	Test1_47Hz	Test2_47Hz
0.034	0.0367	0.0805	0.0783	0.0202	0.0379
0.0154	0.0143	0.0655	0.059	0.0145	0.0227
0.025	0.0198	0.0705	0.0582	0.0216	0.0154
0.0219	0.021	0.0569	0.0581	0.0085	0.0231
0.0233	0.0219	0.0574	0.064	0.0171	0.0244
0.0182	0.0222	0.0592	0.073	0.0234	0.0218
0.0462	0.0681	0.0923	0.1154	0.0541	0.085
0.1035	0.1452	0.1289	0.1995	0.0581	0.1625



Varhour Frequency variation test for various phase angles

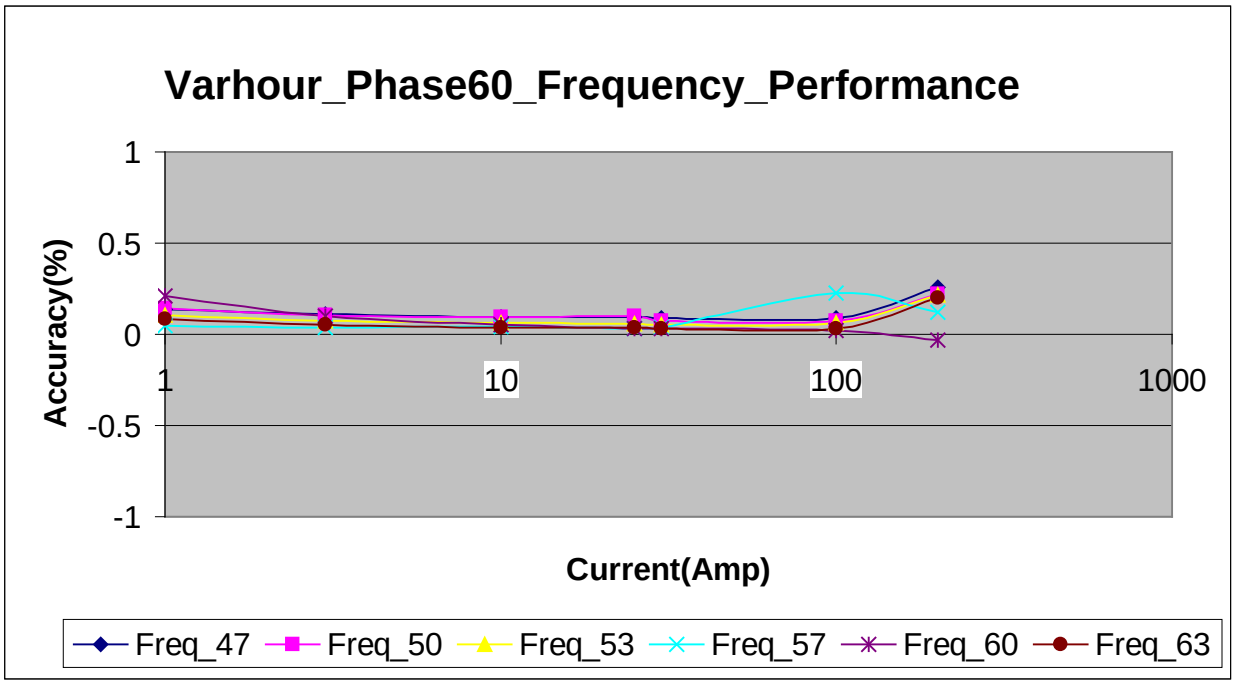
Phase_Angle0

step	volt	amp	Freq_47	Freq_50	Freq_53	Freq_57	Freq_60	Freq_63
1	120	200	0.0785	0.067	0.0526	0.0213	0.0335	-0.0151
2	120	100	0.0782	0.0677	0.0528	0.0294	0.0329	-0.0167
3	120	30	0.0874	0.0758	0.0604	0.0347	0.0466	-0.0109
4	120	25	0.0875	0.0751	0.0591	0.038	0.0437	-0.0114
5	120	10	0.0878	0.0718	0.0606	0.0361	0.043	-0.0158
6	120	3	0.0597	0.0456	0.04	0.0217	-0.003	-0.0307
7	120	1	0.004	-0.0422	-0.0322	-0.0969	-0.041	-0.0937



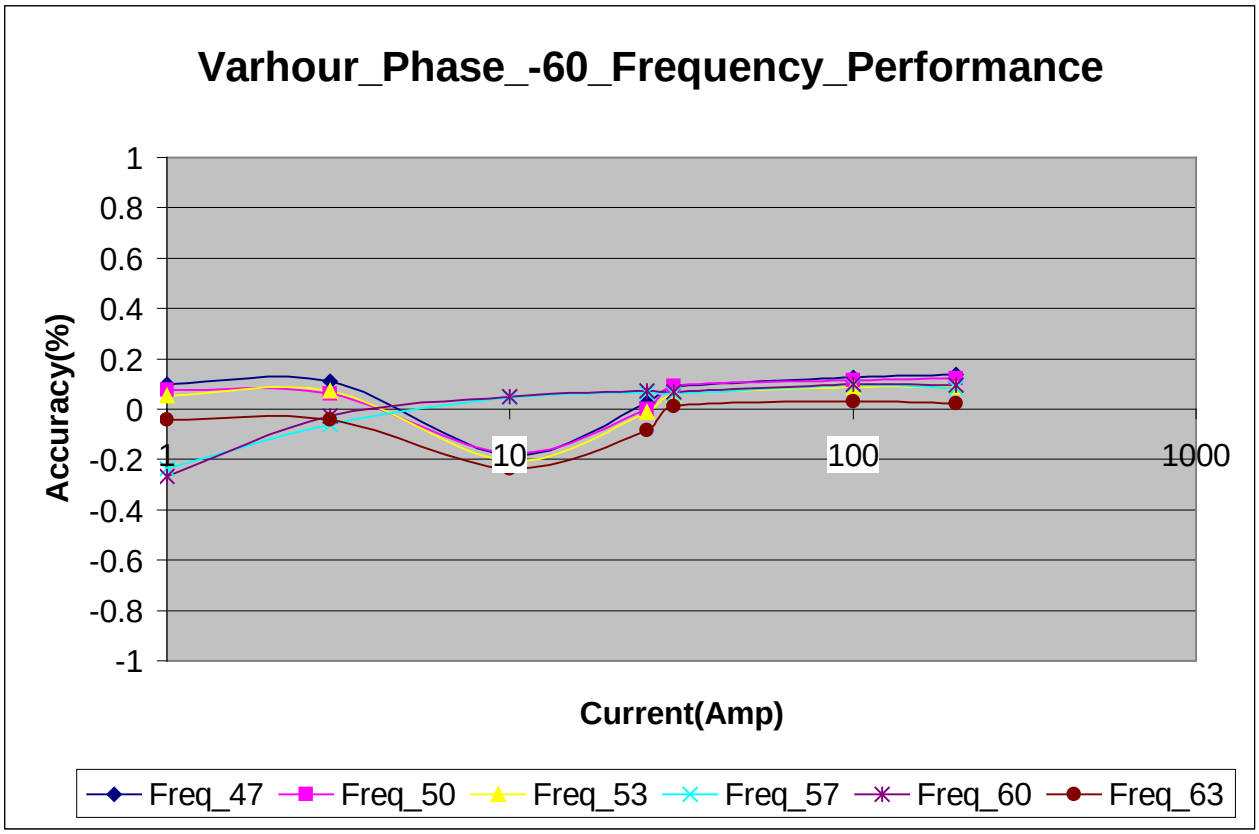
Phase_Angle60

step	volt	amp	Freq_47	Freq_50	Freq_53	Freq_57	Freq_60	Freq_63
17	120	200	0.1085	0.1045	0.0915	-0.0703	-0.0008	0.0088
18	120	100	0.078	0.0722	0.0459	-0.047	0.013	-0.0372
19	120	30	-0.0082	-0.0222	-0.1268	-0.016	0.0509	-0.1701
20	120	25	-0.0074	-0.0157	-0.0652	-0.0195	0.0582	-0.0925
21	120	10	-0.0177	-0.0087	-0.0524	-0.0152	0.0621	-0.0991
22	120	3	0.0251	0.0227	-0.0073	-0.0788	0.0125	-0.0593
23	120	1	0.0314	0.0307	-0.0133	-0.3669	-0.1583	-0.0554



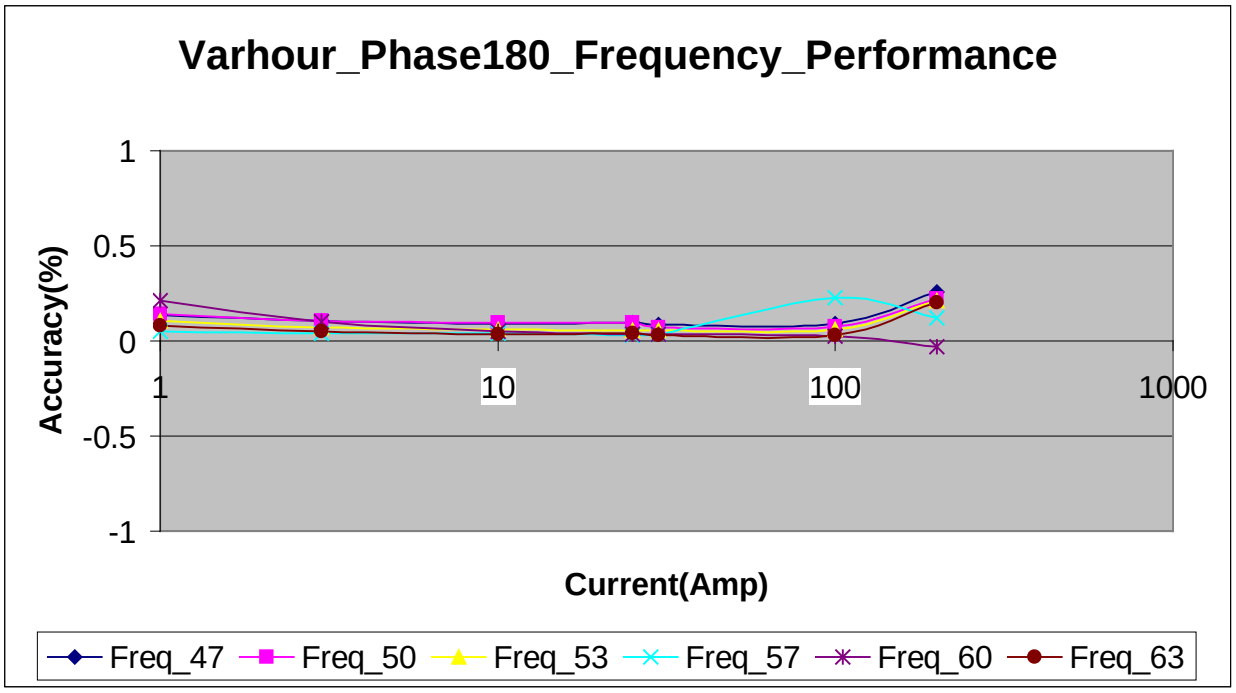
Phase_Angle-60

step	volt	amp	Freq_47	Freq_50	Freq_53	Freq_57	Freq_60	Freq_63
9	120	200	0.1384	0.1214	0.0881	0.0822	0.0965	0.023
10	120	100	0.1241	0.1137	0.0879	0.0944	0.0988	0.0304
11	120	30	0.0867	0.0919	0.0577	0.0603	0.0668	0.0103
12	120	25	0.027	-0.0002	-0.0129	0.0632	0.071	-0.0844
13	120	10	-0.1844	-0.1763	-0.2053	0.0462	0.0507	-0.2362
14	120	3	0.1101	0.0623	0.0735	-0.0599	-0.0265	-0.0433
15	120	1	0.0979	0.0768	0.0527	-0.2352	-0.2666	-0.041



Phase_Angle180

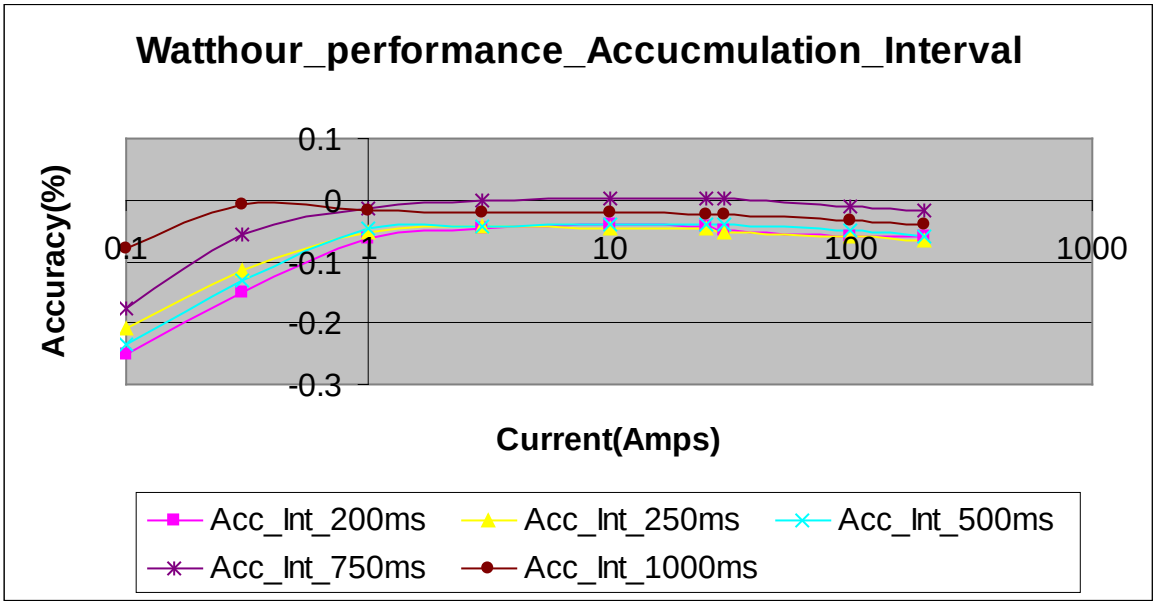
step	volt	amp	Freq_47	Freq_50	Freq_53	Freq_57	Freq_60	Freq_63
25	120	200	0.2582	0.2205	0.2133	0.1212	-0.0308	0.202
26	120	100	0.0918	0.0733	0.0617	0.2265	0.0235	0.0305
27	120	30	0.0883	0.0717	0.0535	0.0351	0.0337	0.0328
28	120	25	0.0966	0.0974	0.0569	0.0324	0.034	0.0387
29	120	10	0.0929	0.094	0.0626	0.0419	0.0502	0.037
30	120	3	0.1079	0.1048	0.0713	0.0392	0.1002	0.0525
31	120	1	0.138	0.1403	0.1045	0.0486	0.2098	0.0821



Accumulation interval variation

Watthour Performance with Sum Cycles (Accumulation Interval)

step	amp	Acc_Int_200ms	Acc_Int_250ms	Acc_Int_500ms	Acc_Int_750ms	Acc_Int_1000ms
1	200	-0.0591	-0.0647	-0.0583	-0.0162	-0.0395
2	100	-0.0592	-0.0581	-0.0503	-0.0107	-0.0345
3	30	-0.0483	-0.0521	-0.0384	0.002	-0.0241
4	25	-0.0438	-0.0476	-0.0409	0.0016	-0.023
5	10	-0.0413	-0.045	-0.0384	0.0032	-0.0199
6	3	-0.0451	-0.0442	-0.0429	0.0002	-0.0203
7	1	-0.0628	-0.0542	-0.0455	-0.0132	-0.0183
8	0.3	-0.1499	-0.1146	-0.1309	-0.056	-0.0088
9	0.1	-0.2504	-0.2103	-0.2349	-0.1757	-0.08



Harmonic Performance

Harmonic performance was tested with the Rotek calibrator. The signals supplied by the Rotek have been measured for the amount of distortion contained using a spectrum analyzer.

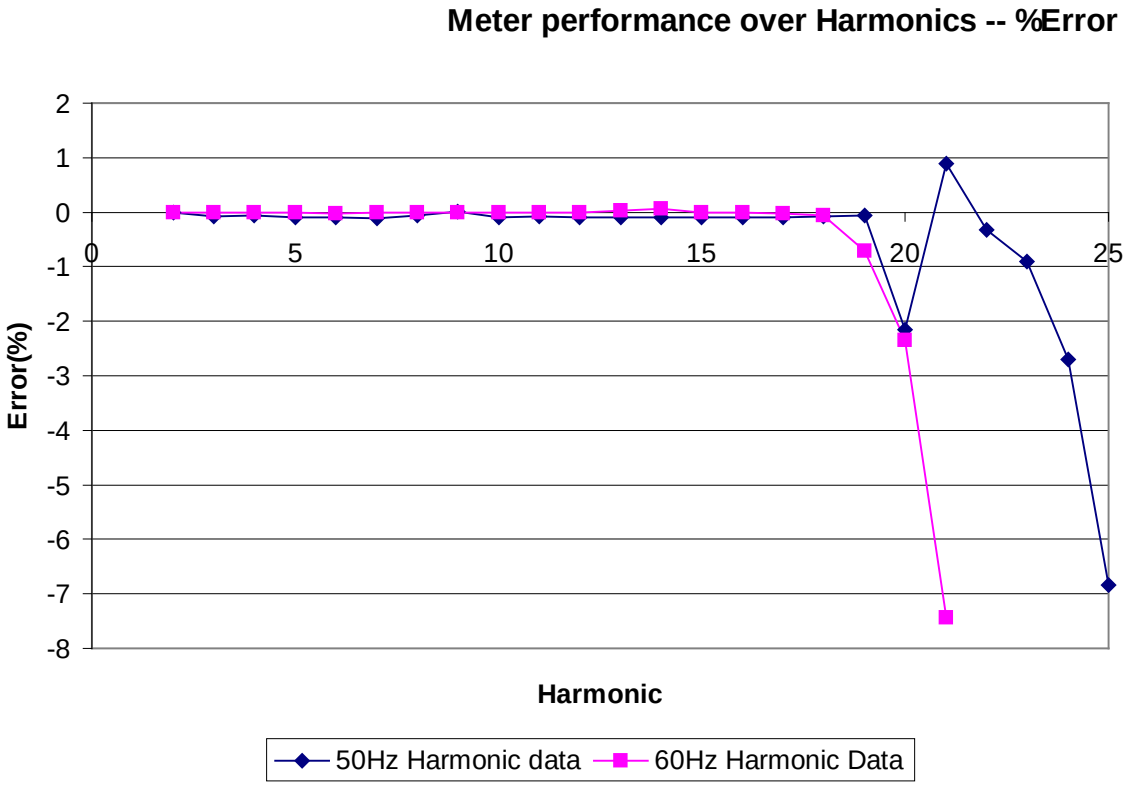
The distortion current and voltage amplitudes were introduced at various harmonic frequencies of both the 50 and 60Hz fundamental frequencies of operation. Results are provided below for both tests:

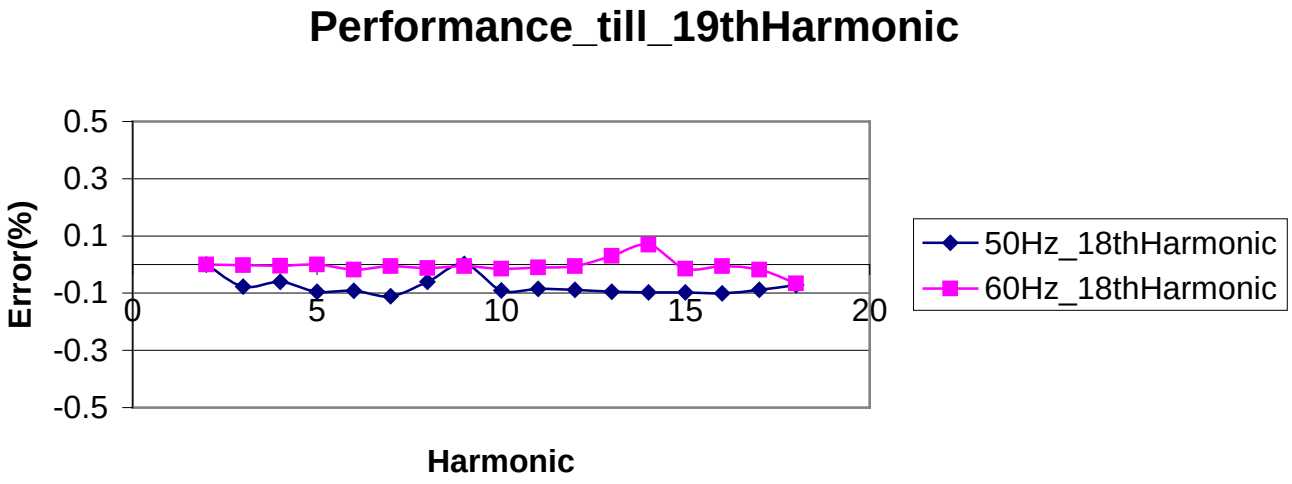
Harmonic performance results are provided for both 50Hz and 60Hz fundamental to the 25th harmonic at 50Hz and up to the 21st harmonic at 60Hz. Both measurements were performed at 240VAC and 30A. The current distortion amplitude was 40% in both tests; the voltage distortion amplitude was 10% in both tests. The results are listed in the tables below:

V	A	f [Hz]	Harmonic of 50Hz	Current Distortion Amplitude [%]	Voltage Distortion amplitude [%]	Result	Accuracy (%)
240	30	50	2	40	10	33.2	0
240	30	50	3	40	10	33.225	-0.0774108
240	30	50	4	40	10	33.219	-0.05994066
240	30	50	5	40	10	33.231	-0.09548337
240	30	50	6	40	10	33.23	-0.09126643
240	30	50	7	40	10	33.236	-0.11084504
240	30	50	8	40	10	33.22	-0.06054308
240	30	50	9	40	10	33.199	0.002108465
240	30	50	10	40	10	33.23	-0.09066402
240	30	50	11	40	10	33.228	-0.08554346
240	30	50	12	40	10	33.229	-0.08825434
240	30	50	13	40	10	33.231	-0.09548337
240	30	50	14	40	10	33.232	-0.09698941
240	30	50	15	40	10	33.232	-0.09729062
240	30	50	16	40	10	33.233	-0.10090513
240	30	50	17	40	10	33.229	-0.08855555
240	30	50	18	40	10	33.223	-0.07198904
240	30	50	19	40	10	33.222	-0.06837452
240	30	50	20	40	10	33.916	-2.15786382
240	30	50	21	40	10	32.907	0.882543412
240	30	50	22	40	10	33.306	-0.31988434
240	30	50	23	40	10	33.501	-0.90754379
240	30	50	24	40	10	34.095	-2.69732978
240	30	50	25	40	10	35.469	-6.83715116

V	A	Harmonic of 60Hz	f [Hz]	Result	Accuracy (%)
240	30	2	60	33.2298	0
240	30	3	60	33.2305	-0.00211
240	30	4	60	33.2313	-0.00451
240	30	5	60	33.2298	0
240	30	6	60	33.2359	-0.01836
240	30	7	60	33.2318	-0.00602
240	30	8	60	33.2339	-0.01234
240	30	9	60	33.2318	-0.00602
240	30	10	60	33.2347	-0.01475
240	30	11	60	33.2332	-0.01023
240	30	12	60	33.2318	-0.00602
240	30	13	60	33.2198	0.030093
240	30	14	60	33.2068	0.069215
240	30	15	60	33.2346	-0.01444
240	30	16	60	33.2318	-0.00602
240	30	17	60	33.2359	-0.01836
240	30	18	60	33.2519	-0.06651
240	30	19	60	33.4661	-0.71111
240	30	20	60	34.0121	-2.35421
240	30	21	60	35.7026	-7.44151

The meter performance is depicted in the figures that follow:


Meter performance over Harmonics -- %Error
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
0
5
10
15
20
25
Error(%)
Harmonic
50Hz Harmonic data
60Hz Harmonic Data


Performance_till_19thHarmonic
0.5
0.3
0.1
-0.1
-0.3
-0.5
0
5
10
15
20
Error(%)
Harmonic
50Hz_18thHarmonic
60Hz_18thHarmonic

Variation of Temperature

Linearity Test over Temperature

Linearity was tested over temperature using the available thermal stream equipment and three different chips. Parts were tested with and without temperature compensation. The mathematical compensation for performance is achieved using Compute Engine Firmware. All the results provided are compensated temperature performance.

The test results for the 71M6513 are listed in the table below:

step	element	V	A	phase angle	f	-5C	-40C	55C	25C	85C
1	S	240	200	0	60	-0.0066	0.0166	-0.0175	-0.022	-0.0285
2	S	240	100	0	60	-0.0377	-0.0184	-0.0099	-0.0163	-0.0184
3	S	240	30	0	60	-0.0507	-0.0434	0.0064	-0.0018	-0.0075
4	S	240	25	0	60	-0.0613	-0.0781	0.0195	-0.0054	-0.0076
5	S	240	10	0	60	-0.0637	-0.0727	0.0396	0.0063	0.0018
6	S	240	3	0	60	-0.0645	-0.0644	0.05	0.002	0.0161
7	S	240	1	0	60	-0.0533	-0.033	0.0586	0.0076	0.0262
8	S	240	0.3	0	60	-0.0522	-0.0072	0.0704	0.0241	0.0722
9	S	240	0.1	0	60	0.0144	0.1148	0.1634	0.1145	0.0938

The test results for chip #1 are shown in graphical form in the figure below: