Program to read sinusoidal fit data from "fitarray.txt" file and to compute tables and write to files

Read in data file names

$CWD := \text{"C:\WebberLocal\MIBPM_cable_offsets\data"}$

$fnames :=$ ...\fnames.txt

$lastfile := last(fnames)$ $\qquad rows(fnames) = 431$

$fnames := submatrix(fnames, 1, lastfile, 0, 0)$ Exclude first entry that is simply "fnames.txt"

Now read "fitarray.txt"

$fitarray := READPRN(\text{"fitarray.txt"})$

Now define "index" to be able to select scope trace data from a single cable pair

$index := 46 \qquad fnames_{index} = \text{"HP214_25.CSV"}$

Chkdat will be scope trace data from selected BPM cable pair: time, Channel 1, Channel 2

$chkdat := READPRN(fnames_{index})$

$xaxis := chkdat^{\langle 0 \rangle} \qquad chn1 := chkdat^{\langle 1 \rangle} \qquad chn2 := chkdat^{\langle 2 \rangle}$

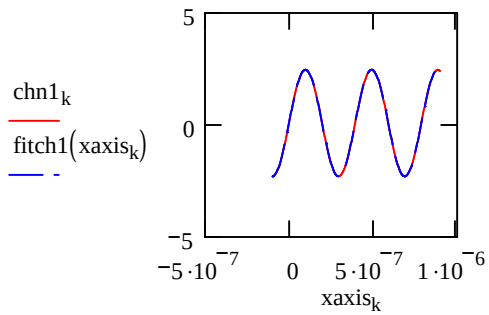
Read fit parameters for data from selected cables, compute fitted curve, and plot together as check of the fit

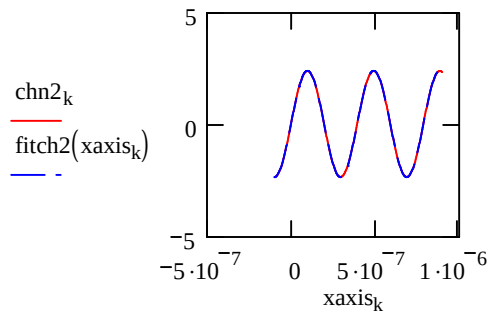
$thisbpm := submatrix(fitarray, 5 \cdot index, 5 \cdot index + 4, 0, 1)$

$k := 0 .. last(xaxis)$

$fitch1(t) := thisbpm_{1,0} \cdot \sin\left[\left(2 \cdot \pi \cdot thisbpm_{2,0} \cdot t\right) + thisbpm_{3,0}\right] + thisbpm_{4,0}$

$fitch2(t) := thisbpm_{1,1} \cdot \sin\left[\left(2 \cdot \pi \cdot thisbpm_{2,1} \cdot t\right) + thisbpm_{3,1}\right] + thisbpm_{4,1}$





Create header for "_outputfile.txt" that will contain BPM location, received signal amplitudes (in volts) through A and B cables respectively at each test frequency and the phase (in degrees) of the 53 MHz signals

WRITEPRN("_outputfile.txt") := (" BPM " " A2.5v " " B2.5v " " A53v " " B53v " " A53deg "

Correlate the 2.5 and 53 Mhz data from each cable pair, create two-column array with first column the indices of the 2.5 data in fitarray, second column indices of corresponding 53 data

```
corlat := | n ← 0
          | for row ∈ 0,5.. last(fitarray⟨0⟩)
          |   if substr(fitarray_row,0, 6, 2) = "25"
          |     | z_n,0 ← row
          |     | bpm ← substr(fitarray_row,0, 2, 3)
          |     | for r ∈ 0,5.. last(fitarray⟨0⟩)
          |     |   z_n,1 ← r  if substr(fitarray_r,0, 2, 6) = concat(bpm, "_53")
          |     | n ← n + 1
          | z
```

Now sort fitted data into array "out" and write to "_outputfile.txt" as:
BPM, A2.5v, B2.5v, A53v, B53v, A53deg, B53deg

$$
\text{out} := \left| \begin{array}{l}
\text{for } m \in 0..\text{rows}(\text{corlat}) - 1 \\
\quad \left| \begin{array}{l}
i25 \leftarrow \text{corlat}_{m,0} \\
i53 \leftarrow \text{corlat}_{m,1} \\
\text{sout}_{m,0} \leftarrow \text{substr}\left(\text{fitarray}_{i25,0}, 0, 5\right) \\
\text{sout}_{m,1} \leftarrow \text{fitarray}_{i25+1,0} \\
\text{sout}_{m,2} \leftarrow \text{fitarray}_{i25+1,1} \\
\text{sout}_{m,3} \leftarrow \text{fitarray}_{i53+1,0} \\
\text{sout}_{m,4} \leftarrow \text{fitarray}_{i53+1,1} \\
\text{sout}_{m,5} \leftarrow \frac{180}{\pi} \cdot \text{fitarray}_{i53+3,0} \\
\text{sout}_{m,6} \leftarrow \frac{180}{\pi} \cdot \text{fitarray}_{i53+3,1}
\end{array} \right. \\
\text{sout}
\end{array} \right.
$$

Put bogus number into one cable just to excentuate correction for check of sign

$$\text{bogus} := 0$$

$$\text{out}_{0,3} := \text{out}_{0,3} + \text{bogus}$$

$$\text{APPENDPRN}(\text{"_outputfile.txt"}) := \text{out}$$

Create header for file "_phases.txt" that will contain BPM location, received signal amplitudes (in volts) through A and B cables respectively at each test frequency and the 53 MHz received signal phases

$$\text{PRNCOLWIDTH} := 17$$

WRITEPRN("_phases.txt") := (" BPM " " A2.5deg " " B2.5deg " " A53deg " " B53deg "

$$\text{phasesout} := \left| \begin{array}{l} \text{for } m \in 0..\text{rows}(\text{corlat}) - 1 \\ \quad \left| \begin{array}{l} i25 \leftarrow \text{corlat}_{m,0} \\ i53 \leftarrow \text{corlat}_{m,1} \\ \text{sout}_{m,0} \leftarrow \text{substr}\left(\text{fitarray}_{i25,0}, 0, 5\right) \\ \text{sout}_{m,1} \leftarrow \frac{180}{\pi} \cdot \text{fitarray}_{i25+3,0} \\ \text{sout}_{m,2} \leftarrow \frac{180}{\pi} \cdot \text{fitarray}_{i25+3,1} \\ \text{sout}_{m,3} \leftarrow \frac{180}{\pi} \cdot \text{fitarray}_{i53+3,0} \\ \text{sout}_{m,4} \leftarrow \frac{180}{\pi} \cdot \text{fitarray}_{i53+3,1} \end{array} \right. \\ \text{APPENDPRN("_phases.txt", sout)} \\ \text{sout} \end{array} \right.$$

Now create new array "rawBoverAratios" containing three columns: BPM, 2.5 MHz B/A transmission ratio (linear, not db), and 53 MHz B/A transmission ratio

$$\text{rawBoverAratios} := \left| \begin{array}{l} \text{for } m \in 0..\text{rows}(\text{out}) - 1 \\ \quad \left| \begin{array}{l} \text{rat}_{m,0} \leftarrow \text{out}_{m,0} \\ \text{rat}_{m,1} \leftarrow \frac{\text{out}_{m,2}}{\text{out}_{m,1}} \\ \text{rat}_{m,2} \leftarrow \frac{\text{out}_{m,4}}{\text{out}_{m,3}} \\ \text{rat}_{m,3} \leftarrow \frac{\left(\text{out}_{m,2} - \text{out}_{m,1}\right)}{\left(\text{out}_{m,2} + \text{out}_{m,1}\right)} \\ \text{rat}_{m,4} \leftarrow \frac{\left(\text{out}_{m,4} - \text{out}_{m,3}\right)}{\left(\text{out}_{m,4} + \text{out}_{m,3}\right)} \end{array} \right. \\ \text{rat} \end{array} \right.$$

Now determine any systematic difference of B-over-A ratios from unity
(Mean > 0 implies B signals systematically greater than A signals

$$\text{mean25BoArat} := \text{mean}\left(\overrightarrow{\frac{\text{out}^{\langle 2\rangle}}{\text{out}^{\langle 1\rangle}}}\right) \qquad \text{mean25BoArat} = 1.006$$

$$\text{mean53BoArat} := \text{mean}\left(\overrightarrow{\frac{\text{out}^{\langle 4\rangle}}{\text{out}^{\langle 3\rangle}}}\right) \qquad \text{mean53BoArat} = 1.013$$

Now force the average ratios to unity by multiplying A amplitudes by the mean BoverA ratio (there is no reason to believe that A cables should be systematically different from B cables)

$$\text{A25corrected} := \text{mean25BoArat}\cdot\text{out}^{\langle 1\rangle}$$

$$\text{A53corrected} := \text{mean53BoArat}\cdot\text{out}^{\langle 3\rangle}$$

Check that this is correct

$$\text{mean}\left(\overrightarrow{\frac{\text{out}^{\langle 2\rangle}}{\text{A25corrected}}}\right) = 1 \qquad \text{mean}\left(\overrightarrow{\frac{\text{out}^{\langle 4\rangle}}{\text{A53corrected}}}\right) = 1$$

$$\text{normBoverAratios}^{\langle 0\rangle} := \text{out}^{\langle 0\rangle}$$

$$\text{normBoverAratios}^{\langle 1\rangle} := \overrightarrow{\frac{\text{out}^{\langle 2\rangle}}{\text{A25corrected}}}$$

$$\text{normBoverAratios}^{\langle 2\rangle} := \overrightarrow{\frac{\text{out}^{\langle 4\rangle}}{\text{A53corrected}}}$$

Now print file containing BPM, normalized 2.5 MHz B/A signal ratio, and normalized

53 MHz B/A signal ratio. This file then contains factors to be multiplied with A signal amplitudes from real beam signals so that cable gain differences are corrected

PRNCOLWIDTH := 35 PRNPRECISION := 4

WRITEPRN("_normalized_ratios.txt") := (" BPM " " 2.5MHz_B/A_xmsn " " 53MHz

APPENDPRN("_normalized_ratios.txt") := normBoverAratios

Following is just attempt to correlate systematic non-unity ratios to scope gain/signal amplitude or other things.

$$j := 0 .. \frac{(\mathrm{rows}(\mathrm{fitarray}) - 1)}{5}$$

$$kpp := 0 .. \mathrm{rows}(\mathrm{fitarray}) - 1$$

$$\mathrm{Ch1dc}_j := \left(\mathrm{fitarray}^{\langle 0 \rangle}\right)_{5 \cdot j + 4}$$

$$\mathrm{mean}(\mathrm{Ch1dc}) = 0.057$$

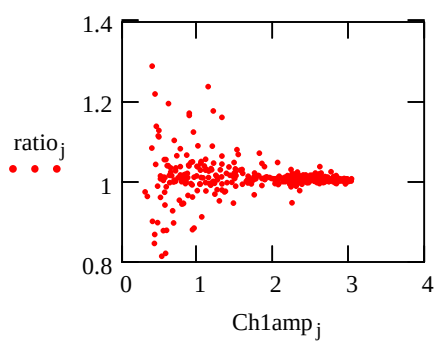
$$Ch1amp_j := \left(fitarray^{\langle 0 \rangle}\right)_{5\cdot j+1}$$

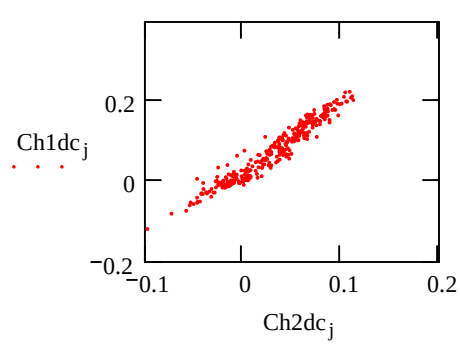
$$Ch2dc_j := \left(fitarray^{\langle 1 \rangle}\right)_{5\cdot j+4} \qquad mean(Ch2dc) = 0.018$$

$$Ch2amp_j := \left(fitarray^{\langle 1 \rangle}\right)_{5\cdot j+1}$$

$$nn := \left[0 .. \frac{(rows(fitarray) - 1)}{10}\right]$$

$$dbdiff_j := 20\cdot\log\left(\frac{Ch2amp_j}{Ch1amp_j}\right) \qquad ratio_j := \frac{Ch2amp_j}{Ch1amp_j}$$





fnames =

	0
0	"HP100_25.CSV"
1	"HP100_53.CSV"
2	"HP101_25.CSV"
3	"HP101_53.CSV"
4	"HP102_25.CSV"
5	"HP102_53.CSV"
6	"HP104_25.CSV"
7	"HP104_53.CSV"
8	"HP106_25.CSV"
9	"HP106_53.CSV"
10	"HP108_25.CSV"
11	"HP108_53.CSV"
12	"HP110_25.CSV"
13	"HP110_53.CSV"
14	"HP112_25.CSV"
15	"HP112_53.CSV"

$$\text{thisbpm} = \begin{pmatrix} \text{"HP214_25_Ch1"} & \text{"HP214_25_Ch2"} \\ 2.38 & 2.374 \\ 2.54 \times 10^{6} & 2.54 \times 10^{6} \\ 0.026 & 0.022 \\ 0.078 & 0.04 \end{pmatrix}$$

$\text{rows(fnames)} = 430$

$\text{rows(fitarray)} = 2.15 \times 10^{3}$

" B53deg")

fitarray =

	0	1
0	"HP100_25_Ch1"	"HP100_25_Ch2"
1	2.81	2.821
2	$2.54 \cdot 10^{6}$	$2.54 \cdot 10^{6}$
3	$-1.116 \cdot 10^{-3}$	$-4.808 \cdot 10^{-3}$
4	0.162	0.082
5	"HP100_53_Ch1"	"HP100_53_Ch2"
6	2.029	2.036
7	$5.282 \cdot 10^{7}$	$5.282 \cdot 10^{7}$
8	0.077	0.091
9	0.226	0.103
10	"HP101_25_Ch1"	"HP101_25_Ch2"
11	2.889	2.904
12	$2.54 \cdot 10^{6}$	$2.54 \cdot 10^{6}$
13	0.052	0.052
14	$-4.909 \cdot 10^{-4}$	-0.042
15	"HP101_53_Ch1"	"HP101_53_Ch2"

$\text{substr}\left(\text{fitarray}_{0,0}, 2, 6\right) = \text{"100_25"}$

corlat =

	0	1
0	0	5
1	10	$1.065 \cdot 10^{3}$
2	20	25
3	30	35
4	40	45
5	50	55
6	60	65
7	70	75
8	80	85
9	90	95
10	100	105
11	110	115
12	120	125
13	130	135
14	140	145
15	150	155

	0	1
0	"HP100_25_Ch1"	"HP100_25_Ch2"
1	2.81	2.821
2	$2.54 \cdot 10^{6}$	$2.54 \cdot 10^{6}$

)

fitarray =

3	$-1.116\cdot10^{-3}$	$-4.808\cdot10^{-3}$
4	0.162	0.082
5	"HP100_53_Ch1"	"HP100_53_Ch2"
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13	0.052	0.052
14	$-4.909\cdot10^{-4}$	-0.042
15	"HP101_53_Ch1"	"HP101_53_Ch2"

	0	1	2	3	4
0	"HP100"	1.004	1.003	$1.953\cdot10^{-3}$	$1.722\cdot10^{-3}$
1	"HP101"	1.005	1.004	$2.589\cdot10^{-3}$	$1.781\cdot10^{-3}$

rawBoverAratios =

2	"HP102"	1.004	1.006	$1.879 \cdot 10^{-3}$	$3.042 \cdot 10^{-3}$
3	"HP104"	1.005	1.008	$2.422 \cdot 10^{-3}$	$4.111 \cdot 10^{-3}$
4	"HP106"	1.004	1.006	$2.145 \cdot 10^{-3}$	$2.908 \cdot 10^{-3}$
5	"HP108"	1.003	1.005	$1.271 \cdot 10^{-3}$	$2.707 \cdot 10^{-3}$
6	"HP110"	1.003	0.998	$1.314 \cdot 10^{-3}$	$-1.083 \cdot 10^{-3}$
7	"HP112"	1.011	1.04	$5.272 \cdot 10^{-3}$	0.019
8	"HP114"	0.997	0.961	$-1.347 \cdot 10^{-3}$	-0.02
9	"HP116"	0.989	0.878	$-5.457 \cdot 10^{-3}$	-0.065
10	"HP118"	1.005	1.104	$2.324 \cdot 10^{-3}$	0.049
11	"HP120"	1.002	0.966	$1.211 \cdot 10^{-3}$	-0.017
12	"HP122"	1.017	1.051	$8.312 \cdot 10^{-3}$	0.025
13	"HP124"	0.999	0.952	$-3.736 \cdot 10^{-4}$	-0.024
14	"HP126"	1.006	1.049	$3.114 \cdot 10^{-3}$	0.024
15	"HP128"	1.005	1.011	$2.436 \cdot 10^{-3}$	$5.525 \cdot 10^{-3}$

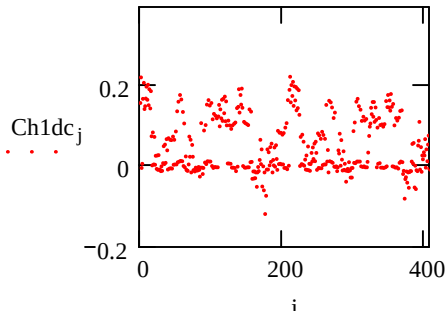
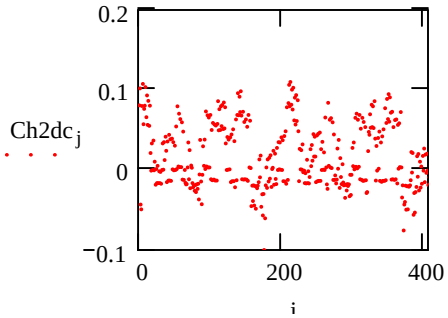
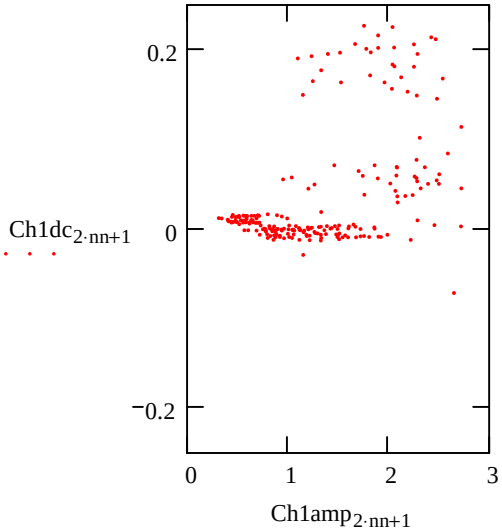
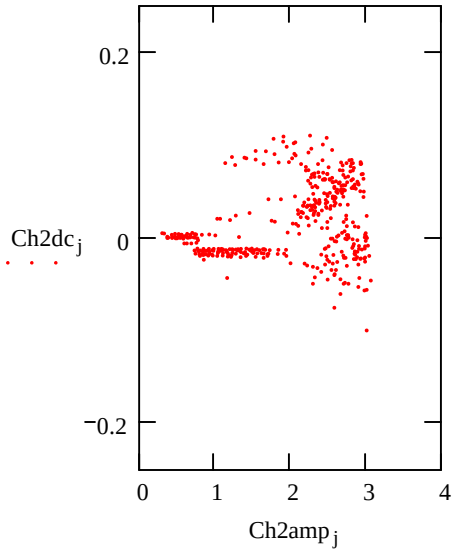
	0	1	2
0	"HP100"	0.998	0.991

z_B/A_xmsn")

normBoverAratios =

0	"HP100"	0.998	0.991
1	"HP101"	0.999	0.991
2	"HP102"	0.998	0.993
3	"HP104"	0.999	0.995
4	"HP106"	0.998	0.993
5	"HP108"	0.997	0.993
6	"HP110"	0.997	0.985
7	"HP112"	1.005	1.026
8	"HP114"	0.991	0.949
9	"HP116"	0.983	0.867
10	"HP118"	0.999	1.089
11	"HP120"	0.997	0.953
12	"HP122"	1.011	1.037
13	"HP124"	0.993	0.94
14	"HP126"	1	1.035
15	"HP128"	0.999	0.998

	0
0	2.81
1	2.029
2	2.889
3	2.276
4	2.921
5	2.458

Ch1amp =

6	2.883
7	2.18
8	2.791
9	1.886
10	2.75