

# How to Use the IEEEtran BIB<sub>T</sub>E<sub>X</sub> Style

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**Abstract**—This article describes how to use the IEEEtran.bst BIB<sub>T</sub>E<sub>X</sub> style file to produce bibliographies that conform to the standards of the publications of the Institute of Electrical and Electronics Engineers (IEEE).

**Index Terms**—bibliography, BIB<sub>T</sub>E<sub>X</sub>, IEEE, L<sup>A</sup>T<sub>E</sub>X, paper, references, style, template, typesetting.

## I. INTRODUCTION

THE IEEEtran.bst BIB<sub>T</sub>E<sub>X</sub> style file described in this document can be used with BIB<sub>T</sub>E<sub>X</sub> to produce L<sup>A</sup>T<sub>E</sub>X bibliographies of high quality that are suitable for use in IEEE publications. Other potential applications include thesis and academic work, especially when such work is in the area of electrical and/or computer engineering.

This document applies to version 1.14 and later of the IEEEtran BIB<sub>T</sub>E<sub>X</sub> style. Prior versions do not have all of the features described here. IEEEtran.bst will display the version number on the user's console during execution. The most recent version of this package can be obtained on CTAN [1] and may also be mirrored at various places within IEEE's website [2]. Additional support may be found at the IEEEtran homepage [3].

It is assumed that the reader has a basic understanding of the operation and use of BIB<sub>T</sub>E<sub>X</sub>. Documentation for the use of BIB<sub>T</sub>E<sub>X</sub> includes the user's guide [4] as well as supplementary information such as a comprehensive tutorial [5], FAQs [6], [7], and a guide using practical examples [8]. The large collection of sample bibliographies and string definitions at the T<sub>E</sub>X User Group Bibliography Archive may also be of help [9]. General support for BIB<sub>T</sub>E<sub>X</sub> related questions can be obtained in the usenet newsgroup comp.text.tex.

Note that the references section of this document is used for two purposes: (1) to provide information where additional information can be found; and (2) to provide examples of references created using the IEEEtran BIB<sub>T</sub>E<sub>X</sub> style. The first few citations above fall into the first category, while the vast majority of the citations that follow will serve as examples and are not meant to be actually referred to. Hopefully, it will be clear from context which way a particular reference is used.

## II. INSTALLATION

The IEEEtran BIB<sub>T</sub>E<sub>X</sub> package consists of the following files. Note that the IEEEtran packages from IEEE's website

Manuscript created on June 20, 2002; revised August 26, 2015. This work is distributed under the L<sup>A</sup>T<sub>E</sub>X Project Public License (LPPL) (<http://www.latex-project.org/>) version 1.3. A copy of the LPPL, version 1.3, is included in the base L<sup>A</sup>T<sub>E</sub>X documentation of all distributions of L<sup>A</sup>T<sub>E</sub>X released 2003/12/01 or later. The opinions expressed here are entirely that of the author. No warranty is expressed or implied. User assumes all risk.

See <http://www.michaelshell.org/> for current contact information.

may not carry the non-IEEE compliant (natbib compatible, etc.) variants. See the CTAN site [1] for the complete set of files.

**IEEEtran\_bst\_HOWTO.pdf**: This documentation.

**IEEEtran.bst**: The standard IEEEtran BIB<sub>T</sub>E<sub>X</sub> style file (unsorted, i.e., references will appear in the order in which they are cited). Recommended for work that is to be submitted to the IEEE.

**IEEEtranS.bst**: The IEEEtran BIB<sub>T</sub>E<sub>X</sub> style file, but with additional sorting code, similar to that of plain.bst, which sorts the entries based on the names of the authors, editors, organizations, etc. Some IEEE conferences/publications may allow/use sorted bibliographies, but the vast majority are unsorted.

**IEEEtranSA.bst**: Like IEEEtranS.bst, but with alphanumeric citation tags like alpha.bst. Not for normal IEEE use.

**IEEEtranN.bst**: Like IEEEtran.bst, but based on plainnat.bst and is compatible with Patrick W. Daly's natbib package [10]. Not for normal IEEE use.

**IEEEtranSN.bst**: Sorting version of IEEEtranN.bst. Not for normal IEEE use.

**IEEEexample.bib**: A BIB<sub>T</sub>E<sub>X</sub> database that contains the references shown in the references section of this document. Users can copy the entries therein to serve as starting templates. The entries also have comments which may be of additional help.

**IEEEfull.bib**: A file that contains a comprehensive set of BIB<sub>T</sub>E<sub>X</sub> string definitions for the full names of IEEE journals and magazines. Because IEEE's bibliography style uses abbreviated journal names, this file's intended use is for specialized or non-IEEE related work.

**IEEEabrv.bib**: Same as above, but contains the abbreviated form of the journal and magazine names. Recommended for work that is to be submitted to the IEEE.

BIB<sub>T</sub>E<sub>X</sub> .bst files can be accessed system-wide when they are placed in the

```
<texmf>/bibtex/bst
```

directory, where <texmf> is the root directory of the user's T<sub>E</sub>X installation. Similarly, system-wide .bib files (IEEEfull.bib and IEEEabrv.bib) can be placed in

```
<texmf>/bibtex/bib
```

On systems that have a local texmf tree (<texmflocal>), which may be named "texmf-local" or "localtexmf", it may be advisable to install packages in <texmflocal>, rather than <texmf> as the contents of the former, unlike that of the latter, are preserved after the L<sup>A</sup>T<sub>E</sub>X system is reinstalled and/or upgraded.

Alternatively, on  $\TeX$  Live and  $\text{te}\TeX$  systems, users can set the `BSTINPUTS` and `BIBINPUTS` environment variables to specify the search paths for `.bst` and `.bib` files, respectively. Similarly,  $\text{MiK}\TeX$  users can alter the “Input Dirs” path in the `BibTEX` section of the `miktex.ini` configuration file. On some  $\LaTeX$  systems, the directory look-up tables will need to be refreshed after making additions or deletions to the system files. For  $\TeX$  Live and  $\text{te}\TeX$  systems this is accomplished via executing

```
texhash
```

as root.  $\text{MiK}\TeX$  users can run

```
initexmf -u
```

to accomplish the same thing.

Users not willing or able to install the files system-wide can install them in their personal directories, but will then have to provide the path (full or relative) in addition to the filename when referring to them in  $\LaTeX$ .

### III. USAGE

`IEEEtran.bst` is invoked using the normal  $\LaTeX$  bibliography commands:

```
\bibliographystyle{IEEEtran}
\bibliography{IEEEabrv,mybibfile}
```

String definition files must be loaded before any database files containing entries that utilize them — so the file names within the `\bibliography` command must be listed in a proper order.

In standard `BIBTEX` fashion, new documents will require a  $\LaTeX$  run followed by a `BIBTEX` run and then two more  $\LaTeX$  runs in order to resolve all of the references. An additional series of runs will be required as citations are added to the document.

#### A. Resource Requirements

IEEE’s bibliography style has several unique attributes that increase the complexity of `BIBTEX` styles that attempt to mimic it. Because the primary design goal of `IEEEtran.bst` is to reproduce the IEEE bibliography style as accurately and as fully as possible, `IEEEtran.bst` will consume significantly more computation resources (especially memory) during execution than many other `BIBTEX` style files. Most modern `BIBTEX` installations will be able to meet these demands without problem. However, some earlier `BIBTEX` platforms, especially those running on the MS Windows operating system, may be unable to provide the required memory space. Users who encounter `BIBTEX` resource limitations should upgrade their `BIBTEX` installation.

#### B. Nonstandard Extensions

Another, related, issue is that `IEEEtran.bst` provides extensions beyond the standard `BIBTEX` entry types and fields. These additional features are necessary for IEEE style work and were designed to closely follow the existing as well as “probable future” releases of the standard `BIBTEX` styles. Nevertheless,

users should be aware that many current `BIBTEX` styles may not be compatible with `BIBTEX` databases that employ advanced features of `IEEEtran.bst`. `BIBTEX` will generate an error if it encounters a (cited) entry type that the style file does not support, but unsupported fields within an entry will simply be ignored. For this reason, users are encouraged to keep all nonstandard entry types in a `BIBTEX` database (`.bib`) file of their own. The nonstandard `IEEEtran.bst` entry types are: (1) “electronic” which is used for internet references; (2) “patent” which is used for patents; (3) “periodical” which is used for journals and magazines; and (4) “standard” which is used for published standards.

The most important extensions to the supported fields will now be briefly mentioned.

1) *The URL Field:* Every entry type supports an optional URL entry field for documents that are available on the internet. URLs will appear at the end of the bibliography entry and preceded by the words “[Online]. Available:” as is shown in [1]. The IEEE does not place any punctuation at the end of a URL as this could be mistaken as being part of the URL. URLs are notoriously difficult to break properly. `IEEEtran.bst` places all URL text within a `\url{}` command so as to provide “plug-and-play” use with packages that provide such a command. It is strongly suggested that, when using entries with URLs, the popular  $\LaTeX$  package `url.sty` [11] is also loaded to provide some intelligence in URL line breaking. Alternatively, the `hyperref.sty` package [12] also provides a hyperlinked `\url` command (which can work in conjunction with `url.sty`).

Remember, that unless a url handling package is loaded,  $\LaTeX$  will require that special characters such as `_`, `%`, etc., be escaped (`\_`, `\%`). Failure to do so will result in compilation errors. Oren Patashnik, `BIBTEX`’s author, recommends that a URL package (such as `url.sty`) be loaded so that URLs can be conveniently entered in natural, unescaped form. The `\url` command of `hyperref.sty` version 6.72y (2002-09-12) and later also does not require unescaped URL characters. Note that it is *not* safe to escape URL characters in conjunction with `url.sty` or `hyperref.sty` as the `\url` commands of these packages will retain the backslash as-is in the formatted URL.

Users should be aware that version 1.5 and prior of `url.sty` interacts with `BIBTEX` (version 0.99c and prior) in way that can result in the anomalous appearance of “%” symbols within the URLs. To avoid this problem, be sure that the `url.sty` used is at least version 1.6. If used, `hyperref.sty` should be at least version 6.70s (2000-08-31) for the same reason. Finally, users should be aware that `hyperref` hyperlinked text, including URLs, cannot normally be broken across lines or pages under DVI (but not PDF) output. To get around this limitation, use the `breakurl.sty` package [13] with `hyperref.sty` under DVI output.

Even with intelligent URL breaking, formatting an entry with a URL can still pose challenges as URLs may contain long segments within which breaks are not possible (or at least strongly discouraged). In its publications, the IEEE deals with this problem by allowing the interword space to stretch more than usual. To accomplish this, `IEEEtran.bst` automatically engages a “super-stretch” feature for every entry that contains a URL. The interword spacing within entries that contain

URLs is allowed to stretch up to four times normal without causing underfull hbox warnings. Reference [7] illustrates this feature.

Section VII discusses how users can control the amount of allowed stretch in entries with URLs. Alternatively, the default value of this stretch factor can be adjusted via a  $\LaTeX$  command, which must be placed before the bibliography begins:

```
\newcommand\BIBentryALTinterwordstretchfactor{
2.5}
```

However, these adjustment mechanisms are of limited use for reducing the stretch factor because doing so usually just results in underfull hbox warnings. Another way to handle problem URLs is to configure `url.sty` to allow more possible break points.

2) *The Language Field*: IEEEtran.bst supports an optional language field which allows alternate hyphenation patterns to be used for the title and/or booktitle fields when these fields are in language other than the default. For examples, see Sections V-N and VI-C as they each contain a reference that uses the language field. This feature is especially important for languages that alter the spelling of words based on how they are hyphenated.

Unlike some other  $\text{BIB}_{\text{T}}\text{E}_{\text{X}}$  style files, the use of the Babel package is not required to use this feature. In fact, `Babel.sty` should *not* be loaded with `IEEEtran.cls` as the former can interfere with the latter. However, the names given in the language field must follow Babel’s convention for the names of the hyphenation patterns. See the Babel documentation for details [14].

It is a  $\text{T}_{\text{E}}\text{X}$  limitation that, to be available for use, a hyphenation pattern must be loaded within a “format file” (memory image) and, therefore, cannot be loaded when running a `.tex` file. A list of available patterns is displayed on the console each time  $\LaTeX$  is started. If a requested hyphenation pattern is not available, the default will be used and a warning will be issued. Users wishing to add hyphenation patterns will need to activate the desired ones in their

```
<texmf>/tex/generic/config/language.dat
```

file and rebuild their  $\LaTeX$  format file<sup>1</sup>. Adding hyphenation patterns does reduce the amount of memory available to  $\text{T}_{\text{E}}\text{X}$ , so it cannot be done with impunity.

Some languages may require a slightly different entry format than is done in English. For example, extra braces are needed to preserve the capitalization of the first letter of each word in German titles.

3) *Expanded Use of the Howpublished Field*: The standard  $\text{BIB}_{\text{T}}\text{E}_{\text{X}}$  styles support the `howpublished` field for the booklet and misc entry types. IEEEtran.bst extends this to also include electronic, manual, standard and techreport. The rationale for doing this is because, with these entry types, there is often a need to explain *in what form* the given work was produced. The additional information provided by `howpublished`

<sup>1</sup>On  $\text{T}_{\text{E}}\text{X}$  Live and  $\text{t}_{\text{E}}\text{X}$  systems, this can be accomplished simply by running “`fmtutil-sys --all`” as root. For  $\text{Mik}_{\text{T}}\text{E}_{\text{X}}$  users, the command “`initexmf --dump`”, or the equivalent in the  $\text{Mik}_{\text{T}}\text{E}_{\text{X}}$  GUI setup/configuration utility, will do the trick.

is placed, as given, in normal font, just after the title (or booktitle, if used) of the entry.

The IEEE exploits this feature most often for electronic references, but it has application with any entry whose exact form would be unclear without additional information (unlike optional notes which tend to be more “by the way” in nature). See Section V for more details.

### C. The `BIBdecl` Command Hook

IEEEtran.bst generated bibliographies feature a command hook (`\BIBdecl`) that is executed just prior to the first item in the bibliography list. This hook can be used to modify the default behavior of an existing bibliography environment. For example,

```
\newcommand{\BIBdecl}{\bfseries\setlength{\itemsep}{1\baselineskip plus 0.1\baselineskip minus 0.1\baselineskip}
\bibliographystyle{IEEEtran}
\bibliography{IEEEabrv,mybibfile}}
```

will result in a bibliography that is set in bold with entries that are spaced with an extra blank line (assuming they were single spaced to begin with).

### D. Use With Cross-referenced Entries

IEEE bibliographies do not normally contain references that refer to other references. Therefore, IEEEtran.bst does not format entries that use cross references (via the `crossref` field) any differently from entries that don’t. Nevertheless, it does allow the entries using the `crossref` field to silently inherit any missing fields from their respective cross-referenced entries in the standard  $\text{BIB}_{\text{T}}\text{E}_{\text{X}}$  manner. However, users who take advantage of this “parent/child” feature are cautioned that  $\text{BIB}_{\text{T}}\text{E}_{\text{X}}$  will automatically, and without warning, add a cross-referenced entry to the end of the bibliography if the number of references using the cross-reference is equal to or greater than “`min-crossrefs`”. Because such additional entries are unwanted in IEEE style, users who employ cross-referenced entries need to ensure that the cross-referenced entries are not added to the bibliography. The default value of `min-crossrefs` on most  $\text{BIB}_{\text{T}}\text{E}_{\text{X}}$  systems is two. Unfortunately, this value is set when  $\text{BIB}_{\text{T}}\text{E}_{\text{X}}$  is compiled and cannot be altered within `.bst` files. However,  $\text{BIB}_{\text{T}}\text{E}_{\text{X}}$  does offer a way to control it on the command line. Therefore, when using cross-referenced entries, users must remember to set `min-crossrefs` to a large value (greater than the number of bibliography entries) when invoking  $\text{BIB}_{\text{T}}\text{E}_{\text{X}}$ :

```
bibtex -min-crossrefs=900 myfile
```

Because cross-referenced entries must always appear after any entries that refer to them, it is recommended that the cross-referenced entries be kept in separate (`.bib`) file(s) so that they can be loaded after the other (`.bib`) database files:

```
\bibliography{IEEEabrv,mybibfile,myxrefbibs}
```

#### IV. EXAMPLES OF THE THREE MOST COMMONLY USED ENTRY TYPES

Journal articles, conference papers and books account for the vast majority of references in most IEEE bibliographies. It may be helpful to the user to briefly illustrate a simple example of each of these common entry types before divulging into ones with more complex or obscure details.

A typical journal article entry looks like

```
@article{IEEEexample:article_typical,
  author = "S. Zhang and C. Zhu and J. K. O. Sin
           and P. K. T. Mok",
  title = "A Novel Ultrathin Elevated Channel
           Low-temperature Poly-{Si} {TFT}",
  journal = IEEE_J_EDL,
  volume = "20",
  month = nov,
  year = "1999",
  pages = "569-571"
}
```

which is shown as reference [15]. Using an entry key prefix that is used only by the given database file (“IEEEexample” in the above entry) ensures that the entry key will remain unique even if multiple database files are used simultaneously. Although initials are used for the first names here, users are encouraged to use full names whenever they are known as IEEE<sub>TR</sub>AN.bst will automatically abbreviate names as needed (but BIB<sub>T</sub>E<sub>X</sub> styles that use full names will require them to be present). Likewise, it is a good idea to provide all the authors’ names rather than using “and others” to get “et al.” [16]. Section VII describes how IEEE<sub>TR</sub>AN.bst can be configured to force the use of “et al.” if the number of names exceeds a set limit.

Within the title, braces are used to preserve the capitalization of acronyms. The journal name is entered as a string that is defined in the IEEE<sub>ABR</sub>V.bib file. Not only does this approach reduce the probability of spelling mistakes, but it allows the user to instantly switch to full journal names by using the IEEE<sub>FULL</sub>.bib definitions instead (not for use with work to be submitted to the IEEE). In like fashion, the month is entered as a standard BIB<sub>T</sub>E<sub>X</sub> three letter code<sup>2</sup> so that the month format can automatically be controlled by the string (macro) month name definitions provided within every .bst file.

It is generally a good idea to also provide the journal number, but many journal article references in IEEE publications do not show the number. Section VII discusses how the user can configure IEEE<sub>TR</sub>AN.bst to ignore journal numbers for articles.

A typical paper in a conference proceedings entry looks like

```
@inproceedings{IEEEexample:conf_typical,
  author = "R. K. Gupta and S. D. Senturia",
  title = "Pull-in Time Dynamics as a Measure
           of Absolute Pressure",
  booktitle = "Proc. {IEEE} International Workshop
              on Microelectromechanical Systems
              ({MEMS}'97)",
  address = "Nagoya, Japan",
  month = jan,
  year = "1997",
  pages = "290-294"
}
```

<sup>2</sup>For reference, these are: jan, feb, mar, apr, may, jun, jul, aug, sep, oct, nov and dec.

which is shown as reference [17].

The IEEE typically prepends “Proc.” to the conference name (when forming the booktitle field):

```
booktitle = "Proc. {ECOC}'99",
```

IEEE<sub>TR</sub>AN.bst does *not* do this automatically as it may not be appropriate for every conference.

The conference entry type is also available as an alias for inproceedings. There is no functional difference between the two.

Finally, a typical book entry looks like

```
@book{IEEEexample:book_typical,
  author = "B. D. Cullity",
  title = "Introduction to Magnetic Materials",
  publisher = "Addison-Wesley",
  address = "Reading, MA",
  year = "1972"
}
```

which is shown as reference [18]. One of the unusual attributes of IEEE bibliography references is that, when formatting entries, they precede the publisher address with a period and a larger than normal space.

#### V. SUPPORTED ENTRY TYPES

The fields that are recognized by each entry type are shown at the beginning of each of the subsections below. A **bold** font indicates a required field, while a *slanted* font is used to indicate fields that are extensions that may not be supported by the standard BIB<sub>T</sub>E<sub>X</sub> styles for the given entry type.

The reader is reminded that IEEE<sub>EXAMPLE</sub>.bib file contains the actual BIB<sub>T</sub>E<sub>X</sub> entries that were used to make the references demonstrated here.

##### A. Article

**Supported fields:** **author**, **title**, *language*, **journal**, volume, number, pages, month, **year**, note, *url*.

Another typical journal article is shown in [19]. Because the referenced journal was not published by the IEEE, the IEEE<sub>ABR</sub>V.bib file will not contain the needed string definition. So, the user will either have to make his/her own supplementary string definition file, or enter the abbreviated journal name directly into the journal field. See published IEEE bibliographies for examples of how to properly abbreviate the journal name at hand. Note also how the IEEE uses small spaces to divide page (and other) numbers with five digits or more into groups of three. As mentioned previously, the display of the number field for articles can be controlled (see Section VII).

Sometimes it is desirable to put extra information into the month field such as the day, or additional months [20]. This is accomplished by using the BIB<sub>T</sub>E<sub>X</sub> concatenation operator “#”:

```
month = sep # "/" # oct,
```

1) *Articles Pending Publication*: Articles that have not yet been published can be handled as a misc type with a note [21]:

```
@misc{IEEEexample:TBPmisc,
  author      = "M. Coates and A. Hero and R. Nowak
                and B. Yu",
  title       = "Internet Tomography",
  howpublished = IEEE_M_SP,
  month       = may,
  year        = "2002",
  note        = "to be published"
}
```

(date information is optional) or they can be handled as an article type with the pending status in the year field [22]:

```
@article{IEEEexample:TBPparticle,
  author = "N. Kahale and R. Urbanke",
  title  = "On the Minimum Distance of Parallel
            and Serially Concatenated Codes",
  journal = IEEE_J_IT,
  year   = "submitted for publication"
}
```

### B. Book

**Supported fields:** **author** and/or **editor**, **title**, *language*, *edition*, *series*, *address*, **publisher**, *month*, **year**, *volume*, *number*, *note*, *url*.

Books may have authors [18], editors [23] or both [24]. Note that the standard BIB<sub>T</sub>EX styles do not support book entries with both author and editor fields, but IEEEtran.bst does.

The standard BIB<sub>T</sub>EX way of entering edition numbers is in capitalized ordinal word form:

```
edition = "Second",
```

IEEEtran.bst can automatically convert up to the tenth edition to the “Arabic ordinal” form (e.g., “2nd”) that the IEEE uses. For editions over the tenth in references that are to be used in IEEE style bibliographies, it is best to enter edition fields in the “Arabic ordinal” form (e.g., “101st”).

A book may also be part of a series and have a volume or number [25].

### C. Inbook

**Supported fields:** **author** and/or **editor**, **title**, *language*, *edition*, *series*, *address*, **publisher**, *month*, **year**, *volume*, *number*, *chapter*, *type*, *pages*, *note*, *url*.

Inbook is used to reference a part of a book, such as a chapter [26] or selected page(s) [27]. The type field can be used to override the word chapter (for which the IEEE uses the abbreviation “ch.”) when the book uses parts, sections, etc., instead of chapters

```
type = "sec.",
```

### D. Incollection

**Supported fields:** **author**, **title**, **booktitle**, *language*, *edition*, *series*, *editor*, *address*, *publisher*, *month*, **year**, *volume*, *number*, *chapter*, *type*, *pages*, *note*, *url*.

Incollection is used to reference part of a book having its own title [28]. Like book, incollection supports the series [29],

chapter and pages fields [30]. Also, the type field can be used to override the word chapter.

The IEEE sometimes uses incollection somewhat like inproceedings when the book in question is a composition of articles from various conferences [31]. For such use, the differences between incollection and inproceedings are minor — one distinctive sign is that, with incollection, the volume number appears after the date, while with inproceedings it appears before. To better support such use, IEEEtran.bst, unlike the standard BIB<sub>T</sub>EX styles, does not require a publisher field for incollection entries.

### E. Booklet

**Supported fields:** **author**, **title**, *language*, *howpublished*, *organization*, *address*, *month*, *year*, *note*, *url*.

Booklet is used for printed and bound works that are not formally published. IEEEtran.bst formats titles of booklets like articles — not like manuals and books. A primary difference between booklet and unpublished is that the former is/was distributed by some means. Booklet is rarely used in IEEE bibliographies.

### F. Manual

**Supported fields:** **author**, **title**, *language*, *edition*, *howpublished*, *organization*, *address*, *month*, *year*, *note*, *url*.

Technical documentation is handled by the manual entry type [32]. Note that the cited example places the databook part number with the title. Perhaps a more correct approach would be to put this information into the howpublished field instead [33]. However, other BIB<sub>T</sub>EX styles will probably not support the howpublished field for manuals.

### G. Inproceedings/Conference

**Supported fields:** **author**, **title**, *intype*, **booktitle**, *language*, *series*, *editor*, *volume*, *number*, *organization*, *address*, *publisher*, *month*, **year**, *paper*, *type*, *pages*, *note*, *url*.

References of papers in conference proceedings are handled by the inproceedings or conference entry types. These two types are functionally identical and can be used interchangeably.

If desired, the days of the conference can be added to the month via the BIB<sub>T</sub>EX concatenation operator “#” [34]:

```
month = dec # " 5--9",
```

Although not common with conference proceedings, the volume and number fields are also supported [35]. Note that, unlike the other entry types, the IEEE places such information prior to the date. From IEEE’s viewpoint, the location and date of the conference may form the dividing point between information related to identifying which proceedings and information that pertains to the location of the information referenced therein (pages, etc.).

IEEEtran.bst supports a paper field (a nonstandard extension) for paper numbers [36]:

```
paper = "11.3.4",
```

The type field can be used to override the default paper type (“paper”) [37]:

```
type = "postdeadline paper",
```

Section VII describes how these extensions can be disabled if desired for journals with bibliographies that tend not to display such information (while allowing the user to retain such information in the database entries for those journals that do).

There are events that happen during conferences that may not be in the written proceedings record (speeches, etc.). Sometimes it is necessary to reference such things. For these occasions, IEEE<sub>TR</sub>AN.bst supports the `intype` field (a nonstandard extension) which can override the word “in” in the reference [38]:

```
intype = "presented at the",
```

Note that when using `intype`, the `booktitle` field is no longer italicized because the book that contains the written conference record is no longer what is being referred to.

#### H. Proceedings

**Supported fields:** `editor`, **title**, *language*, *series*, *volume*, *number*, *organization*, *address*, *publisher*, *month*, **year**, *note*, *url*.

It is rare to need to reference an entire conference proceedings, but, if necessary, the proceedings entry type can be used to do so.

#### I. Mastersthesis

**Supported fields:** **author**, **title**, *language*, *type*, **school**, *address*, *month*, **year**, *note*, *url*.

Master’s (or minor) theses can be handled with the mastersthesis entry type [39]. The optional `type` field can be used to override the words “Master’s thesis” if a different designation is desired [40]:

```
type = "M. Eng. thesis",
```

#### J. Phdthesis

**Supported fields:** **author**, **title**, *language*, *type*, **school**, *address*, *month*, **year**, *note*, *url*.

The `phdthesis` entry type is used for Ph.D. dissertations (major theses) [41]. Like `mastersthesis`, the `type` field can be used to override the default designation.

#### K. Techreport

**Supported fields:** **author**, **title**, *language*, *howpublished*, **institution**, *address*, *number*, *type*, *month*, **year**, *note*, *url*.

`Techreport` is used for technical reports [42]. The optional `type` field can be used to override the default designation “Tech. Rep.” [43], [44]. This entry type is also suitable for reports about standards (use the standard entry type for complete and/or proposed standards) and changes thereof [45]. Note that some IEEE journals do not abbreviate the task group (e.g., “TGe” versus “Task Group E”).

#### L. Unpublished

**Supported fields:** **author**, **title**, *language*, *month*, *year*, **note**, *url*.

The unpublished entry type is used for documents that have not been formally published. The IEEE typically just uses “unpublished” for the required `note` field [46].

#### M. Electronic (IEEE<sub>TR</sub>AN.bst extension)

**Supported fields:** *author*, *month*, *year*, *title*, *language*, *howpublished*, *organization*, *address*, *note*, *url*.

IEEE<sub>TR</sub>AN.bst provides the electronic entry type for internet references [47], [48]. IEEE<sub>TR</sub>AN.bst also provides the aliases “online”, “internet”, “webpage” and “www” for compatibility with some existing BIB<sub>T</sub><sub>E</sub>X database and style files. However, “electronic” (or perhaps “online” for those who also use Philipp Lehman’s `biblatex` [49]) should be used for all new work. The IEEE formats electronic references differently by not using italics or quotes and separating fields with periods rather than commas. Also, the date is enclosed within parentheses and is placed closer to the title. This is probably done to emphasize that electronic references may not remain valid on the rapidly changing internet. Note also the liberal use of the `howpublished` field to describe the form or category of the entries.

The organization and address fields may also be used [50].

#### N. Patent (IEEE<sub>TR</sub>AN.bst extension)

**Supported fields:** *author*, *title*, *language*, *assignee*, *address*, **nationality**, *type*, **number**, *day*, *dayfiled*, *month*, *monthfiled*, **year** or **yearfiled**, *note*, *url*.

Patents are supported by IEEE<sub>TR</sub>AN.bst. The nationality field provides a means to handle patents from different countries [51], [52]

```
nationality = "United States",
```

or

```
nationality = "Japanese",
```

Note that, with the exception of the U.S., the word for the nationality of a patent is not usually the same as the word for the country that issued the patent. The nationality for a U.S. patent can be entered either as “U.S.” or “United States”. IEEE<sub>TR</sub>AN.bst will automatically detect and convert the latter form to “U.S.” as is done by IEEE. The nationality should be capitalized.

The assignee and address (of the assignee) fields are not used by the IEEE or IEEE<sub>TR</sub>AN.bst. However, they are provided, and proper values should be assigned to them (if known) for all patent entries as other BIB<sub>T</sub><sub>E</sub>X styles may use them.

The `type` field provides a way to override the “patent” description with other patent related descriptions such as “patent application” or “patent request” [53]:

```
type = "Patent Request",
```

In order to provide full support for both patents and patent applications, two sets of date fields are provided. One set pertains to the date the patent was granted (day, month and

year) the other pertains to the date the patent application was filed (dayfiled, monthfiled and yearfiled). There is a slight complication because the IEEE displays only one date for references of patents or patent applications. IEEEtran.bst looks for the presence of the year and yearfiled files. If the year field is present, the set pertaining to the date granted is used. Otherwise, IEEEtran.bst uses the set pertaining to the date filed.

#### O. Periodical (IEEEtran.bst extension)

**Supported fields:** editor, **title**, *language*, series, volume, number, organization, month, **year**, note, *url*.

The periodical entry type is used for journals and magazines [54].

#### P. Standard (IEEEtran.bst extension)

**Supported fields:** author, **title**, *language*, *howpublished*, **organization** or **institution**, *type*, number, *revision*, address, month, year, note, *url*.

The standard entry type is used for proposed or formally published standards [55]. For the name of the issuing entity, either the organization or institution fields can be used based on whatever the preference of the issuing entity may be. The IEEE (and thus IEEEtran.bst) does not display the address of the issuing organization/institution, but this information should be provided as other BIB<sub>T</sub>E<sub>X</sub> styles might.

The *type* field can be used to override the default description “std.” while the optional *revision* field can be used to provide a revision number [56]:

```
type      = "Working Draft Proposed Standard",
revision = "5.2",
```

Alternatively, the *misc* entry type, along with its *howpublished* field, can be used to create references of standards [57].

As mentioned in Section V-K, the technical report entry type is used for reports about, and mere revisions/changes to, standards [45]. Thanks to Guido Hiertz for providing information about how to correctly handle such reports.

#### Q. Misc

**Supported fields:** author, **title**, *language*, *howpublished*, *organization*, *address*, *pages*, month, year, note, *url*.

Misc is the most flexible type and can be used when none of the other entry types are applicable. The *howpublished* field can be used to describe what exactly (or in what form) the reference is (or appears as). Note that IEEEtran.bst, unlike the standard styles, also supports the *organization*, *address* and *pages* fields.

Possible applications include technical-report-like entries that lack an institution [58], white papers [59] and data sheets [60].

## VI. UNUSUAL TYPES OF REFERENCES

### A. Private Communication

Private communication entries can be created using the *misc* type with a note indicating “private communication” or “personal correspondence”, etc., [61].

### B. Software Packages

Because of the intangible nature of software, it is recommended that the user manual be what is actually referenced [62]. For software that is primarily distributed online, the electronic entry type may be a good choice [63]. As a last resort, the *misc* entry type can be employed.

### C. Laws and Regulations

Legal documents and laws are probably best handled by the *misc* type [64]. The *howpublished* field can handle the regulation number/description, while the *organization* field can carry the issuing body. The cited example also uses the *language* field as it is written in German.

### D. Internet RFCs

Internet “Request For Comments” (RFC) documents are usually handled via the *misc* entry type [65]. The *howpublished* field can contain the RFC number. Because of the online nature of RFCs, it is a good idea to provide a *URL* field if at all possible. Alternatively, RFCs can be handled as electronic entry types, albeit with less portability (under other .bst files).

### E. Other References

When dealing with a reference that does not fit into any of the categories of the previous examples, the best strategy is to use the closest one that fits. If that fails, fall back on the *misc* entry type.

Sometimes the most difficult step is determining *what* a particular reference actually is. Consider [66] which appeared in an IEEE journal. Now, from the appearance of this reference, one could conclude that what is being cited is an article that appeared in a journal called “Blue Book”. However, CCSDS’s Blue Books are actually a series of books, number four of which is what is being referenced. So, it might be better to use the book entry type with a series field [67]. (Also, note in this reference how the IEEE replaces author names that are identical to the previous reference with a long dash.) But, using the *author* field for organizations is not a good practice. Therefore, the manual entry type, which provides an *organization* field and does not require an *author*, might be even better [68]. The *howpublished* field is used for the Blue Book series and number.

Upon even closer inspection, one finds that Blue Book number four is actually a request for a standard! So, perhaps the best approach is to use the IEEEtran.bst entry type for standards [69].

## VII. THE IEEE<sub>TR</sub>AN BST CONTROL ENTRY TYPE

IEEEtran.bst provides a very special entry type that can be used to externally control some aspects of the bibliography style. By altering these controls, a user can make adjustments in order to (1) compensate for minor variations in the typical bibliography styles of the various IEEE journals; (2) tweak certain aspects of the produced bibliographies to better suit the particular taste of the author (within the bounds of IEEE’s standards); and (3) provide a limited means to implement

changes that might be desirable in certain types of non-IEEE related work such as theses. IEEEtran.bst is not a universal style — alterations beyond those described here are outside of the scope of IEEEtran.bst’s design. Users are cautioned that changes to some of the controls can result in a bibliography style that is no longer compliant to IEEE’s style.

In order to access the IEEEtran.bst controls, users must create an “IEEEtranBSTCTL” entry in one of their database (.bib) files:

```
@IEEEtranBSTCTL{IEEEexample:BSTcontrol,
  CTLuse_article_number = "yes",
  CTLuse_paper          = "yes",
  CTLuse_url            = "yes",
  CTLuse_forced_et_al  = "no",
  CTLmax_names_forced_et_al = "10",
  CTLnames_show_et_al = "1",
  CTLuse_alt_spacing   = "yes",
  CTLalt_stretch_factor = "4",
  CTLdash_repeated_names = "yes",
  CTLname_format_string = "{f.~}{vv~}{ll}{, jj}",
  CTLname_latex_cmd     = "",
  CTLname_url_prefix    = "[Online]. Available:"
}
```

The above example shows all of the available control fields and their default values. Only the fields that need to be changed have to be listed in a control entry — fields that are missing will not be altered. The changes are activated by citing the control entry type (in the user’s .tex file) using a special cite command which is a modified version of \nocite:

```
\bstctlcite{IEEEexample:BSTcontrol}
```

This command is provided by the IEEEtran.cls L<sup>A</sup>T<sub>E</sub>X class as well as by the IEEEtrantools.sty package [1]. Users using other class or package files will have to manually define the command in the preamble of their document:

```
\makeatletter
\def\bstctlcite{\ifnextchar[{\@bstctlcite}{\@bstctlcite[@auxout]}}
\def\bstctlcite[#1]#2{\@bsphack
  \@for\citeb=#2\do{%
    \edef\@citeb{\expandafter\@firstofone\@citeb}%
    \if@filesw\immediate\write\csname #1\endcsname{\string\citation{\@citeb}}\fi}%
  \@esphack}
\makeatother
```

The source code of \bstctlcite can also be found in the comments near the top of the IEEEtran.bst file. \bstctlcite also supports an optional argument to allow for the specification of an alternate auxiliary file. This may be useful when using packages that produce multiple bibliographies, such as multibib.sty [70]:

```
\usepackage{multibib}
.
.
\newcites{sec}{Secondary Literature}
\bstctlcite[@auxoutsec]{BSTcontrol2}
```

The default auxiliary file specifier is “@auxout”, to which multibib appends a suffix of each bibliography name given as the first argument to \newcites. Other packages may have different auxiliary file naming conventions. For those of you who know T<sub>E</sub>X, the \bstctlcite command evaluates the contents of the optional argument within a \csname ...

\endcsname construct and the resulting command sequence contains the output file number.

\bstctlcite is silent — it will not add any entry to, or affect the numbering of, the bibliography, nor will it place any citation numbers in the main text. There are two main limitations on its use:

- 1) For the unsorted BIB<sub>T</sub>E<sub>X</sub> style, it must be placed before any entries that it is to affect. Because the user will almost always want to apply the changes to all the bibliography entries, a good location is just after \begin{document}. For the sorting style, control entries will automatically be given a sort key value that will put them at the beginning of the references. If this is not desired, a control entry can be manually given a key field with a value that will result in the desired sort position.
- 2) operation is “one shot.” That is to say the same control entry cannot be used again (within the same bibliography). However, it is possible to call another control entry that uses a different key name. This behavior is directly related to the way BIB<sub>T</sub>E<sub>X</sub> allows a reference to be cited multiple times, yet still produces only one entry within the bibliography.

#### A. BST Control Entry Fields

Here is a brief description of each of the control entry fields. **CTLuse\_article\_number**: Setting this to “no” will turn off the display of the number field for articles. “yes” enables. This is useful for IEEE publications that tend not to show the number field for referenced articles, but the user wishes to include the number field in the database entries. Turning off the display of the number fields for articles can also help to give more consistent results if the database article entries are erratic in their inclusion of the number field. The default value is “yes”.

**CTLuse\_paper**: Likewise, setting this to “no” turns off the display of paper and type fields for inproceedings entries. “yes” enables. The default value is “yes”.

**CTLuse\_url**: This setting controls the display of URLs. The default value is “yes”.

**CTLuse\_forced\_et\_al**: Setting this to “yes” enables IEEEtran.bst to automatically truncate a list of author names and force the use of “et al.” if the number of authors in an entry exceeds a set limit. “no” disables. The default value is “no”.

**CTLmax\_names\_forced\_et\_al**: This value is the maximum number of names that can be present beyond which “et al.” usage is forced (if forced “et al.” is enabled). The default value is 10.

**CTLnames\_show\_et\_al**: The number of names that are shown with a forced “et al.” Must be less than or equal to CTLmax\_names\_forced\_et\_al. The default value is 1.

**CTLuse\_alt\_spacing**: Setting this to “no” will shut off the alternate interword spacing for entries with URLs. This feature may be of use to those who do not want the entries in the bibliography files (.bbl) to contain the added L<sup>A</sup>T<sub>E</sub>X code required by this feature. The default value is “yes”. Alternate interword spacing will not be used if the display of URLs is disabled regardless of the value of this setting.

**CTLalt\_stretch\_factor:** If alternate interword spacing for entries with URLs is enabled, this is the interword spacing stretch factor that will be used. For example, the default value of 4 means that the interword spacing in entries with URLs can stretch to four times normal. The given value does not have to be an integer.

**CTLDash\_repeated\_names:** Setting this to “no” turns off the use of dashes for entries with names that are identical to those of the previous entry (repeated names) [67]. May be useful for non-IEEE related work. The IEEE normally does this, so the default value is “yes”.

**CTLname\_format\_string:** This is the BIB<sub>TEX</sub> name format string that controls the format of the author and editor names. See [71] for more information. Do not alter this control for work that is to be submitted to the IEEE.

**CTLname\_latex\_cmd:** If not empty, specifies a L<sup>A</sup>T<sub>E</sub>X command, that must use a single argument, which is to process each of the (formatted) author and editor names in all the entries. For example, using

```
CTLname_latex_cmd = "\textsc"
```

will result in all of the author and editor names being rendered in the small caps font. Because the IEEE does not use a different font for names, this control should not be used for work that is to be submitted to the IEEE. The default is empty.

**CTLname\_url\_prefix:** The prefix text used before URLs (if the display of URLs is enabled). The default is “[Online]. Available:”. Note that a space will be automatically inserted after this text. If this space is not wanted, just end the string with `\relax`. Do not alter this control for work that is to be submitted to the IEEE.

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