Suggested timing setup for IP surveying ABEM Terrameter LS

Some notes about timing set-up for time-domain IP measurements

It is important to choose suitable timing when doing IP measurements. According to the theoretical models commonly used when modelling and interpreting IP data the charge-up and decay processes have equal time characteristics. Although this may not always be the case in reality, it is recommendable to use equal duration for current-on and current-off in the measuring cycle. It is also important to use sufficient time to allow the IP phenomena to build up and decay, otherwise the measured chargeabilities can have large errors due to this. These errors cannot be removed by stacking but only by using longer times in the measuring cycle. Furthermore, the measured resistivities will be under estimated.

Since the IP decay is exponential it is suitable to use a logarithmic distribution of the time windows. At the same time it is important to use integration times that are multiples of the power net frequency period in order to suppress noise from the power grid. This type of noise is often magnitudes larger than the IP decay signals.

In order to capture as much as possible of the IP decay it is important to start measuring the decay soon after current has been turned off. For Terrameter LS a delay of 10 to 20 ms before the first IP time windows often works well. Some instruments on the market have strong analogue filters on the input channels in order to reduce noise which affects early time IP data so that meaningful data can only be achieved after around 100 ms. Terrameter LS uses digital filtering instead in order to allow unbiased data from early times.

In cases of difficult measuring conditions (mostly due to high electrode contact resistances) longer delay times may be useful for reducing noise in IP data, but this can be achieved afterwards by excluding the first time window from the data that is used in the interpretation.

This document includes suggested timings for measuring with pulse times of 1, 2 and 4 seconds, in versions for use in areas with 50 Hz and 60 Hz power grid respectively.

In addition to the regular power grid it is important to beware of noise from railway power supply. It is critical to use integration times that are multiples of the used frequency when operating close to electrically powered railways. Railways may apart from DC operate at the frequencies 16 $^2/3$ Hz, 25 Hz, 50 Hz and 60 Hz, with voltages up to 25 kV.

Timing setup for surveying in areas with 50 Hz power grid

Ton = 1s (e.g. delay time = 0.4s, acq time = 0.6s), Toff = 1s, IP delay 10 ms

Window #	Time[s]
1	0.02
2	0.04
3	0.06
4	0.08
5	0.12
6	0.16
7	0.20
8	0.28
Sum	0.96

Ton = 2s (delay time = 0.8s, acq time = 1.2s), Toff = 2s, IP delay 10 ms

Window #	Time[s]
1	0.02
2	0.04
3	0.06
4	0.08
5	0.10
6	0.14
7	0.18
8	0.26
7	0.40
8	0.58
Sum	1.86

Ton = 4s (e.g. delay time = 1.6s, acq time = 2.4s), Toff = 4s, IP delay 10 ms

Window #	Time[s]
1	0.02
2	0.04
3	0.06
4	0.08
5	0.10
6	0.14
7	0.18
8	0.26
7	0.40
8	0.60
7	0.88
8	1.20
Sum	3.96

The IP delay time can be set to for example 10 or 20 ms.

The integration time for each time window is a multiple of the period time 20 ms in order to suppress power line noise.

The sum of time for the time windows is furthermore a multiple of 60 ms which is the period time of 16 2/3 Hz which is used for railway power supply in some countries (e.g. Germany, Austria, Switzerland, Norway and Sweden).

Timing setup for surveying in areas with 16 ⅔ Hz power grid

Ton = 1s (e.g. delay time = 0.4s, acq time = 0.6s), Toff = 1s, IP delay 10 ms

Window #	Time[s]
1	0.06
2	0.06
3	0.06
4	0.06
5	0.12
6	0.18
7	0.18
8	0.24
Sum	0.96

Ton = 2s (delay time = 0.8s, acq time = 1.2s), Toff = 2s, IP delay 10 ms

Window #	Time[s]
1	0.06
2	0.06
3	0.06
4	0.12
5	0.18
6	0.24
7	0.30
8	0.36
9	0.42
Sum IP win	1.80

Ton = 4s (e.g. delay time = 1.6s, acq time = 2.4s), Toff = 4s, IP delay 10 ms

Window #	Time[s]
1	0.06
2	0.06
3	0.06
4	0.12
5	0.12
6	0.18
7	0.24
8	0.30
9	0.36
10	0.48
11	0.72
12	0.90
Sum	3.60

The IP delay time can be set to for example 10 or 20 ms.

The integration time for each time window is a multiple of the period time 60 ms in order to suppress not only power line noise but also railway power supply of 16 ⅔ Hz (used in e.g. Germany, Austria, Switzerland, Norway and Sweden).

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Timing setup for surveying in areas with 60 Hz power grid

Ton = 1s (e.g. delay time = 0.4s, acq time = 0.6s), Toff = 1s, IP delay 10 ms

Window #	Time[s]
1	0.017
2	0.033
3	0.050
4	0.067
5	0.083
6	0.100
7	0.133
8	0.167
9	0.250
Sum	0.900

Ton = 2s (e.g. delay time = 0.8s, acq time = 1.2s), Toff = 2s, IP delay 10 ms

Window #	Time[s]
1	0.017
2	0.033
3	0.050
4	0.067
5	0.083
6	0.100
7	0.133
8	0.167
9	0.217
10	0.283
11	0.350
12	0.450
Sum	1.950

Ton = 4s (e.g. delay time = 1.6s, acq time = 2.4s), Toff = 4s, IP delay 10 ms

Window #	Time[s]
1	0.017
2	0.033
3	0.050
4	0.067
5	0.083
6	0.100
7	0.133
8	0.167
9	0.217
10	0.283
11	0.367
12	0.483
13	0.600
14	0.800
Sum	3.400

The IP delay time can be set to for example 10 or 20 ms.

The integration time for each time window is a multiple of the period time 16 2/3 ms in order to suppress power line noise.