Author’s Guidelines for the Transactions of the Institute of Electrical Engineers of Japan

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Author's Guidelines for the Transactions of the Institute of Electric Engineers of Japan

Preface

Transactions of the Institute of Electric Engineers of Japan (IEEJ) are important source of information delivered monthly to the society members directly. The authors are advised to read the guidelines before submission as all papers and articles submitted to the IEEJ Transactions are processed according to these guidelines. As a general rule, Papers, Technical Notes, Letters and Discussions to be published in the IEEJ Transactions will be printed from the manuscript in style file submitted by the authors.

These Guidelines are an abridged translation of the guidelines in Japanese, and designed to help the authors who wish to submit papers or articles in English.

[1] Rules for Submission

1. Qualifications of the authors

As a general rule, the authors should be a member of the IEEJ. If there are more than one author, at least one of the authors should be a member. However, a paper or an article submitted from outside Japan will be accepted even if it does not have an author who is an IEEJ member.

2. Categories and Scope of IEEJ Transactions

Attached Table 1 indicates the IEEJ Transactions their categories and scopes.

3. Types of Submission and Requirements

There are four types of submission: Paper, Technical Note, Letter and Discussion. Other than these four types of submission, articles deemed appropriate by the Editorial Committee will be accepted for publication. (Hereinafter they will be referred to as Papers and Articles.)

3.1 Requirements of Paper

A Paper published in the Transactions of the IEEJ should have the contents that contribute to the scientific research or technology in the electrical engineering, and should satisfy at least one of the following requirements (1) through (3), and the two essential requirements (4) and (5), below.

(1) The paper is objectively judged to have creativity. (Creativity)
(2) The paper is objectively judged to have originality. (Originality)
(3) The paper is useful to the development of the scientific research or the technology. (Usefulness)
(4) The paper contains no obvious error.
(5) The paper should not be published in the other publications prior to submission to IEEJ. The publications refer to the books and journals printed in Japan or elsewhere, and the in-house publication of the government, public institutions and the universities. However, in the following cases, the author may still submit the paper as a new paper.
  (a) Paper that had been presented in the annual conferences or topical meetings sponsored or co-sponsored by IEEJ, or in similar occasions, prior to the publication in the Transactions.
  (b) Paper that expands the Letter previously published as late news in the Transactions.

3.2 Requirements of Technical Note

Technical Notes to be published in the IEEJ Transactions must not be published in the other publications prior to submission to the IEEJ, and must meet one of the following criteria.

(1) Systematic analysis of the existing theories.
(2) Test results, test criteria, numerical tables and technical practice with universal interest.
(3) Comprehensive report of scientific or technical topic that is worth specific attention at the time.
(4) Other topics that are deemed to have scientific or technical contributions.

Authors may submit as a Technical Note the content which have been previously published in the meetings or symposia sponsored or co-sponsored by IEEJ or such similar meetings prior to submission in the Transactions .

3.3 Requirements of Letter

Letter to be published in the IEEJ Transactions must not be published in the other publications prior to submission to IEEJ, and must meet one of the following critera.

(1) Late News on a creative new research or technical developments.
(2) Late News on an original scientific study or technology.

Author may submit as a Letter the contents which have been previously published in the meeting or symposia sponsored or co-sponsored by IEEJ or any such similar meetings prior to submission in the Transactions .

3.4 Requirements for Discussion

Discussion of Paper, Technical Note and Letter and the responses from the author constitute Discussion. Authors should directly state the point of argument with only a short preamble. Objective of Discussion should be to help the authors to discover the truth. Discussion should state only what is relevant to the original article and should not touch upon items not relevant to the paper.

4. Date of Submission, Receipt, Review, Evaluation and Deadline of Resubmission

(1) As a general rule, all papers received before the 25th of each month will be presented to the Paper Committee Meeting held in the first week of the following month.
(2) The papers and articles submitted are registered in the log book of the IEEJ Transactions Editorial Department, and the authors will receive a note of receipt with a paper number and the date of receipt. (Resubmitted articles and papers are treated in the same manner.) However when an article or a paper deviates significantly from the instructions described in these guidelines, the said paper or the article may be returned to the author for revision.
(3) The article or paper submitted will be reviewed in accordance with the “Rules for Paper Screening” by one or two or more referees who is a member of the paper committee. Based on the comments of the referees, the topical editor of the Paper Committee evaluate the paper and report the results to the chairman of the Editorial Board. The chairman of the Editorial Board, based on this evaluation report, decides acceptance or rejection as categorized below, and then notify the author accordingly.

(a) Publish as it is.
(b) Publish with minor revision. (Conditional Acceptance)

(c) Refer back to the authors for clarifications before decision on acceptance. (Reevaluation After Referral)
(d) Not to be published. (Reject)

(4) When no response is received after three months of the paper being returned to the author for revision or clarification as described in the items (b) and (c) above, the submission will be erased from the log book of submission. Resubmission after 3 months will be considered as a new submission.
(5) When the authors do not hear from the IEEJ after 6 months of receipt of submission, the author could not be prohibited from submitting the paper to another journal.
(6) Paper screening procedure follows the steps described above and the IEEJ Editorial Board shall not be held responsible for any liabilities incurred.

5. Mailing Address for Paper Submission

Transaction Editor,
Editorial Dept.,
Institute of Electrical Engineers Japan
8th Floor Homat HorizonBldg.
6-2 Gobancho, Chiyoda-ku, Tokyo
102-0076 Japan

Phone 81-3-3221-7302
Fax 81-3-3221-3704

6. Copyrights

Copyrights of all articles and papers, appearing in the IEEJ Transactions shall be transferred to IEEJ. Authors are requested to submit the Copyright Transfer Form (Appendix 1) with papers and article submitted to IEEJ. The authors should understand that the following applies to the copyright transfer. When the paper is rejected for publication, the copyright transfer becomes invalid from the moment the decision is made to reject the paper.

(1) Copyright transfer applies to translation rights, adaptation rights and utilization rights for derivative work.
(2) Authors should not submit the articles containing the same contents to multiple publications.
(3) Authors should take full cautions in quoting articles from another work to avoid any infringement of copyrights.
(4) The following rights will remain with the authors after the copyright transfer.
(a) All rights other than the copyrights, such as patent rights.
(b) The author's rights to use the work as part of compiling a biography of his/her work.
(c) The author's rights to reproduce copies of the work for non-commercial use. (For example for educational material.)
(d) Other uses of the work that will not infringe upon the Japanese Copyright Law.
(5) IEEJ agrees under the contract with John Wiley & Sons (USA) to translate and publish in an English journal “Electrical Engineering in Japan” the papers and articles appeared in the IEEJ Transactions. Authors may hear directly from John Wiley & Sons about the publication in the said journal.

As described above, IEEJ makes efforts to publicize the papers and articles by requesting the authors to transfer copyrights, without diminishing the author‘s proprietary rights.

7. Others

Manuscripts that are not complete, such as missing figures or tables, or manuscripts exceeding the specified page limitations, or not following the guidelines will not be received. Please follow the [2] Guideline for Manuscript Preparation carefully.
Authors will have, as a general rule, a chance to proof read the final copy of manuscript.

[2] Guideline for Manuscript Preparation

1. General Remarks

IEEJ Transactions are public forum for communicating expeditiously and extensively to the members, the results of new research, development and applications that contribute to the scientific research and technology in the electric engineering. Therefore the authors should keep in mind to communicate effectively the information valuable and interesting to the members. Furthermore, to ensure that the paper is published in the Transactions promptly, it is necessary to reduce the time required for review, therefore, the authors should keep in mind the following points, when writing a manuscript.

(1) Ensure that the significance of the subject to be published and the results are under-standable to the readers who are the specialists in the field as well as the non-specialists. Special attention should be taken when writing the abstract and the introduction.
(2) Express clearly, omitting the subjects irrelevant to the theme. Check elaborately for any spelling errors or typographical errors. We recommend the manuscript to be read by a reliable third person.
(3) Summarise the current status of study in the related field, and explicitly define the position of the content to be published.
(4) Express clearly the creative, original or useful aspects of the paper to be published. For example, illuminate the points how theory, experimental methods or the results differ from the existing theories, methods or results.
(5) Contents of the paper should be presented in a logical order and there should not be any leap of logic in the explanation.
(6) A paper with a leap of logic in part will not be credible. Propriety of the hypothesis or the conditions which form the premise of the paper should be considered carefully and the universality should be illuminated.
(7) Authors are encouraged to submit in addition to the manuscript, “Highlights of the Paper”, “Induction of Mathematical Equation” and “Bibliography” to facilitate the review process.

2. Preparation of Manuscript and Forms to be Submitted

2.1 Preparation of Manuscript

As a general rule, a style file submitted by the author for Paper, Technical Note, Letter and Discussion, will be used to print IEEJ Transactions. In this procedure, the elctronic data as submitted by the author will be printed as it is, and the author should prepare the manuscript according to the paper format described in section “4. Manuscript Format.”

Manuscript should be prepared following the method indicated below.

(a) Manuscript prepared in style file. Please refer to the section “4.1 Manuscript Format in Style File.”

Please refer to section 4.1 for instruction for downloading the LaTeX style.

Authors, when preparing a manuscript, should be careful with the format and layout of manuscript, including the figures and tables, to ensure clarity and legibility.

2.2 Manuscript Submission

Forms to be submitted are indicated in the Table 2. A floppy disk, MO disk or CD-R/RW containing the electronic data required for printing and sample print-outs are to be submitted after the article is accepted for publication.

(1) Paper and Technical Note

(1.1) Prepare three copies of the manuscripts for (a) and (b) below and submit with a copy of IEEJ Submission Form (Hereinafter referred to as "Submission Form." Appendix 2. Please copy and use the form as necessary.) and Copyright Transfer Form (Appendix 1. Please copy and use the form as necessary.)

(a) Text (including Summary, Tables and Figures, Author Introduction.): to be published in the IEEJ Transactions.

(b) Extended Summary: to be published in the IEEJ Web Site.

(1.2) Please follow the Section 5. "Guidelines for Manuscript Preparation" and prepare Paper and Extended Summary on A4-sized papers.

(2) Letter

Prepare the manuscript for Letter on A4-sized paper, according to Section 5.2 submit two copies of the manuscript with a copy of Submission Form and Copyright Transfer Form.

(3) Discussion

Prepare the manuscript for Discussion on A4-sized paper and submit two copies of the manuscript with a copy of Submission Form and Copyright Transfer Form. Please inquire the IEEJ Editorial Department for details of style format.

3. Language and Page Limitations

(1) All texts should be written in English, provided however when the Paper Committee approves, this will not be the case.

(2) Page Limitations (See Table 2)

(2.1) Paper and Technical Note

Paper and Technical Note should be 6 pages or less. However, Author may use up to the maximum of 14 pages, this is to say that the author is allowed to use 8 additional pages if necessary. When an author submit two articles that are deemed to be of single topic, but divided into two submission due to the page limitations, the author will be requested to rewrite and combine the two articles.

(2.2) Letter

Letter should not exceed 2 pages.

(2.3) Discussion

Discussion should not exceed 1 page.

4. Manuscript Format

4.1 Manuscript Format in Style File

LaTeX Style File is available for downloading from the IEEJ web-site at:

http://www.iee.or.jp

(1) When preparing the manuscript using LaTeX style file

(a) Use floppy disk or MO disk formatted as indicated below or use CR-R/RW. A floppy disk, MO disk or CD-R/RW is to be submitted after the article is accepted for publication.

- DOS/V formatted 3.5-inch floppy (1.44 MB. 720 KB)
- MO disk (DOS formatted or Mac formatted) 3.5-inch disk (230MB, 640 KB)
- CD-R/RW (230MB, 650 MB)

(b) Figures and photographs in EPS formats should be electronically included in the manuscript.

(c) Style file distributed should not be modified.

5. Guidelines for Manuscript Preparation (See Appendix 3)

5.1 Paper and Technical Note

(1) Style for First Page

(1.1) Prepare according to the steps (a) to (d) below, in reference to Appendix 3.

(a) Title, name of the author(s), membership category

(b) Summary (150 to 200 words.)

(c) Keywords

(d) Author affiliation and contact information are to be given in footnotes in the left column of page one. (See Appendix 3 for details.)

(1.2) Keywords

Select six or less keywords that represent the theme of paper and place them under the summary with a comma separating each keyword. Words should be selected following the criteria below.

(a) Select words or phrases with specific meanings.
(b) Use nouns.
(c) Abbreviations should be limited to those used and understood extensively in Japan and elsewhere. (New words coined by the author should not be used.)
(d) Compound words should be limited to commonly used terms.

(1.3) Writing the main text

Text should be organized by their importance in the following order. Double line space before the Capter heading.

Chapter: 1. Heading
Article: 1.1 Sub-heading

(1.4) Typeface and style

(a) Paper and Technical Note: Text must be in English.
(b) References

- References should include not only the author's own papers but the papers written by others, and ensure that appropriate and sufficient list of bibliography is provided. If necessary, the author may attach three copies of reference material that are most closely related to content of the paper submitted.
- All references should be numbered and listed at the end of the main text, and the numbers should be noted in the main text with a parenthesized number in superscript, where the reference is made in the main text.
- Committee reports and in-house reports not available to public should not be included in the references.
- Papers pending acceptance should not be quoted.
- Reference should be stated in the following manner.

  Name of the author(s): "Title", Name of Publication, Volume, Number, Page (Year and Month of Publication)

  Include all the author's names in full. Try to avoid abbreviating the title.

(1.5) Figures and Photographs

(a) Place captions for figures and photographs directly below the figure or photograph described.
(b) Figures and photographs should be serially numbered.
(c) The size and position of figures inserted should be clearly legible to the readers.
(d) When a figure does not fill the full column width, do not use the remaining space for text.

(1.6) Tables

(a) Table captions should be placed above the table.
(b) Tables should be serially numbered as for figures.

(2) Author Introduction

Use the last seven lines of the text for author introduction. Place a facial photo (28 mm (height) by 22 mm (width)) flush left under the name of the author. Following the membership category, write the date of birth and short introduction. (See page 2 of Appendix 3)

(3) Extended Summary

Extended Summary should be prepared according to Appendix 4. The Extended Summary submitted will be published on the IEEJ web site as it is.

(3.1) An Extended Summary on a single A4 page should be prepared for each Paper and Technical Note submitted. Outline of the paper should be understandable in the Extended Summary.
(3.2) Title, names, membership category and affiliation should be indicated at the top of page according to 5.1 (1) (a). When an E-mail address is provided, place the address with the affiliation in the parentheses as (Affiliation, E-mail address)

5.2 Letter

(1) Text

Follow (1) of 5.1 "Paper and Technical Note". Summary should be about 100 words.

(2) Author Introduction

Author may include author introduction, but if an author introduction is included, the instruction in 5.1 (2) must be followed and it should be included within the page and/or

word limitations. Author may omit facial photo.

5.3 Discussion

Inquire the IEEJ Editorial Department about the details.

6. Procedures Following Acceptance

(1) Submission of final manuscript

Author upon receiving the letter of acceptance, must submit the following items to the IEEJ Editorial Department (See Table 3). The final manuscript (including the floppy disk) submitted for printing in the IEEJ Transactions will not be returned.

(1.1) When LaTeX style file is used. (See 4.1)

(a) A floppy disk, MO disk or CD-R/RW containing the electronic data of the final manuscript and sample copy in A4 pages (one copy).
(b) On the floppy disk, MO disk or CD-R/RW containing the electronic data of the final manuscript, write the following information.

Paper Number
File Name
LaTeX System name and version
Disk format type

(c) Figures, photographs and tables in electronic format should be included in the final manuscript.

(d) Photograph for author introduction in electronic format should be included in the final manuscript.

- Refer to the 5.2 (2) for Author Introduction of a Letter.

(c) Extended Summary (Not applicable for submission of Letter)

Please submit the Extended Summary electronically as a PDF file, as much as possible. If it is not feasible, IEEJ accepts Extended Summary printed out on a piece of A4 paper.

(2) Proofreading by the author

(2.1) As a general rule, author will proof-read the final copy once.

[3] Publishing Fee

When the paper is accepted for publication, the author will be requested to purchase 50 or more copies of the reprint at a fee. The publishing fee are indicated in the Table 4 “Publishing Fee”.

[4] Support for Submission from Outside of Japan

Authors submitting from outside of Japan who may have difficulties in paying the Publishing Fee indicated above, may apply for partial waiver of payment by submitting a letter of request. There is no special format for this letter of request.

Table 1: IEEJ Transactions, Topical Categories and Scope

Society Transaction	Category	Scope	
Fundamentals and Materials	Category A	(Common Interests) a101 Education and Research a102 Applied Mathematics a103 Electrical Theory a104 Electromagnetic Compatibility a105 Instrument and Measurement a106 Light Applications and Visual Science a107 History of Electrical Engineering (Fundamentals) a201 Electrical Discharges a202 Plasma a203 Pulse Power	(Materials) a301 Insulation and Dielectric Materials a302 Semiconducting Materials a303 Conducting Materials a304 Functional Materials a305 Material Testing and Characterization (Magnetics) a401 Magnetic Materials a402 Applied Magnetics a403 Micromagnetics a404 Biomagnetics
Power and Energy	Category B	(Power System) b101 Power System Planning and Operation b102 Power System Control b103 System Analysis and Simulation b104 Power System Relaying b105 EMS/SCADA b106 Energy System	(Energy Conversion and Transmission) b201 Transmission and Distribution Line and Cables b202 Transmission and Distribution Apparatus, Insulators b203 Switchear and Protective Devices, Lightning Protection, Arc Phenomena b204 Substation Apparatus and Devices b205 Superconducting Devices b206 High Voltage, Lightning and Surge b207 Energy Conversion and Storage b208 Other Apower System Apparatus
Electronics, Information and Systems	Category C	(Electronics) c101 Electronic Materials c102 Electronic Devices c103 Integrated Electronic-Circuits c104 Optoelectronics & Quantum Electronics c105 Biomedical Engineering c106 Electronics Applications c107 Sensing Systems c108 Communication and Networks	(Information Engineering System) c201 Multimedia Technology c202 Sound and Image Processing and Recognition c203 Control and Measurement c204 Robotics c205 Neural Network, Fuzzy and Chaos Systems c206 System Engineering c207 Software and Information Processing c208 Electronic Commerce

Society Transaction	Category	Scope	
Industry Applications	Category D	(Power Electronics) d101 Power Semiconductor Devices and Application d102 Power Conversion and Control d103 Power Supplies d104 AC and DC Drive Control d105 Var & Harmonics Com-pensation (Industrial System) d201 Industrial System and Electric Power Application d202 Motion Control Mechatronics d203 Electric Vehicle d204 Industrial Control and instrumentation	D205 Information System for Industry d206 Metal and Industrial Application System d207 Manufacturing, Transportation and Public Utility Application System (Electric Devices) d301 Rotating Machines d302 Linear Drives d303 Magnetic Levitation and Magnetic Bearings d304 Static Power Apparatus d305 Applied Superconductivity d306 Transportation & Electric Railway
Sensors and Micromachines	Category E	(Sensor and Micromachine) e101 Mechanical Sensor e102 Optical and Radiation Sensors e103 Other Physical Sensors e104 Gas and Humidity Sensors e105 Ion and Bio Sensors e106 Other Chemical Sensors e107 Materials for Sensor and Actuator e108 Process and Micromachining Technologies	e109 Micromachine e110 Actuator e111 Sensor System e112 Sensor Application e113 Design and Modeling e114 Sensing Algorithm e115 Optical Sensing e116 Extreme Sensing e117 New Sensor Technology

Table 2:Types of Submission and Forms to be Submitted

		Paper	Technical Note	Letter	Discussion
Standard Number of Pages (Maximum Number of Pages)		6 pages or less (14 pages)	6 pages or less (14 pages)	2 pages or less (2 pages)	1 page or less (2 pages)
Number of Copies to be Submitted	Submission Form	1	1	1	1
	Copy of Manuscript	3	3	2	2
	Copy of Extended Summary	3	3	NA	NA
	Copyright Transfer Form	1	1	1	1

Table 3: Forms to be Submitted After Acceptance for Publication

Type of Manuscript	Style file
Final Manuscript	Printed sample copy and floppy disk.
Figures, Tables and Photographs	Electronic files to be included in the final manuscript.
Extended Summary*	Floppy disk or original.
Facial Photo for Author Introduction**	Electronic files to be included in the final manuscript.
Proof Reading by the Author	Once

* for Paper and Technical Note submission only

**See Section 5.2(2) for Letter

Note: Floppy disk in the table above refers to include MO disk and CD-R/RW

Table 4: Publishing Fee

(yen)

No. of Copies / Printed pages	50	100	200	300	400	500
1 page	25,300	27,300	32,600	38,700	45,000	51,600
2 pages	37,300	39,300	44,600	50,700	57,000	63,600
3 pages	49,300	51,300	56,600	62,700	69,000	75,600
4 pages	61,300	63,300	68,600	74,700	81,000	87,600
5 pages	79,400	81,400	86,700	92,800	99,100	105,700
6 pages	91,400	93,400	98,700	104,800	111,100	117,700
7 pages	124,400	126,400	131,700	137,800	144,100	150,700
8 pages	154,400	156,400	161,700	167,800	174,100	180,700
9 pages	189,500	191,500	196,800	202,900	209,200	215,800
10 pages	219,500	221,500	226,800	232,900	239,200	245,800
11 pages	264,500	266,500	271,800	277,900	284,200	290,800
12 pages	304,500	306,500	311,800	317,900	324,200	330,800
13 pages	349,500	351,500	356,800	362,900	369,200	375,800
14 pages	389,500	391,500	396,800	402,900	409,200	415,800

* not include the consumption tax

Appendix 1

THE INSTITUTE OF ELECTRICAL ENGINEERS OF JAPAN
COPYRIGHT TRANSFER FORM

This completed and signed form must be included with papers, technical notes, letter or discussions when they are submitted to the Institute for the first time.

PROPOSED TITLE : _____

AUTHOR(S) : _____

ORGANIZATION(S) : _____

PLANNED PUBLICATION JOURNAL(S) : _____

All the author(s) have read and understand the Copyright and Publishing rights as described in the Publication Guide for the Technical Journal of the IEEJ, and agree to the following items.

(1)Copyright rights to this work are hereby transferred to IEEJ. The transferred rights include transformation rights to electronic media, translation rights adaptation rights, and utilization rights of secondary works.

(2)This work or a substantially similar work has not been published elsewhere and is not currently being considered for another publication in any language.

Note: Such materials as published in the IEEJ Conference Paper, IEEJ Technical Meeting Paper and other IEEJ sponsored meeting papers are not the subject of this item.

(3)This work shall not infringe upon the rights of any third party. In the case of author(s) using copyrighted material in his/her work, written permission from the copyright holders shall be obtained for such use free of charge to IEEJ by the author(s) prior to the submission.

(4)All the persons who have made substantial contributions to the work shall appear as authors.

(5)An agreement for publication shall be obtained in cases where it is necessary from a person having appropriate authority in any organization to which author(s) belongs.

The author(s) reserves the following rights :

*All proprietary rights other than copyright, such as patent rights
*Re-use of all or part of the paper for their curriculum vitae
*To make copies for his/her own purposes other than for commercial purposes
*To use without violating the Japanese Copyright Law

Name of author : _____ Signature : _____

Date : _____

For jointly authored papers, one author representing all the authors should sign the above signature line. In the case where an authorized representative signature is necessary for the copyright transfer from the author's organization, the following shall be completed.

Name : _____ Signature : _____

(Authorized representative of the organization)

Title : _____ Date : _____

Appendix 2

Paper No.

SUBMISSION FORM

Fill in this form (mark where appropriate) and submit with the manuscript.
(Please check with list in Table 2 for Forms to be Submitted with Manuscript)

1. Title of the Manuscript Submitted

2. Shortened title (in eight words or less) to be used as the paper heading printed outside the margin

3. Name of the Main Author, Affiliation and Contacts

Name		Membership Category		Member ID No.	
Affiliation				Phone	
Office Address					
Email					

4. Co-authors
If there are any co-author, write all of their names below. The main author will be held responsible for all liabilities pertaining to the submission of a paper.

Membership Category	Member ID No.	Name

5. Type of Manuscript Submitted

( ) 1. Paper ( ) 2. Technical Note
( ) 3. Letter ( ) 4 Discussion

6. Category of Submitted Paper

( ) A. Fundamentals and Materials (Transaction A)
( ) B. Power and Energy (Transaction B)
( ) C. Electronics, Information and Systems (Transaction C)
( ) D. Industry Applications (Transaction D)
( ) E. Sensors and Micromachines (Transaction E)

Topic	, Others ( )

Select from the Table 1 the topical area in the order of relevancy (eg. a305, a303 etc.)
If the topic cannot be found in the Table, write the topic in the parentheses for Others.

25 mm
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248 mm
16 mm
16 mm
24 mm

Paper

Triple Space

16 pt fonts
Use doubleline

Analysis of SO_2 measurement accuracy by multiwavelength DIAL

Center the title

12 pt
Double Space

Taro Denshi* Member
9 pt
Hanako Denki** Non-member

Double Space

This paper presents two multiwavelength methods to improve the accuracy of a DIAL system for measuring SO_2 in the lower atmosphere: a dual-DIAL method using three or four wavelengths, and a curvefitting method using five wavelengths. By the selection of appropriate wavelengths, these methods can eliminate the effects of ozone and aerosols. Since there is no significant difference in accuracy between the four wavelength dual-DIAL and curvefit methods, the former is advantageous for SO_2 detection in view of the measurement and data processing speeds.

Indent two strokes each on both margins

Double Space

8 pt
Key words: laser radar, SO_2, DIAL, multiwavelength differential absorption

Double Space

Use 2 lines for the heabing
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10 pt

□1. Introduction

Indent a stroke

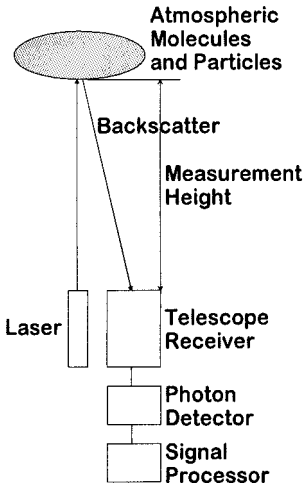
□LIDAR (LIght Detection And Ranging) has been used for measurement of atmospheric pollutants by Raman scattering, resonant fluorescence, and differential absorption[1]. Fig. 1 is a schematic diagram of a LIDAR system. This apparatus transmits laser radiation into the atmosphere, collects light backscattered by atmospheric molecules and particulates using a receiving telescope, and converts it to an electric signal using a photodetector such as a photomultiplier tube. The measurement height is obtained from the time delay between illumination and detection. Therefore, to measure the height profile one measures the received photon counts as a function of time delay relative to illumination using a multichannel scaler. The measurement range resolution ΔR is determined by the time width of the channel $\Delta t = 2\Delta R/c$, where c is the speed of light. The smaller the time Δt, the better the range resolution, but the photon count per channel becomes less and the relative error larger.

Use 9 pt font

This paper examines DIAL (DIfferential Absorption Lidar), a method to obtain the concentration profile of the measurement target molecule from the backscatter intensity at two or more illumination wavelengths. The measurement target is atmospheric SO_2, which is a substance causing acid rain. Until now, measurements of atmospheric SO_2 have been limited mainly to cases of localized SO_2 concentrations, e. g. smokestack exhaust and volcanic eruptions[2]~[4]. In these cases, the SO_2 concentration is over 100 ppb, therefore the measurement was relatively easy and the measurement accuracy was not a problem. However, when measuring SO_2 in the ambient atmosphere, its concentration is of ppb order, and the measurement accuracy becomes an issue.

*Technical Research Labs., Shin-nichi Electric Co., Ltd.
7-2, Gobancho, Chiyoda-ku, Tokyo 102-0076
**Technical Labs., Kagoshima Electron Corp.
2-100, Daikan-cho, Kagoshima 890-0099

8 pt



Do not fill the blank space around the figures with text

8 mm between the columns

Center the caption

□□ Fig. 1. Schematic diagram of a LIDAR system □□

Double Space

We performed a theoretical analysis of the measurement accuracy of conventional two-wavelength DIAL, and indicated the necessity of elimminating effects due to ozone and other substances which cause measurement error[5]. In this paper, we examined the measurement accuracy of dual-DIAL methods using three or four wavelengths (consisting of a combination of two two-wavelength DIAL pairs) and a curvefit method using five wavelengths.

□2. Multiwavelength Differential Absorption

Two strokes space after the heading

□2.1 Fundamentals of DIAL

□□The received energy for a LIDAR is given by the following LIDAR equation:

〔Anequation startsat two-stroke indent〕

$$\square\square E_r(R,\lambda_i)=[E_0\eta A]\frac{\Delta R}{R^2}\beta_\pi(R)\times \exp\left[-2\int_0^R(\alpha_0+\alpha_x)dR'\right] \quad \cdots\cdots(1)$$

Here $E_r(R, \lambda_i)$ is the backscattered photon energy received from range between R and $R+\Delta R$ from the illumination laser, λ_i the illumination wavelength, E_0 the illumination energy, η the optical efficiency of the

4. Conclusion

In this paper, we calculated the error due to ozone and aerosols in measurement of SO_2 concentrations of ppb order using DIAL. The statistical error of the return signal and background noise can be overcome by improving the system constant (laser output, receiver area, optical efficiency of the receiver). On the other hand, systematic errors due to ozone and erosols are inherent in the measurement method, and cannot be eliminated solely by improving the system constant. In conentional two-wavelength DIAL, the systematic error is over 1.5 ppb and the measurement accuracy is insufficient. In order to improve the measurement accuracy, a multiwavelength differential absorption method using three or more wavelengths is effective. In this paper we have considered dual-DIAL methods using three or four wavelengths and a curvefit method using five wavelengths, and indicated that the measurement errors due to ozone and aerosols can be reduced relative to conventional DIAL or eliminated. When these methods are compared, four-wavelength dual-DIAL is superior in view of measurement accuracy and measurement/processing speeds.

(Manuscript received September 25, 1997)

↕ Double Space

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Use boldface ↕ Double Space

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28 mm

22 mm

Hanako Denki (Member) was born in Okayama, Japan, on February 25, 1960. She received a Ph. D. degree in electrical engineering from Electric University in 1984, and is presently a Chief engineer at Kagoshima Electron Corp. She has worked on analysis of electromagnetic flow coupler pumps, development of Cherenkhov radiation monitors for nuclear inspection, and development of laser beam intensity transformation techniques. Japan Applied Physics Society, Laser Society of Japan, Optical Society of America member.

Appendix 4

Sample of Extended Summary

Analysis of SO_2 measurement accuracy by multiwavelength DIAL

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Keywords: laser radar, SO_2, DIAL, multiwavelength differential absorption

The measurement accuracy of SO_2 in the ambient atmosphere by DIAL (DIfferential Absorption Lidar) is examined. Localized, relatively high (~100 ppb) SO_2 concentrations, such as smokestack exhaust, have been successfully measured by DIAL in the past. However, measurement of SO_2 in the ambient atmosphere (few ppb) is difficult because of effects due to ozone and other substances which cause measurement error. In this paper, we examine multiwavelength DIAL methods to improve the resolution of SO_2 measurement.

The absorption cross section of SO_2 near 300 nm is shown on Fig.1. Conventional DIAL uses the wavelength pair (λ_{on}=300.0 nm, λ_{off}=299.3 nm) for which the differential absorption cross section is $\Delta\sigma \simeq 10^{-22}$ m^2. This is about 30 times the value for ozone.

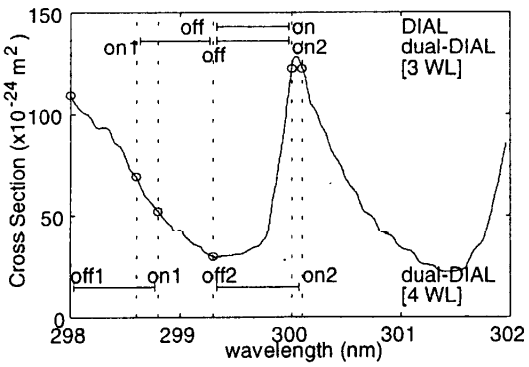

Fig. 1. Absorption cross section of SO_2 indicating wavelengths used in DIAL and dual-DIAL

The SO_2 measurement error due to aerosols and ozone for conventional two wavelength DIAL is about 1.5 ppb and the accuracy may be insufficient for measurement of SO_2 in the ambient atmosphere.

In order to remove these effects, we consider dual-DIAL methods using three or four wavelengths and a curvefit method using five wavelengths. The dual-DIAL methods consist of a combination of two DIAL wavelength pairs, (λ_{on}= 300.0 nm, λ_{off}= 299.3 nm) and (λ_{on}= 298.6, λ_{off}= 299.3 nm) for three wavelengths and (λ_{on}= 300.1, λ_{off}= 299.3 nm) and (λ_{on}= 298.0, λ_{off}= 298.8 nm) for four wavelengths. The curvefit method uses the wavelengths (299.70 nm, 299.90 nm, 300.10 nm, 300.55 nm, and 301.10 nm), which corresponds to a wavelength interval containing one absorption peak.

We calculated the SO_2 measurement error due to ozone and aerosols for the multiwavelength DIAL methods. A certain SO_2 concentration was assumed, and the backscatter signal (photon counts) was calculated using the lidar equation. The calculated SO_2 concentration was deduced from the signal, and its deviation from the initially assumed value was taken as the measurement error. The calculations were performed for vertical range upto 3 km, vertical range resolution 100 m, and the atmospheric visibility and ozone concentration as variable parameters. A background radiation of $S_\lambda = 10^{-6}$ W/cm^2-sr-μm at λ = 300 nm was included. The ozone concentration was taken to be uniform with respect to height and invariant within the measurement time. The atmospheric visibility and background radiation level were taken to be invariant within the measurement time. Fig.2 shows the SO_2 measurement error due to ozone for a typical atmospheric visibility of 10 km, and shows that the multiwavelength methods are effective in suppressing the effects due to ozone.

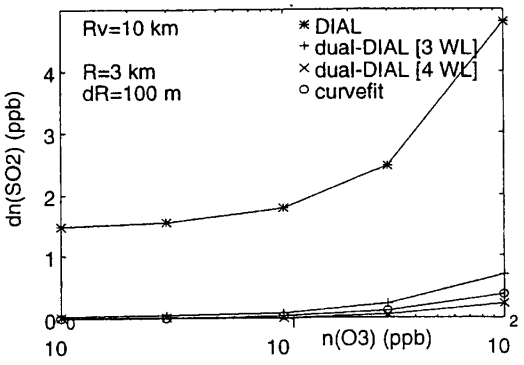

Fig. 2. SO_2 measurement error due to ozone

The effects due to aerosols can be similarly suppresed by the use of multiwavelength methods.

When the multiwavelength methods are compared, dual-DIAL using four wavelengths is best in view of measurement accuracy and speed.