A Complete Study of Variability in Time and Amplitude of a Standard ECG Database

Manuel M. Casas, Roberto L. Avitia, Alexandra Gomez-Caraveo, Marco A. Reyna, and Jose A. Cardenas-Haro

***Abstract*—Currently the Electrocardiogram (ECG) is still an important and conventional tool that represents a pre-diagnosis system in a wide variety of heart diseases. Conventional Electrocardiography pre-diagnosis is based on time variations and ECG waveforms characteristics. Because of this, there are many studies and tables that describe time variations as heart healthy patterns, but there are almost no waveform amplitude variation studies that describe heart healthy patterns in an ECG trace. We reported here a complete evaluation of time and amplitude variations described by a very used ECG database called The PTB Diagnostic ECG Database. In order to measure ECG waveforms patterns in time and amplitude, we used a slightly modified and classic algorithm developed by Pan and Tompkins, as wells as a proposed method based on wavelets. Results show complete descriptive tables that represent a heart-healthy subject both in time amplitude variations.**

***Index Terms*—ECG trace, amplitude variability, time variability, ECG parameters.**

I. Introduction

Electrocardiogram or simply ECG trace is still an important pre-diagnosis tool that is continuously studied. Some researchers have developed many techniques and methods to interpret ECG as normal or abnormal based on professional experiences [1]. To classify an ECG as normal or abnormal, professional analyzes carefully characteristic waveforms called P wave, QRS complex, ST segment and T wave. A Normal Sinus Rhythm is reflective of a normally functioning conduction system, and an experimented physician can determine it looking the ECG trace and some parameters such as Rhythm, Rate, P wave configuration, PR interval and QRS duration and configuration [2], [3]. On the other hand, some authors have shown that waveforms (e.g. Q waves or ST segments) can mimic another kind of cardiac anomaly such as left bundle branch block or Hyperkalemia [4], [5], making ECG interpretation a diagnosis completely based on physician experience not a quantitative or automatic diagnosis. In this work, we classified the Normal Sinus Rhythm as a quantitative description in time and amplitude. We utilized the PTB Diagnostic ECG Database (PTBDED) and only that ECG traces considered as normal [6]. We used a classic and slightly modified Pan and Tompkins algorithm [7] to calculate the ECG parameters in time and a proposed method based on Wavelets to calculate the ECG parameters in amplitude. Results show a complete description in time and amplitude of that ECG traces considered as Normal Sinus Rhythm.

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II. Materials and Methods

The PTBDED is part of Physionet databases that offers free access via the web to large collections of recorded physiologic signals. We selected the best defined 36 three Frank lead ECGs (X, Y, Z) with a sample rate of 1000 samples per second and aged 17 to 87. We localized those ECG segments considered as normal by the database (i.e. about 380 beats each orthogonal ECG traces) and those were characterized in time and amplitude as follow:

A. Classification in Time of Normal ECG Traces

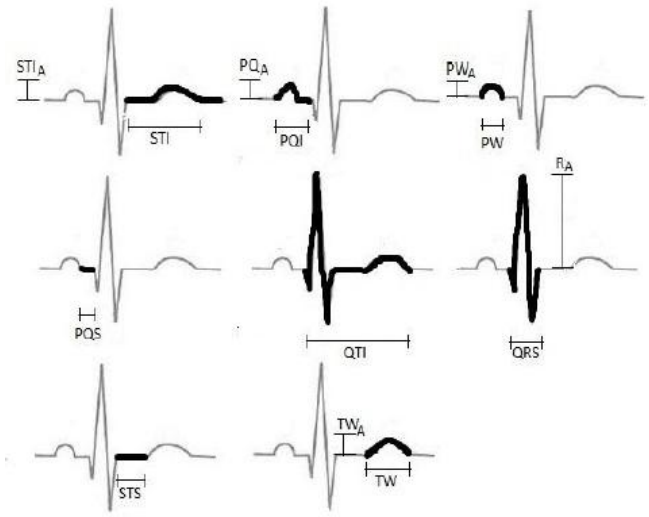

Fig. 1. Time and amplitude parameters taken in consideration to compute the ECG variability for the X and Y leads.

After ECG trace selection based on low noise signals (visual criterion), we classified each ECG trace in time-duration by the mean of the parameters described as: ST segment (STS), PQ interval (PQI), P wave (PW), PQ segment (PQS), QT interval (QTI), QRS complex (QRS), ST-T complex (STI) and T wave (TW) as shown in Fig. 1.

ECG traces were smoothed with a simple moving averaged filter of three points (assuring ECG bandwidth was not affected) and adjusted to an isoelectric baseline using a MATLAB® function msbackadj as shown in Fig. 2.

In order to calculate the beginning and the ending of the QRS complex (QRSon and QRSoff respectively), a slightly

modified of classical Pan and Tompkins algorithm was applied. This algorithm involves two filters that act as a band-pass filter (5-15 Hz) and a differentiation process that enhance the QRS complex and provides information of the slope. After this differentiation process, the QRS is squared to heighten much more the higher frequencies in the complete ECG trace. A moving integration window gives information to detect the QRSon and QRSoff as shown in Fig. 3.

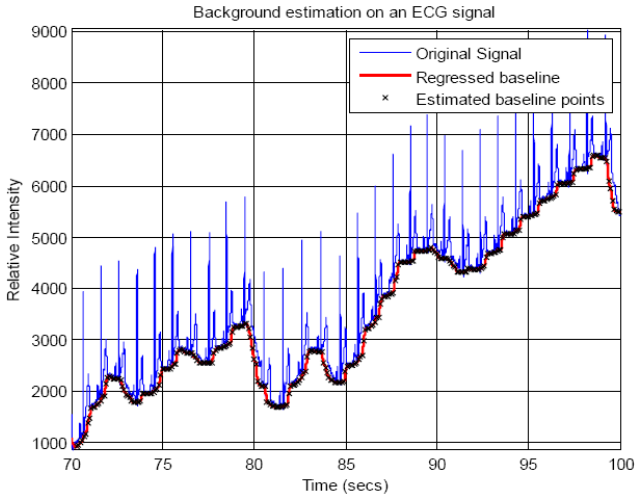

Fig. 2. Background estimation of an ECG with variable isoelectric line by applying *msbackadj* function. It permits to adjust each ECG trace to a constant isoelectric line.

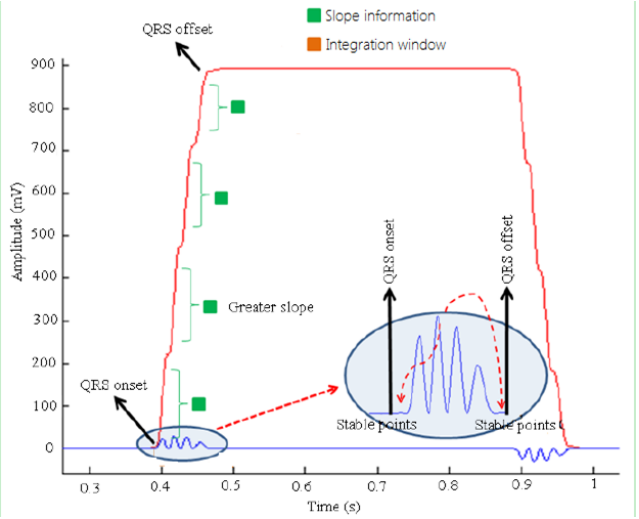

Fig. 3. Integration windows used to calculate QRSonset and QRSoffset for each ECG trace. Slope calculation of the integration window give us the QRS duration.

Once we found QRSon and QRSoff the difference between them was defined as QRS complex duration in ms or simply QRS. STS was computed from the QRSoff to the time where the T wave slope starts to increase, and we calculated the TW when this slope finished to decrease. STI was defined adding STS+TW and QTI was found adding QRS+STS. PQS was established with the time when P wave finished decreasing to the time when QRSon occurred. PQI was found adding PW+PQS and RRI was defined with the difference between each R-peak. Each parameter variability in time was calculated using equation 1, where *par* is the parameter measured (e.g. QRS, PQI, and so on) , *VTpar* is the parameter variability, *N* is the number of beats recorded (about 150 beats) and $\overline{par}$ is the mean of the parameter in each ECG trace taken in consideration. Variability in time is given in ms^2.

$$VT_{par} = \frac{1}{N}\sum_{i=1}^{N}(par_i - \overline{par})^2 \quad (1)$$

B. Classification in Amplitude of Normal ECG Traces

The ECG trace physiological nature makes the process of identifying its ECG waveforms in amplitude a very complicated issue. The application of time-frequency analysis gives us an important alternative to study and to identify these ECG waveforms in amplitude. We defined amplitude parameters for X and Y leads in each ECG trace as the mean of ST interval amplitude (STIA), P wave amplitude (PWA), R-peak amplitude (RA), T wave amplitude (TWA) and Q wave amplitude (QWA). We applied a special treatment for Z lead that has different behavior, thus we defined three more parameters described as T wave with negative and positive in amplitude (NTWA and PTWA) and PQ amplitude (PQA) as shown in Fig. 5.

1) Detection of critical points for X and Y leads

The wavelet transform is a very used technique for Time-Frequency Representations for ECG traces [8]. In this particular issue, we used the Continuous Wavelet Transform (CWT) as a tool to identify characteristic points in time amplitude and extract components localized in high and low frequencies of the signal ECG(t) for X and Y leads. The CWT is defined in equation 2.

$$CWT(b,a)_{ECG} = \frac{1}{\sqrt{a}}\int_{-\infty}^{+\infty} ECG(t)\Psi^*\left(\frac{t-b}{a}\right)dt \quad (2)$$

where the CWT(b, a)$_{ECG}$ is the convolution of the ECG(t) trace and the conjugated wavelet function $\Psi^*(t)$ that was shifted in time (t) by a parameter b and compressed in amplitude by a parameter a.

In order to identify different critical points that represent the beginning and ending of characteristic waves along all 36 ECG traces, we implemented the CWT by using MATLAB® with different scale (H) variations. An high scale was used for low frequency signals (e.g. T wave) and low scale was used for high frequency signals (e.g. QRS). Each critical point was determined by the time where $\Psi(t)$ had a zero-crossing point. For signals that have Q and S waves we applied a scaled of H=2. The $\Psi(t)$ higher peak was localized defining a dynamic threshold and a 50 ms temporal window around it. In order to detect the S wave higher peak, we moved this temporal window going forward and downward from the $\Psi(t)$ higher peak to the zero-crossing point. In the same manner, to detect when the Q wave lower peak occurs, we moved this temporal window going backward and upward from the $\Psi(t)$ lower peak to the $\Psi(t)$ zero-crossing point. For QRS complex beginning (QRSon) and ending (QRSoff) detection we used a $\Psi(t)$ scaled in H=14 and H=17 respectively. QRSon was identified moving the temporal window again backward and upward from $\Psi(t)$ lower peak to zero-crossing point. QRSoff was localized moving the temporal window from $\Psi(t)$ higher peak downward and forward to a $\Psi(t)$ local minimum. Also applying H=20 and H=17 we identified P wave beginning and T wave ending respectively. We noticed that in $\Psi(t)$ both waves have

almost the same behaviors but P wave occurs first than the T wave; thus we moved the temporal window from a $\Psi(t)$ local minimum upward and backward to $\Psi(t)$ zero-crossing point to find PWon, and from $\Psi(t)$ local maximum downward and forward to zero crossing point to find PWoff. Finally we moved the temporal window from a $\Psi(t)$ local minimum backward and upward to $\Psi(t)$ zero-crossing point in order to find TWon and from a $\Psi(t)$ local maximum downward and forward in order to find TWoff. Fig. 4 shows a complete description of $\Psi(t)$ and ECG(t) relationship applying this temporal window for different scales in X and Y leads.

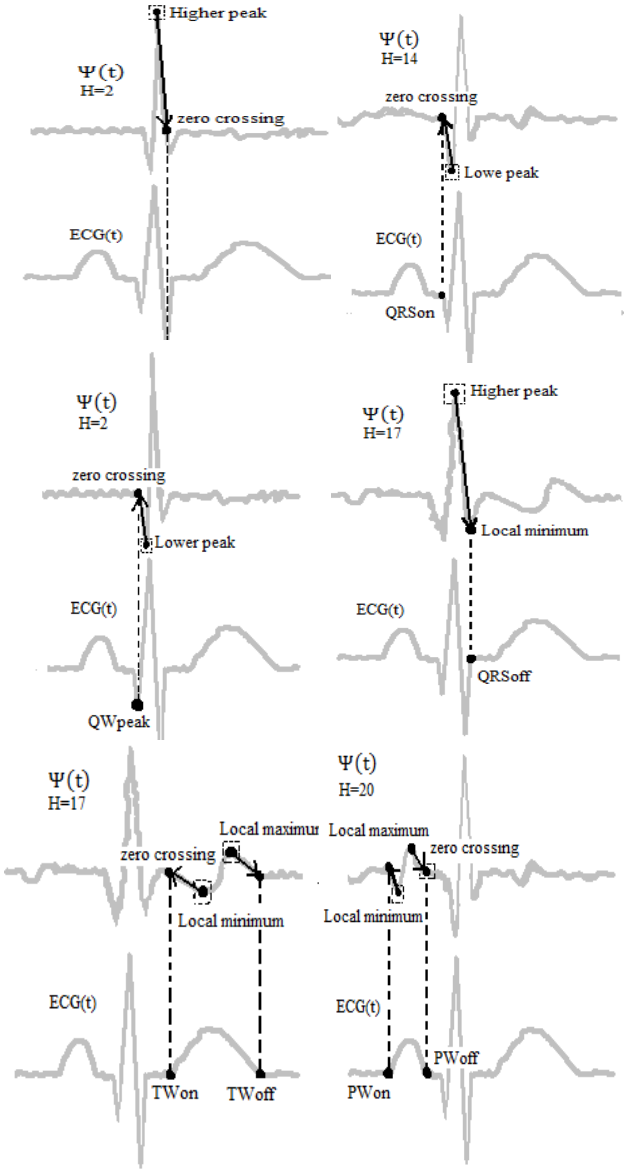

Fig. 4. Relationship between Wavelet transform with different scales and ECG(t) . Each critical point detected in ECG(t) were used as reference to find waveform amplitudes.

2) Detection of critical points for Z leads

The Frank Z lead is a very different ECG waveform in comparison with X and Y leads. In all Z lead traces we noticed that P and S waves were not presented. On the other hand, Z lead traces always presented a well-defined Q wave, a fact that not always happened with X and Y leads. Furthermore we noticed that T wave behavior is biphasic with a falling slope in T wave beginning (TW_{on}) followed by a rising slope for T wave ending (TW_{off}). In order to extract information according to the waveform of the Z lead, we modified the algorithm to detect crucial points that better described it. Critical points that better defined the ECG waveforms in the X lead were compared with Z lead and they were used to define its own waveforms. Critical points where X and Z lead coincided were the Q wave peak (Q_{peak}), R wave peak (R_{peak}) and QRS_{off} as shown in Fig. 5.

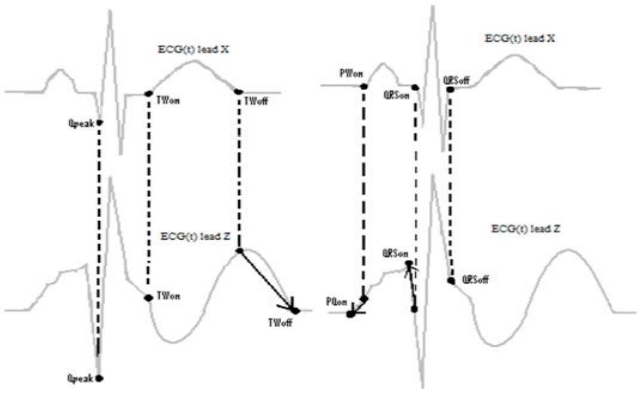

Fig. 5. The Z lead presented a biphasic T wave labeled as TW_{on} and TW_{off}, two parameters taken as critical points. The X lead parameters were used as reference to detect critical points in the Z lead.

We noticed that X lead TW_{on} and Z lead TW_{off} coincided, as well as X lead Q_{peak} coinded with Z lead Q_{peak} along all ECG traces, thus we defined Q_A and R_A for Z lead as the maximum negative and maximum positive detection respectively.

On the other hand, X lead TW_{off} did not coincide with Z lead TW_{off}. Thus we had to move this not coincidence point downward and forward until T wave stopped to decrease in order to find Z lead TW_{off}. NTW_A was defined as the maximum negative T wave and PTW_A as maximum potitive T wave.

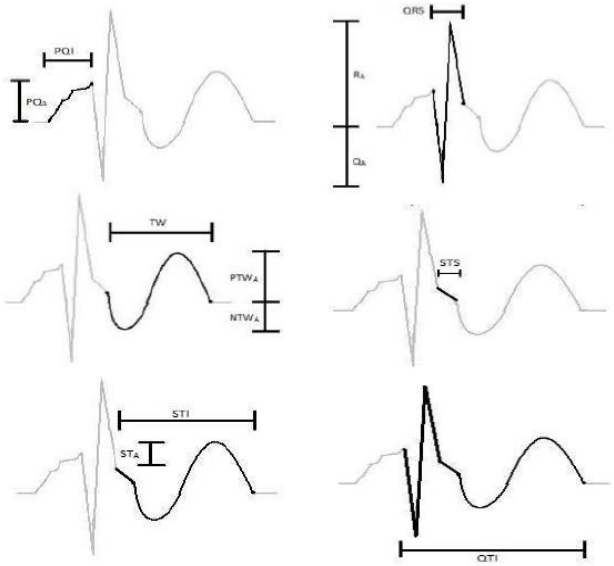

Fig. 6. Time and amplitude parameters taken in consideration to compute the ECG variability for Z lead.

We also noticed that X lead QRS_{off} coincided with Z lead QRS_{off}, thus we computed the Z lead ST segment (STS) in time with the difference between TW_{on} minus QRS_{off}; and ST

segment in amplitude (ST_A) as the maximum peak between them. Z lead Q_A generally has a very pronounced falling slope compared with other leads. The amplitude of PQ interval (PQI) was computed by the difference between QRS_{on} minus PQ_{on} and we labeled this paramer as PQ_A. A complete description of parameters taken in consideration for Z lead re show in Fig. 6.

Once all the ECG waveforms were defined, a simple maximum-peak detection algorithm was developed to find the maximum value for the P, R and T waves as the amplitude reference, with the exception of the STI_A that was measured from the difference between TW_A and QRS_{off}.

TABLE I: MAXIMUM VOLTAGES IN EACH ECG TRACE

Trace	Lead X max(mV)	Lead Y max(mV)	Lead Z max(mV)
104	2.54	1.01	1.03
116	1.44	0.70	0.84
117	1.79	1.45	1.12
150	1.78	1.83	0.63
155	1.35	0.85	1.00
156	0.73	2.68	1.66
165	1.70	0.70	0.88
166	4.67	1.43	1.09
169	1.17	0.63	0.82
170	1.84	0.39	0.98
172	1.66	0.82	1.17
173	0.99	1.26	0.83
174	1.46	1.09	0.91
180	1.04	0.47	0.74
182	1.69	0.94	0.50
214	1.08	0.84	1.27
234	1.04	1.01	0.64
235	1.50	0.28	1.14
237	1.42	0.70	0.71
238	1.09	0.70	1.04
239	0.86	0.34	1.17
240	0.95	1.03	1.22
241	2.39	1.48	1.40
242	0.90	1.54	1.45
243	0.87	1.13	0.32
244	1.71	0.59	0.65
245	1.38	0.66	0.94
251	1.04	0.59	1.16
252	2.12	0.61	0.78
255	1.04	0.99	1.46
260	0.92	1.29	1.29
264	1.62	0.92	0.71
267	1.22	0.55	0.93
276	1.52	0.70	1.01
277	1.94	0.99	0.61
284	1.21	1.71	1.03

Each parameter variability in amplitude was calculated using *Equation 3*, where *par* is the amplitude parameter measured (e.g. R, T, and so on), *VApar* is the parameter variability, *N* is the number of beats recorded (about 150 beats) and $\overline{par}$ is the mean of the parameter in amplitude for each ECG trace taken in consideration.

$$VA_{par} = \frac{1}{N}\sum_{i=1}^{N}(par_i - \overline{par})^2 \quad (3)$$

We established the maximum detected value as the reference in which all amplitude values should be normalized as we can see in Table I, thus if we have an amplitude value of one, this represents the maximum percentage (100%) and its Variability in amplitude is given in $\%^2$.

III. RESULTS

In Appendix section we can see Table II(A) and Table II(B) continued for time-parameters and time-variability and in Table III and Table III continued for amplitude-parameters and amplitude-variability. All this tables and information are related with all ECG traces and leads taken from PTBDED. These tables have the mean and variability for each wave, segment, interval and complex. The mean and variability time parameters tables give the data of the duration in milliseconds of each parameter measured by the algorithms. As expected from healthy controls traces, the variability is very low, practically zero in some cases.

As we described before in algorithm implementation, all ECG traces were smoothed, adjusted to an isoelectric baseline and normalized to 1 as the highest value. All the amplitudes are presented in percentages and were measured from the baseline to the highest peak of each parameter. Some R wave peaks amplitude parameters are over 100% because the baseline is not in zero but lower. The percentages are equivalent to a voltage value in mV and these are presented in Table I for each trace and lead. Compared in time, the variability presented some changes through the ECG trace but did not cause a major change to the mean value. These findings tell us that the ECG variability trace are very low, even though between leads could present some significant differences in amplitude and time.

IV. CONCLUSION

The old algorithms as the Pan-Tompkins are still a good QRS onset detection and the remaining characteristic waveforms of the ECG trace. Furthermore with these algorithms, the wavelet transform gives the advantage to work with no significance variations in amplitude due to it compares with a reference waveform called wavelet transform with different scales. This is a very useful technique because the ECG trace baseline is not stable and his waveforms identification were crucial. We implemented different algorithms for a complete database that contains the variability in time and amplitude of healthy ECG traces. We can see that there is almost no change in the waveforms, complexes and intervals within same lead but between different leads amplitude variability changes are consistent. This information is part of a greater project that pretends to get a mathematician model from healthy ECG traces.

APPENDIX

TABLE II(A): PARAMETERS AND VARIABILITY IN TIME OF X, Y AND Z LEADS (TRACES 104-244)

Trace/Par	STI(ms) $\pm V_{STI}(ms^2)$	PQI(ms) $\pm V_{PQI}(ms^2)$	PW(ms) $\pm V_{PW}(ms^2)$	PQS(ms) $\pm V_{PQS}(ms^2)$	QTI(ms) $\pm V_{QTI}(ms^2)$	RRI(ms) $\pm V_{RRI}(ms^2)$	QRS(ms) $\pm V_{QRS}(ms^2)$	STS(ms) $\pm V_{STS}(ms^2)$	TW(ms) $\pm V_{TW}(ms^2)$
104	X:309 ±0.0076 Y: 286 ±0.008 Z: 426 ±0.008	X:142 ±0.14 Y: 162 ±0.14 Z:159 ±0.107	X:99.6 ±0.107 Y: 142 ±0.107 Z:ND	X:43.2 ±0.014 Y:20.2 ±0.014 Z:ND	X:391 ±0.013 Y:414 ±0.014 Z:542 ±0.017	X:969 ±4.11 Y:969 ±4.13 Z:969 ±4.12	X:82 ±0.006 Y:128 ±0.007 Z:115 ±0.007	X:125 ±0.015 Y:112 ±0.016 Z:125 ±0.015	X:185 ±0.022 Y:175 ±0.022 Z:302 ±0.022
116	X: 326 ±0.076 Y:316 ±0.008 Z: 416 ±0.008	X: 203 ±1.05 Y:203 ±1.05 Z: 198 ±1.06	X:130 ±0.006 Y:130 ±1.06 Z: ND	X: 73 ±0.006 Y:73 ±0.007 Z: ND	X:406 ±0.008 Y:406 ±0.008 Z: 00 ±0.012	X:972 ±0.67 Y:972 ±0.676 Z:972 ±0.672	X:80 ±0.0003 Y:89 ±0.0003 Z: 85 ±0.007	X:155 ±0.05 Y:144 ±0.05 Z:155 ±0.057	X:171 ±0.06 Y:171 ±0.063 Z:261 ±0.063
117	X: 274 ±0.002 Y: 273 ±0.002 Z: 353 ±0.002	X:183 ±0.007 Y:183 ±0.008 Z:211 ±0.006	X:117 ±0.006 Y:117 ±0.006 Z: ND	X: 66 ±0.0017 Y:66 ±0.002 Z: ND	X:369 ±0.002 Y:369 ±0.002 Z:480 ±0.005	X:874 ±1.54 Y:874 ±1.545 Z:874 ±1.607	X:95 ±0.0007 Y:95 ±0.001 Z:127 ±0.002	X: 70 ±0.013 Y:105 ±0.013 Z: 70 ±0.013	X:204 ±0.013 Y:169 ±0.014 Z:283 ±0.014
150	X:319 ±0.22 Y:319 ±0.22 Z: 420 ±0.220	X:166 ±0.22 Y: 165 ±0.22 Z:205 ±0.236	X:98 ±0.236 Y:98 ±0.236 Z: ND	X:67 ±0.013 Y:67 ±0.013 Z: ND	X:402 ±0.206 Y:402 ±0.207 Z:518 ±0.207	X:908 ±11.75 Y:907 ±11.77 Z:907 ±11.76	X:83 ±0.013 Y:83 ±0.014 Z: 98 ±0.025	X:129 ±0.70 Y:129 ±0.701 Z:129 ±0.701	X:190 ±0.17 Y:190 ±0.17 Z:291 ±0.172
155	X:285 ±0.0062 Y:277 ±0.006 Z: 285 ±006	X:174 ±0.023 Y:196 ±0.023 Z:169 ±0.025	X:121 ±0.024 Y:115 ±0.025 Z: ND	X:53 ±0.0016 Y:82 ±0.002 Z: ND	X:352 ±0.005 Y:365 ±0.006 Z:400 ±0.007	X:772 ±1.55 Y:772 ±1.542 Z: 771 ±1.55	X:87 ±0.0004 Y:87 ±0.0004 Z:115 ±0.002	X:108 ±0.035 Y:108 ±0.035 Z: 98 ±0.035	X:176 ±0.02 Y:168 ±0.02 Z: 185 ±0.029
156	X:267 ±0.0027 Y:258 ±0.003 Z: 361 ±0.003	X:154 ±0.027 Y:153 ±0.028 Z:134 ±0.012	X:109 ±0.0123 Y:91 ±0.012 Z: ND	X:45 ±0.0181 Y:62 ±0.018 Z: ND	X:355 ±0.0218 Y:347 ±0.022 Z: 469 ±0.011	X:861 ±4.86 Y:861 ±4.668 Z: 861 ±4.62	X:88 ±0.017 Y:88 ±0.018 Z:107 ±0.007	X:74 ±0.05 Y:84 ±0.05 Z: 74 ±0.050	X:192 ±0.04 Y:174 ±0.04 Z: 287 ±0.046
165	X:310 ±0.002 Y:310 ±0.002 Z: 433 ±0.002	X:161 ±0.0049 Y: 161 ±0.005 Z: 224 ±0.005	X:116 ±0.0046 Y:116 ±0.005 Z: ND	X:45 ±0.0015 Y:45 ±0.002 Z: ND	X:395 ±0.0021 Y:395 ±0.002 Z: 535 ±0.003	X:1025 ±0.99 Y:1025 ±0.994 Z: 1024 ±0.99	X:85 ±0.0003 Y:85 ±0.0003 Z:101 ±0.001	X:121 ±0.014 Y:120 ±0.014 Z:120 ±0.014	X:189 ±0.014 Y189: ±0.014 Z: 312 ±0.014
166	X:306 ±0.0023 Y:306 ±0.002 Z: 456 ±0.002	X:167 ±0.013 Y: 206 ±0.014 Z: 205 ±0.014	X:97 ±0.016 Y:135 ±0.017 Z: ND	X:71 ±0.0028 Y:70 ±0.003 Z: ND	X:412 ±0.0020 Y:412 ±0.002 Z: 562 ±0.002	X: 999 ±1.32 Y:99 ±1.328 Z: 999 ±1.28	X:105 ±0.0002 Y:105 ±0.0002 Z:105 ±0.0002	X:104 ±0.029 Y:104 ±0.029 Z:104 ±0.029	X:202 ±0.027 Y:202 ±0.027 Z: 352 ±0.027
169	X:326 ±0.086 Y:326 ±0.087 Z: 456 ±0.087	X:135 ±0.1024 Y: 144 ±0.102 Z: 211 ±0.384	X:103 ±0.3843 Y:113 ±0.384 Z: ND	X:31 ±0.1040 Y:31 ±0.1040 Z: ND	X:408 ±0.0259 Y: 409 ±0.026 Z: 552 ±0.037	X:1052 ±3.68 Y:1052 ±3.704 Z: 1052 ±3.69	X:83 ±0.0731 Y:83 ±0.073 Z:96 ±0.146	X:143 ±0.123 Y:142 ±0.123 Z:142 ±0.123	X:183 ±0.059 Y:183 ±0.059 Z: 313 ±0.059
170	X:258 ±0.0057 Y:238 ±0.006 Z: 315 ±0.006	X:118 ±0.1975 Y: 168 ±0.197 Z: 133 ±0.192	X:60 ±1.76 Y:116 ±1.761 Z: ND	X:58 ±1.38 Y:52 ±1.38 Z: ND	X:355 ±0.0151 Y:336 ±0.015 Z: 413 ±0.015	X:636 ±0.239 Y:636 ±0.239 Z: 636 ±0.23	X:97 ±0.0088 Y:97 ±0.009 Z: 97 ±0.009	X:72 ±0.0534 Y:72 ±0.053 Z: 72 ±0.053	X:186 ±0.054 Y:166 ±0.054 Z: 243 ±0.054
172	X:314 ±0.0032 Y:343 ±0.003 Z: 393 ±0.003	X:155 ±0.0432 Y: 184 ±0.043 Z: 163 ±0.082	X:97 ±0.0824 Y:126 ±0.082 Z: ND	X:58 ±0.0547 Y:58 ±0.055 Z: ND	X:418 ±0.0088 Y:417 ±0.009 Z: 517 ±0.047	X:889 ±0.5015 Y:888 ±0.505 Z: 888 ±0.51	X:104 ±0.007 Y:74 ±0.007 Z:124 ±0.047	X:107 ±0.021 Y:136 ±0.021 Z:106 ±0.021	X:207 ±0.022 Y:206 ±0.022 Z: 286 ±0.022
173	X:316 ±0.0318 Y:315 ±0.032 Z: 410 ±0.032	X:163 ±0.0695 Y:173 ±0.069 Z: 158 ±0.065	X:108 ±0.0647 Y:117 ±0.065 Z: ND	X:55 ±0.0062 Y:55 ±0.006 Z: ND	X:391 ±0.0365 Y:390 ±0.036 Z: 503 ±0.027	X:909 ±20 Y:909 ±19.65 Z: 909 ±19.7	X:75 ±0.0011 Y:75 ±0.001 Z: 93 ±0.005	X:128 ±0.044 Y:128 ±0.044 Z:128 ±0.044	X:187 ±0.023 Y:187 ±0.023 Z: 282 ±0.023
174	X:298 ±0.0047 Y:318 ±0.005 Z: 407 ±0.005	X:186 ±0.0077 Y:192 ±0.008 Z: 192 ±0.005	X:95 ±0.0048 Y:101 ±0.005 Z: ND	X:91 ±0.0085 Y:91 ±0.009 Z: ND	X:403 ±0.0052 Y:402 ±0.005 Z: 524 ±0.017	X:916 ±0.6365 Y:916 ±0.676 Z: 915 ±0.63	X:104 ±0.0003 Y:84 ±0.0003 Z: 117 ±0.008	X:101 ±0.02 Y:121 ±0.02 Z:101 ±0.021	X:197 ±0.013 Y:197 ±0.013 Z: 306 ±0.013
180	X:271 ±0.0755 Y:253 ±0.075 Z: 371 ±0.075	X:131 ±0.073 Y:150 ±0.073 Z: 123 ±0.088	X:77 ±0.0881 Y:96 ±0.088 Z: ND	X:54 ±0.0048 Y:54 ±0.005 Z: ND	X:362 ±0.0016 Y:362 ±0.002 Z: 516 ±0.005	X:888 ±1.78 Y:888 ±1.76 Z: 888 ±1.79	X:91 ±0.077 Y:110 ±0.077 Z:145 ±0.081	X:92 ±0.103 Y:99 ±0.103 Z: 91 ±0.103	X:179 ±0.039 Y:153 ±0.039 Z: 279 ±0.039
182	X:296 ±0.0018 Y:296 ±0.002 Z: 396 ±0.002	X:186 ±0.0053 Y:178 ±0.005 Z: 170 ±0.005	X:115 ±0.0055 Y:104 ±0.005 Z: ND	X:71 ±0.0021 Y:74 ±0.002 Z: ND	X:373 ±0.002 Y:379 ±0.002 Z: 487 ±0.003	X:839 ±0.7557 Y:839 ±0.756 Z: 839 ±0.76	X:76 ±0.0003 Y:83 ±0.0003 Z: 91 ±0.002	X:95 ±0.021 Y:124 ±0.021 Z: 94 ±0.021	X:201 ±0.02 Y:171 ±0.022 Z: 301 ±0.022
214	X:241 ±0.0014 Y:240 ±0.001 Z: 273 ±0.001	X:148 ±0.0165 Y:143 ±0.016 Z: 124 ±2.70	X:62 ±2.7 Y:75 ±2.7 Z: ND	X:86 ±2.73 Y:67 ±2.73 Z: ND	X:322 ±0.0014 Y:341 ±0.001 Z: 401 ±2.732	X:611 ±0.3992 Y:611 ±0.402 Z: 611 ±0.4	X:81 ±0.0005 Y:100 ±0.0005 Z: 127 ±2.73	X:77 ±0.0346 Y:77 ±0.035 Z: 77 ±0.035	X:164 ±0.035 Y:163 ±0.035 Z: 196 ±0.035
234	X:329 ±0.0472 Y:343 ±0.009 Z: 499 ±0.009	X:208 ±0.0652 Y:203 ±0.065 Z: 248 ±0.074	X:109 ±0.0741 Y:108 ±0.074 Z: ND	X:100 ±0.0076 Y:95 ±0.008 Z: ND	X:437 ±0.0092 Y:441 ±0.009 Z: 619 ±0.013	X:1113 ±4.87 Y:1113 ±4.858 Z: 1113 ±4.85	X:107 ±0.0004 Y:99 ±0.0004 Z:120 ±0.007	X:138 ±0.016 Y:152 ±0.016 Z:138 ±0.016	X:191 ±0.008 Y:190 ±0.009 Z: 360 ±0.009
235	X:301 ±0.0096 Y:287 ±0.010 Z: 391 ±0.010	X:175 ±0.017 Y:175 ±0.018 Z: 153 ±0.025	X:125 ±0.0246 Y:125 ±0.025 Z: ND	X:50 ±0.0061 Y:50 ±0.006 Z: ND	X:387 ±0.011 Y:387 ±0.011 Z: 528 ±0.013	X:890 ±6.12 Y:890 ±6.22 Z: 890 ±6.12	X:86 ±0.0003 Y:99 ±0.0003 Z:136 ±0.005	X:98 ±0.03 Y:139 ±0.034 Z:135 ±0.034	X:202 ±0.401 Y:148 ±0.04 Z: 256 ±0.040
237	X:296 ±0.0016 Y:287 ±0.002 Z: 422 ±0.002	X:165 ±0.0122 Y:164 ±0.012 Z: 152 ±0.007	X:111 ±0.0071 Y:111 ±0.007 Z: ND	X:53 ±0.0069 Y:53 ±0.007 Z: ND	X:388 ±0.0019 Y:388 ±0.002 Z: 526 ±0.008	X:981 ±0.3809 Y:981 ±0.387 Z: 981 ±0.38	X:91 ±0.0004 Y:100 ±0.0004 Z:103 ±0.006	X:103 ±0.013 Y:112 ±0.014 Z:103 ±0.014	X:193 ±0.014 Y:176 ±0.015 Z: 319 ±0.015
238	X:287 ±0.0088 Y:273 ±0.009 Z: 363 ±0.009	X:140 ±0.009 Y:140 ±0.009 Z:112 ±0.012	X:112 ±0.012 Y: 112 ±0.012 Z: ND	X:29 ±0.0036 Y:29 ±0.004 Z: ND	X:372 ±0.0097 Y:372 ±0.010 Z: 477 ±0.007	X:764 ±4.07 Y:765 ±4.10 Z:764 ±4.09	X:85 ±0.0004 Y:98 ±0.0004 Z:113 ±0.003	X:103 ±0.043 Y:140 ±0.043 Z:102 ±0.043	X:183 ±0.043 Y133: ±0.043 Z: 260 ±0.043
239	X:319 ±0.0256 Y:311 ±0.026 Z: 319 ±0.026	X:139 ±1.02 Y:152 ±1.026 Z: 142 ±1.11	X:113 ±1.11 Y:125 ±1.18 Z: ND	X:26 ±0.02 Y:27 ±0.02 Z: ND	X:388 ±0.027 Y:388 ±0.028 Z: 414 ±0.036	X:745 ±8.85 Y:745 ±8.83 Z: 745 ±8.83	X:69 ±0.0014 Y:76 ±0.001 Z: 95 ±0.017	X:143 ±0.379 Y:136 ±0.379 Z:115 ±0.379	X:175 ±0.352 Y:175 ±0.353 Z: 203 ±0.35
240	X:292 ±0.009 Y:291 ±0.009 Z: 390 ±0.009	X:149 ±0.0209 Y:165 ±0.021 Z: 152 ±0.022	X:100 ±0.0217 Y:117 ±0..022 Z: ND	X:49 ±0.0047 Y:49 ±0.005 Z: ND	X:368 ±0.0101 Y: 368 ±0.010 Z: 490 ±0.018	X:771 ±0.603 Y:771 ±0.605 Z: 771 ±0.604	X:76 ±0.0003 Y:76 ±0.0003 Z: 99 ±0.005	X:104 ±0.065 Y:113 ±0.066 Z:104 ±0.066	X:188 ±0.074 Y:177 ±0.075 Z: 286 ±0.075
241	X:315 ±0.0046 Y:315 ±0.005 Z: 391 ±0.005	X:156 ±0.0416 Y:148 ±0.042 Z: 147 ±0.041	X:86 ±0.0407 Y:86 ±0.041 Z: ND	X:71 ±0.0021 Y:63 ±0.002 Z: ND	X:400 ±0.0051 Y:408 ±0.005 Z: 484 ±0.007	X:1077 ±5.6 Y:1077 ±5.619 Z: 1077 ±5.63	X:85 ±0.0004 Y:93 ±0.0004 Z: 93 ±0.002	X:118 ±0.013 Y:118 ±0.013 Z:117 ±0.013	X:197 ±0.014 Y:197 ±0.015 Z: 273 ±0.015
242	X:273 ±0.0023 Y:272 ±0.002 Z: 333 ±0.002	X:150 ±0.0197 Y:153 ±0.02 Z: 138 ±0.021	X:93 ±0.0211 Y:123 ±0.021 Z: ND	X:56 ±0.0092 Y:30 ±0.009 Z: ND	X:357 ±0.0049 Y:383 ±0.005 Z: 474 ±0.008	X:831 ±1.74 Y:831 ±1.74 Z:831 ±1.74	X:85 ±0.0026 Y:111 ±0.003 Z:141 ±0.007	X:90 ±0.0434 Y:90 ±0.043 Z:159 ±0.043	X:183 ±0.042 Y:183 ±0.043 Z: 173 ±0.043
243	X:254 ±0.006 Y:254 ±0.006 Z: 253 ±0.006	X:150 ±2.47 Y:172 ±2.47 Z: 147 ±3.27	X:90 ±3.26 Y:131 ±3.27 Z: ND	X:60 ±1.23 Y:41 ±1.231 Z: ND	X:340 ±0.0064 Y:345 ±0.006 Z: 379 ±1.18	X:651 ±0.7986 Y:651 ±0.801 Z: 651 ±0.81	X:86 ±0.0005 Y:91 ±0.0005 Z:125 ±1.235	X:69 ±0.0815 Y:80 ±0.081 Z: 69 ±0.081	X:185 ±0.091 Y:173 ±0.09 Z: 184 ±0.091

244	X:262 ±0.034 Y:262 ±0.034 Z: 338±0.034	X:159 ±0.014 Y:158 ±0.014 Z: 152±0.012	X:105 ±0.012 Y:104 ±0.012 Z: ND	X:53 ±0.0072 Y:54 ±0.007 Z: ND	X:367±0.0011 Y:367±0.001 Z: 451±0.007	X:803 ±0.18 Y:803 ±0.185 Z: 831±0.17	X:106±0.035 Y:106±0.035 Z:113±0.040	X:99±0.0437 Y:99±0.044 Z: 98±0.044	X:163±0.016 Y:163±0.017 Z: 240±0.017

TABLE II(B): PARAMETERS AND VARIABILITY IN TIME OF X, Y AND Z LEADS (TRACES 245-284)

Trace/ Par	PW_A(%) $\pm V_{PWA}$(%^{2})	R_A(%) $\pm V_{RA}$(%^{2})	ST_A(%) $\pm V_{STA}$(%^{2})	TW_A(%) $\pm V_{TWA}$(%^{2})	PQI_A(%) $\pm PQI_A$(%^{2})	Q_A(%) $\pm Q_A$(%^{2})	PTW_A(%) $\pm PTW_V$(%^{2})	NTW_A(%) $\pm NTW_V$(%^{2})
104	X: 3.08±0.0007 Y:16.51±0.0205 Z: ND	X: 95.45±0.1628 Y: 96.36±0.1628 Z: 100.51±0.0423	X:14.02±0.0127 Y:24.53±0.0362 Z: 3.06±0.1418	X:14.90±0.0127 Y:26.15±0.0328 Z:ND	X: ND Y: ND Z:5.72±0.0309	X: ND Y: ND Z: -13.90±0.04	X: ND Y: ND Z: 12.28±0.094	X:ND Y:ND Z:-4.51±0.047
116	X: 9.97±0.0205 Y: 9.07±0.0580 Z: ND	X: 98.99±0.1132 Y: 89.78±0.3416 Z: 98.16±0.1961	X: 7.59±0.1186 Y: 0.35±0.2756 Z: -10.25±0.270	X:14.01±0.0109 Y:12.24±0.0254 Z:ND	X: ND Y: ND Z:10.72±0.177	X: ND Y: ND Z: -31.10±0.11	X: ND Y: ND Z: 3.01±0.015	X:ND Y:ND Z:-2.38±0.009
117	X: 5.51±0.0088 Y: 6.01±0.0086 Z: ND	X: 98.73±0.0623 Y: 99.11±0.0762 Z: 87.43±0.4551	X:16.04±0.0644 Y: 5.89±0.1322 Z: -8.55±0.3059	X:20.42±0.0104 Y:12.60±0.0101 Z:ND	X: ND Y: ND Z:28.04±0.531	X: ND Y: ND Z: -18.73±0.32	X: ND Y: ND Z:10.55±0.150	X:ND Y:ND Z:-3.49±0.088
150	X: 5.96±0.0019 Y: 2.14±0.0036 Z: ND	X: 103.55±0.0193 Y: 99.05±0.0954 Z: 53.10±0.3611	X:24.25±0.0931 Y:13.01±0.7539 Z: 2.35±1.6963	X:29.88±0.0399 Y:17.38±0.5205 Z:ND	X: ND Y: ND Z:11.14±0.459	X: ND Y: ND Z:-15.81 ±0.25	X: ND Y: ND Z:11.92±0.613	X: ND Y: ND Z: -7.81±0.893
155	X:11.58±0.3085 Y:14.76±0.0087 Z: ND	X: 90.40±0.4221 Y: 98.39±0.0869 Z: 95.24±0.1922	X: -0.36±0.4659 Y:10.04±0.0516 Z: 3.15±0.0086	X:16.28±0.1574 Y:13.80±0.0271 Z:ND	X: ND Y: ND Z:1.25±0.006	X: ND Y: ND Z: -9.64±0.008	X: ND Y: ND Z: 3.18±0.002	X: ND Y: ND Z: -2.38±0.010
156	X:14.51±0.0820 Y: 5.50±0.0024 Z: ND	X: 101.54±0.1994 Y: 101.90±0.0351 Z: 98.70±0.2330	X:63.99±0.6541 Y:20.50±0.0542 Z: -2.74±0.1912	X:71.22±0.3611 Y:24.33±0.0079 Z:ND	X: ND Y: ND Z:13.19±0.136	X: ND Y: ND Z:-14.78 ±1.26	X: ND Y: ND Z: 9.28±0.075	X: ND Y: ND Z: -3.98±0.080
165	X: 5.47±0.0004 Y: 8.73±0.0141 Z: ND	X: 102.37±0.0598 Y: 100.94±0.0620 Z: 100.68±0.0923	X:30.62±0.0735 Y:13.27±0.1874 Z: 16.10±1.2091	X:34.34±0.0124 Y:18.99±0.0497 Z:ND	X: ND Y: ND Z:23.41±0.221	X: ND Y: ND Z: -45.66±0.18	X: ND Y: ND Z:39.74±1.352	X: ND Y: ND Z: -9.68±0.381
166	X: 3.60±0.026 Y:10.58±0.0057 Z: ND	X: 101.93±0.1035 Y: 94.36±0.3758 Z: 90.14±1.1995	X:15.35±0.1328 Y:21.58±0.1139 Z: -12.30±0.750	X:23.15±0.0193 Y:25.23±0.0338 Z:ND	X: ND Y: ND Z:31.26±0.457	X: ND Y: ND Z: -20.68±0.24	X: ND Y: ND Z:11.08±0.107	X: ND Y: ND Z: -4.13±0.031
169	X: 5.08±0.0033 Y:17.72±0.0569 Z: ND	X: 98.97±0.0364 Y: 96.93±0.1697 Z: 99.81±0.1062	X:24.09±0.0156 Y:14.22±0.1177 Z: -6.66±0.173	X:23.58±0.0090 Y:20.05±0.0310 Z:ND	X: ND Y: ND Z:11.63±0.073	X: ND Y: ND Z: -22.29±0.06	X: ND Y: ND Z: 7.39±0.034	X: ND Y: ND Z: -3.04 ±0.027
170	X: 7.13±0.4786 Y:44.25±0.2234 Z: ND	X: 99.58±0.2732 Y: 94.22±0.7130 Z: 101.58±0.3931	X: 6.22±0.3233 Y:46.38±0.2683 Z: -3.13±0.2130	X:20.90±0.1626 Y:42.84±0.1309 Z:ND	X: ND Y: ND Z:11.07±0.442	X: ND Y: ND Z: -39.72±1.02	X: ND Y: ND Z: 10.02±0.119	X: ND Y: ND Z: -8.62±0.262

TABLE III(A): PARAMETERS AND VARIABILITY IN AMPLITUDE OF X, Y AND Z LEADS (TRACES 104-170)

Trace /Par	STI(ms) $\pm V_{STI}$(ms^2)	PQI(ms) $\pm V_{PQI}$(ms^2)	PW(ms) $\pm V_{PW}$(ms^2)	PQS(ms) $\pm V_{PQS}$(ms^2)	QTI(ms) $\pm V_{QTI}$(ms^2)	RRI(ms) $\pm V_{RRI}$(ms^2)	QRS(ms) $\pm V_{QRS}$(ms^2)	STS(ms) $\pm V_{STS}$(ms^2)	TW(ms) $\pm V_{TW}$(ms^2)
245	X:302 ±0.006 Y:301 ±0.006 Z:380±0.006	X:179±0.103 Y:168 ±0.103 Z: 149±0.131	X:122±0.131 Y:114±0.131 Z: ND	X:57±0.0284 Y:55±0.028 Z: ND	X:385±0.009 Y:395±0.009 Z: 493±0.024	X:980 ±13.6 Y:980±13.70 Z:980±13.4	X:83±0.0025 Y:93 ±0.003 Z: 113±0.026	X:116±0.071 Y:116±0.071 Z:115±0.071	X:186±0.077 Y:186±0.078 Z:265±0.078
251	X:302±0.0073 Y:272±0.007 Z: 392±0.007	X:183±0.052 Y: 183±0.052 Z: 167±0.032	X:131±0.032 Y:114 ±0.032 Z: ND	X:51±0.0143 Y:68±0.014 Z: ND	X:379±0.008 Y:362±0.008 Z: 485±0.027	X:774 ±1.088 Y:774 ±1.089 Z: 774±1.08	X:77±0.0010 Y:90 ±0.001 Z: 93±0.016	X:125±0.049 Y:112±0.049 Z:112±0.049	X:176±0.056 Y:160±0.056 Z:279±0.056
252	X:333±0.0067 Y:333 ±0.007 Z:501±0.007	X:152±0.048 Y:160±0.048 Z: 197±0.047	X:80±0.0469 Y:97±0.047 Z: ND	X:73±0.0027 Y:62±0.003 Z: ND	X:412±0.005 Y: 412±0.005 Z: 597±0.005	X:981 ±1.93 Y:981 ±1.935 Z:981 ±1.93	X:78±0.0038 Y:78 ±0.004 Z: 95±0.007	X:160±0.029 Y:160 ±0.03 Z:140±0.030	X:173±0.03 Y:174±0.03 Z:361±0.030
255	X:310±0.0361 Y:290 ±0.036 Z: 430±0.036	X:173±0.075 Y:191±0.075 Z:190±0.068	X:102±0.067 Y: 120±0.068 Z: ND	X:71±0.0679 Y:71±0.019 Z: ND	X:415±0.052 Y:396±0.053 Z:542±0.046	X:916 ±0.588 Y:916 ±0.591 Z: 916±0.58	X:105±0.016 Y:105±0.016 Z: 112±0.006	X:81±0.1626 Y:89 ±0.163 Z: 81±0.163	X:229±0.177 Y:201±0.178 Z:349±0.178
260	X:283±0.0049 Y:283 ±0.005 Z:363±0.005	X:129±0.030 Y:129 ±0.031 Z:122±0.035	X: 97±0.0348 Y:97±0.035 Z: ND	X:32±0.0348 Y:32±0.005 Z: ND	X:365±0.005 Y:365±0.005 Z:477±0.008	X:978 ±3.67 Y:978 ±3.690 Z: 978±3.69	X:81±0.0008 Y:81 ±0.001 Z:113±0.003	X:99±0.0605 Y:99 ±0.06 Z: 99±0.061	X:184±0.057 Y:184±0.057 Z:264±0.057
264	X:319±0.0027 Y:319±0.003 Z: 470±0.003	X:161±0.215 Y:161±0.216 Z:171±0.238	X:103±0.238 Y:103±0.238 Z: ND	X:58±0.2385 Y:58±0.007 Z: ND	X:413±0.003 Y:413±0.003 Z: 587±0.009	X:963 ±2.47 Y:963 ±2.47 Z: 963±2.42	X:94±0.0003 Y:94 ±0.0003 Z:117 ±0.007	X:123±0.017 Y:124±0.018 Z:123±0.018	X:195±0.02 Y:195 ±0.02 Z:346±0.020
267	X:366±0.0014 Y:366 ±0.001 Z: 498±0.001	X:179±0.011 Y:179 ±0.012 Z:166±0.010	X:123±0.009 Y:123±0.01 Z: ND	X:55±0.0017 Y:55±0.002 Z: ND	X:453±0.001 Y:453±0.002 Z:598±0.004	X:1091±0.88 Y:1091±0.89 Z: 1091±0.87	X:86±0.0003 Y:86 ±0.0003 Z:100±0.002	X:170±0.013 Y:170±0.013 Z:170±0.013	X:196±0.014 Y:196±0.014 Z:328±0.014
276	X:291±0.0055 Y:271±0.006 Z:349±0.006	X:129±0.067 Y:173±0.067 Z:156±0.066	X:67±0.0664 Y:107±0.066 Z: ND	X:62±0.0025 Y:66±0.003 Z: ND	X:378±0.005 Y:368±0.006 Z: 454±0.008	X:786±0.495 Y:786±0.494 Z: 786±0.49	X:87±0.0003 Y:96±0.0003 Z:105±0.002	X:104±0.045 Y:84 ±0.046 Z:163±0.046	X:186±0.048 Y:186±0.048 Z:185±0.048
277	X:352±0.0029 Y:352 ±0.003 Z:477 ±0.003	X:149±0.011 Y:169±0.011 Z:114±0.011	X:83±0.0109 Y:116 ±0.011 Z: ND	X:66±0.0028 Y:53±0.003 Z: ND	X:438±0.002 Y:438±0.003 Z:629±0.005	X:1217±4.75 Y:1217±4.76 Z:1217±4.8	X:86±0.0003 Y:86 ±0.0003 Z:152±0.003	X:143±0.021 Y:143±0.021 Z:143±0.021	X:208±0.017 Y:208±0.018 Z:333±0.018
284	X:274±0.0038 Y:274 ±0.004 Z:424±0.004	X:166±0.044 Y:176±0.044 Z:171±0.169	X:90±0.1693 Y:100±0.169 Z: ND	X:75 ±0.1515 Y:76±0.152 Z: ND	X:361±0.004 Y:361±0.004 Z:523±0.154	X:795 ±1.79 Y:795 ±1.8 Z:795±1.82	X:86±0.0003 Y:86 ±0.0003 Z:99±0.148	X:92 ±0.047 Y:102±0047 Z: 92±0.047	X:182±0.047 Y:172±0.047 Z: 332±0.04

TABLE III(B): PARAMETERS AND VARIABILITY IN APMPLITUDE OF X, Y AND Z LEADS (TRACES 172-284)

Trace/ Par	PWA(%) ±VPWA(%2)	RA(%) ±VRA(%2)	STA(%) ±VSTA(%2)	TWA(%) ±VTWA(%2)	PQIA(%) ±PQIA(%2)	QA(%) ±QA(%2)	PTWA(%) ±PTWV(%2)	NTWA(%) ±NTWV(%2)
172	X:10.30±0.2747 Y:13.03±0.0136 Z: ND	X: 94.50±0.5025 Y: 93.91±0.2682 Z: 98.85±0.1927	X:12.56±0.2881 Y:13.22±0.0523 Z: 7.60±0.1266	X:24.75±0.0153 Y:22.25±0.0463 Z:ND	X: ND Y: ND Z:1.89±0.120	X: ND Y: ND Z:-7.96±0.19	X: ND Y: ND Z: 12.43±0.067	X: ND Y: ND Z: -6.36±0.123
173	X: 9.85±0.0125 Y:11.85±0.02 Z: ND	X: 95.37±0.4351 Y: 101.45±0.0307 Z: 97.39±0.1093	X:35.80±0.0983 Y:19.06±0.0195 Z: -0.76±0.0780	X:40.44±0.0584 Y:24.70±0.0088 Z:ND	X: ND Y: ND Z:6.81±0.0179	X: ND Y: ND Z:-22.2±0.02	X: ND Y: ND Z: 8.34±0.0506	X: ND Y: ND Z:-3.58±0.038
174	X: 5.36±0.4786	X: 99.68±0.0723	X:31.65±0.3603	X:43.16±0.0380	X: ND	X: ND	X: ND	X: ND

	Y:10.15 ±0.0142	Y: 102.61 ±0.0486	Y:26.58 ±0.0663	Y:35.51 ±0.0187	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 97.62 ±0.0630	Z: -0.82 ±0.1294	Z:ND	Z: 8.98 ±0.0615	Z:-12.6 ±0.04	Z: 7.56 ±0.0162	Z:-3 ±0.0279
	X: 7.52 ±0.0033	X:99.97 ±0.072	X:28.59 ±0.1284	X:37.59 ±0.0252	X: ND	X: ND	X: ND	X: ND
180	Y:23.09 ±0.0478	Y: 99.73 ±0.2411	Y:41.74 ±0.4020	Y:54.66 ±0.1389	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 98.62 ±0.4943	Z: 0.08 ±1.3535	Z:ND	Z:21.03 ±0.533	Z:-69.8 ±0.47	Z: 29.56 ±0.408	Z:-11.74 ±0.62
	X: 8.19 ±0.0029	X: 101.48 ±0.1217	X:23.50 ±0.0637	X:25.88 ±0.0176	X: ND	X: ND	X: ND	X: ND
182	Y:18.27 ±0.0067	Y: 100.92 ±0.0710	Y: 7.57 ±0.1230	Y:15.38 ±0.0158	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 96.24 ±0.1590	Z: 7.56 ±0.6691	Z:ND	Z:14.61 ±0.117	Z: -59.4 ±0.12	Z: 21.50 ±0.252	Z:-9.27 ±0.273
	X: 8.93 ±0.3972	X: 103.95 ±0.3091	X:26.42 ±0.5086	X:42.82 ±0.2165	X: ND	X: ND	X: ND	X: ND
214	Y:19.06 ±0.0652	Y: 100.18 ±0.1904	Y:19.05 ±0.0779	Y:23.65 ±0.0289	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 98.20 ±0.1937	Z: 6.02 ±0.6264	Z:ND	Z:4.37 ±0.1216	Z:-16.6 ±0.10	Z: 18.74 ±0.362	Z:-9.54 ±0.294
	X: 6.29 ±0.0209	X: 102.78 ±0.1304	X:34.76 ±0.3901	X:45.78 ±0.0423	X: ND	X: ND	X: ND	X: ND
234	Y:10.05 ±0.0285	Y: 102.24 ±0.0447	Y:19.73 ±0.0393	Y:26.70 ±0.0210	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 85.64 ±0.2776	Z:10.27 ±0.1675	Z:ND	Z:6.79 ±0.0239	Z:-14.1 ±0.04	Z: 16.50 ±0.284	Z:-5.9 ±0.009
	X:10.13 ±0.0602	X: 98.58 ±0.1758	X:18.27 ±0.0951	X:23.91 ±0.0152	X: ND	X: ND	X: ND	X: ND
235	Y:59.76 ±0.4143	Y:99.30 ±0.1.3805	Y:37.91 ±2.0350	Y:57.72 ±0.3911	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 98.91 ±0.3104	Z: -3.10 ±0.5911	Z:ND	Z:14.59 ±0.339	Z:-29.5 ±0.22	Z:12.91 ±0.1632	Z:-6.73 ±0.051
	X: 7.33 ±0.0011	X: 103.40 ±0.0251	X:33.90 ±0.0710	X:35.97 ±0.0176	X: ND	X: ND	X: ND	X: ND
237	Y: 6.85 ±0.0445	Y: 96.16 ±0.2035	Y:19.65 ±0.5585	Y:35.32 ±0.0633	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 103.21 ±0.1443	Z:20.95 ±0.4566	Z:ND	Z:5.18 ±0.0141	Z:-1.64 ±0.02	Z:38.91 ±0.7833	Z:-7.99 ±0.054
	X:77.32 ±0.0011	X: 100.20 ±0.0724	X:12.80 ±0.0358	X:16.10 ±0.0137	X: ND	X: ND	X: ND	X: ND
238	Y:15.41 ±0.1498	Y: 89.88 ±0.8704	Y:-1.04 ±0.4450	Y:17.82 ±0.1186	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 96.19 ±0.4490	Z: -8.99 ±0.2498	Z:ND	Z:10.93 ±0.155	Z:-32.5 ±0.32	Z: 4.25 ±0.1667	Z:-6.87 ±0.278
	X:9.85 ±0.0187	X: 98.44 ±0.3115	X:-2.06 ±0.3138	X:15.76 ±0.0282	X: ND	X: ND	X: ND	X: ND
239	Y:52.70 ±0.6438	Y: 84.17 ±2.8349	Y:27.12 ±0.3317	Y:34.56 ±0.3068	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 98.56 ±0.049	Z: -6.53 ±0.092	Z:ND	Z:5.82 ±0.062	Z:-25.1 ±0.08	Z: 4.99 ±0.072	Z:-4 ±0.034
	X:8.16 ±0.0004	X: 97.85 ±0.1235	X:17.35 ±0.0598	X:24.59 ±0.0209	X: ND	X: ND	X: ND	X: ND
240	Y:11.05 ±0.0098	Y: 100.75 ±0.0423	Y:11.70 ±0.0121	Y:13.81 ±0.0092	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 98.24 ±0.3426	Z: -2.40 ±0.2840	Z:ND	Z:12.71 ±0.193	Z:-42.8 ±0.23	Z: 8.90 ±0.0590	Z:-7.73 ±0.164
	X:3.33 ±0.0015	X: 100.88 ±0.0730	X:15.85 ±0.0582	X:22.61 ±0.0057	X: ND	X: ND	X: ND	X: ND
241	Y:7.28 ±0.0034	Y: 101.68 ±0.0250	Y: 1.30 ±0.0285	Y:14.94 ±0.0053	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 97.09 ±0.1658	Z: -8 ±0.1924	Z:ND	Z:9.82 ±0.0523	Z:-22.4 ±0.05	Z:12.06 ±0.0685	Z:-5.16 ±0.072
	X:20.34 ±0.5847	X: 98.52 ±0.0730	X:16.11 ±1.4475	X:47.62 ±0.1339	X: ND	X: ND	X: ND	X: ND
242	Y:7.09 ±0.0169	Y: 100.54 ±0.0929	Y:14.25 ±0.0595	Y:20.44 ±0.0269	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 95.46 ±0.3248	Z: -4.59 ±0.2055	Z:ND	Z:9.07 ±0.0955	Z:15.4 ±0.75	Z:-0.89 ±0.0415	Z:-4.36 ±0.050
	X:5.54 ±0.0232	X: 105.08 ±0.0555	X:31.23 ±0.0580	X:34.61 ±0.0316	X: ND	X: ND	X: ND	X: ND
243	Y:16.14 ±0.0629	Y: 104.26 ±0.0641	Y:18.11 ±0.0270	Y:19.53 ±0.0126	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 92.62 ±0.6850	Z: -3.30 ±0.4061	Z:ND	Z:11.79 ±0.646	Z: -39.9 ±0.49	Z: 1.72 ±0.2504	Z:-11.28 ±0.23
	X:6.89 ±0.0068	X: 101.27 ±0.1450	X:27.59 ±0.1257	X:31.36 ±0.0103	X: ND	X: ND	X: ND	X: ND
244	Y:15.93 ±0.0226	Y: 100.20 ±0.2310	Y:42.87 ±0.1160	Y:45.91 ±0.0538	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 97.88 ±2.0105	Z:-12.46 ±3.184	Z:ND	Z:43.64 ±2.887	Z:-50.23 ±2.1	Z:44.21 ±1.1510	Z:-17.79 ±1.86
	X:7.39 ±0.0080	X: 101.68 ±0.0613	X:23.92 ±0.1167	X:29.11 ±0.0344	X: ND	X: ND	X: ND	X: ND
245	Y:7.12 ±0.1464	Y: 90.18 ±0.6750	Y:4.54 ±90.1190	Y:13.41 ±0.0495	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 97.98 ±0.1907	Z: 6 ±0.1316	Z:ND	Z:5.55 ±0.0218	Z:-12.4 ±0.03	Z:13.12 ±0.1575	Z:-5.16 ±0.022
	X:8.88 ±0.0143	X: 101.67 ±0.0914	X:23.84 ±0.0443	X:26.92 ±0.0150	X: ND	X: ND	X: ND	X: ND
251	Y:19.99 ±0.0519	Y: 98.01 ±0.1564	Y:22.75 ±0.0641	Y:25.24 ±0.0372	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 100.58 ±0.1234	Z: -3.63 ± 0.223	Z:ND	Z:8.10 ±0.0767	Z: -22.03 ±0.1	Z:13.04 ±0.0803	Z:-5.32 ±0.051
	X:3.01 ±0.0014	X: 100.16 ±0.0602	X:21.66 ±0.0249	X:25.75 ±0.0082	X: ND	X: ND	X: ND	X: ND
252	Y:11.65 ±0.0164	Y: 96.08 ±0.1317	Y:25.19 ±0.0484	Y:30.91 ±0.0231	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 99.65 ±0.2957	Z:12.35 ±0.3551	Z:ND	Z:12.78 ±0.173	Z: -31.4 ±0.13	Z:32.39 ±0.3351	Z:-9.69 ±0.066
	X:5.94 ±0.0114	X: 99.73 ±0.1167	X:6.07 ±0.1294	X:12.14 ±0.0580	X: ND	X: ND	X: ND	X: ND
255	Y:12.08 ±0.0041	Y: 100.82 ±0.0410	Y:11.63 ±0.0060	Y:12.08 ±0.0091	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 103.13 ±0.0975	Z: 3.15 ±0.1916	Z:ND	Z:9.78 ±0.1432	Z:-10.1 ±0.21	Z:15.71 ±0.1537	Z:-3.16 ±0.018
	X:10.77 ±0.0221	X: 98.91 ±0.1425	X:26.87 ±0.1337	X:33.41 ±0.0385	X: ND	X: ND	X: ND	X: ND
260	Y:7.96 ±0.0068	Y: 98.03 ±0.0458	Y:21.62 ±0.0331	Y:25.24 ±0.0092	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 96.98 ±0.1960	Z: 2.96 ±0.6700	Z:ND	Z:12.32 ±0.172	Z: -37.2 ±0.17	Z:20.66 ±0.2636	Z -7.7 ±0.2772
	X:6.62 ±0.0221	X: 101.29 ±0.1619	X:26.56 ±0.1717	X:32.40 ±0.0173	X: ND	X: ND	X: ND	X: ND
264	Y:14.87 ±0.0599	Y: 96.82 ±0.3005	Y:16.35 ±0.1632	Y:24.75 ±0.0194	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 99.18 ±0.6534	Z: 2.54 ±1.7962	Z:ND	Z:31.44 ±0.778	Z: -41.5 ±0.53	Z:27.92 ±0.7095	Z:-13.59 ±0.14
	X:8.82 ±0.0027	X: 103.19 ±0.0372	X:34.05 ±0.0098	X:36.91 ±0.0081	X: ND	X: ND	X: ND	X: ND
267	Y:23.74 ±0.0371	Y: 91.84 ±0.4343	Y:38.32 ±0.0746	Y:40.44 ±0.0539	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 98.34 ±1.25	Z: -6.50 ±0.7766	Z:ND	Z:22.89 ±0.627	Z: -31.1 ±0.95	Z:11.53 ±0.5567	Z:-6.59 ±0.185
	X:5.26 ±0.0076	X: 85.05 ±0.2649	X: 4.37 ±0.0787	X:10.14 ±0.0136	X: ND	X: ND	X: ND	X: ND
276	Y:30.87 ±0.5372	Y: 91.13 ±0.9410	Y: 0.79 ±1.2310	Y:28.61 ±0.3511	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 88.07 ±0.8951	Z: -10.25 ±0.501	Z:ND	Z:17.66 ±0.292	Z: -8.54 ±0.54	Z:2.78 ±0.1828	Z:-6.36 ±0.108
	X:3.53 ±0.0025	X: 101.67 ±0.0403	X:32.96 ±0.0901	X:35.44 ±0.0282	X: ND	X: ND	X: ND	X: ND
277	Y:10.35 ±0.0045	Y: 101.66 ±0.0156	Y:18.38 ±0.0305	Y:25.48 ±0.0167	Y: ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 88.97 ±1.3851	Z: -14.02 ±0.53	Z:ND	Z:19.18 ±0.495	Z:-22.3 ±0.67 7	Z: 4.09 ±0.5282	Z:-8.69 ±0.16
	X:7.08 ±0.0302	X: 96.59 ±0.3143	X:21.8 ±0.2322	X:28.63 ±0.0219	X:ND	X: ND	X: ND	X: ND
284	Y:10.31 ±0.0084	Y: 98.52 ±0.1048	Y:13.48 ±0.0723	Y:17.62 ±0.0073	Y:ND	Y: ND	Y: ND	Y: ND
	Z: ND	Z: 97.7 ±0.5849	Z: 5.60 ±0.5677	Z:ND	Z:16.56 ±0.726	Z:-20.9 ±0.14	Z: 25.08 ±0.41	Z:-5.6 ±0.081

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