Toyota Data Survey

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# Introduction

Towards the objective of Loading, Visualization, and Splitting of Data into Train/Validate/Test sets for algorithm development, comparison, and selection; initial data surveys were conducted on the Continuous, ADEF, Mentor Graphics, and Hardware in the Loop (HIL) datasets. Datasets were provided in various .xlsx, .mat, and .h5 formats. Some datasets were raw time series, some in various stages of curation, some were autoencoder outputs, some were Exponential Weighted Moving Average (EWMA) outputs.

# Data

## Continuous Dataset

Temperature, , , , and data were collected from IGBTs A5052, A5058, and other devices (A5003,A5054, B5025, and B5110). No failures were noted in this dataset.

### A5052

Data was ingested from the 0-200kcyc folder consisting of metadata (.mat), ten .xlsx files representing time series data, a .h5 file containing heterogenous data, and medians (.mat).

#### Metadata

A5052\_138k\_200k Metadata is included as a .mat file. This file includes a dataStruct that holds: (1,1) a note to see the h5 file for data and medians (1,3) a string which appears to include timestamps (2,1) a note that Restarts are ordered with "Row 1 start, Row 2 stop. (2,2) an unpopulated 2x1 double cell, I assume to hold start and stop times (2,3) a label the restart duration is ordered in Row 1/2/3 hours/minutes/seconds (2,4) a 3x1 dbl cell that is presumable included to hold restart data (2,5) A label indicating Restart Cycle Indices (2,6) Indices (3,5) A label indicating cycle lengths (3,6) A 61,700x3 cell presumably following the hours/minutes/seconds format for restarts.

rm(list = ls())  
setwd("~/Power\_Converters/data/Continuous Analysis Dataset/0-200kcyc/A\_5052")  
load("A5052meta.RData")  
summary(A5052meta)

## Length Class Mode   
## dataStruct 18 -none- list   
## 185100 -none- numeric  
## 494476168 -none- numeric

summary(A5052$dataStruct)

## Warning: Unknown or uninitialised column: `dataStruct`.

## Length Class Mode   
## 0 NULL NULL

#### A5052 Gaps

Data from A5052 Gaps was provided in .mat format. Gaps contain the indices of start/stop events.

gapsA5052$gaps

## [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12]  
## [1,] 3562 9442 11197 20635 36298 36866 107468 107507 138349 150138 61700 240850  
## [,13] [,14]  
## [1,] 256906 296195

rm(list = ls())

#### A5052 Time Series

A5052 Time Series data were presented in .xlsx format. This data contains fields for Time, (CH1-2-2), (CH1-2-6), (CH1-1-2), and (CH1-1-6). The statistics of this data were:

## Time CH1-2-2[V] Vf\_No.5052 CH1-2-6[V] Vg\_No.5052  
## '18-12-26 14:11:05.5s: 1 Min. :1.047 Min. :-0.478   
## '18-12-26 14:11:05.6s: 1 1st Qu.:1.055 1st Qu.: 0.045   
## '18-12-26 14:11:05.7s: 1 Median :1.097 Median :14.758   
## '18-12-26 14:11:05.8s: 1 Mean :1.189 Mean : 9.223   
## '18-12-26 14:11:05.9s: 1 3rd Qu.:1.375 3rd Qu.:14.761   
## '18-12-26 14:11:06.0s: 1 Max. :1.428 Max. :15.299   
## (Other) :9889499   
## CH1-1-2[V] Vce\_No.5052 CH1-1-6[A] Ice\_No.5052  
## Min. :0.005 Min. : -0.032   
## 1st Qu.:2.612 1st Qu.: 0.016   
## Median :2.643 Median :155.104   
## Mean :3.094 Mean : 96.858   
## 3rd Qu.:3.904 3rd Qu.:155.232   
## Max. :5.883 Max. :187.376   
##

#### A5052\_138k\_200k .h5 File

A .h5 file was included. The exact structure is unclear, but the dimensionality is as follows. I assume the temperature data is included in this file, as I could not find it elsewhere. V1 appears to contain indexes. V2 appears to contain V\_f, V3 appears to contain V\_g, V4 appears to contain V\_ce. V5-V7 are unclear as to the contents.

## group name otype dclass dim  
## 0 / time\_series H5I\_DATASET FLOAT 9889505 x 7

## list()

## V1 V2 V3 V4   
## Min. : 1 Min. :1.047 Min. :-0.478 Min. :0.005   
## 1st Qu.:2472377 1st Qu.:1.055 1st Qu.: 0.045 1st Qu.:2.612   
## Median :4944753 Median :1.097 Median :14.758 Median :2.643   
## Mean :4944753 Mean :1.189 Mean : 9.223 Mean :3.094   
## 3rd Qu.:7417129 3rd Qu.:1.375 3rd Qu.:14.761 3rd Qu.:3.904   
## Max. :9889505 Max. :1.428 Max. :15.299 Max. :5.883   
## V5 V6 V7   
## Min. : -0.032 Min. :-244.96875 Min. : -0.1248   
## 1st Qu.: 0.016 1st Qu.: 0.01684 1st Qu.: 0.0624   
## Median :155.104 Median : 0.01702 Median :397.0662   
## Mean : 96.858 Mean : Inf Mean :252.4243   
## 3rd Qu.:155.232 3rd Qu.: 244.46875 3rd Qu.:408.8389   
## Max. :187.376 Max. : Inf Max. :676.6342

#### A5052 Medians

Data from A5052 Medians was provided in .mat format. Medians is organized: Cycle index, Body diode voltage, Vgs, Vds, Ids, Rds

summary(medA5052$data)

## V1 V2 V3 V4   
## Min. : 1 Min. :1.048 Min. : 1.024 Min. :1.132   
## 1st Qu.: 75013 1st Qu.:1.059 1st Qu.: 14.754 1st Qu.:2.607   
## Median :150025 Median :1.059 Median : 14.760 Median :2.615   
## Mean :150025 Mean :1.063 Mean : 14.816 Mean :2.613   
## 3rd Qu.:225037 3rd Qu.:1.070 3rd Qu.: 14.934 3rd Qu.:2.624   
## Max. :300049 Max. :2.276 Max. :144.816 Max. :3.914   
## V5 V6   
## Min. : 0.0 Min. :0.01451   
## 1st Qu.:154.9 1st Qu.:0.01657   
## Median :155.2 Median :0.01690   
## Mean :155.7 Mean : Inf   
## 3rd Qu.:157.2 3rd Qu.:0.01692   
## Max. :159.2 Max. : Inf

### A5058

#### A5058 Gaps

Data from A5058 Gaps was provided in .mat format. Gaps contain the indices of start/stop events.

gapsA5058$gaps

## [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9]  
## [1,] 36294 107464 107502 138344 150133 61701 240846 256903 296193

#### A5058 Time Series

Time Series data from A5058 was provided in .xlsx format.

## Time CH1-2-4[V] Vf\_No.5058 CH1-2-8[V] Vg\_No.5058  
## '18-12-26 14:11:05.5s: 1 Min. :1.045 Min. :-0.363   
## '18-12-26 14:11:05.6s: 1 1st Qu.:1.053 1st Qu.: 0.042   
## '18-12-26 14:11:05.7s: 1 Median :1.098 Median :14.779   
## '18-12-26 14:11:05.8s: 1 Mean :1.186 Mean : 9.236   
## '18-12-26 14:11:05.9s: 1 3rd Qu.:1.366 3rd Qu.:14.783   
## '18-12-26 14:11:06.0s: 1 Max. :1.426 Max. :15.163   
## (Other) :9889499   
## CH1-1-4[V] Vce\_No.5058 CH1-1-8[A] Ice\_No.5058  
## Min. :0.0085 Min. : 0.016   
## 1st Qu.:2.4985 1st Qu.: 0.096   
## Median :2.5210 Median :149.584   
## Mean :3.0281 Mean : 93.450   
## 3rd Qu.:3.9120 3rd Qu.:149.712   
## Max. :5.8745 Max. :184.384   
##

#### A5058 Medians

Data from A5058 Medians was provided in .mat format. Medians is organized: Cycle index, Body diode voltage, Vgs, Vds, Ids, Rds

## V1 V2 V3 V4   
## Min. : 1 Min. :1.046 Min. :14.76 Min. :1.484   
## 1st Qu.: 75013 1st Qu.:1.058 1st Qu.:14.78 1st Qu.:2.489   
## Median :150024 Median :1.058 Median :14.78 Median :2.509   
## Mean :150024 Mean :1.062 Mean :14.84 Mean :2.503   
## 3rd Qu.:225036 3rd Qu.:1.071 3rd Qu.:14.96 3rd Qu.:2.511   
## Max. :300047 Max. :1.274 Max. :15.00 Max. :2.528   
## V5 V6   
## Min. :100.0 Min. :0.01484   
## 1st Qu.:149.7 1st Qu.:0.01640   
## Median :149.8 Median :0.01676   
## Mean :150.4 Mean :0.01664   
## 3rd Qu.:151.5 3rd Qu.:0.01677   
## Max. :153.6 Max. :0.01688

### Other Continuous Devices

Data from A5003, A5054, A5025, A5110 medians and gaps were included in .mat format.

#### Gaps

Gaps contain the indices of start/stop events.

gapsA5003$gaps

## [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9]  
## [1,] 35306 36372 107552 107563 138412 200045 240846 256902 296192

gapsA5054$gaps

## [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8]  
## [1,] 36294 107464 107502 138346 200045 240846 256903 296193

gapsA5025$gaps

## [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8]  
## [1,] 35306 36372 107552 107563 138412 200020 240821 256876

gapsA5110$gaps

## [,1] [,2] [,3] [,4] [,5] [,6]  
## [1,] 36371 107551 107566 138410 200019 240820

#### Medians

Medians is organized: Cycle index, Body diode voltage, Vgs, Vds, Ids, Rds. It would appear that “data” contains the medians, and “gaps” contain the gaps.

summary(medA5003$data)

## V1 V2 V3 V4   
## Min. : 1 Min. :1.039 Min. :14.74 Min. :1.492   
## 1st Qu.: 75012 1st Qu.:1.048 1st Qu.:14.75 1st Qu.:2.677   
## Median :150024 Median :1.048 Median :14.76 Median :2.705   
## Mean :150024 Mean :1.053 Mean :14.81 Mean :2.696   
## 3rd Qu.:225035 3rd Qu.:1.062 3rd Qu.:14.93 3rd Qu.:2.709   
## Max. :300046 Max. :1.279 Max. :14.99 Max. :2.724   
## V5 V6   
## Min. : 99.95 Min. :0.01493   
## 1st Qu.:156.26 1st Qu.:0.01688   
## Median :156.66 Median :0.01731   
## Mean :157.11 Mean :0.01716   
## 3rd Qu.:158.45 3rd Qu.:0.01733   
## Max. :159.55 Max. :0.01741

summary(medA5054$data)

## V1 V2 V3 V4   
## Min. : 1 Min. :1.048 Min. :14.76 Min. :1.440   
## 1st Qu.: 75013 1st Qu.:1.062 1st Qu.:14.77 1st Qu.:2.487   
## Median :150024 Median :1.062 Median :14.77 Median :2.508   
## Mean :150024 Mean :1.067 Mean :14.83 Mean :2.501   
## 3rd Qu.:225036 3rd Qu.:1.078 3rd Qu.:14.95 3rd Qu.:2.513   
## Max. :300047 Max. :1.271 Max. :14.99 Max. :2.546   
## V5 V6   
## Min. :100.0 Min. :0.01440   
## 1st Qu.:148.8 1st Qu.:0.01646   
## Median :149.0 Median :0.01686   
## Mean :149.6 Mean :0.01672   
## 3rd Qu.:150.7 3rd Qu.:0.01687   
## Max. :153.2 Max. :0.01706

summary(medA5025$data)

## V1 V2 V3 V4   
## Min. : 1 Min. :1.045 Min. : 1.111 Min. :1.510   
## 1st Qu.: 65864 1st Qu.:1.047 1st Qu.:14.762 1st Qu.:2.971   
## Median :131726 Median :1.048 Median :14.765 Median :2.993   
## Mean :131726 Mean :1.049 Mean :14.804 Mean :2.998   
## 3rd Qu.:197589 3rd Qu.:1.049 3rd Qu.:14.768 3rd Qu.:3.021   
## Max. :263451 Max. :1.301 Max. :15.036 Max. :3.905   
## V5 V6   
## Min. : -0.048 Min. :-81.34375   
## 1st Qu.:165.760 1st Qu.: 0.01788   
## Median :168.000 Median : 0.01793   
## Mean :167.580 Mean : 0.01758   
## 3rd Qu.:169.264 3rd Qu.: 0.01796   
## Max. :170.448 Max. : 0.01805

summary(medA5110$data)

## V1 V2 V3 V4   
## Min. : 1 Min. :1.047 Min. :14.72 Min. :1.528   
## 1st Qu.: 64188 1st Qu.:1.050 1st Qu.:14.73 1st Qu.:2.927   
## Median :128376 Median :1.051 Median :14.73 Median :2.936   
## Mean :128376 Mean :1.052 Mean :14.76 Mean :2.934   
## 3rd Qu.:192563 3rd Qu.:1.052 3rd Qu.:14.73 3rd Qu.:2.943   
## Max. :256750 Max. :1.292 Max. :14.97 Max. :2.957   
## V5 V6   
## Min. : 99.82 Min. :0.01531   
## 1st Qu.:163.25 1st Qu.:0.01791   
## Median :163.47 Median :0.01798   
## Mean :163.69 Mean :0.01792   
## 3rd Qu.:163.81 3rd Qu.:0.01800   
## Max. :165.66 Max. :0.01806

## ADEF

### Metadata

The ADEF\_combined contains .mats for index\_since\_restart and gaps.

## Length Class Mode   
## index.since.restart 289433 -none- numeric

## Length Class Mode   
## index.since.restart 289429 -none- numeric

## Length Class Mode   
## index.since.restart 226647 -none- numeric

## Length Class Mode   
## index.since.restart 165873 -none- numeric

## Length Class Mode   
## index.since.restart 6974 -none- numeric

## Length Class Mode   
## index.since.restart 220377 -none- numeric

## Length Class Mode   
## index.since.restart 194180 -none- numeric

## Length Class Mode   
## gaps 4 -none- numeric

## Length Class Mode   
## gaps 4 -none- numeric

## Length Class Mode   
## gaps 3 -none- numeric

## Length Class Mode   
## gaps 2 -none- numeric

## Length Class Mode   
## gaps 4 -none- numeric

## Length Class Mode   
## gaps 7 -none- numeric

## Length Class Mode   
## gaps 5 -none- numeric

### Time Series

#### Datasets 1,2,3

Temperature, V\_gs, I\_ds, and V\_ds data were collected from MOSFETs A47, A58, D80, D81, E84, E85, F88, and F89 with failures noted on E84, F88, and F89. 1) 2 on/6 off to A47, A58, D80, and D81 2) 5 on/6 off to E84, E85 {E84 failed - decreased current} 3) 10 on/6 off to F88 and F89 {both failed} plotDataMat\_Dshift was provided in the root folder. plotDataMat\_Dshift, medianOnData for each device (A47, A58, D80, D81, E84, E85, F88, F89) is provided in .mat format. .mat plotDataMat\_Dshift, medianOnData for each. My environment fails to load “plotDataMat\_Dshift.mat” due to size, so subset extraction will have to occur separately.

setwd("~/Power\_Converters/data/Datasets 1 ,2 ,3")  
load("datasets123.RData")  
#summary(plotDataMat\_Dshift)  
rm(list = ls())

#### Dataset1

Dataset 1 contains .xlsx time series data from A47, A58, D80, D81, E84, E85, F88, and F89. Though no headers are included, the columns can probably be deciphered from other datasets that do have labelled headers.

## 18-01-12 19:04:45.5s 1.4156 3.6999999999999998E-2 -1.5E-3   
## Length:59999 Min. :1.031 Min. :-0.097 Min. :-0.0015   
## Class :character 1st Qu.:1.218 1st Qu.: 0.037 1st Qu.: 4.4748   
## Mode :character Median :1.359 Median : 0.040 Median : 4.5045   
## Mean :1.299 Mean : 3.721 Mean : 4.0140   
## 3rd Qu.:1.393 3rd Qu.: 0.112 3rd Qu.: 4.5060   
## Max. :1.416 Max. :14.964 Max. : 4.6805   
## 0   
## Min. : -1.350   
## 1st Qu.: 0.000   
## Median : 0.060   
## Mean : 38.537   
## 3rd Qu.: 4.005   
## Max. :211.590

#### Dataset 3

Presented as a Zip folder containing .mat files. Dataset 3 contains .xlsx Time Series data from A47, A58, D80, D81, E84, E85, F88, and F89. Though many if not all contain no headers, the columns can probably be deciphered from other datasets that do have labeled headers. Also included is TRI-NA\_Data-set table\_STEP3\_1130…xlsx

#THIS IS JUST ONE...MANY MORE TO READ  
summary(ADEFdataset3)

## 18-02-08 10:56:56.0s 1.415 4.1000000000000002E-2 0   
## Length:59999 Min. :1.031 Min. :-0.115 Min. :-0.5325   
## Class :character 1st Qu.:1.218 1st Qu.: 0.041 1st Qu.: 4.4698   
## Mode :character Median :1.363 Median : 0.042 Median : 4.5100   
## Mean :1.301 Mean : 3.717 Mean : 4.0206   
## 3rd Qu.:1.395 3rd Qu.: 0.051 3rd Qu.: 4.5100   
## Max. :1.415 Max. :14.944 Max. : 4.6700   
## 0.15   
## Min. : -1.170   
## 1st Qu.: 0.120   
## Median : 0.150   
## Mean : 38.790   
## 3rd Qu.: 0.765   
## Max. :211.560

#### Raw Datasets

Data from “raw dataset1 and raw dataset2” and “raw dataset3” were loaded. “Raw dataset1 and raw dataset2” Consists of plotDataMat\_Dshift.mat Raw Dataset 3 was extracted from a .zip file and consists of “Copy of rawData\* (1).mat” files for each device. It is unclear whether or not this data is redundant to dataset 3 data found elsewhere.

#THIS IS JUST ONE...MANY MORE TO READ  
#summary(plotDataMat\_Dshift)

rm(list = ls())  
setwd("~/Power\_Converters/data/Datasets 1 ,2 ,3/raw dataset3")  
load("rawDataset3.RData")  
  
summary(rawDataA47)

## Length Class Mode   
## dataStruct 3 -none- list   
## MCOS 6 -none- raw   
## 6 -none- numeric  
## 85305032 -none- numeric

#### Delta

The “delta Tj from rainflow” folder contains a .mat for each of DS1,2,3. Data from A47 dataset 1 was read.

summary(DS1\_A47\_delataTj$deltaTj)

## V1   
## Min. :0.3195   
## 1st Qu.:0.3463   
## Median :0.3540   
## Mean :0.3537   
## 3rd Qu.:0.3613   
## Max. :0.3870

### Medians

#### Dataset 1, 2, 3

The root Datasets 1,2,3 folder contains "medianOnData\*.mat" files for A47, A58, D80, D81, E84, E85, F88, F89.

setwd("~/Power\_Converters/data/Datasets 1 ,2 ,3")  
load("medOnData.RData")  
summary(medOnDataA47)  
summary(medOnDataA58)  
summary(medOnDataD80)  
summary(medOnDataD81)  
summary(medOnDataE85)  
summary(medOnDataF88)  
summary(medOnDataF89)  
  
#summary(medOnDataA47$dataStruct)  
#summary(medOnDataA47$MCOS)  
#summary(medOnDataA47$``)  
rm(list = ls())

setwd("~/Power\_Converters/data/Datasets 1 ,2 ,3/ADEF\_Combined")  
  
mediansA47<-readMat("mediansA47.mat")  
mediansA58<-readMat("mediansA58.mat")  
mediansD80<-readMat("mediansD80.mat")  
mediansD81<-readMat("mediansD81.mat")  
mediansE84<-readMat("mediansE84.mat")  
mediansE85<-readMat("mediansE85.mat")  
mediansF88<-readMat("mediansF88.mat")  
mediansF89<-readMat("mediansF89.mat")  
  
save.image("ADEF\_Combined\_Medians.RData")

#### JK Median Filtered Files

Contains .mat files for median OnOffData47\_dataset1 + Individual MOSFET files.

setwd("~/Power\_Converters/data/Datasets 1 ,2 ,3/John\_Kaminski\_Median\_Filtered\_Files")  
load("jkMed.RData")  
summary(A47\_med\_fil$A47)

## Length Class Mode  
## [1,] 1 -none- list  
## [2,] 1 -none- list  
## [3,] 1 -none- list  
## [4,] 1 -none- list  
## [5,] 1 -none- list  
## [6,] 1 -none- list

summary(medOnOffDataA47\_dataset1)

## Length Class Mode   
## dataStruct 14 -none- list   
## 0 -none- NULL   
## 78849 -none- numeric  
## 0 -none- NULL   
## 60852384 -none- numeric

rm(list = ls())

#### Autoencoder Outputs

The autoencoder\_ADEF contains train and test encoded/decoded from the output of the Autoencoder for each dataset - provided in .mat format.

summary(F89\_test\_decoded$F89.test.decoded)

## V1 V2 V3   
## Min. :1.394 Min. :111.8 Min. :0.01650   
## 1st Qu.:2.917 1st Qu.:164.7 1st Qu.:0.01769   
## Median :2.949 Median :165.8 Median :0.01775   
## Mean :2.991 Mean :167.2 Mean :0.01770   
## 3rd Qu.:3.106 3rd Qu.:171.3 3rd Qu.:0.01780   
## Max. :3.178 Max. :173.8 Max. :0.01792

### EWMA Medians

Output from the EWMA Medians were provided in .mat format.

summary(ewmaMedA47$data)

## V1 V2 V3   
## Min. : 1 Min. :-0.1918000 Min. :-7.300e-02   
## 1st Qu.: 72359 1st Qu.:-0.0107878 1st Qu.:-5.310e-04   
## Median :144717 Median :-0.0013673 Median : 1.395e-05   
## Mean :144717 Mean :-0.0004234 Mean :-1.714e-04   
## 3rd Qu.:217075 3rd Qu.: 0.0097696 3rd Qu.: 4.703e-04   
## Max. :289433 Max. : 0.1958481 Max. : 8.264e-02   
## V4 V5 V6   
## Min. :-0.9856904 Min. :-53.23093 Min. :-1.202e-03   
## 1st Qu.:-0.0090881 1st Qu.: -0.09821 1st Qu.:-5.996e-05   
## Median :-0.0004685 Median : -0.00015 Median :-3.690e-06   
## Mean : 0.0020855 Mean : 0.10324 Mean : 3.456e-06   
## 3rd Qu.: 0.0094403 3rd Qu.: 0.09805 3rd Qu.: 6.093e-05   
## Max. : 0.9737500 Max. : 51.99000 Max. : 1.457e-03

summary(ewmaMedA58$data)

## V1 V2 V3   
## Min. : 1 Min. :-0.1975355 Min. :-0.0690000   
## 1st Qu.: 72358 1st Qu.:-0.0109621 1st Qu.:-0.0003951   
## Median :144715 Median :-0.0013524 Median : 0.0000052   
## Mean :144715 Mean :-0.0003987 Mean :-0.0001643   
## 3rd Qu.:217072 3rd Qu.: 0.0099700 3rd Qu.: 0.0003445   
## Max. :289429 Max. : 0.1549500 Max. : 0.0715778   
## V4 V5 V6   
## Min. :-0.7402500 Min. :-40.00500 Min. :-8.402e-04   
## 1st Qu.:-0.0104783 1st Qu.: -0.09976 1st Qu.:-6.975e-05   
## Median :-0.0005096 Median : 0.00130 Median :-4.097e-06   
## Mean : 0.0020720 Mean : 0.09859 Mean : 3.509e-06   
## 3rd Qu.: 0.0105990 3rd Qu.: 0.10462 3rd Qu.: 6.921e-05   
## Max. : 1.0257973 Max. : 50.14500 Max. : 1.744e-03

summary(ewmaMedD80$data)

## V1 V2 V3 V4   
## Min. : 1 Min. :-0.1421500 Min. :-9.305e-02 Min. :-0.114598   
## 1st Qu.: 56663 1st Qu.:-0.0093960 1st Qu.:-4.029e-04 1st Qu.:-0.017330   
## Median :113324 Median :-0.0013991 Median :-7.730e-06 Median : 0.001149   
## Mean :113324 Mean :-0.0002448 Mean :-7.264e-05 Mean : 0.001576   
## 3rd Qu.:169986 3rd Qu.: 0.0088688 3rd Qu.: 3.785e-04 3rd Qu.: 0.018225   
## Max. :226647 Max. : 0.0225729 Max. : 2.407e-03 Max. : 0.779500   
## V5 V6   
## Min. :-0.52671 Min. :-6.280e-04   
## 1st Qu.:-0.08662 1st Qu.:-9.819e-05   
## Median :-0.00550 Median : 5.989e-06   
## Mean : 0.05936 Mean : 3.560e-06   
## 3rd Qu.: 0.08130 3rd Qu.: 1.024e-04   
## Max. :29.34000 Max. : 1.764e-03

summary(ewmaMedE84$data)

## V1 V2 V3 V4   
## Min. : 1 Min. :-0.2255863 Min. :-0.0828100 Min. :-0.0154993   
## 1st Qu.:1744 1st Qu.:-0.0030687 1st Qu.:-0.0005526 1st Qu.:-0.0038070   
## Median :3488 Median :-0.0007513 Median :-0.0001361 Median : 0.0006531   
## Mean :3488 Mean :-0.0069090 Mean :-0.0025593 Mean : 0.0396166   
## 3rd Qu.:5231 3rd Qu.: 0.0017823 3rd Qu.: 0.0004307 3rd Qu.: 0.0057631   
## Max. :6974 Max. : 0.0059061 Max. : 0.0017265 Max. : 1.2852438   
## V5 V6   
## Min. :-0.41116 Min. :-7.468e-05   
## 1st Qu.:-0.10183 1st Qu.:-1.793e-05   
## Median :-0.01359 Median : 6.485e-06   
## Mean : 1.91316 Mean : 6.660e-05   
## 3rd Qu.: 0.10755 3rd Qu.: 3.233e-05   
## Max. :63.38376 Max. : 2.106e-03

summary(ewmaMedE85$data)

## V1 V2 V3   
## Min. : 1 Min. :-0.2191866 Min. :-7.629e-02   
## 1st Qu.: 77152 1st Qu.:-0.0023471 1st Qu.:-3.639e-04   
## Median :154304 Median :-0.0001440 Median :-3.095e-05   
## Mean :154304 Mean :-0.0002334 Mean :-9.666e-05   
## 3rd Qu.:231455 3rd Qu.: 0.0022337 3rd Qu.: 3.327e-04   
## Max. :308606 Max. : 0.0081833 Max. : 2.913e-03   
## V4 V5 V6   
## Min. :-0.0289402 Min. :-0.50946 Min. :-1.784e-04   
## 1st Qu.:-0.0036745 1st Qu.:-0.06461 1st Qu.:-2.203e-05   
## Median : 0.0002533 Median :-0.00022 Median : 1.244e-06   
## Mean : 0.0015738 Mean : 0.06611 Mean : 3.348e-06   
## 3rd Qu.: 0.0040804 3rd Qu.: 0.06901 3rd Qu.: 2.385e-05   
## Max. : 1.2171287 Max. :58.60508 Max. : 2.167e-03

summary(ewmaMedF88$data)

## V1 V2 V3   
## Min. : 1 Min. :-2.374e-01 Min. :-13.702607   
## 1st Qu.: 55095 1st Qu.:-6.105e-04 1st Qu.: -0.000306   
## Median :110189 Median :-3.903e-05 Median : 0.000052   
## Mean :110189 Mean :-6.239e-04 Mean : -0.000204   
## 3rd Qu.:165283 3rd Qu.: 5.200e-04 3rd Qu.: 0.000384   
## Max. :220377 Max. : 2.356e-01 Max. : 0.086645   
##   
## V4 V5 V6   
## Min. :-3.0473128 Min. :-173.29332 Min. :-0.018   
## 1st Qu.:-0.0019602 1st Qu.: -0.06349 1st Qu.: 0.000   
## Median : 0.0000000 Median : 0.01230 Median : 0.000   
## Mean : 0.0004444 Mean : 0.12002 Mean : 0.000   
## 3rd Qu.: 0.0022176 3rd Qu.: 0.10518 3rd Qu.: 0.000   
## Max. : 1.2807578 Max. : 63.41493 Max. : 0.002   
## NA's :18012

summary(ewmaMedF89$data)

## V1 V2 V3   
## Min. : 1 Min. :-0.2383500 Min. :-8.000e-02   
## 1st Qu.: 48546 1st Qu.:-0.0010157 1st Qu.:-3.463e-04   
## Median : 97091 Median :-0.0001302 Median : 3.401e-05   
## Mean : 97091 Mean :-0.0007459 Mean :-2.564e-04   
## 3rd Qu.:145635 3rd Qu.: 0.0007096 3rd Qu.: 2.951e-04   
## Max. :194180 Max. : 0.2541627 Max. : 8.944e-02   
## V4 V5 V6   
## Min. :-1.3687819 Min. :-63.61692 Min. :-2.411e-03   
## 1st Qu.:-0.0026015 1st Qu.: -0.07511 1st Qu.:-1.051e-05   
## Median : 0.0004461 Median : 0.00475 Median : 2.191e-06   
## Mean : 0.0042837 Mean : 0.18129 Mean : 8.985e-06   
## 3rd Qu.: 0.0035609 3rd Qu.: 0.08758 3rd Qu.: 1.490e-05   
## Max. : 1.4460000 Max. : 65.10000 Max. : 2.870e-03

#### ewma\_autoencoder\_adef:

.mat encoded/decoded train and test sets for each device.

summary(eF89\_test\_decoded$F89.test.decoded)

## V1 V2 V3   
## Min. :-1.53266 Min. :-77.22110 Min. :-1.913e-03   
## 1st Qu.:-0.04170 1st Qu.: -0.54034 1st Qu.: 5.968e-06   
## Median :-0.03604 Median : -0.26716 Median : 1.395e-05   
## Mean :-0.03325 Mean : -0.14729 Mean : 1.839e-05   
## 3rd Qu.:-0.03031 3rd Qu.: 0.00792 3rd Qu.: 2.203e-05   
## Max. : 1.41500 Max. : 67.03312 Max. : 2.150e-03

## Mentor Graphics Dataset

Devices: MOSFETs s1-s6 File: CombinedMatrix\_V3.mat (included in “MG Data and EWMA” and “MG Data and EWMA/Mentor” folders). Notes: notes.docx Cycling Temperature, Delta Temperature, R\_th\_Ja(?) ({)9 features total) were collected from devices S1.1, S1.3, S2.1, S2.3, S3.1, S3.3, S4.1, S4.3, S5.3 (Exp 1) and S5.3 (Exp3) using a control strategy of maintaining a constant maximum junction temperature during conductive periods by changing load current with failures noted on S3.3, S4.3, and S5.3 (Exp 3) 3 experiments conducted: 1) 5 on/5 off applied to all 6 modules (S1.1-S6.1) 2) 40 on/10 off applied to all 6 (S1.3-S6.3) {S3.3 failed - broken bond wire, S4.3 failed soon after - short circuit} 3) 40 on/10 off applied to S5.3 and S6.3 (S5.3 TIM2 delamination during "experimental session 2)

### Combined Matrix

Medians and ewmamedians from the Mentor Graphics dataset provided in .mat format. See Description.docx. Combined Matrix v3 contains 19 features.

CombinedMatrix\_V3: 1. NewOrOld: 0 is old, 1 is new 2. ON\_Time: 40 and 5 3. OFF\_Time: 10 and 5 4. Module\_Num: 1-6 5. Device\_Position: 1 and 3 6. Case\_Temp 7. Cycle\_Number (1) 8. ‘Cycling\_Current’ (2) 9. ‘Delta\_temp’ (3) 10. ‘Normalized\_RthJA’ (4) 11. ‘Power\_Step’ (5) 12. ‘Tj\_max\_hot’ (6) 13. ‘Tj\_min\_cold’ (7) 14. ‘Vcold\_Measurement\_Current’ (8) 15. ‘Vhot\_Measurement\_Current’ (9) 16. ‘Von\_Cycling\_current’ (10) 17. ‘R\_ds’ (11) 18. RUL 19. Falure\_Flag: 1 is fail, 0 is not fail

load("~/Power\_Converters/data/MG Data and EWMA/MGcombMat.RData")  
  
  
MGCombData<-data.frame(NewOrOld=combMatData[,1],  
 ON\_Time=combMatData[,2],  
 OFF\_Time=combMatData[,3],  
 Model\_Num=combMatData[,4],  
 Device\_Position=combMatData[,5],  
 Case\_Temp=combMatData[,6],  
 Cycle\_Num=combMatData[,7],  
 Cycling\_Current=combMatData[,8],  
 Delta\_temp=combMatData[,9],  
 Normalized\_RthJA=combMatData[,10],  
 Power\_Step=combMatData[,11],  
 Tj\_max\_hot=combMatData[,12],  
 Tj\_min\_cold=combMatData[,13],  
 Vcold\_Measurement\_Current=combMatData[,14],  
 Vhot\_Measurement\_Current=combMatData[,15],  
 Von\_Cycling\_current=combMatData[,16],  
 R\_ds=combMatData[,17],  
 RUL=combMatData[,18],  
 Falure\_Flag=combMatData[,19]  
 )  
  
  
summary(MGCombData)

## NewOrOld ON\_Time OFF\_Time Model\_Num   
## Min. :0.0000 Min. : 5.00 Min. : 5.000 Min. :1.000   
## 1st Qu.:0.0000 1st Qu.: 5.00 1st Qu.: 5.000 1st Qu.:2.000   
## Median :0.0000 Median :40.00 Median :10.000 Median :4.000   
## Mean :0.2743 Mean :23.26 Mean : 7.608 Mean :3.869   
## 3rd Qu.:1.0000 3rd Qu.:40.00 3rd Qu.:10.000 3rd Qu.:5.000   
## Max. :1.0000 Max. :40.00 Max. :10.000 Max. :6.000   
## Device\_Position Case\_Temp Cycle\_Num Cycling\_Current  
## Min. :1.000 Min. :65.56 Min. : 0 Min. :42.26   
## 1st Qu.:1.000 1st Qu.:66.29 1st Qu.:11763 1st Qu.:47.08   
## Median :3.000 Median :67.11 Median :23528 Median :50.98   
## Mean :2.043 Mean :67.27 Mean :24310 Mean :50.12   
## 3rd Qu.:3.000 3rd Qu.:67.49 3rd Qu.:35864 3rd Qu.:52.05   
## Max. :3.000 Max. :70.58 Max. :57428 Max. :56.58   
## Delta\_temp Normalized\_RthJA Power\_Step Tj\_max\_hot   
## Min. :38.88 Min. :0.4259 Min. : 76.17 Min. :103.6   
## 1st Qu.:51.58 1st Qu.:0.5120 1st Qu.: 99.05 1st Qu.:114.6   
## Median :55.28 Median :0.5298 Median :108.45 Median :121.0   
## Mean :60.79 Mean :0.5335 Mean :113.28 Mean :126.6   
## 3rd Qu.:71.01 3rd Qu.:0.5554 3rd Qu.:131.73 3rd Qu.:137.3   
## Max. :89.16 Max. :0.6502 Max. :154.65 Max. :155.1   
## Tj\_min\_cold Vcold\_Measurement\_Current Vhot\_Measurement\_Current  
## Min. :62.56 Min. :-2.697 Min. :-2.538   
## 1st Qu.:65.66 1st Qu.:-2.668 1st Qu.:-2.513   
## Median :65.99 Median :-2.632 Median :-2.489   
## Mean :65.78 Mean :-2.639 Mean :-2.490   
## 3rd Qu.:66.34 3rd Qu.:-2.621 3rd Qu.:-2.470   
## Max. :69.54 Max. :-2.607 Max. :-2.430   
## Von\_Cycling\_current R\_ds RUL Falure\_Flag   
## Min. :1.740 Min. :0.03867 Min. : 0 Min. :0.0000   
## 1st Qu.:2.136 1st Qu.:0.04161 1st Qu.: 9481 1st Qu.:0.0000   
## Median :2.250 Median :0.04597 Median :19563 Median :0.0000   
## Mean :2.294 Mean :0.04571 Mean :21077 Mean :0.2609   
## 3rd Qu.:2.556 3rd Qu.:0.04933 3rd Qu.:31002 3rd Qu.:1.0000   
## Max. :3.018 Max. :0.05949 Max. :57428 Max. :1.0000

## Hardware In the Loop (HIL) Data

Case Temperature, plate temperature, delta temperature, V\_gs, I\_ds, and V\_ds data were collected from S3.1\_4A, S3.1\_5A, and S3.2\_5A with failures noted on S3.1\_5A and S3.2\_5A. 1) S3.1 tested under 4A and 5A current 2) S3.2 tested under 5A current S3.1\_4A no failure, S3.1\_5A and S3.2\_5A failed - short circuit.

### Metadata

#### Data 3 Amps and Data 4 Amps

Data 3 Amps and Data 4 Amps are included in the “2. Data 7-31-19” folder. “2. Data 7-31-19 v2” appears to be empty shell folders. Data files for median data appears to be included in this subset.

setwd("~/Power\_Converters/data/HIL Data/2. Data 7-31-19/Data 3 Amps")  
save.image("d3.RData")  
  
setwd("~/Power\_Converters/data/HIL Data/2. Data 7-31-19/Data 4 Amps")  
save.image("d4.RData")

setwd("~/Power\_Converters/data/HIL Data/2. Data 7-31-19/Data 3 Amps")  
load("d3.RData")  
  
setwd("~/Power\_Converters/data/HIL Data/2. Data 7-31-19/Data 4 Amps")  
load("d4.RData")

### Time Series

#### HIL New Data (from “Read me.pdf”)

Testing condition: 1. Power cycling: 40s On, 10s Off 2. Sampling rate: 1Hz  
 Testing results: No Device Failure  
 Files Description: 1. The devices are the same devices used to generated dataset last time 2. The datasets should follow the number order to be connected 3. The time gap between datasets varies from several hours to a day, which are indicated by the “Time” column 4. In each dataset, there are electrical and thermal measurements, and they have been synchronized by looking at the “Gate Signal” Column 5. In each dataset, there are data for two devices, S1 and S3, the features for S1 are columns A, C, G, K, the features for S3 are columns B, D, H, L 6. In each dataset, “Gate Signal” columns are just digital gate signal, they can NOT be used as feature 7. In each dataset, the beginning portion of data contains transient period which should be eliminated, and only steady-state data should be used. HIL New Data.zip contained Datasets 2-6 of S1 and S3. .xlsx data provided for Datasets 2-6 of S1 and S3 devices appear to be raw data.

setwd("~/Power\_Converters/data/HIL Data/HIL New Data")  
load("HilNewData.RData")  
  
ds2<-sapply(ds2,as.numeric)  
ds3<-sapply(ds3,as.numeric)  
ds4<-sapply(ds4,as.numeric)  
ds5<-sapply(ds5,as.numeric)  
ds6<-sapply(ds6,as.numeric)  
  
summary(ds2)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. : 1.363 Min. : 1.363 Min. :-0.2139 Min. :-0.1108   
## 1st Qu.: 2.548 1st Qu.: 2.015 1st Qu.: 2.6518 1st Qu.: 2.7848   
## Median : 2.844 Median : 2.133 Median : 2.6801 Median : 2.8114   
## Mean : 5.607 Mean : 5.125 Mean : 2.0660 Mean : 2.1916   
## 3rd Qu.: 3.318 3rd Qu.: 2.370 3rd Qu.: 2.6984 3rd Qu.: 2.8280   
## Max. :16.000 Max. :16.000 Max. : 2.7566 Max. : 2.8862   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001483 Min. :43580 Min. :27.75 Min. :27.84   
## 1st Qu.: 3.273935 1st Qu.:43580 1st Qu.:58.26 1st Qu.:55.01   
## Median : 3.274583 Median :43580 Median :59.67 Median :56.01   
## Mean : 2.555838 Mean :43580 Mean :59.16 Mean :55.46   
## 3rd Qu.: 3.274908 3rd Qu.:43580 3rd Qu.:61.10 3rd Qu.:57.16   
## Max. : 3.276204 Max. :43580 Max. :63.50 Max. :59.26   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :28.00 Min. : 30.74 Min. :-0.2676 Min. :-0.1743   
## 1st Qu.:34.21 1st Qu.:344.67 1st Qu.:22.9435 1st Qu.:19.5121   
## Median :36.18 Median :345.00 Median :24.0310 Median :20.3644   
## Mean :35.09 Mean :282.43 Mean :24.0698 Mean :20.3750   
## 3rd Qu.:36.89 3rd Qu.:345.08 3rd Qu.:25.3309 3rd Qu.:21.5300   
## Max. :37.19 Max. :345.34 Max. :27.9218 Max. :23.4561

summary(ds3)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. : 1.304 Min. : 1.363 Min. :-0.2471 Min. :-0.1524   
## 1st Qu.: 2.548 1st Qu.: 1.956 1st Qu.: 2.6518 1st Qu.: 2.7798   
## Median : 2.785 Median : 2.133 Median : 2.6867 Median : 2.8164   
## Mean : 5.349 Mean : 4.843 Mean : 2.1263 Mean : 2.2486   
## 3rd Qu.: 3.200 3rd Qu.: 2.311 3rd Qu.: 2.7050 3rd Qu.: 2.8330   
## Max. :16.000 Max. :16.000 Max. : 2.9211 Max. : 2.8978   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001483 Min. :43580 Min. :28.35 Min. :28.37   
## 1st Qu.: 3.273611 1st Qu.:43580 1st Qu.:57.89 1st Qu.:52.88   
## Median : 3.274260 Median :43580 Median :58.93 Median :53.85   
## Mean : 2.618516 Mean :43580 Mean :58.57 Mean :53.37   
## 3rd Qu.: 3.274583 3rd Qu.:43580 3rd Qu.:60.41 3rd Qu.:54.85   
## Max. : 3.275556 Max. :43580 Max. :62.39 Max. :56.32   
## Plate T Gate Signal Delta S1 Delta S3   
## Min. :28.97 Min. : 30.2 Min. :-0.7076 Min. :-0.6885   
## 1st Qu.:34.42 1st Qu.:343.9 1st Qu.:22.6128 1st Qu.:17.8041   
## Median :35.88 Median :344.0 Median :23.6166 Median :18.4584   
## Mean :34.88 Mean :281.2 Mean :23.6922 Mean :18.4865   
## 3rd Qu.:36.12 3rd Qu.:344.0 3rd Qu.:24.9751 3rd Qu.:19.3647   
## Max. :36.25 Max. :344.3 Max. :26.3157 Max. :20.4324

summary(ds4)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. : 1.541 Min. : 1.363 Min. :-0.2737 Min. :-0.169   
## 1st Qu.: 2.548 1st Qu.: 1.956 1st Qu.: 2.6419 1st Qu.: 2.778   
## Median : 2.785 Median : 2.133 Median : 2.6917 Median : 2.825   
## Mean : 5.350 Mean : 4.845 Mean : 2.1291 Mean : 2.256   
## 3rd Qu.: 3.200 3rd Qu.: 2.311 3rd Qu.: 2.7100 3rd Qu.: 2.841   
## Max. :16.000 Max. :16.000 Max. : 2.7732 Max. : 2.909   
## Gate signal Time S1 Case T S3 Case T   
## Min. :-0.001807 Min. :43581 Min. :26.78 Min. :26.85   
## 1st Qu.: 3.273611 1st Qu.:43581 1st Qu.:58.52 1st Qu.:52.72   
## Median : 3.274260 Median :43581 Median :59.40 Median :53.31   
## Mean : 2.619775 Mean :43581 Mean :59.10 Mean :52.98   
## 3rd Qu.: 3.274583 3rd Qu.:43581 3rd Qu.:60.89 3rd Qu.:54.25   
## Max. : 3.275880 Max. :43581 Max. :62.60 Max. :55.59   
## Plate T Gate Signal Delta S1 Delta S3   
## Min. :27.05 Min. : 30.11 Min. :-0.2982 Min. :-0.2402   
## 1st Qu.:35.11 1st Qu.:343.84 1st Qu.:23.0397 1st Qu.:17.2670   
## Median :35.86 Median :344.13 Median :24.0283 Median :18.0100   
## Mean :34.95 Mean :281.44 Mean :24.1505 Mean :18.0299   
## 3rd Qu.:36.00 3rd Qu.:344.19 3rd Qu.:25.3884 3rd Qu.:18.7845   
## Max. :36.31 Max. :344.31 Max. :26.9752 Max. :20.8784

summary(ds5)

## 1.6592793464660645 1.4222517013549805 2.7282981872558594 2.7698564529418945  
## Min. : 1.481 Min. : 1.363 Min. :-0.2837 Min. :-0.1773   
## 1st Qu.: 2.489 1st Qu.: 1.955 1st Qu.: 2.6286 1st Qu.: 2.7582   
## Median : 2.785 Median : 2.074 Median : 2.6768 Median : 2.8097   
## Mean : 5.321 Mean : 4.822 Mean : 2.1145 Mean : 2.2407   
## 3rd Qu.: 3.200 3rd Qu.: 2.311 3rd Qu.: 2.6967 3rd Qu.: 2.8297   
## Max. :16.000 Max. :16.000 Max. : 2.9078 Max. : 2.8929   
## 3.2732868194580078 43581.594446733965 26.23211037335577 26.339057877290756  
## Min. :-0.001807 Min. :43582 Min. :26.23 Min. :26.34   
## 1st Qu.: 3.273287 1st Qu.:43582 1st Qu.:57.41 1st Qu.:50.78   
## Median : 3.273935 Median :43582 Median :58.64 Median :52.06   
## Mean : 2.619077 Mean :43582 Mean :58.11 Mean :51.32   
## 3rd Qu.: 3.274260 3rd Qu.:43582 3rd Qu.:60.12 3rd Qu.:52.90   
## Max. : 3.275556 Max. :43582 Max. :62.32 Max. :54.51   
## 26.594568754179491 342.94453942067793 -0.10694750393498609  
## Min. :26.55 Min. : 29.34 Min. :-0.1165   
## 1st Qu.:33.61 1st Qu.:343.09 1st Qu.: 6.2783   
## Median :35.14 Median :343.56 Median : 6.7443   
## Mean :34.01 Mean :280.81 Mean : 6.7871   
## 3rd Qu.:35.53 3rd Qu.:343.66 3rd Qu.: 7.4153   
## Max. :35.80 Max. :343.85 Max. : 8.4088   
## -0.25551087688873508  
## Min. :-0.2744   
## 1st Qu.:16.6854   
## Median :17.3117   
## Mean :17.3056   
## 3rd Qu.:18.0483   
## Max. :19.6623

summary(ds6)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. : 1.244 Min. : 1.244 Min. :-0.2804 Min. :-0.1756   
## 1st Qu.: 2.370 1st Qu.: 1.837 1st Qu.: 2.6385 1st Qu.: 2.7682   
## Median : 2.726 Median : 2.015 Median : 2.6834 Median : 2.8164   
## Mean : 5.257 Mean : 4.753 Mean : 2.1224 Mean : 2.2480   
## 3rd Qu.: 3.141 3rd Qu.: 2.193 3rd Qu.: 2.7050 3rd Qu.: 2.8380   
## Max. :16.000 Max. :16.000 Max. : 2.9211 Max. : 2.8978   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001807 Min. :43583 Min. :24.04 Min. :24.11   
## 1st Qu.: 3.272963 1st Qu.:43583 1st Qu.:55.05 1st Qu.:48.49   
## Median : 3.273287 Median :43583 Median :56.74 Median :50.31   
## Mean : 2.618810 Mean :43583 Mean :56.00 Mean :49.30   
## 3rd Qu.: 3.273611 3rd Qu.:43583 3rd Qu.:58.27 3rd Qu.:51.19   
## Max. : 3.274908 Max. :43583 Max. :60.53 Max. :52.64   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :24.40 Min. : 27.27 Min. :-0.4022 Min. :-0.3245   
## 1st Qu.:31.31 1st Qu.:341.19 1st Qu.:22.7516 1st Qu.:16.5621   
## Median :33.57 Median :341.91 Median :23.7527 Median :17.1070   
## Mean :32.19 Mean :279.15 Mean :23.8174 Mean :17.1115   
## 3rd Qu.:34.02 3rd Qu.:342.13 3rd Qu.:25.1017 3rd Qu.:17.8695   
## Max. :34.23 Max. :342.42 Max. :26.5864 Max. :18.8774

#### datasets\_of\_variable\_current\_UCONNHIL.zip

Contains Datasets from 4.167A, 4.54A, 4.34A, and 4A.

setwd("~/Power\_Converters/data/HIL Data/datasets\_of\_variable\_current\_UCONNHIL/Datasets of variable current/S3\_1\_Dataset\_4.167A")  
load("varCur.RData")  
summary(S3\_4167d1)

## S1 Voltage S1 Current Gate Signal Time   
## Min. :-0.2963 Min. :-0.5546 Min. :-0.001807 Min. :43724   
## 1st Qu.: 4.3259 1st Qu.: 3.1223 1st Qu.: 3.271990 1st Qu.:43724   
## Median : 4.9185 Median : 3.1705 Median : 3.272963 Median :43724   
## Mean : 6.8211 Mean : 2.4732 Mean : 2.619581 Mean :43724   
## 3rd Qu.: 5.3924 3rd Qu.: 3.2353 3rd Qu.: 3.273611 3rd Qu.:43724   
## Max. :16.0000 Max. : 3.6808 Max. : 3.274583 Max. :43724   
## S1 Case T Plate T Gate Signal S1 Delta T   
## Min. : 22.20 Min. :22.22 Min. : 24.74 Min. :-0.06739   
## 1st Qu.: 88.30 1st Qu.:29.36 1st Qu.:338.86 1st Qu.:57.12190   
## Median : 92.86 Median :32.04 Median :339.56 Median :62.07067   
## Mean : 92.91 Mean :30.70 Mean :276.94 Mean :62.21312   
## 3rd Qu.: 98.48 3rd Qu.:33.04 3rd Qu.:339.99 3rd Qu.:67.40873   
## Max. :106.25 Max. :33.55 Max. :340.36 Max. :73.11530

summary(S3\_4167d2)

## S1 Voltage S1 Current Gate Signal Time   
## Min. :-0.3556 Min. :-0.558 Min. :-0.001807 Min. :43724   
## 1st Qu.: 4.3259 1st Qu.: 3.116 1st Qu.: 3.272315 1st Qu.:43725   
## Median : 4.9185 Median : 3.165 Median : 3.273287 Median :43725   
## Mean : 6.8427 Mean : 2.472 Mean : 2.621670 Mean :43725   
## 3rd Qu.: 5.3332 3rd Qu.: 3.230 3rd Qu.: 3.273611 3rd Qu.:43725   
## Max. :16.0000 Max. : 3.689 Max. : 3.274583 Max. :43725   
## S1 Case T Plate T Gate Signal S1 Delta T   
## Min. : 24.51 Min. :22.87 Min. : 25.42 Min. : 1.57   
## 1st Qu.: 93.81 1st Qu.:29.44 1st Qu.:339.48 1st Qu.:62.89   
## Median :100.01 Median :32.12 Median :339.97 Median :69.16   
## Mean : 99.86 Mean :30.77 Mean :277.46 Mean :69.09   
## 3rd Qu.:106.90 3rd Qu.:33.00 3rd Qu.:340.14 3rd Qu.:75.60   
## Max. :115.26 Max. :33.39 Max. :340.26 Max. :82.15

summary(S3\_4167d3)

## S1 Voltage S1 Current Gate Signal Time   
## Min. :-0.1778 Min. :-0.4466 Min. :-0.001807 Min. :43725   
## 1st Qu.: 4.5036 1st Qu.: 3.1372 1st Qu.: 3.272963 1st Qu.:43725   
## Median : 5.0962 Median : 3.1871 Median : 3.273287 Median :43725   
## Mean : 6.9997 Mean : 2.4985 Mean : 2.619404 Mean :43725   
## 3rd Qu.: 5.5111 3rd Qu.: 3.2536 3rd Qu.: 3.273611 3rd Qu.:43725   
## Max. :16.0000 Max. : 3.7971 Max. : 3.274583 Max. :43725   
## S1 Case T Plate T Gate Signal S1 Delta T   
## Min. : 25.68 Min. :25.68 Min. : 25.86 Min. :-0.1412   
## 1st Qu.: 96.91 1st Qu.:33.38 1st Qu.:340.12 1st Qu.:63.8806   
## Median :103.28 Median :33.54 Median :340.41 Median :70.1150   
## Mean :103.29 Mean :33.02 Mean :277.73 Mean :70.2730   
## 3rd Qu.:109.94 3rd Qu.:33.80 3rd Qu.:340.65 3rd Qu.:76.8243   
## Max. :117.14 Max. :34.05 Max. :340.77 Max. :83.5090

### 4.34A

## S1 Voltage S1 Current Gate Signal Time   
## Min. :-0.2371 Min. :-0.5463 Min. :-0.001807 Min. :43726   
## 1st Qu.: 5.3332 1st Qu.: 3.1488 1st Qu.: 3.272639 1st Qu.:43726   
## Median : 6.1036 Median : 3.2104 Median : 3.273287 Median :43727   
## Mean : 7.7109 Mean : 2.5194 Mean : 2.621036 Mean :43727   
## 3rd Qu.: 6.6962 3rd Qu.: 3.2968 3rd Qu.: 3.273611 3rd Qu.:43727   
## Max. :16.0000 Max. : 3.8520 Max. : 3.274583 Max. :43727   
## S1 Case T Plate T Gate Signal S1 Delta T   
## Min. : 22.51 Min. :22.55 Min. : 24.93 Min. : -0.07003   
## 1st Qu.:110.31 1st Qu.:31.81 1st Qu.:339.11 1st Qu.: 77.44552   
## Median :117.98 Median :34.44 Median :339.77 Median : 85.09590   
## Mean :117.76 Mean :32.76 Mean :277.22 Mean : 85.00218   
## 3rd Qu.:126.29 3rd Qu.:35.06 3rd Qu.:340.06 3rd Qu.: 92.92648   
## Max. :136.99 Max. :35.47 Max. :340.29 Max. :101.64882

## S1 Voltage S1 Current Gate Signal Time   
## Min. :-0.1778 Min. :-0.5646 Min. :-0.001807 Min. :43727   
## 1st Qu.: 5.3925 1st Qu.: 3.1472 1st Qu.: 3.272315 1st Qu.:43727   
## Median : 6.2221 Median : 3.2087 Median : 3.272963 Median :43727   
## Mean : 7.7969 Mean : 2.5170 Mean : 2.618436 Mean :43727   
## 3rd Qu.: 6.7555 3rd Qu.: 3.2968 3rd Qu.: 3.273287 3rd Qu.:43728   
## Max. :16.0000 Max. : 3.8836 Max. : 3.274260 Max. :43728   
## S1 Case T Plate T Gate Signal S1 Delta T   
## Min. : 21.4 Min. :21.24 Min. : 23.67 Min. : 0.1016   
## 1st Qu.:111.4 1st Qu.:31.89 1st Qu.:338.01 1st Qu.: 78.9717   
## Median :119.4 Median :33.76 Median :338.89 Median : 86.9810   
## Mean :119.1 Mean :32.31 Mean :276.11 Mean : 86.7594   
## 3rd Qu.:127.8 3rd Qu.:34.32 3rd Qu.:339.23 3rd Qu.: 94.9416   
## Max. :137.4 Max. :34.86 Max. :339.59 Max. :102.7319

## S1 Voltage S1 Current Gate Signal Time   
## Min. :-0.2963 Min. :-0.5397 Min. :-0.002131 Min. :43728   
## 1st Qu.: 5.5703 1st Qu.: 3.1322 1st Qu.: 3.272639 1st Qu.:43728   
## Median : 6.3999 Median : 3.1921 Median : 3.273287 Median :43728   
## Mean : 7.8960 Mean : 2.4340 Mean : 2.554411 Mean :43728   
## 3rd Qu.: 6.9332 3rd Qu.: 3.2802 3rd Qu.: 3.273611 3rd Qu.:43728   
## Max. :16.0000 Max. : 3.7057 Max. : 3.274583 Max. :43728   
## S1 Case T Plate T Gate Signal S1 Delta T   
## Min. : 24.56 Min. :24.41 Min. : 25.85 Min. : 0.1011   
## 1st Qu.:114.90 1st Qu.:34.03 1st Qu.:340.09 1st Qu.: 80.6218   
## Median :122.98 Median :35.48 Median :340.45 Median : 88.9555   
## Mean :122.77 Mean :34.10 Mean :277.80 Mean : 88.6728   
## 3rd Qu.:131.51 3rd Qu.:35.66 3rd Qu.:340.65 3rd Qu.: 97.0618   
## Max. :140.51 Max. :35.85 Max. :340.83 Max. :104.8257

### 4.54A

setwd("~/Power\_Converters/data/HIL Data/datasets\_of\_variable\_current\_UCONNHIL/Datasets of variable current/S3\_1\_Dataset\_4.54A")  
load("s3\_454A.RData")  
  
summary(S3\_454d1)

## S1 Voltage S1 Current Gate Signal Time   
## Min. :-0.2963 Min. :-0.563 Min. :-0.001807 Min. :43728   
## 1st Qu.: 5.5110 1st Qu.: 3.127 1st Qu.: 3.271990 1st Qu.:43728   
## Median : 6.3406 Median : 3.185 Median : 3.272963 Median :43729   
## Mean : 7.7692 Mean : 2.501 Mean : 2.620210 Mean :43729   
## 3rd Qu.: 6.8740 3rd Qu.: 3.279 3rd Qu.: 3.273287 3rd Qu.:43729   
## Max. :16.0000 Max. : 3.850 Max. : 3.274260 Max. :43729   
## S1 Case T Plate T Gate Signal S1 Delta T   
## Min. : 21.39 Min. :21.42 Min. : 23.92 Min. : -0.0961   
## 1st Qu.:113.24 1st Qu.:31.26 1st Qu.:338.16 1st Qu.: 80.6627   
## Median :121.45 Median :33.94 Median :338.99 Median : 89.1407   
## Mean :121.20 Mean :32.34 Mean :276.47 Mean : 88.8579   
## 3rd Qu.:130.32 3rd Qu.:34.82 3rd Qu.:339.48 3rd Qu.: 97.4116   
## Max. :140.72 Max. :35.63 Max. :339.84 Max. :105.4260

summary(S3\_454d2)

## S1 Voltage S1 Current Gate Signal Time   
## Min. :-0.2963 Min. :-0.5663 Min. :-0.002131 Min. :43733   
## 1st Qu.: 5.6296 1st Qu.: 3.1206 1st Qu.: 3.272963 1st Qu.:43733   
## Median : 6.4592 Median : 3.1904 Median : 3.273611 Median :43733   
## Mean : 7.6775 Mean : 2.6038 Mean : 2.619855 Mean :43733   
## 3rd Qu.: 7.1110 3rd Qu.: 3.3018 3rd Qu.: 3.273935 3rd Qu.:43733   
## Max. :16.0000 Max. : 3.8487 Max. : 3.275232 Max. :43733   
## S1 Case T Plate T Gate Signal S1 Delta T   
## Min. : 23.72 Min. :23.78 Min. : 26.29 Min. : -0.1153   
## 1st Qu.:121.34 1st Qu.:35.69 1st Qu.:340.59 1st Qu.: 85.4554   
## Median :131.44 Median :37.56 Median :341.42 Median : 95.6018   
## Mean :130.48 Mean :36.14 Mean :278.84 Mean : 94.3363   
## 3rd Qu.:141.82 3rd Qu.:38.04 3rd Qu.:341.91 3rd Qu.:104.3734   
## Max. :149.45 Max. :39.25 Max. :342.33 Max. :111.2222

### 4A

load("~/Power\_Converters/data/HIL Data/datasets\_of\_variable\_current\_UCONNHIL/Datasets of variable current/S3\_1\_Dataset\_4A/4A.RData")  
summary(S3\_4d1)

## S1 Voltage S1 Current Gate Signal Time   
## Min. : 1.659 Min. :-0.5613 Min. :-0.001807 Min. :43714   
## 1st Qu.: 3.852 1st Qu.: 3.0441 1st Qu.: 3.272963 1st Qu.:43715   
## Median : 4.267 Median : 3.0907 Median : 3.273611 Median :43715   
## Mean : 6.426 Mean : 2.4064 Mean : 2.619367 Mean :43715   
## 3rd Qu.: 4.622 3rd Qu.: 3.1422 3rd Qu.: 3.273935 3rd Qu.:43715   
## Max. :16.000 Max. : 3.5295 Max. : 3.274908 Max. :43715   
## S1 Case T Plate T Gate Signal S1 Delta T   
## Min. :22.92 Min. :22.88 Min. : 25.56 Min. :-0.01758   
## 1st Qu.:79.45 1st Qu.:30.88 1st Qu.:339.79 1st Qu.:48.00346   
## Median :83.72 Median :32.31 Median :340.40 Median :52.41101   
## Mean :83.75 Mean :31.19 Mean :277.62 Mean :52.55548   
## 3rd Qu.:88.62 3rd Qu.:32.74 3rd Qu.:340.56 3rd Qu.:57.07776   
## Max. :94.41 Max. :32.95 Max. :341.07 Max. :61.80960

summary(S3\_4d2)

## S1 Voltage S1 Current Gate Signal Time   
## Min. : 1.541 Min. :-0.5463 Min. :-0.001807 Min. :43717   
## 1st Qu.: 3.793 1st Qu.: 3.0524 1st Qu.: 3.272639 1st Qu.:43718   
## Median : 4.267 Median : 3.0957 Median : 3.273287 Median :43718   
## Mean : 6.406 Mean : 2.4114 Mean : 2.619634 Mean :43718   
## 3rd Qu.: 4.622 3rd Qu.: 3.1472 3rd Qu.: 3.273611 3rd Qu.:43718   
## Max. :16.000 Max. : 3.5312 Max. : 3.274583 Max. :43718   
## S1 Case T Plate T Gate Signal S1 Delta T   
## Min. :22.68 Min. :22.68 Min. : 25.31 Min. :-0.04129   
## 1st Qu.:79.12 1st Qu.:29.83 1st Qu.:339.45 1st Qu.:48.26499   
## Median :83.41 Median :31.70 Median :340.11 Median :52.76727   
## Mean :83.44 Mean :30.51 Mean :277.38 Mean :52.92367   
## 3rd Qu.:88.39 3rd Qu.:32.22 3rd Qu.:340.30 3rd Qu.:57.58487   
## Max. :94.56 Max. :32.57 Max. :340.55 Max. :62.36949

summary(S3\_4d3)

## S1 Voltage S1 Current Gate Signal Time   
## Min. : 1.659 Min. :-0.5147 Min. :-0.001807 Min. :43718   
## 1st Qu.: 3.793 1st Qu.: 3.0591 1st Qu.: 3.272639 1st Qu.:43718   
## Median : 4.267 Median : 3.0990 Median : 3.273287 Median :43718   
## Mean : 6.414 Mean : 2.4165 Mean : 2.619482 Mean :43718   
## 3rd Qu.: 4.622 3rd Qu.: 3.1522 3rd Qu.: 3.273611 3rd Qu.:43718   
## Max. :16.000 Max. : 3.5528 Max. : 3.274583 Max. :43718   
## S1 Case T Plate T Gate Signal S1 Delta T   
## Min. :25.38 Min. :25.52 Min. : 26.36 Min. :-0.2232   
## 1st Qu.:79.93 1st Qu.:30.14 1st Qu.:340.38 1st Qu.:48.9084   
## Median :84.48 Median :31.82 Median :340.58 Median :53.5248   
## Mean :84.44 Mean :30.87 Mean :277.83 Mean :53.5734   
## 3rd Qu.:89.52 3rd Qu.:32.27 3rd Qu.:340.60 3rd Qu.:58.4270   
## Max. :95.53 Max. :32.52 Max. :340.65 Max. :63.2529

### datasets\_4A\_5A\_current\_UCONNHIL

This folder contains various files and folders with a mix of raw data, curated data, and code in a variety of formats.

## S1 Voltage S1 Current Gate Signal   
## Min. :-0.2371 Min. :-0.5463 Min. :-0.001807   
## 1st Qu.: 5.3332 1st Qu.: 3.1488 1st Qu.: 3.272639   
## Median : 6.1036 Median : 3.2104 Median : 3.273287   
## Mean : 7.7109 Mean : 2.5194 Mean : 2.621036   
## 3rd Qu.: 6.6962 3rd Qu.: 3.2968 3rd Qu.: 3.273611   
## Max. :16.0000 Max. : 3.8520 Max. : 3.274583   
##   
## Time S1 Case T Plate T Gate Signal   
## 43726.443275011035: 1 Min. : 22.51 Min. :22.55 Min. : 24.93   
## 43726.443286586269: 1 1st Qu.:110.31 1st Qu.:31.81 1st Qu.:339.11   
## 43726.443298611113: 1 Median :117.98 Median :34.44 Median :339.77   
## 43726.443309736729: 1 Mean :117.76 Mean :32.76 Mean :277.22   
## 43726.443321311963: 1 3rd Qu.:126.29 3rd Qu.:35.06 3rd Qu.:340.06   
## 43726.443332887189: 1 Max. :136.99 Max. :35.47 Max. :340.29   
## (Other) :10034   
## S1 Delta T   
## Min. : -0.07003   
## 1st Qu.: 77.44552   
## Median : 85.09590   
## Mean : 85.00218   
## 3rd Qu.: 92.92648   
## Max. :101.64882   
##

## S1 Voltage S1 Current Gate Signal   
## Min. :-0.1778 Min. :-0.5646 Min. :-0.001807   
## 1st Qu.: 5.3925 1st Qu.: 3.1472 1st Qu.: 3.272315   
## Median : 6.2221 Median : 3.2087 Median : 3.272963   
## Mean : 7.7969 Mean : 2.5170 Mean : 2.618436   
## 3rd Qu.: 6.7555 3rd Qu.: 3.2968 3rd Qu.: 3.273287   
## Max. :16.0000 Max. : 3.8836 Max. : 3.274260   
##   
## Time S1 Case T Plate T Gate Signal   
## 43727.397256944445: 1 Min. : 21.4 Min. :21.24 Min. : 23.67   
## 43727.397265915999: 1 1st Qu.:111.4 1st Qu.:31.89 1st Qu.:338.01   
## 43727.397277491225: 1 Median :119.4 Median :33.76 Median :338.89   
## 43727.397289066459: 1 Mean :119.1 Mean :32.31 Mean :276.11   
## 43727.397300641693: 1 3rd Qu.:127.8 3rd Qu.:34.32 3rd Qu.:339.23   
## 43727.397312216919: 1 Max. :137.4 Max. :34.86 Max. :339.59   
## (Other) :13001   
## S1 Delta T   
## Min. : 0.1016   
## 1st Qu.: 78.9717   
## Median : 86.9810   
## Mean : 86.7594   
## 3rd Qu.: 94.9416   
## Max. :102.7319   
##

## S1 Voltage S1 Current Gate Signal   
## Min. :-0.2963 Min. :-0.5397 Min. :-0.002131   
## 1st Qu.: 5.5703 1st Qu.: 3.1322 1st Qu.: 3.272639   
## Median : 6.3999 Median : 3.1921 Median : 3.273287   
## Mean : 7.8960 Mean : 2.4340 Mean : 2.554411   
## 3rd Qu.: 6.9332 3rd Qu.: 3.2802 3rd Qu.: 3.273611   
## Max. :16.0000 Max. : 3.7057 Max. : 3.274583   
##   
## Time S1 Case T Plate T Gate Signal   
## 43727.634564550892: 1 Min. : 24.56 Min. :24.41 Min. : 25.85   
## 43727.634571759256: 1 1st Qu.:114.90 1st Qu.:34.03 1st Qu.:340.09   
## 43727.634587701352: 1 Median :122.98 Median :35.48 Median :340.45   
## 43727.634599276586: 1 Mean :122.77 Mean :34.10 Mean :277.80   
## 43727.634610851819: 1 3rd Qu.:131.51 3rd Qu.:35.66 3rd Qu.:340.65   
## 43727.634622427046: 1 Max. :140.51 Max. :35.85 Max. :340.83   
## (Other) :12920   
## S1 Delta T   
## Min. : 0.1011   
## 1st Qu.: 80.6218   
## Median : 88.9555   
## Mean : 88.6728   
## 3rd Qu.: 97.0618   
## Max. :104.8257   
##

### Data from 7-31-19

Data from “2. Data 7-31-19.zip” contains “Data 3 Amps” and Data 4 Amps, which appear to be raw data in .xlsx form. Additional data files for median data appears to be included in this subset. “2. Data 7-31-19v2.zip” appears to be empty shell folders.

#### Data 3 Amps

Data 3 Amps contains 12 datasets from S1 and S3. This appears to be raw data.

summary(d3A1)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-0.8296 Min. :-0.4149 Min. :-0.2654 Min. :-0.1673   
## 1st Qu.: 4.5630 1st Qu.: 3.4962 1st Qu.: 3.2054 1st Qu.: 3.4065   
## Median : 5.1555 Median : 3.8518 Median : 3.2403 Median : 3.4381   
## Mean : 7.0362 Mean : 6.1178 Mean : 2.5762 Mean : 2.7487   
## 3rd Qu.: 5.8073 3rd Qu.: 4.1481 3rd Qu.: 3.2818 3rd Qu.: 3.4647   
## Max. :16.0000 Max. :16.0000 Max. : 3.4331 Max. : 3.5744   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001483 43592.620385766204: 1 Min. :26.39 Min. :26.41   
## 1st Qu.: 3.273935 43592.620397341438: 1 1st Qu.:88.55 1st Qu.:78.51   
## Median : 3.274583 43592.620408905088: 1 Median :91.10 Median :81.44   
## Mean : 2.617500 43592.620420480322: 1 Mean :89.73 Mean :79.98   
## 3rd Qu.: 3.274908 43592.620432055555: 1 3rd Qu.:93.65 3rd Qu.:83.88   
## Max. : 3.276204 43592.620443630789: 1 Max. :98.62 Max. :88.64   
## (Other) :10960   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :26.44 Min. : 27.53 Min. :-0.06369 Min. :-0.04652   
## 1st Qu.:40.79 1st Qu.:342.50 1st Qu.:46.47533 1st Qu.:36.73485   
## Median :43.55 Median :344.50 Median :48.13087 Median :38.38221   
## Mean :41.51 Mean :281.66 Mean :48.21826 Mean :38.46990   
## 3rd Qu.:44.24 3rd Qu.:345.25 3rd Qu.:50.57964 3rd Qu.:40.58781   
## Max. :45.33 Max. :346.02 Max. :53.64435 Max. :43.46927   
##

summary(d3A2)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-0.7111 Min. :-0.4148 Min. :-0.2421 Min. :-0.1391   
## 1st Qu.: 4.3259 1st Qu.: 3.2592 1st Qu.: 3.2137 1st Qu.: 3.4148   
## Median : 4.8592 Median : 3.6148 Median : 3.2486 Median : 3.4414   
## Mean : 6.7870 Mean : 5.9499 Mean : 2.5851 Mean : 2.7506   
## 3rd Qu.: 5.5110 3rd Qu.: 3.9703 3rd Qu.: 3.2885 3rd Qu.: 3.4680   
## Max. :16.0000 Max. :16.0000 Max. : 3.7273 Max. : 3.5927   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001483 43594.417256843233: 1 Min. :26.22 Min. :26.29   
## 1st Qu.: 3.273611 43594.417268418467: 1 1st Qu.:80.83 1st Qu.:70.79   
## Median : 3.274260 43594.417279993693: 1 Median :85.94 Median :75.94   
## Mean : 2.618095 43594.417291568927: 1 Mean :83.75 Mean :73.81   
## 3rd Qu.: 3.274583 43594.417303144161: 1 3rd Qu.:88.73 3rd Qu.:78.57   
## Max. : 3.275556 43594.417314719387: 1 Max. :94.56 Max. :83.57   
## (Other) :4326   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :26.47 Min. : 29.3 Min. :-0.2971 Min. :-0.2313   
## 1st Qu.:33.74 1st Qu.:343.1 1st Qu.:45.3492 1st Qu.:35.4910   
## Median :38.73 Median :343.5 Median :46.9187 Median :36.9268   
## Mean :37.07 Mean :280.8 Mean :46.6785 Mean :36.7473   
## 3rd Qu.:41.24 3rd Qu.:344.0 3rd Qu.:49.3230 3rd Qu.:38.9815   
## Max. :42.46 Max. :344.4 Max. :52.2313 Max. :41.1907   
##

summary(d3A3)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-1.007 Min. : 1.659 Min. :-0.2754 Min. :-0.1673   
## 1st Qu.: 4.444 1st Qu.: 3.378 1st Qu.: 3.2203 1st Qu.: 3.4148   
## Median : 4.978 Median : 3.733 Median : 3.2586 Median : 3.4514   
## Mean : 6.925 Mean : 6.013 Mean : 2.5974 Mean : 2.7652   
## 3rd Qu.: 5.570 3rd Qu.: 4.030 3rd Qu.: 3.3001 3rd Qu.: 3.4796   
## Max. :16.000 Max. :16.000 Max. : 3.7423 Max. : 3.5927   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001807 43602.432328085764: 1 Min. :25.51 Min. :25.59   
## 1st Qu.: 3.273287 43602.432339659841: 1 1st Qu.:85.50 1st Qu.:72.59   
## Median : 3.273611 43602.432351233911: 1 Median :87.42 Median :74.22   
## Mean : 2.621118 43602.432362807987: 1 Mean :86.43 Mean :73.34   
## 3rd Qu.: 3.273935 43602.432374370488: 1 3rd Qu.:89.98 3rd Qu.:75.87   
## Max. : 3.275232 43602.432385944558: 1 Max. :94.59 Max. :80.44   
## (Other) :11784   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :25.78 Min. : 28.16 Min. :-0.3133 Min. :-0.2353   
## 1st Qu.:39.62 1st Qu.:342.25 1st Qu.:44.8825 1st Qu.:31.9143   
## Median :41.63 Median :343.52 Median :46.4827 Median :33.5842   
## Mean :39.79 Mean :280.97 Mean :46.6407 Mean :33.5449   
## 3rd Qu.:42.14 3rd Qu.:344.34 3rd Qu.:48.8695 3rd Qu.:35.0571   
## Max. :42.59 Max. :344.58 Max. :52.2109 Max. :38.9541   
##

summary(d3A4)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-0.8889 Min. :-0.3556 Min. :-0.2205 Min. :-0.1474   
## 1st Qu.: 2.0148 1st Qu.: 1.8963 1st Qu.: 2.6502 1st Qu.: 2.7333   
## Median : 2.3704 Median : 2.0741 Median : 2.6718 Median : 2.7549   
## Mean : 4.9420 Mean : 4.7649 Mean : 2.1128 Mean : 2.1953   
## 3rd Qu.: 2.9629 3rd Qu.: 2.3111 3rd Qu.: 2.6867 3rd Qu.: 2.7699   
## Max. :16.0000 Max. :16.0000 Max. : 2.7449 Max. : 2.8214   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001807 43656.649299166027: 1 Min. :32.37 Min. :32.35   
## 1st Qu.: 3.273611 43656.649310741261: 1 1st Qu.:56.33 1st Qu.:50.47   
## Median : 3.274583 43656.649322316487: 1 Median :57.87 Median :51.77   
## Mean : 2.629294 43656.649333891721: 1 Mean :57.26 Mean :51.36   
## 3rd Qu.: 3.274908 43656.649345466954: 1 3rd Qu.:59.12 3rd Qu.:52.95   
## Max. : 3.276204 43656.649357042181: 1 Max. :61.61 Max. :55.14   
## (Other) :2430   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :32.58 Min. : 33.13 Min. :-0.3961 Min. :-0.4142   
## 1st Qu.:33.71 1st Qu.:346.25 1st Qu.:21.7997 1st Qu.:15.7696   
## Median :35.04 Median :346.49 Median :22.6329 Median :16.6579   
## Mean :34.83 Mean :284.85 Mean :22.4274 Mean :16.5356   
## 3rd Qu.:35.93 3rd Qu.:346.74 3rd Qu.:23.8826 3rd Qu.:17.7578   
## Max. :36.87 Max. :346.97 Max. :25.1592 Max. :18.8049   
##

summary(d3A5)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-0.4741 Min. :-0.3556 Min. :-0.2072 Min. :-0.1341   
## 1st Qu.: 1.9555 1st Qu.: 1.8963 1st Qu.: 2.6635 1st Qu.: 2.7566   
## Median : 2.3111 Median : 2.0741 Median : 2.6867 Median : 2.7798   
## Mean : 4.9187 Mean : 4.7884 Mean : 2.1264 Mean : 2.2147   
## 3rd Qu.: 2.9629 3rd Qu.: 2.3111 3rd Qu.: 2.7017 3rd Qu.: 2.7965   
## Max. :16.0000 Max. :16.0000 Max. : 2.9078 Max. : 2.8563   
## NA's :1 NA's :1 NA's :1 NA's :1   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001807 43657.480536852338: 1 Min. :29.40 Min. :29.19   
## 1st Qu.: 3.274260 43657.480548426407: 1 1st Qu.:59.28 1st Qu.:45.31   
## Median : 3.274908 43657.480560000484: 1 Median :61.59 Median :47.11   
## Mean : 2.619739 43657.480571574561: 1 Mean :60.65 Mean :46.36   
## 3rd Qu.: 3.274908 43657.48058314863 : 1 3rd Qu.:62.92 3rd Qu.:47.97   
## Max. : 3.276204 43657.480594711131: 1 Max. :65.46 Max. :49.72   
## NA's :1 (Other) :7145   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :28.51 Min. : 29.13 Min. : 0.2134 Min. : 0.6812   
## 1st Qu.:33.72 1st Qu.:343.64 1st Qu.:13.8483 1st Qu.:10.6817   
## Median :36.11 Median :344.95 Median :14.4465 Median :11.2990   
## Mean :35.08 Mean :282.32 Mean :14.2906 Mean :11.2829   
## 3rd Qu.:37.19 3rd Qu.:345.60 3rd Qu.:15.0377 3rd Qu.:11.9549   
## Max. :37.66 Max. :345.99 Max. :16.4416 Max. :13.6130   
##

summary(d3A6)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-1.007 Min. :-0.4149 Min. :-0.2372 Min. :-0.1557   
## 1st Qu.: 1.837 1st Qu.: 1.8370 1st Qu.: 2.6385 1st Qu.: 2.7316   
## Median : 2.193 Median : 2.0148 Median : 2.6568 Median : 2.7482   
## Mean : 4.857 Mean : 4.7519 Mean : 2.0877 Mean : 2.1757   
## 3rd Qu.: 2.785 3rd Qu.: 2.2518 3rd Qu.: 2.6718 3rd Qu.: 2.7615   
## Max. :16.000 Max. :16.0000 Max. : 2.7233 Max. : 2.8131   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001807 43657.624847140585: 1 Min. :30.08 Min. :30.30   
## 1st Qu.: 3.273611 43657.624858715819: 1 1st Qu.:55.83 1st Qu.:43.28   
## Median : 3.274583 43657.624870291045: 1 Median :57.59 Median :44.58   
## Mean : 2.617391 43657.624881866279: 1 Mean :56.53 Mean :44.06   
## 3rd Qu.: 3.274908 43657.624893441513: 1 3rd Qu.:58.92 3rd Qu.:45.61   
## Max. : 3.275556 43657.624905016746: 1 Max. :61.86 Max. :49.09   
## (Other) :1589   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :30.35 Min. : 31.91 Min. :-0.3528 Min. :-0.1327   
## 1st Qu.:31.03 1st Qu.:345.31 1st Qu.:24.0863 1st Qu.:11.4901   
## Median :32.29 Median :345.44 Median :24.8500 Median :12.0146   
## Mean :32.30 Mean :282.26 Mean :24.2273 Mean :11.7547   
## 3rd Qu.:33.54 3rd Qu.:345.54 3rd Qu.:26.1294 3rd Qu.:12.7196   
## Max. :34.43 Max. :345.66 Max. :27.4807 Max. :16.1236   
##

summary(d3A7)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-1.126 Min. :-0.237 Min. :-0.1939 Min. :-0.1175   
## 1st Qu.: 2.015 1st Qu.: 1.955 1st Qu.: 2.6618 1st Qu.: 2.7566   
## Median : 2.370 Median : 2.074 Median : 2.6851 Median : 2.7782   
## Mean : 5.242 Mean : 5.098 Mean : 2.0682 Mean : 2.1577   
## 3rd Qu.: 3.081 3rd Qu.: 2.370 3rd Qu.: 2.7000 3rd Qu.: 2.7915   
## Max. :16.000 Max. :16.000 Max. : 2.7599 Max. : 2.8480   
## NA's :5 NA's :5 NA's :5 NA's :5   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001807 43657.646449370041: 1 Min. :34.33 Min. :33.82   
## 1st Qu.: 3.274260 43657.646460945267: 1 1st Qu.:61.88 1st Qu.:48.04   
## Median : 3.274908 43657.646472520501: 1 Median :62.86 Median :49.02   
## Mean : 2.554967 43657.646484095734: 1 Mean :62.64 Mean :48.98   
## 3rd Qu.: 3.275232 43657.646495670961: 1 3rd Qu.:64.13 3rd Qu.:50.00   
## Max. : 3.276204 43657.646507246194: 1 Max. :66.16 Max. :51.99   
## NA's :5 (Other) :7156   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :34.27 Min. : 32.2 Min. :-0.2357 Min. :-0.7532   
## 1st Qu.:36.42 1st Qu.:345.8 1st Qu.:24.6890 1st Qu.:10.5959   
## Median :37.47 Median :346.3 Median :25.5730 Median :12.2833   
## Mean :37.06 Mean :283.8 Mean :25.5809 Mean :11.9249   
## 3rd Qu.:37.95 3rd Qu.:346.6 3rd Qu.:26.8274 3rd Qu.:13.2559   
## Max. :38.33 Max. :346.8 Max. :28.1411 Max. :15.1079   
##

summary(d3A8)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-0.6518 Min. :-0.3556 Min. :-0.2721 Min. :-0.1923   
## 1st Qu.: 2.0148 1st Qu.: 1.8963 1st Qu.: 2.6219 1st Qu.: 2.7117   
## Median : 2.3704 Median : 2.0741 Median : 2.6585 Median : 2.7532   
## Mean : 5.2382 Mean : 5.0640 Mean : 2.0416 Mean : 2.1315   
## 3rd Qu.: 3.1407 3rd Qu.: 2.3703 3rd Qu.: 2.6784 3rd Qu.: 2.7715   
## Max. :16.0000 Max. :16.0000 Max. : 2.7399 Max. : 2.8846   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001807 43658.456381874799: 1 Min. :29.07 Min. :29.16   
## 1st Qu.: 3.274260 43658.456393448869: 1 1st Qu.:60.21 1st Qu.:48.03   
## Median : 3.274583 43658.456405022946: 1 Median :62.03 Median :48.80   
## Mean : 2.555292 43658.456416597015: 1 Mean :61.22 Mean :48.41   
## 3rd Qu.: 3.274908 43658.456428171092: 1 3rd Qu.:63.32 3rd Qu.:49.59   
## Max. : 3.275880 43658.456439745169: 1 Max. :65.83 Max. :54.00   
## (Other) :9186   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :29.18 Min. : 29.89 Min. :-0.1542 Min. :-0.07166   
## 1st Qu.:34.84 1st Qu.:344.17 1st Qu.:24.5425 1st Qu.:11.43728   
## Median :36.79 Median :345.55 Median :25.4020 Median :12.47408   
## Mean :35.76 Mean :283.03 Mean :25.4567 Mean :12.64682   
## 3rd Qu.:37.49 3rd Qu.:346.26 3rd Qu.:26.6318 3rd Qu.:13.78511   
## Max. :37.90 Max. :346.59 Max. :28.0494 Max. :17.76303   
##

summary(d3A9)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-0.2963 Min. :-0.2963 Min. :-0.2172 Min. :-0.1341   
## 1st Qu.: 2.0148 1st Qu.: 1.8963 1st Qu.: 2.6419 1st Qu.: 2.7383   
## Median : 2.3704 Median : 2.0741 Median : 2.6651 Median : 2.7632   
## Mean : 5.2480 Mean : 5.0573 Mean : 2.0498 Mean : 2.1434   
## 3rd Qu.: 3.0814 3rd Qu.: 2.3111 3rd Qu.: 2.6818 3rd Qu.: 2.7782   
## Max. :16.0000 Max. :16.0000 Max. : 2.7416 Max. : 2.8330   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001807 43658.627506388686: 1 Min. :32.12 Min. :31.75   
## 1st Qu.: 3.274260 43658.627517962763: 1 1st Qu.:60.68 1st Qu.:43.29   
## Median : 3.274908 43658.627529536832: 1 Median :62.27 Median :44.52   
## Mean : 2.555336 43658.627541110909: 1 Mean :61.67 Mean :44.13   
## 3rd Qu.: 3.275232 43658.627552684979: 1 3rd Qu.:63.54 3rd Qu.:45.30   
## Max. : 3.276204 43658.627564259055: 1 Max. :65.95 Max. :46.72   
## (Other) :5784   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :32.37 Min. : 32.39 Min. :-0.345 Min. :-0.7145   
## 1st Qu.:35.13 1st Qu.:345.98 1st Qu.:24.679 1st Qu.: 7.4943   
## Median :36.76 Median :346.37 Median :25.533 Median : 8.0118   
## Mean :36.17 Mean :283.93 Mean :25.505 Mean : 7.9616   
## 3rd Qu.:37.55 3rd Qu.:346.75 3rd Qu.:26.778 3rd Qu.: 8.4673   
## Max. :38.03 Max. :347.04 Max. :28.114 Max. : 9.7023   
##

summary(d3A10)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. : 0.6519 Min. : 1.244 Min. :-0.2521 Min. :-0.1889   
## 1st Qu.: 1.9556 1st Qu.: 1.896 1st Qu.: 2.6369 1st Qu.: 2.7300   
## Median : 2.3703 Median : 2.074 Median : 2.6734 Median : 2.7665   
## Mean : 4.9569 Mean : 4.777 Mean : 2.1146 Mean : 2.2024   
## 3rd Qu.: 3.0222 3rd Qu.: 2.252 3rd Qu.: 2.6934 3rd Qu.: 2.7865   
## Max. :16.0000 Max. :16.000 Max. : 2.9078 Max. : 2.8596   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001807 43661.461700796615: 1 Min. :28.18 Min. :28.46   
## 1st Qu.: 3.273935 43661.461712371849: 1 1st Qu.:59.66 1st Qu.:40.90   
## Median : 3.274583 43661.461723947083: 1 Median :61.44 Median :42.35   
## Mean : 2.621992 43661.461735522309: 1 Mean :60.62 Mean :41.67   
## 3rd Qu.: 3.274908 43661.461747097543: 1 3rd Qu.:62.74 3rd Qu.:42.94   
## Max. : 3.275880 43661.461758672776: 1 Max. :65.03 Max. :44.06   
## (Other) :8876   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :28.35 Min. : 29.42 Min. :-0.2008 Min. :0.08839   
## 1st Qu.:34.46 1st Qu.:343.71 1st Qu.:24.2759 1st Qu.:5.58956   
## Median :36.56 Median :345.16 Median :25.1561 Median :6.11839   
## Mean :35.42 Mean :282.70 Mean :25.2030 Mean :6.24636   
## 3rd Qu.:37.24 3rd Qu.:345.80 3rd Qu.:26.3810 3rd Qu.:6.62480   
## Max. :37.56 Max. :346.10 Max. :27.6769 Max. :9.09757   
##

summary(d3A11)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-0.237 Min. :-0.237 Min. :-0.1806 Min. :-0.09752   
## 1st Qu.: 2.015 1st Qu.: 1.955 1st Qu.: 2.7034 1st Qu.: 2.79811   
## Median : 2.430 Median : 2.074 Median : 2.7316 Median : 2.82637   
## Mean : 5.004 Mean : 4.822 Mean : 2.1715 Mean : 2.26049   
## 3rd Qu.: 3.022 3rd Qu.: 2.311 3rd Qu.: 2.7482 3rd Qu.: 2.84299   
## Max. :16.000 Max. :16.000 Max. : 2.9627 Max. : 2.92112   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001807 43661.601647752876: 1 Min. :31.34 Min. :31.32   
## 1st Qu.: 3.274260 43661.601659328109: 1 1st Qu.:61.33 1st Qu.:45.68   
## Median : 3.274908 43661.601670903343: 1 Median :62.83 Median :46.67   
## Mean : 2.619847 43661.601682478569: 1 Mean :62.25 Mean :46.25   
## 3rd Qu.: 3.275232 43661.601694053803: 1 3rd Qu.:64.11 3rd Qu.:47.35   
## Max. : 3.276204 43661.601705629037: 1 Max. :66.43 Max. :48.59   
## (Other) :9195   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :31.56 Min. : 32.29 Min. :-0.3541 Min. :-0.3794   
## 1st Qu.:36.14 1st Qu.:345.65 1st Qu.:24.5336 1st Qu.: 8.8356   
## Median :37.63 Median :346.55 Median :25.3875 Median : 9.4351   
## Mean :36.83 Mean :281.50 Mean :25.4243 Mean : 9.4257   
## 3rd Qu.:38.18 3rd Qu.:347.10 3rd Qu.:26.6311 3rd Qu.: 9.9851   
## Max. :38.80 Max. :347.34 Max. :28.1393 Max. :11.9023   
##

summary(d3A12)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. : 0.7704 Min. : 1.363 Min. :-0.2355 Min. :-0.1607   
## 1st Qu.: 2.0148 1st Qu.: 1.896 1st Qu.: 2.6552 1st Qu.: 2.7516   
## Median : 2.3704 Median : 2.074 Median : 2.7000 Median : 2.7965   
## Mean : 5.0065 Mean : 4.810 Mean : 2.1375 Mean : 2.2311   
## 3rd Qu.: 3.0222 3rd Qu.: 2.311 3rd Qu.: 2.7200 3rd Qu.: 2.8181   
## Max. :16.0000 Max. :16.000 Max. : 2.7815 Max. : 2.8846   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.002131 43662.584655942119: 1 Min. :27.78 Min. :27.93   
## 1st Qu.: 3.274260 43662.584667517352: 1 1st Qu.:61.11 1st Qu.:48.03   
## Median : 3.274908 43662.584679092586: 1 Median :63.01 Median :49.07   
## Mean : 2.619867 43662.584690667813: 1 Mean :62.09 Mean :48.30   
## 3rd Qu.: 3.275232 43662.584702243046: 1 3rd Qu.:64.31 3rd Qu.:49.98   
## Max. : 3.276204 43662.58471381828 : 1 Max. :66.60 Max. :52.07   
## (Other) :13057   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :27.87 Min. : 28.79 Min. :-0.1008 Min. : 0.03333   
## 1st Qu.:35.78 1st Qu.:343.58 1st Qu.:24.8220 1st Qu.:11.38630   
## Median :37.57 Median :345.95 Median :25.6741 Median :11.94599   
## Mean :36.35 Mean :283.23 Mean :25.7380 Mean :11.94720   
## 3rd Qu.:38.07 3rd Qu.:346.75 3rd Qu.:26.8947 3rd Qu.:12.58186   
## Max. :38.48 Max. :347.20 Max. :28.3248 Max. :13.77156   
##

#### Data 4 Amps

Data 4 Amps contains Test1 and Test2 folders. Test 1 contains 2 datasets in .xlsx format: Dataset1 and 2 from S1\_S3. Test2 contains 8 datasets in .xlsx format from S1\_S3. It’s unclear whether or not datasets 1 and 2 are redundant from the Test 1 folder. This appears to be raw data. ##### Test 1

summary(d4t1A1)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-1.363 Min. : 1.956 Min. :-0.2272 Min. :-0.159   
## 1st Qu.: 4.267 1st Qu.: 3.378 1st Qu.: 3.2419 1st Qu.: 3.430   
## Median : 4.918 Median : 3.674 Median : 3.2802 Median : 3.461   
## Mean : 6.850 Mean : 6.000 Mean : 2.6175 Mean : 2.772   
## 3rd Qu.: 5.748 3rd Qu.: 3.970 3rd Qu.: 3.3217 3rd Qu.: 3.486   
## Max. :16.000 Max. :16.000 Max. : 3.6525 Max. : 3.606   
##   
## Gate Signal Time S1 Case T   
## Min. :-0.001807 43663.524375174427: 1 Min. : 28.66   
## 1st Qu.: 3.274260 43663.524386749661: 1 1st Qu.: 98.20   
## Median : 3.274908 43663.524398324887: 1 Median :100.09   
## Mean : 2.620578 43663.524409900121: 1 Mean : 99.15   
## 3rd Qu.: 3.275232 43663.524421475355: 1 3rd Qu.:102.85   
## Max. : 3.276204 43663.524433050581: 1 Max. :106.91   
## (Other) :13470   
## S3 Case T Plate T Gate Signal S1 Delta T   
## Min. :28.88 Min. :28.79 Min. : 29.76 Min. :-0.1608   
## 1st Qu.:58.79 1st Qu.:43.03 1st Qu.:344.42 1st Qu.:53.9882   
## Median :60.78 Median :44.64 Median :346.47 Median :55.7529   
## Mean :63.30 Mean :43.23 Mean :284.05 Mean :55.9171   
## 3rd Qu.:70.33 3rd Qu.:45.74 3rd Qu.:347.49 3rd Qu.:58.3454   
## Max. :78.08 Max. :46.71 Max. :348.41 Max. :61.0110   
##   
## S3 Delta T   
## Min. : 0.07061   
## 1st Qu.:13.83434   
## Median :19.85338   
## Mean :20.06994   
## 3rd Qu.:26.13094   
## Max. :33.33985   
##

summary(d4t1A2)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-1.422 Min. :-0.5333 Min. :-0.1491 Min. :-0.06262   
## 1st Qu.: 4.030 1st Qu.: 3.3185 1st Qu.: 3.3383 1st Qu.: 3.49792   
## Median : 4.741 Median : 3.6740 Median : 3.3766 Median : 3.54114   
## Mean : 6.327 Mean : 6.3996 Mean : 2.7693 Mean : 2.72823   
## 3rd Qu.: 5.452 3rd Qu.: 4.0888 3rd Qu.: 3.4231 3rd Qu.: 3.56607   
## Max. :16.000 Max. :16.0000 Max. : 3.8620 Max. : 4.77619   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001807 43664.429239488825: 1 Min. : 28.68 Min. :28.96   
## 1st Qu.: 3.273935 43664.429251064059: 1 1st Qu.: 90.82 1st Qu.:49.96   
## Median : 3.274583 43664.429262639293: 1 Median : 96.71 Median :52.46   
## Mean : 2.619814 43664.429274214526: 1 Mean : 91.93 Mean :51.26   
## 3rd Qu.: 3.274908 43664.429285789753: 1 3rd Qu.: 99.42 3rd Qu.:53.59   
## Max. : 3.276204 43664.429297364986: 1 Max. :104.56 Max. :67.73   
## (Other) :7246   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :28.85 Min. : 29.8 Min. :-0.2128 Min. :-5.962   
## 1st Qu.:38.95 1st Qu.:344.0 1st Qu.:52.5979 1st Qu.: 9.364   
## Median :42.71 Median :345.7 Median :54.1990 Median :10.523   
## Mean :40.76 Mean :283.1 Mean :51.1692 Mean :10.493   
## 3rd Qu.:44.14 3rd Qu.:346.6 3rd Qu.:56.8946 3rd Qu.:12.094   
## Max. :44.55 Max. :347.0 Max. :60.2469 Max. :23.615   
##

##### Test 1

summary(d4t2A1)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-0.8296 Min. :-0.6518 Min. :-0.2056 Min. :-0.1391   
## 1st Qu.: 4.1480 1st Qu.: 3.5555 1st Qu.: 3.3018 1st Qu.: 3.4198   
## Median : 4.7407 Median : 3.8518 Median : 3.3483 Median : 3.4580   
## Mean : 6.7321 Mean : 6.1561 Mean : 2.6740 Mean : 2.7709   
## 3rd Qu.: 5.6296 3rd Qu.: 4.2074 3rd Qu.: 3.3865 3rd Qu.: 3.4879   
## Max. :16.0000 Max. :16.0000 Max. : 3.5328 Max. : 3.6060   
##   
## Gate Signal Time S1 Case T   
## Min. :-0.001807 43670.479917329416: 1 Min. : 27.76   
## 1st Qu.: 3.273287 43670.479928904642: 1 1st Qu.: 86.95   
## Median : 3.273935 43670.479940479876: 1 Median : 89.84   
## Mean : 2.621646 43670.479952043534: 1 Mean : 89.26   
## 3rd Qu.: 3.274583 43670.479963618767: 1 3rd Qu.: 92.67   
## Max. : 3.275880 43670.479975193994: 1 Max. :100.20   
## (Other) :8025   
## S3 Case T Plate T Gate Signal S1 Delta T   
## Min. : 27.85 Min. :27.99 Min. : 30.6 Min. :-0.2763   
## 1st Qu.: 85.69 1st Qu.:38.73 1st Qu.:344.2 1st Qu.:48.1077   
## Median : 89.49 Median :40.01 Median :344.8 Median :50.8698   
## Mean : 88.82 Mean :38.82 Mean :282.3 Mean :50.4465   
## 3rd Qu.: 92.77 3rd Qu.:40.81 3rd Qu.:345.0 3rd Qu.:52.6709   
## Max. :101.28 Max. :42.26 Max. :345.2 Max. :58.3916   
##   
## S3 Delta T   
## Min. :-0.181   
## 1st Qu.:47.297   
## Median :50.042   
## Mean :50.004   
## 3rd Qu.:53.078   
## Max. :59.154   
##

summary(d4t2A2)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-0.9482 Min. :-0.8888 Min. :-0.1341 Min. :-0.1008   
## 1st Qu.: 4.1480 1st Qu.: 3.5555 1st Qu.: 3.3367 1st Qu.: 3.4497   
## Median : 4.7406 Median : 3.8518 Median : 3.3716 Median : 3.4813   
## Mean : 6.9363 Mean : 6.3872 Mean : 2.6286 Mean : 2.7233   
## 3rd Qu.: 5.6888 3rd Qu.: 4.2666 3rd Qu.: 3.4065 3rd Qu.: 3.5046   
## Max. :16.0000 Max. :16.0000 Max. : 3.5677 Max. : 3.6193   
##   
## Gate Signal Time S1 Case T   
## Min. :-0.001807 43670.606434100198: 1 Min. : 30.51   
## 1st Qu.: 3.272963 43670.606445675425: 1 1st Qu.: 85.25   
## Median : 3.273611 43670.606457250658: 1 Median : 87.78   
## Mean : 2.554239 43670.606468825892: 1 Mean : 87.38   
## 3rd Qu.: 3.274260 43670.606480401118: 1 3rd Qu.: 90.77   
## Max. : 3.276204 43670.606491976352: 1 Max. :101.81   
## (Other) :8253   
## S3 Case T Plate T Gate Signal S1 Delta T   
## Min. : 30.67 Min. :31.10 Min. : 31.5 Min. :-0.7069   
## 1st Qu.: 84.61 1st Qu.:38.24 1st Qu.:344.7 1st Qu.:46.3646   
## Median : 87.51 Median :39.79 Median :345.2 Median :48.3331   
## Mean : 87.33 Mean :38.96 Mean :282.8 Mean :48.4181   
## 3rd Qu.: 91.51 3rd Qu.:40.66 3rd Qu.:345.7 3rd Qu.:50.9007   
## Max. :102.27 Max. :43.40 Max. :346.6 Max. :60.2296   
##   
## S3 Delta T   
## Min. :-0.5516   
## 1st Qu.:45.3407   
## Median :48.4593   
## Mean :48.3649   
## 3rd Qu.:51.5749   
## Max. :59.7751   
##

summary(d4t2A3)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-1.422 Min. :-0.1186 Min. :-0.1391 Min. :-0.07924   
## 1st Qu.: 4.207 1st Qu.: 3.6148 1st Qu.: 3.3550 1st Qu.: 3.47132   
## Median : 4.859 Median : 3.9704 Median : 3.3899 Median : 3.50623   
## Mean : 6.777 Mean : 6.2402 Mean : 2.7178 Mean : 2.81837   
## 3rd Qu.: 5.689 3rd Qu.: 4.3259 3rd Qu.: 3.4281 3rd Qu.: 3.53117   
## Max. :16.000 Max. :16.0000 Max. : 3.5993 Max. : 3.64420   
##   
## Gate Signal Time S1 Case T   
## Min. :-0.001807 43671.458426875528: 1 Min. : 27.61   
## 1st Qu.: 3.273611 43671.458438450754: 1 1st Qu.: 90.72   
## Median : 3.273935 43671.458450025988: 1 Median : 93.95   
## Mean : 2.619891 43671.458461601222: 1 Mean : 92.39   
## 3rd Qu.: 3.274260 43671.458473176448: 1 3rd Qu.: 96.45   
## Max. : 3.275556 43671.458484740106: 1 Max. :100.90   
## (Other) :9004   
## S3 Case T Plate T Gate Signal S1 Delta T   
## Min. : 27.69 Min. :27.86 Min. : 30.45 Min. :-0.2986   
## 1st Qu.: 90.39 1st Qu.:38.83 1st Qu.:343.99 1st Qu.:51.0367   
## Median : 93.25 Median :41.38 Median :344.71 Median :52.6893   
## Mean : 92.47 Mean :39.69 Mean :282.19 Mean :52.6986   
## 3rd Qu.: 97.11 3rd Qu.:41.99 3rd Qu.:345.16 3rd Qu.:55.0692   
## Max. :102.23 Max. :43.66 Max. :345.52 Max. :58.8786   
##   
## S3 Delta T   
## Min. :-0.2147   
## 1st Qu.:50.0129   
## Median :52.6835   
## Mean :52.7785   
## 3rd Qu.:56.0373   
## Max. :60.2372   
##

summary(d4t2A4)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-1.363 Min. :-0.237 Min. :-0.1341 Min. :-0.06594   
## 1st Qu.: 4.148 1st Qu.: 3.615 1st Qu.: 3.3117 1st Qu.: 3.43974   
## Median : 4.800 Median : 3.911 Median : 3.3483 Median : 3.46800   
## Mean : 6.716 Mean : 6.183 Mean : 2.6783 Mean : 2.78292   
## 3rd Qu.: 5.630 3rd Qu.: 4.267 3rd Qu.: 3.3882 3rd Qu.: 3.49293   
## Max. :16.000 Max. :16.000 Max. : 3.5677 Max. : 3.63589   
##   
## Gate Signal Time S1 Case T   
## Min. :-0.002131 43671.596580055339: 1 Min. : 32.15   
## 1st Qu.: 3.273611 43671.596591630565: 1 1st Qu.: 89.28   
## Median : 3.274260 43671.596603205799: 1 Median : 92.87   
## Mean : 2.622153 43671.596614781032: 1 Mean : 91.49   
## 3rd Qu.: 3.274583 43671.596626356259: 1 3rd Qu.: 95.71   
## Max. : 3.275880 43671.596637931492: 1 Max. :101.90   
## (Other) :3911   
## S3 Case T Plate T Gate Signal S1 Delta T   
## Min. : 32.21 Min. :32.31 Min. : 31.87 Min. :-0.3292   
## 1st Qu.: 88.46 1st Qu.:36.52 1st Qu.:345.15 1st Qu.:51.6886   
## Median : 92.31 Median :39.42 Median :345.42 Median :53.4700   
## Mean : 91.27 Mean :38.48 Mean :283.19 Mean :53.0128   
## 3rd Qu.: 95.90 3rd Qu.:40.84 3rd Qu.:345.85 3rd Qu.:55.8726   
## Max. :102.64 Max. :42.13 Max. :346.35 Max. :60.1315   
##   
## S3 Delta T   
## Min. :-0.2646   
## 1st Qu.:50.4623   
## Median :52.9776   
## Mean :52.7924   
## 3rd Qu.:56.4027   
## Max. :60.9890   
##

summary(d4t2A5)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-1.837 Min. :-0.2963 Min. :-0.2122 Min. :-0.1308   
## 1st Qu.: 4.089 1st Qu.: 3.5555 1st Qu.: 3.2586 1st Qu.: 3.3915   
## Median : 4.800 Median : 3.9111 Median : 3.2935 Median : 3.4198   
## Mean : 6.747 Mean : 6.1538 Mean : 2.6263 Mean : 2.7348   
## 3rd Qu.: 5.748 3rd Qu.: 4.2666 3rd Qu.: 3.3334 3rd Qu.: 3.4464   
## Max. :16.000 Max. :16.0000 Max. : 3.7556 Max. : 3.5711   
##   
## Gate Signal Time S1 Case T   
## Min. :-0.001807 43672.481800562826: 1 Min. : 28.27   
## 1st Qu.: 3.273935 43672.481812138059: 1 1st Qu.: 89.22   
## Median : 3.274583 43672.481823713293: 1 Median : 93.82   
## Mean : 2.622111 43672.481835288527: 1 Mean : 91.67   
## 3rd Qu.: 3.274908 43672.481846863753: 1 3rd Qu.: 96.42   
## Max. : 3.275880 43672.481858427411: 1 Max. :101.90   
## (Other) :6470   
## S3 Case T Plate T Gate Signal S1 Delta T   
## Min. : 28.27 Min. :28.12 Min. : 30.79 Min. : 0.1242   
## 1st Qu.: 89.23 1st Qu.:37.83 1st Qu.:344.56 1st Qu.:50.3387   
## Median : 93.24 Median :41.90 Median :345.09 Median :51.8798   
## Mean : 91.93 Mean :39.94 Mean :282.78 Mean :51.7332   
## 3rd Qu.: 97.12 3rd Qu.:43.41 3rd Qu.:345.59 3rd Qu.:54.2574   
## Max. :103.09 Max. :44.14 Max. :345.97 Max. :57.9940   
##   
## S3 Delta T   
## Min. : 0.12   
## 1st Qu.:49.32   
## Median :51.99   
## Mean :51.99   
## 3rd Qu.:55.38   
## Max. :59.15   
##

summary(d4t2A6)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-1.718 Min. :-0.7111 Min. :-0.2488 Min. :-0.1989   
## 1st Qu.: 4.207 1st Qu.: 3.6148 1st Qu.: 3.2386 1st Qu.: 3.3733   
## Median : 4.918 Median : 3.9703 Median : 3.2752 Median : 3.4032   
## Mean : 6.815 Mean : 6.2050 Mean : 2.6096 Mean : 2.7187   
## 3rd Qu.: 5.807 3rd Qu.: 4.3259 3rd Qu.: 3.3134 3rd Qu.: 3.4314   
## Max. :16.000 Max. :16.0000 Max. : 3.7489 Max. : 3.5544   
##   
## Gate Signal Time S1 Case T   
## Min. :-0.001807 43672.657891341441: 1 Min. : 29.44   
## 1st Qu.: 3.273935 43672.657902916675: 1 1st Qu.: 95.12   
## Median : 3.274583 43672.657914491901: 1 Median : 97.23   
## Mean : 2.619859 43672.657926067135: 1 Mean : 95.95   
## 3rd Qu.: 3.274908 43672.657937642369: 1 3rd Qu.: 99.92   
## Max. : 3.276528 43672.657949206026: 1 Max. :103.76   
## (Other) :8848   
## S3 Case T Plate T Gate Signal S1 Delta T   
## Min. : 29.48 Min. :29.73 Min. : 31.84 Min. :-0.3705   
## 1st Qu.: 92.95 1st Qu.:40.70 1st Qu.:345.54 1st Qu.:52.8394   
## Median : 95.30 Median :43.35 Median :346.21 Median :54.4693   
## Mean : 94.66 Mean :41.53 Mean :283.60 Mean :54.4263   
## 3rd Qu.: 99.22 3rd Qu.:43.62 3rd Qu.:346.63 3rd Qu.:56.9429   
## Max. :104.21 Max. :45.63 Max. :346.83 Max. :60.0609   
##   
## S3 Delta T   
## Min. :-0.3271   
## 1st Qu.:50.3058   
## Median :53.1021   
## Mean :53.1309   
## 3rd Qu.:56.4986   
## Max. :60.3347   
##

summary(d4t2A7)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-0.7704 Min. :-0.2963 Min. :-0.2056 Min. :-0.1324   
## 1st Qu.: 3.9110 1st Qu.: 3.3185 1st Qu.: 3.2486 1st Qu.: 3.3766   
## Median : 4.5036 Median : 3.6148 Median : 3.2818 Median : 3.4015   
## Mean : 6.4679 Mean : 5.8635 Mean : 2.6154 Mean : 2.7207   
## 3rd Qu.: 5.0073 3rd Qu.: 3.9111 3rd Qu.: 3.3217 3rd Qu.: 3.4289   
## Max. :16.0000 Max. :16.0000 Max. : 3.4963 Max. : 3.5478   
##   
## Gate Signal Time S1 Case T S3 Case T   
## Min. :-0.001483 43674.500279236781: 1 Min. :33.61 Min. :33.29   
## 1st Qu.: 3.273935 43674.500290810851: 1 1st Qu.:82.57 1st Qu.:81.34   
## Median : 3.274583 43674.500302384928: 1 Median :86.33 Median :85.05   
## Mean : 2.626943 43674.500313959004: 1 Mean :83.60 Mean :83.27   
## 3rd Qu.: 3.274583 43674.500325533074: 1 3rd Qu.:88.93 3rd Qu.:88.50   
## Max. : 3.275556 43674.500337107151: 1 Max. :94.54 Max. :95.02   
## (Other) :1041   
## Plate T Gate Signal S1 Delta T S3 Delta T   
## Min. :31.38 Min. : 31.65 Min. : 2.211 Min. : 1.899   
## 1st Qu.:32.36 1st Qu.:345.46 1st Qu.:49.722 1st Qu.:47.951   
## Median :34.14 Median :345.50 Median :51.337 Median :50.260   
## Mean :34.16 Mean :283.47 Mean :49.436 Mean :49.101   
## 3rd Qu.:35.87 3rd Qu.:345.53 3rd Qu.:53.965 3rd Qu.:53.878   
## Max. :37.34 Max. :345.61 Max. :57.202 Max. :57.694   
##

summary(d4t2A8)

## S1 Voltage S3 Voltage S1 Current S3 Current   
## Min. :-0.8888 Min. :-0.4148 Min. :-0.2887 Min. :-0.2205   
## 1st Qu.: 4.1481 1st Qu.: 3.5555 1st Qu.: 3.2120 1st Qu.: 3.3300   
## Median : 4.6814 Median : 3.9110 Median : 3.2469 Median : 3.3666   
## Mean : 6.8761 Mean : 6.5585 Mean : 2.4985 Mean : 2.5544   
## 3rd Qu.: 5.3332 3rd Qu.: 4.2666 3rd Qu.: 3.2852 3rd Qu.: 3.3932   
## Max. :16.0000 Max. :16.0000 Max. : 3.4813 Max. : 3.5062   
##   
## Gate Signal Time S1 Case T   
## Min. :-0.002131 43674.617069333581: 1 Min. : 29.97   
## 1st Qu.: 3.274260 43674.617080955104: 1 1st Qu.: 88.87   
## Median : 3.274583 43674.617092576635: 1 Median : 93.84   
## Mean : 2.551984 43674.617104198165: 1 Mean : 91.71   
## 3rd Qu.: 3.274908 43674.617115819688: 1 3rd Qu.: 96.99   
## Max. : 3.275880 43674.617127441219: 1 Max. :103.36   
## (Other) :3683   
## S3 Case T Plate T Gate Signal S1 Delta T   
## Min. : 30.04 Min. :30.23 Min. : 32.55 Min. :-0.2746   
## 1st Qu.: 87.36 1st Qu.:35.78 1st Qu.:346.25 1st Qu.:51.7471   
## Median : 92.55 Median :40.04 Median :346.41 Median :53.4906   
## Mean : 90.57 Mean :38.83 Mean :283.61 Mean :52.8799   
## 3rd Qu.: 96.39 3rd Qu.:42.47 3rd Qu.:346.71 3rd Qu.:55.9603   
## Max. :103.45 Max. :43.77 Max. :346.92 Max. :59.7563   
##   
## S3 Delta T   
## Min. :-0.2049   
## 1st Qu.:49.9039   
## Median :52.4380   
## Mean :51.7430   
## 3rd Qu.:55.9023   
## Max. :60.0791   
##

### Variable Current Device3

Variable Current device 3 contains median files for runs at various currents. This median data may become useful as previously extracted feature data (dimensionality reduction).

setwd("~/Power\_Converters/data/HIL Data/VariableCurrent\_Device3")  
  
mOn4<-readMat("medianOn4A\_Dev3.mat")  
mOn4167<-readMat("medianOn4p167A\_Dev3.mat")  
mOn434<-readMat("medianOn4p34A\_Dev3.mat")  
mOn454<-readMat("medianOn4p54A\_Dev3.mat")

summary(mOn4)

## Length Class Mode   
## dataStruct 18 -none- list   
## 5625 -none- numeric  
## 751856 -none- numeric

summary(mOn4167)

## Length Class Mode   
## dataStruct 18 -none- list   
## 2211 -none- numeric  
## 296344 -none- numeric

summary(mOn434)

## Length Class Mode   
## dataStruct 18 -none- list   
## 2154 -none- numeric  
## 288880 -none- numeric

summary(mOn454)

## Length Class Mode   
## dataStruct 18 -none- list   
## 1701 -none- numeric  
## 228416 -none- numeric

### UCONN HIL

The UCONNHIL folder contains data from medians, gaps, and ewma medians in .mat form. I will hold on this data for now, but the gaps may become useful in future analysis, the medians may become useful as previously extracted features, and the EWMA Medians may be useful in the algorithm comparison and competition phase.

#### autoencoder\_UCONNHIL

Train/test encoded/decoded from Dev1, Dev2, Dev3, On4A\_Dev3, and ON data from 4A, 4.167A, 4.34A, 4.54A, and 5A in various runs and datasets. All appear to be in .mat format. I will hold on this data for now, but the autoencoded outputs may be useful to use as extracted features for algorithm applications.

#### ewma\_autoencoder\_UCONNHIL

Train/test encoded/decoded from Dev1, Dev2, Dev3, On4A\_Dev3, and ON data from 4A, 4.167A, 4.34A, 4.54A, and 5A in various runs and datasets. All appear to be in .mat format. I will hold on this data for now, but this data may be useful for algorithm comparison and competition in future stages.

# Conclusions and Recommendations

Recommend establishing a managed repository for the protection of Raw Data and version control of code and curated data. Continue extraction and cleaning of data. My intention is to focus on what appears to be raw data, and then move forward with curation and algorithm application. I’ll then circle back to previously curated data and features that have been previously extracted.