

## CONTENTS

<b>1. INTRODUCTION .....</b>	<b>5</b>
<b>1.1 Basic Principles of the Suggested Measuring Method .....</b>	<b>6</b>
<b>1.2 Mathematical Proof of Justification of the Suggested Measuring Method .....</b>	<b>11</b>
<b>1.3 Mathematical Proof of Correctness in Active Power Processing.....</b>	<b>14</b>
<b>1.3.1. Analysis of the Numerical Procedures Suggested in the Processing of Periodic Signals .....</b>	<b>18</b>
<b>1.4 Adaptability of the Suggested Algorithm Used for Measuring of Electrical Values in Electric Utilities .....</b>	<b>19</b>
<b>1.5 Analysis of Possible Sources of Errors in Digital Processing</b>	
<b>With a Suggested Measurement Concept .....</b>	<b>21</b>
<b>1.5.1 Simulation Results .....</b>	<b>26</b>
<b>1.5.2 Analysis of the Error Caused by Imprecision in Determining Sampling Interval .....</b>	<b>27</b>
<b>1.6 Simulation of the Suggested Measuring Method in the Matlab Program Package .....</b>	<b>33</b>
<b>1.6.1 Software Testing of the Suggested Measuring Concept of Electrical Values Based on Measurement Results in Real Electric Utilities.....</b>	<b>38</b>
<b>1.7 Practical Realization of the Suggested Digital Measuring System.....</b>	<b>41</b>
<b>1.8 Results of Practical Measurements with Realized Digital Wattmeter.....</b>	<b>49</b>
<b>References .....</b>	<b>55</b>
<b>2. DIGITAL PROCESSING OF SYNCHRONOUSLY SAMPLED AC SIGNALS IN PRESENCE OF INTERHARMONICS AND SUBHARMONICS.....</b>	<b>58</b>
<b>2.1 Synchronous Sampling in the Presence of Subharmonics and Interharmonics .....</b>	<b>59</b>
<b>2.1.1 <i>Derived Conditions for Precisely Processing</i>.....</b>	<b>67</b>
<b>2.1.2 <i>Asynchronous Sampling</i> .....</b>	<b>69</b>
<b>2.2 Simulation Results .....</b>	<b>70</b>
<b>2.3 Calculation of the Truncation Errors in Case of Asynchronous Sampling of Complex AC Signals .....</b>	<b>73</b>
<b>2.3.1 Analysis of Worst Case Errors .....</b>	<b>73</b>
<b>2.3.1.1 <i>Average Method</i> .....</b>	<b>75</b>
<b>2.3.1.2 <i>Trapezoidal Method</i> .....</b>	<b>76</b>
<b>2.3.1.3 <i>Stenbakken's Compensation</i>.....</b>	<b>77</b>
<b>2.3.1.4 <i>Zu-Liang Compensation</i>.....</b>	<b>77</b>
<b>2.3.1.5 <i>Average Method- approximate expression</i>.....</b>	<b>78</b>
<b>2.3.1.6 <i>Trapezoidal Method- approximate expression</i>.....</b>	<b>78</b>
<b>2.3.1.7 <i>Stenbakken's Compensation- approximate expression</i>.....</b>	<b>78</b>
<b>2.3.1.8 <i>Zu-Liang Compensation- approximate expression</i> .....</b>	<b>79</b>
<b>2.3.2 Simulation Results .....</b>	<b>79</b>
<b>References .....</b>	<b>83</b>
<b>Appendix A .....</b>	<b>84</b>
<b>3. RECONSTRUCTION OF NONUNIFORMLY SAMPLED AC SIGNALS.....</b>	<b>86</b>
<b>3. 2. Proposed Method of Processing .....</b>	<b>88</b>
<b>3.2.1 <i>The Determinants of the Van der Monde Matrix</i>.....</b>	<b>89</b>
<b>3.2.2 <i>Reconstruction of Band Limited Signals in Form of Fourier Series</i> .....</b>	<b>90</b>
<b>3.3. Simulation Result and Error Analysis.....</b>	<b>95</b>

<b>3.4. Possible Hardware Realization of the Proposed Method of Processing .....</b>	<b>99</b>
<b>References .....</b>	<b>102</b>
<b>Appendix B .....</b>	<b>104</b>
<b>Appendix C .....</b>	<b>104</b>
<b>Appendix D .....</b>	<b>108</b>
<b>Appendix E .....</b>	<b>110</b>
<b>4. NEW METHOD FOR PROCESSING OF BASIC ELECTRICAL VALUES BASED ON DEFINITION FORMULA IN TIME DOMAIN .....</b>	<b>112</b>
<b>    4. 1. Suggested Method of Processing .....</b>	<b>112</b>
<b>    4.1.1 <i>Estimation of Measuring Uncertainty</i>.....</b>	<b>115</b>
<b>    4.2. Simulation of the Suggested Measuring Method .....</b>	<b>115</b>
<b>    4.3. Practical realization of the proposed algorithm .....</b>	<b>117</b>
<b>    4.4. Experimental Results.....</b>	<b>119</b>
<b>    References .....</b>	<b>121</b>