

# **13th IET International Conference on Developments in Power System Protection (DPSP 2016)**

IET Conference Publications 671

Edinburgh, United Kingdom  
7-10 March 2016

ISBN: 978-1-5108-2355-6

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2016) by the Institution of Engineering and Technology  
All rights reserved.

Printed by Curran Associates, Inc. (2016)

For permission requests, please contact the Institution of Engineering and Technology  
at the address below.

Institution of Engineering and Technology  
P. O. Box 96  
Stevenage, Hertfordshire  
U.K. SG1 2SD

Phone: 01-441-438-767-328-328  
Fax: 01-441-438-767-328-375

[www.theiet.org](http://www.theiet.org)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2633  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# TABLE OF CONTENTS

<b>NATIONAL GRID EXPERIENCE OF PROTECTION SETTING RE-CALCULATION DUE TO TRANSMISSION SYSTEM REINFORCEMENTS</b> .....	1
<i>S. Dhakshinamurthi ; I. Sokhey ; J. Singh ; N. Tart ; A. Sharman</i>	
<b>FUNCTIONALITY, DESIGN AND BENEFIT ANALYSIS OF END-TO-END DIGITAL SUBSTATION</b> .....	6
<i>D.H. Wilson ; J.W. Wright ; S. Richards ; P. Mohapatra</i>	
<b>IMPLICATIONS AND BENEFITS OF STANDARDISED PROTECTION AND CONTROL SCHEMES</b> .....	11
<i>R. Loken; A.P. Apostolov</i>	
<b>INNOVATIVE VOLTAGE MANAGEMENT TECHNIQUES TO DERIVE ACTIVE NETWORK SERVICES FROM EXISTING ASSETS</b> .....	15
<i>O. Olabisi; S. Cox</i>	
<b>NATIONAL GRID PROCEDURAL TEST REQUIREMENTS FOR COMMISSIONING OF MULTIFUNCTION NUMERICAL PROTECTION RELAYS</b> .....	20
<i>A. Sharman ; I. Sokhey ; B. Chong ; J. Watson ; S. Dhakshinamurth</i>	
<b>HOW SIMULATION-BASED PROTECTION TESTING CAN UNVEIL POTENTIAL PROBLEMS IN COMPLEX PROTECTION SCHEMES</b> .....	26
<i>C. Budenbender ; K. Machtel ; T. Hensler</i>	
<b>POSTE INTELLIGENT - THE NEXT GENERATION SMART SUBSTATION FOR THE FRENCH POWER GRID</b> .....	31
<i>T. Buhagiar ; J.-P. Cayuela ; A. Procopiou ; S. Richards</i>	
<b>USE OF FRAME AGREEMENT TO STANDARDIZE PROTECTION IN DIGITAL SUBSTATION AUTOMATION SYSTEMS, COOPERATION BETWEEN STATNETT AND ABB</b> .....	35
<i>R. Loken ; R. Mangelrd ; M.M. Saha ; A. Ling</i>	
<b>STRATEGIES AND TECHNIQUES APPLIED TO IEC 61850 BASED DSAS ARCHITECTURES</b> .....	42
<i>A.T.A. Pereira ; L.A.C. Lisboa ; A.M.N. Lima</i>	
<b>MANAGED ETHERNET SWITCHES PERFORMANCE OVER IEC 61850 NETWORKS: APPLICATIONS WITH HIGH TRAFFIC FLOW</b> .....	47
<i>L.B. Oliveira ; M. Zapella ; A. Sarda ; W. Zanatta</i>	
<b>UTILITY IN-HOUSE DESIGN AND DELIVERY OF IEC 61850 SUBSTATION PROJECTS</b> .....	53
<i>C. McTaggart; J.G. Moreno</i>	
<b>APPLICATION OF LAYER 2 NETWORK TO RING PROTECTION SYSTEM</b> .....	58
<i>Xiaojiao Tang ; H. Sugiura ; K. Seiichi ; I. Yoshiharu</i>	
<b>A NEW METHOD OF SELECTION BETWEEN FAULTY AND HEALTHY CIRCUITS IN SERIES COMPENSATED PARALLEL LINES WITH USE OF ONE-END CURRENT MEASUREMENTS</b> .....	64
<i>P. Pierz ; E. Rosolowski ; J. Izykowski ; P. Balcerek ; M.M. Saha</i>	
<b>CYBER SECURITY MEASURES IN PROTECTION AND CONTROL IEDS</b> .....	71
<i>K. Hagman ; L. Frisk ; J. Menezes ; M.M. Saha</i>	
<b>NEW DESIGN OF DISTANCE PROTECTION FOR SMART GRID APPLICATIONS</b> .....	76
<i>J. Blumschein ; C. Dzienis ; Y. Yelgin</i>	
<b>NATIONAL GRID PROTECTION AND CONTROL REQUIREMENTS FOR QUADRATURE BOOSTER WITH AUTOMATIC ISOLATION FACILITY</b> .....	84
<i>I. Sokhey ; G. Standerline ; B. Chong ; S. Dhakshinamurthi ; C. Jennings</i>	
<b>INTERNAL FAILURE DETECTION AND PROTECTION ON CAPACITOR BANKS</b> .....	90
<i>J. Wang ; M. Ibrahim ; Z. Gajic ; M.M. Saha</i>	
<b>TESTING OF THE RELAY PROTECTION FOR OVERCOMPENSATED LINES</b> .....	96
<i>L.C. Haarla ; J. Tuominen ; A. Harjula ; H. Eriksson ; M.M. Saha ; S. Lidstrom</i>	
<b>NATIONAL GRID BACK-UP PROTECTION SETTING TOOL FOR GRADING COORDINATION ACROSS DISTRIBUTION NETWORK OPERATORS/ THIRD PARTY INTERFACES</b> .....	102
<i>B. Chong ; A. Sharman ; I. Sokhey ; S. Dhakshinamurithi</i>	
<b>PROTECTION OF TODAY'S AND FUTURE LOW VOLTAGE GRIDS WITH HIGH DG PENETRATION: LABORATORY AND SIMULATIVE ANALYSIS OF BLINDING OF PROTECTION WITH INVERTERS</b> .....	108
<i>F. Glinka ; R. Bertram ; T. Wippenbeck ; P. Erlinghagen ; A. Schnettler</i>	

<b>IMPLEMENTATION OF DISTANCE RELAYING IN DISTRIBUTION NETWORK WITH DISTRIBUTED GENERATION.....</b>	<b>114</b>
<i>K. Pandakov ; H.K. Hidalen ; J.I. Marvik</i>	
<b>CONSIDERATIONS FOR THE APPLICATION OF HIGH IMPEDANCE AND LOW IMPEDANCE BUSBAR PROTECTION.....</b>	<b>121</b>
<i>C.E.F. Kemp; P.G. Farmer</i>	
<b>POLARITY IDENTIFICATION OF INSTALLED CTS FROM CURRENT MEASUREMENTS ON DISTRIBUTION FEEDERS IN DAS.....</b>	<b>127</b>
<i>Hyung-Seung Kim ; Myeon-Song Choi ; Seung-Jae Lee ; Seong-Il Lim</i>	
<b>AN ACCELERATED ADAPTIVE OVERCURRENT PROTECTION FOR DISTRIBUTION NETWORKS WITH HIGH DG PENETRATION.....</b>	<b>131</b>
<i>J.H. He ; Y.H. Cheng ; J. Hu ; H.T. Yip</i>	
<b>A SIMPLE MULTI AGENT SYSTEM BASED ADAPTIVE RELAY SETTING STRATEGY FOR DISTRIBUTION SYSTEM WITH WIND GENERATION INTEGRATION.....</b>	<b>136</b>
<i>Z. Liu; H.K. Hidalen</i>	
<b>REALIZATION OF LINE CURRENT DIFFERENTIAL PROTECTION OVER IP-BASED NETWORKS USING IEEE 1588 FOR SYNCHRONOUS SAMPLING.....</b>	<b>142</b>
<i>A. Aichhorn ; R. Mayrhofer ; H. Krammer ; T. Kern</i>	
<b>DISTANCE PROTECTION IMPEDANCE MEASUREMENT FOR INHOMOGENEOUS MULTIPLE-CIRCUIT 400/150 KV: TRANSMISSION LINES WITH SHARED TOWERS.....</b>	<b>148</b>
<i>C.L. Bak ; R. Sigurbjornsson ; B.S. Bukh ; R. Post</i>	
<b>OPTIMISATION OF PROTECTION IED USER INTERACTION AND IMPLEMENTING SELF-MONITORING PROTECTION SCHEMES.....</b>	<b>154</b>
<i>M. Stockton ; J. Kelly ; M. Mohemmed</i>	
<b>CONSIDERATIONS AND METHODOLOGY IN APPLICATION OF DISTANCE SCHEMES TO SERIES COMPENSATED NETWORKS- A QUANTITATIVE APPROACH FOR ADJACENT CIRCUITS.....</b>	<b>160</b>
<i>A. Khanna; A. Taylor</i>	
<b>SOLID STATE CIRCUIT BREAKER BASED DC SHIPBOARD DISTRIBUTION PROTECTION.....</b>	<b>167</b>
<i>L. Qi ; A. Antoniazzi ; L. Raciti ; B. Leoni ; H. Kim</i>	
<b>CHALLENGES OF DC DATA CENTER POWER DISTRIBUTION PROTECTION.....</b>	<b>173</b>
<i>G. Wawrzola</i>	
<b>FAULT INDUCTANCE BASED PROTECTION FOR DC DISTRIBUTION SYSTEMS.....</b>	<b>179</b>
<i>X. Feng ; L. Qi ; J. Pan</i>	
<b>SENSITIVITY COMPARISON OF ADMITTANCE AND WATT-METRIC CRITERIA FOR GROUND FAULT DETECTION.....</b>	<b>185</b>
<i>B. Brusilowicz ; Michalik ; W. Rebizant ; L. Schiel</i>	
<b>MANAGING POST-FAULT OSCILLATION PHENOMENON IN COMPENSATED MV-NETWORKS.....</b>	<b>191</b>
<i>S. Zubic ; A. Wahlroos ; J. Altonen ; P. Balcerek ; P. Dawidowski</i>	
<b>APPLICATION OF IEC 61850-6 AND IEC 61970 DATA MODELS FOR AUTOMATED PROTECTION TEST SPECIFICATION.....</b>	<b>197</b>
<i>B. Bauernschmitt ; D. Hilbrich ; B.M. Keune ; C. Rehtanz</i>	
<b>EFFECTIVE COMMISSIONING OF BUS BAR PROTECTION SYSTEMS USING A DYNAMIC SIMULATION IN THE FIELD.....</b>	<b>203</b>
<i>F. Fink ; J. Koppel ; T. Hensler</i>	
<b>TESTING OF IEC 61850 BASED FUNCTIONAL PROTECTION CHAIN USING NON-CONVENTIONAL INSTRUMENT TRANSFORMERS AND SAMU.....</b>	<b>209</b>
<i>V. Leitloff ; P. Brun ; S. de Langle ; B. Ilas ; R. Darmony ; M. Jobert ; C. Bertheau ; P. Ferrat ; M. Boucherit ; G. Duverbecq ; J. Cayuela ; R. Bouchet</i>	
<b>AN ADAPTIVE INVERSE TIME OVERCURRENT RELAY MODEL IMPLEMENTATION FOR REAL TIME SIMULATION AND HARDWARE-IN-THE-LOOP TESTING.....</b>	<b>215</b>
<i>Z. Liu; H.K. Hidalen</i>	
<b>REMOTE TESTING OF MULTIFUNCTIONAL PROTECTION IEDS: BENEFITS AND CHALLENGES.....</b>	<b>221</b>
<i>A.P. Apostolov</i>	
<b>COMPUTATIONAL MODELING OF FREQUENCY RELAY FOR ISLANDING DETECTION OF DISTRIBUTED GENERATION BY PERFORMANCE OF FREQUENCY ESTIMATION METHODS.....</b>	<b>227</b>
<i>H.S. Sanca ; B.A. Souza ; F.B. Costa</i>	

<b>CHALLENGES WITH CHANGEOVER TO ISLAND MODE OPERATION: SMART GRID SOLUTIONS</b> .....	233
<i>O. Mogstad ; M.-R. Jacobsen ; J. Heggset</i>	
<b>ALL-OPTICAL BUSBAR DIFFERENTIAL PROTECTION SCHEME FOR ELECTRIC POWER SYSTEMS</b> .....	237
<i>M. Nasir ; A. Dysko ; P. Niewczas ; G. Fusiek</i>	
<b>FAULT CURRENT CHARACTERISATION IN VSC-BASED HVDC SYSTEMS</b> .....	243
<i>S. Ademi ; D. Tzelepis ; A. Dysko ; S. Subramanian ; Hengxu Ha</i>	
<b>TRAVELLING WAVES-BASED FAULT DETECTION METHOD IN MULTI-TERMINAL HVDC GRIDS CONNECTING OFFSHORE WIND FARMS</b> .....	250
<i>R.E. Torres-Olguin; H.K. Hidalen</i>	
<b>INTEGRATED PROTECTION FOR GENERATOR-MOTOR APPLICATIONS</b> .....	257
<i>C. Popescu; N. Costa</i>	
<b>IMPACT OF PECKING FAULTS ON THE OPERATING TIMES OF NUMERICAL AND ELECTROMECHANICAL OVER-CURRENT RELAYS</b> .....	261
<i>M. Kuflo ; P.A. Crossley ; Nan Liu</i>	
<b>A TWO-LAYER DETECTION STRATEGY FOR PROTECTING MULTI-TERMINAL HVDC SYSTEMS AGAINST FAULTS WITHIN A WIDE RANGE OF IMPEDANCES</b> .....	267
<i>J.I. Marvik ; S. D'Arco ; J.A. Suul</i>	
<b>SHORT-CIRCUIT PROTECTION AND AUTOMATIC-RECLOSING SEQUENCE FOR MULTITERMINAL HVDC LINK</b> .....	273
<i>C. Heising ; D. Meyer ; M.K. Jager ; V. Staudt</i>	
<b>LIMITATIONS OF DI/DT TECHNIQUE IN DC LINE PROTECTION</b> .....	279
<i>M.A. Ikhide ; S.B. Temakoon ; A. Griffiths ; S. Subramanian ; H. Ha ; A. Adamczyk</i>	
<b>PROTECTION COORDINATION IN MULTI-TERMINAL HVDC NETWORKS FOR DC FAULT CLEARANCE</b> .....	285
<i>R. Gupta ; C.D. Barker ; A. Adamczyk ; R.S. Whitehouse ; K.J. Dyke</i>	
<b>SELECTIVE WAVE-FRONT BASED PROTECTION ALGORITHM FOR MTDC SYSTEMS</b> .....	291
<i>N. Johannesson ; S. Norrga ; C. Wikstrom</i>	
<b>ASSESSING COMMUNICATION NETWORKS FOR DISTRIBUTED PROTECTION AND AUTOMATION SYSTEMS WITH TIME SYNCHRONIZED AND DISTRIBUTED MEASUREMENT SYSTEMS</b> .....	297
<i>F. Steinhäuser</i>	
<b>DESIGN OF A HYBRID PLATFORM FOR ONLINE APPLICATION TESTING WITH IEC 61970</b> .....	301
<i>D. Hilbrich ; B. Bauerschmitt ; B.M. Keune ; C. Rehtanz ; S. Lehnhoff</i>	
<b>SIMULATION AND ANALYSIS OF THE CONTROL AND PROTECTION PERFORMANCE FOR A MULTI-TERMINAL VSC-HVDC SYSTEM</b> .....	307
<i>Wen An ; C.Z. Wei ; M. Mou ; W.F. Huang ; X. Jin ; H. Ye</i>	
<b>COMPARISON FREQUENCY ESTIMATION METHODS ON ADAPTIVE PROTECTION ARCHITECTURE APPLIED ON SYSTEMS WITH DISTRIBUTED GENERATION</b> .....	311
<i>H.S. Sanca ; F.C. Souza ; B.A. Souza ; F.B. Costa</i>	
<b>NETWORK SEGREGATION IN THE DIGITAL SUBSTATION</b> .....	317
<i>J. Arnaud ; J.W. Wright</i>	
<b>PERFORMANCE CONSIDERATIONS IN DIGITAL SUBSTATIONS</b> .....	321
<i>S. Meier ; T. Werner ; C. Popescu-Cirstucescu</i>	
<b>REQUIREMENTS AND METHODS FOR REDUCING FAULT CLEARING TIMES IN SMART GRIDS</b> .....	330
<i>A.P. Apostolov</i>	
<b>THE AZERBAIJANI EXPERIENCES IN DIGITAL SUBSTATION DEPLOYMENT. HOW PROCESS BUS AND IEC 61850 ADDRESSES UTILITY REQUIREMENTS</b> .....	336
<i>Saeid ; J. Seco ; J. Cardenas</i>	
<b>STANDARDIZATION OF AUTOMATED DISTURBANCE MANAGEMENT FOR URBAN DISTRIBUTION POWER SYSTEMS</b> .....	342
<i>B.M. Keune ; B. Bauerschmitt ; D. Hilbrich ; C. Rehtanz ; S. Lehnhoff</i>	
<b>REAL-TIME CLOSED-LOOP TEST TO ADAPTIVE PROTECTION IN A SMART-GRID CONTEXT</b> .....	348
<i>H. Leite ; E. Almeida ; N. Silva</i>	
<b>ASSESSMENT OF TRANSMISSION LINE PROTECTION WITH INTEGRATED OFFSHORE WIND FARM IN UAE</b> .....	353
<i>D. Khalifa; M. Nour</i>	

<b>A SYSTEMATIC EVALUATION OF NETWORK PROTECTION RESPONSES IN FUTURE CONVERTER-DOMINATED POWER SYSTEMS.....</b>	359
<i>Ruiqi Li ; C. Booth ; A. Dysko ; A. Roscoe ; H. Urdal ; Jiebei Zhu</i>	
<b>DEPLOYMENT AND EVALUATION OF PTPV2 IN A PRP NETWORK.....</b>	366
<i>L.B. Oliveira ; G. Silvano ; H. Rachadel ; M. Dalmas ; M. Zapella</i>	
<b>AN ISLANDING DETECTION METHOD FOR INVERTER-INTERFACED DISTRIBUTED GENERATION USING AN ADAPTIVE POWER DISTURBANCE APPROACH.....</b>	372
<i>Y.K. Xu ; J.H. He ; H.T. Yip</i>	
<b>PERFORMANCE OF LOSS-OF-MAINS DETECTION IN MULTI-GENERATOR POWER ISLANDS.....</b>	378
<i>D. Tzelepis ; A. Dysko ; C. Booth</i>	
<b>GRID CODE COMPATIBLE ISLANDING DETECTION SCHEMES USING TRADITIONAL PASSIVE METHODS.....</b>	384
<i>H. Laaksonen</i>	
<b>HARDWARE TESTING OF PHOTOVOLTAIC INVERTER LOSS OF MAINS PROTECTION PERFORMANCE.....</b>	390
<i>I. Abdulhadi; A. Dysko</i>	
<b>PROTECTIVE RELAY SETTING CRITERIA CONSIDERING DERS AND DISTRIBUTED AUTOMATION.....</b>	396
<i>J.M. Gers; C. Viggiano</i>	
<b>VALIDATING SECURE AND RELIABLE IP/MPLS COMMUNICATIONS FOR CURRENT DIFFERENTIAL PROTECTION.....</b>	405
<i>S.M. Blair ; C.D. Booth ; B. De Valck ; D. Verhulst ; C. Kirasack ; K.Y. Wong ; S. Lakshminarayanan</i>	
<b>DESIGN &amp; COMMISSIONING OF A DISTRIBUTED IEC61850 COMMUNICATION BASED PROTECTION SCHEME FOR A RAILWAY ELECTRIFICATION PROJECT.....</b>	411
<i>R. Cobbold ; C. Pritchard ; N. Burnham ; M. Iacovelli ; A. Jordan</i>	
<b>APPLICATION OF WIDE-AREA PROTECTION TO RUNNING-IN RISK IN RAILWAY PROTECTION SYSTEMS.....</b>	416
<i>D.B. Hewings</i>	
<b>ESTIMATING THE IMPACT OF WIDE-AREA PROTECTION SYSTEMS ON POWER SYSTEM PERFORMANCE AND RELIABILITY.....</b>	420
<i>I.P. de Siqueira</i>	
<b>A MULTILEVEL SYSTEM INTEGRITY PROTECTION SCHEME BASED ON GOOSE MESSAGING.....</b>	426
<i>C. McTaggart; D. Adam</i>	
<b>IMPLEMENTATION OF A WIDE-AREA MONITORING SCHEME FOR THE INDIAN POWER SYSTEM.....</b>	431
<i>P.J. Harding ; A. Varghese ; R. Bharat ; A. Gillies ; G. Lloyd</i>	
<b>SYSTEM INTEGRITY PROTECTION SCHEME BASED ON ON-LINE TRANSIENT STABILITY CALCULATION USING PROTECTION RELAY DEVICE HARDWARE.....</b>	437
<i>H. Iwaki ; Y. Inoue ; A. Ishibashi ; M. Kimura ; K. Omata ; Y. Ishihara</i>	
<b>DYNAMIC PROTECTION SECURITY ASSESSMENT: INFLUENCES OF PROTECTION SYSTEMS ON THE TRANSIENT SYSTEM SECURITY.....</b>	443
<i>C. Romeis ; T. Eberle ; J. Jaeger</i>	
<b>DISTRIBUTED AUTOMATIC TAP CHANGE CONTROL FOR POWER TRANSFORMERS UTILISING IEC61850.....</b>	449
<i>C. Popescu; A. Mills</i>	
<b>A NEW INDEPENDENT METHODOLOGY FOR PROTECTION AND CONTROL COORDINATION STUDIES USING REAL TIME DIGITAL SIMULATION.....</b>	455
<i>D. Kong ; A. Taylor ; Y. Xue ; X.-P. Zhang</i>	
<b>DESIGN OF AN INTELLIGENT SYSTEM FOR COMPREHENSIVE VALIDATION OF PROTECTION SETTINGS.....</b>	461
<i>Q. Hong ; C. Booth ; A. Dysko ; V. Catterson</i>	
<b>A NOVEL POLE-TO-GROUND FAULT DETECTION ALGORITHM FOR MESHED HVDC GRIDS WITH HALF-BRIDGE MMC CONVERTERS AND FULL RECOURSE TO DC CIRCUIT BREAKERS.....</b>	468
<i>G. Auran ; B. Raison ; J. Descloux ; S. Nguefeu</i>	
<b>CONDITION-BASED MAINTENANCE: A FORWARD STEP ON THE POWER SYSTEM PROTECTION MAINTENANCE AT THE PORTUGUESE TRANSMISSION SYSTEM OPERATOR.....</b>	474
<i>H. Leite ; B. Soares ; S. Costa</i>	

<b>MINING SPATIAL FREQUENCY TIME SERIES DATA FOR EVENT DETECTION IN POWER SYSTEMS</b> .....	478
<i>S.A. Lavand ; G.R. Gajjar ; S.A. Soman ; R. Gajbhiye</i>	
<b>FAULT ANALYSIS FOR PROTECTION PURPOSES IN MARITIME APPLICATIONS</b> .....	484
<i>C.I. Ciontea ; C.L. Bak ; F. Blaabjerg ; K.K. Madsen ; C.H. Sterregaard</i>	
<b>MULTIFUNCTION INTELLIGENT RELAY FOR INVERTER-BASED DISTRIBUTED GENERATION</b> .....	490
<i>Qiushi Cui ; Shijia Li ; K. El-Arroudi ; G. Joos</i>	
<b>PROTECTION SYSTEMS IN DISTRIBUTION GRIDS WITH VARIABLE SHORT-CIRCUIT CONDITIONS</b> .....	496
<i>M. Biller ; J. Jaeger ; I. Mladenovic ; C. Schacherer ; D. Wolter ; M. Stoetzel</i>	
<b>A SUM-DIFFERENCE IMPEDANCE PROTECTION OF TRANSMISSION LINE</b> .....	501
<i>Liu Huangzhang ; Wang Xingguo ; Zhou Zexin</i>	
<b>A NEW ADAPTIVE HIGH SPEED DISTANCE PROTECTION SCHEME FOR POWER TRANSMISSION LINES</b> .....	505
<i>M.M. Saha ; T. Einarsson ; S. Lidstrom</i>	
<b>DIGITAL SUBSTATION BACKUP PROTECTION USING A MULTI-AGENT SYSTEM APPROACH</b> .....	511
<i>Jinghan He ; T. Yip ; Yupeng Huang ; Ziqi Wang ; Lin Liu</i>	
<b>EQUIVALENT CIRCUIT OF DFIG WITH CROWBAR PROTECTION FOR RELAY PROTECTION ANALYSIS</b> .....	517
<i>Jinhua Zhang ; Baohui Zhang ; Zhiguo Hao</i>	
<b>TESTS TO ASSESS 61850-9-2 BASED STAND ALONE MERGING UNITS FOR METERING PURPOSES</b> .....	522
<i>L.D. Roux ; Z. Qastalane ; Y. Leitloff</i>	
<b>IMPACT OF OPEN PHASE FAULT CONDITIONS ON ELECTRICAL PROTECTION AND MOTOR BEHAVIOUR</b> .....	527
<i>D.S. Batorowicz ; J. Hanson ; O. Goieva ; W. Schoenberger ; A. Shustov</i>	
<b>CURRENT TRANSFORMERS SATURATION AND ITS IMPLICATIONS IN PROTECTIVE DIFFERENTIAL SCHEMES DETECTION AND OPERATION DECISION USING WAVELET TRANSFORM AND ARTIFICIAL NEURAL NETWORKS</b> .....	533
<i>R.A. Benes Ferreira ; F.A. Reis Filho</i>	
<b>SIMULATION OF DIFFERENTIAL PROTECTIONS OF TRANSFORMERS IN POWER SYSTEMS</b> .....	539
<i>M.V. Andreev ; A.O. Sulaymanov ; A.S. Gusev</i>	
<b>REACTIVE POWER COMPENSATION OF NONLINEAR LOAD</b> .....	545
<i>B. Brusilowicz ; J. Szafran ; G. Wisniewski</i>	
<b>IMPACT OF INTERFERENCE ON DIGITAL INFORMATION FLOW IN DYNAMICALLY CHANGING PLC NETWORK TOPOLOGY CYBER SECURITY IN SMART GRID</b> .....	551
<i>R. Czechowski</i>	
<b>IMPROVEMENTS IN POWER SYSTEM FREQUENCY ESTIMATION SOLUTION</b> .....	557
<i>Jinlei Xing ; Lifan Yang</i>	
<b>PRACTICAL IMPLEMENTATION OF LONGITUDINAL TAPPED ADMITTANCE TRANSFORMER PROTECTION</b> .....	563
<i>S.M. Liu ; R.S. Liu ; L. Jiang</i>	
<b>PROTECTION RELAY BEHAVIOUR DURING POWER SYSTEM RESTORATION - A BOUNDARY BASED STATE CLASSIFICATION APPROACH</b> .....	568
<i>M. Jaworski ; J. Jaeger</i>	
<b>EMERGENCY ZONE 3 MODIFICATION TO PREVENT CASCADED OUTAGES: LOCAL VS. CENTRALIZED APPROACH</b> .....	574
<i>V.C. Nikolaidis ; A.M. Chliara</i>	
<b>APPLICATION OF ATP-EMTP IN DETERMINATION OF OPTIMAL SETTINGS FOR DIFFERENTIAL PROTECTION IEDS UNDER CT SATURATION</b> .....	580
<i>A. Khanna</i>	
<b>TRAVELLING WAVE FAULT LOCATION PRINCIPLE BASED ON ROGOWSKI COIL'S DIFFERENTIAL OUTPUT AND HILBERT-HUANG TRANSFORM</b> .....	586
<i>D. Wang ; H.L. Gao ; S.B. Luo ; G.B. Zou</i>	
<b>PRELIMINARY STUDY ON HIERARCHICAL PROTECTION SYSTEM</b> .....	592
<i>F. Peng ; H.L. Gao ; G.B. Zou</i>	
<b>PROTECTION PERFORMANCE OF TRADITIONAL DISTANCE RELAYS UNDER WIND POWER INTEGRATION</b> .....	598
<i>Chenqing Wang ; Guobing Song ; Jisi Tang</i>	

<b>THE OPTIMAL CIRCUITOUS COMMUNICATION ROUTE SEARCH FOR PILOT PROTECTION BASED ON ANT COLONY ALGORITHM .....</b>	<b>603</b>
<i>Xin Chen ; Zhiqian Bo ; Xingzhou Dong ; Shenxing Shi ; Bin Wang</i>	
<b>A STUDY ON THE UNDEREXCITATION LIMITER PERFORMANCE IN KOREAN 154KV TRANSMISSION SYSTEM .....</b>	<b>608</b>
<i>J.K. Park ; K.H. Kim ; G.H. Gwon ; Y.S. Oh ; C.H. Kim ; Y.S. Lyu ; J.J. Yang</i>	
<b>A STUDY ON THE DISTANCE RELAY OPERATION CHARACTERISTICS FOR KOREAN SINGLE TRACK AC ELECTRICAL RAILWAY SYSTEM .....</b>	<b>614</b>
<i>G.J. Cho ; K.S. Ryu ; H.D. Lee ; S.H. Heo ; H.D. Kim ; C.H. Kim ; S.I. Kwon</i>	
<b>HIGH FREQUENCY TRANSFER CHARACTERIZATION OF A THREE PHASE TRANSFORMER USING TWO-PORT VECTOR NETWORK ANALYZER .....</b>	<b>619</b>
<i>Kwangho Kim; Wansoo Nah</i>	
<b>POWER LINE CARRIER BASED LOSS OF MAINS PROTECTION IN MEDIUM VOLTAGE DISTRIBUTION NETWORKS .....</b>	<b>624</b>
<i>S. Voima ; P. Valisuo ; K. Kauhaniemi</i>	
<b>AN IMPROVED FREQUENCY ESTIMATION ALGORITHM BASED ON DFT AND ITERATIVE METHOD .....</b>	<b>630</b>
<i>Woo-Seok Seo ; Sang-Hee Kang ; Young-Doo Yoon</i>	
<b>DIFFERENTIAL PROTECTION PERFORMANCE IN PRESENCE OF CHARGING CURRENT FOR HV TRANSMISSION .....</b>	<b>635</b>
<i>J.M.C. Guimaraes ; R. Rossi ; P.M. Silveira ; C.A. Guerrero</i>	
<b>A NOVEL HYBRID DIRECTIONAL COMPARISON PILOT PROTECTION SCHEME FOR THE LCC-VSC HYBRID HVDC TRANSMISSION LINES .....</b>	<b>641</b>
<i>Yanting Wang; Baohui Zhang</i>	
<b>ADAPTABILITY ANALYSIS OF DIRECTIONAL RELAYS IN POWER SYSTEMS WITH WIND FARMS .....</b>	<b>647</b>
<i>Jisi Tang ; Guobing Song ; Chenqing Wang</i>	
<b>SOME LIKE IT HOT! CONDITION MONITORING IN LOW VOLTAGE CIRCUIT BREAKER TECHNOLOGY .....</b>	<b>653</b>
<i>T. Craig; T. Electric</i>	
<b>ANALYSIS AND SIMULATION OF DYNAMIC PERFORMANCE OF PMU ACCORDING TO IEEE C37.118.1-2011 STANDARD .....</b>	<b>659</b>
<i>L.B. Oliveira ; M.N. Agostini ; M. Dalmas ; A.O. Pires ; S.L. Zimath</i>	
<b>ENHANCING SECURITY OF DISTANCE RELAYS DURING POWER SWING UNBLOCKING FUNCTION FOR DOUBLE CIRCUIT TRANSMISSION LINES: A DIFFERENTIAL POWER APPROACH .....</b>	<b>665</b>
<i>P.N. Gawande; S.S. Dambhare</i>	
<b>PROTECTIVE RELAY WITH FAULT RIDE-THROUGH REQUIREMENT: ASSESSMENT BY CLOSED-LOOP TEST IN REAL TIME .....</b>	<b>671</b>
<i>H. Leite; B. Silva</i>	
<b>NEW GROUND FAULT LOCATION ALGORITHM FOR TRANSMISSION LINE USING SYNCHROPHASORS .....</b>	<b>677</b>
<i>T.P. Hinge; S.S. Dambhare</i>	
<b>TRAVELLING WAVE DIFFERENTIAL PROTECTION BASED ON EQUIVALENT TRAVELLING WAVE .....</b>	<b>683</b>
<i>Lanxi Tang ; Xinzhou Dong ; Shenxing Shi ; Bin Wang</i>	
<b>EFFECTIVE UTILIZATION OF SCADA FOR SUBSTATION PROTECTION AND CONTROL APPLICATIONS .....</b>	<b>689</b>
<i>P. Rajagopal; S. Sayapogu</i>	
<b>DEVELOPMENT OF WIDE AREA LOAD MANAGEMENT SCHEMES TO ENHANCE SYSTEM OPERABILITY .....</b>	<b>694</b>
<i>B. Dukic; C. McTaggart</i>	
<b>APPROXIMATE ANALYTICAL SOLUTION OF STATIONARY COMPONENT OF FAULT-INDUCED TRAVELING WAVES ON TRANSMISSION LINE .....</b>	<b>698</b>
<i>Ao-yu Lei ; Xin-zhou Dong ; Shenxing Shi ; Bin Wang</i>	
<b>HIGH IMPEDANCE FAULT DETECTION ON DISTRIBUTION SYSTEMS WITH HARMONIC INTERFERENCE IN WIND FARMS .....</b>	<b>704</b>
<i>Jiang Ni ; Bin Wang ; Xinzhou Dong</i>	
<b>ANALYSIS OF THE INFLUENCE OF THE OVERHEAD LINE PARAMETERS ON THE FAULT TRAVELING WAVE .....</b>	<b>709</b>
<i>Teng Feng ; Xinzhou Dong ; Shenxing Shi ; Bin Wang</i>	
<b>Author Index</b>	