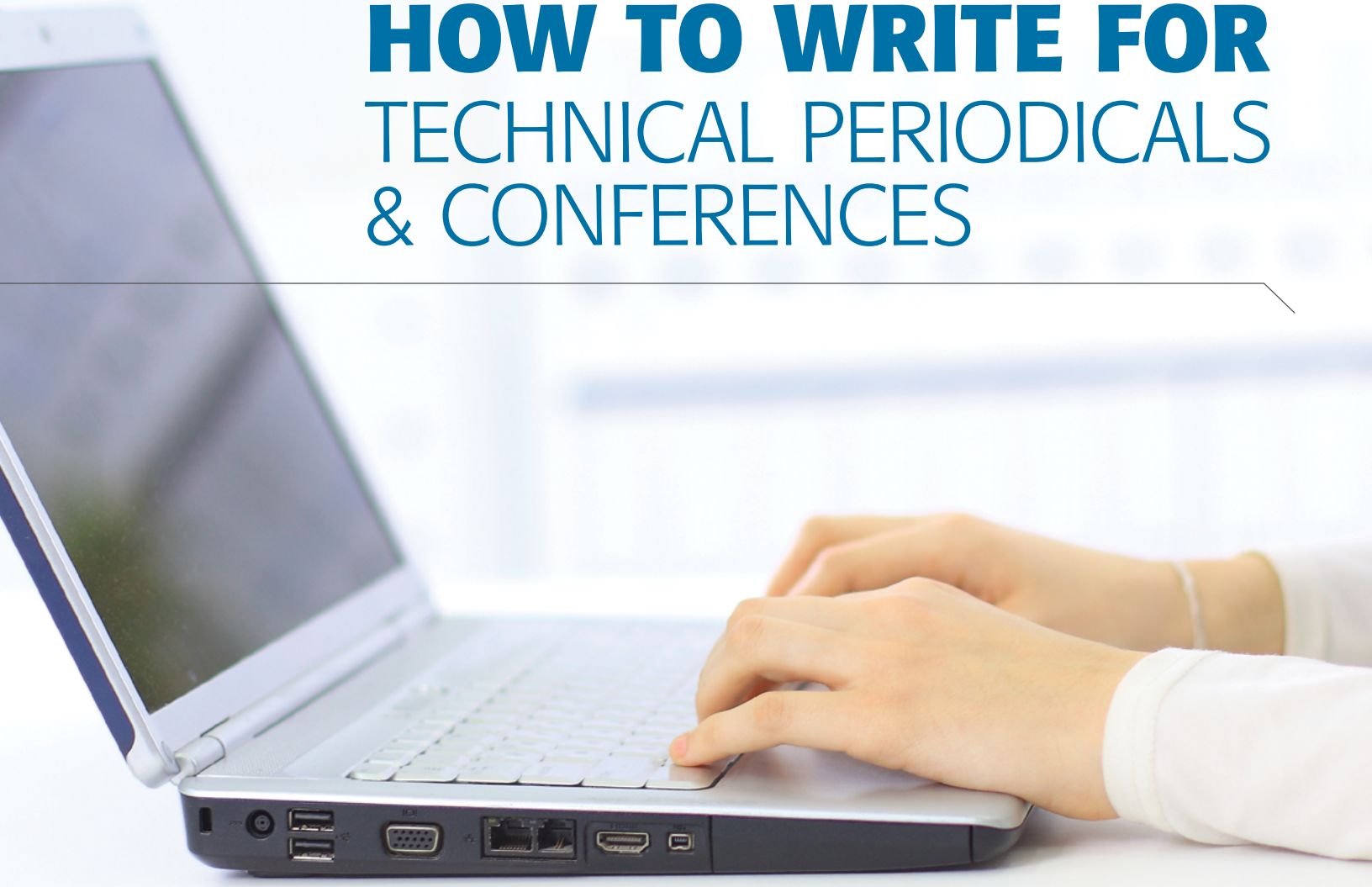
IEEE AUTHORSHIP SERIES

HOW TO WRITE FOR TECHNICAL PERIODICALS & CONFERENCES

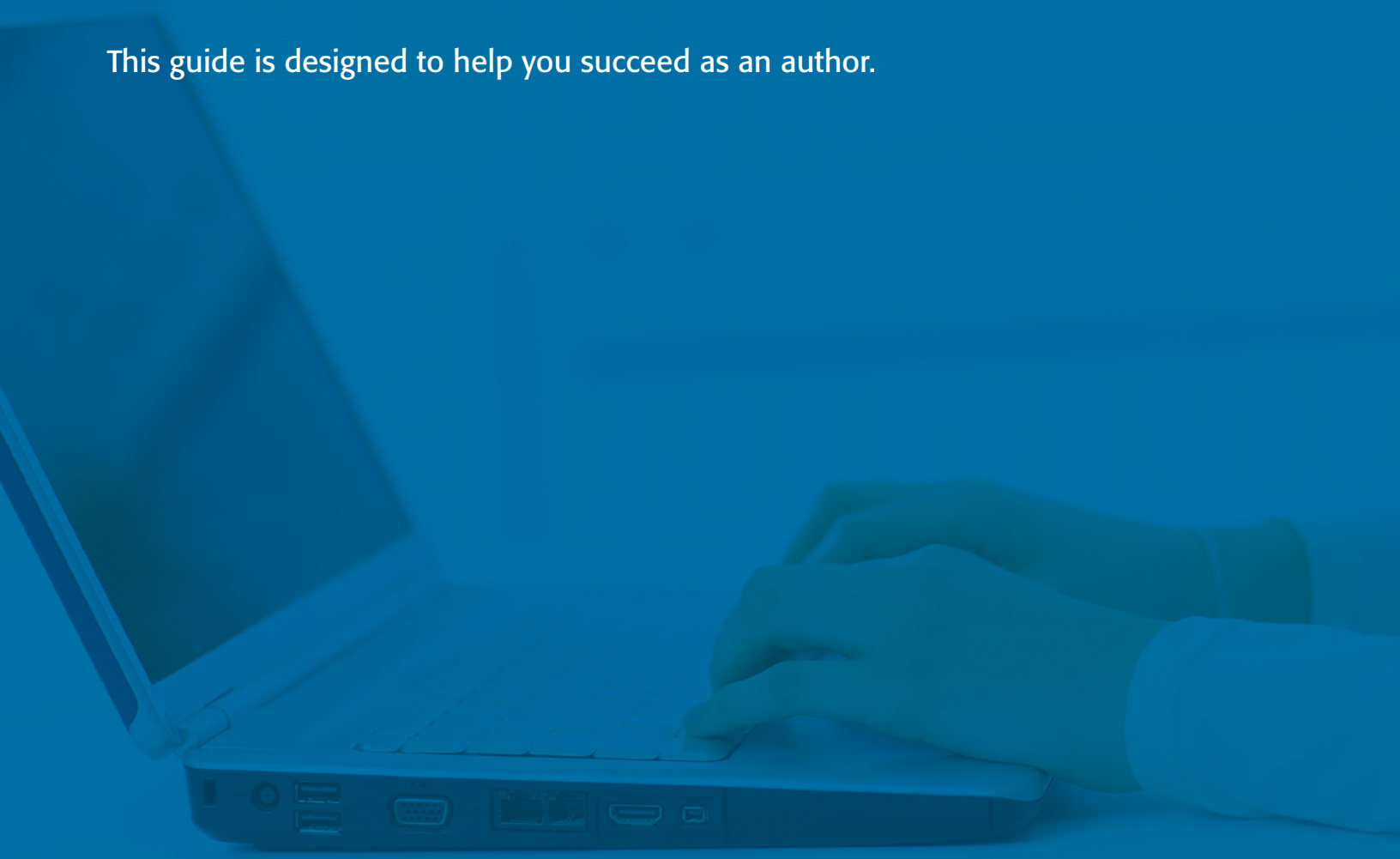


IEEE
Advancing Technology for Humanity

As a researcher or practicing engineer, you know how important it is to publish the results of your work. It is not just about career advancement or getting recognition. Publication is a critical step in the scientific process. Your discoveries will foster innovation and help advance technology for public good.

But that can only happen if your research can be read, understood, and built upon by your fellow researchers and engineers.

This guide is designed to help you succeed as an author.



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SECTION 1
INTRODUCTION

You will learn how to prepare, write, and submit your manuscript for peer review by an IEEE conference, journal, or magazine. We will show you how successful authors structure quality work to improve their chances of being accepted. You will find practical tips on how to select an appropriate periodical or conference, organize your manuscript, write in a clear and grammatically correct style, and work through peer review. You will also learn how to avoid common mistakes and ethical lapses that will prevent your manuscript from being accepted and may damage your reputation.

Publishing is central to the mission of IEEE: to foster technological innovation and excellence for the benefit of humanity. IEEE provides high quality, innovative information by attracting the best authors and supporting them through the publishing process. A Web-based workflow and tools such as reference validation, graphics checking, and templates streamline the submission process.

Where you publish matters. Your technology colleagues want to know that the information they cite comes from a credible publication. For over 125 years, IEEE has been a trusted source for researchers in academia, corporations, and government. IEEE conference proceedings are recognized worldwide as the most vital collection of consolidated published articles in electrical engineering, computer science, and related fields. IEEE journals are cited over three times more often in patent applications than other leading publishers' journals [1]. As an IEEE author, you will both contribute to and benefit from that impact and reputation.

Authors need to find your research in order to cite it. The IEEE *Xplore*® digital library is an advanced online platform containing most of the published material from IEEE Publications and its predecessors. It is designed so that your published work will appear in search results quickly and in the right context. Depending upon the periodical in which you publish, your work will be indexed by organizations that facilitate discovery and connections among scholarly publishers, such as Google, CrossRef, Elsevier, Thomson Reuters, ProQuest, IET, and NLM.

If you have solved a new and important problem in your field or you have gathered and analyzed data about an important engineering process, it is time to share your results with your colleagues. You want to publish your best work in the right periodical to advance progress in your field. This guide will help you get there.

Good luck.

SECTION 2
BEFORE YOU BEGIN

The development of your manuscript will begin long before you begin to actually write your first draft. You should not write just for the sake of publishing or to accumulate citations for your curriculum vitae. If you do, surviving peer review will be a challenge. As you plan your research project, think about how your work will be received and evaluated by your peers.

Ask yourself these questions:

- Is this an important problem, or, is the data collected and analyzed of interest to the wider community?
- What has been done in the past?
- Does this research significantly advance the state of the field?

To answer these questions, you need a solid understanding of the relevant literature.

Conducting Your Literature Search

Your research problem must contribute new and important knowledge to your field. A thorough review of the published literature will help you determine if this is the case. You must be able to show reviewers and readers that you understand what work has been done before, and that your research adds some new understanding to the field.

Some, although not all, of the resources you identify in the literature review will become references in your work. They will be used in the introduction and the discussion sections to show how you are making an important contribution to your field. Finally, a thorough review of the literature will help you select the publication or conference to which you will submit your work, a task you will read more about in Section 5.

The Internet has made it easy—perhaps too easy—to find information. You need a solid search strategy to find the literature that is most relevant to your work. Your first instinct may be to start your search in Google or one of the other general search engines. This approach is likely to generate tens of thousands of results. Some results will be from reliable, citable resources, but many will not. Resist the temptation to "Google it" until after you have used databases of peer-reviewed literature that are more trustworthy and targeted to scientific investigation.

IEEE *Xplore*® Digital Library

IEEE *Xplore* offers a robust interface to help you discover and access scientific content from IEEE and its publishing partners. It provides online access to more than three million full-text documents published in some of the world's most highly cited publications in electrical engineering, computer science, and electronics.

Bibliographic Databases

There are a number of databases experienced engineering writers use to conduct literature searches, including Compendex® and Inspec®. These databases will help you identify references from a broad selection of literature.

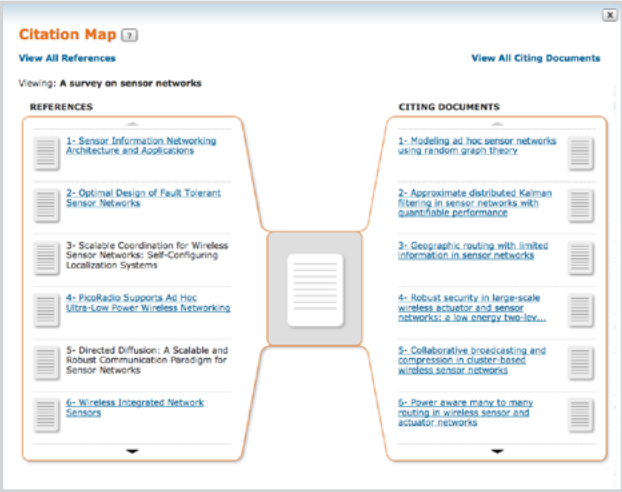
Your Institution's Library

If you are affiliated with an academic or government institution, you are in luck. Your library has invested heavily in resources specifically to help you conduct your research and publish your results. Librarians at your institution are trained to conduct precise searches to answer your questions. They can help you access resources that are available in your library and they will find external documents for you as well. Corporate libraries can also provide excellent resources.

References and Citations

Once you identify a major document that is relevant to your research, check the references. They will lead you to the research that laid the basis for your area of study. Use tools available in platforms such as IEEE *Xplore* to find works that cite the documents you have identified. These will highlight more recent research results.

Citation Map from IEEE Xplore



Taking Notes and Keeping Track

As you search, scan the abstracts and key words. There is no need to read through every document. For each reference you want to include in your bibliography, make note of the original publication source and, if appropriate, the URL location. As you scan the article, take notes in your own words. Keep track of where you got ideas [2]. Even if you do not directly quote a source in your article, you will need to give attribution to the original source material. Making detailed notes now will help you avoid the danger of accidentally plagiarizing someone else's work. See Section 3 for a complete discussion of plagiarism.

Next Steps

Once you are confident that you have solved an important problem or completed a set of experiments and analyzed the results, and done a thorough literature search, it is time to decide what to include in your manuscript and how to present it. Spend some time brainstorming about your research. What are the three or four fundamental points you want readers to understand and remember once they have finished reading your work [3, 4]? Decide which methods and what data support each of those messages. Which references help you make the case that your work is new and significant? What conclusions can you draw from your research? This exercise will help you decide what information to include.

Draft an Outline

An outline will organize your writing and keep you from going off on tangents. It will help you develop a logical, structured manuscript that will be easily understood by reviewers and readers. It will show the order of topics you will discuss, the relative importance of each, and how they relate to each other.

Most word processing programs have a tool that makes it easy to create and edit an outline. Your outline may use phrases, complete sentences, or a combination of both. Scientific articles follow a standard structure: Introduction, Problem Formulation, Previous Research Relevant to the Problem, Methods or Model and Results, Conclusion (see Section 6). This can provide a useful structure for organizing your outline. Start by brainstorming about all of the ideas and data you want to include. Then group related ideas together. Arrange your information into subsections. Begin with general information and then move to more specific ideas. Then create headings and subheadings for each section.

If you are working with coauthors, the outline can be a useful tool to get agreement on the content and organization of the article [3].

SECTION 3
ETHICS IN SCIENTIFIC PUBLISHING

Of the many steps you will take to successfully publish your work, none is more important than following the highest ethical standards while you conduct and write about your research. You must understand what is and is not acceptable in writing your article. Cutting corners could negatively impact your reputation.

IEEE, and other reputable publishers with whom you will work, do not tolerate fraudulent research and publication. Your submission will be screened, and if you have violated any standards of publication, the consequences can be severe. Depending on the nature of the violation, corrective actions at IEEE can range from a three-year to lifetime suspension of publication privileges, public notice of the violation in the publishing journal and in IEEE *Xplore*, and referral to IEEE Ethics and Membership Committees.

Follow the guidelines below to ensure that your work is beyond reproach. If you have any questions or doubt about whether information you are including in your article is acceptable, speak with an advisor or an experienced colleague.

Who is an Author?

Authors have very clear roles and responsibilities. IEEE guidelines state that authorship and coauthorship should be based on a substantial intellectual contribution. The list of authors on a work indicates who is responsible. When you and your colleagues are evaluated for employment, promotions, or grants, the quality and quantity of your publications will be a consideration. Therefore, it is critical that the list of authors on your work includes all of those—and only those—who had a significant role in its development.

It can be considered an ethical breach if you omit an author who contributed to your work, or if you include a person who did not have much to do with it. It may be tempting to remove a colleague who is not cooperative, or who has not contributed much. But the colleague could very well file an authorship dispute with the journal. IEEE guidelines require a coauthor's permission to withdraw their name.

Adding an author who did not contribute significantly to an article is also a violation of ethics. Do not add authors simply to build up credibility. A person who made minor contributions, such as reading and giving feedback, or conducting statistical analysis, should not be on the list of authors. It may be appropriate to include this person in the acknowledgements section of your work (refer to Section 6).

Develop a list of authors that includes a description of each person's contribution to the project and the writing of the manuscript, then document the reasons for any additions or deletions of authors along the way [5].

Proper Citation of Original Work

Plagiarism

Here is an example: As you are reviewing the literature, you come across a passage that makes a point far better than you have done. You copy it and paste it into your notes. Later, when you are writing your article, you include it verbatim in your text.

Do not do it!

Copying word-for-word what another author has written, or even paraphrasing someone's original text without proper attribution is plagiarism, and plagiarism can quickly derail your career.

IEEE defines plagiarism as the reuse of someone else's prior ideas, processes, results, or words without explicitly acknowledging the original author or source. Plagiarism in any form, at any level, is unacceptable and is considered a serious breach of professional conduct, with potentially severe legal and ethical consequences. IEEE guidelines against plagiarism apply equally to periodical articles and conference proceedings.

IEEE Recognizes Five Degrees of Plagiarism:
1. Copying someone else's entire article, or a major portion of the article (more than 50%) verbatim, without credit to the original author(s) or copying your own previously published work (see Redundant Publication, below).
2. Copying a large proportion (20-50%) of someone else's work, or your own previous work, without credit.
3. Copying without credit individual elements such as paragraphs, sentences, or illustrations, resulting in a significant portion (up to 20%) of an article.
4. Uncredited paraphrasing of pages or paragraphs from another source.
5. Credited verbatim copying of a major portion of an article without clear delineation, such as quotes or indents.

All sources of information, even those in the public domain, need to be properly cited.

Any ideas you have discovered elsewhere should be cited. It is rare to quote verbatim in scientific literature, but if you must, use quotation marks [3]. Experts recommend that you annotate and paraphrase to avoid plagiarism. Put what you have read into your own words, but even then you must include a citation.

Redundant Publication

Never submit work for review to more than one publication at the same time. Doing so risks being accepted by both publications and, consequently, multiple publications. Multiple publication wastes funds and space, reduces the value of periodicals to readers and libraries, and creates problems with indexing and citation. Submit to your first choice. If the article is rejected, then submit it to your second choice.

IEEE uses plagiarism detection software to screen every submitted article.

It is common in technical publishing for material to be presented at various stages of evolution. For example, early ideas may be published in a workshop; more developed work in conference proceedings; and the fully developed study may be published in a journal. However, IEEE guidelines require that authors fully cite their prior work. Authors must be able to demonstrate significant advances from prior publications. Penalties can include suspension of publication privileges in the journal or the next volume of the conference proceedings.

Copyright

When you publish a regular article with IEEE or most other organizations and professional societies, you will be required to transfer your copyright (ownership of a written work) by way of a copyright transfer form. By owning and maintaining copyright, IEEE is able to (a) protect the intellectual property and (b) make the content more widely available.

Following the transfer of copyright to IEEE, you will continue to have the right to reuse your article as follows:

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- You have the right to post the **ACCEPTED** version of your article on your personal Web site, or on your employer's Web site, with a copyright notice (e.g., © 2012 IEEE) displayed on the initial screen.
- You may use the **ACCEPTED** version of your article in your teaching, training, or work. You must acknowledge IEEE as the copyright holder, and include either a link to the original article on IEEE *Xplore* or the Digital Object Identifier (DOI), which can be found at the bottom of the first page of the final version of your article.
- You may follow the mandates of agencies that funded your research by posting the **ACCEPTED** version of your article in the agencies' publicly accessible repositories. You should credit IEEE as the copyright holder and include a link to the original article on IEEE *Xplore* or the DOI after the article is published.
- If you have posted a copy of your article on a preprint server, once you submit the final version to an IEEE publication, you should update it with a prominently displayed IEEE copyright notice. Upon publication of the article by IEEE, replace any previously posted electronic version with either the full citation to the IEEE work with a DOI, a link to the article abstract in IEEE *Xplore*, or the accepted version only (not the IEEE-published version), including the IEEE copyright notice and full citation, with a link to the final, published article in IEEE *Xplore*.
- Authors of open access articles are permitted to post the final, published version on their personal Web sites, their employers' sites, or those of their funding agencies.
- Authors are encouraged to check IEEE Copyright Policies for updates.

Fabrication of Data

Research misconduct undermines the scientific record, destroys the trust that scientists need to verify and build on each other's results, and may even lead to serious public harm [6].

Of course, honest errors can occur and there can be legitimate differences of opinion about findings. But if you are discovered falsifying results, fabricating data, manipulating images, or engaging in other activity that misrepresents your work, you can expect serious consequences. Your job and your professional standing will be at risk.

Take these steps to protect yourself:

- Keep meticulous records of your experiments.
- Retain data records after your work is published.
- Read the Instructions for Authors for your publication or conference to understand how images should be handled. While it is usually acceptable to resize an image, enhancing an image or altering it digitally rarely is [3].

SECTION 4
SELECT AN APPROPRIATE FORMAT

There are several different categories of publications. Depending on the stage of your research or the level of information you are presenting, one may be more appropriate than another for your work. Evaluate the message you want to communicate, and then select your format.

Conference or Periodical?

Your first decision will be whether to submit your article to a journal, magazine, or other periodical, or if you should present it at a conference instead. A journal article will be a fully developed presentation of your work and its final findings. In a journal article clear conclusions can be made, firmly supported by the data available. A conference article may be written while you are still in the process of conducting your research. This may be a practical route for disseminating information about your research. Or you may want to obtain informal feedback on your ideas from your peers that you will use to inform your research project. The structure of your article will be similar whether it is a conference or journal article, however, a conference article will be shorter, it may include fewer references, and it is written in less detail.

Full Length, Original Research

Original research results are most commonly reported in a full-length journal article. A journal article will be a fully developed presentation of your work and its final findings. It presents a hypothesis, and then presents evidence to support it. Clear conclusions are made. It tries to persuade the reader of the validity of its arguments [2].

Conference Articles

A conference article may present preliminary results, or highlight recent work. The article is presented at a scientific conference and then published in the conference proceedings. The purpose of a conference article is to obtain feedback on a particular idea, and the writer uses that feedback to inform further research. IEEE guidelines require presentation at the conference.

Typically a student will write and present several conference articles before attempting an original research article.

Reviews

Review articles provide a broad analysis of the research that has been published in a particular area. Although the research is not new per se, the authors will provide new insights or introduce new theories based on their interpretations of a wide body of work.

Letters

IEEE Letters journals provide rapid turnaround for short reports on high impact new results. They provide full experimental detail and references, but are generally four or five typeset pages long.

SECTION 5
SELECTING WHERE TO SUBMIT

Selecting a Periodical

Do not wait until your article is finished to select your target journals. Make your decision early, while you are still conducting your research or during the early stages of writing. If you know what the journal is looking for, what types of articles it publishes, and who reads it, you will be more likely to develop an article that is appropriate for publication in that journal [7].

It can be overwhelming to select a journal for article submission. You are looking for a journal that will give your article the attention it deserves, by attracting readers who are likely to refer to it in their own work [4]. You want a journal that has a good reputation, so your work will have credibility. And you want a journal that supports you as an author, with an expedient process and tools to help you through the steps of publication. If you do not match your article with an appropriate journal, months may be wasted on a review that does not lead to publication [3].

There are hundreds of engineering periodicals, and probably a dozen or more with some relevance to your research. There are a number of ways to narrow your selection and find the publication most likely to be a good fit for your work. Begin by reviewing the results of your literature search. Which journals publish articles most like yours? Are there journals that came up frequently? These will likely be most closely related to your research topic.

Once you have identified four or five solid target journals, go to their Web sites. The Aims and Scope will provide a description of the types of articles the journal is looking for. Who is the editor, and who serves on the editorial board? Are these people you recognize as leaders in your field? Scan a few articles from each journal. What audience do they seem to be speaking to?

A number of metrics evaluate the influence of a journal. The Thomson Reuters Journal Citation Reports® (JCR) measure various citation factors of journals, including the important Impact Factor. Impact Factor is the average number of times articles from a journal published in the past two years have been cited in the JCR year. Another measure is Source-Normalized Impact per Paper (SNIP), which uses data from the SCOPUS database to measure contextual citation impact based on total citations in a scientific discipline. It accounts for the fact that fields such as mathematics and engineering tend to have lower impact values than the life sciences. SCImago Journal Rank (SJR) also uses the SCOPUS data and accounts for both the number of citations an article receives and the prestige of the journals that cite it. While all these metrics are valuable, remember that journals with higher metrics may not necessarily have the right audience for your article.

Determine the length of time it takes for a journal to publish articles. On IEEE *Xplore*, most journals show the date an article was received, revised, accepted, and published. Consider whether the journal has page charges, or charges for certain types of illustrations. If your targeted journal has these charges, you should have a plan to pay for them, either through your grant, your institution, or with personal funds.

Your goal is to find the journal with the broadest readership, highest impact, and greatest likelihood of publishing your work [7]. The journal with the highest impact factor or the most noteworthy editor may not deliver the best readership for your article. The truth is that high profile journals reject as many as 90% of the manuscripts submitted [2]. Making an inappropriate choice will only mean a substantial delay in getting your research to the audience that needs to hear about it.

Selecting a Conference

There are thousands of conferences held around the world every year. You can search a database of Calls for Articles for IEEE-affiliated conferences. Be sure that your research is a good match for a conference before you submit your article. Pay careful attention to the dates. You must be available to present your findings in person at the conference. According to IEEE Guidelines, articles that are not presented at conferences may be suppressed in IEEE *Xplore* and therefore are not indexed by or included in Thomson Reuters or Elsevier databases.

Open Access Journals

Another relatively recent option for authors is to choose open access publication for their articles. Open access provides free access to your article online to anyone who may be interested.

Open Access Models

There are several different models:

- **Green open access**
  Authors publish in a journal and then self-archive a copy of their publication on their own Web site, their institutional repository, or some other central repository. Depending upon the journal publisher's policies, the version of the article that is archived is either the final manuscript as submitted to the publisher after revisions, or the final published article. IEEE is considered a "green" publisher by SHERPA-RoMEO (www.sherpa.ac.uk/romeo/), a not-for-profit group that tracks publisher policies.
- **Gold open access**
  The final published article is made immediately available online by the publisher to anyone who is interested in reading it. The costs of publication are usually supported by fees paid by the author. The author's funders or institution may support the fee. Some journals waive fees for authors from developing countries.
- **Hybrid open access**
  In a hybrid open access journal, an author can choose to make an article freely available online by paying the article processing fee. If an article processing fee is not paid, the article is available to subscribers only.

Open Access Publishing at IEEE

IEEE open access policy supports the principle of providing open access as one way to enhance the dissemination of publicly funded research to strengthen science and engineering, encourage innovation, and serve the greater interests of society. To help researchers gain maximum exposure for their ground-breaking research, IEEE offers a number of options to authors.

IEEE Hybrid Journals: Most IEEE transactions, journals, and letters offer a hybrid open access option, with traditional subscription-based content as well as open access, author-supported content. Most of these journals have an established impact factor and are well-respected. The quality of the review process is the same for open access and traditional articles. Open access articles are published in any format offered by the journal, including print and online.

Fully Open Access Journals: IEEE publishes several fully open access journals. They are dedicated to specific subject areas, publish author-pays articles, and are delivered online only.

IEEE Photonics Journal, The IEEE Photonics Society Publication, launched in 2009, became first fully open access IEEE journal in 2012. The second, launched in 2012, is *IEEE Journal on Translational Engineering in Health and Medicine*, by the IEEE Engineering in Medicine and Biology Society. Other fully open access journals in development include *IEEE Journal of the Electron Devices Society*, produced by the IEEE Electron Devices Society, and *IEEE Transactions on Emerging Topics in Computing*, produced by the IEEE Computer Society.

IEEE Access™: In 2013, IEEE will launch a rapid publication, open access megajournal. This journal is aimed at a broad audience across all IEEE fields of interest, including general readers, specialists, and practitioners. There will be practical articles, as well as research articles. By adopting acceptance criteria of technical relevance and accuracy, rather than scientific importance, *IEEE Access* will create a publishing home for new authors and will engage readers among the vast number of electrical, electronics, and computer engineers who work in corporations, as opposed to universities. Dr. Michael Pecht, founder and director of the Center for Advanced Life Cycle Engineering at the University of Maryland, is the journal's inaugural editor-in-chief.

SECTION 6
DEVELOPING YOUR MANUSCRIPT

Author Responsibilities

As discussed in Section 3, there are very clear guidelines about who to include as an author. Disputes about authorship can lead to ethical inquires. You should decide who will be an author on the work as soon as possible, perhaps even before you begin your research project. Each author has a responsibility not only for the final article, but also for the design and execution of the research [3].

IEEE Publication Services and Products Board Operations Manual (PDF, 1.2 MB) states that authorship credit must be reserved for individuals who have made a significant contribution to the theoretical development, system or experimental design, prototype development, and/or the analysis and interpretation of data associated with the work reported in the article. An author must contribute to drafting the article and reviewing or revising it. Each individual named as an author must approve the final version of the article as accepted for publication, including the references.

One individual must be named as corresponding author. The corresponding author is responsible for submitting the manuscript and managing it through the review and revision process with the publisher. The corresponding author makes sure that all authors are kept apprised of the current status of the work.

Divide responsibilities among authors. Designate the best writer to draft the more textual parts of the work, such as the introduction, summary, and conclusions [2]. Other authors can take responsibility for the problem formulation and results.

IEEE leaves the order of authors to the discretion of the authors. Typically, the first author listed is the person who has taken the most responsibility for the work. Other authors are listed in order of the level of their contribution. Sometimes, the senior author is the head of the department and is listed last. Colleagues who have contributed in a non-significant way, by reviewing the article and providing feedback, for example, can be thanked in the acknowledgements section.

The First Draft

The hardest part of writing can be simply getting started. Experts recommend that you set aside time in your calendar for writing and set deadlines to stay on track. Find a quiet place and avoid interruptions. If you cannot think of the right word or you have forgotten some detail you need, do not stop to look it up. Type a placeholder such as "xxxx" or make a note using the comments feature of your word processing program. Later you can search your document for your placeholders to fix them. To maintain your momentum, do as Ernest Hemingway did: he wrote the first paragraph of the next chapter before he would stop for the day. It will give you a jump start in your next writing session.

When you are writing the first draft, do not focus so much about style or grammar. You will revise your work several times after you have written the first draft. In Section 7 you will find tips and guidance for making sure your writing is clear and grammatically correct. Follow your outline, but be open to revising it as you go along. Some ideas may become less relevant to you or your coauthors once you begin putting your article together, and new ideas will emerge.

Where to Begin Writing

Scientific and technical articles typically follow this format: Abstract; Introduction; Previous Research; Problem Formulation; Model or Methods and Results; Conclusion; References; Acknowledgements. Each section plays a different role in explaining why your research presents a new and important problem, what has been done before, and how your research substantially advances your field, as discussed in Section 2.

Many inexperienced writers start writing with the abstract. Then they move on to the introduction, the methods and results, and the conclusion. But the core of your article is the problem formulation and the methods you used to solve it. This is where you describe your unique approach to the problem and how you developed it. Because this is the material that is most familiar to you, it makes sense to start your writing with this section [8]. You can then move on to your results. Most experienced writers recommend that you write the introduction next, and then your conclusions. The abstract should be written last. After you have drafted all of the sections, you should revisit your working title to be sure it accurately represents your final work. Acknowledgements and references can be completed after the article is written.

Sections

Title and Index Terms

The purpose of your title is to grab the attention of your readers and help them decide if your work is relevant to them. As you write, develop a list of keywords that will attract your intended readers. Use these keywords towards the beginning of your title [2]. Use words that help the reader understand why your work is different from previous studies [8]. Keep your title concise. Some journals set a limit on the number of words in a title. Avoid unnecessary words. You may want to develop a list of possible titles as you develop your article, then select the best one [2].

For IEEE journals, you must provide a list of index terms or keywords that reflect the content of your article. You can select your terms from the IEEE taxonomy (PDF, 375 KB). Abstracting and indexing services and search engines use the article title and index terms to help readers find your article. Think about how you would search for your article. What search terms would you use [7]? Let these terms guide your selection of index terms and the development of your title.

It is important to get your title and index terms right so that your article appears when engineers and researchers are conducting searches in your area of expertise.

Abstracts

The abstract is the last section of your article to be written because it is a condensed version of the entire article. It includes the key points of the introduction, methods and results, and conclusions. An abstract is generally 100–250 words long. It is written in the past tense. An abstract should not include references; use the background and conclusions to help frame the context of your work [9].

Readers will use the abstract to decide if your article is relevant to them. Use keywords and index terms in your abstract to capture reader interest and improve the likelihood of your article appearing in relevant searches [3]. Readers who find your article through an abstracting service may never see the rest of your article. Be sure the abstract conveys why your research problem is important and how your work moves the field forward. Reviewers also look at the abstract first. Strive to make a good impression with your abstract to engage their attention.

Introduction and Published Research

The Introduction serves to help the reader understand our three key questions: Why is this a new and important problem? What has been done before? How does your research bring significant new understanding to the field? The reader should find enough information to understand why your research was necessary, without having to refer to other source material or published works [7]. The introduction should be concise, no more than one or two pages. It is written in the present tense.

Your introductory paragraph should start with what is generally known about your subject. Then move step by step through more detailed information, ending with a description of the specific problem or hypothesis your article will discuss. Try to use an attention-grabbing statement to hook the reader [10] while being careful not to sensationalize your results.

In the next few paragraphs, refer to the published research to show what is already known about your subject and why your work is needed. Do not try to include everything from your literature review. Your goal is to orient the reader to the most relevant studies. Explain how each earlier study relates to your own approach to the problem. Does it have limitations? Does it make different assumptions [11]? Show your readers how your study builds upon or is different from this existing work. If you have published an earlier version of your work, for example as a conference or journal article, you must explain how the current study builds upon your own prior work [3].

After you have explained the historical context of your work, introduce your hypothesis and provide a general description of the results you have obtained. You will flesh these out more fully later in the article, but providing an overview here motivates your audience to read on. At the end of your introduction, tell the reader how the article is organized. This will allow readers to move to sections of particular interest, if they wish.

Problem Formulation and Results

The Problem Formulation, or Methods, section should be the first part of your article that you write. In this section, you describe the methods that you used to solve the problem, or prove or disprove your hypothesis. It includes a detailed description of the problem, defines all the terminology and the notations used, and develops the equations you used for reaching a solution. In some fields, for example, biomedical engineering, you may have to describe the materials and methods you used in your experiments.

The section should be written objectively, without analysis or interpretation. The level of detail should be enough to allow a reader to replicate your work. Reviewers and readers will evaluate this section to determine if your methods were appropriate to obtain the data you report in the results section of your article. Include only the most significant equations in the body of your article; detailed derivations can be described in the appendices [12]. Equations are numbered sequentially, and referred to in the text by their reference number.

Write the Results section of your article next. Here is where the reader or reviewer will determine if you have in fact found a better solution than previously published work. If your work is analytical, you will show results obtained from your equations; if it is experimental, then you will show experimental measurements [13]. The results will demonstrate that you have developed a new solution to a problem, and that your work is a significant advance over what has come before. The results should be clear and concise, and figures or tables will typically be used to illustrate your findings.

In some journals and disciplines, the results are presented as raw data, without interpretation. In others, results and discussion are combined. You should review representative articles in your targeted periodicals to determine which approach is preferred. In the discussion, you will interpret your results.

You should acknowledge any limitations of your study, and be absolutely certain about your conclusions.

Conclusion

This section should explain what your research has achieved, as well as the benefits and shortcomings of your solution. It is similar to the abstract, but it can provide more detail. Remind readers of the key points of each section of your article. Then provide a summary of the main findings you have reported, the important conclusions that can be drawn, and the implications for the field. You should also discuss the benefits and shortcomings of your approach, and suggest future areas for research [11]. A well-written conclusion can also help when writing the abstract.

Illustrations

Tables, graphs, and figures in your article will help clarify your ideas and support your conclusions. A figure can quickly show ideas or conclusions that would require a lot of explanation in the body of your work [12]. Because readers frequently scan the illustrations in an article without first reading the text, they should be self-explanatory. Table titles and graphic captions should help the reader understand the data. While illustrations can appear anywhere in the article, they are typically used in the results section.

Preparing your illustrations can help clarify your ideas and support your arguments. The process can make writing easier, and for that reason, you should begin thinking about your illustrations early in the process [2]. Decide which ideas or methods would be effectively presented by illustration and what format best conveys the information. A table is effective for presenting repetitive data or when it is important for the reader to see the exact values. A graph can show the relationship between data points or trends in your data.

Think carefully about how you want the illustrations to look. Be sure they are readable and easy to understand. Use thick lines and be sure that your labels are large enough to be read. Most journals charge for the use of color in printed journals, so think about how the illustration will look in black and white or greyscale. A poor image cannot be improved in the production process, so be sure that the image you submit is of high quality. Design your table or graphic to fit in the column format used by your target periodical.

Resist the temptation to include too many illustrations. Each figure should be essential to your story. A good piece of advice is to ask someone who is not directly involved in your field of research to review your illustrations to see how well they communicate your message [2].

IEEE provides a number of tools, guidelines, and frequently asked questions to help you prepare your artwork for submission to IEEE *Xplore*. You can find them in the IEEE Author Digital Toolbox under "Preparing Your Graphics or Multimedia Materials." You will also find a tool to check that your artwork meets IEEE publication standards.

References

References demonstrate to the reader that you have done your homework. They show that you have researched the work that has been done. They support your argument that you have found a new and significant approach to a problem. They help you make a case for the importance of your research question.

Experts say that there are more mistakes in the reference section of an article than any other section [7, 3]. It is meticulous work, but keeping your references accurate and complete will help demonstrate the quality of your work when it goes through peer review. It will also allow your research to be more effectively used by those who come after you.

Cite only those references that directly support your work. Do not include references from "big names" just to build credibility. Try not to cite material that has not been vetted by peer review, such as theses, abstracts, and dissertations. After you have drafted your article, be sure that every reference that appears in the text has a citation in the reference section, and that every citation in the reference section is used in the text. Check your reference list against the original source material. Be sure that each part—authors' names, the article, the name of the journal or book, the page numbers, etc.—is correct.

There are a number of different formats used by journals for references. Check the Instructions for Authors for your journal and be sure you follow the style it requires. If you do not, it is likely that your submission will be returned to you. IEEE journals generally follow a citation number system.

The first source cited is assigned number 1; the second source is assigned number 2; and so on. Later citations to a source use the original number no matter where they appear in the text. The IEEE citation reference style (PDF, 319 KB) is supported by a number of reference manager software tools. These tools can help you easily record and use citations.

If you do not have access to a reference management tool, use the author's name and year of publication in parentheses as your in-text citation while you work on your article. As you make revisions and move text around, it will be easier to keep track of your references than using a numbering system. When you are working on your final revision, replace the in-text citations with numbers.

The IEEE Reference Preparation Assistant is an automated tool that validates references against both the IEEE *Xplore* and CrossRef databases to ensure successful online linking. You should use the Assistant before submitting an article to IEEE.

Authorship Footnote, Acknowledgements, and Author Bibliography

In most IEEE journals, an unnumbered footnote appears on the first page of the article. It includes the date you submit your article (the date of revision and acceptance will be filled in later). This is also where you should disclose any financial support. The affiliations of all authors are included here.

In the Acknowledgements section, recognize individuals who provided technical or other assistance to your work but who do not qualify to be included as authors, as discussed above. Examples are a statistician who helped with analysis or a graphic artist who created images. You might also include colleagues who reviewed your article prior to submission or who gave you other feedback on your research.

Most IEEE journals provide space for author biographies at the end of an article. The biography includes a photograph of each author and his or her educational and work background..

Formatting Your Article

Follow the Instructions for Authors

Every journal has guidelines or instructions for authors published in the journal or on the journal's Web site. You can usually find the document in the first issue of a volume year. Follow these guidelines closely or your article may be returned to you. The guidelines include technical specifications for preparing your article, including the format (e.g., type size, font, headings, column width), article length, instructions for handling figures and tables, and reference format.

LaTeX vs. Word

LaTeX is a document preparation system designed for technical and scientific communication. It produces professionally typeset documents. With LaTeX, you do not format as you type. Instead, you write in a plain text file and enter commands to indicate where text needs to be styled in a particular way (e.g., title, section heads, figures, and captions). The software creates a final typeset output.

LaTeX handles equations particularly well. In Word, you must use the mouse to insert mathematical symbols. In LaTeX, you type the equations on the keyboard using commands to indicate the correct formatting. Because you are entering plain text, editing a LaTeX document can be easier. Figures are correctly placed. LaTeX can automatically generate references and indexes. Another benefit is that it is available free of charge.

LaTeX has a learning curve and is highly customizable, but it is recommended that authors avoid customization as much as possible in order to minimize errors in the production process that can be caused in the conversion of a file from a custom to standard version of LaTeX.

Word can produce a reasonably professional document with very little training. You can see how your document will look as you are writing it. It also includes features that can help in editing your article, such as spell check and grammar check.

IEEE Templates

IEEE Author Digital Toolbox includes a number of tools and information to assist with article preparation, including the IEEE Style Manual (PDF, 319 KB), with editorial guidelines for publishing in transactions, journals, and letters. You will also find the IEEE taxonomy, a reference preparation assistant, and a tool to check your PDF to ensure it complies with IEEE *Xplore* requirements.

Use the Templates for preparing your articles for submission in either LaTeX or Word. Most, but not all, IEEE journals use these templates. Check the home page of your individual journal for any special requirements.

Guidelines for conference articles can vary depending on the organizer. IEEE offers a number of templates for conference organizers. However, you should refer to the conference Web site for specific instructions.

Whether you use Word or LaTeX to prepare your work, you should follow the instructions you will find in TRANS-JOUR.DOC or TRANS-JOUR.PDF in the toolbox. If you are using Word, you should use the .doc version of the template to prepare your article. Either type directly into the template, or cut and paste from another document. Your text will automatically appear in the IEEE double column format. The template and instructions will show you how to properly format section headings, import and size your artwork, and check that your graphics are suitable for an IEEE publication. Depending on the publication, artwork can either be placed within in the text, or at the end of the article. IEEE will do the final formatting of your article. The template also includes information on formatting for references and equations, units, and IEEE editorial policies. You should delete the instructions text before you save the final version of your article.

SECTION 7
IMPROVING AND REVISING

When you write the first draft of your article, do not be overly concerned with grammar and format. No one writes a perfect first draft. You will go through a number of revisions to make your article clear, concise, and readable.

It helps to read a lot of articles in your discipline. After a while, you will begin to understand what makes a good article stand out. Every discipline has a unique way of expressing ideas or concepts, and you will learn how to write in the language of your field [4].

Good science is what is most important in your article. But if your article is poorly written, then the Editor and reviewers may not be able to appreciate the full impact of your work. An article with serious grammar, language, or spelling problems may be returned for editing before it is even thoroughly reviewed. Revise your article, and then revise it again. Do not let your writing detract from the science.

How to Revise

Set your article aside for a few days after you have completed the first draft, so you can return to it with a fresh eye. Read all the way through it first, without changing anything. Some people prefer to read a printed version. You may find it helpful to read the article aloud during a later revision cycle. This will help you spot missing words, incorrect use of words that sound the same but have different meanings, and other grammatical errors that can be overlooked in print. Keep an original copy of your first and all subsequent drafts. As you go through many rounds of revisions, it may be useful to refer back to your earlier work.

On your first pass, identify areas where there are obvious problems with the scientific content. Take notes but do not correct anything. Then go through and resolve each problem you have found. Then review your work again. Once the science in order, move on to editing the structure and language[4].

Does the order of your presentation make sense? Try rearranging some sections to improve the flow. Be a strict editor. Remove any information that does not support your key messages. Is every table and graph you have included necessary? Remove any that are redundant or that do not communicate an important result. Would an additional illustration clarify a result? Finally, review for usage, spelling, and grammar. Do not rely solely on the spell checker in your word processing program.

Polishing

Outlined below are some common best practices and errors typically found in engineering articles. However, there are many outstanding references for editing guidance. See the IEEE Style Manual (PDF, 319 KB) for specific editorial guidelines for IEEE journals, transactions, and proceedings. For spelling, IEEE uses Webster's College Dictionary, and for additional grammar and usage help, refer to The Chicago Manual of Style, published by the University of Chicago Press.

Making Your Article Interesting to Read

Write in paragraphs, not long blocks of text [12]. Every paragraph should have a topic sentence, supporting sentences that build on that key message, and a summary sentence. Vary the length of your paragraphs to make your article easier to read. Think about the transition from one paragraph to the next. Is there a logical progression?

Write clear, simple sentences in the form of noun-verb-object. Varying sentence length can make an article more engaging. Compound sentences add variety and are useful for comparing ideas [12]. Every word in a sentence should contribute something; eliminate unnecessary words.

Avoid the passive voice, in which the subject is acted upon. In the active voice, the subject performs the action. "It was hypothesized," is passive; "We hypothesized," is active. The active voice is more interesting and less ambiguous. Edit passive sentences to active sentences as much as possible.

Write in the first person ("I," "we") to make it clear who has done the work and the writing. It is particularly helpful when you are comparing your work to someone else's work [3].

The abstract and the methods section will be written in the past tense, because they describe work that you have already done. The Introduction and Discussion section are usually written in the present tense, because they describe knowledge that currently exists.

Syntax

Syntax refers to how words are arranged in a sentence, and how they relate to each other. Many of the problems found in scientific articles relate to syntax.

These errors can be particularly confusing:

- **Introductory phrases**
  Avoid unnecessary phrases such as "Obviously," or "As previously mentioned." Don't use "This" at the beginning of a sentence. It can be ambiguous.

- **Subjects and verbs must agree**
  Singular nouns require singular verbs and plural nouns require plural verbs: "The engineer says," "The engineers say."

- **Misplaced and dangling modifiers**
  Modifiers are words or phrases that provide a description in a sentence, but when they appear in the wrong place they can be confusing. A misplaced modifier is incorrectly separated from the word it modifies. Do not say "Reading the Aims and Scope, the journal would be a good fit for my article." Say "Reading the Aims and Scope, I realized the journal would be a good fit for my article." A dangling modifier modifies an unintended word because it is in the wrong place in the sentence. Do not say "The engineer wanted a cold glass of water;" say "The engineer wanted a glass of cold water."

Use Words Carefully and Correctly

- Do not use slang in your article. Be cautious about using technical jargon that may not be understood by an international audience outside of your immediate subspecialty.

- The words "that" and "which" are often confused. Restrictive clauses are essential to the meaning of the sentence, and use "that." "The article that was written by Prof. Smith was accepted by the journal." If you take out the words "that was written by Prof. Smith," you are no longer referring to a specific article. Use "which" when the phrase can be left out. It is usually set off with commas: "The article, which was accepted by the journal, was written by Prof. Smith."

- Avoid abbreviations if possible. If you do use one, define it in parentheses after the first use of the phrase.

- Use simple, common words: "start" instead of "initiate." "Use" instead of "utilize."

- Try to avoid "lazy" verbs such as demonstrate, exhibit, present, observe, occur, report, and show. Use your word processing program to find these words in your document and find a different way to express your idea [2].

- The IEEE Style Manual (PDF, 319 KB), section VI, details some mistakes common to articles in engineering. "Data" is plural, not singular. Use the word "alternatively" to present an option, not "alternately," unless you are actually discussing something that alternates. Do not use the word "issue" when you mean "problem."

Punctuation

- Semicolons, colons, and dashes should be used sparingly in scientific articles.
- Use commas to add clarity and emphasis.
- The possessive singular of nouns is formed by adding an apostrophe: engineer's article.
- Use a series comma after each term except the last.
- Do not use double parentheses in text, but do keep them in math.

Measurements and Numbers

Refer to the IEEE Style Manual (PDF, 319 KB).

Tips for Non-English Speakers

Editors want their journals to reflect the global contributions of science and are generally receptive to reviewing contributions from non-English speakers. They will be interested in your article if it presents a good and important problem that significantly advances the field. The rules are the same for all writers: submit an organized, interesting, and clearly written article. If your article is poorly organized, or if the science is not good, publication is less likely [7].

Write in a clear, matter-of-fact style. Avoid a narrative or story-telling approach. Include the most relevant published research, but do not provide a lengthy historical overview.

Pay attention to structural differences that might make your meaning hard to understand. As discussed earlier, you should write in the first person ("I" or "we"). The first sentence in a paragraph states the main point, and the remaining sentences present information related to that point. In English, the subject comes at the beginning of the sentence, followed by the noun and the object. Other languages may, for example, place the verb at the end of the sentence. There are also differences in the use of punctuation such as commas and quotation marks.

It is not acceptable to copy someone else's writing in English language journals. Put other people's ideas into your own words, and use a citation to show where the idea came from. If you are quoting someone word for word, you should use quotation marks. Do not cut and paste someone else's writing into your article.

If possible, ask an English-speaking colleague to review your article for language and grammar. Never use an online tool such as Google Translator to translate your writing into English. Such tools do not translate accurately. In general IEEE editorial staff will work with you to correct or question grammatical errors, obvious inconsistencies or omissions, spelling, and punctuation. But they will not edit technical content or writing style. For a fee, the IEEE English-language editing service will work with you to improve the clarity and organization of your article.

Internal Review

Your coauthors should review drafts and revisions because they have equal responsibility for the article. When you are confident that your article is grammatically clean and well-structured, it is time to ask internal colleagues and/or your department head to review your article. Ask these reviewers to check that your methodology is appropriate and that you have interpreted the data correctly. In addition to asking colleagues who are very familiar with your field of study, consider getting a review from someone outside your discipline. An outsider will be able to tell you if your article is coherent and easily understood.

SECTION 8
SUBMISSIONS

Before you submit your article to a journal or conference, you should do one last, thorough review of your work.

Review the Instructions for Authors, found on the journal or conference Web site or in an issue of the journal (typically in the first issue of the year). Check that your article adheres to the guidelines for reference style, headings, and illustrations. Proofread one last time. Check again that every citation in the reference section is cited in the text, and that every text citation is included in the list of references. Check that every figure and table is accurately cited in the text.

Cover Letter

Your cover letter is your first chance to make a good impression on the journal editor (conference article submissions do not require a cover letter). Help make the editor's job easier by explaining how your article fits the scope of the journal [4]. Discuss how your article addresses a new and important problem, and how it advances the field. Confirm that the work is original and that it has not been submitted to any other publication. It should be brief and business like. Check the journal Web site to be sure you have the name of the current editor, and use it in the salutation.

Your cover letter should include:

- The name of the journal you are submitting to, because editorial offices may handle more than one journal.
- The title of your article.
- The name and current place of employment of each contributing author.
- The corresponding author's full contact information, including address, fax number, phone number, and e-mail address.
- An explanation of any special requirements, such as special features or unusual length.

Journal Submissions

Many journals now require electronic article submission. Most, but not all, IEEE journals use the ScholarOne Manuscripts system. Electronic submission saves time, money, and effort for everyone. Authors do not have to submit multiple copies of the article and artwork, and the system automates the review process to make it more efficient.

It can take an hour or so to enter all the data about your article and upload your files. You can pause and save the work you have already done. Have all the information you will need at hand: cover letter and article file, the names and affiliations of your co-authors, the illustrations, and the names and contact information for your preferred reviewers (see Section 9).

To access the ScholarOne site for your journal, go to the journal's homepage in IEEE *Xplore* and click on the "Submit a Manuscript" button.

If you have not done so, you will be prompted to establish an account. You will first enter the title and abstract for your article. Next you will enter the keywords or index terms you selected when you were writing your article. You will enter the names and affiliations of all of your coauthors, and then the names and contact information for at least two preferred reviewers. You can upload your cover letter, or type it directly into ScholarOne Manuscripts. Then you will upload all documents for your article: the manuscript and, if relevant, separate files for the images and any ancillary documents. Upon completion of the submission process in ScholarOne Manuscripts, you will be asked to electronically transfer copyright to the IEEE though the use of the IEEE eCopyright Form.

ScholarOne Manuscripts allows you to track the progress of your article through the peer review process. After your article has been reviewed and accepted for publication, and after you have made any necessary revisions, in most cases you will be instructed to return to your ScholarOne Author Center to upload your final article for production.

ScholarOne Manuscripts provides training and trouble-shooting information for IEEE authors.

Conference Submissions

Guidelines for submission of an abstract and/or article to a conference for peer review vary widely depending upon the conference organizer. Follow the instructions on the organizer's Web site.

IEEE works with the organizers of the more than 1,200 sponsored and affiliated conferences to ensure that all articles submitted for publication on IEEE *Xplore* and the Computer Society Digital Library meet a minimum standard for print and electronic publishing. IEEE eXpress Conference Publishing and IEEE Computer Society Conference Publishing Services provide tools and templates so that authors can correctly format their PDF documents for publication and properly assign copyright. You will receive instructions from your conference organizer.

Remember that your article may be excluded from IEEE *Xplore* and the Computer Society Digital Library if you do not appear at the conference to present your article.

SECTION 9
PEER REVIEW

In the peer review process, qualified individuals evaluate the quality, relevance, and appropriateness of an article for a particular journal. Peer review improves science. It confirms that published work has been tested and validated.

Peer review offers an opportunity for your work to be evaluated by your peers. The peer review process will almost certainly provide feedback that will improve your work and make your article stronger. Although some feedback can be disheartening, be open to the reviewers' comments and consider how you can construct a more valid and convincing argument as a result.

All scientific articles and communications published in regular IEEE periodicals are reviewed by at least two referees who have experience in the area of the subject matter of the article. IEEE also requests that conference organizers implement a process for review by independent referees who are knowledgeable in the subject area.

How Peer Review Works

While the journal editor-in-chief is responsible for the content of the journal, many journals have associate editors who handle the peer review process for certain subject areas. After you submit your article, a first pass will be done to determine if it is within the scope of the journal, readable, and that the quality of the science presented is acceptable. A very poorly written article, or one that is simply not relevant to the journal, is likely to be rejected at this point.

As part of the submission process, you will be offered the opportunity to recommend potential peer reviewers for your article. You should nominate individuals who you know will understand your research and the related literature. The associate editor may select one or both of your recommendations for review or may choose other reviewers from the journal's network. At least two reviewers will be assigned. Reviewers maintain anonymity from the authors.

A reviewer will evaluate your article to determine:

- Does it address a new and important problem?
- Is the material original?
- Are the methods and rationale valid?
- Do the conclusions make sense?
- Is it clearly written?
- Do the illustrations, tables, and charts support the text?
- Are the references current and relevant to the subject?
- Is the content appropriate, in scope and level, for the journal [9]?

The reviewers will recommend whether the article should be published as is, or if changes would improve the science as it is presented. The editor-in-chief will weigh the comments from the reviewers before making a final decision. If the reviews are mixed, the editor-in-chief decides whether to publish the article, and decides which revisions recommended by the reviewers will be passed back to the author.

A word about the timing of reviews: Most editors-in-chief, and all reviewers, are volunteers. When reviewers are approached to do a review, they are asked if they have adequate time in their schedule to meet the deadline. Despite this, a reviewer may miss a deadline if his or her own work interferes. Some delay is not unusual.

Review Outcomes

Most articles that are submitted for publication are rejected. The top journals can reject 90 to 95% of all submissions. Just because your article is rejected does not mean that you should consider abandoning your research or discontinuing your efforts to publish. The review process may give you some guidance about how to improve your writing, or additional experimental work to do, to improve the likelihood of acceptance in the future.

There are three possible outcomes to the review. You should read the communication from the journal carefully to be sure you fully understand the status of your publication:

ACCEPT AS IS: This is extremely rare. Very few articles will be accepted without the need for any editing or revision.

MODIFY YOUR ARTICLE: This can take a few different forms. Your article may be "accepted with modifications." This means that if you make the changes recommended, your article will be accepted and published. You may be asked to make some editing changes, add additional references, or check some calculations, for example. Alternatively, you might be informed that you should "modify and resubmit" your article. The science in your article may have been interesting, but there are some shortcomings that need to be addressed. If you address these concerns, you are encouraged to resubmit your article to the journal. It may or may not undergo additional review.

REJECTED: If there is no encouragement to revise your article and resubmit it, then it was deemed unsuitable for the journal. This does not necessarily mean that your article is flawed. Remember, some journals reject up to 95% of the articles submitted. It is possible that your article just has not met a particularly stringent set of requirements.

Here are some reasons for rejection:

- The content is not a good fit.
- There are serious scientific flaws—inconclusive results, incorrect interpretation.
- It is poorly written.
- It does not address a big enough problem or advance the scientific field.
- The work was previously published.
- The quality is not good enough for the journal.
- Reviewers have misunderstood the article.

Response Letter and Article Revision

If the journal recommends that you revise your article, you will receive a list of the specific concerns and issues from the reviewers. Do not let this discourage you, and do not take the criticisms personally. Remember, editors-in-chief and reviewers want to help you publish good science. When you receive the reviewers' comments, do not respond immediately. Put them aside for a few days, while you think about what your response should be and what you may need to change.

Evaluate the feedback you receive. No author is right 100% of the time, and neither is any reviewer [4]. It is possible that a reviewer misunderstood something in your article. There may be conflicting comments from different reviewers. However, if all reviewers agree on a particular point, there probably is a valid concern. Some comments may be relatively minor.

Go through your article, point by point, to address the issues raised in the reviews. Keep detailed notes about the changes you have made or additional work you have done. Your response letter should be polite, respectful, and detailed. Be sure to address every reviewer comment. It does not make sense to pick fights over minor edits. But if you believe a criticism is not valid, provide a strong, assertive rebuttal and support your comments with a literature reference, if possible [3]. Remember, the editor and the reviewers are volunteering their time—thank them for their comments.

If Your Article is Rejected

If your article is rejected, try to understand the reasons. Was it out of scope? Then you should go back to your original list of target journals and find one that is better suited to the content and level of your work. If there were serious flaws in the science, or if you did not provide enough new information to warrant publication, then you have additional work to do before you can rewrite and submit the article to another journal.

Peer Review—An Editor's Perspective

In an editorial in *IEEE Signal Processing Magazine* [14], 2012–2013 Signal Processing Society President K.J. Ray Liu asks, "Some say that peer review is not perfect, but it is the best system our journals have. Is that so?" An associate editor, who selects the reviewers and then must make an informed, fair decision based on their feedback, has a difficult job since every reviewer has a different viewpoint. Prof. Liu notes that an explosion in article submissions, leading to a shortage of qualified reviewers, has made the associate editor's job even more challenging. In response, the IEEE Signal Processing Society has introduced systematic training for associate editors. Associate editors must be senior enough, with technical authority, to be able to make timely and informed judgments. They must be well connected with a wide network of potential reviewers who can conduct a fair review. "Qualified and trained associate editors are essential to the success of the peer review process," says Prof. Liu. He concludes that "peer review is the best system our journals can have, only if we do it right!"

SECTION 10
THE FINAL STEPS

You have revised your article and returned it to the editorial office. In the near future it will appear on IEEE *Xplore* alongside the most significant articles published in your area of research. There are a few final steps you will take, however, before your article can be published in print and online. And the appearance of your article in print and online is not the end of the story.

Reviewing Page Proofs

When you submit the final version of your article to the journal, it may be copy edited. A copy editor will correct any grammatical and spelling errors. The copy editor will also question anything that is inconsistent or doesn't make sense. These questions are referred to as author queries.

At some point before the publication of your article in most IEEE journals, you will receive notification that the proof of your article is ready for your review. A proof is the article formatted as it will appear in the journal and on IEEE *Xplore*. The margins of the proof will include notations to indicate where the copy editor had questions or made changes. For most IEEE journals you will receive an e-mail that will include a unique Web link, a login ID, and password. Once you log in, you will have access to a high-resolution PDF of your article to download and review. You will also find a list of author queries raised by the copy editor. Instructions will be provided on how to mark your corrections and responses to author queries, either on the PDF using Adobe Reader or directly through the Web site used to facilitate author proof review

This is not the time to add new information or make any substantive changes to your article. Any material you add now has not gone through peer review and cannot be published except in the most extraordinary circumstances. You should review the proof to correct the rare error that you missed when you prepared the final version of your article, and any errors that were introduced in the formatting of your article. You will also have to respond to each author query. Finally, you will review the tables, charts, and illustrations and the citations and references.

You are responsible for the quality control of your article [7]. Check your proofs carefully. Even though the process is largely electronic, errors can creep in. So review the proof word by word. Pay careful attention to numbers. As suggested in Section 7, it is good to read the text out loud, or to have someone else read it out loud while you follow along. If you can, ask someone who has not been involved in the article to review it.

Check to see that your illustrations are placed properly within the text and are not upside down or sideways and that the reproduction is acceptable. Is the quality of the photographs satisfactory? Are they too light or too dark? Review the captions, headings, and labels.

Take the time to review your proofs carefully, but do it promptly. Most journals request that proofs be returned within 48 hours. Your article may be slated to appear in a specific issue of the journal, and adhering to the deadline set by the publisher will prevent any delays in publishing your article.

Page Charges, Reprints, Open Access Fees

Some business issues are usually handled during this phase of publication. When you receive your proofs, you will also receive an invoice for any page or color charges you have incurred. You will also get a form to order reprints. Article reprints are used less frequently now that articles are widely available in electronic format. You may want to order 100 or so to send to countries where Internet service is less reliable, or to include in presentation packets. Note that open access fees are collected upon acceptance of the article.

Publication

Once you have returned your proofs, the publisher will make corrections. Depending on the journal, your article may appear online in advance of publication in the print journal. Some journals post articles to IEEE *Xplore* as preprints, within one to three days of acceptance. Others post final articles in an Early Access section of the journal or directly into the issue in which the article will appear in print. E-mail trans@ieee.org or your staff editor to find out when your article will appear. You may receive a printed, bound copy of the issue in which your article is published. Some journals provide printed copies for coauthors as well; check the Instructions for Authors to find out if your journal does so.

Discoverability of Your Article

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SECTION 11
APPENDIX

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IEEE EDITORIAL STYLE MANUAL

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V7 09-22-2014

TABLE OF CONTENTS

I. INTRODUCTION

A. Purpose of Manual

This style manual provides general editing guidelines for IEEE Transactions, Journals, and Letters. For guidance in grammar and usage notincluded in this manual, please consult *The Chicago Manual of Style*, published by the University of Chicago Press.

B. IEEE Transactions Editing Philosophy

The IEEE's responsibility in editing papers for the Transactions is not to make any determination on or do any editing of the technical content of the papers we work with, but is instead to render the work as readable, grammatically correct, and as consistent with IEEE style as possible.

Since we are concerned with style mainly in the sense of IEEE house style, we do not try to change an author's style of writing. We do a mechanical edit to correct or question grammatical errors, obvious inconsistencies or omissions, spelling, and punctuation. Since we work with highly technical text, we also do extensive formatting of mathematical material.

Some manuscripts require closer editing than others. Some papers, for example, are from authors unfamiliar with the English language. Often, an IEEE Staff Editor must walk a fine line in determining how to correct a grammatical error or in deciding what can be safely changed or corrected without altering the author's original meaning. Because of the highly technical nature of the material we deal with, and because of our often limited understanding of that material, it is especially important that we as Staff Editors do not risk making any unnecessary changes or any that may affect the author's meaning.

Sometimes there are cases where it is simply not possible for us to decipher an author's meaning or to find a way to correct a sentence. In these cases, a judgment is made either to query the author on the proof about the passage in question, to directly contact the author, or in rare cases, to work with the Transactions Editor or Guest Editor to clarify the material.

For a new Staff Editor, experience, familiarity with the material in this guide, and continued consultation with the training of IEEE Staff Editors will lead to an understanding of how much in a paper to change or question and what form those changes or questions should take.

C. Preprinting (Pre-edit Rapid Posting)

Preprinting is a term used to define the process of posting an author-submitted PDF of his/her manuscript online on the IEEEXplore site. This is done within a day or two of receipt at the IEEE. The author is required to include a signed copyright form with their submission package. If the form is not provided, the paper cannot be preprinted. On Xplore, it appears under "Early Access." This version of the paper has been accepted for publication by IEEE, but has not yet been edited and may not have been assigned to a print issue. A paper that has been preprinted is considered published.

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- In Print Collections, the front cover will contain information reflecting the pages on which the Index of Contents will appear in each issue. Staff may refer to the "Table of Contents (ToC)" section for more information.

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3) Index Terms
4) Nomenclature (optional)
5) Introduction
6) Body of Paper
7) Conclusion
8) Appendix(es)
9) Acknowledgment
10) References
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Steven T. Dougherty, *Fellow, IEEE*

(Invited Paper)

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Shadow Codes and Weight Enumerators *(Invited Paper)* . . . . . *S. T. Dougherty* 24

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IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 23, NO. 3, MARCH 2014

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Manuscript received June 10, 2014; revised July 29, 2014; accepted July 31, 2014. Date of publication August 29, 2014; date of current verson October 2, 2014.

Manuscript received February 22, 2009; accepted March 3, 2009. Date of publication June 8, 2009; date of current version August 29, 2009.

Manuscript received January 15, 2013; revised April 10, 2013; accepted April 29, 2013. Manuscript received in final form on May 20, 2013. Date of publication September 8, 2013; date of current version January 18, 2014.

In some Transactions, the *Volunteer Associate Editor* who processed the paper is listed next in the first paragraph, and this is referred to as a "recommended line." See specific Transactions for placement and wording. Some examples are:

Manuscript received February 5, 2007; revised March 29, 2007; accepted March 29, 2007. Date of publication June 8, 2007; date of current version January 18, 2008. Paper recommended by Associate Editor Thomas Lynch.

Manuscript received February 5, 2007; revised March 29, 2007. Date of publication June 8, 2007; date of current version January 18, 2008. This paper was recommended by Associate Editor T. Lynch.

Manuscript received July 4, 2007; revised September 4, 2007. Date of publication June 8, 2007; date of current version July 18, 2008. This work was supported by the UEFISCSU under Grant PN-II 65/01.10.2007 and Grant PN-II 331/01.10.2007. The associate editor coordinating the review of this manuscript and approving it for publication was Prof. Vesa Valimaki. *(Corresponding author: J. Ming.)*

All *financial support* for the work in the paper is listed next in the first paragraph and not in the Acknowledgment at the end of the paper. Examples of financial support acknowledgment are:

1) This work was supported by the National Science Foundation under Grant 90210 and Grant ECS-12345.
2) This work was supported in part by the Natural Sciences and Engineering Research Council of Canada under Contract 12345 and Contract 702589 and in part by the National Science Foundation.
3) This work was supported by grants from the Muscular Dystrophy Association of America and the Swedish Medical Research Council.
4) If an author/organization requests specific wording, e.g., by National Institutes of Health (NIH), use language provided.

If support was given to a *specific* author, the following wording is used:

The work of C. T. Walsh was supported by the National Institutes of Health.

Information of full or partial *prior presentation* of a paper at a conference may be included in the first paragraph of the first footnote. It may not be necessary, however, to cite prior presentation of a paper at a conference if the paper is appearing in a special issue made up exclusively of papers presented at the conference.

If a paper is a thesis or part of a thesis or dissertation, this should be so noted in the last sentence of the first paragraph of the footnote.

Below is a sample of a first paragraph of the first footnote:

Manuscript received January 15, 2008; revised April 10, 2008; accepted April 29, 2008. Manuscript received in final form on May 20, 2008. Date of publication September 8, 2008; date of current version January 18, 2009. This work was supported in part by the National Science Foundation under Grant GK-716, by the Joint Services Electronics Program under Contract AF-AFOSR-128-94/95, and by the Adolph C. and Mary Sprague Miller Institute for Basic Research in Science. This paper was presented in part at the Fourth *(or 4th)* Annual Allerton Conference on Circuit and System Theory, University of Illinois, Urbana, IL, October 1995.

The second paragraph of the first footnote is made up of the authors' affiliations, and the corresponding author's email address. There are instances when several authors may want their email addresses included. E-mail addresses are separated by semicolons. Examples are shown below.

.

For one author or if all authors have the same, or more than one affiliation:

The author is with the Department of Electrical Engineering, Rutgers University, Piscataway, NJ 08854 USA, and also with Bellcore, Morristown, NJ 07960 USA (e-mail: author@ieee.org).

The author(s) is (are) with the Laboratory for Information and Decision Systems, Massachusetts Institute of Technology, Cambridge, MA 02139 USA (e-mail: corresponding-author@ieee.org).

K. Gong is with the Tsinghua National Laboratory, Beijing 10084, China, and also with Tianjin University, Tianjin, 300725, China (e-mail: gongk@tsinghua.edu.cn).

The authors are with the Laboratory for Information and Decision Systems, Massachusetts Institute of Technology, Cambridge, MA 02139 USA (e-mail: firstauthor@mit.edu; IamNext@mit.org; thirdauthor@ieee.org).

Two or more authors: For two or more authors with different affiliations, use separate sentences and paragraphs for each, using all initials with a surname. Group the authors with the same affiliation together; list the affiliations according to the order of the first author listed in the byline for each location. Email addresses are separated by semicolons. Examples:

L. P. Li is with the Department of Electrical Engineering and the Electronics Research Laboratory, University of California at Berkeley, Berkeley, CA 94720 USA.

T. Ikeda and H. Ishikawa are with Fujitsu Laboratories Ltd., Atsugi, Kanagawa 243-01, Japan (e-mail:correspondingauthor@ieee.org).

The authors are with Fujitsu Laboratories Ltd., Atsugi, Kanagawa 243-01, Japan, and also with the Department of Electrical Engineering and the Electronics Research Laboratory, University of California at Berkeley, Berkeley, CA 94720 USA (e-mail: corresponding-author@ieee.org).

If an author had one affiliation at the time the paper was written and a new one at the time of publication, list the information as follows:

The author was with the Department of Electrical, Computer, and Systems Engineering, Rensselaer Polytechnic Institute, Troy, NY 12181 USA. He is now with the Institute for Microstructural Sciences, National Research Council, Ottawa, ON K1A 0R6, Canada.

If an author is on leave from his current position, list the information as follows:

The author is with the Faculty of Information Sciences and Engineering, University of Canberra, Canberra, A.C.T. 2616, Australia, on leave from the Department of Electronic Engineering, Zhengzhou University, Zhengzhou, China.

Additional Examples:

Retired author:

L. A. Tepper, retired, was with the Applied Research Laboratory, Bellcore, Morristown, NJ 07851 USA. He resides in Laguna Niguel, CA 92677 USA (e-mail: retiredauthor@yahoo.com).

Deceased author:

P. Dorigo, deceased, was with the Progetto di Intelligenza Artificiale e Robotica, Dipartimento di Elettronica e Informazione, Politecnico di Milano, 20133 Milano, Italy.

Consultant:

P. Leff Jr. was with the Department of Biomedical Engineering, University of Virginia, Charlottesville, VA 22908 USA. He resides in Charlottesville, VA 22908 USA.

Additional Notes:

- Do not include street addresses of employers. For domestic authors, use official U.S. Postal Service abbreviations for states and include U.S. zip codes, and country. Use Canadian Province and international codes as listed in this manual. Also include international cities, countries, and zip codes.
- List department or subdivision first, then company or school. Write out the words "Company" and "Corporation." Abbreviate "Inc." and "Ltd." (One exception to this is Texas Instruments Incorporated.)
- At the request of some societies, most Transactions include e-mail addresses in the affiliation. The standard usage of e-mail addresses is to list the address at the end of the affiliation line for that particular author.

E-mail listing for one author:

R. A. Morgan is with the Department of Information Technology, Honeywell Corporation, Bloomington, MN 55420 USA (e-mail: r.morgan@empire.honeywell.com

E-mail listing for more than one author:

H. Saidi and P. S. Min are with the Department of Electrical Engineering, Washington University, St. Louis, MO 63130 USA (e-mail: saidi@rgit.wustl.edu; psm@ee.wustl.edu).

- In a book review, to avoid confusion with the author of a book, when listing the affiliation of the reviewer of a book, do not use "The author is with …"; instead, list the reviewer's affiliation ("The reviewer is with …").
- Except in rare cases (e.g., IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING to indicate the corresponding author), asterisks or daggers are not acceptable means of referencing a footnote in IEEE Transactions.
-

The third or final paragraph of the first footnote contains the Digital Object Identifier (DOI). (The DOI system m was conceived by the Association of American Publishers (AAP) in partnership with the Corporation for National Research Initiatives and is now administered by the International DOI Foundation. Essentially, the DOI system is a scheme for Web page redirection by a central manager.) In January 2004, the IEEE adopted the use of the Digital Object Identifier system to provide unique identification of documents and facilitate on-line publication. The purpose of the DOI is to describe the structure and assignment of an identification code for publication items (articles) within publication types (journals and books).

The DOI consists of the following:

- 10.1109 identifies IEEE Publication;
- the calendar year of the date of assignment;
- a number unique to the publication item within the publication type.

An example of the DOI as it appears in the first footnote is as follows:

Digital Object Identifier 10.1109/JQE.2004.834561

The DOI is the last line of the author affiliation paragraph.

NOTE: It is very important that this number appear correctly in print. It will be a permanent means of identifying the document. If the printed DOI number does not match the database assigned DOI number, errors will result when linking the electronic version of the document.

C. Editing the Body of the Paper

Abstract

Every published paper must contain an Abstract; request one immediately from the EIC and/or author if it is not provided with the manuscript. Abstracts appear in text in 8-point boldface type per Transactions specs. All variables should appear lightface italic; numbers and units will remain bold. Abstracts should be a single paragraph. By nature, Abstracts shall not contain numbered mathematical equations nor numbered references. Numbered reference citations are not allowed. If a citation is made, reword the sentence to exclude citation numbers.

In order for an abstract to be effective when displayed in *IEEE Xplore*® as well as through indexing services such as Compendex, INSPEC, Medline, ProQuest, and Web of Science, it must be an accurate, stand-alone reflection of the contents of the article.

The abstract must be a concise yet comprehensive reflection of what is in your article. In particular:

- The abstract must be self-contained, without abbreviations, footnotes, or references. It should be a microcosm of the full article.
- The abstract must be between 150-250 words. Be sure that you adhere to these limits; otherwise, you will need to edit your abstract accordingly.
- The abstract must be written as one paragraph, and should not contain displayed mathematical equations or tabular material.
- The abstract should include three or four different keywords or phrases, as this will help readers to find it. It is important to avoid over-repetition of such phrases as this can result in a page being rejected by search engines.

- Ensure that your abstract reads well and is grammatically correct.

Index Terms

All papers must contain Index Terms. These are keywords provided by the authors. Request them if they are not provided. Index Terms appear in bold type in the same style as the Abstract, in alphabetical order, and as a final paragraph of the Abstract section. Separate Abstract and Index Terms by a 6-pt. space. Capitalize the first word of the Index Terms list; lower case the rest unless capitalized in text. Include the definition of an acronym followed by the acronym in parentheses. Example:

***Index Terms*—Abstraction, computer-aided system engineering (CASE), conceptual schema, data model, entity type hierarchy, ISO reference model, layered architecture meta model, reverse engineering.**

Note to Practitioners

This is formatted in the same style as Abstracts. It follows the Abstract and is separated by a line space. There may be more than one paragraph. The text appears in boldface and in 8-point type. Example:

***Note to Practitioners*—Abstraction, computer-aided system engineering (CASE), conceptual schema, data model, entity type hierarchy, ISO reference model, layered architectural meta model, reverse engineering.**

Note Added in Proof: This added information is usually inserted at the end of the Conclusion section of the paper or in whatever section contains the last paragraph of the main body of the paper. (See p. 18.)

Nomenclature

Nomenclature lists (lists of symbols and definitions) generally follow the Abstract and Index Terms and precede the Introduction. This type of list is characterized by the following.

1) The Nomenclature heading is a primary heading without a Roman numeral.
2) The first column of the list is flush left.
3) The second column is aligned on the left.
4) There is one em space from the longest item on the left side to the right side.
5) The first letter on the right-hand side is capitalized.
6) Each item ends with a period.
7) Do not use “is” or “the” at the beginning of items.
8) Do not use equality symbols between the left and right sides.

Equations in an item should be handled as follows.

1) When the equation is at the beginning of an item, align the equal sign with the right-hand side capitals, end the equation with a period, begin the definition with a capital, and end with a period.
2) When the equation is at the end of an item, end the definition with a comma, follow with an equal sign and the rest of the equation, then end with a period.

NOMENCLATURE

SPQ	Strictly proper pole constraints.
M	Minimal weighted sensitivity.
$P(s)$	Physical feedback.
W	Weighting.
Q	$= P - 1$. Improper function.
S, l	Signal density, $= P, M$.

NOTE: Acronyms defined in a Nomenclature list do not need to be defined again in the text. If the section headings are made up of only previously defined acronyms, we should continue to add the acronym in parentheses next the the definition, as it becomes unreadable otherwise**.**

Text Section Headings

Standard specifications have been established for Transactions text section headings. There are four levels of section headings with established specs: primary (section), secondary (subsect1), tertiary (subsect2), and quaternary (subsect3) heads.

Enumeration of section headings is desirable, but is not required. Follow the author's preference. However, the choice must be consistent throughout the paper. That is, if an author enumerates some but not all section headings, the remaining headings in the paper should be labeled so that all headings and all levels of section headings in the paper are enumerated.

Author enumeration notation that is not in IEEE style should be changed to IEEE style. For example, if an author labels primary headings with capital letters, they should be changed to Roman numerals to match IEEE style. The remaining style rules for each level of section heading as listed below should also be followed.

Primary headings (section) are enumerated by Roman numerals, centered above text, and set in 10-pt. and 8-pt. caps. Note that Introduction, Conclusion, and Acknowledgment are Singular heads. Example:

I. INTRODUCTION

Secondary headings (subsect1) are enumerated by capital letters followed by periods ("A.," "B.," etc.), flush left, italic, upper and lower case. Example:

A. Formal Frameworks

Tertiary headings (subsect2) are enumerated by Arabic numerals followed by parentheses. They are indented one em, run into the text in their sections, italic, upper and lower case, and followed by a colon. Example:

1) Sophisticated Local Control: Sophisticated local control is applied when …

Quaternary headings (subsect3) are identical to tertiary headings, except that they are indented two ems instead of one em, lower case letters are used as labels, and only the first letter of the heading is capitalized. Example:

a) Communication policies: Policies developed to improve communication …

Reference and Acknowledgment headings are unlike all other section headings in text. They are never enumerated. They are simply primary headings without labels, regardless of whether the other headings in the papers are enumerated. Example:

REFERENCES

ACKNOWLEDGMENT (note spelling here)

Appendix headings are a special case. The primary heading(s) in the Appendix or Appendixes (note spelling of plural) are set according to the usual style, except that there is flexibility in the enumeration of the heading. The author may use Roman numerals as heading numbers (Appendix I) or letters (Appendix A). Either is acceptable. The Appendix is not preceded by a Roman numeral. Follow the rules given earlier for labeling subsidiary heads. Note that if there is only one Appendix in the paper, leave the Appendix unnumbered and unnamed as is. (Appendix subheads should also not be enumerated in this case.) Examples:

APPENDIX

APPENDIX I
PROOF OF THEOREM

APPENDIX A
PROOF OF THEOREM

Headings for Theorems, Proofs, and Postulates: Some papers do not conform to an outline style for theorems and proofs that is easily transformed into the normal heading sequence. The preferred style is to set the head giving the theorem number as a tertiary heading (no Arabic numeral preceding) and the proof head as a quaternary head. This rule also applies to Lemmas, Hypotheses, Propositions, Definitions, Conditions, etc.

In-text references to text sections are written: "in Section II" or "in Section II-A" or "in Section II-A1." Capitalize the word "Section." Do not use the word "Subsection"; use "Section" and write out the complete citation.

Introduction

Initial Cap or Drop Cap: In full length papers and/or editorials (but not in short papers), the first letter of the Introduction is set as an initial cap, two lines deep (drop cap). After the cap, the next 8–12 characters (1–2 words) are capitalized. (Do not break up hyphenated words into cap and lower case sections—extend the caps if necessary.)

If it is not possible to use the first word or character of the Introduction as an initial cap (i.e., if the paper begins with a quotation mark), try rewriting the sentence and query the author. See Section II-A of this guide for type specs of the initial cap.

Text Equations

Consecutive Numbering: Equations within a paper are numbered consecutively from the beginning of the paper to the end. There are some Transactions in which an author's own numbering system such as numbering by section, e.g., (1.1), (1.2.1), (A1), is permitted.

Appendix Equations: Continued consecutive numbering of equations is best in the Appendix, but if an author starts equation numbering over with (A1), (A2), etc., for Appendix equations, it is permissible to leave the copy as is.

Hyphens and Periods: Hyphens and periods are accepted, if consistent in paper, e.g., (1a), (1.1), (1-1). This should be done consistently throughout the paper.

Appendix

Refer to the Appendix in text as "given in the Appendix." Note that the plural of Appendix is Appendixes. Also note that all figures and tables in the Appendixes must be labeled in consecutive order with the other figures in the paper. Never start a separate numbering system or group of numbers for the figures or tables in the Appendix section.

Acknowledgment

The placement of the Acknowledgment appears after the final text of the paper, just before the References and after any Appendix(es). The spelling of the heading for the Acknowledgment section is always singular, with no "e" between the "g" and the "m." As noted previously in the Text Headings section, the Acknowledgment head is a primary heading. Do not enumerate the Acknowledgment heading.

When citing names within the Acknowledgment, use first initials only, not full names. Drop Mr., Mrs., or Miss (list first initial and last name only). For Dr. or Prof., use the Dr. or Prof. title with each name separately; do not use plural Drs. or Profs. with lists of names.

All acknowledgments of financial support must be removed from the Acknowledgment section and placed in the first footnote/author affiliation.

Any acknowledgments of permission to publish and disclaimers to the content of the work made to/by the author's employer may be added as an Acknowledgment section.

Rewrite the Acknowledgment section to be read in the third person. Rewrite it even if the paper is given in the first person.

References

A few guidelines related to the editing of references are summarized here. See Section V of this manual for a more complete discussion of reference style.

The numbering of references is employed by citing one reference per number. Every reference in a Transactions reference list should be a separate number entry. Use of one reference number to designate a group of references is not preferred, and is discouraged. If the author-supplied reference list is unnumbered, the Staff Editor must provide numbers, or if the list contains multiple references, these should be separated and renumbered by the Staff Editor. If numbering or renumbering is necessary, then in-text references to the reference list must be checked and renumbered by the Staff Editor.

Footnotes or other words and phrases that are part of the reference format do not belong on the reference list. These full footnotes or extraneous phrases must always be removed from the list, changed into text or footnotes on the appropriate page, and the references renumbered (renumber reference citation in text as well). Even the words "For example" should not introduce references in the actual list, but should instead be included in parentheses in text (or in a footnote), followed by the reference number, i.e., "For example, see [5]."

Do not say "in reference [1] …"; rather, the text should be edited to read simply, "in [1] …" The author's name should not be included in a text reference with a number (i.e., "In Smith [1]") and should be changed to "in [1]" except in such cases where the author's name is integral to the understanding of the sentence (e.g., "Smith [1] reduced calculated time …"). Reference dates should not be used as reference identifiers and should be deleted in text except in rare cases where the date is somehow relevant to the paper's subject.

Sometimes an author will refer to a specific figure of a reference or to a specific page or equation from a reference. To avoid confusion, rewrite phrases such as "in Fig. 2 of reference [1]" to the IEEE cross-reference notation "in [1, Fig. 2]." Similarly, rewrite phrases such as "in equation (8) of reference [1]" to be [1, eq. (8)]. Other phrases may be rewritten as [1, Sec. IV], [1, Th. 4.2], or [1, Ch. 3].

If an author lists the same reference more than once on the reference list, giving a new reference number for each page or part of the same source that is cited, these separate references should all be made into one reference and the separate citations of pages, equations, etc., should be made in text using the notation explained in the previous paragraph.

If a reference author's name is mentioned in text, check its spelling against the reference list.

Text Citation of Figures and Tables

All first citations of figures and tables in the paper must be in numerical order. If a figure is not mentioned or if the first text mentions are not in order, call or query the author and/or renumber the figures where necessary. Citations to figures in text always carry the abbreviation "Fig." followed by the figure number. The abbreviation is used even when it begins a sentence.

Figures: If labeled, parts of figures (callouts) should be 8-pt. lower case Roman letters within parentheses. Whenever possible, all caption parts shown on the figure must be removed and keyed along with the caption.

The general style for captions is such that each caption number should be cited with the abbreviation "Fig." and the number, followed by a period, an em space, and then the text of the caption. The first word of the caption should always be capitalized, regardless of any style that may be chosen to list caption parts (a), (b), etc., if included. In general, do not use A, An, or The at the beginning of a figure or table caption. Example:

Fig. 1. Theoretical measured values of *n*.

There are several acceptable styles for listing the parts of the figure in the caption. Be consistent within each paper, but otherwise use whichever style is most convenient for the figure. Regardless of which caption notation is used, the citation of (a), (b), etc., should always appear before the corresponding caption part. Examples:

Fig. 1. Intercomplex crosstalk characteristics. (a) Electrode transmission. (b) Interelectrode crosstalk.

Fig. 2. (a) Variation of effective mode index with time. (b) Step-index change.

Fig. 3. Output resistance as a function of channel doping for 1-m-long gate. (a) InGaAs and (b) InP JFETs with pinchoff voltage as a parameter.

Fig. 4. (a) and (b) Plain and side views, respectively, of the experimental setup used to measure the effective diffraction loss which can be achieved using the feedback technique.

Do not use:

Fig. 1. (a) Electrode transmission. (b) Interelectrode crosstalk.

If a figure after reduction will run more than one 21-pica column in width, the caption should be flush left on 43 picas.

If parts of a figure after reduction will run the length of more than one page, the full descriptive part of the caption should be cited with the first part of the figure followed by the corresponding caption for the part. On the subsequent pages, the word (*Continued.*) will be placed under the carryover parts of the figure followed by a repeat of the full descriptive part of the caption and the corresponding caption for the carryover parts.

Captions for Landscape/broadside figures: The text should appear below the figures and facing outward at all times. Example:

Fig. 6. True and estimated spectra for a real data sequence. (a) True spectrum.

Fig. 6. (*Continued.*.) True and estimated spectra for a real data sequence. (b) Estimated with the periodogram.

Tables: The general style for table captions is such that each caption number should be centered above the table with the label TABLE (set in 8-pt. caps) and the enumeration given in Roman numerals. The descriptive text of the caption should be centered directly below the table number caption and is set in 8-pt. and 6-pt. caps. The captions are usually centered on 21 picas, unless the table will be wider than one column width, in which case the table caption should be centered on 43 picas.

The descriptive text of the table caption does not contain a period at the end of the caption, although punctuation may be necessary within the caption itself. In general, table captions should be set as an inverted pyramid.

As in figures, labeled parts of tables should be 8-pt. lower case Roman letters within parentheses. The style for listing the parts of a table in the caption and in text depends on whichever style is most convenient for the table. The most acceptable style is to follow the conventions for callouts of figures. Example:

TABLE I
PARAMETER VALUES

TABLE II
OPTIMAL WAVELENGTH AS A FUNCTION OF POLARIZER ANGLE. (a) WAVELENGTH FOR EXTERNAL CAVITY. (b) ESTIMATED WAVELENGTH FOR LASER DIODE

A single rule should be added above and below the table body. Use the **hrule** macro to create rules. The type specs for the text of a table is 8-pt. TR for full length papers, brief papers, and short papers.

The same rules as in figures apply for listing table part labels (callouts).

Table footnotes should be 8-pt. type and should be placed below the bottom rule of the table.

Obtaining permission to reuse copyrighted material

1) **Reusing IEEE graphics previously published in IEEE publications. Author should email IEEE Intellectual property department at: *copyrights@ieee.org*. In mose cases, the only requirements will be to give full credit to the original source and to obtain the author's approval (as a courtesy to the author). At the end of the caption, add the reference number of the papers from which the graphics are being used.**
2) ***Reusing graphics previously published in non-IEEE publications.* Author must have obtained permission to republish from copyright holder (in most cases, this is the publishing house (not the author of the paper). The wording is provided by the author (usually supplied by the publishing house itself). This text is added at the end of the caption.**

Photos and Biographies

IEEE Transactions author biographies are generally divided into three paragraphs. However, if appropriate information for each paragraph is not provided by the author, the biography may be only one or two paragraphs.

The author's photograph is sized at 6 picas wide by 7.5 picas deep and is surrounded by the biography.

The biography begins with the author's full name and IEEE membership history as listed in the *IEEE Membership Directory*. The author's name appears in boldface type and must match the byline. A nickname may appear within parentheses, e.g., Sung-Mo (Steve) Kang, but not in the byline. The format for listing the IEEE membership history is to list each grade of membership attained followed by an apostrophe and the year it was attained, with each year and grade combination separated from the others by an en dash. Note that if an author attains the same membership grade in more than one year, list only the first year that it was reached. Check the current membership listed with the biography against the byline.

Abbreviations for IEEE membership grades are: S (Student Member), A (Associate Member), M (Member), SM (Senior Member), F (Fellow), LA (Life Associate Member), LM (Life Member), LSM (Life Senior Member), and

LF (Life Fellow). Note that A stands for Associate, not Affiliate, Member. Affiliate memberships are not listed in the byline or biography membership history.

Delete all references to IEEE membership from the text of the biography.

First Paragraph: If provided by the author, the first paragraph may contain a place and/or date of birth (list place, then date). Next, the author's educational background is listed. When listing degrees earned, the biography should state "[S]he received the Ph.D. degree from …" (not "[S]he received [her] his Ph.D. degree from …"). Always add the word degree after a degree title if it is not included. Include the years degrees were received. If the author was educated overseas, the names of the degrees earned may not be familiar. Abbreviations for some common international and domestic degrees are:

Dipl.Ing., Diplom-Physiker, Dr. Ing., Dr. Phil., Dr. Eng., B.S., S.B., B.Sc.(Hons.), B.E.E., B.S.E., M.Eng., M.Sc.(tech.), M.S.E.E., M.S.E., Civilingenir, Lic.es Sci., Lic.es Lett.

Add the locations of universities and colleges the first time they are mentioned if not included (*refer to the University website for location*). For U.S. state-named universities, repeat the state name in the location, and included the country (e.g., University of Colorado, Boulder, CO, USA); but for city-named universities, repeat the name of the city when giving the location (e.g., University of Chicago, Chicago, IL, USA). For universities outside the U.S., give locations with the name of the city (postal abbreviations of Canadian Provinces, if used) and the country the first time.

Use lower case for the author's major field of study.

Second Paragraph: The second paragraph of the biography should list military and work experience, including summer and fellowship jobs and consultant positions. Job titles are capitalized. The current job must have a location; previous positions may be listed without one (retain if given). Do not abbreviate city names, Company, Laboratory, or Department. Use standard names for all countries. If there is space, information the author provides about

previous publications may be included at the end of this paragraph. Edit out long lists of published books or articles. Instead use the sentence s(he) "is the author of several books and many published articles." The format for listing publishers of an author's books within the biography is: *Title of the Book* (publisher name, year) similar to a reference. List author affiliations with non-IEEE journals. The author often notes current and sometimes previous research interests. If space is available, these may be retained; otherwise, edit out the prior interests and leave in the current. Any homepage of the author may be listed in the biography only.

Do not repeat the author's name in the second paragraph; use "he" or "she."

Third Paragraph: The third paragraph begins with the author's title and last name (e.g., Dr. Smith, Prof. Jones, Mr. Kajor, Ms. Hunter). It lists the author's memberships in professional societies other than the IEEE and his or her status as a Professional Engineer if given. Finally, list awards and work for IEEE committees and publications, affiliation with other professional societies, and symposia.

Personal notes such as hobbies should be deleted from the biography. Examples:

Michael C. Author, Jr. (S'87–A'89–SM'90–F'93) was born in New York, NY, USA, on March 2, 1969. He received the B.S. degree in applied mathematics from the University of Michigan, Ann Arbor, MI, USA, in 1989, the M.S. degree in mathematical physics from Stanford University, Stanford, CA, in 1991, and the Ph.D. degree in electrical engineering from the Massachusetts Institute of Technology, Cambridge, MA, USA, in 1995.

From 1993 to 1995, he was with the Raytheon Corporation, Bedford, MA, USA. From 1995 to 1996, he was with the General Electric Space Laboratory, Valley Forge, PA, USA. During 1996–1997, he was a Fulbright Lecturer at the University of Madrid, Madrid, Spain. He is currently an Associate Professor of Electrical Engineering at the University of Maryland, College Park, MD, USA. His research has been concerned with reentry plasma effects and microwave diagnostics of plasmas.

Dr. Author, Jr. is a Registered Professional Engineer in the State of Pennsylvania.

Katsunari Okamoto was born in Hiroshima Prefecture, Japan, on October 19, 1949. He received the B.S. degree from Rutgers University, New Brunswick, NJ, in 1979 and the M.S. degree from Monmouth University, Long Branch, NJ, USA, in 1984

He was a Postdoctoral Fellow at the University of Tokyo in 1978. He joined the Ibaraki Electrical Communication Laboratory, N.T.T., Ibaraki-ken, Japan, in 1979, where he was engaged in research on the optimum waveguide structure of optical fibers. At present, he is a Member of Technical Staff at Bellcore, Red Bank, NJ, USA.

Dr. Okamoto is a member of the Institute of Electronics and Communication Engineers of Japan.

NOTE: If no photograph is available or the journal does not require them, the biography is set 8/9×21 picas.

Squibs

If no biography or photograph is available, a squib is used. The phrase is run at 8/9 ×21 picas, flush left. Example:

James A. Author, (S'87–A'89–SM'90–F'93) photograph and biography not available at the time of publication.

D. Other Text to Edit

Footnotes

Footnotes should be numbered in consecutive order throughout the text. In full length, brief, and short papers, they are 8/9 TR ×21. Each footnote should be a new paragraph. The footnote numbers are superscripts in text and in the actual footnotes. In text, place the superscript footnote numbers after punctuation such as periods, commas, and parentheses, quotation marks, but generally before dashes, colons, and semicolons in a compound sentence. The footnotes should be placed at the bottom of the text column in which they are cited.

Lists in Text

There are three types of lists in text: run-in lists, displayed lists, and where lists. The ordering of labeling for all lists is 1), 2), 3) followed by a), b), c), and then i), ii), iii). All are Roman; note single parenthesis. The order of indentation is 1 em, 2 ems, 3 ems.

Run-In Lists: Lists that run in with text must be grammatically correct. They must also be introduced by a colon, separated by semicolons, and have parallel construction. Example:

> The carrier–phonon interaction matrices are given by: 1) polar optical phonons; 2) deformation potential optical phonons; and 3) piezoelectric acoustic phonons.

Displayed Lists: Lists that are displayed may be either incomplete sentence items or full sentence items. Incomplete sentence items contain a few items, are very short, are grammatically parallel, and are handled in two ways. If the items are not mentioned in the text or are less than three items, run in as shown in the example for run-in lists. If, however, the items are mentioned later in text, introduce the item with a colon, number the items, begin

the entry with a lower case letter, and set block paragraph style. Use semicolons between items and a period at the end of the list. Example:

This operating scenario provides all of the contributors necessary to configure a resonant power distribution system:

1) the implementation of capacitor power factor correction on the power line;
2) the presence of nonlinear load;
3) the tuning of the power line by the load adjustments to a frequency present in the nonlinear generator.

Incomplete sentence items that are mentioned in text may also be formatted as shown in the example for full sentence items.

Full sentence items may be introduced by "that" or other words taking object and are rewritten to end with a period. If the items are introduced by a sentence ending with a colon, change the colon to a period. Number all items, start each entry with a capital letter, and end with a period. Example:

The synthesis is performed in three major steps.

1) Geometry is generated for the selected module variants.
2) Shape variants using different fold counts for resistors are generated for each module.
3) Routing and postprocessing complete the final layout.

Where Lists: Where lists define variables in the equations preceding the list. They are characterized by incomplete sentences and follow the same rules as *Nomenclature* lists, with the following exceptions.

1) There is no primary heading.
2) The left-hand side is indented one em space.
3) The first letter on the right-hand side is lower case.
4) Each item ends with a semicolon (except for the last item, which ends with a period).
5) The lists are at least three items long; if fewer than three items, the list is generally run in paragraph form. Follow author preference for run-in or displayed lists. Example:

where

$\Delta\upsilon_S$ $= \Delta V_S \cos(\omega' t + \phi')$;
ΔV_S amplitude of supply voltage flicker;
ω' angular frequency of supply voltage flicker;
V_{Sf} supply voltage amplitude;
ω supply angular frequency.

Note the alignment of the equal sign with the right-hand side.

Lists having mixed items (start with an incomplete item, then have a full sentence explanation) are treated as a full sentence item list.

Note Added in Proof

An author may wish to add a brief note in the proof stage, citing results obtained after acceptance of the paper or mentioning additional references that have come to the author's attention since acceptance. This added information is usually inserted at the end of the Conclusion section of the paper or in whatever section contains the last paragraph of the main body of the paper. As long as the note is not a major change to the paper or more than a few lines long, the addition generally does not require further review procedures. Use the tertiary heading "Note Added in Proof:" (run into text), but set in boldface italic with no enumeration and an em space indent. Example:

Note Added in Proof:

E. Other Types of Papers

Editorials

This category of papers includes the various types of introductory papers, such as Editorials, Guest Editorials, Forewords, Introductions, and Editorial Announcements that appear at the beginning of issues as non-technical introductory material. A discussion of the papers in an editorial should follow the order of the table of contents. The editorial may contain illustrations, citations, and references. Follow general rules for editing. An acknowledgment does not contain a heading. If a heading is required, set as a separate section and follow the primary heading specs without enumeration. *Note:* In the Editorial, the Acknowledgment does not need to be in third person.

Procedures and style for Editorials include the following.

General Specs: Type specs are the same as for full length papers. The initial cap remains the same. The title of the Editorial is set in 24 pt. as in a full length paper title. There is no Abstract. There is a rule above the DOI.

NOTE: Editorials generally do not carry a section heading above the title. Center the word "Editorial" in 24-pt. type above the title.

Byline: Note that the byline for the Editorial does NOT appear below the title as it does in a full length paper. The name of the author of the Editorial or Foreword (usually the Editor or Guest Editor) (called "signature") appears at the end of the Editorial, 6 pts. below the end of text, in 10-pt. and 8-pt. caps. Stack and align the name or names with an identifier such as "Guest Editor" which should appear in italics next to the name. The affiliation should appear as a "list" under each name. The right edge of the longest of these aligned lines should then be flush right at the end of the last column of text. Example:

M. K. SAIN, *Guest Editor*
Department of Electrical Engineering
University of Illinois
Urbana, IL 60617 USA

Biographies and Photos: Biographies and photographs that appear with Editorials are set differently from regular biographies and photos in the Transactions. They are, for example, not 8/9 type, but are the same type size as the text of the Editorial (normally 10/12). In addition, Editorial biographies are: first 13 lines ×32, rest at 43 picas. The photos are reduced to 9 1/2 ×12 picas.

Copyright Line: Run a copyright line for the Editorial, even if no copyright form is submitted by the Editor.

Brief Papers

Brief papers are set up like full length papers, except that the paper title is set in 16-pt. TR, centered on 43 picas. These papers do contain Abstracts and also take the initial cap. The byline includes the membership grade. See Section I-B. They do not contain biographies and photographs of the authors. Footnotes, references, and figure/table captions are 8/9 TR. The papers carry issue running heads on both left and right pages.

Short Papers, Correspondence, and Communications

Short papers are set up like full-length papers, except that usually they are 9/11 type and their titles and bylines are smaller type and run across only one column. Usually, short paper titles are 10/12 bold with bylines 9-pt. upper and lower case. These papers do contain Abstracts, but do not take the initial cap. The membership grade is not included in the byline. Author biographies and photos are not included. Footnotes, captions, references are 8/9 type.

Comments and Replies

Comments are generally in response to a previously published paper. The Comments and Author(s) Reply are short papers published together in that the "Reply" is in response to the Comments. These short items may appear without Abstracts. A special format applies for Comments and Author(s) Reply. Begin the first sentence with "In the above paper [1], ..." Reference [1] is the commented paper's citation, will appear as Reference [1] in the References section. Include a copyright line for Comments and Replies even if no new forms are required from the author(s). Some publications refer to these articles as Discussions and Closures.
Index Terms are optional.

Example of the Comments:

Title: Comments on "Harmonics: The Effects on Power Quality and Transformers"

Byline: Keith H. Sueker

Footnote:
Manuscript received July 15, 1995.
The author is with the School of Engineering, Vanderbilt University, Nashville, TN 37235 USA (e-mail: k.sueker@ieee.org)..
Digital Object Identifier 10.1109/JQE.2006.12345

NOTE: The footnote here relates back to the original paper being commented upon. The title is not repeated.

Example of the Reply:

Title: Authors' Reply

Byline: Robert D. Henderson and Patrick J. Rose

Footnote:

Manuscript received October 3, 2009; accepted October 5, 2009. Date of publication November 2, 2009; date of current version November 25, 2009.

The authors are with RDH Consultants, Inc., Charlotte, NC 28241 USA.

Digital Object Identifier 10.1109/JQE.2006.12348

Corrections/Errata

The format for a Corrections is basically the same as for the Comments, except that a Corrections does not carry a Reply. Run a copyright line with a Corrections even if no new forms are received from the author(s). Corrections that has been generated in-house may be labeled "Erratum," and should also follow the standard format, although the byline may be omitted because the IEEE Transactions/Journals Department assumes authorship of the Corrections. *Note:* The plural form of the word is used in the title, even if there may be only one correction. Example of a "Corrections" article:

Title: Corrections to "On the Exact Realization of LOG-Domain Elliptic Filters Using the Signal Flow Graph Approach"

Byline: Costas Psychalinos and Spiridon Vlassis

Footnote:

Manuscript received May 1, 2003.

The authors are with the Physics Department, Electronics Laboratory, Aristotle University of Thessaloniki, GR-54124 Thessaloniki, Greece (e-mail: cpsychal@physics.auth.gr; svals@skiathos.physics.auth.gr).

Digital Object Identifier 10.1109/TCSII.2003.814788

Example of Errata:

Title: Erratum

Byline: There is no byline for an erratum, as this is created if the department (staff/vendor) is responsible for the error.

Footnote:

Manuscript received January 20, 2004.
Digital Object Identifier 10.1109/TVLSI.2004.830244

Book Reviews

Some publications carry Book Reviews. The type specs of the text are the same as for a short paper or correspondence; however, the title runs additional information about the book that is being reviewed. The title is separated from the book's author by an em dash. Included in parentheses is the city of publication, publisher, date of publication, the total number of pages of the book, and the price. Outside of the parentheses is the reviewer's name in italics. Some Transactions carry a short biography of the reviewer under the title. Book Reviews appear in the table of contents with a listing for both the author of the book and the reviewer. Example:

Title and Byline:

The Analysis and Design of Pneumatic Systems—B. L. Andersen. (New York: Wiley, 1987, 302 pp., $65.00.) *Reviewed by J. L. Shearer*.

First Footnote:

The reviewer is with the College of Engineering, Idaho State University, Pocatello, ID 83209 USA. Digital Identifier 0090-6778/TNN.2005.828433.

Table of Contents:

The Analysis and Design of Pneumatic Systems—B. L. Andersen . . . . . *Reviewed by J. L. Shearer* 123

Obituaries/In Memoriam

Obituaries are usually run as the first page of an issue, like an Editorial. They are set up with the same specs as Editorials. Obituaries normally are formatted as one column, at 36 picas width. They may carry a photo of the person being memorialized, usually the same size as in Editorials (9-1/2 ×12 picas). The name appears above the photograph in 12-pts., boldface. The photograph is generally centered above the text. The years of birth and death are generally cited at the bottom of the photo in 12-pts., boldface type in parentheses. The obituary is normally set as one column, across a 36-pica width.

F. Editing Style for Transactions

The following provides a summary of the most important style distinctions to be made in the final copy editing of a Transactions paper.

Acronyms

Define acronyms the first time they appear in the Abstract as well as the first time they appear in the body of the paper, written out first as part of the sentence, followed by the acronym in parentheses. Widely used or familiar terms should be defined (see Section VIII-F of this manual for some terms that must be defined the first time they are used in text). Acronyms do not need to be defined in the text if mentioned in the Nomenclature. Coined plurals or plurals of acronyms do not take the apostrophe as per *Chicago Manual of Style*. Example: FET (singular); FETs (plural).

Indefinite articles are assigned to abbreviations to fit the sound of the first letter: an FCC regulation; a BRI.

Spelling

Obviously, in reading and editing a paper, misspellings and typographical errors are top priority for correction. Note that IEEE Transactions use the first spellings indicated in our first reference, the most current edition of *Webster's New Collegiate Dictionary.*

British Spellings and Terminology: Change all British spellings to American spellings. In particular, watch for "our" endings in words like "behaviour" (change to "behavior") and "re" endings in words like "centre" (change to "center"). Also watch for the use of "s" rather than "z" in words like "polarisation" (change to "polarization"). See "Common Hyphenations and Misspellings" in Section VIII-E.

Trademarks

The trademark symbol, ™ and ® are no longer used. Capitalize the first letter in the trademark name only. Follow the author's notation. The symbols ™ and ®, which often accompany registered trademark names on product packaging and in advertisements, need not be used in running text.

Plurals

Plurals of units of measure take the "s." For example, the plural form of 3 mil is 3 mils; 3 bits/s instead of 3 bit/s. The plural of calendar years do not take the apostrophe before the "s." For example, the plural form of 1990 is 1990s.

Hyphenation Rules

For hyphenation and spelling guidelines, IEEE style follows: 1) the list of preferred spellings and hyphenated words; 2) the guidelines discussed in the Grammar and Usage in Transactions section of this guide; and 3) the first version of the spelling given in *Webster's Tenth New Collegiate Dictionary*. Do not hyphenate most compound modifiers if they occur after the noun being modified, even if hyphenating them before the noun. "Except for *cooperate* and *coordinate*, use a hyphen if the prefix ends in a vowel and the word that follows begins with the same vowel."

Example:

The plan was well prepared. The man was little known. The woman was better qualified. His boat was 42 feet long. He has a 42-feet-long boat. T was the data period of the 40-Gb/s data signal. The 160-GHz MLLD was a diode in which a 40-nm-long saturable absorber was located.

Follow the author's preference if the result is consistent and clear. The most important hyphenation guideline is to be certain that the hyphenation for a particular word or group of adjectives is consistent within a particular paper.

The En, Em, or Two-Em Dash

The en dash represents the words "to," "through," or "and." Use it between page numbers, reference numbers, figure citations, academic years, proper nouns, names, a range of values, or for opposites. Examples are: pp. 10–15, 1984–1990, Jones–Smith theorem, input–output, voltage–current curve, analog–digital converter, 10–20 cm. Also, use the en dash in chemical abbreviations such as Ni–Al–Si. When using the en dash to represent a range, if the word "from" occurs, the word "to" must be used rather than an en dash (ranges from 5 to 50 times).

The em dash is used in ordinary writing to mark a suspension of the sense. It is also used like parentheses, to mark a subordinate thought within a sentence.

Grammar

Check closely for lapses of clarity, subject/verb agreement, and parallel clause construction. See samples below and a more detailed discussion in the Grammar and Usage in Transactions section of this guide.

Number:

A number of samples were taken …

A number *N* expressing the relation *x/y* is chosen …

Data:

The data were collected … (always plural)

Series:

A series of tests was run … (always singular with "a")

Some, All, Half:

Some (all, half) of it is …

Some of them are …

Quantity:

Three volts was applied …

Four grams was added …

Contractions

Contractions such as "don't" and "can't" are not used in technical text. Change to "do not" and "cannot."

Note: "don't care," "best-case," and "worst-case" are allowed and used often in journals like TCAD.

Capitalization

In general, discourage capitalization in text except where absolutely necessary. For example, only proper names attached to the names of laws, principles, theorems, etc., get capitalized (Boyle's law, Newton's first law, etc.). Computer commands are in computer tags and remain small caps; most computer languages (Cobol, Java, LISP, PERL, etc.) are upper and lower case. In text, the names of IEEE publications are 10-pt. and 8-pt. caps: TRANSACTIONS, IEEE SPECTRUM, PROCEEDINGS OF THE IEEE.

Math

Some brief guidelines for editing math are explained here. For further discussion, see Section IV of this guide.

1) Variables are set italic; vectors are usually boldface italic (if distinguished by the author).
2) Remove commas around variables in text.
3) If not included by the author, always add a zero before decimals, but do not add after (e.g., 0.25).
4) Stet the use of the author's parentheses and brackets (i.e., [0,1) may be correct).
5) Spell out units used in text without quantities (e.g., "where the noise is given in decibels"). For units appearing with quantities, use the standard abbreviations listed in Section VIII-G.
6) Numbers and units used as compound adjectives may be hyphenated only if needed for clarity: 10-kV voltage, 5-in-thick glass. Do not insert a hyphen when they are not used as adjectives: a current of 2 A, a line 4 in long, a length of 3.05 mm.
7) Use thin spaces instead of commas between numbers in tens or hundreds of thousands (e.g., 62 000, 100 000, but 4000).
8) Always change μ to μm, "micron" to "micrometer," "submicron" to submicrometer." Always change cycle per second to hertz (Hz); cycle per second may not appear as cycle, cps, c/s, csec. See "Table of Units and Quantity Symbols" in Section VIII-G.
9) In text, break down (shill) multiline (built-up) fractions so they can be placed on one line. Sometimes parentheses may need to be added to distinguish between expressions, especially when a minus appears [e.g., $\frac{a}{b-c}$ becomes $a/(b-c)$], $\frac{c-d}{k+4}$ becomes $\left[(c-d)/(k+4)\right]$.
10) In exponential expressions [e.g., $e^{-(jwt)xyzk}$], there are sometimes long and complicated superscripts. These may be brought down on line with the substitution of "exp" for "e" and the addition of square brackets (e.g., exp[–(*jwt*)*xyzk*]).
11) Distinguish between lower case italic "ell" or "oh" versus one and zero.
12) Always use numerals for numbers written with units. Otherwise, spell out numbers below 11, and use numerals for others unless they begin a sentence or are combined in a phrase (gives 7 to 13 times more).
13) Use zeroth, first, *n*th, (*k* + 1)th, not 1st, 2nd, (*k* + 1)st, etc.
14) Use the word "equation" at the start of a sentence, but in text, just use the number [e.g., in (1)].

15) Use the $ symbol versus “dollars” in sums of money.
16) The slash (/) is acceptable in place of the word “per” when it lends to the clarity of the sentence. For example: “the ratio of 16 samples/s to 35 samples/s as compared to …”

Ellipses: In mathematics an author may use dots (ellipses) to show continuation in an expression (e.g., x_2, ..., x_{16}). The type of mathematical expression will determine whether the ellipses points are set on the baseline or centered. If commas or operational signs are present, they are placed after each term and after the three ellipses points (almost all expressions will use three points). If operational signs are used, the ellipses are centered on the operator. When commas are used the ellipses are on the baseline. Example:

$x_1, x_2, \cdots, x_n$ not $x_1, x_2 \ldots x_n$

$x_1 + x_2 + \cdots + x_n$ not $x_1 + x_2 + \cdots x_n$

$y = 0, 1, 2, \ldots$ not $y = 0, 1, 2 \ldots$

$x_1 x_2 \cdots a_n$ not $x_1 x_2 \cdots a_n$

Conditions: In displayed equations, there should be a comma or parentheses and a two-em space between the main expression and the condition following it. Example:

$$x = yn^{-2} \qquad \forall n = 3$$

$$x = yn^{-2}, \qquad \text{if } n = 3 - y^{-4}.$$

$$x = yn^{-2}, \qquad y = 3, \ldots, m$$

NOTE: There is no comma before a for all “ $\forall$ ” symbol.

Compound Units: Compound units should be separated by a multidot (e.g., 4 V · s), but leave the slash if the author uses it since this has a different meaning (for instance, 6 V/s means volts per second). It is also possible to use a negative power to put a unit in the denominator: cm/s^2 = cm · s^{-2}. Parentheses may be used to clarify a unit: g/(cm · s) or g · cm^{-1} · s^{-1}.

Use of Periods and Commas: Equations which conclude a sentence should end with a period. The only time punctuation is used to lead into an equation is when the lead-in text is a complete sentence. Example:

where we had the following:

$$x = Y + Z.$$

or where, i.e.,

$$x = Y + Z.$$

Commas appearing at the ends of equations are deleted unless they are critical to the punctuation of the sentence containing the equation.

Equation Numbers

Check that equation numbering is consecutive, that it appears flush right on line with the last line of an equation, that there are no repeats or missing numbers, and that a correct numbering style has been used.

Displayed Equations

Material in displayed equations is automatically italic unless otherwise indicated by the author. Some simple general rules apply. All variables are italic. Function names and abbreviations are Roman, as are units, unit abbreviations, complete words, and abbreviations of words. Superscripts and subscripts follow this same formula: when they are variables, they are italic; when they are abbreviations of words (such as “in” and “out” for input and output), they are Roman. Single-letter superscripts and subscripts may be italic even if they are abbreviations, unless this leads to inconsistency between italic and Roman characters for similar types of subscripts.

Typical Problems

Which does the author mean: zero or “oh”? one or “ell”? subscript variable or on line? A general guideline to help resolve these questions before querying the author is to read carefully through the paper—does the author mention “O” for output or use a series of numbers like 0, 1, 2,?—and look through the illustrations—does V_s appear in the figures or is it *Vs*? This may provide clues.

G. General Layout Rules

1) Normal page depth for a Transactions is 60 picas (called even).
2) Pages may run one line long (61 picas) or short (59 picas), but facing pages (left and right) must be the same depth.
3) Transactions papers are set in a two-column format. Each column is 21 picas wide, with a 1-pica space between the two columns, giving a total page width of 43 picas.
4) Specifics of type area spacing are approximately 18 pts. between text and footnotes or figures and text, 6 pts. above and below equations and lists, 12 pts. above primary heads, at least 6 pts. above secondary heads, and 3 picas between biographies.
5) Figures and tables are placed at the tops of columns as close to their first mention as possible, but preferably after the mention.
6) Figures and tables progress vertically, not horizontally, on pages.
7) Footnotes must appear at the bottom of the column where they are first mentioned.
8) There must be at least two or three lines of text under a head at the bottom of a column.
9) Never leave widows at the tops of columns when breaking text. (A “widow” is any single last line of a paragraph, even if it is of full column width.) The exceptions are when widows are used to introduce equations or when they are in the Reference section.
10) Avoid breaking multiline equations so that one line appears at the bottom of a column and the others at the top of the next column.
11) The starting page number is determined by checking the previous issue—it is the next page number after the last page of the preceding issue, including any fillers. Issues beginning a new calendar year always start with page 1.
12) Obituaries/In Memoriam(s) are articles formatted on 36-pica width.

III. GRAMMAR AND USAGE IN TRANSACTIONS

A. Rules of Grammar

The principles of style given below aim to concentrate on fundamentals of modern usage. Particular emphasis is given to the rules most commonly violated.

1) **Form the possessive singular of nouns by adding's** (*Avogadro's theorem*).
2) **In a series of three or more terms, use a comma immediately before the coordinating conjunction** (*usually and, or,* **or** *nor*).
3) **Enclose parenthetic expressions between commas** (
4) **Use the semicolon, not the comma, to separate two complete sentences which form a compound sentence.**
5) **Use a colon after an independent clause to introduce a list.**
6) **Punctuation always goes inside quotation marks, except for the colon and semicolon.** Use single quotation marks around quotes within quotes. Quotes may be used around a new or special usage of a term the first time only, but use of quotes in this manner should be kept to a minimum.
7) **Do not use double parentheses in text expressions, but keep them in math.** For example, (see (10)) should become [see (10)].
8) **All acronyms and numerical plurals do not use apostrophes,** i.e., *FETs, 1980s*.
9) **Compound nouns made from a one-syllable verb and a short adverb are one word when found that way in the dictionary** (setup, takeoff, breakup). Compound nouns are likely to be two words, without a hyphen, or one word (bandwidth, bypass, flowchart, phase shift, sideband, standing wave). Compound nouns of more than two words can be hyphenated.
10) **A pair of words, modifying a third word separately, does not get a hyphen** (a tall water tower, a hot metal cylinder). If the first word modifies the second, and the pair together modify the third, there is a hyphen between the pair (a high-frequency signal, a second-order equation). The exception to this is the adverb ending in "ly," which needs no hyphen to join it to the next word.
11) **A hyphen is not used after the comparative or the superlative** (a higher order equation, a worst case value, nearest neighbor method). Do not hyphenate chemical compounds (sodium chloride crystals). Alloys and mixtures take the en dash (Ni–Co, He–Ne laser).
12) **Do not use commas between adjectives** (a planar equiangular spiral antenna).
13) **Do not hyphenate predicate adjectives** (… is well known, …is second order).
14) **Compound verbs are generally hyphenated** (arc-weld, freeze-dry). Keep the hyphen when using the participles of such verbs as adjectives (freeze-dried, arc-welded). However, verbs with up, out, down, off, on, etc., do not have a hyphen, although the nouns formed from them may be hyphenated or one word (Verb: set up, break down, read out; Noun: setup, breakdown, readout).

B. Words Often Confused

Affect: to change or modify (verb).
Effect: result (noun); cause (verb).

Alternate: a substitute.
Alternative: a matter of choice.

Among: involves more than two things.
Between: involves more than two things, but considers each individually.

Compare to: point out resemblances between different objects.
Compare with: point out differences between same objects.

Compose: a set composed of members.
Comprise: a set comprising members; members comprising a set.

Farther: distance.
Further: quantity.

Fewer: modifies plural nouns specifying countable units, e.g., fewer tubes.
Less: modifies singular mass nouns and singular abstract nouns, e.g., less air.

Imply: something suggested though not expressed.
Infer: something deduced from evidence.

Number: a large number of people.
Amount: a large amount of water.

Principal: chief, main, most important (adjective).
Principle: a rule (noun).

Precede: come before.
Proceed: continue, advance.

That: (defining, restrictive).
Which: (nondefining, nonrestrictive)

IV. EDITING MATHEMATICS

A. The Language of Math

When editing technical publications it is important to remember that the mathematics often carries as much if not more meaning than the body of text itself. Therefore, it is critical that the grammar of an equation be taken into account when editing.

Most equations should read like a sentence. They should contain a noun and a verb and often contain adjectives, prepositional phrases, conjunctions, and conditions. Equations also contain punctuation. When math occurs along with text it shares the grammatical characteristics of the text. A displayed expression may be a main or subordinate clause, an expression in apposition, a direct object, an item in a list, or the object of a preposition. **Use comma at end of introductory sentences after: i.e., e.g., "Hence" or "That is." Use a colon after words such as "following" or "as follows."** There should be no punctuation after forms of the verb to be, or between a verb and its object or a preposition and its object. IEEE style dictates that the only punctuation used at the end of an equation is a period. There is, however, other punctuation permitted in the equation itself and between an equation and its condition. This interior punctuation contains mathematical meaning and must not be changed.

Some examples of interior punctuation are as follows.

Mathematical Ellipses:

$$I = 1, 2, 3, \ldots, n$$

NOTE: *Only three dots* are used and they are enclosed by commas and are on the baseline.

Matrix:

$$C_{\mathrm{Eopt}} = \begin{bmatrix} -4.65E^{+0} & -1.07E^{-1} & -1.42E^{-1} & -9.50E^{-4} & 2.52E^{+1} & 3.36E^{+0} \\ 1.97E^{+0} & 1.44E^{-1} & 8.80E^{+0} & 5.88E^{-2} & 2.14E^{+1} & 1.46E^{+0} \\ -1.62E^{+0} & -1.10E^{-1} & 1.01E^{+1} & 6.27E^{-2} & -1.92E^{+1} & -1.37E^{+0} \end{bmatrix} \quad (1)$$

NOTE: There is a centered operator, equation number, and period.

Parenthetic Statement:

$$v(t) = u(t), \qquad t = 1, 2, \ldots, m.$$

NOTE: There is a 2em space after the comma and before the condition $t = 1, 2, \ldots, m$. Multiple conditions should be separated with a semicolon, with a comma at the end of the equation, a 2em space, and the condition aligned on the operator.

B. In-Line Equations and Expressions

An inline equation is an equation within text or part of a paragraph. It is not displayed.

Rule 1: Equations appearing in text should be broken after a verb or an operator, meaning, if at all possible, the verb or operator should remain on the top line of text.

Rule 2: Fractions should not appear stacked in line. $\frac{(xy + 6\alpha)}{xy}$ should be written as $(xy + 6\alpha)/(xy)$.

Rule 3: Collective signs should not appear with limits to top and bottom, but to the side instead.

$\sum_{i=0}^{i=\infty}$ should be written as $\sum_{i=0}^{i=\infty}$.

Rule 4: Use Roman function exp instead of *e* followed by a lengthy superscript. $e^{(zx^2 + y)(\alpha - 2yx) + zx}$ should be written as $\exp[(zx^2 + y)(\alpha - 2yx) + zx]$.

Rule 5 (optional): Avoid square roots (radical signs) having long bars. $\sqrt{(x + \alpha)}$ should be rewritten as $(x + \alpha)^{1/2}$.

C. Break/Alignment Rules

Rule 1: Break equations at verbs and align on same when possible for a displayed equation.

$$\begin{aligned} A &= (5\alpha + x) + (10y + \beta)^2 \\ &\geq (5x - \alpha + y + x^2) \\ &\equiv B^2 \end{aligned}$$

Rule 2: In equations with one verb, break at operators and align to the right of verb.

$$A = (5\alpha + x) + (10y + \beta)^2 - (5x - \alpha + y + x^2)$$

Rule 3: Separate all equations with 1) an em quad if they fit on one line or 2) stack and align on verb.

$$x = (-b + 4ac) \quad y = (a - 2bc)$$
$$z = (-c + 3ab)$$

*Rule 4:*An equation that will fit conveniently on two lines without further breaks should be broken at the verb and aligned flush left/flush right over the column width.

$$2xy = \frac{(-c + 3ab) + (a - bc)^2 - (b - 2c)}{(4ac + 3bc) - (2c + 3ab)}$$

Rule 5: When breaking an equation within fences, break at an operator and align inside the left-hand fence.

$$x = \left[\left(\frac{-c + 3ab}{-bc}\right) - (b - 2\alpha) + \left(\frac{4ac + 3bc}{ac}\right) - (2c + 3ab)\right]$$

NOTE: Pairs of fences should match in size and be proportional to the math within.

Rule 6: A period is placed at the end of a fraction, case equation, or closed delimiters, shown as

$$2xy = \frac{(-c + 3ab) + (a - bc)^2 - (b - 2c)}{(4ac + 3bc) - (2c + 3ab)}.$$

$$x = \left[\left(\frac{-c + 3ab}{-bc}\right) - (b - 2\alpha) + \left(\frac{4ac + 3bc}{ac}\right) - (2c + 3ab)\right]$$

NOTE: Pairs of fences should match in size and be proportional to the math within.

D. Exceptions and Oddities

Right to Left Equations: Equations in which the verb appears in the right half of the statement are broken before an operator and aligned to the left of the verb.

$$5\alpha + x + 10y + \beta^2 + z = x$$

Solidus as Operator: Break after a solidus and align the next line to the right of the verb.

$$A = [(2z - 5\alpha + x)\,(xy + 6\alpha)] / [(xy + 6\alpha)]$$

Implied Product: When a set of fences is followed directly by another set of fences, the equation may be broken between them, provided a multiplication sign (×, ·) is inserted. Alignment is to the right of the verb as for other operators.

$$x = (-b + 4ac)\,(a - 2bc) \times (-c + 3ab)$$

Integrals and Differentials: If an equation containing an integral must be broken before the differential expression (see Section VIII-G: Glossary), break at an operator and align to the right of the integral. It is preferential not to break this type of equation until a differential occurs, then break after the differential expression.

Preferential

$$x = \int_1^0 \frac{1}{2} + \left(\frac{n-1}{n}\right) - dy A_0 + (2x - 3zy)$$

If necessary

$$x = \int_1^0 \frac{1}{2}\left(\frac{n-1}{n}\right) - dy\, A_0 + (2x - 3zy)$$

E. Headings for Theorems, Proofs, and Postulates

Some papers do not conform to an outline style for theorems and proofs that is easily transformed into the normal heading sequence. The preferred style is to set the head giving the theorem number as a tertiary heading (no Arabic numeral preceding) and the proof head as a quaternary head. This rule also applies to Lemmas, Hypotheses, Propositions, Definitions, Conditions, etc.

In-text references to text sections are written: "in Section II" or "in Section II-A" or "in Section II-A1." Capitalize the word "Section." Do not use the word "Subsection"; use "Section" and write out the complete citation.

F. Text Equations

Consecutive Numbering: Equations within a paper are numbered consecutively from the beginning of the paper to the end. There are some Transactions in which an author's own numbering system such as numbering by section, e.g., (1.1), (1.2.1), (A1), is permitted.

Appendix Equations: Continued consecutive numbering of equations is best in the Appendix, but if an author starts equation numbering over with (A1), (A2), etc., for Appendix equations, it is permissible to leave the copy as is.

Hyphens and Periods: Hyphens and periods are usually removed from equation numbers, i.e., (1a) rather than (1-a) and (2a) rather than (2.a). This should be done consistently throughout the paper.

G. Reminders

Angle Brackets: Angle brackets are not the same as greater than and less than signs.

Vectors: Vectors are usually made boldface italic (if distinguished by the author).

Thin Spaces and Roman Functions and Differentials: Thin spaces occur on either side of both functions and differentials.

Incorrect

$$\sin t_t = \log \mu r$$

Correct

$$\sin\, t_t = \log\, \mu r$$

Incorrect

$$x = \int_0^x dx A_0 + \partial z \beta$$

Correct

$$x = \int_0^x dx\, A_0 + \partial z \beta$$

However, a thin space is not necessary when functions and differentials are preceded or followed by verbs or an operator.

H. Short Reference List of Italics, Roman, and Small Capitals

Italics	Roman	Small Caps
RC	p-n	A.M., P.M.
RL	p-i-n	NOR
I-V	p^{+}-n-p^{++}	OR
LC	and variations thereof	ORing
S/N	(don't forget the hyphen)	ORed
f/22	SNR	AND
et al.	O ring	NAND
in situ	T junction	ADD
inter alia	Y-connected circuit	DIFFER
in toto	class-A amplifier	EXTRACT
in vivo	2N5090 transistor	XOR
in vitro	,e.g.,	EXCLUSIVE OR
a priori	,i.e.,	DIMENSION
a posteriori	viz.,	GO TO
	Fortran IV	DO
	Algol 60	READ
	Cobol	WRITE
	Atlas Autocode	PRINT
	PL/1	CONTINUE
	BAL	PAUSE
	cf.,	FORMAT
	Tr	END
	Ke	ON
	Im	OFF
		MOSFET
		IGFET
		IMPATT
		TRAPATT
		ONE
		ZERO
		BARITT

I. Functions and Operators Always Set in Roman Font

ad	(adjoint)
arg	(argument)
cos	(cosine)
cosh	(hyperbolic cosine)
cot	(cotangent; do not use ctg)
coth	(hyperbolic cotangent)
csc	(cosecant; do not use cosec)
csch	(hyperbolic cosecant)
curl	(curl)
det	(determinant)
diag	(diagonal)
dim	(dimension)
div	(divergence)
exp	(exponential)
hom	(homology)
Im	(Imaginary)
inf	(inferior)
ker	(kernel)
lim	(limit)

liminf	(limit inferior)
limsup	(limit superior)
ln	(natural logarithm)
log	(logarithm)
lub	(least upper bound)
max	(maximum)
min	(minimum)
mod	(modulus)
Pr	(Probability)
Re	(real)
sec	(secant)
sin	(sin)
sinh	(hyberbolic sine)
tan	(tangent)
tanh	(hyperbolic tangent)
tr	(trace)
Tr	(transpose)
wr	(wreath)

K. The Greek Alphabet

Name	Upper Case	Lower Case
Alpha	A	α
Beta	B	β
Gamma	Γ	γ
Delta	Δ	δ
Epsilon	E	ε
Zeta	Z	ζ
Eta	H	η
Theta	Θ	θ
Iota	I	ι
Kappa	K	κ
Lambda	Λ	λ
Mu	M	μ
Nu	N	ν
Xi	Ξ	ξ
Omicron	O	o
Pi	Π	π
Rho	P	ρ
Sigma	Σ	σ
Tau	T	τ
Upsilon	Y	υ
Phi	Φ	φ
Chi	X	χ
Psi	Ψ	ψ
Omega	Ω	ω

V. EDITING REFERENCES

A. Citing References

References in Text: References need not be cited in the text. When they are, they appear on the line, in square brackets, *inside the punctuation*. Grammatically, they may be treated as if they were footnote numbers, e.g.,

as shown by Brown [4], [5]; as mentioned earlier [2], [4]–[7], [9]; Smith [4] and Brown and Jones [5]; Wood et al. [7]

NOTE: Use *et al.* when **six** or more names are given.

or as nouns:

as demonstrated in [3]; according to [4] and [6]–[9].

References Within a Reference: Check the reference list for *ibid.* or *op. cit.* These refer to a previous reference and should be eliminated from the reference section. In text, repeat the earlier reference number and renumber the reference section accordingly. If the *ibid.* gives a new page number, or other information, use the following forms:

[3, Th. 1]; [3, Lemma 2]; [3, pp. 5-10]; [3, eq. (2)]; [3, Fig. 1]; [3, Appendix I]; [3, Sec. 4.5]; [3, Ch. 2, pp. 5-10]; [3, Algorithm 5].

NOTE: Editing of references may entail careful renumbering of references, as well as the citations in text.

B. Style

Reference numbers are set flush left and form a column of their own, hanging out beyond the body of the reference. The reference numbers are on the line, enclosed in square brackets. In all references, the given name of the author or editor is abbreviated to the initial only and precedes the last name. Use commas around Jr., Sr., and III in names. IEEE publications must list names of all authors, up to six names. If there are more than six names listed, use *et al.* after the first author. For non-IEEE publications, *et al.* may be used if names are not provided. Abbreviate Conference titles (see Section V-E and V-F). Note that when citing IEEE Transactions, if the issue number or month is not available, research IEEEXplore to update the information. Retain or request the day of the month when referencing a patent. References may not include all information; please obtain and include relevant information. Do not combine references. There must be only one reference with each number. If there is a URL included with the print reference, it is included at the end of the reference (see style for on-line references).

Periodicals

Prior to 1988, the volume number of IEEE Transactions/Journals carried the acronym of the journal. For example, an issue of the IEEE TRANSACTIONS ON AUTOMATIC CONTROL would read: *IEEE Trans. Automat. Contr.*, vol. AC-26, no. 1, pp. 1–34, Jan. 1981. When referencing IEEE Transactions, both the issue number and month are included upon verification of frequency and starting month.

NOTE: The only exception to this rule is PROCEEDINGS OF THE IEEE, which never carried an acronym on the masthead.

Basic Format:

[1] J. K. Author, "Name of paper," *Abbrev. Title of Periodical*, vol. *x*, no. *x*, pp. *xxx-xxx*, Abbrev. Month, year.

Examples:

[1] M. Ito *et al*., "Application of amorphous oxide TFT to electrophoretic display," *J. Non-Cryst. Solids, vol. 354*, no. 19, pp. 2777–2782, Feb. 2008.

[2] R. Fardel, M. Nagel, F. Nuesch, T. Lippert, and A. Wokaun, "Fabrication of organic light emitting diode pixels by laser-assisted forward transfer," *Appl. Phys. Lett.*, vol. 91, no. 6, Aug. 2007, Art.ID. 061103.

[3] J. Zhang and N. Tansu, "Optical gain and laser characteristics of InGaN quantum wells on ternary InGaN substrates," *IEEE Photon. J.*, vol. 5, no. 2, Apr. 2013, Art. ID 2600111.

[4] J. U. Buncombe, "Infrared navigation—Part I: Theory," *IEEE Trans. Aerosp. Electron. Syst.*, vol. AES-4, no. 3, pp. 352–377, Sep. 1944.

[5] S. Azodolmolky *et al*., Experimental demonstration of an impairment aware network planning and operation tool for transparent/translucent optical networks," *J. Lightw. Technol*., vol. 29, no. 4, pp. 439–448, Sep. 2011.
[6] H. Eriksson and P. E. Danielsson, "Two problems on Boolean memories," *IEEE Trans. Electron. Devices*, vol. ED-11, no. 1, pp. 32–33, Jan. 1959.
[7] F. Aronowitz, "Theory of traveling-wave optical maser," *Phys. Rev.*, vol. 134, pp. A635–A646, Dec. 8, 1965.
[8] Ye. V. Lavrova, "Geographic distribution of ionospheric disturbances in the F2 layer," *Tr. IZMIRAN*, vol. 19, no. 29, pp. 31–43, 1961 (Transl.: E. R. Hope, Directorate of Scientific Information Services, Defence Research Board of Canada, Rep. T384R, Apr. 1963).
[9] E. P. Wigner, "On a modification of the Rayleigh–Schrodinger perturbation theory," (in German), *Math. Naturwiss. Anz. Ungar. Akad. Wiss.*, vol. 53, p. 475, 1935.
[10] E. H. Miller, "A note on reflector arrays," *IEEE Trans. Antennas Propag.*, to be published.*** *Always use this style when the paper has been accepted or scheduled for a future publication, i.e., do not use "to appear in."****
[11] C. K. Kim, "Effect of gamma rays on plasma," submitted for publication. *** *Always use this style when the paper has not yet been accepted or scheduled for publication, i.e., do not use "to appear in."****
[12] W. Rafferty, "Ground antennas in NASA's deep space telecommunications," *Proc. IEEE,* vol. 82, no. 5, pp. 636-640, May 1994.
[13] L. T. Wu *et al.*, "Real-time analytic sensitivity method for transient security assessment and prevent control," *Proc. Inst. Elect. Eng.*, vol. 135, pt. C, pp. 107-117, Mar. 1988.
*****Authors may refer to this journal as Proc. IEE, but the abbreviation must be as listed above. Proc. IEE is printed in the U.K. and must not be confused with the Proc. IEEE.****
[14] *Special Issue on Artificial Neural Network Applications, Proc. IEEE*, vol. 84, pp. 1353-1576, Oct. 1996.

Article Referred to in the Same Issue:

[1] R. U. Aslip, "Surface and leaky wave antennas," *IEEE Trans. Circuits Syst. I, Fundam. Theory Appl.*, vol. 30, no.1, pp. 545–546, Jan. 2000.

NOTE: Handle it exactly as any other reference with no difference.

Books

Basic Format:

[1] J. K. Author, "Title of chapter in the book," in *Title of His Published Book, x*th ed. City of Publisher, (only U.S. State), Country: Abbrev. of Publisher, year, ch. *x*, sec. *x*, pp. *xxx–xxx*.

Examples:

[1] B. Klaus and P. Horn, *Robot Vision.* Cambridge, MA, USA: MIT Press, 1986.
[2] L. Stein, "Random patterns," in *Computers and You*, J. S. Brake, Ed. New York, NY, USA: Wiley, 1994, pp. 55-70.
[3] R. L. Myer, "Parametric oscillators and nonlinear materials," in *Nonlinear Optics*, vol. 4, P. G. Harper and B. S. Wherret, Eds. San Francisco, CA, USA: Academic, 1977, pp. 47-160.
[4] M. Abramowitz and I. A. Stegun, Eds., *Handbook of Mathematical Functions* (Applied Mathematics Series 55). Washington, DC, USA: NBS, 1964, pp. 32-33.
[5] E. F. Moore, "Gedanken-experiments on sequential machines," in *Automata Studies* (Ann. of Math. Studies, no. 1), C. E. Shannon and J. McCarthy, Eds. Princeton, NJ, USA: Princeton Univ. Press, 1965, pp. 129-153.
[6] Westinghouse Electric Corporation (Staff of Technology and Science, Aerospace Div.), *Integrated Electronic Systems*. Englewood Cliffs, NJ, USA: Prentice-Hall, 1970.
[7] M. Gorkii, "Optimal design," *Dokl. Akad. Nauk SSSR*, vol. 12, pp. 111-122, 1961 (Transl.: in L. Pontryagin, Ed., *The Mathematical Theory of Optimal Processes.* New York, NY, USA: Interscience, 1962, ch. 2, sec. 3, pp. 127-135).
[8] A. Histace, "Image restoration—Recent advances and applications," in *Super-Resolution Restoration and Image Reconstruction for Passive Millimeter Wave Imaging.* Rijeka, Croatia: InTech, 2012, pp. 25–45.

Reports

The general form for citing technical reports is to place the name and location of the company or institution after the author and title and to give the report number and date at the end of the reference.

Basic Format:

[1] J. K. Author, "Title of report," Abbrev. Name of Co., City of Co., Abbrev. State, Country, Rep. *xxx*, year.

Examples:

[1] E. E. Reber, R. L. Michell, and C. J. Carter, "Oxygen absorption in the earth's atmosphere," Aerospace Corp., Los Angeles, CA, USA, Tech. Rep. TR-0200 (4230-46)-3, Nov. 1988.
[2] J. H. Davis and J. R. Cogdell, "Calibration program for the 16-foot antenna," Elect. Eng. Res. Lab., Univ. Texas, Austin, Tech. Memo. NGL-006-69-3, Nov. 15, 1987.
[3] R. E. Haskell and C. T. Case, "Transient signal propagation in lossless isotropic plasmas," USAF Cambridge Res. Labs., Cambridge, MA, Rep. ARCRL-66-234 (II), 1994, vol. 2.
[4] M. A. Brusberg and E. N. Clark, "Installation, operation, and data evaluation of an oblique-incidence ionosphere sounder system," in "Radio Propagation Characteristics of the Washington–Honolulu Path," Stanford Res. Inst., Stanford, CA, USA, Contract NOBSR-87615, Final Rep., Feb. 1995, vol. 1.
[5] P. Diament, S. L. Richert, and W. L. Lupatkin, "V-line surface-wave radiation and scanning," Dep. Elect. Eng., Columbia Univ., New York, Sci. Rep. 85, Aug. 1991.

Handbooks

Basic Format:

[1] *Name of Manual/Handbook*, *x* ed., Abbrev. Name of Co., City of Co., Abbrev. State, year, pp. *xxx-xxx.*

Examples:

[1] *Transmission Systems for Communications*, 3rd ed., Western Electric Co., Winston-Salem, NC, 1985, pp. 44–60.
[2] *Motorola Semiconductor Data Manual*, Motorola Semiconductor Products Inc., Phoenix, AZ, 1989.
[3] *RCA Receiving Tube Manual*, Radio Corp. of America, Electronic Components and Devices, Harrison, NJ, Tech. Ser. RC-23, 1992.

Published Conference Proceedings

The general form for citing conference proceedings is to list the author and title of the paper, followed by the name (and location, if given) of the conference *in italics* using standard abbreviations.

Annals	Ann.
Annual	Annu.
Colloquium	Colloq.
Conference	Conf.
Congress	Congr.
Convention	Conv.
Digest	Dig.
Exposition	Expo.
International	Int.
Meeting	Meeting
National	Nat.
Proceedings	Proc.
Record	Rec.
Symposium	Symp.
Technical Digest	Tech. Dig.
Technical Paper	Tech. Paper
Workshop	Workshop
First	1st
Second	2nd
Third	3rd
Fourth/nth...	4^{th}/nth…

Write out all the remaining words, but omit most articles and prepositions like "of the" and "on." That is, *Proceedings of the 1996 Robotics and Automation Conference* becomes *Proc. 1996 Robotics and Automation Conf.*

NOTE: All published conference or proceedings papers have page numbers.

Basic Format:

[1] J. K. Author, "Title of paper," in *Abbreviated Name of Conf.*, (location of conference is optional), year, pp. *xxx-xxx.*

Examples:

[1] G. R. Faulhaber, "Design of service systems with priority reservation," in *Conf. Rec. 1995 IEEE Int. Conf. Commun.*, pp. 3–8. *** *If the year is given in the conference title, it may be omitted from the end of the reference as shown here.****

[2] S. P. Bingulac, "On the compatibility of adaptive controllers," in *Proc. 4th Annu. Allerton Conf. Circuit and Systems Theory*, New York, 1994, pp. 8–16.

[3] W. D. Doyle, "Magnetization reversal in films with biaxial anisotropy," in *1987 Proc. INTERMAG Conf.*, pp. 2.2-1–2.2-6.

[4] C. T. Meadow and D. W. Waugh, "Computer assisted interrogation," in *1991 Fall Joint Computer Conf., Proc. AFIPS Conf.*, vol. 29. Washington, DC: Spartan, 1991, pp. 381–394. *** *There is an <emspace> between "vol. 29." and "Washington."****

[5] P. C. Parks, "Lyapunov redesign of model reference adaptive control systems," in *1993 Joint Automatic Control Conf., Preprints*, pp. 485–491.

[6] T. S. Hsia, "System identification," in *IEDM Tech. Dig.*, 1993, vol. 2, no. 8, pp. 6–13.

Papers Presented at Conferences

Basic Format:

[1] J. K. Author, "Title of paper," presented at the abbrev. Name of Conf., City of Conf., Abbrev. State, year.

Examples:

[1] J. G. Kreifeldt, "An analysis of surface-detected EMG as an amplitude-modulated noise," presented at the 1989 Int. Conf. Medicine and Biological Engineering, Chicago, IL, USA, Nov. 9–12, 1989.

[2] G. W. Juette and L. E. Zeffanella, "Radio noise currents on short sections on bundle conductors," presented at the IEEE Summer Power Meeting, Dallas, TX, Jun. 22-27, 1990, Paper 90 SM 690-0 PWRS. *** *PES Papers—For years prior to 1997, all Power papers were presented at a conference.****

[3] J. Arrillaga and B. Giessner, "Limitation of short-circuit levels by means of HVDC links," presented at the IEEE Summer Power Meeting, Los Angeles, CA, Jul. 12–17, 1990, Paper 70 CP 637. ****Preprints are available before the conference from the IEEE Customer Services Department, at the conference from Paper Sales, and after the conference from ASK*IEEE.****

Patents

Basic Format:

[1] J. K. Author, "Title of patent," U.S. Patent *x xxx xxx,* Abbrev. Month, day, year.

Example:

[1] J. P. Wilkinson, "Nonlinear resonant circuit devices," U.S. Patent 3 624 125, July 16, 1990.

[2] T. Mei and T. Yang, "Circuit and method for average –current regulation of light-emitting diodes," U.S. Patent 7 898 187 B1, 2011, Mar. 1, 2012.

[3] S. P. Voinigescu *et al*., Direct *m*-ary quadrature amplitude modulation (QAM) operating in saturated power mode," U.S. Patent Appl. 20110013726A1, Jan. 20, 2011.

NOTE: Use "issued date" if several dates are given.

Theses (B.S., M.S.) and Dissertations (Ph.D.)

Basic Format:

[1] J. K. Author, "Title of thesis," M.S. thesis, Abbrev. Dept., Abbrev. Univ., City of Univ., Abbrev. State, year.

[2] J. K. Author, "Title of dissertation," Ph.D. dissertation, Abbrev. Dept., Abbrev. Univ., City of Univ., Abbrev. State, year.

Examples:

[1] J. O. Williams, "Narrow-band analyzer," Ph.D. dissertation, Dept. Elect. Eng., Harvard Univ., Cambridge, MA, 1993.
[2] N. Kawasaki, "Parametric study of thermal and chemical nonequilibrium nozzle flow," M.S. thesis, Dept. Electron. Eng., Osaka Univ., Osaka, Japan, 1993.
[3] N. M. Amer, "The effects of homogeneous magnetic fields on developments of tribolium confusum," Ph.D. dissertation, Radiation Lab., Univ. California, Berkeley, Tech. Rep. 16854, 1995. *** *The state abbreviation is omitted if the name of the university includes the state name, i.e., "Univ. California, Berkeley."****
[4] C. Becle, These de doctoral d'etat, Univ. Grenoble, Grenoble, France, 1968.

Unpublished

These are the two most common types of unpublished references.

Basic Format :

[1] J. K. Author, private communication, Abbrev. Month, year.
[2] J. K. Author, "Title of paper," unpublished.

Examples:

[1] A. Harrison, private communication, May 1995.
[2] B. Smith, "An approach to graphs of linear forms," unpublished.
[3] A. Brahms, "Representation error for real numbers in binary computer arithmetic," IEEE Computer Group Repository, Paper R-67-85.

Standards

Basic Format:

[1] *Title of Standard*, Standard number, date.

Examples:

[1] *IEEE Criteria for Class IE Electric Systems*, IEEE Standard 308, 1969.
[2] *Letter Symbols for Quantities*, ANSI Standard Y10.5-1968.

C. On-Line Sources

The guidelines for citing electronic information as offered here are in modified illustration of the adaptation by the International Standards Organization (ISO) documentation system and the American Psychological Association style.

Guidelines for Breaking URLs:

- Break after slash or double slash.
- Break "before" the hyphen that is part of an address, but do not break after; do not add hyphens or spaces; do not let addresses hyphenate.
- Break "before" a tilde (~), a hyphen, an underline (_), a question mark, or a percent (%) symbol.
- Break before or after an equals sign or an ampersand (follow the same rule for the "at" (@) symbol).

Books, Monographs

Online Basic Format:

[1] [1] J. K. Author, "Title of chapter in the book," in *Title of Published Book*, xth ed. City of Publisher, State, Country: Abbrev. of Publisher, year, ch. x, sec. x, pp. xxx–xxx. [Online]. Available: http://www.web.com

Example:

[1] G. O. Young, "Synthetic structure of industrial plastics," in Plastics, vol. 3, Polymers of Hexadromicon, J. Peters, Ed., 2nd ed. New York, NY, USA: McGraw-Hill, 1964, pp. 15-64. [Online]. Available: http://www.bookref.com.

[2] *The Founders' Constitution*, Philip B. Kurland and Ralph Lerner, eds., Chicago, IL, USA: Univ. Chicago Press, 1987. [Online]. Available: http://press-pubs.uchicago.edu/founders/

[3] The Terahertz Wave eBook. ZOmega Terahertz Corp., 2014. [Online]. Available: http://dl.z-thz.com/eBook/zomega_ebook_pdf_1206_sr.pdf. Accessed on: May 19, 2014.

[4] Philip B. Kurland and Ralph Lerner, eds., *The Founders' Constitution*. Chicago, IL, USA: Univ. of Chicago Press, 1987, http://press-pubs.uchicago.edu/founders/. Accessed on: Feb. 28, 2010.

[5]

Periodicals

Basic Format:

[1] J. K. Author, "Name of paper," *Abbrev. Title of Periodical*, vol. x, no. x, pp. xxx-xxx, Abbrev. Month, year. [Online]. Available: site/path/file. Accessed on: Month, Day, Year.

Examples:

[1] J. S. Turner, "New directions in communications," *IEEE J. Sel. Areas Commun*., vol. 13, no. 1, pp. 11-23, Jan. 1995.

[2] W. P. Risk, G. S. Kino, and H. J. Shaw, "Fiber-optic frequency shifter using a surface acoustic wave incident at an oblique angle," *Opt. Lett.*, vol. 11, no. 2, pp. 115–117, Feb. 1986. [Online]. Available: http://ol.osa.org/abstract.cfm?URI=ol-11-2-115

[3]

Papers Presented at Conferences

Basic Format:

[1] J. K. Author. Title. presented at abbrev. Conference title. [Type of Medium]. Available: site/path/file

Example:

[1] Process Software Corp., MA. Intranets: Internet technologies deployed behind the firewall for corporate productivity. presented at INET'96 Annu. Meeting [Online]. Available: http://www.process.com/Intranets/wp2.htp

Reports and Handbooks

The general form for citing technical reports is to place the name and location of the company or institution after the author and title and to give the report number and date (retain month if given) at the end of the reference. Retain volume and issue number before date if given. The report title appears in quotation marks. For reports cited online, please ensure a year is included and add the URL to the end of the reference.

Basic Online Format:

[1] J. K. Author, "Title of report," Abbrev. Name of Co., City of Co., Abbrev. State, Country, Rep. no., vol./issue, year. [Online]. Available: site/path/file

Basic Format:

[1] J. K. Author. (year, month). Title. Company. City, State, Country. [Type of Medium]. Available: site/path/file

Examples:

[1] R. J. Hijmans and J. van Etten, "Raster: Geographic analysis and modeling with raster data," R Package Version 2.0-12, Jan. 12, 2012. [Online]. Available: http://CRAN.R-project.org/package=raster

[2] Teralyzer. Lytera UG, Kirchhain, Germany [Online]. Available: http://www.lytera.de/Terahertz_THz_Spectroscopy.php?id=home, Accessed on: Jun. 5, 2014.

[3] Linear Technology, Standalone linear Li-ion battery charger and dual synchronous buck converter," Rep. no. LTC3552, Datasheet., 2012. Accessed on Sep. 12, 2014.

[4] Bureau of Meteorology, "Bureau of Meteorology: Measuring Rainfall in Australia," 2009. [Online]. Available: http://www.bom.gov.au/climate/cdo/about/ definitionsrain.shtml#meanrainfall.

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[6] K. Kagaku. Multipurpose chest phantom: Lungman. [Online]. Available: http://www.kyotokagaku.com/products/detail03/pdf/ph-1_catalog.pdf. Accessed Apr. 17, 2014.

[7] Apple Inc., Palo Alto, CA, USA, "Apple iPhone," Available: http://apple.com/iphone/. Accessed: Feb. 26, 2013.

U.S. Government Documents

Basic Format:

[1] Legislative body. Number of Congress, Session. (year, month day). *Number of bill or resolution*, *Title*. [Type of medium]. Available: site/path/file

Example:

[1] U.S. House. 102nd Congress, 1st Session. (1991, Jan. 11). *H. Con. Res. 1*, *Sense of the Congress on Approval of Military Action*. [Online]. Available: LEXIS Library: GENFED File: BILLS

Patents

Basic Format:

[1] Name of the invention, by inventor's name. (year, month day). *Patent Number* [Type of medium]. Available: site/path/file

Example:

[1] Musical toothbrush with adjustable neck and mirror, by L.M.R. Brooks. (1992, May 19). *Patent D 326 189* [Online]. Available: NEXIS Library: LEXPAT File: DESIGN

Manuals/Software

[1] L. Breimann. (2003). *Manual on Setting Up, Using, and Understanding Random Forests v4.0*. [Online]. Available: http://oz.berkeley.edu/users/breiman/Using_random_forests_v4.0.pdf, Accessed on: Apr. 16, 2014.

[2] M. Kuhn. *The Caret Package.* (2012) [Online]. Available: http://cranr-project.org/web/packages /caret /caret.pdf

[3] Antcom, Torrance, CA, USA. *Antenna Products.* (2011) [Online]. Available: http://www.antcom.com /documents/catalogs /L1L2GPSAntennas.pdf, Accessed on: Feb. 12, 2014.

D. Common Abbreviations of Words in References

Acoustics	Acoust.
Administration	Admin.
Administrative	Administ.
American	Amer.
Analysis	Anal.
Annals	Ann.
Annual	Annu.
Apparatus	App.
Applications	Appl.
Applied	Appl.
Association	Assoc.
Automatic	Automat.
British	Brit.
Broadcasting	Broadcast.
Business	Bus.
Canadian	Can.
Chinese	Chin.
Communications	Commun.
Computer(s)	Comput.
Conference	Conf.
Congress	Congr.
Convention	Conv.
Correspondence	Corresp.
Cybernetics	Cybern.
Department	Dept.
Development	Develop.

Digest	Dig.
Economic(s)	Econ.
Education	Edu.
Electrical	Elect.
Electronic	Electron.
Engineering	Eng.
Ergonomics	Ergonom.
European	Eur.
Evolutionary	Evol.
Foundation	Found.
Geoscience	Geosci.
Graphics	Graph.
Industrial	Ind.
Information	Inform.
Institute	Inst.
Intelligence	Intell.
International	Int.
Japan	Jpn.
Journal	J.
Letter(s)	Lett.
Machine	Mach.
Magazine	Mag.
Management	Manage.
Managing	Manag.
Mathematical	Math.
Mechanical	Mech.
Meeting	Meeting
National	Nat.
Newsletter	Newslett.
Nuclear	Nucl.
Occupation	Occupat.
Operational	Oper.
Optical	Opt.
Optics	Opt.
Organization	Org.
Philosophical	Philosoph.
Proceedings	Proc.
Processing	Process.
Production	Prod.
Productivity	Productiv.
Quarterly	Quart.
Record	Rec.
Reliability	Rel.
Report	Rep.
Research	Res.
Review	Rev.
Royal	Roy.
Science	Sci.
Selected	Select.
Society	Soc.
Sociological	Sociol.
Statistics	Statist.
Studies	Stud.
Supplement	Suppl.
Symposium	Symp.
Systems	Syst.
Technical	Tech.
Techniques	Techn.
Technology	Technol.

Telecommunications	Telecommun.
Transactions	Trans.
Vehicular	Veh.
Working	Work.

E. IEEE Abbreviations for Transactions, Journals, Letters

NOTE: * denotes past acronyms/abbreviations of journals (used for pre-1988 publications).

Publication	Acronym	Reference Abbreviation
IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS	AES	*IEEE Trans. Aerosp. Electron. Syst.*
	ANE*	*IEEE Trans. Aeronaut. Navig. Electron.**
	ANE*	*IEEE Trans. Aerosp. Navig. Electron.**
	AS*	*IEEE Trans. Aerosp.**
	MIL*	*IEEE Trans. Mil. Electron.**
	AE*	*IEEE Trans. Airborne Electron.**
IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION	AP	*IEEE Trans. Antennas Propag.*
IEEE ANTENNAS AND WIRELESS PROPAGATION LETTERS	LAWP	*IEEE Antennas Wireless Propag. Lett.*
IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY	ASC	*IEEE Trans. Appl. Supercond.*
IEEE/ACM TRANSACTIONS ON AUDIO, SPEECH, AND LANGUAGE PROCESSING	ASLP	*IEEE/ACM Trans. Audio, Speech, Language Process.*
IEEE TRANSACTIONS ON AUDIO, SPEECH, AND LANGUAGE PROCESSING	ASL	*IEEE Trans. Audio, Speech, Language Process.(2006–2013)*
	SAP*	*IEEE Speech Audio Process. (1993−2005)*
IEEE TRANSACTIONS ON AUTOMATIC CONTROL	AC	*IEEE Trans. Autom. Control*
IEEE TRANSACTIONS ON AUTOMATION SCIENCE AND ENGINEERING	ASE	*IEEE Trans. Autom. Sci. Eng. (from July 2004)*
IEEE TRANSACTIONS ON AUTONOMOUS MENTAL DEVELOPMENT	AMD	*IEEE Trans. Auton. Mental Develop.*
IEEE TRANSACTIONS ON BIG DATA	BD	*IEEE Trans. Big Data*
IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS	BHI	*IEEE J. Biomed. Health Inform.*
	ITB	*IEEE Trans. Inf. Technol. Biomed. (1995–2012)*
IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS	BCAS	*IEEE Trans. Biomed. Circuits Syst.*
IEEE REVIEWS IN BIOMEDICAL ENGINEERING	RBME	*IEEE Rev. Biomed. Eng.*
IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING	BME	*IEEE Trans. Biomed. Eng.*
	BME*	*IEEE Trans. Bio-Med. Eng.**
	BME*	*IEEE Trans. Bio-Med. Electron.**
	PGME*	*IEEE Trans. Med. Electron.**
IEEE TRANSACTIONS ON BROADCASTING	BC	*IEEE Trans. Broadcast.*
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—I: REGULAR PAPERS	CSI	*IEEE Trans. Circuits Syst. I, Reg. Papers*
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—II: EXPRESS BRIEFS	CSII	*IEEE Trans. Circuits Syst. II, Exp. Briefs*
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—I: FUNDAMENTAL THEORY AND APPLICATIONS	CAS1*	*IEEE Trans. Circuits Syst. I, Fundam. Theory Appl. (1993–2003)*
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—II: ANALOG AND DIGITAL SIGNAL PROCESSING	CAS2*	*IEEE Trans. Circuits Syst. II, Analog Digit. Signal Process.(1993–2003)*
	CAS*	*IEEE Trans. Circuits Syst.* (1974–1992)*
	CT*	*IEEE Trans. Circuit Theory* (until 1973)*
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY	CSVT	*IEEE Trans. Circuits Syst. Video Technol.*
IEEE TRANSACTIONS ON CLOUD COMPUTING	CC	*IEEE Trans. Cloud Comput.*
IEEE TRANSACTIONS ON COGNITIVE COMMUNICATIONS AND NETWORKING	CCN	*IEEE Trans. Cogn. Commun. Netw.*
IEEE TRANSACTIONS ON COMMUNICATIONS	COM	*IEEE Trans. Commun.*
	COM*	*IEEE Trans. Commun. Technol.* (until 1971)*
IEEE COMMUNICATIONS LETTERS	COMML	*IEEE Commun. Lett.*
IEEE COMMUNICATIONS SURVEYS & TUTORIALS	COMST	*IEEE Commun. Surveys Tuts.*
IEEE TRANSACTIONS ON COMPONENTS, PACKAGING AND MANUFACTURING TECHNOLOGY	CPMT	*IEEE Trans. Compon. Packag. Manuf. Technol.*
	CAPT	*IEEE Trans. Compon. Packag. Technol.(1999–2010)*

Publication	Acronym	Reference Abbreviation
	CPMTA	*IEEE Trans. Compon., Packag.,Manuf. Technol. A (1994–1998)*
	CHMT*	*IEEE Trans. Compon., Hybrids, Manuf. Technol.* (1978–1993)*
	MFT*	*IEEE Trans. Manuf. Technol.* (1972–1977)*
	PHP*	*IEEE Trans. Parts, Hybrids, Packag.* (June 1971–1977)*
	PMP*	*IEEE Trans. Parts, Mater., Packag.* (1965−1971)*
	ADVP	*IEEE Trans. Adv. Packag. (1999–2010)*
	CPMTB	*IEEE Trans. Compon., Packag., Manuf. Technol. B (1994–1998)*
	EPM	*IEEE Trans. Electron. Packag. Manuf. (1999−2010)*
	CPMTC	*IEEE Trans. Compon., Packag., Manuf. Technol. C (1996–1998)*
IEEE/ACM TRANSACTIONS ON COMPUTATIONAL BIOLOGY AND BIOINFORMATICS	CBB	*IEEE/ACM Trans. Comput. Biol. Bioinf.*
IEEE TRANSACTIONS ON COMPUTATIONAL INTELLIGENCE AND AI IN GAMES	CIAIG	*IEEE Trans. Comput. Intell. AI in Games*
IEEE TRANSACTIONS ON COMPUTATIONAL SOCIAL SYSTEMS	CSS	*IEEE Trans. Comput. Social Syst.*
IEEE TRANSACTIONS ON COMPUTERS	C	*IEEE Trans. Comput.*
IEEE TRANSACTIONS ON COMPUTER-AIDED DESIGN OF INTEGRATED CIRCUITS AND SYSTEMS	CAD	*IEEE Trans. Comput.-Aided Design Integr. Circuits Syst.*
IEEE COMPUTER ARCHITECTURAL LETTERS	CAL	*IEEE Comput. Archit. Lett.*
IEEE TRANSACTIONS ON CONSUMER ELECTRONICS	CE	*IEEE Trans. Consum. Electron.*
	BTR	*IEEE Trans. Broadcast. Telev. Receiv. (1963−1974)*
IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY	CST	*IEEE Trans. Control Syst. Technol.*
	CYB	*IEEE Trans. Cybern.*
IEEE TRANSACTIONS ON CYBERNETICS	SMCB*	*IEEE Trans. Syst. Man, Cybern. B, Cybern. (1995–2012)*
IEEE TRANSACTIONS ON DEVICE AND MATERIALS RELIABILITY	DMR	*IEEE Trans. Device Mater. Rel.*
IEEE TRANSACTIONS ON DIELECTRICS AND ELECTRICAL INSULATION	DEI	*IEEE Trans. Dielectr. Electr. Insul.*
	EI*	*IEEE Trans. Electr. Insul.* (through 1993)*
IEEE/OSA JOURNAL OF DISPLAY TECHNOLOGY	DT	*J. Display Technol.*
IEEE TRANSACTIONS ON EDUCATION	E	*IEEE Trans. Educ.*
IEEE TRANSACTIONS ON ELECTROMAGNETIC COMPATIBILITY	EMC	*IEEE Trans. Electromagn. Compat.*
	RFI*	*IEEE Trans. Radio Freq. Interference**
IEEE TRANSACTIONS ON ELECTRON DEVICES	ED	*IEEE Trans. Electron Devices*
IEEE JOURNAL OF ELECTRON DEVICES SOCIETY	EDS	*IEEE J. Electron Devices Soc.*
IEEE ELECTRON DEVICE LETTERS	EDL	*IEEE Electron Device Lett.*
IEEE TRANSACTIONS ON ELECTRONICS PACKAGING MANUFACTURING	EPM	*IEEE Trans. Electron. Packag. Manuf.(1999−2010)*
IEEE EMBEDDED SYSTEMS LETTERS	ES	*IEEE Embedded Syst. Lett.*
IEEE TRANSACTIONS ON EMERGING TOPICS IN COMPUTING	ETC	*IEEE Trans. Emerg. Topics Comput.*
IEEE JOURNAL ON EMERGING AND SELECTED TOPICS IN CIRCUITS AND SYSTEMS	ETCAS	*IEEE J. Emerg. Sel. Topics Circuits Syst.*
IEEE JOURNAL ON EMERGING AND SELECTED TOPICS IN POWER ELECTRONICS	ESTPE	*IEEE J. Emerg. Sel. Topics Power Electron.*
IEEE TRANSACTIONS ON ENERGY CONVERSION	EC	*IEEE Trans. Energy Convers.*
IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT	EM	*IEEE Trans. Eng. Manag.*
IEEE TRANSACTIONS ON EVOLUTIONARY COMPUTATION	EVC	*IEEE Trans. Evol. Comput.*
IEEE TRANSACTIONS ON EXPLORATORY SOLID-STATE COMPUTATIONAL DEVICES AND CIRCUITS	XCDC	*IEEE Trans. Explor. Solid-State Comput. Devices Circuits*
IEEE TRANSACTIONS ON FUZZY SYSTEMS	FUZZ	*IEEE Trans. Fuzzy Syst.*
IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING	GRS	*IEEE Trans. Geosci. Remote Sens.*

Publication	Acronym	Reference Abbreviation
IEEE Geoscience and Remote Sensing Letters	GRSL	*IEEE Geosci. Remote Sens. Lett.*
IEEE Transactions on Human–Machine Systems	HMS*	*IEEE Trans. Human–Mach. Syst.*
	SMCC*	*IEEE Trans. Syst., Man, Cybern. C, Appl. Rev. (1995–2012)*
	SMC*	*IEEE Trans. Syst., Man, Cybern.* (1971–1995)*
	SSC*	*IEEE Trans. Syst. Sci. Cybern.* (through 1970)*
IEEE Transactions on Image Processing	IP	*IEEE Trans. Image Process.*
IEEE Transactions on Industrial Electronics	IE	*IEEE Trans. Ind. Electron.*
IEEE Transactions on Industrial Informatics	II	*IEEE Trans. Ind. Informat.*
IEEE Transactions on Industry Applications	IA	*IEEE Trans. Ind. Appl.*
IEEE Transactions on Information Forensics and Security	IFS	*IEEE Trans. Inf. Forensics Security*
IEEE Transactions on Information Theory	IT	*IEEE Trans. Inf. Theory*
IEEE Transactions on Instrumentation and Measurement	IM	*IEEE Trans. Instrum. Meas.*
	I, PGI*	*IEEE Trans. Instrum.**
IEEE Transactions on Intelligent Transportation Systems	ITS	*IEEE Trans. Intell. Transp. Syst.*
IEEE Internet of Things Journal	IoT	*IEEE Internet Things J.*
IEEE Transactions on Knowledge and Data Engineering	KDE	*IEEE Trans. Knowl. Data Eng.*
IEEE Life Sciences Letters	LS	*IEEE Life Sci. Lett.*
IEEE/OSA Journal of Lightwave Technology	LT	*J. Lightw. Technol.*
IEEE Transactions on Magnetics	MAG	*IEEE Trans. Magn.*
IEEE Magnetics Letters	MAGL	*IEEE Magn. Lett.*
IEEE/ASME Transactions on Mechatronics	MECH	*IEEE/ASME Trans. Mechatronics*
IEEE Transactions on Medical Imaging	MI	*IEEE Trans. Med. Imag.*
IEEE Journal of Microelectromechanical Systems	MEMS	*J. Microelectromech. Syst.*
IEEE/ASME Journal of Microelectromechanical Systems	MEMS	*J. Microelectromech. Syst.(1992–2013)*
IEEE Microwave and Wireless Components Letters	MWCL	*IEEE Microw. Compon. Lett.*
	MGWL	*IEEE Microw. Guided Wave Lett. (1991−2000)*
IEEE Transactions on Microwave Theory and Techniques	MTT	*IEEE Trans. Microw. Theory Techn.*
IEEE Transactions on Mobile Computing	MC	*IEEE Trans. Mobile Comput.*
IEEE Transactions on Molecular, Biological and Multi-Scale Communications		*IEEE Trans. Mol. Biol. Multi-Scale Commun.*
IEEE Transactions on Multimedia	MM	*IEEE Trans. Multimedia*
IEEE Transactions on Multi-Scale Computing Systems		*IEEE Trans. Multi-Scale Comput. Syst.*
IEEE Transactions on NanoBioscience	NB	*IEEE Trans. Nanobiosci.*
IEEE Transactions on Nanotechnology	NANO	*IEEE Trans. Nanotechnol.*
IEEE Nanotechnology Express	ENANO	*IEEE Nanotechnol. Express*
IEEE/ACM Transactions on Networking	NET	*IEEE/ACM Trans. Netw.*
IEEE Transactions on Neural Networks and Learning Systems	NNLS	*IEEE Trans. Neural Netw. Learn. Syst.*
	NN	*IEEE Trans. Neural Netw. (1990−2011)*
IEEE Transactions on Nuclear Science	NS	*IEEE Trans. Nucl. Sci.*
IEEE Transactions on Neural Systems and Rehabilitation Engineering	NSRE	*IEEE Trans. Neural Syst. Rehabil. Eng.*
	RE*	*IEEE Trans. Rehabil. Eng.* (1993–2000)*
IEEE Journal of Oceanic Engineering	OE	*IEEE J. Ocean. Eng.*
IEEE Journal of Optical Communications and Networking	OCN	*IEEE J. Opt. Commun. Netw.*
IEEE Transactions on Parallel and Distributed Systems	PDS	*IEEE Trans. Parallel Distrib. Syst.*
IEEE Transactions on Pattern Analysis and Machine Intelligence	PAMI	*IEEE Trans. Pattern Anal. Mach. Intell.*
IEEE Photonics Technology Letters	PTL	*IEEE Photon. Technol. Lett.*
IEEE Photonics Journal	PJ	*IEEE Photon. J.*
IEEE Journal of Photovoltaics	PHOT	*IEEE J. Photovolt.*

Publication	Acronym	Reference Abbreviation
IEEE TRANSACTIONS ON PLASMA SCIENCE	PS	*IEEE Trans. Plasma Sci.*
IEEE TRANSACTIONS ON POWER APPARATUS AND SYSTEMS	PAS*	*IEEE Trans. Power App. Syst.* (through 1985)*
IEEE TRANSACTIONS ON POWER DELIVERY	PWRD	*IEEE Trans. Power Del.*
IEEE TRANSACTIONS ON POWER ELECTRONICS	PEL	*IEEE Trans. Power Electron.*
	LPEL	*IEEE Power Electron Lett. (2003-2005; abolished)*
IEEE TRANSACTIONS ON POWER SYSTEMS	PWRS	*IEEE Trans. Power Syst.*
IEEE JOURNAL OF PRODUCT SAFETY ENGINEERING	PSE	*IEEE J. Product Safety Eng.*
IEEE POWER AND ENERGY TECHNOLOGY SYSTEMS JOURNAL	PETS	*IEEE Power Energy Technol. Syst. J.*
IEEE TRANSACTIONS ON PROFESSIONAL COMMUNICATION	PC	*IEEE Trans. Prof. Commun.*
IEEE JOURNAL OF QUANTUM ELECTRONICS	QE	*IEEE J. Quantum Electron.*
IEEE RFIC JOURNAL	RFIC	*IEEE RFIC J.*
IEEE RFID JOURNAL	RFID	*IEEE RFID J.*
IEEE TRANSACTIONS ON RELIABILITY	R	*IEEE Trans. Rel.*
IEEE TRANSACTIONS ON ROBOTICS	RO	*IEEE Trans. Robot.*
IEEE TRANSACTIONS ON ROBOTICS AND AUTOMATION	RA*	*IEEE Trans. Robot. Autom. (1989–Jun. 2004)*
	RA*	*IEEE J. Robot. Autom.* (1985–1988)*
IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING	STARS	*IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*
IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS	SAC	*IEEE J. Sel. Areas Commun.*
IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS	STQE	*IEEE J. Sel. Topics Quantum Electron.*
IEEE JOURNAL OF SELECTED TOPICS IN SIGNAL PROCESSING	STSP	*IEEE J. Sel. Topics Signal Process.*
IEEE TRANSACTIONS ON SEMICONDUCTOR MANUFACTURING	SM	*IEEE Trans. Semicond. Manuf.*
IEEE SENSORS JOURNAL	SEN	*IEEE Sensors J.*
IEEE TRANSACTIONS ON SIGNAL PROCESSING	SP	*IEEE Trans. Signal Process.*
	ASSP*	*IEEE Trans. Acoust., Speech, Signal Process. * (1975–1990)*
	AU*	*IEEE Trans. Audio Electroacoust.* (until 1974)
IEEE SIGNAL PROCESSING LETTERS	SPL	*IEEE Signal Process. Lett.*
IEEE TRANSACTIONS ON SMART GRID	SG	*IEEE Trans. Smart Grid*
IEEE TRANSACTIONS ON SUSTAINABLE ENERGY	STE	*IEEE Trans. Sustain. Energy*
IEEE SYSTEMS JOURNAL	SJ	*IEEE Syst. J.*
IEEE TRANSACTIONS ON SOFTWARE ENGINEERING	SE	*IEEE Trans. Softw. Eng.*
IEEE JOURNAL OF SOLID-STATE CIRCUITS	SSC	*IEEE J. Solid-State Circuits*
IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS: SYSTEMS	SMC	*IEEE Trans. Syst., Man, Cybern.,Syst.*
	SMCA*	*IEEE Trans. Syst., Man, Cybern. A, Syst.,Humans (1995-2012)*
	MMS*	*IEEE Trans. Man-Mach. Syst.* (through 1970)*
	HFE*	*Hum. Factors Electron.* (through 1968)*
IEEE JOURNAL OF TRANSLATIONAL ENGINEERING IN HEALTH AND MEDICINE	TEHM	*IEEE J. Transl. Eng. Health Med.*
IEEE TRANSLATION JOURNAL ON MAGNETICS IN JAPAN	TJMJ	*IEEE Transl. J. Magn. Jpn.(through 2010)*
IEEE JOURNAL ON TECHNOLOGY IN COMPUTER AIDED DESIGN	TCAD	*IEEE J. Technol. Computer Aided Des.*
IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY	THz	*IEEE Trans. THz Sci. Technol.*
IEEE TRANSACTIONS ON TRANSPORTATION ELECTRIFICATION		*IEEE Trans. Transport. Electrific.*

Publication	Acronym	Reference Abbreviation
IEEE TRANSACTIONS ON ULTRASONICS, FERROELECTRICS, AND FREQUENCY CONTROL	UFFC	*IEEE Trans. Ultrason., Ferroelectr., Freq. Control*
	SU*	*IEEE Trans. Sonics Ultrason.* (through 1985)*
	UE*	*IEEE Trans. Ultrason. Eng.**
	PGUE*	*IEEE Trans. Ultrason. Eng.**
IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY	VT	*IEEE Trans. Veh. Technol.*
	VC*	*IEEE Trans. Veh. Commun.**
IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEMS	VLSI	*IEEE Trans. Very Large Scale Integr. (VLSI) Syst.*
IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS	VCG	*IEEE Trans. Vis. Comput. Graphics*
IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS	WC	*IEEE Trans. Wireless Commun.*
PROCEEDINGS OF THE IEEE		*Proc. IEEE*
		Proc. IRE (through 1962)*

List of IEEE Magazines

Magazines	Reference Abbreviation
IEEE Aerospace and Electronics Systems Magazine	*IEEE Aerosp. Electron. Syst. Mag.*
IEEE Annals of the History of Computing	*IEEE Ann. Hist. Comput.*
IEEE Antennas and Propagation Magazine	*IEEE Antennas Propag. Mag.*
IEEE ASSP Magazine (1984–1990)	*IEEE ASSP Mag.*
IEEE Circuits and Systems Magazine	*IEEE Circuits Syst. Mag.*
IEEE Circuits and Devices Magazine (1988–2006)	*IEEE Circuits Devices Mag.*
IEEE Communications Society Magazine (through 1978)	*IEEE Commun. Soc. Mag.*
IEEE Communications Magazine (1979–present)	*IEEE Commun. Mag.*
IEEE Computational Intelligence Magazine	*IEEE Comput. Intell. Mag.*
IEEE Computing in Science and Engineering Magazine	*IEEE Comput. Sci. Eng.*
IEEE Computer Magazine	*IEEE Computer*
IEEE Computer Applications in Power	*IEEE Comput. Appl. Power*
IEEE Computer Graphics and Applications Magazine	*IEEE Comput. Graph. Appl. Mag.*
IEEE Concurrency	*IEEE Concurrency*
IEEE Consumer Electronics Magazine	*IEEE Consum. Electron. Mag.*
IEEE Control Systems Magazine	*IEEE Control Syst. Mag.*
IEEE Design & Test	*IEEE Des. Test.* *IEEE Des. Test. Comput.* (through 2012)*
IEEE Electrical Insulation Magazine	*IEEE Elect. Insul. Mag.*
IEEE Electomagnetic Compatibility Magazine	*IEEE Electrmagn. Compat.*
IEEE Electrification Magazine	*IEEE Electrific. Mag.*
IEEE ElectroTechnology Review	*IEEE ElectroTechnol. Rev.* *IEEE Eng. Med. Biol. Mag. (1982−2009)*
IEEE Engineering Management Review	*IEEE Eng. Manag. Rev.*
IEEE Expert (through 1997)	*IEEE Expert*
IEEE Geoscience and Remote Sensing Magazine	*IEEE Geosci. Remote Sens. Mag.(replaces Newsletter)*
IEEE Industrial Electronics Magazine	*IEEE Ind. Electron. Mag.*
IEEE Industry Applications Magazine	*IEEE Ind. Appl. Mag.*
IEEE Instrumentation and Measurement Magazine	*IEEE Instrum. Meas. Mag.*
IEEE Intelligent Systems (formerly IEEE Expert)	*IEEE Intell. Syst.*
IEEE Intelligent Transportation Systems Magazine	*IEEE Intell. Transp. Syst. Mag.*
IEEE Internet Computing Magazine	*IEEE Internet Comput.*
IEEE IT Professional	*IEEE IT Prof.*
IEEE Micro Magazine	*IEEE Micro*
IEEE Microwave Magazine	*IEEE Microw. Mag.*
IEEE MultiMedia Magazine	*IEEE Multimedia Mag.*
IEEE Nanotechnology Magazine	*IEEE Nanotechnol. Mag.*
IEEE Network	*IEEE Netw.*
IEEE Personal Communications	*IEEE Pers. Commun.*
IEEE Potentials	*IEEE Potentials*
IEEE Power Electronics Magazine	*IEEE Power Electron. Mag.*
IEEE Power and Energy Magazine	*IEEE Power Energy Mag.*
IEEE Power Engineering Review	*IEEE Power Eng. Rev.*
IEEE Pulse	*IEEE Pulse*
IEEE Robotics and Automation Magazine	*IEEE Robot. Autom. Mag.*
IEEE Signal Processing Magazine (1991–present)	*IEEE Signal Process. Mag.*
IEEE Solid-State Circuits Magazine	*IEEE Solid State Circuits Mag.*
IEEE Security and Privacy	*IEEE Security Privacy*
IEEE Software	*IEEE Softw.*
IEEE Spectrum	*IEEE Spectr.*
IEEE Systems, Man, and Cybernetics Magazine	*IEEE Syst., Man, Cybern. Mag.*
IEEE Technology and Society Magazine	*IEEE Technol. Soc. Mag.*
IEEE Vehicular Technology Magazine	*IEEE Veh. Technol. Mag.*
China Communications Magazine	*China Commun.*
Internet Computing	*Internet Comput.*

G. Some Common Acronyms and Abbreviations

NOTE: Asterisks (*) indicate terms which must be defined the first time they are used in text. Other terms listed here may be used without definition. A complete list can be found in Section VIII-I.

ac	alternating current
A–D, A/D	analog-to-digital
AF	audio frequency*
AFC	automatic frequency control*
AGC	automatic gain control*
AM	amplitude modulation
APD	avalanche photodiode
AR	antireflection*
ARMA	autoregressive moving average*
ASIC	application-specified integrated circuit*
ASK	amplitude shift keying
ATM	asynchronous transfer mode
av	average (subscript)*
avg	average (function)
AWGN	additive white Gaussian noise*
B–E	base–emitter source
BER	bit error rate*
BPSK	binary phase-shift keying
BWO	backward-wave oscillator*
c.c.	complex conjugate (in equations)
CCD	charge-coupled device*
CDMA	code division multiple access*
CD-ROM	compact disk read-only memory
CIM	computer integrated manufacturing*
CIR	carrier-to-interference ratio*
CMOS	complimentary metal–oxide–semiconductor
CPFSK	continuous phase frequency-shift keying*
CPM	continuous phase modulation*
CPSK	continuous phase-shift keying*
CPU	central processing unit
CRT	cathode-ray tube
CT	current transformer*
CV	capacitance–voltage
CW	continuous wave*
dc	direct current
DC	directional coupler
DF	direction finder*; deuterium fluoride; degree of freedom*
DFT	discrete Fourier transform*
DMA	direct memory access*
DPCM	differential pulse code modulation*
DPSK	differential phase-shift keying*
EDP	electronic data processing
EHF	extremely high frequency*
ELF	extremely low frequency*
EMC	electromagnetic compatibility*
EMF	electromotive force*
EMI	electromagnetic interference*
ems	expected value of mean square*
FDM	frequency division multiplexing*

FDMA	frequency division multiple access*
FET	field-effect transistor
FFT	fast Fourier transform*
FIR	finite-impulse response*
FM	frequency modulation
FSK	frequency-shift keying*
FTP	file transfer protocol
FWHM	full-width at half-maximum*
GUI	graphical user interface
HBT	heterojunction bipolar transistor
HEMT	high-electron mobility transistor
HF	high frequency
HTML	hypertext markup language
HV	high voltage
HVdc	high voltage direct current
IC	impedance compensation*; integrated circuit
ID	inside diameter; induced draft*; interdigital*
IDP	integrated data processing*
IF	intermediate frequency
IGFET	insulated-gate field-effect transistor
i.i.d.	independent identically distributed*
IM	intermediate modulation
IMPATT	impact ionization avalanche transit time (diode)
I/O, I–O	input–output
IR	infrared
IR	current-resistance
ISI	intersymbol interference
I–V	current–voltage
JFET	junction field-effect transistor
JPEG	Joint Photographers Expert Group
LAN	local area network
LC	inductance–capacitance
LED	light-emitting diode
LHS	left-hand side*
L–I	light output–current
LMS	least mean square
LO	local oscillator*
LP	linear programming*
LPE	liquid phase epitaxy*
LR	inductance–resistance
MESFET	metal–semiconductor field-effect transistor
MF	medium frequency*
MFSK	minimum frequency-shift keying
MHD	magnetohydrodynamics
MIS	metal–insulator–semiconductor
MLE	maximum-likelihood estimator*
MLSE	maximum-likelihood sequence estimator*
MMF	magnetomotive force
MMIC	monolithic microwave integrated circuit*
MoM	method of moments*
MOS	metal–oxide–semiconductor
MOSFET	metal–oxide–semiconductor field-effect transistor
MOST	metal–oxide–semiconductor transistor
MPEG	Motion Pictures Expert Group

NA	numerical aperture*
NIR	near infrared response*
NMR	nuclear magnetic resonance*
n-p-n	(diode)
NRZ	nonreturn to zero*
OD	outside diameter
OEIC	optoelectronic integrated circuit*
OOP	object-oriented programming
PAM	pulse-amplitude modulation*
PC	personal computer
PCM	pulse-code modulation*
pdf	probability density function*
PDM	pulse-duration modulation*
PF	power factor*
PID	Proportional-integral differential
p-i-n, p-n-p	(diode)
PLL	phase-locked loop*
PM	phase modulation*
PML	perfectly matched layer
pp, p–p	peak-to-peak*
PPM	pulse-position modulation*
PRF	pulse-repetition frequency*
PRR	pulse-repetition rate*
PSK	phase-shift keying*
PTM	pulse–time modulation
p.u.	per unit*
PWM	pulse width modulation*
Q	quality factor; figure of merit
QoS	quality of service
QPSK	quaternary phase-shift keying
RAM	random access memory
RC	resistance–capacitance
R&D	research and development
RF	radio frequency
RFI	radio frequency interference*
RHS	right-hand side*
RIN	relative intensity noise*
RL	resistance–inductance
rms	root mean square
ROM	read-only memory
RV	random variable
SAW	surface acoustic wave*
SGML	standard generalized markup language
SHF	super high frequency*
SI	International System of Units; severity index*
SIR	signal-to-interference ratio
S/N, SNR	signal-to-noise ratio
SOC	system-on-a-chip*
SSB	single sideband*
SW	short wave*
SWR	standing-wave ratio*
TDM	time-division modulation*; time-division multiplexing*
TDMA	time-division multiple access*

TE	transverse electric
TEM	transverse electromagnetic
TFT	thin-film transistor*
TM	transverse magnetic
TVI	television interference*
TWA	traveling-wave amplifier*
UHF	ultrahigh frequency
UV	Ultraviolet
VCO	voltage-controlled oscillator*
VHF	very high frequency*
V–I	voltage–current
VLF	very low frequency*
VLSI	very large scale integration*
WAN	wide area network
WDM	wavelength division multiplexing*

IEEE Abbreviations for Transactions, Journals, Letters, and Magazines

NOTE: * denotes past acronyms/abbreviations of journals (used for pre-1988 publications).

List of IEEE Transactions, Journals, and Letters

Publication	Acronym	Reference Abbreviation
IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS	AES	*IEEE Trans. Aerosp. Electron. Syst.*
	ANE*	*IEEE Trans. Aeronaut. Navig. Electron.**
	ANE*	*IEEE Trans. Aerosp. Navig. Electron.**
	AS*	*IEEE Trans. Aerosp.**
	MIL*	*IEEE Trans. Mil. Electron.**
	AE*	*IEEE Trans. Airborne Electron.**
IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION	AP	*IEEE Trans. Antennas Propag.*
IEEE ANTENNAS AND WIRELESS PROPAGATION LETTERS	LAWP	*IEEE Antennas Wireless Propag. Lett.*
IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY	ASC	*IEEE Trans. Appl. Supercond.*
IEEE/ACM TRANSACTIONS ON AUDIO, SPEECH, AND LANGUAGE PROCESSING	ASLP	*IEEE/ACM Trans. Audio, Speech, Language Process.*
IEEE TRANSACTIONS ON AUDIO, SPEECH, AND LANGUAGE PROCESSING	ASL	*IEEE Trans. Audio, Speech, Language Process. (2006–2013)*
	SAP*	*IEEE Speech Audio Process. (1993–2005)*
IEEE TRANSACTIONS ON AUTOMATIC CONTROL	AC	*IEEE Trans. Autom. Control*
IEEE TRANSACTIONS ON AUTOMATION SCIENCE AND ENGINEERING	ASE	*IEEE Trans. Autom. Sci. Eng. (from July 2004)*
IEEE TRANSACTIONS ON AUTONOMOUS MENTAL DEVELOPMENT	AMD	*IEEE Trans. Auton. Mental Develop.*
IEEE TRANSACTIONS ON BIG DATA	BD	*IEEE Trans. Big Data*
IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS	BHI	*IEEE J. Biomed. Health Inform.*
	ITB	*IEEE Trans. Inf. Technol. Biomed. (1995–2012)*
IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS	BCAS	*IEEE Trans. Biomed. Circuits Syst.*
IEEE REVIEWS IN BIOMEDICAL ENGINEERING	RBME	*IEEE Rev. Biomed. Eng.*
IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING	BME	*IEEE Trans. Biomed. Eng.*
	BME*	*IEEE Trans. Bio Med. Eng.**
	BME*	*IEEE Trans. Bio Med. Electron.**
	PGME*	*IEEE Trans. Med. Electron.**
IEEE TRANSACTIONS ON BROADCASTING	BC	*IEEE Trans. Broadcast.*
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—I: REGULAR PAPERS	CSI	*IEEE Trans. Circuits Syst. I, Reg. Papers*
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—II: EXPRESS BRIEFS	CSII	*IEEE Trans. Circuits Syst. II, Exp. Briefs*
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—I: FUNDAMENTAL THEORY AND APPLICATIONS	CAS1*	*IEEE Trans. Circuits Syst. I, Fundam. Theory Appl. (1993–2003)*
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—II: ANALOG AND DIGITAL SIGNAL PROCESSING	CAS2*	*IEEE Trans. Circuits Syst. II, Analog Digit. Signal Process.(1993–2003)*
	CAS*	*IEEE Trans. Circuits Syst.* (1974–1992)*
	CT*	*IEEE Trans. Circuit Theory* (until 1973)*
IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY	CSVT	*IEEE Trans. Circuits Syst. Video Technol.*
IEEE TRANSACTIONS ON CLOUD COMPUTING	CC	*IEEE Trans. Cloud Comput.*
IEEE TRANSACTIONS ON COGNITIVE COMMUNICATIONS AND NETWORKING	CCN	*IEEE Trans. Cogn. Commun. Netw.*
IEEE TRANSACTIONS ON COMMUNICATIONS	COM	*IEEE Trans. Commun.*
	COM*	*IEEE Trans. Commun. Technol.* (until 1971)*

IEEE Abbreviations for Transactions, Journals, Letters, and Magazines (ctd.)

Publication	Acronym	Reference Abbreviation
IEEE COMMUNICATIONS LETTERS	COMML	*IEEE Commun. Lett.*
IEEE TRANSACTIONS ON COMPONENTS, PACKAGING AND MANUFACTURING TECHNOLOGY	CPMT	*IEEE Trans. Compon. Packag. Manuf. Technol.*
	CAPT	*IEEE Trans. Compon. Packag. Technol. (1999–2010)*
	CPMTA	*IEEE Trans. Compon., Packag.,Manuf. Technol. A (1994–1998)*
	CHMT*	*IEEE Trans. Compon., Hybrids, Manuf. Technol.* (1978–1993)*
	MFT*	*IEEE Trans. Manuf. Technol.* (1972–1977)*
	PHP*	*IEEE Trans. Parts, Hybrids, Packag.* (June 1971–1977)*
	PMP*	*IEEE Trans. Parts, Mater., Packag.* (1965—1971)*
	ADVP	*IEEE Trans. Adv. Packag. (1999–2010)*
	CPMTB	*IEEE Trans. Compon., Packag., Manuf. Technol. B (1994–1998)*
	EPM	*IEEE Trans. Electron. Packag. Manuf. (1999—2010)*
	CPMTC	*IEEE Trans. Compon., Packag., Manuf. Technol. C (1996–1998)*
IEEE/ACM TRANSACTIONS ON COMPUTATIONAL BIOLOGY AND BIOINFORMATICS	CBB	*IEEE/ACM Trans. Comput. Biol. Bioinf.*
IEEE TRANSACTIONS ON COMPUTATIONAL INTELLIGENCE AND AI IN GAMES	CIAIG	*IEEE Trans. Comput. Intell. AI in Games*
IEEE TRANSACTIONS ON COMPUTATIONAL SOCIAL SYSTEMS	CSS	*IEEE Trans. Comput. Social Syst.*
IEEE TRANSACTIONS ON COMPUTERS	C	*IEEE Trans. Comput.*
IEEE TRANSACTIONS ON COMPUTER-AIDED DESIGN OF INTEGRATED CIRCUITS AND SYSTEMS	CAD	*IEEE Trans. Comput.-Aided Design Integr. Circuits Syst.*
IEEE COMPUTER ARCHITECTURAL LETTERS	CAL	*IEEE Comput. Archit. Lett.*
IEEE TRANSACTIONS ON CONSUMER ELECTRONICS	CE	*IEEE Trans. Consum. Electron.*
	BTR	*IEEE Trans. Broadcast. Telev. Receiv. (1963—1974)*
IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY	CST	*IEEE Trans. Control Syst. Technol.*
IEEE TRANSACTIONS ON CYBERNETICS	CYB	
	SMCB*	*IEEE Trans. Cybern.*
		IEEE Trans. Syst. Man, Cybern. B, Cybern. (1995–2012)
IEEE TRANSACTIONS ON DEVICE AND MATERIALS RELIABILITY	DMR	*IEEE Trans. Device Mater. Rel.*
IEEE TRANSACTIONS ON DIELECTRICS AND ELECTRICAL INSULATION	DEI	*IEEE Trans. Dielectr. Electr. Insul.*
	EI*	*IEEE Trans. Electr. Insul.* (through 1993)*
IEEE/OSA JOURNAL OF DISPLAY TECHNOLOGY	DT	*J. Display Technol.*
IEEE TRANSACTIONS ON EDUCATION	E	*IEEE Trans. Educ.*
IEEE TRANSACTIONS ON ELECTROMAGNETIC COMPATIBILITY	EMC	*IEEE Trans. Electromagn. Compat.*
	RFI*	*IEEE Trans. Radio Freq. Interference**
IEEE TRANSACTIONS ON ELECTRON DEVICES	ED	*IEEE Trans. Electron Devices*
IEEE JOURNAL OF ELECTRON DEVICES SOCIETY	EDS	*IEEE J. Electron Devices Soc.*
IEEE ELECTRON DEVICE LETTERS	EDL	*IEEE Electron Device Lett.*
IEEE TRANSACTIONS ON ELECTRONICS PACKAGING MANUFACTURING	EPM	*IEEE Trans. Electron. Packag. Manuf. (1999—2010)*
IEEE EMBEDDED SYSTEMS LETTERS	ES	*IEEE Embedded Syst. Lett.*
IEEE TRANSACTIONS ON EMERGING TOPICS IN COMPUTING	ETC	*IEEE Trans. Emerg. Topics Comput.*
IEEE TRANSACTIONS ON EMERGING AND SELECTED TOPICS IN CIRCUITS AND SYSTEMS	ETCAS	*IEEE Trans. Emerg. Sel. Topics Circuits Syst.*
IEEE TRANSACTIONS ON EMERGING AND SELECTED TOPICS IN POWER ELECTRONICS	ESTPE	*IEEE Trans. Emerg. Sel. Topics Power Electron.*

IEEE Abbreviations for Transactions, Journals, Letters, and Magazines (ctd.)

Publication	Acronym	Reference Abbreviation
IEEE TRANSACTIONS ON ENERGY CONVERSION	EC	*IEEE Trans. Energy Convers.*
IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT	EM	*IEEE Trans. Eng. Manag.*
IEEE TRANSACTIONS ON EVOLUTIONARY COMPUTATION	EVC	*IEEE Trans. Evol. Comput.*
IEEE TRANSACTIONS ON EXPLORATORY SOLID-STATE COMPUTATIONAL DEVICES AND CIRCUITS	XCDC	*IEEE Trans.*
IEEE TRANSACTIONS ON FUZZY SYSTEMS	FUZZ	*IEEE Trans. Fuzzy Syst.*
IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING	GRS	*IEEE Trans. Geosci. Remote Sens.*
IEEE GEOSCIENCE AND REMOTE SENSING LETTERS	GRSL	*IEEE Geosci. Remote Sens. Lett.*
IEEE TRANSACTIONS ON HUMAN–MACHINE SYSTEMS	HMS*	*IEEE Trans. Human–Mach. Syst.*
	SMCC*	*IEEE Trans. Syst., Man, Cybern. C, Appl. Rev. (1995–2012)*
	SMC*	*IEEE Trans. Syst., Man, Cybern.* (1971–1995)*
	SSC*	*IEEE Trans. Syst. Sci. Cybern.* (through 1970)*
IEEE TRANSACTIONS ON IMAGE PROCESSING	IP	*IEEE Trans. Image Process.*
IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS	IE	*IEEE Trans. Ind. Electron.*
IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS	II	*IEEE Trans. Ind. Informat.*
IEEE TRANSACTIONS ON INDUSTRY APPLICATIONS	IA	*IEEE Trans. Ind. Appl.*
IEEE TRANSACTIONS ON INFORMATION FORENSICS AND SECURITY	IFS	*IEEE Trans. Inf. Forensics Security*
IEEE TRANSACTIONS ON INFORMATION THEORY	IT	*IEEE Trans. Inf. Theory*
IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT	IM	*IEEE Trans. Instrum. Meas.*
	I, PGI*	*IEEE Trans. Instrum.**
IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS	ITS	*IEEE Trans. Intell. Transp. Syst.*
IEEE INTERNET OF THINGS JOURNAL	IoT	*IEEE Internet Things J.*
IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING	KDE	*IEEE Trans. Knowl. Data Eng.*
IEEE LIFE SCIENCES LETTERS	LS	*IEEE Life Sci. Lett.*
IEEE/OSA JOURNAL OF LIGHTWAVE TECHNOLOGY	LT	*J. Lightw. Technol.*
IEEE TRANSACTIONS ON MAGNETICS	MAG	*IEEE Trans. Magn.*
IEEE MAGNETICS LETTERS	MAGL	*IEEE Magn. Lett.*
IEEE/ASME TRANSACTIONS ON MECHATRONICS	MECH	*IEEE/ASME Trans. Mechatronics*
IEEE TRANSACTIONS ON MEDICAL IMAGING	MI	*IEEE Trans. Med. Imag.*
IEEE JOURNAL OF MICROELECTROMECHANICAL SYSTEMS	MEMS	*J. Microelectromech. Syst.*
IEEE/ASME JOURNAL OF MICROELECTROMECHANICAL SYSTEMS	MEMS	*J. Microelectromech. Syst. (1992–2013)*
IEEE MICROWAVE AND WIRELESS COMPONENTS LETTERS	MWCL	*IEEE Microw. Compon. Lett.*
	MGWL	*IEEE Microw. Guided Wave Lett. (1991–2000)*
IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES	MTT	*IEEE Trans. Microw. Theory Techn.*
IEEE TRANSACTIONS ON MOBILE COMPUTING	MC	*IEEE Trans. Mobile Comput.*
IEEE TRANSACTIONS ON MOLECULAR, BIOLOGICAL AND MULTI-SCALE COMMUNICATIONS		*IEEE Trans. Mol. Biol. Multi-Scale Commun.*
IEEE TRANSACTIONS ON MULTIMEDIA	MM	*IEEE Trans. Multimedia*
IEEE TRANSACTIONS ON MULTI-SCALE COMPUTING SYSTEMS		*IEEE Trans. Multi-Scale Comput. Syst.*
IEEE TRANSACTIONS ON NANOBIOSCIENCE	NB	*IEEE Trans. Nanobiosci.*
IEEE TRANSACTIONS ON NANOTECHNOLOGY	NANO	*IEEE Trans. Nanotechnol.*
IEEE NANOTECHNOLOGY EXPRESS	ENANO	*IEEE Nanotechnol. Express*
IEEE/ACM TRANSACTIONS ON NETWORKING	NET	*IEEE/ACM Trans. Netw.*
IEEE TRANSACTIONS ON NEURAL NETWORKS AND LEARNING SYSTEMS	NNLS	*IEEE Trans. Neural Netw. Learn. Syst.*
	NN	*IEEE Trans. Neural Netw. (1990–2011)*

IEEE Abbreviations for Transactions, Journals, Letters, and Magazines (ctd.)

Publication	Acronym	Reference Abbreviation
IEEE TRANSACTIONS ON NUCLEAR SCIENCE	NS	*IEEE Trans. Nucl. Sci.*
IEEE TRANSACTIONS ON NEURAL SYSTEMS AND REHABILITATION ENGINEERING	NSRE	*IEEE Trans. Neural Syst. Rehabil. Eng.*
	RE*	*IEEE Trans. Rehabil. Eng.* (1993–2000)*
IEEE JOURNAL OF OCEANIC ENGINEERING	OE	*IEEE J. Ocean. Eng.*
IEEE JOURNAL OF OPTICAL COMMUNICATIONS AND NETWORKING	OCN	*IEEE J. Opt. Commun. Netw.*
IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS	PDS	*IEEE Trans. Parallel Distrib. Syst.*
IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE	PAMI	*IEEE Trans. Pattern Anal. Mach. Intell.*
IEEE PHOTONICS TECHNOLOGY LETTERS	PTL	*IEEE Photon. Technol. Lett.*
IEEE PHOTONICS JOURNAL	PJ	*IEEE Photon. J.*
IEEE JOURNAL OF PHOTOVOLTAICS	PHOT	*IEEE J. Photovolt.*
IEEE TRANSACTIONS ON PLASMA SCIENCE	PS	*IEEE Trans. Plasma Sci.*
IEEE TRANSACTIONS ON POWER APPARATUS AND SYSTEMS	PAS*	*IEEE Trans. Power App. Syst.* (through 1985)*
IEEE TRANSACTIONS ON POWER DELIVERY	PWRD	*IEEE Trans. Power Del.*
IEEE TRANSACTIONS ON POWER ELECTRONICS	PEL	*IEEE Trans. Power Electron.*
IEEE POWER ELECTRONICS LETTERS	LPEL	*IEEE Power Electron Lett. (2003-2005; abolished)*
IEEE TRANSACTIONS ON POWER SYSTEMS	PWRS	*IEEE Trans. Power Syst.*
IEEE JOURNAL OF PRODUCT SAFETY ENGINEERING	PSE	*IEEE J. Product Safety Eng.*
IEEE POWER AND ENERGY TECHNOLOGY SYSTEMS JOURNAL	PETS	*IEEE Power Energy Technol. Syst. J.*
IEEE TRANSACTIONS ON PROFESSIONAL COMMUNICATION	PC	*IEEE Trans. Prof. Commun.*
IEEE JOURNAL OF QUANTUM ELECTRONICS	QE	*IEEE J. Quantum Electron.*
IEEE RFIC JOURNAL	RFIC	*IEEE RFIC J.*
IEEE RFID JOURNAL	RFID	*IEEE RFID J.*
IEEE TRANSACTIONS ON RELIABILITY	R	*IEEE Trans. Rel.*
IEEE TRANSACTIONS ON ROBOTICS	RO	*IEEE Trans. Robot.*
IEEE TRANSACTIONS ON ROBOTICS AND AUTOMATION	RA*	*IEEE Trans. Robot. Autom. (1989–June 2004)*
	RA*	*IEEE J. Robot. Autom.* (1985–1988)*
IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS IN REMOTE SENSING	STARS	*IEEE J. Sel. Topics Appl. Earth Observ.*
IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS	SAC	*IEEE J. Sel. Areas Commun.*
IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS	STQE	*IEEE J. Sel. Topics Quantum Electron.*
IEEE JOURNAL OF SELECTED TOPICS IN SIGNAL PROCESSING	STSP	*IEEE J. Sel. Topics Signal Process.*
IEEE TRANSACTIONS ON SEMICONDUCTOR MANUFACTURING	SM	*IEEE Trans. Semicond. Manuf.*
IEEE SENSORS JOURNAL	SEN	*IEEE Sensors J.*
IEEE TRANSACTIONS ON SIGNAL PROCESSING	SP	*IEEE Trans. Signal Process.*
	ASSP*	*IEEE Trans. Acoust., Speech, Signal Process. * (1975–1990)*
	AU*	*IEEE Trans. Audio Electroacoust. (until 1974)*
IEEE SIGNAL PROCESSING LETTERS	SPL	*IEEE Signal Process. Lett.*
IEEE TRANSACTIONS ON SMART GRID	SG	*IEEE Trans. Smart Grid*
IEEE TRANSACTIONS ON SUSTAINABLE ENERGY	STE	*IEEE Trans. Sustain. Energy*
IEEE SYSTEMS JOURNAL	SJ	*IEEE Syst. J.*
IEEE TRANSACTIONS ON SOFTWARE ENGINEERING	SE	*IEEE Trans. Softw. Eng.*
IEEE JOURNAL OF SOLID-STATE CIRCUITS	SSC	*IEEE J. Solid-State Circuits*

IEEE Abbreviations for Transactions, Journals, Letters, and Magazines (ctd.)

Publication	Acronym	Reference Abbreviation
IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS: SYSTEMS	SMC	*IEEE Trans. Syst., Man, Cybern.,Syst.*
	SMCA*	*IEEE Trans. Syst., Man, Cybern. A, Syst.,Humans (1995-2012)*
	MMS*	*IEEE Trans. Man-Mach. Syst.* (through 1970)*
	HFE*	*Hum. Factors Electron.* (through 1968)*
IEEE JOURNAL OF TRANSLATIONAL ENGINEERING IN HEALTH AND MEDICINE	TEHM	*IEEE J. Transl. Eng. Health Med.*
IEEE TRANSLATION JOURNAL ON MAGNETICS IN JAPAN	TJMJ	*IEEE Transl. J. Magn. Jpn. (through 2010)*
IEEE JOURNAL ON TECHNOLOGY IN COMPUTER AIDED DESIGN	TCAD	*IEEE J. Technol. Computer Aided Des.*
IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY	THz	*IEEE Trans. THz Sci. Technol.*
IEEE TRANSACTIONS ON TRANSPORTATION ELECTRIFICATION		*IEEE Trans. Transport. Electrific.*
IEEE TRANSACTIONS ON ULTRASONICS, FERROELECTRICS, AND FREQUENCY CONTROL	UFFC	*IEEE Trans. Ultrason., Ferroelectr., Freq. Control*
	SU*	*IEEE Trans. Sonics Ultrason.* (through 1985)*
	UE*	*IEEE Trans. Ultrason. Eng.**
	PGUE*	*IEEE Trans. Ultrason. Eng.**
IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY	VT	*IEEE Trans. Veh. Technol.*
	VC*	*IEEE Trans. Veh. Commun.**
IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEMS	VLSI	*IEEE Trans. Very Large Scale Integr. (VLSI) Syst.*
IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS	VCG	*IEEE Trans. Vis. Comput. Graphics*
IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS	WC	*IEEE Trans. Wireless Commun.*
PROCEEDINGS OF THE IEEE		*Proc. IEEE*
		Proc. IRE (through 1962)*

List of IEEE Magazines

List of IEEE Magazines

Magazine	Reference Abbreviation
IEEE Aerospace and Electronics Systems Magazine	*IEEE Aerosp. Electron. Syst. Mag.*
IEEE Annals of the History of Computing	*IEEE Ann. Hist. Comput.*
IEEE Antennas and Propagation Magazine	*IEEE Antennas Propag. Mag.*
IEEE ASSP Magazine (1984–1990)	*IEEE ASSP Mag.*
IEEE Circuits and Systems Magazine	*IEEE Circuits Syst. Mag.*
IEEE Circuits and Devices Magazine (1988–2006)	*IEEE Circuits Devices Mag.*
IEEE Communications Society Magazine (through 1978)	*IEEE Commun. Soc. Mag.*
IEEE Communications Magazine (1979–present)	*IEEE Commun. Mag.*
IEEE Computational Intelligence Magazine	*IEEE Comput. Intell. Mag.*
IEEE Computing in Science and Engineering Magazine	*IEEE Comput. Sci. Eng.*
IEEE Computer Applications in Power	*IEEE Comput. Appl. Power*
IEEE Computer Graphics and Applications Magazine	*IEEE Comput. Graph. Appl. Mag.*
IEEE Concurrency	*IEEE Concurrency*
IEEE Consumer Electronics Magazine	*IEEE Consum. Electron. Mag.*
IEEE Control Systems Magazine	*IEEE Control Syst. Mag.*
IEEE Design & Test	*IEEE Des. Test.*
	IEEE Des. Test. Comput. (through 2012)*
IEEE Electrical Insulation Magazine	*IEEE Elect. Insul. Mag.*
IEEE Electomagnetic Compatibility Magazine	*IEEE Electrmagn. Compat.*
IEEE Electrification Magazine	*IEEE Electrific. Mag.*
IEEE ElectroTechnology Review	*IEEE ElectroTechnol. Rev.*
	IEEE Eng. Med. Biol. Mag. (1982–2009)
IEEE Engineering Management Review	*IEEE Eng. Manag. Rev.*
IEEE Expert (through 1997)	*IEEE Expert*
IEEE Geoscience and Remote Sensing Magazine	*IEEE Geosci. Remote Sens. Mag. (replaces Newsletter)*
IEEE Industrial Electronics Magazine	*IEEE Ind. Electron. Mag.*
IEEE Industry Applications Magazine	*IEEE Ind. Appl. Mag.*
IEEE Instrumentation and Measurement Magazine	*IEEE Instrum. Meas. Mag.*
IEEE Intelligent Systems (formerly IEEE Expert)	*IEEE Intell. Syst.*
IEEE Intelligent Transportation Systems Magazine	*IEEE Intell. Transp. Syst. Mag.*
IEEE Internet Computing Magazine	*IEEE Internet Comput.*
IEEE IT Professional	*IEEE IT Prof.*
IEEE Micro Magazine	*IEEE Micro*
IEEE Microwave Magazine	*IEEE Microw. Mag.*
IEEE MultiMedia	*IEEE Multimedia Mag.*
IEEE Nanotechnology Magazine	*IEEE Nanotechnol. Mag.*
IEEE Network	*IEEE Netw.*
IEEE Personal Communications	*IEEE Pers. Commun.*
IEEE Potentials	*IEEE Potentials*
IEEE Power Electronics Magazine	*IEEE Power Electron. Mag.*
IEEE Power and Energy Magazine	*IEEE Power Energy Mag.*
IEEE Power Engineering Review	*IEEE Power Eng. Rev.*
IEEE Pulse	*IEEE Pulse*
IEEE Robotics and Automation Magazine	*IEEE Robot. Autom. Mag.*
IEEE Signal Processing Magazine (1991–present)	*IEEE Signal Process. Mag.*

List of IEEE Magazines

Magazine	Reference Abbreviation
IEEE Solid-State Circuits Magazine	*IEEE Solid State Circuits Mag.*
IEEE Security and Privacy	*IEEE Security Privacy*
IEEE Software	*IEEE Softw.*
IEEE Spectrum	*IEEE Spectr.*
IEEE Technology and Society Magazine	*IEEE Technol. Soc. Mag.*
IEEE Vehicular Technology Magazine	*IEEE Veh. Technol. Mag.*
China Communications Magazine	*China Commun.*
Communications Surveys and Tutorials	*Commun. Surveys Tuts.*
Computer Magazine	*Computer*
Internet Computing	*Internet Comput.*
Pervasive Computing	*Pervasive Comput.*
Today's Engineer	*Today's Engineer*
Wireless Communications	*Wireless Commun.*

2014 IEEE Taxonomy

Version 1.0

Created by The Institute of Electrical and Electronics Engineers (IEEE)

IEEE

Advancing Technology for Humanity

IEEE Taxonomy: A Subset Hierarchical Display of IEEE Thesaurus Terms

The IEEE Taxonomy comprises the first three hierarchical 'levels' under each term-family (or branch) that is formed from the top-most terms of the IEEE Thesaurus. In this document these term-families are arranged alphabetically and denoted by **boldface** type. Each term family's hierarchy goes to no more than three sublevels, denoted by indents (in groups of four dots) preceding the next level terms. A term can appear in more than one hierarchical branch and can appear more than once in any particular hierarchy. The 2014 IEEE Taxonomy is defined in this way so that it is always a subset of the 2014 IEEE Thesaurus.

Aerospace and electronic systems
....Aerospace control
.....Air traffic control
.....Attitude control
.....Ground support
....Aerospace engineering
.....Aerospace biophysics
.....Aerospace electronics
.....Aerospace safety
.....Air safety
.....Aerospace simulation
.....Aerospace testing
.....Satellites
.....Artificial satellites
.....Earth Observing System
.....Low earth orbit satellites
.....Moon
.....Space stations
.....Space technology
.....Space exploration
....Aerospace materials
.....Aerospace components
....Aircraft manufacture
....Aircraft navigation
....Aircraft propulsion
.....Propellers
....Command and control systems
....Electronic warfare
.....Electronic countermeasures
.....Jamming
.....Radar countermeasures
....Military equipment
.....Military aircraft
.....Payloads
.....Military satellites
.....Weapons
.....Guns
.....Missiles
.....Nuclear weapons
.....Projectiles
....Radar
.....Airborne radar
.....Bistatic radar
.....Doppler radar
.....Ground penetrating radar
.....Laser radar
.....Meteorological radar
.....Millimeter wave radar
.....Multistatic radar
.....MIMO radar
.....Passive radar
.....Radar applications
.....Radar countermeasures
.....Radar detection
.....Radar imaging
.....Radar measurements
.....Radar polarimetry
.....Radar remote sensing
.....Radar tracking
.....Radar clutter
.....Radar cross-sections
.....Radar equipment
.....Radar theory
.....Spaceborne radar
.....Spread spectrum radar
.....Synthetic aperture radar
.....Inverse synthetic aperture radar
.....Polarimetric synthetic aperture radar
.....Ultra wideband radar
....Sensor systems
.....Gunshot detection systems
....Sonar
.....Sonar applications
.....Sonar detection
.....Sonar measurements
.....Sonar equipment
.....Synthetic aperture sonar
....Telemetry
.....Biomedical telemetry

Antennas and propagation
....Antennas
.....Antenna accessories
.....Antenna arrays
.....Adaptive arrays
.....Butler matrices
.....Linear antenna arrays
.....Log periodic antennas
.....Microstrip antenna arrays
.....Microwave antenna arrays
.....Phased arrays
.....Planar arrays
.....Antenna radiation patterns
.....Near-field radiation pattern
.....Antenna theory
.....Frequency selective surfaces
.....Apertures
.....Aperture antennas
.....Aperture coupled antennas
.....Broadband antennas
.....Ultra wideband antennas
.....Vivaldi antennas
.....Dielectric resonator antennas
.....Dipole antennas
.....Directional antennas
.....Directive antennas
.....Feeds
.....Antenna feeds
.....Fractal antennas
.....Helical antennas
.....Horn antennas
.....Leaky wave antennas
.....Loaded antennas
.....Log-periodic dipole antennas
.....Microstrip antennas
.....Microwave antennas
.....Mobile antennas
.....Multifrequency antennas
.....Omnidirectional antennas
.....Patch antennas
.....Radar antennas
.....Receiving antennas
.....Rectennas
.....Reflector antennas
.....Satellite antennas
.....Slot antennas
.....Transmission line antennas
.....Transmitting antennas
.....UHF antennas
.....Yagi-Uda antennas
....Electromagnetic propagation
.....Electromagnetic diffraction
.....Optical diffraction
.....Physical theory of diffraction
.....X-ray diffraction
.....Electromagnetic propagation in absorbing media
.....Electromagnetic reflection
.....Optical reflection
.....Microwave propagation
.....Millimeter wave propagation
.....Optical propagation
.....Optical surface waves
.....Optical waveguides
.....Propagation constant
.....Propagation losses
.....Radio propagation
.....Radiowave propagation
.....Submillimeter wave propagation
.....UHF propagation
....Radio astronomy

Broadcast technology
....Broadcasting
.....Digital audio broadcasting
.....Digital audio players
.....Digital Radio Mondiale
.....Digital multimedia broadcasting
.....Digital video broadcasting
.....Radio broadcasting
.....Frequency modulation
.....Radio networks
.....Satellite broadcasting
.....TV broadcasting

Circuits and systems
....Circuits
.....Active circuits
.....Active inductors
.....Gyrators
.....Operational amplifiers
.....Adders
.....Analog circuits
.....Analog integrated circuits
.....Analog processing circuits
.....Application specific integrated circuits
.....System-on-chip
.....Asynchronous circuits
.....Bipolar integrated circuits
.....BiCMOS integrated circuits

.....Bipolar transistor circuits
.....Bipolar integrated circuits
.....Bistable circuits
.....Latches
.....Bridge circuits
.....Charge pumps
.....Circuit analysis
.....Circuit analysis computing
.....Coupled mode analysis
.....Nonlinear network analysis
.....Circuit faults
.....Electrical fault detection
.....Circuit noise
.....Thermal noise
.....Circuit simulation
.....Circuit synthesis
.....High level synthesis
.....Integrated circuit synthesis
.....Coprocessors
.....Counting circuits
.....Coupling circuits
.....Digital circuits
.....Circuit topology
.....Digital integrated circuits
.....Digital signal processors
.....Distributed parameter circuits
.....Driver circuits
.....Electronic circuits
.....Breadboard circuit
.....Central Processing Unit
.....Stripboard circuit
.....Equivalent circuits
.....Feedback
.....Feedback circuits
.....Negative feedback
.....Neurofeedback
.....Hybrid integrated circuits
.....Integrated circuits
.....Analog-digital integrated circuits
.....Analog integrated circuits
.....Application specific integrated circuits
.....Bipolar integrated circuits
.....CMOS integrated circuits
.....Coprocessors
.....Current-mode circuits
.....Digital integrated circuits
.....FET integrated circuits
.....Field programmable gate arrays
.....Hybrid integrated circuits
.....Integrated circuit interconnections
.....Integrated circuit modeling
.....Integrated circuit noise
.....Integrated circuit synthesis
.....Large scale integration
.....MESFET integrated circuits
.....Microprocessors
.....Microwave integrated circuits
.....Millimeter wave integrated circuits
.....Mixed analog digital integrated circuits
.....Monolithic integrated circuits
.....Photonic integrated circuits
.....Power integrated circuits
.....Radiofrequency integrated circuits
.....Submillimeter wave integrated circuits
.....Superconducting integrated circuits
.....Thick film circuits
.....Thin film circuits
.....Three-dimensional integrated circuits
.....Through-silicon vias
.....UHF integrated circuits
.....Ultra large scale integration
.....Very high speed integrated circuits
.....Very large scale integration
.....Wafer scale integration
.....Isolators
.....Large scale integration
.....Ultra large scale integration
.....Very large scale integration
.....Wafer scale integration
.....Linear circuits
.....Logic arrays
.....Programmable logic arrays
.....Logic circuits
.....Combinational circuits
.....Logic arrays
.....Programmable logic arrays
.....Superconducting logic circuits
.....Magnetic circuits
.....Microprocessors
.....Automatic logic units
.....Biomimetics
.....Coprocessors
.....Microcontrollers
.....Microprocessor chips
.....Vector processors
.....Microwave circuits
.....Millimeter wave circuits
.....Millimeter wave integrated circuits

.....Millimeter wave integrated circuits
.....MIMICs
.....Monolithic integrated circuits
.....MIMICs
.....MMICs
.....MOSFET circuits
.....CMOSFET circuits
.....MOS integrated circuits
.....Power MOSFET
.....Multiplying circuits
.....Nonlinear circuits
.....Nonlinear network analysis
.....Passive circuits
.....Phase shifters
.....Phase transformers
.....Power dissipation
.....Power integrated circuits
.....Printed circuits
.....Flexible printed circuits
.....Programmable circuits
.....Field programmable analog arrays
.....Programmable logic arrays
.....Programmable logic devices
.....Programmable logic arrays
.....Programmable logic devices
.....Pulse circuits
.....Flip-flops
.....Radiation detector circuits
.....Rail to rail operation
.....Rail to rail amplifiers
.....Rail to rail inputs
.....Rail to rail outputs
.....Rectifiers
.....RLC circuits
.....Sampled data circuits
.....Sequential circuits
.....Silicon-on-insulator
.....Silicon on sapphire
.....Submillimeter wave circuits
.....Submillimeter wave integrated circuits
.....Summing circuits
.....Switched circuits
.....Switched capacitor circuits
.....Switching circuits
.....Choppers (circuits)
.....Logic circuits
.....Switching converters
.....Zero current switching
.....Zero voltage switching
.....Thick film circuits
.....Thin film circuits
.....Thyristor circuits
.....Time varying circuits
.....Trigger circuits
.....UHF circuits
.....UHF integrated circuits
.....UHF integrated circuits
.....Ultra large scale integration
.....Very large scale integration
.....Neuromorphics
.....Wafer scale integration
.....VHF circuits
.....Wafer scale integration
....Contacts
.....Brushes
.....Contact resistance
.....Ohmic contacts
....Filtering
.....Filters
.....Active filters
.....Anisotropic
.....Bragg gratings
.....Channel bank filters
.....Digital filters
.....Equalizers
.....Filtering theory
.....Gabor filters
.....Harmonic filters
.....IIR filters
.....Kalman filters
.....Low-pass filters
.....Matched filters
.....Microstrip filters
.....Nonlinear filters
.....Particle filters
.....Power filters
.....Resonator filters
.....Spatial filters
.....Superconducting filters
.....Transversal filters
.....Information filtering
.....Information filters
.....Recommender systems
....Integrated circuit technology
.....CMOS technology
.....CMOS process
.....Silicon on sapphire
.....Moore's Law
....Logic devices
.....Logic gates
.....Programmable logic devices

....Oscillators
.....Digital-controlled oscillators
.....Injection-locked oscillators
.....Local oscillators
.....Microwave oscillators
.....Phase noise
.....Ring oscillators
.....Voltage-controlled oscillators
....Single electron devices
.....Single electron memory
.....Hetero-nanocrystal memory
.....Single electron transistors
....Tunable circuits and devices
.....RLC circuits
.....Tuned circuits

Communications technology
....Communication equipment
.....Auditory displays
.....Codecs
.....Speech codecs
.....Video codecs
.....Modems
.....Optical communication equipment
.....Optical transmitters
.....Radio communication equipment
.....Base stations
.....Ham radios
.....Land mobile radio equipment
.....Radio transceivers
.....Transponders
.....Receivers
.....Optical receivers
.....RAKE receivers
.....Receiving antennas
.....Repeaters
.....Speech codecs
.....Telephone equipment
.....Cellular phones
.....Telephone sets
.....Vocoders
.....Transceivers
.....Radio transceivers
.....Transmitters
.....Auxiliary transmitters
.....Diversity methods
.....Neurotransmitters
.....Optical transmitters
.....Radio transmitters
.....Transmitting antennas
.....Transponders
.....TV equipment
.....Large screen displays
.....TV receivers
.....Video codecs
.....Video equipment
.....Video codecs
.....Vocoders
....Communication switching
.....Code division multiplexing
.....Electronic switching systems
.....Frame relay
.....Handover
.....Multiprotocol label switching
.....Packet switching
.....Burst switching
.....Frame relay
.....Multiprotocol label switching
.....Packet loss
....Communication systems
.....ARPANET
.....Biomedical communication
.....Biomedical telemetry
.....Telemedicine
.....Broadband communication
.....B-ISDN
.....Broadband amplifiers
.....Communication networks
.....Central office
.....Cyberspace
.....Industrial communication
.....Relay networks (telecommunications)
.....Software defined networking
.....Communication system control
.....Telecommunication control
.....Communication system security
.....Radio communication countermeasures
.....Communication system signaling
.....Communication system software
.....Streaming media
.....Communication system traffic
.....Communication system traffic control
.....Computer networks
.....Ad hoc networks
.....Computer network management
.....Content distribution networks
.....Cyberspace
.....Diffserv networks
.....Domain Name System

.....Ethernet networks
.....Google
.....Internet
.....Intserv networks
.....IP networks
.....Metropolitan area networks
.....Multiprocessor interconnection networks
.....Network servers
.....Next generation networking
.....Overlay networks
.....Peer-to-peer computing
.....Software defined networking
.....Storage area networks
.....Token networks
.....Unicast
.....Virtual private networks
.....Wide area networks
.....Cross layer design
.....Data buses
.....Backplanes
.....Data communication
.....Asynchronous communication
.....Asynchronous transfer mode
.....Data buses
.....Data transfer
.....Telecommunication buffers
.....Telemetry
.....Teleprinting
.....Digital communication
.....Baseband
.....DICOM
.....Digital audio broadcasting
.....Digital images
.....Digital multimedia broadcasting
.....Digital video broadcasting
.....DSL
.....ISDN
.....Passband
.....Portable media players
.....SONET
.....Spread spectrum communication
.....Facsimile
.....FDDI
.....Indoor communication
.....Indoor environments
.....Internet
.....Crowdsourcing
.....Instant messaging
.....Internet of Things
.....Internet telephony
.....Internet topology
.....Middleboxes
.....Semantic Web
.....Social computing
.....Web 2.0
.....Web services
.....IP networks
.....TCPIP
.....ISDN
.....B-ISDN
.....Land mobile radio cellular systems
.....Cellular networks
.....Paging strategies
.....Local area networks
.....Wireless LAN
.....Machine-to-machine communications
.....Metropolitan area networks
.....Microwave communication
.....Rectennas
.....Military communication
.....Reconnaissance
.....Millimeter wave communication
.....MIMO
.....Rician channels
.....Mobile communication
.....3G mobile communication
.....4G mobile communication
.....Ambient networks
.....Dual band
.....Land mobile radio
.....Land mobile radio cellular systems
.....Mobile nodes
.....Mobile radio mobility management
.....Software radio
.....Molecular communication
.....Multiaccess communication
.....Direct-sequence code-division multiple access
.....Frequency division multiaccess
.....Multicarrier code division multiple access
.....Subscriber loops
.....Time division multiple access
.....Time division synchronous code division multiple access
.....Multicast communication
.....Multicast VPN
.....Multimedia communication
.....Narrowband
.....Optical fiber communication
.....FDDI

.....Optical buffering
.....Optical fiber networks
.....Optical fiber subscriber loops
.....Optical interconnections
.....Optical packet switching
.....Optical wavelength conversion
.....Scheduling algorithms
.....SONET
.....Personal communication networks
.....Protocols
.....Access protocols
.....Asynchronous transfer mode
.....Cryptographic protocols
.....Master-slave
.....Multicast protocols
.....Multiprotocol label switching
.....Routing protocols
.....Transport protocols
.....Wireless application protocol
.....Quality of service
.....Admission control
.....Radio communication
.....Baseband
.....Bluetooth
.....Indoor radio communication
.....Land mobile radio
.....Land mobile radio cellular systems
.....Packet radio networks
.....Passband
.....Personal area networks
.....Radio broadcasting
.....Radio communication countermeasures
.....Radio frequency
.....Radio link
.....Radio spectrum management
.....Satellite communication
.....Satellite ground stations
.....Software radio
.....Zigbee
.....Routing
.....Wavelength routing
.....Satellite communication
.....Downlink
.....Satellite broadcasting
.....Satellite ground stations
.....Uplink
.....Satellite ground stations
.....SIMO
.....SISO
.....Spatial diversity
.....Submillimeter wave communication
.....Subscriber loops
.....Switching systems
.....Electronic switching systems
.....Switching frequency
.....Switching loss
.....Telecommunication switching
.....Synchronous digital hierarchy
.....Telecommunications
.....Ambient intelligence
.....Feedback communications
.....IP networks
.....Radio access networks
.....Railway communication
.....Telecommunication computing
.....Telecommunication network topology
.....Telecommunication services
.....Telematics
.....Teleconferencing
.....Telegraphy
.....Telephony
.....Teleprinting
.....Teletext
.....Token networks
.....UHF communication
.....Underwater communication
.....Videophone systems
.....Videotex
.....Visual communication
.....Wide area networks
.....Wideband
.....Wireless communication
.....Cognitive radio
.....Cooperative communication
.....GSM
.....Open wireless architecture
.....Roaming
.....Spatial diversity
.....WiMAX
.....Wireless application protocol
.....Wireless networks
.....Wireless mesh networks
.....Wireless sensor networks
.....Body sensor networks
.....Event detection
....Couplers
.....Directional couplers
....High-speed electronics
.....High-speed integrated circuits
.....High-speed networks

.....Ultrafast electronics
....Image communication
.....Facsimile
.....Picture archiving and communication systems
....Message systems
.....Electronic mail
.....Unified messaging
.....Unsolicited electronic mail
.....Electronic messaging
.....Instant messaging
.....Unified messaging
.....Postal services
.....Publish subscribe systems
.....Voice mail
....Modulation
.....Amplitude modulation
.....Amplitude shift keying
.....Quadrature amplitude modulation
.....Chirp modulation
.....Demodulation
.....Digital modulation
.....Constellation diagram
.....Partial response signaling
.....Frequency modulation
.....Frequency shift keying
.....Magnetic modulators
.....Modulation coding
.....Interleaved codes
.....Optical modulation
.....Electrooptic modulators
.....Intensity modulation
.....Phase modulation
.....Continuous phase modulation
.....Differential phase shift keying
.....Phase shift keying
.....Pulse modulation
.....Pulse width modulation
.....Pulse width modulation inverters
.....Space vector pulse width modulation
....Multiplexing
.....Code division multiplexing
.....Demultiplexing
.....Frequency division multiplexing
.....Multiplexing equipment
.....Add-drop multiplexers
.....OFDM
.....Multiple access interference
.....OFDM modulation
.....Partial transmit sequences
.....Peak to average power ratio
.....Time division multiplexing
.....Wavelength division multiplexing
.....WDM networks
....Network topology
.....Complex networks
.....Computer network reliability
....Presence network agents
....TV
.....Cable TV
.....Digital TV
.....Analog TV
.....HDTV
.....IPTV
.....Mobile TV
.....Three-dimensional television
....UHF technology
.....UHF antennas
.....UHF circuits
.....UHF integrated circuits
.....UHF communication
.....UHF devices
.....UHF integrated circuits
....Ultra wideband technology
.....Ultra wideband antennas
.....Ultra wideband communication
.....Ultra wideband radar
....VHF devices

Components, packaging, and manufacturing technology

....Component architectures
....Electronic components
.....Capacitors
.....Power capacitors
.....Varactors
.....Coils
.....Superconducting coils
.....Connectors
.....Plugs
.....Sockets
.....Diodes
.....Diode lasers
.....Electrodes
.....Anodes
.....Cathodes
.....Microelectrodes
.....Fuses
.....Inductors
.....Active inductors

.....Thick film inductors
.....Thin film inductors
.....Resistors
.....Memristors
.....Switched capacitor networks
.....Varistors
.....Structural plates
.....Switches
.....Contactors
.....Microswitches
.....Optical switches
.....Transducers
.....Acoustic transducers
.....Biomedical transducers
.....Chemical transducers
.....Piezoelectric transducers
.....Ultrasonic transducer arrays
....Electronic equipment manufacture
.....Damascene integration
.....Micromachining
.....Radiation hardening (electronics)
.....Semiconductor device manufacture
.....Diffusion processes
.....Flip-chip devices
.....High-K gate dielectrics
.....Quasi-doping
.....Semiconductor device doping
.....Semiconductor epitaxial layers
.....Semiconductor growth
.....Silicidation
.....Wafer bonding
....Electronics packaging
.....Chip scale packaging
....Environmentally friendly manufacturing techniques
....Integrated circuit manufacture
.....Surface-mount technology
....Integrated circuit packaging
.....Multichip modules
.....Plastic integrated circuit packaging
....Semiconductor device packaging
....Thermal management of electronics
.....Electronic packaging thermal management
.....Electronics cooling

Computational and artificial intelligence
....Artificial intelligence
.....Context awareness
.....Cooperative systems
.....Decision support systems
.....Intelligent systems
.....Intelligent robots
.....Knowledge based systems
.....Expert systems
.....Mobile agents
.....Knowledge engineering
.....Inference mechanisms
.....Knowledge acquisition
.....Knowledge discovery
.....Knowledge representation
.....Learning (artificial intelligence)
.....Distance learning
.....Electronic learning
.....Learning systems
.....Backpropagation
.....Learning automata
.....Semisupervised learning
.....Supervised learning
.....Unsupervised learning
.....Machine learning
.....Boosting
.....Statistical learning
.....Prediction methods
.....Linear predictive coding
.....Predictive coding
.....Predictive encoding
.....Predictive models
....Autonomous mental development
....Computational intelligence
.....Computation theory
.....Computational complexity
.....Concurrent computing
.....Greedy algorithms
.....Support vector machines
.....Evolutionary computation
.....Particle swarm optimization
.....Fuzzy systems
.....Fuzzy control
.....Fuzzy neural networks
.....Hybrid intelligent systems
.....Genetic algorithms
....Logic
.....Fuzzy logic
.....Fuzzy cognitive maps
.....Takagi-Sugeno model
.....Multivalued logic
.....Probabilistic logic
.....Sufficient conditions
....Machine intelligence
.....Pattern analysis

....Neural networks
.....Artificial neural networks
.....Hebbian theory
.....Self-organizing feature maps
.....Biological neural networks
.....Cellular neural networks
.....Feedforward neural networks
.....Multilayer perceptrons
.....Multi-layer neural network
.....Neural network hardware
.....Radial basis function networks
.....Recurrent neural networks
.....Hopfield neural networks

Computers and information processing
....Computer applications
.....Affective computing
.....Application virtualization
.....Computer aided analysis
.....Computer aided engineering
.....Computer aided instruction
.....Computer generated music
.....Computer integrated manufacturing
.....Control engineering computing
.....Green computing
.....High energy physics instrumentation computing
.....Linear particle accelerator
.....Knowledge management
.....Knowledge transfer
.....Medical information systems
.....Electronic medical records
.....Military computing
.....Physics computing
.....Power engineering computing
.....Power system analysis computing
.....Publishing
.....Bibliometrics
.....Company reports
.....Desktop publishing
.....Electronic publishing
.....Open Access
.....Scientific publishing
.....Scientific computing
.....Telecommunication computing
.....Internetworking
.....Soft switching
.....Virtual enterprises
.....Virtual manufacturing
.....Virtual machining
.....Web sites
.....Facebook
.....MySpace
.....Uniform resource locators
.....Web design
.....YouTube
.....World Wide Web
.....Mashups
....Computer architecture
.....Accelerator architectures
.....Data structures
.....Arrays
.....Binary decision diagrams
.....Null value
.....Octrees
.....Table lookup
.....Tree data structures
.....Dynamic voltage scaling
.....Memory architecture
.....Memory management
.....Multiprocessor interconnection
.....Hypercubes
.....Parallel architectures
.....Multicore processing
.....Reconfigurable architectures
....Computer interfaces
.....Application programming interfaces
.....WebRTC
.....Browsers
.....Field buses
.....Firewire
.....Haptic interfaces
.....Data gloves
.....Force feedback
.....Grasping
.....Hypertext systems
.....Interface phenomena
.....Network interfaces
.....Interface states
.....Musical instrument digital interfaces
.....Ports (Computers)
.....System buses
....Computer networks
.....Ad hoc networks
.....AODV
.....Mesh networks
.....Mobile ad hoc networks
.....Vehicular ad hoc networks
.....Computer network management
.....Computer network reliability
.....Disruption tolerant networking

.....Management information base
.....Middleboxes
.....Network address translation
.....Network synthesis
.....Content distribution networks
.....Cyberspace
.....Diffserv networks
.....Domain Name System
.....Ethernet networks
.....EPON
.....Google
.....Internet
.....Crowdsourcing
.....Instant messaging
.....Internet of Things
.....Internet telephony
.....Internet topology
.....Middleboxes
.....Semantic Web
.....Social computing
.....Web 2.0
.....Web services
.....Intserv networks
.....IP networks
.....TCPIP
.....Metropolitan area networks
.....Multiprocessor interconnection networks
.....Network servers
.....Next generation networking
.....Overlay networks
.....Peer-to-peer computing
.....Software defined networking
.....Storage area networks
.....Token networks
.....Unicast
.....Virtual private networks
.....Extranets
.....Wide area networks
....Computer performance
.....Computer errors
.....Computer crashes
.....Performance loss
....Computer peripherals
.....Disk drives
.....Keyboards
.....Modems
.....Printers
....Computers
.....Analog computers
.....Calculators
.....Difference engines
.....Microcomputers
.....Portable computers
.....Workstations
.....Parallel machines
.....Supercomputers
.....Tablet computers
.....Wearable computers
....Computer science
.....Formal languages
.....Computer languages
.....Runtime library
.....Network theory (graphs)
.....Programming
.....Augmented reality
.....Automatic programming
.....Concatenated codes
.....Functional programming
.....Granular computing
.....Integer linear programming
.....Logic programming
.....Microprogramming
.....Object oriented methods
.....Object oriented programming
.....Opportunistic software systems development
.....Parallel programming
.....Performance analysis
.....Programming profession
.....Robot programming
....Concurrency control
.....Processor scheduling
.....Scheduling algorithms
....Database machines
....Data systems
.....Data acquisition
.....Fastbus
.....User-generated content
.....Data compression
.....Adaptive coding
.....Audio compression
.....Huffman coding
.....Source coding
.....Test data compression
.....Transform coding
.....Data conversion
.....Analog-digital conversion
.....Digital-analog conversion
.....Data engineering
.....Data handling
.....Data assimilation

.....Data encapsulation
.....Document handling
.....Merging
.....Sorting
.....Data processing
.....Associative processing
.....Business data processing
.....Data analysis
.....Data collection
.....Data integration
.....Data preprocessing
.....Data transfer
.....Information exchange
.....Spreadsheet programs
.....Text processing
.....Virtual enterprises
.....Data storage systems
.....Data warehouses
....Digital systems
.....Internet
.....Crowdsourcing
.....Instant messaging
.....Internet of Things
.....Internet telephony
.....Internet topology
.....Middleboxes
.....Semantic Web
.....Social computing
.....Web 2.0
.....Web services
.....ISDN
.....B-ISDN
.....Local area networks
.....Wireless LAN
.....Metropolitan area networks
.....Token networks
....Distributed computing
.....Client-server systems
.....Middleware
.....Servers
.....Collaborative work
.....Cooperative communication
.....Crowdsourcing
.....Social computing
.....Diffserv networks
.....Distributed databases
.....Distributed information systems
.....Publish-subscribe
.....Internet
.....Crowdsourcing
.....Instant messaging
.....Internet of Things
.....Internet telephony
.....Internet topology
.....Middleboxes
.....Semantic Web
.....Social computing
.....Web 2.0
.....Web services
.....Metacomputing
.....Grid computing
.....Peer-to-peer computing
....DNA computing
....File servers
....Hardware
.....Open source hardware
....High performance computing
....Image processing
.....Active shape model
.....Feature extraction
.....Geophysical image processing
.....Gray-scale
.....Image analysis
.....Image classification
.....Image motion analysis
.....Image quality
.....Image sequence analysis
.....Image texture analysis
.....Object detection
.....Subtraction techniques
.....Image coding
.....Image color analysis
.....Image decomposition
.....Image denoising
.....Image enhancement
.....Image fusion
.....Image generation
.....Plasma displays
.....Visual effects
.....Image recognition
.....Image edge detection
.....Image reconstruction
.....Image registration
.....Image representation
.....Image resolution
.....High-resolution imaging
.....Spatial resolution
.....Image restoration
.....Image sampling
.....Image segmentation
.....Image sequences
.....Image texture

.....Machine vision
.....Object recognition
.....Object segmentation
.....Morphological operations
.....Optical feedback
.....Smart pixels
.....Spatial coherence
.....Table lookup
....Memory
.....Analog memory
.....Associative memory
.....Buffer storage
.....Computer buffers
.....Cache memory
.....Cache storage
.....Content addressable storage
.....Flash memories
.....Flash memory cells
.....Magnetic memory
.....Floppy disks
.....Hard disks
.....Memory management
.....Nonvolatile memory
.....Nonvolatile single electron memory
.....Phase change memory
.....Phase change random access memory
.....Random access memory
.....DRAM chips
.....Phase change random access memory
.....SDRAM
.....SRAM cells
.....SRAM chips
.....Read only memory
.....PROM
.....Read-write memory
.....Registers
.....Shift registers
.....Scanning probe data storage
.....Semiconductor memory
....Mobile computing
....Molecular computing
....Multitasking
.....Parametric study
....Open systems
.....Open Access
.....Public domain software
.....Physical layer
....Optical computing
....Parallel processing
.....Multiprocessing systems
.....Data flow computing
.....Processor scheduling
.....Systolic arrays
.....Multithreading
.....Parallel algorithms
.....Pipeline processing
....Pattern recognition
.....Active shape model
.....Character recognition
.....Clustering methods
.....Pattern clustering
.....Data mining
.....Association rules
.....Data privacy
.....Text analysis
.....Text mining
.....Web mining
.....Face recognition
.....Fingerprint recognition
.....Gesture recognition
.....Sign language
.....Handwriting recognition
.....Forgery
.....Pattern matching
.....Image matching
.....Speech recognition
.....Automatic speech recognition
.....Speech analysis
.....Text recognition
....Pervasive computing
.....Ubiquitous computing
.....Context-aware services
.....Wearable computers
....Petascale computing
....Platform virtualization
....Quantum computing
.....Quantum cellular automata
....Real-time systems
.....WebRTC
....Software
.....Application software
.....Embedded software
.....Middleware
.....Mediation
.....Message-oriented middleware
.....Web services
.....Open source software
.....Optical character recognition software
.....Public domain software
.....Software agents

.....Autonomous agents
.....Intelligent agents
.....Software as a service
.....Software debugging
.....Software design
.....Software maintenance
.....Software packages
.....EMTDC
.....MATLAB
.....PSCAD
.....SPICE
.....Software performance
.....Software quality
.....Software reusability
.....Software safety
.....Software systems
.....Software tools
.....Authoring systems
.....System software
.....File systems
.....Operating systems
.....Program processors
.....Utility programs
....Software engineering
.....Capability maturity model
.....Computer aided software engineering
.....Formal verification
.....Programming environments
.....Reasoning about programs
.....Runtime
.....Dynamic compiler
.....Runtime environment
.....Software architecture
.....Client-server systems
.....Microarchitecture
.....Representational state transfer
.....Software libraries
....System recovery
.....Checkpointing
.....Core dumps
.....Debugging
....Time sharing computer systems
....Virtual machine monitors

Consumer electronics
....Ambient intelligence
....Audio systems
.....Audio-visual systems
.....Auditory displays
.....Headphones
.....Loudspeakers
.....Microphones
.....Microphone arrays
.....Portable media players
.....Sonification
....Home automation
.....Portable media players
.....Refrigerators
.....Smart homes
.....Washing machines
....Home computing
....Low-power electronics
....Microwave ovens
....Multimedia systems
.....Multimedia communication
.....Multimedia computing
.....Multimedia databases

Control systems
....Automatic control
.....Power generation control
....Automatic generation control
....Bidirectional control
....CAMAC
....Centralized control
....Closed loop systems
....Control design
....Control engineering
....Control equipment
.....Actuators
.....Electrostatic actuators
.....Hydraulic actuators
.....Intelligent actuators
.....Microactuators
.....Piezoelectric actuators
.....Pneumatic actuators
.....Fasteners
.....Microcontrollers
.....Regulators
.....Servosystems
.....Servomotors
.....Switches
.....Contactors
.....Microswitches
.....Optical switches
.....Switchgear
.....Circuit breakers
.....Interrupters
.....Relays
.....Telecontrol equipment

.....Thermostats
....Controllability
....Control system synthesis
....Decentralized control
.....Distributed parameter systems
....Delay systems
.....Added delay
.....Delay lines
....Digital control
.....Programmable control
.....Flow graphs
....Feedback
.....Feedback circuits
.....Output feedback
.....Negative feedback
.....Neurofeedback
....Fluid flow control
....Fluidics
.....Microfluidics
.....Nanofluidics
....Linear feedback control systems
.....Frequency locked loops
.....Phase locked loops
.....State feedback
.....Tracking loops
....Magnetic variables control
....Mechanical variables control
.....Displacement control
.....Force control
.....Level control
.....Gyroscopes
.....Motion control
.....Collision avoidance
.....Collision mitigation
.....Kinetic theory
.....Motion planning
.....Path planning
.....Visual servoing
.....Position control
.....Nanopositioning
.....Shape control
.....Size control
.....Strain control
.....Stress control
.....Thickness control
.....Torque control
.....Velocity control
.....Angular velocity control
.....Vibration control
.....Weight control
....Medical control systems
....Moisture control
.....Humidity control
....Motion compensation
....Networked control systems
....Nonlinear control systems
....Open loop systems
....Optical control
.....Lighting control
.....Optical variables control
....Optimal control
.....Bang-bang control
.....Infinite horizon
....PD control
....Pi control
....Pneumatic systems
....Pressure control
....Proportional control
....Radio control
....Robot control
.....Robot motion
....SCADA systems
....Sensorless control
....Sliding mode control
....Supervisory control
.....SCADA systems
....Thermal variables control
.....Temperature control
.....Cooling
.....Heating
.....Thermal analysis
.....Thermomechanical processes
....Traffic control
.....Queueing analysis
.....Vehicle routing

Dielectrics and electrical insulation

....Dielectrics
.....Dielectric constant
.....High-K gate dielectrics
.....Dielectric devices
.....Capacitors
.....Ferroelectric devices
.....Piezoelectric devices
.....Pyroelectric devices
.....Dielectric losses
.....Dielectric substrates
.....Dielectrophoresis
.....Electrohydrodynamics
.....Electrokinetics
.....Electrostriction

....Electric breakdown
.....Avalanche breakdown
.....Corona
.....Dielectric breakdown
.....Arc discharges
.....Discharges (electric)
.....Electrostatic discharges
.....Flashover
.....Glow discharges
.....Partial discharges
.....Surface discharges
.....Vacuum breakdown
.....Sparks
....Insulation
.....Cable insulation
.....Power cable insulation
.....Ceramics
.....Porcelain
.....Gas insulation
.....Sulfur hexafluoride
.....Insulators
.....Metal-insulator structures
.....Plastic insulators
.....Rubber
.....Topological insulators
.....Trees - insulation
.....Isolation technology
.....Oil insulation
.....Oil filled cables
.....Plastic insulation

Education
....Computer science education
....Continuing education
.....Education courses
....Educational institutions
....Educational technology
.....Computer aided instruction
.....Courseware
.....Electronic learning
....Engineering education
.....Biomedical engineering education
.....Communication engineering education
.....Control engineering education
.....Electrical engineering education
.....Electronics engineering education
.....Engineering students
.....Power engineering education
.....Student experiments
.....Systems engineering education
....Physics education
....Power engineering education
....Qualifications
....Training
.....Industrial training
.....Management training
.....On the job training
.....Vocational training

Electromagnetic compatibility and interference
....Electromagnetic compatibility
.....Immunity testing
.....Reverberation chambers
....Electromagnetics
.....Electromagnetic analysis
.....Air gaps
.....Computational electromagnetics
.....Delay effects
.....Electromagnetic fields
.....Electromagnetic forces
.....Electromagnetic refraction
.....Permeability
.....Spark gaps
.....Time-domain analysis
.....Electromagnetic coupling
.....Mutual coupling
.....Optical coupling
.....Electromagnetic devices
.....Electromagnetic induction
.....Eddy currents
.....Inductive power transmission
.....Electromagnetic metamaterials
.....Electromagnetic radiation
.....Correlators
.....Electromagnetic wave absorption
.....Frequency
.....Gamma-rays
.....Line-of-sight propagation
.....Electromagnetic shielding
.....Cable shielding
.....Magnetic shielding
.....Electromagnetic transients
.....EMP radiation effects
.....EMTDC
.....EMTP
.....Power system transients
.....Surges
.....Proximity effects
....Interference

.....Clutter
.....Crosstalk
.....Diffraction
.....Echo interference
.....Electromagnetic interference
.....Radiofrequency interference
.....Specific absorption rate
.....Electromagnetic radiative interference
.....Electrostatic interference
.....Immunity testing
.....Interchannel interference
.....Interference cancellation
.....Interference channels
.....Interference constraints
.....Interference elimination
.....Interference suppression
.....Intersymbol interference
.....Rain fading
.....Terrain factors
.....TV interference

Electron devices
....Cathode ray tubes
....Electron guns
....Electron multipliers
....Electron tubes
.....Field emitter arrays
.....Klystrons
.....Magnetrons
.....Thyratrons
....Mechatronics
.....Biomechatronics
....Microelectromechanical systems
.....Microelectromechanical devices
.....Microactuators
.....Micromotors
.....Micropumps
.....Microvalves
.....Radiofrequency microelectromechanical systems
....Microfluidics
....Micromechanical devices
.....Biomedical microelectromechanical systems
.....Fluidic microsystems
.....Microfabrication
....Photoelectricity
.....Photovoltaic effects
.....Shunts (electrical)
....Photovoltaic cells
.....Light trapping
....Quantum computing
.....Quantum cellular automata
....Quantum well devices
.....Quantum well lasers
.....Quantum cascade lasers
.....Quantum wells
.....Two dimensional hole gas
....Semiconductivity
....Semiconductor devices
.....Flip-chip devices
.....Gunn devices
.....Hall effect devices
.....Junctions
.....Heterojunctions
.....Hybrid junctions
.....P-n junctions
.....Waveguide junctions
.....MIS devices
.....Charge coupled devices
.....MOS devices
.....MONOS devices
.....Piezoresistive devices
.....P-i-n diodes
.....Power semiconductor devices
.....Power transistors
.....Power semiconductor switches
.....Bipolar transistors
.....Thyristors
.....Quantum dots
.....Quantum well lasers
.....Quantum cascade lasers
.....Schottky diodes
.....Semiconductor counters
.....Semiconductor detectors
.....Semiconductor device modeling
.....Semiconductor device noise
.....Semiconductor diodes
.....P-i-n diodes
.....Schottky diodes
.....Semiconductor-metal interfaces
.....Superluminescent diodes
.....Varactors
.....Semiconductor-insulator interfaces
.....Semiconductor lasers
.....Laser tuning
.....Quantum dot lasers
.....Quantum well lasers
.....Semiconductor laser arrays
.....Semiconductor optical amplifiers
.....Surface emitting lasers

.....Semiconductor waveguides
.....Silicon devices
.....SONOS devices
.....Superluminescent diodes
.....Surface emitting lasers
.....Vertical cavity surface emitting lasers
.....Thermistors
.....Transistors
.....Field effect transistors
.....Heterojunction bipolar transistors
.....Millimeter wave transistors
.....Phototransistors
....Single electron devices
.....Single electron memory
.....Hetero-nanocrystal memory
.....Single electron transistors
....Thick film devices
.....Thick film inductors
....Thin film devices
.....Film bulk acoustic resonators
.....Thin film inductors
.....Thin film transistors
.....Organic thin film transistors
....Tunneling
.....Gate leakage
.....Josephson effect
.....Magnetic tunneling
.....Resonant tunneling devices
.....Tunneling magnetoresistance
....Vacuum technology
.....Photomultipliers
.....Vacuum systems
.....Gettering

Electronic design automation and methodology

....Design automation
.....CADCAM
.....Logic design
.....Reconfigurable logic
.....PSCAD
....Design methodology
.....Design for disassembly
.....Design for experiments
.....Design for manufacture
.....Design for quality
.....Design for testability
.....Graphics
.....Animation
.....Art
.....Character generation
.....Computer graphics
.....Engineering drawings
.....Layout
.....Shape
.....Symbols
.....Virtual reality
.....Visualization
.....Green design
.....Ecodesign
.....Green computing
.....Process design
.....Pattern formation
.....Product design
.....Prototypes
.....Technical drawing
.....Time to market
.....User centered design
.....Virtual prototyping

Engineering - general

....Acoustical engineering
....Agricultural engineering
....Chemical engineering
....Civil engineering
.....Railway engineering
.....Railway safety
.....Structural engineering
.....Offshore installations
....Concurrent engineering
....Design engineering
....Electrical engineering
.....Electrical engineering computing
....Engineering profession
....Maintenance engineering
.....Predictive maintenance
.....Preventive maintenance
.....Condition monitoring
....Mechanical engineering
.....Mechanical power transmission
.....Torque converters
.....Mechanical systems
.....Mechanical energy
.....Micromechanical devices
....Precision engineering
....Production engineering
.....Production planning
.....Capacity planning
.....Materials requirements planning

.....Process planning
....Research and development
....Reverse engineering
....Sanitary engineering
....Standardization
.....Formal specifications
.....Guidelines
.....Standards
.....ANSI standards
.....Code standards
.....Communication standards
.....IEC standards
.....IEEE standards
.....ISO standards
.....Measurement standards
.....Military standards
.....Software standards
.....Standards activities board
.....Standards organizations
.....Telecommunication standards
.....Universal Serial Bus
....Thermal engineering

Engineering in medicine and biology
....Bioinformatics
....Biology
.....Biochemistry
.....Amino acids
.....Biochemical analysis
.....Peptides
.....Proteins
.....Biodiversity
.....Biogeography
.....Bioelectric phenomena
.....Electric shock
.....Biological cells
.....Cells (biology)
.....Chromosome mapping
.....Fibroblasts
.....RNA
.....Stem cells
.....Biological information theory
.....Biological processes
.....Biological interactions
.....Chronobiology
.....Circadian rhythm
.....Coagulation
.....Symbiosis
.....Biological system modeling
.....Biological systems
.....Anatomy
.....Molecular communication
.....Organisms
.....Biology computing
.....Biophotonics
.....Biophysics
.....Aerospace biophysics
.....Biomagnetics
.....Cellular biophysics
.....Molecular biophysics
.....Evolution (biology)
.....Memetics
.....Phylogeny
.....Genetics
.....DNA
.....Gene therapy
.....Genetic communication
.....Genetic expression
.....Genetic programming
.....Genomics
.....Microinjection
.....Nanobioscience
.....DNA computing
.....Nanobiotechnology
.....Physiology
.....Predator prey systems
.....Synthetic biology
.....Systematics
.....Systems biology
.....Vegetation
.....Crops
.....Marine vegetation
.....Zoology
.....Animals
....Biomedical communication
.....Biomedical telemetry
.....Telemedicine
....Biomedical computing
.....Biomedical informatics
.....Medical expert systems
.....Medical information systems
.....Electronic medical records
....Biomedical engineering
.....Bioimpedance
.....Biological techniques
.....Biomedical applications of radiation
.....Biomedical electronics
.....Biomedical signal processing
.....Biomedical image processing
.....Biotechnology
.....Cloning

.....Drug delivery
.....Targeted drug delivery
.....Neural engineering
.....Neural microtechnology
.....Neural nanotechnology
.....Neural prosthesis
.....Protein engineering
.....Tissue engineering
.....Regeneration engineering
....Biomedical equipment
.....Assistive technology
.....Assistive devices
.....Wheelchairs
.....Biomedical electrodes
.....Biomedical telemetry
.....Biomedical transducers
.....Catheters
.....Cybercare
.....Endoscopes
.....Gerontechnology
.....Hypodermic needles
.....Implantable biomedical devices
.....Implants
.....Auditory implants
.....Brainstem implants
.....Cochlear implants
.....Microelectronic implants
.....Intracranial pressure sensors
.....Lithotriptors
.....Pacemakers
.....Stethoscope
.....Surgical instruments
.....Laparoscopes
....Biomedical imaging
.....Angiocardiography
.....Angiography
.....Biomedical optical imaging
.....Cardiography
.....Echocardiography
.....Electrocardiography
.....Phonocardiography
.....DICOM
.....Encephalography
.....Mammography
.....Medical diagnostic imaging
.....Anatomical structure
.....Molecular imaging
.....Phantoms
....Bionanotechnology
....Bioterrorism
....Computational biology
.....Computational biochemistry
.....Computational biophysics
.....Computational systems biology
....Genetic engineering
....Medical services
.....Assisted living
.....Catheterization
.....Clinical diagnosis
.....Cybercare
.....Health information management
.....Hospitals
.....In vitro
.....In vitro fertilization
.....In vivo
.....Medical conditions
.....Aneurysm
.....Arteriosclerosis
.....Arthritis
.....Atrophy
.....Blindness
.....Cancer
.....Deafness
.....Diabetes
.....Diseases
.....Epilepsy
.....Hemorrhaging
.....Hypertension
.....Hyperthermia
.....Influenza
.....Injuries
.....Pregnancy
.....Retinopathy
.....Sleep apnea
.....Thrombosis
.....Tumors
.....Medical diagnosis
.....Autopsy
.....Bronchoscopy
.....Colonography
.....Computer aided diagnosis
.....Medical signal detection
.....Nanomedicine
.....Plethysmography
.....Sensitivity and specificity
.....Medical tests
.....Amniocentesis
.....Biopsy
.....Cancer detection
.....Colonoscopy
.....Pregnancy test
.....Medical treatment

.....Anesthesia
.....Angioplasty
.....Brachytherapy
.....Brain stimulation
.....Cardiology
.....Chemotherapy
.....Clinical trials
.....Defibrillation
.....Dentistry
.....Electrical stimulation
.....Electronic medical prescriptions
.....Embolization
.....Fibrillation
.....Gastroenterology
.....Gerontology
.....Gynecology
.....Hepatectomy
.....Hospitals
.....Hyperthermia
.....Lithotripsy
.....Magnetic stimulation
.....Neonatology
.....Neuromuscular stimulation
.....Neutron capture therapy
.....Noninvasive treatment
.....Oncology
.....Orthopedic procedures
.....Orthotics
.....Pathology
.....Patient rehabilitation
.....Pediatrics
.....Pharmaceuticals
.....Surgery
.....Occupational medicine
.....Prosthetics
.....Artificial biological organs
.....Artificial limbs
.....Prosthetic hand
.....Prosthetic limbs
.....Visual prosthesis
.....Public healthcare
.....Sensory aids
.....Hearing aids
.....Vaccines
.....X-rays
.....X-ray applications
.....X-ray detection
.....X-ray scattering
.....X-ray tomography
....Nuclear medicine
....Synthetic biology

Engineering management
....Business
.....Business data processing
.....Industrial relations
.....Management
.....Asset management
.....Best practices
.....Business continuity
.....Business process re-engineering
.....Communication system operations and management
.....Content management
.....Contingency management
.....Contracts
.....Customer relationship management
.....Decision making
.....Enterprise resource planning
.....Facilities management
.....Financial management
.....Governmental factors
.....Human resource management
.....Information management
.....International collaboration
.....Knowledge management
.....Marketing management
.....Organizational aspects
.....Outsourcing
.....Process planning
.....Production management
.....Project management
.....Public relations
.....Quality management
.....Research and development management
.....Resource management
.....Risk analysis
.....Storage management
.....Supply chain management
.....Operations research
.....Inventory control
.....Virtual enterprises
.....Organizations
.....BNSC
.....Companies
.....Government
.....Sociotechnical systems
....Commercialization
....Economics
.....Costs
.....Cost benefit analysis
.....Econometrics

.....Economic forecasting
.....Economic indicators
.....Share prices
.....Electronic commerce
.....Environmental economics
.....Carbon tax
.....Exchange rates
.....Fuel economy
.....International trade
.....Macroeconomics
.....Privatization
.....Microeconomics
.....Economies of scale
.....Industrial economics
.....Monopoly
.....Oligopoly
.....Power generation economics
.....Electricity supply industry deregulation
.....Profitability
.....Stock markets
.....Supply and demand
.....Trade agreements
.....Venture capital
.....Virtual enterprises
....Innovation management
....Legal factors
.....Copyright protection
.....Software protection
.....Law
.....Censorship
.....Commercial law
.....Consumer protection
.....Contract law
.....Criminal law
.....Employment law
.....Forensics
.....Law enforcement
.....Patent law
.....Trademarks
.....Law enforcement
.....Patents
.....Product liability
.....Warranties
.....Software protection
.....Trademarks
....Market research
....Product development
.....Graphical user interfaces
.....Avatars
.....Product customization
.....Product life cycle management
.....Prognostics and health management
.....Time to market
....Project engineering
.....Scheduling
.....Adaptive scheduling
.....Dynamic scheduling
.....Job shop scheduling
.....Single machine scheduling
....Research and development management
.....Innovation management
....Research initiatives
....Software development management
.....Agile software development
.....Scrum (Software development)
....Technology management

Geoscience and remote sensing

....Environmental factors
.....Biosphere
.....Ecosystems
.....Environmental economics
.....Carbon tax
.....Environmental monitoring
.....Global warming
.....Green products
.....Green buildings
.....Green cleaning
.....Pollution
.....Air pollution
.....Industrial pollution
.....Land pollution
.....Oil pollution
.....Radioactive pollution
.....Thermal pollution
.....Urban pollution
.....Water pollution
....Geographic information systems
.....Geospatial analysis
.....Gunshot detection systems
....Geophysical measurements
.....Geodesy
.....Level measurement
.....Sea measurements
.....Geoacoustic inversion
.....Seismic measurements
....Geophysical measurement techniques
....Geophysical signal processing

....Geoscience
.....Antarctica
.....South Pole
.....Arctic
.....North Pole
.....Atmosphere
.....Atmospheric modeling
.....Atmospheric waves
.....Biosphere
.....Continents
.....Africa
.....Asia
.....Australia
.....Europe
.....North America
.....South America
.....Cyclones
.....Hurricanes
.....Tropical cyclones
.....Earth
.....Earthquakes
.....Earthquake engineering
.....Forestry
.....Geoengineering
.....Geography
.....Cities and towns
.....Rural areas
.....Urban areas
.....Geology
.....Minerals
.....Rocks
.....Geophysics
.....EMTDC
.....Extraterrestrial phenomena
.....Geodynamics
.....Geophysics computing
.....Meteorology
.....Moisture
.....Seismology
.....Surface waves
.....Well logging
.....Ice
.....Ice shelf
.....Ice surface
.....Ice thickness
.....Sea ice
.....Lakes
.....Land surface
.....Levee
.....Meteorological factors
.....Oceans
.....Ocean salinity
.....Ocean temperature
.....Sea coast
.....Sea floor
.....Sea level
.....Sea surface
.....Tides
.....Rivers
.....Sediments
.....Soil
.....Soil moisture
.....Soil properties
.....Soil texture
.....Tornadoes
.....Tsunami
.....Volcanoes
.....Planetary volcanoes
.....Volcanic activity
.....Volcanic ash
....Land surface temperature
....Photometry
....Radar
.....Airborne radar
.....Bistatic radar
.....Doppler radar
.....Ground penetrating radar
.....Laser radar
.....Meteorological radar
.....Millimeter wave radar
.....Multistatic radar
.....MIMO radar
.....Passive radar
.....Radar applications
.....Radar countermeasures
.....Radar detection
.....Radar imaging
.....Radar measurements
.....Radar polarimetry
.....Radar remote sensing
.....Radar tracking
.....Radar clutter
.....Radar cross-sections
.....Radar equipment
.....Radar theory
.....Spaceborne radar
.....Spread spectrum radar
.....Synthetic aperture radar
.....Inverse synthetic aperture radar
.....Polarimetric synthetic aperture radar
.....Ultra wideband radar

....Radiometry
.....Microwave radiometry
.....Radiometers
.....Spectroradiometers
....Remote sensing
.....Hyperspectral sensors
.....Hyperspectral imaging
.....Passive microwave remote sensing
.....Remote monitoring
....Terrain mapping
.....Digital elevation models
....Terrestrial atmosphere
.....Clouds
.....Global warming
.....Ionosphere
.....Magnetosphere
....Vegetation mapping

IEEE organizational topics
....IEEE activities
.....Awards activities
.....Corporate recognition awards
.....External awards
.....Honorary membership
.....Medals
.....Prize paper awards
.....Scholarships
.....Service awards
.....Student awards
.....Technical field awards
.....Conferences
.....Corporate activities
.....Calendars
.....Ethics
.....Finance
.....Legislation
.....Meetings
.....Member relations
.....Membership development
.....Motion-planning
.....Planning
.....Public relations
.....Strategic planning
.....Technology planning
.....Educational activities
.....Accreditation
.....Career development
.....Continuing education
.....Curriculum development
.....Educational programs
.....Scholarships
.....Intersociety activities
.....Local activities
.....Member and Geographic Activities
.....Conferences
.....Meetings
.....Nominations and elections
.....Organizing
.....Professional activities
.....Career development
.....Certification
.....Consortia
.....Continuing education
.....Employment
.....Ethics
.....Intellectual property
.....Legislation
.....Meetings
.....Professional aspects
.....Public policy
.....Publishing activities
.....Books
.....CD-ROMs
.....Conference proceedings
.....Indexes
.....Standards publication
.....Standards activities
.....Standards development
.....Standards publication
.....Student activities
.....Technical activities
.....Conferences
.....Meetings
.....Technical Activities Guide - TAG
.....United States activities
.....Career development
.....Continuing education
.....Employment
.....Ethics
.....Intellectual property
.....Legislation
.....PACE network
.....Public policy
.....Volunteer activities
.....Audit Committee
.....Board of Directors Awards Board Committee
.....Credentials Committee
.....Ethics Committee
.....Executive Committee
.....Fellow Committee

.....Life Members Committee
.....Member Conduct Committee
.....Nominations and elections
.....Strategic Planning Committee
.....Tellers Committee
.....Women in Engineering Committee
....IEEE entities
.....Boards
.....Board of Directors
.....Educational Activities Board
.....IEEE Press Editorial Board
.....IEEE Spectrum Editorial Board
.....Member and Geographic Activities Board
.....Proceedings Editorial Board
.....Publications Board
.....Standards Board
.....Technical Activities Board
.....The Institute Editorial Board
.....United States Activities Board
.....Center for the History of Electrical Engineering
.....History
.....Chapters
.....Student Chapters
.....Committees
.....Awards committees
.....Board committees
.....Communities
.....New Technology Connections Portal
.....Online Communities/Technical Collaboration
.....Standards Working Groups
.....Councils
.....Accreditation Policy Council
.....Career Policy Council
.....Geographic Councils
.....IEEE Biometrics Council
.....IEEE Council on Electronic Design Automation
.....IEEE Council on Superconductivity
.....IEEE Nanotechnology Council
.....IEEE Sensors Council
.....IEEE Systems Council
.....IEEE Technology Management Council
.....Lifelong Learning Council
.....Member Activities Council
.....Metropolitan Councils
.....Nanotechnology Council
.....Operations Council
.....Outreach Council
.....Professional Activities Council
.....Systems Council
.....Technical Councils
.....Technical Field Awards Council
.....Technology Policy Council
.....IEEE Computer Society Press
.....IEEE Foundation
.....IEEE Press
.....Regions
.....Chapters
.....Region 1
.....Region 10
.....Region 2
.....Region 3
.....Region 4
.....Region 5
.....Region 6
.....Region 7
.....Region 8
.....Region 9
.....Sections
.....Student Chapters
.....Sections
.....Chapters
.....Student Chapters
.....Societies
.....IEEE Aerospace and Electronic Systems Society
.....IEEE Antennas and Propagation Society
.....IEEE Broadcast Technology Society
.....IEEE Circuits and Systems Society
.....IEEE Communications Society
.....IEEE Components, Packaging, and Manufacturing Technology Society
.....IEEE Computational Intelligence Society
.....IEEE Computer Society
.....IEEE Consumer Electronics Society
.....IEEE Control Systems Society
.....IEEE Dielectrics and Electrical Insulation Society
.....IEEE Education Society
.....IEEE Electromagnetic Compatibility Society
.....IEEE Electron Devices Society
.....IEEE Engineering in Medicine and Biology Society

.....IEEE Engineering Management Society
.....IEEE Geoscience and Remote Sensing Society
.....IEEE Industrial Electronics Society
.....IEEE Industry Applications Society
.....IEEE Information Theory Society
.....IEEE Instrumentation and Measurement Society
.....IEEE Intelligent Transportation Systems Society
.....IEEE Lasers and Electro-Optics Society
.....IEEE Magnetics Society
.....IEEE Microwave Theory and Techniques Society
.....IEEE Nuclear and Plasma Sciences Society
.....IEEE Oceanic Engineering Society
.....IEEE Photonics Society
.....IEEE Power Electronics Society
.....IEEE Power & Energy Society
.....IEEE Reliability Society
.....IEEE Robotics and Automation Society
.....IEEE Signal Processing Society
.....IEEE Society on Social Implications of Technology
.....IEEE Solid-State Circuits Society
.....IEEE Systems, Man, and Cybernetics Society
.....IEEE Technology Management Council
.....IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society
.....IEEE Vehicular Technology Society
.....Student Chapters
....IEEE governance
.....Bylaws
.....Constitution
.....IEEE Policy and Procedures
.....IEEE Staff
.....Mission and Vision
.....Organization Charts
....IEEE members
.....Associate members
.....Fellows
.....Joining IEEE
.....Signup web site
.....Life members
.....Senior members
.....Student members
....IEEE news
.....Chapter news
.....Region news
.....Section news
.....Society news
....IEEE products
.....Audio tapes
.....Catalogs
.....Educational Activities Product Catalog
.....IEEE catalog
.....IEEE Electronic catalog
.....IEEE standards catalog
.....New products catalog
.....Conference proceedings
.....Educational products
.....Reading series
.....Self-study courses
.....Videos
.....IEEE standards
.....IEEE 1394 Standard
.....IEEE 802.11 Standards
.....IEEE 802.15 Standards
.....IEEE 802.16 Standards
.....IEEE 802.3 Standards
.....IEEE Xplore
.....IEL
.....Merchandise
.....Reading series
.....Self-study courses
.....Videos
....IEEE publications
.....IEEE conference proceedings
.....IEEE directories
.....IEEE Membership Directory
.....IEEE Staff Directory
.....IEEE indexing
.....Awards
.....Book reviews
.....CD-ROM reviews
.....Editorials
.....Interviews
.....Obituaries
.....Software reviews
.....Special issues and sections
.....Tutorials
.....Video reviews
.....IEEE journals
.....IEEE Canadian Journal of Electrical and Computer Engineering

.....IEEE Communications Letters
.....IEEE Communications Surveys & Tutorials
.....IEEE Computer Architecture Letters
.....IEEE Electrochemical and Solid-State Letters
.....IEEE Electron Device Letters
.....IEEE Embedded Systems Letters
.....IEEE Journal of Microelectromechanical Systems
.....IEEE Journal of Oceanic Engineering
.....IEEE Journal of Quantum Electronics
.....IEEE Journal of Robotics and Automation
.....IEEE Journal of Selected Topics in Applied Earth Observation and Remote Sensing
.....IEEE Journal of Selected Topics in Quantum Electronics
.....IEEE Journal of Selected Topics in Signal Processing
.....IEEE Journal of Solid-State Circuits
.....IEEE Journal of Technology Computer Aided Design
.....IEEE Journal on Selected Areas in Communications
.....IEEE Latin America Learning Technologies Journal [IEEE-RITA]
.....IEEE Learning Technology
.....IEEE Magnetics Letters
.....IEEE Microwave and Guided Wave Letters
.....IEEE/OSA Journal of Display Technology
.....IEEE/OSA Journal of Lightwave Technology
.....IEEE/OSA Journal of Optical Communications and Networking
.....IEEE Photonics Journal
.....IEEE Photonics Technology Letters
.....IEEE Reviews in Biomedical Engineering
.....IEEE Signal Processing Letters
.....IEEE Systems Journal
.....Proceedings of the IEEE
.....IEEE magazines
.....IEEE Aerospace and Electronics Society Magazine
.....IEEE Annals of the History of Computing
.....IEEE Antennas and Propagation Magazine
.....IEEE Circuits and Devices
.....IEEE Communications Magazine
.....IEEE Computational Intelligence
.....IEEE Computational Science and Engineering
.....IEEE Computer Applications in Power
.....IEEE Computer Graphics and Applications
.....IEEE Computer Magazine
.....IEEE Concurrency
.....IEEE Control Systems
.....IEEE Design and Test of Computers
.....IEEE Electrical Insulation Magazine
.....IEEE Engineering in Medicine and Biology Magazine
.....IEEE Engineering Management Review
.....IEEE Industrial Electronics Magazine
.....IEEE Industry Applications Magazine
.....IEEE Instrumentation and Measurement Magazine
.....IEEE Intelligent Systems and their Applications
.....IEEE Intelligent Transportation Systems Magazine
.....IEEE Internet Computing
.....IEEE Micro
.....IEEE Multidisciplinary Engineering Education Magazine
.....IEEE Multimedia
.....IEEE Nanotechnology Magazine
.....IEEE Network
.....IEEE Personal Communications
.....IEEE Potentials
.....IEEE Power Engineering Review
.....IEEE Robotics and Automation Magazine
.....IEEE Signal Processing Magazine
.....IEEE Software
.....IEEE Solid-State Circuits Magazine
.....IEEE Spectrum
.....IEEE Technology and Society Magazine

.....IEEE-USA Today's Engineer
.....IEEE newsletters
.....Broadcast Technology Society Newsletter
.....Center for the History of Electrical Engineering Newsletter
.....Circuits and Systems Society Newsletter
.....Components, Packaging, and Manufacturing Technology Society Newsletter
.....Consumer Electronics Society Newsletter
.....Education Society Newsletter
.....Electromagnetic Compatibility Society Newsletter
.....Electron Devices Society Newsletter
.....Electronics and the Environment Newsletter
.....Engineering Management Society Newsletter
.....Geoscience and Remote Sensing Society Newsletter
.....IEEE Circuitboard
.....IEEE Looking Forward
.....IEEE Publications Bulletin
.....Industrial Electronics Society Newsletter
.....Information Theory Society Newsletter
.....Instrumentation and Measurement Society Newsletter
.....Lasers and Electro-Optics Society Newsletter
.....Magnetics Society Newsletter
.....Microwave Theory and Techniques Society Newsletter
.....Nuclear and Plasma Sciences Society Newsletter
.....Oceanic Engineering Society Newsletter
.....Power Electronics Society Newsletter
.....Professional Communication Society Newsletter
.....Reliability Society Newsletter
.....Systems, Man and Cybernetics Society Newsletter
.....The Institute
.....The Staff Circuit
.....Ultrasonics, Ferroelectrics, and Frequency Control Society Newsletter
.....Vehicular Technology Society Newsletter
.....IEEE online publications
.....IEEE Bibliographies On-line
.....IEEE Circuitboard
.....IEEE Communications Interactive
.....IEEE Communications Surveys & Tutorials
.....IEEE Distributed Systems Online
.....IEEE Electrochemical and Solid-State Letters
.....IEEE Electronic catalog
.....IEEE Journal of Technology Computer Aided Design
.....IEEE Journals and Transactions On-LINE - OpeRA
.....IEEE Latin America Learning Technologies Journal [IEEE-RITA]
.....IEEE Latin America Transactions [Revista IEEE America Latina]
.....IEEE Learning Technology
.....IEEE Looking Forward
.....IEEE Multidisciplinary Engineering Education Magazine
.....IEEE Network Interactive
.....IEEE Personal Communications Interactive
.....IEEE Photonics Journal
.....IEEE Transactions on Computational Intelligence and AI in Games
.....IEEE Transactions on Learning Technologies
.....IEEE Transactions on Network and Service Management
.....IEEE Transactions on Services Computing
.....IEEE standard glossaries
.....IEEE transactions
.....IEEE/ACM Transactions on Networking
.....IEEE Biometrics Compendium
.....IEEE Latin America Transactions [Revista IEEE America Latina]
.....IEEE Transactions on Aerospace and Electronic Systems
.....IEEE Transactions on Affective Computing

.....IEEE Transactions on Antennas and Propagation
.....IEEE Transactions on Applied Superconductivity
.....IEEE Transactions on Audio, Speech, and Language Processing
.....IEEE Transactions on Automatic Control
.....IEEE Transactions on Automation Science and Engineering
.....IEEE Transactions on Autonomous Mental Development
.....IEEE Transactions on Biomedical Circuits and Systems
.....IEEE Transactions on Biomedical Engineering
.....IEEE Transactions on Broadcasting
.....IEEE Transactions on Circuits and Systems for Video Technology
.....IEEE Transactions on Circuits and Systems I: Fundamental Theory and Applications
.....IEEE Transactions on Circuits and Systems II: Analog and Digital Signal Processing
.....IEEE Transactions on Communications
.....IEEE Transactions on Components, Packaging, and Manufacturing Technology Part A
.....IEEE Transactions on Components, Packaging, and Manufacturing Technology Part B
.....IEEE Transactions on Components, Packaging, and Manufacturing Technology Part C
.....IEEE Transactions on Computational Intelligence and AI in Games
.....IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems
.....IEEE Transactions on Computers
.....IEEE Transactions on Consumer Electronics
.....IEEE Transactions on Control Systems Technology
.....IEEE Transactions on Dielectrics and Electrical Insulation
.....IEEE Transactions on Education
.....IEEE Transactions on Electromagnetic Compatibility
.....IEEE Transactions on Electron Devices
.....IEEE Transactions on Energy Conversion
.....IEEE Transactions on Engineering Management
.....IEEE Transactions on Evolutionary Computation
.....IEEE Transactions on Fuzzy Systems
.....IEEE Transactions on Geoscience and Remote Sensing
.....IEEE Transactions on Haptics
.....IEEE Transactions on Image Processing
.....IEEE Transactions on Industrial Electronics
.....IEEE Transactions on Industry Applications
.....IEEE Transactions on Information Forensics and Security
.....IEEE Transactions on Information Technology in Biomedicine
.....IEEE Transactions on Information Theory
.....IEEE Transactions on Instrumentation and Measurement
.....IEEE Transactions on Knowledge and Data Engineering
.....IEEE Transactions on Learning Technologies
.....IEEE Transactions on Magnetics
.....IEEE Transactions on Mechatronics
.....IEEE Transactions on Medical Imaging
.....IEEE Transactions on Microwave Theory and Techniques
.....IEEE Transactions on Nanotechnology
.....IEEE Transactions on Network and Service Management
.....IEEE Transactions on Neural Networks
.....IEEE Transactions on Nuclear Science
.....IEEE Transactions on Pattern Analysis and Machine Intelligence
.....IEEE Transactions on Plasma Science

.....IEEE Transactions on Power Delivery
.....IEEE Transactions on Power Electronics
.....IEEE Transactions on Power Systems
.....IEEE Transactions on Professional Communication
.....IEEE Transactions on Rehabilitation Engineering
.....IEEE Transactions on Reliability
.....IEEE Transactions on Robotics
.....IEEE Transactions on Robotics and Automation
.....IEEE Transactions on Semiconductor Manufacturing
.....IEEE Transactions on Services Computing
.....IEEE Transactions on Signal Processing
.....IEEE Transactions on Smart Grid
.....IEEE Transactions on Software Engineering
.....IEEE Transactions on Speech and Audio Processing
.....IEEE Transactions on Sustainable Energy
.....IEEE Transactions on Systems, Man, and Cybernetics Part A: Systems and Humans
.....IEEE Transactions on Systems, Man, and Cybernetics Part B: Cybernetics
.....IEEE Transactions on Systems, Man, and Cybernetics Part C: Applications and Reviews
.....IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control
.....IEEE Transactions on Vehicular Technology
.....IEEE Transactions on Very Large Scale Integration - VLSI
.....IEEE Transactions on Visualization and Computer Graphics
.....IEEE Women in Engineering
.....Notice of Violation
....IEEE services
.....Ask IEEE
.....Conference management
.....Meeting services
.....Member services
.....Career development
.....Electronic mail
.....Financial advantage program
.....IEEE Bibliographies On-line
.....IEEE Electronic catalog
.....Job listing service
.....Membership renewal
.....Travel services
.....Web and internet services
.....Subscriptions
.....Web and internet services
.....Electronic mail
.....IEEE Electronic catalog
.....IEEE Journals and Transactions On-LINE - OpeRA
.....Online banking
....IEEE web sites
.....Society home pages
.....Web page design

Imaging
....Biomedical imaging
.....Angiocardiography
.....Angiography
.....Biomedical optical imaging
.....Cardiography
.....Echocardiography
.....Electrocardiography
.....Phonocardiography
.....DICOM
.....Encephalography
.....Mammography
.....Medical diagnostic imaging
.....Anatomical structure
.....Molecular imaging
.....Phantoms
....Cameras
.....Digital cameras
.....Webcams
....Focusing
....Ground penetrating radar
....Holography
....Image converters
.....Image intensifiers
....Image sensors
.....Active pixel sensors
.....CCD image sensors
.....Charge-coupled image sensors
.....CMOS image sensors
.....Infrared image sensors
....Image storage

....Infrared imaging
.....Night vision
....Magnetic resonance imaging
.....Diffusion tensor imaging
....Magneto electrical resistivity imaging technique
....Microscopy
.....Atomic force microscopy
.....Electron microscopy
.....Photoelectron microscopy
.....Scanning electron microscopy
.....Transmission electron microscopy
.....Scanning probe microscopy
....Microwave imaging
....Motion pictures
....Multispectral imaging
....Nuclear imaging
.....Energy resolution
....Optical imaging
.....Talbot effect
.....Thermoreflectance imaging
....Photography
.....Cinematography
.....Digital photography
.....Image forensics
.....Photomicrography
....Radiation imaging
....Radiography
.....Diagnostic radiography
....Stereo vision
.....Stereo image processing
....Tomography
.....Computed tomography
.....Electrical capacitance tomography
.....Positron emission tomography
.....Whole-body PET
.....Reconstruction algorithms
.....Single photon emission computed tomography

Industrial electronics
....Assembly systems
.....Flexible electronics
.....Robotic assembly
....Computer aided manufacturing
.....CADCAM
.....Silicon compiler
....Cryogenic electronics
....Industrial control
.....Process control
.....Predictive control
.....Three-term control
.....Two-term control
.....Production control
.....Continuous production
.....Lot sizing
.....Optimized production technology
.....Scheduling
....Integrated manufacturing systems
....Machine control
.....Machine vector control
....Manufacturing automation
.....Computer aided manufacturing
.....CADCAM
.....Silicon compiler
.....Computer integrated manufacturing
.....Computer numerical control
.....Flexible manufacturing systems
....Testing
.....Aerospace testing
.....Automatic testing
.....Automatic test pattern generation
.....Ring generators
.....Benchmark testing
.....Built-in self-test
.....Circuit testing
.....Integrated circuit measurements
.....Electronic equipment testing
.....Immunity testing
.....Error analysis
.....Bit error rate
.....Finite wordlength effects
.....Error-free operations
.....Failure analysis
.....Equipment failure
.....Semiconductor device breakdown
.....Frequency response
.....Impulse testing
.....Insulator testing
.....Insulation testing
.....Integrated circuit testing
.....Integrated circuit yield
.....Logic testing
.....Life testing
.....Materials testing
.....Accelerated aging
.....Acoustic testing
.....Adhesive strength
.....Bonding forces
.....Delamination
.....Elastic recovery

.....Nondestructive testing
.....Optical fiber testing
.....Remaining life assessment
.....Ring generators
.....Semiconductor device testing
.....Software testing
.....System testing
.....Model checking
.....Test equipment
.....Automatic test equipment
.....Test facilities
.....Anechoic chambers
.....Laboratories
.....Large Hadron Collider
.....Open area test sites
.....TEM cells

Industry applications
....Accident prevention
.....Accidents
.....Aerospace accidents
.....Electrical accidents
.....Industrial accidents
.....Marine accidents
.....Railway accidents
.....Road accidents
....Chemical technology
.....Chemical reactors
.....Bioreactors
.....Continuous-stirred tank reactor
.....Ignition
.....Chemical sensors
.....Crystallizers
.....Distillation equipment
.....Fluidization
.....Pharmaceutical technology
.....Vitrification
....Cryogenics
....Electrochemical devices
.....Amperometric sensors
.....Batteries
.....Lithium batteries
.....Battery management systems
.....Fuel cells
.....Supercapacitors
....Electrochemical processes
....Electromechanical systems
.....Electromechanical devices
.....Armature
.....SAW filters
....Electrostatic devices
....Electrostatic precipitators
....Electrostatic processes
.....Aerosols
.....Electrophotography
.....Electrostatic analysis
.....Electrostatic induction
.....Electrostatics
.....Electrostatic levitation
.....Particle charging
.....Particle production
.....Space charge
.....Surface charging
.....Triboelectricity
.....Triboelectricity
....Engines
.....Heat engines
.....Steam engines
.....Stirling engines
.....Internal combustion engines
.....Diesel engines
.....Ignition
.....Jet engines
....Environmental management
.....Biodegradation
.....Biodegradable materials
.....Land use planning
.....Pest control
.....Pollution control
.....Recycling
.....Renewable energy sources
.....Biomass
.....Sustainable development
.....Waste management
.....Waste disposal
.....Waste handling
.....Waste recovery
.....Waste reduction
.....Water conservation
.....Desalination
.....Water resources
.....Desalination
.....Reservoirs
....Food technology
.....Food preservation
....High-temperature techniques
.....Rapid thermal processing
....Industrial engineering
.....Industrial communication
....Industries
.....Agriculture

.....Agricultural products
.....Aquaculture
.....Fertilizers
.....Greenhouses
.....Irrigation
.....Architecture
.....Banking
.....Beverage industry
.....Chemical industry
.....Coal industry
.....Communication industry
.....Computer industry
.....Construction
.....Buildings
.....Green buildings
.....Modular construction
.....Prefabricated construction
.....Construction industry
.....Prefabricated construction
.....Defense industry
.....Entertainment industry
.....Gas industry
.....Manufacturing industries
.....Aerospace industry
.....Cement industry
.....Ceramics industry
.....Clothing industry
.....Electrical products industry
.....Electronics industry
.....Food industry
.....Footwear industry
.....Fuel processing industries
.....Glass industry
.....Machinery production industries
.....Metal product industries
.....Plastics industry
.....Pulp and paper industry
.....Rubber industry
.....Shipbuilding industry
.....Textile industry
.....Toy manufacturing industry
.....Metals industry
.....Mining industry
.....Coal mining
.....Natural gas industry
.....Petroleum industry
.....Oil drilling
.....Oil refineries
.....Well logging
.....Power industry
.....Electrical equipment industry
.....Electricity supply industry
.....Nuclear facility regulation
.....Power system interconnection
.....Sugar industry
.....Sugar refining
.....Textile technology
.....Spinning
.....Weaving
.....Toy industry
.....Wood industry
....Inspection
.....Automatic optical inspection
....Machinery
.....Agricultural machinery
.....Ball bearings
.....Belts
.....Drives
.....Hydraulic drives
.....Motor drives
.....Variable speed drives
.....Electric machines
.....AC machines
.....Alternators
.....Brushless machines
.....Compressors
.....Conductors
.....DC machines
.....Electric fences
.....Generators
.....Permanent magnet machines
.....Rotating machines
.....Rotors
.....Stators
.....Washing machines
.....Fans
.....Furnaces
.....Blast furnaces
.....Kilns
.....Gears
.....Hydraulic systems
.....Electrohydraulics
.....Hydraulic equipment
.....Hydraulic fluids
.....Machine components
.....Air cleaners
.....Belts
.....Cams
.....Engine cylinders
.....Exhaust systems
.....Impellers
.....Intake systems

.....Manifolds
.....Mechanical splines
.....Pistons
.....Rotors
.....Shafts
.....Valves
.....Motors
.....AC motors
.....Brushless motors
.....Commutation
.....DC motors
.....Electric motors
.....Hysteresis motors
.....Induction motors
.....Micromotors
.....Permanent magnet motors
.....Servomotors
.....Traction motors
.....Universal motors
.....Printing machinery
.....Pumps
.....Fuel pumps
.....Heat pumps
.....Micropumps
.....Textile machinery
.....Spinning machines
....Manufacturing
.....Assembly
.....Fitting
.....Microassembly
.....Preforms
.....Soldering
.....Assembly systems
.....Flexible electronics
.....Robotic assembly
.....Embossing
.....Fabrication
.....Bonding processes
.....Microfabrication
.....Optical device fabrication
.....Soldering
.....Welding
.....Lithography
.....Colloidal lithography
.....Interferometric lithography
.....Nanolithography
.....Soft lithography
.....Stereolithography
.....X-ray lithography
.....Manufactured products
.....Ceramic products
.....Chemical products
.....Consumer products
.....Electrical products
.....Food products
.....Fuels
.....Glass products
.....Mechanical products
.....Metal products
.....Paper products
.....Paper pulp
.....Plastic products
.....Rubber products
.....Sports equipment
.....Textile products
.....Windows
.....Manufacturing systems
.....Agile manufacturing
.....Automobile manufacture
.....Batch production systems
.....Blanking
.....Cellular manufacturing
.....Flow production systems
.....Food manufacturing
.....Forging
.....Glass manufacturing
.....Integrated manufacturing systems
.....Intelligent manufacturing systems
.....Job production systems
.....Joining processes
.....Layered manufacturing
.....Lean production
.....Manufacturing processes
.....Mass production
.....Melt processing
.....Pulp manufacturing
.....Sheet metal processing
.....Thermoforming
.....Mass customization
.....Tolerance analysis
....Packaging
.....Bagging
.....Bottling
.....Canning
.....Encapsulation
.....Labeling
.....Multichip modules
.....Plastic packaging
.....Wrapping
....Paper technology
....Production
.....Ball milling

.....Compression molding
.....Embossing
.....Food products
.....Dairy products
.....Fats
.....Sugar
.....Group technology
.....Injection molding
.....Materials processing
.....Annealing
.....Bleaching
.....Casting
.....Coatings
.....Curing
.....Etching
.....Heat treatment
.....Joining processes
.....Lamination
.....Machining
.....Melt processing
.....Plasma materials processing
.....Pressing
.....Punching
.....Refining
.....Shearing
.....Smelting
.....Softening
.....Swaging
.....Mechanical products
.....Automotive components
.....Axles
.....Bellows
.....Blades
.....Couplings
.....Fasteners
.....Flanges
.....Gears
.....Hoses
.....Machine components
.....Mechanical guides
.....Needles
.....Orifices
.....Pistons
.....Seals
.....Springs
.....Steering systems
.....Structural shapes
.....Suspensions
.....Tires
.....Vents
.....Wheels
.....Process planning
.....Cause effect analysis
.....Production control
.....Continuous production
.....Lot sizing
.....Optimized production technology
.....Scheduling
.....Production engineering
.....Production planning
.....Production equipment
.....Applicators
.....Clamps
.....Cutting tools
.....Fixtures
.....Machine tools
.....Mining equipment
.....Molding equipment
.....Packaging machines
.....Paper making machines
.....Polishing machines
.....Soldering equipment
.....Production facilities
.....Foundries
.....Greenhouses
.....Industrial plants
.....Machine shops
.....Paper mills
.....Production management
.....Control charts
.....Inventory management
.....Lead time reduction
.....Logistics
.....Process planning
.....Production planning
.....Production materials
.....Abrasives
.....Aerospace materials
.....Automotive materials
.....Inhibitors
.....Ink
.....Joining materials
.....Lubricants
.....Retardants
.....Production systems
.....Assembly systems
.....Exhaust systems
.....Intelligent manufacturing systems
.....Lean production
.....Manufacturing systems
.....Steering systems
.....Productivity

.....Shafts
.....Camshafts
.....Springs
.....Suspensions
.....Shock absorbers
.....Transfer molding
....Safety
.....Aerospace safety
.....Air safety
.....Domestic safety
.....Emergency services
.....Explosion protection
.....Hazards
.....Biohazards
.....Chemical hazards
.....Explosions
.....Fires
.....Flammability
.....Floods
.....Hazardous areas
.....Hazardous materials
.....Toxicology
.....Health and safety
.....Occupational health
.....Occupational safety
.....Marine safety
.....Product safety
.....Protection
.....Explosion protection
.....Lightning protection
.....Radiation safety
.....Safety devices
.....Eye protection
.....Protective clothing
.....Vehicle safety
....Security
.....Access control
.....Authorization
.....Alarm systems
.....Smoke detectors
.....Computer security
.....Authentication
.....Computer crime
.....Computer hacking
.....Firewalls (computing)
.....Identity management systems
.....Invasive software
.....Permission
.....Cryptography
.....Ciphers
.....Encryption
.....Public key
.....Random number generation
.....Data security
.....Cryptography
.....Message authentication
.....Digital signatures
.....Information security
.....Intrusion detection
.....Power system security
.....Reconnaissance
.....Terrorism
.....Bioterrorism
.....National security
.....Watermarking
....Wine industry
.....Wineries

Information theory
....Audio coding
....Biological information theory
....Channel coding
.....Block codes
.....Linear codes
.....Combined source-channel coding
.....Turbo codes
....Codes
.....Binary codes
.....Reflective binary codes
.....Convolutional codes
.....Cyclic redundancy check codes
.....Error correction codes
.....Reed-Solomon codes
.....Parity check codes
.....Iterative decoding
.....Product codes
.....Bar codes
.....Space-time codes
....Communication channels
.....Channel allocation
.....Channel capacity
.....Channel estimation
.....Channel models
.....Channel spacing
.....Channel state information
.....Gaussian channels
.....AWGN channels
.....Multipath channels
.....Multiuser channels
.....Partial response channels
.....Throughput

.....Time-varying channels
....Decoding
.....Maximum likelihood decoding
....Encoding
.....Audio coding
.....Channel coding
.....Block codes
.....Combined source-channel coding
.....Turbo codes
.....Entropy coding
.....Huffman coding
.....Source coding
.....Speech coding
.....Transcoding
....Error compensation
....Genetic communication
....Hamming distance
....Hamming weight
....Information entropy
....Mutual information
....Network coding
....Rate-distortion
....Rate distortion theory
.....Channel rate control
....Source coding
....Speech coding

Instrumentation and measurement
....Computerized instrumentation
....Electric variables
.....Admittance
.....Capacitance
.....Parasitic capacitance
.....Quantum capacitance
.....Capacitance-voltage characteristics
.....Conductivity
.....Photoconductivity
.....Semiconductivity
.....Transconductance
.....Current
.....Bioimpedance
.....Current slump
.....Dark current
.....Fault currents
.....Leakage currents
.....Persistent currents
.....Short-circuit currents
.....Threshold current
.....Current-voltage characteristics
.....Electric potential
.....Gain
.....Impedance
.....Impedance matching
.....Inductance
.....Permittivity
.....Piezoresistance
.....Q-factor
.....Resistance
.....Electric resistance
.....Piezoresistance
.....Surface resistance
.....Thermal resistance
.....Viscosity
.....Voltage
.....Breakdown voltage
.....Dynamic voltage scaling
.....Threshold voltage
.....Voltage fluctuations
.....Wiring
....High energy physics instrumentation computing
.....Linear particle accelerator
....Instruments
.....Compass
.....Goniometers
.....Microscopy
.....Atomic force microscopy
.....Electron microscopy
.....Scanning probe microscopy
.....Oscilloscopes
.....Potentiometers
.....Pressure gauges
.....Probes
.....Radiometers
.....Spectroradiometers
.....Telescopes
.....Theodolites
.....Tuners
.....Vibrometers
.....Voltmeters
.....Watthour meters
.....Wattmeters
....Measurement
.....Accelerometers
.....Acoustic measurements
.....Antenna measurements
.....Anthropometry
.....Area measurement
.....Atmospheric measurements
.....Atomic measurements
.....Biomedical measurement

.....Biomarkers
.....Biomedical monitoring
.....Electroencephalography
.....Electromyography
.....Electrooculography
.....Electrophysiology
.....Photoplethysmography
.....Reproducibility of results
.....Sensitivity and specificity
.....Calorimetry
.....Coordinate measuring machines
.....Density measurement
.....Hydrometers
.....Distance measurement
.....Euclidean distance
.....Distortion measurement
.....Total harmonic distortion
.....Doppler measurement
.....Dosimetry
.....Dynamic range
.....Electric variables measurement
.....Admittance measurement
.....Ammeters
.....Attenuation measurement
.....Capacitance measurement
.....Conductivity measurement
.....Current measurement
.....Dielectric measurement
.....Electrical resistance measurement
.....Electrostatic measurements
.....Energy measurement
.....Impedance measurement
.....Inductance measurement
.....Partial discharge measurement
.....Phasor measurement units
.....Power measurement
.....Q measurement
.....Transmission line measurements
.....Voltage measurement
.....Electromagnetic measurements
.....Electromagnetic modeling
.....Linearity
.....Microwave measurement
.....Millimeter wave measurements
.....Parameter extraction
.....Polarimetry
.....Radiometry
.....Submillimeter wave measurements
.....Extraterrestrial measurements
.....Fluid flow measurement
.....Frequency measurement
.....Frequency-domain analysis
.....Frequency estimation
.....Gain measurement
.....Gas chromatography
.....Geologic measurements
.....Geophysical image processing
.....Geophysical measurements
.....Geodesy
.....Sea measurements
.....Seismic measurements
.....Interferometry
.....Fabry-Perot
.....Interferometers
.....Optical interferometry
.....Phase shifting interferometry
.....Radar interferometry
.....Radio interferometry
.....Sagnac interferometers
.....Length measurement
.....Lifetime estimation
.....Loss measurement
.....Packet loss
.....Magnetic variables measurement
.....Magnetic field measurement
.....Magnetometers
.....Permeability measurement
.....Measurement by laser beam
.....Laser velocimetry
.....Measurement techniques
.....Calibration
.....Dynamic equilibrium
.....Measurement uncertainty
.....Measurement units
.....Nanometers
.....Mechanical variables measurement
.....Angular velocity
.....Displacement measurement
.....Force measurement
.....Motion measurement
.....Position measurement
.....Rotation measurement
.....Strain measurement
.....Stress measurement
.....Thickness measurement
.....Torque measurement
.....Velocity measurement
.....Vibration measurement
.....Volume measurement
.....Weight measurement
.....Moisture measurement
.....Humidity measurement

.....Noise measurement
.....Multiple signal classification
.....Noise figure
.....Noise shaping
.....Nuclear measurements
.....Particle tracking
.....Optical variables measurement
.....Ellipsometry
.....Photometry
.....Reflection coefficient
.....Refractive index
.....Particle beam measurements
.....Particle measurements
.....Performance evaluation
.....Phase measurement
.....pH measurement
.....Plasma measurements
.....Plethysmography
.....Pollution measurement
.....Pressure measurement
.....Altimetry
.....Tire pressure
.....Pulse measurements
.....Reflectometry
.....Reproducibility of results
.....Scintillation counters
.....Solid scintillation detectors
.....Sea state
.....Semiconductor device measurement
.....Sensitivity
.....Sensitivity analysis
.....Shape measurement
.....Size measurement
.....Software measurement
.....Software metrics
.....Soil measurements
.....Spectroscopy
.....Electrochemical impedance spectroscopy
.....Kirchhoff's Law
.....Mass spectroscopy
.....MERIS
.....Neutron spin echo
.....Photoacoustic effects
.....Resonance light scattering
.....Thermal variables measurement
.....Temperature measurement
.....Time measurement
.....Clocks
.....Time dissemination
.....Timing
.....UHF measurements
.....Ultrasonic variables measurement
.....Viscosity
.....Wavelength measurement
.....Wide area measurements
....Monitoring
.....Computerized monitoring
.....Environmental monitoring
.....Patient monitoring
.....Radiation monitoring
.....Radiation dosage
.....Remote monitoring
.....Surveillance
.....Infrared surveillance
.....Video surveillance
....Testing
.....Aerospace testing
.....Automatic testing
.....Automatic test pattern generation
.....Ring generators
.....Benchmark testing
.....Built-in self-test
.....Circuit testing
.....Integrated circuit measurements
.....Electronic equipment testing
.....Immunity testing
.....Error analysis
.....Bit error rate
.....Finite wordlength effects
.....Error-free operations
.....Failure analysis
.....Equipment failure
.....Semiconductor device breakdown
.....Frequency response
.....Impulse testing
.....Insulator testing
.....Insulation testing
.....Integrated circuit testing
.....Integrated circuit yield
.....Logic testing
.....Life testing
.....Materials testing
.....Accelerated aging
.....Acoustic testing
.....Adhesive strength
.....Bonding forces
.....Delamination
.....Elastic recovery
.....Nondestructive testing
.....Optical fiber testing
.....Remaining life assessment

.....Ring generators
.....Semiconductor device testing
.....Software testing
.....System testing
.....Model checking
.....Test equipment
.....Automatic test equipment
.....Test facilities
.....Anechoic chambers
.....Laboratories
.....Large Hadron Collider
.....Open area test sites
.....TEM cells

Intelligent transportation systems
....Automated highways
....Geographic information systems
.....Geospatial analysis
.....Gunshot detection systems
....Intelligent vehicles
.....Vehicle routing
....Navigation
.....Aircraft navigation
.....Course correction
.....Dead reckoning
.....Inertial navigation
.....Marine navigation
.....Radio navigation
.....Satellite navigation systems
.....Global Positioning System
.....Satellite constellations
.....Sonar navigation
....Transportation
.....Air transportation
.....Aircraft
.....Airports
.....Land transportation
.....Rail transportation
.....Road transportation
.....Vehicles
.....Land vehicles
.....Remotely operated vehicles
.....Space vehicles

Lasers and electrooptics
....Electrooptic devices
.....Electrochromic devices
.....Electrooptic deflectors
.....Electrooptic modulators
....Electrooptic effects
.....Electrochromism
.....Kerr effect
.....Optical bistability
.....Stark effect
....Lasers
.....Atom lasers
.....Chemical lasers
.....Diode lasers
.....Free electron lasers
.....Gas lasers
.....Laser applications
.....Dark states
.....Distributed feedback devices
.....Laser ablation
.....Laser beam cutting
.....Laser fusion
.....Laser theory
.....Magnetooptic recording
.....Laser excitation
.....Optical pumping
.....Laser modes
.....Laser mode locking
.....Laser stability
.....Laser transitions
.....Power lasers
.....Pump lasers
.....Quantum well lasers
.....Quantum cascade lasers
.....Ring lasers
.....Fiber lasers
.....Semiconductor lasers
.....Laser tuning
.....Quantum dot lasers
.....Quantum well lasers
.....Semiconductor laser arrays
.....Semiconductor optical amplifiers
.....Surface emitting lasers
.....Solid lasers
.....Microchip lasers
.....Quantum well lasers
.....Semiconductor lasers
.....Surface emitting lasers
.....Surface emitting lasers
.....Vertical cavity surface emitting lasers
.....X-ray lasers
....Optics
.....Adaptive optics
.....Birefringence
.....Brightness

.....Brightness temperature
.....Color
.....Pigmentation
.....Electron optics
.....Extinction coefficients
.....Extinction ratio
.....Fiber optics
.....Fiber nonlinear optics
.....Optical fibers
.....Fluorescence
.....Four-wave mixing
.....Geometrical optics
.....Ray tracing
.....Integrated optics
.....Light sources
.....Electroluminescent devices
.....Fast light
.....Luminescent devices
.....Phosphors
.....Slow light
.....Stray light
.....Superluminescent diodes
.....Ultraviolet sources
.....Luminescence
.....Bioluminescence
.....Electroluminescence
.....Fluorescence
.....Phosphorescence
.....Photoluminescence
.....Thermoluminescence
.....Microoptics
.....Micromirrors
.....Nonlinear optics
.....Fiber nonlinear optics
.....Nonlinear optical devices
.....Optical mixing
.....Optical saturation
.....Photorefractive effect
.....Raman scattering
.....Supercontinuum generation
.....Optical amplifiers
.....Doped fiber amplifiers
.....Erbium-doped fiber amplifiers
.....Semiconductor optical amplifiers
.....Optical crosstalk
.....Optical design
.....Optical design techniques
.....Optical devices
.....Bragg gratings
.....Collimators
.....Displays
.....Holographic optical components
.....Lenses
.....Light deflectors
.....Lighting
.....Luminescent devices
.....Mirrors
.....Optical arrays
.....Optical attenuators
.....Optical collimators
.....Optical device fabrication
.....Optical filters
.....Optical resonators
.....Optical sensors
.....Thermooptical devices
.....Optical distortion
.....Optical fiber applications
.....Optical fiber devices
.....Optical harmonic generation
.....Optical losses
.....Optical microscopy
.....Optical mixing
.....Multiwave mixing
.....Optical polarization
.....Polarization shift keying
.....Stokes parameters
.....Optical pulses
.....Optical retarders
.....Optical saturation
.....Optical solitons
.....Optical tuning
.....Particle beam optics
.....Atom optics
.....Electron optics
.....Stimulated emission
.....Photoluminescence
.....Physical optics
.....Optical refraction
.....Optical vortices
.....Ray tracing
.....Stray light
.....Ultrafast optics
.....Whispering gallery modes
....Optoelectronic devices
.....Charge-coupled image sensors
.....Integrated optoelectronics
.....Light emitting diodes
.....Inorganic light emitting diodes
.....LED lamps
.....Organic light emitting diodes
.....Superluminescent diodes
.....Photoconducting devices

.....Electrophotography
.....Photodetectors
.....Photodiodes
.....Phototransistors
.....Superconducting photodetectors
.....Superluminescent diodes
....Photonics
.....Biophotonics
.....Microwave photonics
.....Nanophotonics
.....Photochromism
.....Photothermal effects
.....Silicon photonics
.....Spontaneous emission
.....Radiative recombination

Magnetics
....Biomagnetics
.....Magnetoencephalography
....Demagnetization
....Gyromagnetism
....Magnetic analysis
.....Magnetization
....Magnetic anisotropy
.....Magnetic domains
.....Magnetic domain walls
.....Magnetic moments
.....Perpendicular magnetic anisotropy
....Magnetic devices
.....Accelerator magnets
.....Ferrite devices
.....Circulators
.....Magnetic cores
.....Transformer cores
.....Magnetic heads
.....Magnetic memory
.....Floppy disks
.....Hard disks
.....Magnetic modulators
.....Magnetooptic devices
.....Magnetoresistive devices
.....Magnetostrictive devices
.....Solenoids
.....Transformer cores
.....Undulators
....Magnetic fields
.....Geomagnetism
.....Magnetic reconnection
.....Magnetic separation
.....Magnetostatics
.....Toroidal magnetic fields
....Magnetic flux
.....Flux pinning
.....Magnetic flux density
.....Magnetic flux leakage
....Magnetic force microscopy
....Magnetic forces
.....Coercive force
....Magnetic hysteresis
....Magnetic levitation
....Magnetic losses
....Magnetic materials
.....Amorphous magnetic materials
.....Antiferromagnetic materials
.....Diamagnetic materials
.....Ferrimagnetic films
.....Ferrite films
.....Garnet films
.....Ferrimagnetic materials
.....Ferrimagnetic films
.....Ferrite films
.....Ferrites
.....Garnet films
.....Garnets
.....Ferrite films
.....Ferrites
.....Ferrite films
.....Garnet films
.....Garnets
.....Garnet films
.....Magnetic films
.....Ferrimagnetic films
.....Ferrite films
.....Garnet films
.....Magnetic liquids
.....Magnetic semiconductors
.....Magnetic superlattices
.....Paramagnetic materials
.....Soft magnetic materials
....Magnetic multilayers
....Magnetic particles
....Magnetic properties
....Magnetic sensors
.....Spin valves
....Magnetic susceptibility
....Magnetic switching
....Magnetization processes
.....Magnetization reversal
.....Saturation magnetization
....Magnetoacoustic effects
....Magnetoelectric effects

.....Hall effect
.....Magnetic tunneling
.....Magnetoelectronics
.....Spin polarized transport
.....Magnetoresistance
.....Anisotropic magnetoresistance
.....Ballistic magnetoresistance
.....Colossal magnetoresistance
.....Enhanced magnetoresistance
.....Extraordinary magnetoresistance
.....Giant magnetoresistance
.....Ordinary magnetoresistance
.....Tunneling magnetoresistance
....Magnetomechanical effects
.....Magnetic field induced strain
.....Magnetoelasticity
.....Magnetostriction
.....Magnetostriction
....Magnetooptic effects
.....Faraday effect
.....Gyrotropism
....Magnets
.....Electromagnets
.....Superconducting magnets
.....Micromagnetics
.....Permanent magnets
....Microwave magnetics
....Nonlinear magnetics
....Remanence

Materials, elements, and compounds
....Chemical elements
.....Boron
.....Boron alloys
.....Carbon
.....Cerium
.....Darmstadtium
.....Helium
.....Hydrogen
.....Deuterium
.....Isotopes
.....Lutetium
.....Nitrogen
.....Silicon nitride
.....Oxygen
.....Roentgenium
.....Tellurium
.....Titanium
.....Titanium alloys
.....Titanium compounds
.....Ytterbium
.....Zirconium
....Compounds
.....Bismuth compounds
.....Gallium compounds
.....Aluminum gallium nitride
.....Gallium arsenide
.....Gallium nitride
.....Indium gallium arsenide
.....Indium gallium nitride
.....Indium compounds
.....Indium gallium arsenide
.....Indium tin oxide
.....Inorganic compounds
.....Lead compounds
.....Organic compounds
.....Carbon compounds
.....Organic semiconductors
.....Volatile organic compounds
.....Silicon compounds
.....Silicides
.....Silicon carbide
.....Silicon nitride
....Materials
.....Acoustic materials
.....Additives
.....Aggregates
.....Amorphous materials
.....Diamond-like carbon
.....Glass
.....Auxetic materials
.....Biological materials
.....Biomedical materials
.....Bioceramics
.....Biomembranes
.....Building materials
.....Asphalt
.....Concrete
.....Floors
.....Mortar
.....Tiles
.....Windows
.....Ceramics
.....Porcelain
.....Composite materials
.....Conducting materials
.....Corrosion inhibitors
.....Crystalline materials
.....Nanocrystals
.....Superlattices
.....Crystals

.....Colloidal crystals
.....Crystallography
.....Crystal microstructure
.....Grain boundaries
.....Grain size
.....Liquid crystals
.....Dielectric materials
.....Dielectric films
.....Dielectric liquids
.....Electrets
.....Epoxy resins
.....High K dielectric materials
.....Piezoelectric materials
.....Films
.....Conductive films
.....Dielectric films
.....Epitaxial layers
.....Ferrimagnetic films
.....Ferrite films
.....Garnet films
.....Magnetic films
.....Optical films
.....Piezoelectric films
.....Plastic films
.....Polymer films
.....Semiconductor films
.....Thick films
.....Thin films
.....Fluids
.....Fluid dynamics
.....Gases
.....Hydraulic fluids
.....Liquids
.....Viscosity
.....Hazardous materials
.....Inorganic materials
.....Lacquers
.....Laminates
.....Magnetic materials
.....Amorphous magnetic materials
.....Antiferromagnetic materials
.....Diamagnetic materials
.....Ferrimagnetic films
.....Ferrimagnetic materials
.....Ferrite films
.....Ferrites
.....Garnet films
.....Garnets
.....Magnetic films
.....Magnetic liquids
.....Magnetic semiconductors
.....Magnetic superlattices
.....Paramagnetic materials
.....Soft magnetic materials
.....Material properties
.....Creep
.....Elasticity
.....Resilience
.....Media
.....Nonhomogeneous media
.....Random media
.....Mesoporous materials
.....Metal foam
.....Metamaterials
.....Electromagnetic metamaterials
.....Optical cloaking
.....Optical metamaterials
.....Nanostructured materials
.....Nanocomposites
.....Nanoporous materials
.....Oils
.....Lubricating oils
.....Vegetable oils
.....Optical materials
.....Optical cloaking
.....Optical polymers
.....Optical retarders
.....Optical superlattices
.....Photorefractive materials
.....Organic inorganic hybrid materials
.....Organic materials
.....Paints
.....Paper pulp
.....Petrochemicals
.....Phase change materials
.....Photoconducting materials
.....Plastics
.....Epoxy resins
.....Fiber reinforced plastics
.....Plastic films
.....Plastic optical fiber
.....Polymer foams
.....Polymer gels
.....Polymers
.....Liquid crystal polymers
.....Optical polymers
.....Polyethylene
.....Polyimides
.....Production materials
.....Abrasives
.....Aerospace materials
.....Automotive materials

.....Inhibitors
.....Ink
.....Joining materials
.....Lubricants
.....Retardants
.....Radioactive materials
.....Nuclear fuels
.....Radioactive decay
.....Radioactive waste
.....Raw materials
.....Resins
.....Epoxy resins
.....Resists
.....Semiconductor materials
.....Amorphous semiconductors
.....Elemental semiconductors
.....Gallium
.....Gallium arsenide
.....Germanium
.....III-V semiconductor materials
.....II-VI semiconductor materials
.....Indium gallium arsenide
.....Indium phosphide
.....Magnetic semiconductors
.....Organic semiconductors
.....Semiconductor superlattices
.....Silicon
.....Silicon germanium
.....Substrates
.....Wide band gap semiconductors
.....Sheet materials
.....Solids
.....Young's modulus
.....Superconducting materials
.....Granular superconductors
.....High-temperature superconductors
.....Multifilamentary superconductors
.....Niobium-tin
.....Type II superconductors
.....Textiles
.....Cotton
.....Fabrics
.....Textile fibers
.....Wool
.....Waste materials
.....Effluents
.....Electronic waste
.....Industrial waste
.....Radioactive waste
.....Slurries
.....Wastewater
.....Wire
....Materials science and technology
.....Absorption
.....Aging
.....Accelerated aging
.....Chemical analysis
.....Activation analysis
.....Chemical processes
.....Chemicals
.....Electronic noses
.....pH measurement
.....Contamination
.....Surface contamination
.....Degradation
.....Filtration
.....Microfiltration
.....Hysteresis
.....Impurities
.....Semiconductor impurities
.....Materials handling
.....Cleaning
.....Decontamination
.....Freight handling
.....Materials handling equipment
.....Remote handling
.....Materials preparation
.....Doping
.....Firing
.....Ion implantation
.....Laser sintering
.....Sputtering
.....Materials reliability
.....Materials testing
.....Accelerated aging
.....Acoustic testing
.....Adhesive strength
.....Bonding forces
.....Delamination
.....Elastic recovery
.....Nondestructive testing
.....Microstructure
.....Periodic structures
.....Gratings
.....Photonic crystals
.....Pigmentation
.....Pigments
.....Separation processes
.....Fractionation
.....Particle separators
.....Surface engineering
.....Surfaces

.....Corrosion
.....Corrugated surfaces
.....Rough surfaces
.....Surface impedance
.....Surface morphology
.....Surface resistance
.....Surface roughness
.....Surface soil
.....Surface structures
.....Surface tension
.....Surface texture
.....Surface topography
.....Surface treatment
....Material storage
.....Bulk storage
.....Containers
.....Freight containers
.....Fuel storage
.....Secure storage
.....Stacking
.....Storage automation
.....Warehousing
.....Water storage
.....Reservoirs
....Metals
.....Alloying
.....Intermetallic
.....Shape memory alloys
.....Aluminum
.....Aluminum alloys
.....Aluminum compounds
.....Barium
.....Barium compounds
.....Bismuth
.....Boron
.....Boron alloys
.....Cadmium
.....Cadmium compounds
.....Calcium
.....Calcium compounds
.....Chromium
.....Chromium alloys
.....Cobalt
.....Cobalt alloys
.....Copper
.....Copper alloys
.....Copper compounds
.....Digital alloys
.....Erbium
.....Gallium
.....Gallium alloys
.....Germanium
.....Germanium alloys
.....Gold
.....Gold alloys
.....Hafnium
.....Hafnium compounds
.....Indium
.....Iron
.....Cast iron
.....Iron alloys
.....Lanthanum
.....Lanthanum compounds
.....Lead
.....Lead isotopes
.....Lithium
.....Lithium compounds
.....Magnesium
.....Magnesium compounds
.....Manganese
.....Manganese alloys
.....Mercury (metals)
.....Metallization
.....Integrated circuit metallization
.....Neodymium
.....Neodymium alloys
.....Neodymium compounds
.....Nickel
.....Nickel alloys
.....Niobium
.....Niobium alloys
.....Niobium compounds
.....Palladium
.....Platinum
.....Platinum alloys
.....Rare earth metals
.....Samarium
.....Samarium alloys
.....Silver
.....Steel
.....Strontium
.....Strontium compounds
.....Tin
.....Tin alloys
.....Tin compounds
.....Titanium
.....Titanium alloys
.....Titanium compounds
.....Tungsten
.....Yttrium
.....Yttrium compounds
.....Zinc

.....Zinc compounds

Mathematics
....Accuracy
....Algebra
.....Abstract algebra
.....Galois fields
.....Modules (abstract algebra)
.....Boolean algebra
.....Boolean functions
.....Linear algebra
.....Linear programming
.....Matrices
.....Vectors
.....Set theory
.....Fuzzy sets
.....Fuzzy set theory
.....Rough sets
....Algorithms
.....Adaptive algorithms
.....Adaptation models
.....Algorithm design and analysis
.....Approximation algorithms
.....Backpropagation algorithms
.....Basis algorithms
.....Change detection algorithms
.....Classification algorithms
.....Clustering algorithms
.....Compression algorithms
.....Density estimation robust algorithm
.....Detection algorithms
.....Distributed algorithms
.....Dynamic programming
.....Filtering algorithms
.....Genetic algorithms
.....Heuristic algorithms
.....Inference algorithms
.....Least mean square algorithms
.....Machine learning algorithms
.....Matching pursuit algorithms
.....Maximum likelihood detection
.....MLFMA
.....Multicast algorithms
.....Parallel algorithms
.....Partitioning algorithms
.....Prediction algorithms
.....Projection algorithms
.....Pursuit algorithms
.....Signal processing algorithms
.....Software algorithms
.....Viterbi algorithm
....Arithmetic
.....Digital arithmetic
.....Fixed-point arithmetic
.....Floating-point arithmetic
....Azimuth
.....Azimuthal angle
.....Azimuthal component
.....Azimuthal current
.....Azimuthal harmonics
.....Azimuthal plane
....Boundary value problems
.....Boundary conditions
.....Upper bound
....Calculus
.....Differential equations
.....Differential algebraic equations
.....Navier-Stokes equations
.....Partial differential equations
.....Transfer functions
.....Integral equations
.....Probability density function
.....Level set
....Closed-form solutions
....Combinatorial mathematics
.....Graph theory
.....Bipartite graph
.....Optimal matching
.....Reachability analysis
.....Shortest path problem
.....Tree graphs
.....Steiner trees
....Computational efficiency
....Conformal mapping
....Convergence
....Convex functions
....Cyclic redundancy check
.....Cyclic redundancy check codes
....Eigenvalues and eigenfunctions
....Equations
.....Boltzmann equation
.....Difference equations
.....Integrodifferential equations
.....Maxwell equations
.....Nonlinear equations
.....Bifurcation
.....Polynomials
.....Riccati equations
....Estimation
.....Estimation error
.....Estimation theory

.....Cramer-Rao bounds
.....Maximum a posteriori estimation
.....Life estimation
.....Maximum likelihood estimation
.....State estimation
.....Observers
.....Yield estimation
....Euclidean distance
.....Hilbert space
....Finite difference methods
....Finite element analysis
....Fourier series
....Functional analysis
....Geometry
.....Computational geometry
.....Fractals
.....Elliptic curves
.....Elliptic design
.....Ellipsoids
.....Information geometry
.....Surface topography
.....Nanotopography
....Gradient methods
....Graph theory
.....Bipartite graph
.....Optimal matching
.....Reachability analysis
.....Shortest path problem
.....Tree graphs
....Harmonic analysis
....Iterative methods
.....Expectation-maximization algorithms
.....Iterative algorithms
.....Belief propagation
.....Iterative closest point algorithm
.....Sum product algorithm
....Kernel
.....Null space
....Laplace equations
....Lattices
.....Lattice Boltzmann methods
....Limit-cycles
....Linearization techniques
....Linear matrix inequalities
....Linear systems
....Mathematical model
.....Mathematical analysis
.....Formal concept analysis
.....Fractional calculus
.....Modal analysis
....Mathematical programming
....Method of moments
....Minimization
.....Minimization methods
....Mode matching methods
....Network theory (graphs)
....Nonlinear equations
.....Bifurcation
....Nonlinear systems
.....Chaos
.....Chaotic communication
.....Complexity theory
.....Spatiotemporal phenomena
.....Nonlinear dynamical systems
....Numerical analysis
.....Adaptive mesh refinement
.....Approximation methods
.....Approximation error
.....Chebyshev approximation
.....Curve fitting
.....Extrapolation
.....Function approximation
.....Interpolation
.....Least squares approximations
.....Linear approximation
.....Perturbation methods
.....Convergence of numerical methods
.....Finite difference methods
.....Finite element analysis
.....Finite volume methods
.....Gradient methods
.....Independent component analysis
.....Iterative methods
.....Expectation-maximization algorithms
.....Iterative algorithms
.....Method of moments
.....Mode matching methods
.....Multigrid methods
.....Newton method
.....Numerical simulation
.....Numerical stability
.....Relaxation methods
.....Sparse matrices
.....Splines (mathematics)
.....Surface fitting
.....Response surface methodology
.....Symmetric matrices
.....Transmission line matrix methods
....Optimization
.....Cost function
.....Optimal scheduling

.....Optimization methods
.....Circuit optimization
.....Design optimization
.....Gradient methods
.....H infinity control
.....Mathematical programming
.....Optimized production technology
.....Pareto optimization
.....Quadratic programming
.....Simulated annealing
....Piecewise linear techniques
.....Piecewise linear approximation
....Predator prey systems
....Probability
.....Ant colony optimization
.....Bayes methods
.....Recursive estimation
.....Error probability
.....Forecasting
.....Demand forecasting
.....Economic forecasting
.....Forecast uncertainty
.....Technology forecasting
.....Memoryless systems
.....Pairwise error probability
.....Possibility theory
.....Probability distribution
.....Exponential distribution
.....Log-normal distribution
.....Maxwell-Boltzmann distribution
.....Nakagami distribution
.....Random variables
.....Statistical distributions
.....Distribution functions
.....Gaussian distribution
.....Weibull distribution
.....Uncertainty
.....Forecast uncertainty
....Quaternions
....Random processes
.....Brownian motion
....Root mean square
....Sequences
.....Binary sequences
.....Random sequences
....Set theory
.....Fuzzy sets
.....Fuzzy set theory
.....Rough sets
....Simulated annealing
....Smoothing methods
....Spirals
....Statistics
.....Adaptive estimation
.....Autoregressive processes
.....Boltzmann distribution
.....Lattice Boltzmann methods
.....Correlation
.....Autocorrelation
.....Correlation coefficient
.....Covariance matrices
.....Gaussian mixture model
.....Higher order statistics
.....Histograms
.....Least squares methods
.....Least mean squares methods
.....Least squares approximations
.....Linear discriminant analysis
.....Maximum likelihood estimation
.....Mean square error methods
.....Minimax techniques
.....Parametric statistics
.....Prediction theory
.....Ranking (statistics)
.....Root mean square
.....Sampling methods
.....Compressed sensing
.....Nonuniform sampling
.....Statistical analysis
.....Analysis of variance
.....Mode matching methods
.....Monte Carlo methods
.....Parameter estimation
.....Pareto analysis
.....Principal component analysis
.....Regression analysis
.....Time series analysis
....Stochastic processes
.....Gaussian processes
.....Gaussian mixture model
.....Markov processes
.....Markov random fields
....Taylor series
....Topology
....Transforms
.....Discrete transforms
.....Discrete cosine transforms
.....Empirical mode decomposition
.....Fourier transforms
.....Discrete Fourier transforms
.....Fast Fourier transforms
.....Karhunen-Loeve transforms

.....Poincare invariance
.....Wavelet transforms
.....Biorthogonal modulation
.....Continuous wavelet transforms
.....Discrete wavelet transforms
.....Wavelet coefficients
.....Wavelet packets
....Transmission line matrix methods
....Uncertain systems
....Utility theory

Microwave theory and techniques
....Microwave technology
.....Beam steering
.....Circulators
.....Masers
.....Gyrotrons
.....Microwave bands
.....C-band
.....K-band
.....L-band
.....Microwave circuits
.....Microwave communication
.....Rectennas
.....Microwave devices
.....Masers
.....Microwave amplifiers
.....Microwave filters
.....Microwave transistors
.....Microwave generation
.....High power microwave generation
.....Microwave photonics
.....Microwave sensors
....Millimeter wave technology
.....Millimeter wave circuits
.....Millimeter wave integrated circuits
.....Millimeter wave communication
.....Millimeter wave devices
.....Millimeter wave transistors
.....Millimeter wave integrated circuits
.....MIMICs
.....Millimeter wave radar
....Submillimeter wave technology
.....Submillimeter wave circuits
.....Submillimeter wave integrated circuits
.....Submillimeter wave communication
.....Submillimeter wave devices
.....Submillimeter wave filters
.....Submillimeter wave integrated circuits

Nanotechnology
....Bionanotechnology
....Casimir effect
....Molecular computing
....Molecular electronics
....Nanobioscience
.....DNA computing
.....Nanobiotechnology
....Nanoelectromechanical systems
....Nanoelectronics
....Nanofabrication
....Nanofluidics
....Nanolithography
....Nanomaterials
....Nanopatterning
.....Colloidal lithography
....Nanophotonics
....Nanopositioning
....Nanoscale devices
.....Nanocontacts
.....Nanotube devices
....Nanosensors
....Nanostructured materials
.....Nanocomposites
.....Nanoporous materials
....Nanostructures
.....Nanoparticles
.....Nanocrystals
.....Nanotubes
.....Carbon nanotubes
.....Semiconductor nanotubes
.....Nanowires
.....Semiconductor nanostructures
....Self-assembly
.....Electrostatic self-assembly
....Self-replicating machines

Nuclear and plasma sciences
....Biomedical applications of radiation
....Colliding beam devices
.....Colliding beam accelerators
.....Muon colliders
....Electron emission
.....Ballistic transport
.....Electronic ballasts
....Elementary particles
.....Charge carriers
.....Charge carrier density
.....Charge carrier lifetime
.....Charge carrier mobility

.....Charge carrier processes
.....Hot carriers
.....Electrons
.....Electron sources
.....Quantum wells
.....Trions
.....Elementary particle exchange interactions
.....Elementary particle vacuum
.....Ions
.....Ionization
.....Ion sources
.....Mesons
.....Neutrino sources
.....Neutrons
.....Particle beams
.....Atomic beams
.....Electron beams
.....Ion beams
.....Particle collisions
.....Phonons
.....Positrons
.....Protons
....Fusion power generation
....Fusion reactors
.....Fusion reactor design
.....Tokamaks
.....Tokamak devices
....Gamma-rays
.....Gamma-ray bursts
.....Gamma-ray detection
.....Gamma-ray effects
....Gas discharge devices
.....Glow discharge devices
....High energy physics instrumentation computing
.....Linear particle accelerator
....Ion beam applications
.....Ion implantation
.....Plasma immersion ion implantation
....Ion emission
....Nuclear electronics
....Nuclear imaging
.....Energy resolution
....Nuclear medicine
....Nuclear physics
.....Alpha particles
.....Beta rays
.....Ignition
.....Ion sources
.....Isotopes
.....Nuclear phase transformations
.....Nuclear thermodynamics
.....Relativistic effects
....Particle accelerators
.....Accelerator magnets
.....Colliding beam accelerators
.....Cyclotrons
.....Electron accelerators
.....Ion accelerators
.....Linear accelerators
.....Photon collider
.....Plasma accelerators
.....Proton accelerators
.....Storage rings
.....Synchrocyclotrons
.....Synchrotrons
.....Synchrotron radiation
.....Undulators
....Particle beam handling
....Particle beam injection
....Plasmas
.....Atmospheric-pressure plasmas
.....Plasma applications
.....Plasma devices
.....Plasma immersion ion implantation
.....Plasma welding
.....Tokamaks
.....Plasma confinement
.....Inertial confinement
.....Magnetic confinement
.....Plasma diagnostics
.....Plasma properties
.....Dusty plasmas
.....Plasma chemistry
.....Plasma density
.....Plasma sheaths
.....Plasma stability
.....Plasma temperature
.....Plasmons
.....Plasma simulation
.....Plasma sources
.....Plasma transport processes
....Radiation effects
.....Biological effects of radiation
.....Gamma-ray effects
.....Ion radiation effects
.....Neutron radiation effects
....Radiation hardening (electronics)
....Radiation monitoring
.....Radiation dosage
....Radiation safety

....Reactor instrumentation
....Scintillation counters
.....Solid scintillation detectors
....Thermionic emission

Oceanic engineering and marine technology
....Marine navigation
....Marine technology
.....Marine equipment
.....Marine transportation
.....Marine vehicles
.....Underwater cables
.....Underwater communication
.....Underwater equipment
.....Rebreathing equipment
.....Underwater structures
.....Underwater technology
.....Underwater communication
.....Underwater equipment
.....Underwater structures
....Oceanographic techniques
....Ocean temperature
....Water pollution
.....Marine pollution

Power electronics
....Converters
.....AC-AC converters
.....DC-AC power converters
.....Digital-to-frequency converters
.....Frequency conversion
.....Mixers
.....Optical frequency conversion
.....Power conversion
.....AC-AC converters
.....AC-DC power converters
.....DC-AC power converters
.....DC-DC power converters
.....Matrix converters
.....Power conversion harmonics
.....Pulse width modulation converters
.....Static power converters
.....Wavelength converters
....Current limiters
.....Fault current limiters
....Inverters
.....Pulse inverters
.....Resonant inverters
....Phase control
....Power conditioning
.....Power smoothing
....Power semiconductor devices
.....Power transistors
....Power semiconductor switches
.....Bipolar transistors
.....Insulated gate bipolar transistors
.....Kirk field collapse effect
.....Thyristors
.....Photothyristors
....Snubbers
....Three-phase electric power

Power engineering and energy
....Electric variables control
.....Current control
.....Electrical ballasts
.....Electric current control
.....Gain control
.....Power control
.....Power system control
.....Bidirectional power flow
.....Load flow control
.....SCADA systems
.....Reactive power control
.....Voltage control
.....Automatic voltage control
....Energy
.....Energy barrier
.....Energy capture
.....Energy consumption
.....Energy conversion
.....Batteries
.....Fuel cells
.....Motors
.....Photovoltaic cells
.....Potential well
.....Solar heating
.....Thermoelectricity
.....Waste heat
.....Energy dissipation
.....Energy exchange
.....Inductive charging
.....Energy harvesting
.....Energy management
.....Energy conservation
.....Energy efficiency
.....Load management
.....Energy resources

.....Fuels
.....Geothermal energy
.....Nuclear fuels
.....Solar energy
.....Wave power
.....Wind energy
.....Wind farms
.....Energy states
.....Effective mass
.....Orbital calculations
.....Energy storage
.....Batteries
.....Flywheels
.....Fuel cells
.....Hydrogen storage
.....Supercapacitors
.....Superconducting magnetic energy storage
....Power engineering
.....Ferroresonance
.....High-voltage techniques
.....Power engineering computing
.....Power system simulation
....Power generation
.....Automatic generation control
.....Cogeneration
.....Distributed power generation
.....Geothermal power generation
.....Hydroelectric power generation
.....Hydroelectric-thermal power generation
.....Microhydro power
.....Picohydro power
.....Magnetohydrodynamic power generation
.....Nuclear power generation
.....Fission reactors
.....Fusion power generation
.....Power generation control
.....Power generation dispatch
.....Power generation planning
.....Solar power generation
.....Maximum power point trackers
.....Photovoltaic systems
.....Trigeneration
.....Turbomachinery
.....Turbines
.....Turbogenerators
.....Wind energy generation
.....Wind energy integration
.....Wind power generation
....Power systems
.....Hybrid power systems
.....Industrial power systems
.....Power distribution
.....Power distribution faults
.....Power distribution lines
.....Power grids
.....Microgrids
.....Smart grids
.....Power supplies
.....Battery chargers
.....Charging stations
.....Current supplies
.....Emergency power supplies
.....Inductive charging
.....Islanding
.....Power demand
.....Power quality
.....Power system restoration
.....Switched-mode power supply
.....Traction power supplies
.....Umbilical cable
.....Power system analysis computing
.....Power system dynamics
.....Power system economics
.....Power system faults
.....Power system harmonics
.....Power harmonic filters
.....Power system management
.....Load flow
.....Power system measurements
.....Meter reading
.....Power system planning
.....Power demand
.....Power system protection
.....Electrical safety
.....Substation protection
.....Surge protection
.....Power system reliability
.....Power system stability
.....Power transmission
.....Flexible AC transmission systems
.....HVDC transmission
.....Inductive power transmission
.....Static VAr compensators
.....Transmission lines
.....PSCAD
.....Pulse power systems
.....Pulsed power supplies
.....Reactive power
.....Substations

.....Substation automation
.....Substation protection
.....Transformers
.....Current transformers
.....Flyback transformers
.....Instrument transformers
.....Phase transformers
.....Power transformers
.....Pulse transformers
.....Uninterruptible power systems
.....Wind energy integration

Product safety engineering
....Consumer protection
....Power system protection
.....Electrical safety
.....Fault protection
.....Grounding
.....Substation protection
.....Surge protection
.....Arresters
....Safety
.....Aerospace safety
.....Air safety
.....Domestic safety
.....Emergency services
.....Explosion protection
.....Hazards
.....Biohazards
.....Chemical hazards
.....Explosions
.....Fires
.....Flammability
.....Floods
.....Hazardous areas
.....Hazardous materials
.....Toxicology
.....Health and safety
.....Occupational health
.....Occupational safety
.....Marine safety
.....Product safety
.....Protection
.....Explosion protection
.....Lightning protection
.....Radiation safety
.....Safety devices
.....Eye protection
.....Protective clothing
.....Vehicle safety
....Vehicle crash testing

Professional communication
....Collaboration
.....Collaborative tools
.....Call conference
.....Collaborative software
.....Videoconferences
.....Discussion forums
.....Teamwork
.....Virtual groups
....Communication aids
....Communication effectiveness
....Communication symbols
.....Semiotics
.....Pragmatics
.....Semantics
.....Syntactics
....Context
....Databases
.....Database systems
.....Audio databases
.....Deductive databases
.....Image databases
.....Indexes
.....Multimedia databases
.....Object oriented databases
.....Query processing
.....Deductive databases
.....Distributed databases
.....Image databases
.....Image retrieval
.....Multimedia databases
.....Object oriented databases
.....Relational databases
.....Spatial databases
.....Transaction databases
.....Itemsets
.....Visual databases
....Global communication
.....Cross-cultural communication
.....Geographic information systems
.....Geospatial analysis
.....Gunshot detection systems
....Grammar
....Information analysis
.....Indexing
....Information resources
....Information retrieval
.....Blogs

.....Content-based retrieval
.....Hypertext systems
.....Information filtering
.....Information filters
.....Recommender systems
.....Information rates
.....Music information retrieval
.....Online services
.....Search engines
.....Search methods
.....Keyword search
.....Metasearch
.....Nearest neighbor searches
.....Search problems
.....Web search
.....Social network services
.....Computer mediated communication
.....Facebook
.....LinkedIn
.....MySpace
.....Second Life
.....Twitter
.....YouTube
.....Tagging
.....Tag clouds
.....Taxonomy
.....Terminology
.....Dictionaries
.....Video sharing
.....Facebook
.....MySpace
.....YouTube
.....Vocabulary
.....Web sites
.....Facebook
.....MySpace
.....Uniform resource locators
.....Web design
.....YouTube
....Information science
....Information services
.....Ask IEEE
.....Dictionaries
.....Document delivery
.....Ask IEEE
.....Encyclopedias
.....Libraries
.....Software libraries
.....Teletext
.....Videotex
.....Wikipedia
....Information systems
.....Database systems
.....Audio databases
.....Deductive databases
.....Image databases
.....Indexes
.....Multimedia databases
.....Object oriented databases
.....Query processing
.....Data systems
.....Data acquisition
.....Data compression
.....Data conversion
.....Data engineering
.....Data handling
.....Data processing
.....Data storage systems
.....Data warehouses
.....Distributed information systems
.....Publish-subscribe
.....Identity management systems
.....Informatics
.....Biomedical informatics
.....Cognitive informatics
.....Information architecture
.....Information management
.....Competitive intelligence
.....Document handling
.....Information security
.....Information sharing
.....Knowledge transfer
.....Information processing
.....Informatics
.....Information exchange
.....Sonification
.....Management information systems
.....Portals
.....Medical information systems
.....Electronic medical records
....Information technology
.....Information representation
.....Printing
.....Digital printing
.....Teleprinting
.....Service computing
.....Telematics
.....Universal Serial Bus
....Manuals
....Oral communication
.....Public speaking
.....Speech

....Plagiarism
....Portfolios
....Professional societies
....Public speaking
....Rhetoric
....Writing
.....Abstracts
.....Bibliographies
.....Biographies
.....Autobiographies
.....Dictionaries
.....Documentation
.....Grammar
.....Readability metrics
.....Resumes
.....Reviews
.....Thesauri

Reliability
....Availability
....Fault diagnosis
.....Dissolved gas analysis
.....Fault location
....Fault tolerance
.....Redundancy
....Fluctuations
....Integrated circuit reliability
....Maintenance
....Maldistribution
....Materials reliability
....Reliability engineering
....Reliability theory
....Robustness
....Semiconductor device reliability
....Software reliability
....Stability
.....Circuit stability
.....Robust stability
.....Stability analysis
.....Stability criteria
.....Thermal stability
....Telecommunication network reliability

Resonance
....Ferroresonance
....Magnetic resonance
.....Nuclear magnetic resonance
.....Paramagnetic resonance
....Resonance light scattering
....Stochastic resonance

Robotics and automation
....Animatronics
....Automation
.....Automated highways
.....Automatic generation control
.....Automatic testing
.....Automatic test pattern generation
.....Ring generators
.....Building automation
.....Manufacturing automation
.....Computer aided manufacturing
.....Computer integrated manufacturing
.....Computer numerical control
.....Flexible manufacturing systems
.....Office automation
.....Workflow management software
.....Storage automation
....Multi-robot systems
....Robots
.....Androids
.....Aquatic robots
.....Automata
.....Turing machines
.....Cognitive robotics
.....Computer vision
.....Active appearance model
.....Face detection
.....Smart cameras
.....Educational robots
.....Humanoid robots
.....Intelligent robots
.....Manipulators
.....End effectors
.....Manipulator dynamics
.....Micromanipulators
.....Medical robotics
.....Rehabilitation robotics
.....Mobile robots
.....Climbing robots
.....Legged locomotion
.....Orbital robotics
.....Parallel robots
.....Robot control
.....Robot motion
.....Robot kinematics
.....Motion analysis
.....Robot programming
.....Robot sensing systems
.....Robot vision systems

.....Simultaneous localization and mapping
.....Tactile sensors
.....Service robots
.....Telerobotics
.....Teleoperators

Science - general
....Astronomy
.....Astrophysics
.....Observatories
.....Orbits (stellar)
.....Planets
.....Earth
.....Extrasolar planets
.....Jupiter
.....Mars
.....Mercury (planets)
.....Pluto
.....Saturn
.....Sun
.....Venus
.....Radio astronomy
.....Solar system
.....Kuiper belt
.....Stellar dynamics
.....Stellar motion
....Biology
.....Biochemistry
.....Amino acids
.....Biochemical analysis
.....Peptides
.....Proteins
.....Biodiversity
.....Biogeography
.....Bioelectric phenomena
.....Electric shock
.....Biological cells
.....Cells (biology)
.....Chromosome mapping
.....Fibroblasts
.....RNA
.....Stem cells
.....Biological information theory
.....Biological processes
.....Biological interactions
.....Chronobiology
.....Circadian rhythm
.....Coagulation
.....Symbiosis
.....Biological system modeling
.....Biological systems
.....Anatomy
.....Molecular communication
.....Organisms
.....Biology computing
.....Biophotonics
.....Biophysics
.....Aerospace biophysics
.....Biomagnetics
.....Cellular biophysics
.....Molecular biophysics
.....Evolution (biology)
.....Memetics
.....Phylogeny
.....Genetics
.....DNA
.....Gene therapy
.....Genetic communication
.....Genetic expression
.....Genetic programming
.....Genomics
.....Microinjection
.....Nanobioscience
.....DNA computing
.....Nanobiotechnology
.....Physiology
.....Predator prey systems
.....Synthetic biology
.....Systematics
.....Systems biology
.....Vegetation
.....Crops
.....Marine vegetation
.....Zoology
.....Animals
....Chemistry
.....Astrochemistry
.....Biochemistry
.....Amino acids
.....Biochemical analysis
.....Peptides
.....Proteins
.....Chemical analysis
.....Activation analysis
.....Chemical processes
.....Chemicals
.....Electronic noses
.....pH measurement
.....Chemical compounds
.....Anti-freeze

.....Ethanol
.....Methanol
.....Inorganic chemicals
.....Interstellar chemistry
.....Organic chemicals
.....Hydrocarbons
.....Photochemistry
.....Photobleaching
....Electricity
.....Photoelectricity
.....Photovoltaic effects
.....Piezoelectricity
.....Piezoelectric effect
.....Piezoelectric polarization
.....Pyroelectricity
.....Thermoelectricity
.....Electrothermal effects
.....Thermoelectric devices
.....Triboelectricity
....Geoscience
.....Antarctica
.....South Pole
.....Arctic
.....North Pole
.....Atmosphere
.....Atmospheric modeling
.....Atmospheric waves
.....Biosphere
.....Continents
.....Africa
.....Asia
.....Australia
.....Europe
.....North America
.....South America
.....Cyclones
.....Hurricanes
.....Tropical cyclones
.....Earth
.....Earthquakes
.....Earthquake engineering
.....Forestry
.....Geoengineering
.....Geography
.....Cities and towns
.....Rural areas
.....Urban areas
.....Geology
.....Minerals
.....Rocks
.....Geophysics
.....EMTDC
.....Extraterrestrial phenomena
.....Geodynamics
.....Geophysics computing
.....Meteorology
.....Moisture
.....Seismology
.....Surface waves
.....Well logging
.....Ice
.....Ice shelf
.....Ice surface
.....Ice thickness
.....Sea ice
.....Lakes
.....Land surface
.....Levee
.....Meteorological factors
.....Oceans
.....Ocean salinity
.....Ocean temperature
.....Sea coast
.....Sea floor
.....Sea level
.....Sea surface
.....Tides
.....Rivers
.....Sediments
.....Soil
.....Soil moisture
.....Soil properties
.....Soil texture
.....Tornadoes
.....Tsunami
.....Volcanoes
.....Planetary volcanoes
.....Volcanic activity
.....Volcanic ash
....Metrology
....Physics
.....Acoustics
.....Acoustic applications
.....Acoustic devices
.....Acoustic emission
.....Acoustic noise
.....Acoustic propagation
.....Acoustic pulses
.....Acoustic waves
.....Acoustooptic effects
.....Biomedical acoustics
.....Cepstral analysis

.....Music
.....Nonlinear acoustics
.....Psychoacoustics
.....Reverberation
.....Spectral shape
.....Underwater acoustics
.....Astrophysics
.....Beams
.....Acoustic beams
.....Laser beams
.....Molecular beams
.....Optical beams
.....Particle beams
.....Biophysics
.....Aerospace biophysics
.....Biomagnetics
.....Cellular biophysics
.....Molecular biophysics
.....Dark energy
.....Entropy
.....Fluid flow
.....Fluid dynamics
.....Hydraulic diameter
.....Hydrology
.....Pipelines
.....Valves
.....Geophysics
.....EMTDC
.....Extraterrestrial phenomena
.....Geodynamics
.....Geophysics computing
.....Meteorology
.....Moisture
.....Seismology
.....Surface waves
.....Well logging
.....Kinetic theory
.....Kinetic energy
.....Levitation
.....Electrostatic levitation
.....Magnetic levitation
.....Lorentz covariance
.....Mechanical factors
.....Acceleration
.....Aerodynamics
.....Biomechanics
.....Damping
.....Dynamics
.....Fatigue
.....Force
.....Friction
.....Hydrodynamics
.....Kinematics
.....Lubrication
.....Magnetohydrodynamics
.....Photoelasticity
.....Pressure effects
.....Shock (mechanics)
.....Strain
.....Stress
.....Surface cracks
.....Torque
.....Vibrations
.....Volume relaxation
.....Workability
.....Network theory (graphs)
.....Orbits
.....Physics education
.....Quantum mechanics
.....Density functional theory
.....Lagrangian functions
.....Proton effects
.....Quantum capacitance
.....Quantum entanglement
.....Relativistic quantum mechanics
.....Schrodinger equation
.....Stationary state
.....Teleportation
.....Tunneling
.....String theory
.....Thermal factors
.....Temperature
.....Temperature dependence
.....Thermal conductivity
.....Thermal expansion
.....Thermal management
.....Thermal stresses
.....Thermoelasticity
.....Thermoelectricity
.....Thermolysis
.....Thermooptic effects
.....Thermoresistivity
.....Waves
.....Atmospheric waves
.....Berry phase
.....Doppler effect
.....Electrodynamics
.....Magnetostatic waves
.....Matter waves
.....Plasma waves
.....Propagation
.....Reflectivity

.....Seismic waves
.....Shock waves
.....Solitons
.....Surface acoustic waves
.....Wave functions
....Sociology
.....Digital divide
....Thermodynamics
.....Isobaric
.....Isothermal processes

Sensors
....Acoustic sensors
....Chemical and biological sensors
.....Biosensors
.....Gas detectors
.....Amperometric sensors
....Electromechanical sensors
.....Microsensors
....Force sensors
....Infrared sensors
....Intelligent sensors
....Intracranial pressure sensors
....Ionizing radiation sensors
.....Position sensitive particle detectors
.....Radiation detectors
.....Bolometers
.....Gamma-ray detectors
.....Infrared detectors
.....Photodetectors
.....Semiconductor radiation detectors
.....Silicon radiation detectors
.....X-ray detectors
....Magnetic sensors
.....Spin valves
....Mechanical sensors
.....Capacitive sensors
....Multimodal sensors
....Nanosensors
....Optical sensors
.....Optical detectors
.....Bar codes
.....Optical fiber sensors
....Optoelectronic and photonic sensors
....Sensor phenomena and characterization
....Sensor systems and applications
.....Detectors
.....Envelope detectors
.....Semiconductor detectors
.....Electric sensing devices
.....Leak detection
.....Radiofrequency identification
.....RFID tags
.....Robot sensing systems
.....Robot vision systems
.....Simultaneous localization and mapping
.....Tactile sensors
.....Sensor arrays
.....Sensor fusion
.....Sensor systems
.....Gunshot detection systems
....Thermal sensors
.....Temperature sensors
....Thick film sensors
....Thin film sensors
....Wearable sensors

Signal processing
....Acoustic signal processing
.....Active noise reduction
.....Echo cancellers
.....Speech processing
.....Human voice
.....Speech enhancement
.....Speech synthesis
....Adaptive signal processing
.....Adaptive filters
.....Adaptive signal detection
....Amplifiers
.....Broadband amplifiers
.....Cavity resonators
.....Laser cavity resonators
.....Differential amplifiers
.....Distributed amplifiers
.....Low-noise amplifiers
.....Operational amplifiers
.....Feedback amplifier
.....Power amplifiers
.....High power amplifiers
.....Predistortion
.....Preamplifiers
.....Pulse amplifiers
.....Radiofrequency amplifiers
....Array signal processing
....Attenuators
.....Optical attenuators
....Chirp
....Convolution
.....Convolvers

....Decorrelation
....Digital signal processing
.....Delta modulation
.....Delta-sigma modulation
.....Sigma-delta modulation
.....Digital signal processing chips
....Dispersion
.....Chromatic dispersion
.....Optical fiber dispersion
....Distortion
.....Acoustic distortion
.....Four-wave mixing
.....Jitter
.....Timing jitter
.....Nonlinear distortion
.....Harmonic distortion
.....Intermodulation distortion
.....Phase distortion
....Error correction
.....Forward error correction
....Fading
.....Frequency-selective fading channels
.....Rayleigh channels
.....Weibull fading channels
....Filters
.....Active filters
.....Band-pass filters
.....Anisotropic
.....Bragg gratings
.....Fiber gratings
.....Channel bank filters
.....Digital filters
.....Finite impulse response filters
.....Equalizers
.....Adaptive equalizers
.....Blind equalizers
.....Decision feedback equalizers
.....Filtering theory
.....Gabor filters
.....Harmonic filters
.....IIR filters
.....Kalman filters
.....Low-pass filters
.....Matched filters
.....Microstrip filters
.....Nonlinear filters
.....Particle filters
.....Power filters
.....Spurline
.....Resonator filters
.....Spatial filters
.....Superconducting filters
.....Transversal filters
....Frequency locked loops
....Geophysical signal processing
....Limiting
....Modulation
.....Amplitude modulation
.....Amplitude shift keying
.....Quadrature amplitude modulation
.....Chirp modulation
.....Demodulation
.....Digital modulation
.....Constellation diagram
.....Partial response signaling
.....Frequency modulation
.....Frequency shift keying
.....Magnetic modulators
.....Modulation coding
.....Interleaved codes
.....Optical modulation
.....Electrooptic modulators
.....Intensity modulation
.....Phase modulation
.....Continuous phase modulation
.....Differential phase shift keying
.....Phase shift keying
.....Pulse modulation
.....Pulse width modulation
.....Pulse width modulation inverters
.....Space vector pulse width modulation
....Multidimensional signal processing
.....Video signal processing
.....Video coding
.....Video compression
....Noise
.....1f noise
.....Additive noise
.....Additive white noise
.....AWGN
.....Colored noise
.....Gaussian noise
.....AWGN
.....Laser noise
.....Laser feedback
.....Low-frequency noise
.....Noise cancellation
.....Phase noise
.....Signal to noise ratio
.....PSNR
.....Superconducting device noise

.....White noise
.....AWGN
....Optical signal processing
.....Laser noise
.....Laser feedback
....Optical wavelength conversion
....Phase locked loops
....Pulse compression methods
.....Optical pulse compression
....Pulse shaping methods
.....Optical pulse shaping
....Quantization (signal)
.....Vector quantization
....Radar signal processing
....Recording
.....Audio recording
.....Digital recording
.....Disk recording
.....Magnetic recording
.....Digital magnetic recording
.....Heat-assisted magnetic recording
.....Magnetic noise
.....Magnetooptic recording
.....Microwave-assisted magnetic recording
.....Perpendicular magnetic recording
.....Optical recording
.....CD recording
.....Video recording
.....High definition video
.....Webcams
....RF signals
....Signal analysis
.....Discrete-event systems
.....Harmonic analysis
.....Parameter estimation
.....Amplitude estimation
.....Direction-of-arrival estimation
.....Frequency estimation
.....Motion estimation
.....Phase estimation
.....Time of arrival estimation
.....Signal mapping
.....Spectral analysis
.....Infrared spectra
.....Judd-Ofelt theory
.....Spectroradiometers
....Signal design
....Signal detection
.....Acoustic signal detection
.....Sonar detection
.....Motion detection
.....Multiuser detection
.....Optical signal detection
.....Phase detection
.....Phase frequency detector
.....Radar detection
....Signal generators
.....Noise generators
.....Pulse generation
.....Optical pulse generation
....Signal reconstruction
.....Signal denoising
....Signal resolution
.....Diversity reception
....Signal restoration
....Signal sampling
....Signal synthesis
....Source separation
.....Blind source separation
....Spectrogram
....Tracking loops

Social implications of technology
....Cultural differences
....Environmental factors
.....Biosphere
.....Ecosystems
.....Environmental economics
.....Carbon tax
.....Environmental monitoring
.....Global warming
.....Green products
.....Green buildings
.....Green cleaning
.....Pollution
.....Air pollution
.....Industrial pollution
.....Land pollution
.....Oil pollution
.....Radioactive pollution
.....Thermal pollution
.....Urban pollution
.....Water pollution
....Ethical aspects
....Globalization
....International relations
....Peace technology
....Philosophical considerations
....Social factors
.....Demography

.....Technology social factors
.....Privacy
....Sustainable development
....Technology
.....Appropriate technology
.....Technological innovation
.....Technology social factors
.....Privacy
.....Technology transfer
.....Small business technology transfer

Solid state circuits
....Circuit subsystems
....Circuit theory
....FET circuits
.....FET integrated circuits
.....Field effect MMIC
.....MESFET integrated circuits
.....JFET circuits
.....JFET integrated circuits
.....MESFET circuits
.....MESFET integrated circuits
.....MODFET circuits
.....MODFET integrated circuits
.....MOSFET circuits
.....CMOSFET circuits
.....MOS integrated circuits
.....Power MOSFET
....Gate leakage
....Solid state circuit design
....Transistors
.....Field effect transistors
.....CNTFETs
.....Double-gate FETs
.....HEMTs
.....JFETs
.....MESFETs
.....MISFETs
.....MODFETs
.....MOSFET
.....MOSHFETs
.....OFETs
.....Schottky gate field effect transistors
.....Thin film transistors
.....Heterojunction bipolar transistors
.....Double heterojunction bipolar transistors
.....Millimeter wave transistors
.....Phototransistors

Superconductivity
....Bean model
....Critical current density (superconductivity)
.....Critical current density
....Flux pinning
....Superconducting devices
.....Josephson junctions
.....SQUIDs
.....Superconducting coils
.....Superconducting magnets
.....Superconducting microwave devices
.....Superconducting photodetectors
....Superconducting filaments and wires
....Superconducting films
.....Superconducting thin films
....Superconducting integrated circuits
....Superconducting magnetic energy storage
....Superconducting materials
.....Granular superconductors
.....High-temperature superconductors
.....Yttrium barium copper oxide
.....Multifilamentary superconductors
.....Niobium-tin
.....Type II superconductors
....Superconducting transition temperature
Systems engineering and theory
....Adaptive systems
.....Adaptive control
.....Line enhancers
.....Multi-agent systems
.....Variable structure systems
....Hierarchical systems
.....Multilevel systems
....Modeling
.....Analytical models
.....Atmospheric modeling
.....Brain modeling
.....Computational modeling
.....Computational cultural modeling
.....Context modeling
.....Data models
.....Deformable models
.....Digital elevation models
.....Emulation
.....Graphical models
.....Green's function methods
.....Hidden Markov models
.....Input variables
.....Integrated circuit modeling

.....Cutoff frequency
.....Inverse problems
.....Deconvolution
.....Load modeling
.....Metamodeling
.....Numerical models
.....Object oriented modeling
.....Power system modeling
.....Load modeling
.....Semiconductor device modeling
.....Semiconductor process modeling
.....Signal representation
.....Simulation
.....Computer simulation
.....Digital simulation
.....Medical simulation
.....Solid modeling
.....System identification
....Multidimensional systems
....Reduced order systems
....Stochastic systems
....System analysis and design
.....Asymptotic stability
.....Control system analysis
.....State-space methods
.....Diakoptics
.....Distributed processing
.....Message passing
.....Distributed vision networks
.....Fault detection
.....Fault tolerant systems
.....Interconnected systems
.....Large-scale systems
.....Lyapunov methods
.....Open systems
.....Open Access
.....Physical layer
.....Petri nets
.....Robust control
.....Scalability
.....Scattering parameters
.....Sequential analysis
.....Sequential diagnosis
.....Software prototyping
.....System-level design
.....System performance
.....Cooperative caching
.....Time factors
.....Continuous time systems
.....Discrete-time systems
.....Time invariant systems
.....Time-varying systems
....Systems engineering education

Systems, man, and cybernetics
....Behavioral science
.....Animal behavior
.....Cognition
.....Consumer behavior
.....Psychiatry
.....Mental disorders
.....Psychology
.....Industrial psychology
.....Mood
.....Psychometric testing
....Biological control systems
.....Biomarkers
.....Molecular biomarkers
....Computational linguistics
.....Sentiment analysis
....Cybernetics
.....Adaptive systems
.....Adaptive control
.....Line enhancers
.....Multi-agent systems
.....Variable structure systems
.....Cognitive informatics
.....Cognitive science
.....Problem-solving
.....Control theory
.....Control nonlinearities
.....Observability
.....Decision theory
.....Decision trees
.....Econophysics
.....Emergent phenomena
.....Intelligent control
.....Feedforward systems
.....Neurocontrollers
.....Linear feedback control systems
.....Frequency locked loops
.....Phase locked loops
.....State feedback
.....Tracking loops
....Ergonomics
.....Job design
....Human factors
.....Affective computing
.....Anthropomorphism
....Identification of persons
.....Biometrics (access control)

.....Gait recognition
.....Iris recognition
.....Face recognition
.....Fingerprint recognition
.....Handwriting recognition
.....Forgery
.....Speaker recognition
.....Speech recognition
.....Automatic speech recognition
.....Speech analysis
....Man machine systems
.....Interactive systems
....Natural languages
.....Natural language processing
.....Morphology
.....Sentiment analysis
....Pervasive computing
.....Ubiquitous computing
.....Context-aware services
.....Wearable computers
....Posthuman
....Teleworking
....Transhuman
....User interfaces
.....Audio user interfaces
.....Brain-computer interfaces
.....Data visualization
.....Isosurfaces
.....Emotion recognition
.....Exoskeletons
.....Graphical user interfaces
.....Avatars
.....Human computer interaction
.....Human-robot interaction
.....Smart cards

Ultrasonics, ferroelectrics, and frequency control
....Ferroelectric materials
.....Ferroelectric films
.....Relaxor ferroelectrics
....Frequency control
.....Automatic frequency control
.....Tunable circuits and devices
.....RLC circuits
.....Tuned circuits
.....Tuning
.....Laser tuning
.....Optical tuning
.....Tuners
....Piezoelectricity
.....Piezoelectric effect
.....Piezoelectric polarization
....Pyroelectricity
....Ultrasonic imaging
.....Ultrasonography
.....Sonogram
....Ultrasonic transducers

Vehicular and wireless technologies
....Automotive engineering
.....Automotive applications
.....Automotive electronics
.....Power steering
.....Vehicle crash testing
.....Vehicle detection
.....Vehicle driving
.....Vehicle dynamics
.....Vehicle safety
....Land mobile radio equipment
.....Mobile antennas
....Navigation
.....Aircraft navigation
.....Course correction
.....Dead reckoning
.....Inertial navigation
.....Marine navigation
.....Radio navigation
.....Satellite navigation systems
.....Global Positioning System
.....Satellite constellations
.....Sonar navigation
....Propulsion
.....Aircraft propulsion
.....Propellers
.....Electromagnetic launching
.....Coilguns
.....Railguns
.....Electrothermal launching
.....Rockets
....Vehicles
.....Land vehicles
.....Bicycles
.....Electric vehicles
.....Road vehicles
.....Remotely operated vehicles
.....Unmanned aerial vehicles
.....Space vehicles
.....Space shuttles
....Wireless sensor networks

.....Body sensor networks
.....Event detection