User's Guide to AMSFonts Version 2.2

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Standard distributions of TEX ordinarily come with all the fonts specified in `plain.tex`, and they may also come with a number of additional fonts intended for use with LATEX. Additional fonts designed for use in mathematics and defined in AMS-TEX are not always included among such font collections. For this reason, the American Mathematical Society has compiled a collection, known as AMSFonts, which contains fonts of symbols and several alphabets corresponding to symbols and alphabets used in AMS publications, including the MathSci online database.

Contents of this document

1. Contents of the AMSFonts collection

The AMSFonts collection contains the following fonts, in the sizes indicated:

- The Euler family, all but `euex` in 5, 6, 7, 8, 9, and 10 point:
  - Fraktur (German), medium-weight and bold (`eufm` and `eufb`)
  - "Roman" cursive, medium-weight and bold (`eurm` and `eurb`)
  - Script, medium-weight and bold (`eusm` and `eusb`)
  - Euler-compatible extension font (`euex`), in 7, 8, 9, and 10 point
- Additional sizes of some Computer Modern math fonts (the 10-point fonts are included in standard TEX distributions):
  - bold math italic (`cmmib`), in 5, 6, 7, 8, and 9 point
  - bold math symbols (`cmbsy`), in 5, 6, 7, 8, and 9 point
  - math extension font (`cmex`), in 7, 8, and 9 point (the 10-point font is included in standard TEX distributions)

- Extra math symbols, in 5, 6, 7, 8, 9, and 10 point:
  - first series, medium-weight (`msam`)
  - second series, including Blackboard Bold, medium-weight (`msbm`)
- Cyrillic, developed at the University of Washington
  - lightface (`wncyr`), in 5, 6, 7, 8, 9, and 10 point
  - bold (`wncyb`), in 5, 6, 7, 8, 9, and 10 point
  - italic (`wncyi`), in 5, 6, 7, 8, 9, and 10 point
  - caps and small caps (`wncysc`), in 10 point
  - sans serif (`wncyss`), in 8, 9, and 10 point
  - virtual font property list (`.vpl`) files to enable the use of these fonts with alternate encodings and transliteration schemes
- Computer Modern caps and small caps (`cmcsc`), in 8 and 9 point (the 10-point font is included in standard TEX distributions)
- The "dummy font," used in $\mathcal{AMS}$-TEX for syntax checking, is provided only as metrics (`dummy.tfm`)
- Packages for using these fonts with LATEX:
  - `amsfonts`, a LATEX package for using the fonts `msam`, `msbm`, and `eufm` in LATEX
  - `amssymb`, a LATEX package for defining en masse (instead of selectively) command names for all the math symbols in the fonts `msam` and `msbm`
  - `eucal`, a LATEX package for using the Euler script font `eusm`
  - `cmmib57`, a LATEX package for adapting the font definitions for `cmmib` and `cmbsy` to scale from sizes 5,7,10 instead of sizes 5,6,7,8,9,10
  - `*.fd`, font definition files
- Macro files for using these fonts with plain TEX:
  - `amssym.tex`, a file defining the symbols in fonts `msam` and `msbm`
  - `amssym.def`, a file that loads the fonts `msam`, `msbm` and `eufm` and defines some control sequences required by `amssym.tex`
  - `cyracc.def`, a file containing definitions needed for proper access to characters in the cyrillic fonts
- Documentation files:
  - `amsfndoc.tex`, the source file for this User's Guide
  - `amsfndoc.cyr`, the source file for the table showing cyrillic input conventions, input by `amsfndoc.tex`
  - `amsfndoc.fnt`, the source file for the tables of the principal 10-point fonts in the AMSFonts collection, input by `amsfndoc.tex`; this file may also be TEXed by itself
  - `amsfndoc.def`, the macros used to format this User's Guide
  - `amsfndoc.ins`, the source file for the appendixes to this User's Guide, input by `amsfndoc.tex`; this file may also be TEXed by itself

Each font at a particular size is provided in seven standard TEX magnifications, magsteps 0 through 5, including magstephalf (except the *Textures*/Macintosh package, which only includes magnifications 0 and 1; see the installation instructions).

The philosophy under which the Euler fonts were implemented was different from that used for Computer Modern, and the result is a lower degree of "metaness". For that reason, the appearance of these fonts is not very good at small sizes when output on low-resolution devices, in particular on screens. Even so, the fonts are included in AMSFonts in all the sizes and magnifications offered, on the assumption that the printed output will be prepared on a device of higher resolution (at least 300dpi) where this effect will not be noticeable.

Font charts are given in Appendix D.

1.1. Font naming conventions

Developers of fonts for use with TeX, at least those using METAFONT, generally try to make the names distinctive, so that a user will know the origin of the font by the font name. For most of the fonts in the AMSFonts collection, the first two letters identify the font source, as follows:

- "CM": These fonts are based directly on the specifications for Knuth's Computer Modern fonts, as described in Volume E of *Computers & Typesetting* [DEK86E].
- "EU": These are members of the Euler family, described below.
- "MS": These fonts of math symbols were developed by or under the direction of the AMS staff.
- "WN": These cyrillic fonts were developed at or under the direction of the University of Washington Humanities and Arts Computing Center, and are distributed with their permission.

The font called `dummy` is a special case; it was developed as part of the Stanford University TeX Project, and follows no particular naming convention.

For information on Computer Modern fonts other than those specifically named here, and on other fonts in general, the TeX Users Group (TUG) is the best source. For TUG's address, see the section **For further information**.

2. History of these fonts

When the AMS began using TeX to produce its publications, the available complement of symbols was found to be inadequate. Several alphabets used extensively as symbols were not available either. While development of the symbols could be undertaken by in-house personnel, using the existing TeX symbol font as a model, the creation of new Fraktur and script alphabets required the assistance of someone with experience in font design.

2.1. Euler

With Donald Knuth's assistance and encouragement, Hermann Zapf, one of the premier font designers of this century, was commissioned to create designs for Fraktur and script, and for a somewhat experimental, upright cursive alphabet that would represent a mathematician's handwriting on a blackboard and that could be used in place of italic. The designs that resulted were named Euler, in honor of Leonhard Euler, a prominent mathematician of the eighteenth century. Zapf's designs were rendered in METAFONT code by graduate students at Stanford, working under Knuth's direction; the process by which the METAFONT fonts were implemented is described in a report by David Siegel [DRS85]. The Euler fonts were designed to be used as math symbols; they are not intended for setting running text.

The Fraktur face of the Euler family has been used by the AMS for several years in its production. However, no extensive test or use had been made of the script or cursive until Knuth decided that they should be used in a textbook, *Concrete Mathematics*, written by him and two co-authors [GKP88]. During the course of preparing that book, a number of errors, particularly in spacing parameters affecting the placement of sub- and superscripts, were discovered. All these errors have been corrected in the new medium-weight versions of the Euler fonts (almost no boldface symbols were used in *Concrete Mathematics*). Knuth also noticed that the style of some symbols in the Computer Modern extension font, in particular the integral sign, was too slanted to be attractive with Euler, and consequently he prepared a new (partial) extension font for use with Euler. Knuth has described his experience with the Euler fonts in a *TUGboat* article [DEK89]. In the article he also identifies the macros he used and where they can be obtained.

2.2. Additional Computer Modern fonts for use in math

Only the 10-point size of the Computer Modern bold math italic (which includes Greek), symbol, and math extension fonts are included in standard distributions of TEX. Since these symbols are often needed in mathematics, other sizes have been constructed, using the principles demonstrated in Knuth's *Computer Modern Typefaces* [DEK86E], and included in the AMSFonts collection.

2.3. Symbols

Two fonts of "extra" symbols are included in the AMSFonts collection. These are named `msam` and `msbm`, and have been newly implemented in "new" METAFONT (MF84); they replace earlier fonts (named `msxm` and `msym`) that were defined in old METAFONT (MF79). These fonts contain symbols needed in the publishing program of the AMS, including the MathSci online database, and include the uppercase letters of an alphabet known as Blackboard Bold ($\mathbb{A}, \ldots, \mathbb{Z}$).

2.4. Cyrillic

Titles of books reviewed in *Mathematical Reviews* are traditionally rendered in their original language. For books published in Russian or other Slavic languages, this frequently requires use of the cyrillic alphabet. A cyrillic font was developed at AMS using METAFONT79 with the `am` fonts as a model. This font was organized in a manner suitable for use with the transliteration scheme adopted by *MR* in 1980, and contained only those letters which appear in current mathematical literature. In particular, this meant that the letters dropped from the Russian alphabet after the Revolution of 1917, and some letters used in non-Slavic languages now rendered in cyrillic (such as Azerbaijani, from which no mathematical literature is currently reviewed in *MR*) were absent.

In 1988, the Humanities and Arts Computing Center of the University of Washington undertook a font development project for support of scholars in Slavic languages. The fonts developed through this project include several different font layouts. One layout is based on that of the original AMS cyrillic augmented with 'й' (cyrillic short 'i'), 'ë' (umlauted 'e'), and several pre-Revolutionary letters. The fonts with the AMS layout are included in the AMSFonts collection with the permission of the University of Washington developers. For information on cyrillic fonts with other layouts, see the section **For further information**.

The cyrillic fonts are based on Computer Modern letter shapes. Type styles include ordinary upright, bold (based on CM bold extended), caps and small caps, italic, and upright sans serif. The principal text fonts (upright, italic and boldface) are present in sizes from 5 through 10 point; sans serif is in sizes 8, 9 and 10 point; caps and small caps are in 10 point only.

2.5. Caps/small caps

The font `cmcsc10` is referenced in `plain.tex` and should be included in all standard TeX distributions. However, Knuth did not generate this font in any other sizes. The AMSFonts collection includes 8 and 9-point sizes, generated according to the same principles as other CM fonts of these sizes.

2.6. Dummy font

The dummy font contains no ligature or kerning information, and all dimensions and parameter values are set to zero. This is a pseudo-font, which has only general font metrics and no characters. No `.pk` or `.gf` files are needed for this font; it is provided only in `.tfm` and `.mf` form.

The dummy font is used in AMS-TeX to implement "syntax checking." (Syntax checking is activated by the `\printoptions` command as described in *The Joy of TeX* [MDS86].) In this mode, the dummy font replaces all the usual "printing" fonts, so that TeX never accumulates any text to be set, and never tries to write out a page, but in the process of reading the input file, checks all control sequences for syntactic correctness. In this mode, an input file will be processed perhaps 30 percent faster than if it were actually being set. However, some errors and conditions are not detected during a syntax check; in particular, overfull boxes cannot be detected until setting actually occurs.

3. How to use AMSFonts with LaTeX

3.1. General.

These instructions are for current LaTeX (version 2e, dated 1994 or later). If you have version 2.09 of LaTeX, dated 1993 or earlier, you must either upgrade to current LaTeX (recommended), or install version 1.1 of AMS-LaTeX and refer to its user's guide for instructions on using the AMSFonts collection.

To use the AMSFonts collection with LaTeX you choose from an assortment of LaTeX 'packages' that provide various kinds of access to the fonts, calling the packages that you need in a given document through standard LaTeX `\usepackage` statements. For example, the statement

```
\usepackage{amsfonts}
```

calls in the `amsfonts` package, which provides blackboard bold letters and selective access to the math symbol fonts `msam` and `msbm`.

The current list of packages is

amsfonts For blackboard bold letters, fraktur letters, and miscellaneous symbols.

amssymb Superset of the `amsfonts` package, defines the full set of symbol names for the `msam` and `msbm` fonts.

eufrak For fraktur letters.

eucal Makes `\mathcal` use Euler script instead of the usual Computer Modern script.

euscript Old name of the `eucal` package, now obsolete but included for convenience in printing pre-existing documents.

All of the above packages have a '`psamsfonts`' option that should be used if and only if your copy of the AMSFonts collection is the Y&Y/Blue Sky Research PostScript version. In that version, the font files are not provided in all the sizes 10,9,8,7,6,5, but only in sizes 10,7,5, with sizes 6,8,9 produced by interpolation. In practice it's easy to tell if you need to use the `psamsfonts` option: you'll get an error message about a missing `.tfm` file:

```
! Font \U/AMSa/m/n/9=msam9 not loadable: Metric (TFM) file not found.
```

where the mentioned font name is one of the AMS font names (`msam`, `msbm`, `eufm`, etc.), and the font size is 6, 8, or 9. If this happens to you, look at your `\usepackage` statements and change

`\usepackage{amssymb}` to `\usepackage[psamsfonts]{amssymb}`

or

`\usepackage{eucal}` to `\usepackage[psamsfonts]{eucal}`

and so forth.

The reason that use of the PostScript AMSfonts is explicitly marked in individual documents is that the interpolation process used for sizes 6,8,9 does not produce character metrics that are identical with those of the noninterpolated font files for those sizes. If these discrepancies were simply ignored, documents exchanged between colleagues might easily suffer unexpected changes in line breaks (and hence possibly also page breaks), *without any warnings*. As it is, if you find it necessary to add or remove the `psamsfonts` option in order to print a colleague's document, you are free to go ahead and do so, but the fact that you must make that change should be understood as a reminder that a small possibility of changed line breaks or page breaks does exist.

Similarly, a package `\cmmib57` is provided to provide analogous font definitions for the fonts `cmmib` and `cmbsy` (yes, both in the same package, despite the name), for those users who have the Y&Y/Blue Sky Research PostScript versions of those fonts. Typical usage is:

```
\documentclass{article}
```

```
\usepackage{cmmib57}
```

3.2. Blackboard bold letters (uppercase only).

The `amsfonts` package defines a 'math alphabet' command `\mathbb` for printing letters of the blackboard bold alphabet that resides in the `msbm` font. This alphabet is restricted to uppercase only (no lowercase, no numerals). The suggested method for defining a `\R` command to print a blackboard bold R is as follows:

```
\usepackage{amsfonts}
\newcommand{\R}{\mathbb{R}}
```

3.3. Extra math symbols.

The `amssymb` package defines math symbol commands for all the extra math symbols in the `msam` and `msbm` fonts, as listed in the table in §7. Thus if you want to use the `\blacktriangle` $\blacktriangle$ and `\nsubseteq` $\nsubseteq$ symbols, the easiest way is to put the statement

```
\usepackage{amssymb}
```

in the preamble of your document.

If you want more selective access to the math symbols in those fonts you can use the `amsfonts` package instead and define math symbol commands individually using LaTeX's `\DeclareMathSymbol` (cf. [LFG] or [GMS94]):

```
\usepackage{amsfonts}
\DeclareMathSymbol{\blacktriangle}{\mathord}{AMSa}{"4E}
\DeclareMathSymbol{\nsubseteq}{\mathrel}{AMSb}{"2A}
```

This alternative might be useful to you if adding the `amssymb` package to your document leads to an error message of the form

```
! TeX capacity exceeded, sorry (hash size=3000)
```

This could happen if you have an older version of TeX with a relatively low limit on the number of commands that can be defined in a single document. (But in that case, note that there may be configuration options for increasing that limit; check the documentation for your TeX system.)

3.4. Euler Fraktur letters.

A math alphabet command `\mathfrak` for using Fraktur letters such as $\mathfrak{A}$ $\mathfrak{m}$ $\mathfrak{g}$ $\mathfrak{H}$ in math can be obtained by using any of the packages `amssymb`, `amsfonts`, or `eufrak`.

3.5. Euler script letters (uppercase only).

The main purpose of the `eucal` package is to change LaTeX's `\mathcal` command so that it produces Euler script instead of Computer Modern calligraphic letters:

CM calligraphic:	$\mathcal{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$
Euler script:	$\mathscr{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$

There is also an option `mathscr` for the `eucal` package that causes Euler script to be associated to a `\mathscr` command, leaving the `\mathcal` command unaffected. This imitates the behavior of the predecessor package `euscript`.

3.6. University of Washington Cyrillic fonts.

There is no AMS package for LaTeX at the present time to support the use of Cyrillic languages in LaTeX documents with the `wncy*` fonts. Producing a proper Cyrillic package involves rather difficult questions of input and output encodings, for which it would be useful to rely on general mechanisms provided by LaTeX; and that area of LaTeX has been an area of active development, at least through the end of 1994. The only possibility that can be suggested at the present time is to consult the LaTeX documentation [LFG], [L94] and use directly the commands described there, such as `\DeclareFontFamily`, `\DeclareFontShape`, and `\symbol`. Further news on this subject will be reported in the AMSFonts `READ.ME` file as it becomes available.

4. How to use AMSFonts with AMS-TEX

In *The Joy of TEX*, Michael Spivak describes various fonts that are used in mathematics in addition to the fonts provided with the standard distributions of TEX. Two references in particular are of interest with respect to AMSFonts: the section **Fonts in math mode** in Chapter 19, and Appendix G, **Further fonts**. The first describes the use of letters from alphabets, including Fraktur, and the second, mostly nonalphabetic symbols.

Instructions for using the fonts of the AMSFonts collection with AMS-TEX are also given in the *User's Guide to AMS-TEX Version 2.1* [AMS91] and in Appendix F of editions of *The Joy of TEX* [MDS90] dated 1990 or later.

Additional fonts to be used with AMS-TEX should be specified at the top of the document input file, in what is known as the "preamble." The arrangement of commands at the top of an input file is the following:

```
\input amstex
⟨preamble commands⟩
\documentstyle{...}
```

AMS-TEX provides a simple method for accessing most of the fonts in the AMSFonts collection. The two extra symbol fonts and Euler Fraktur are loaded automatically by the preprint style (`amsppt.sty`). If you are using AMS-TEX, but not the preprint style, the method used to load these fonts and define the associated symbol names depends on how many symbols will be needed. If a lot of the symbols will be needed, or you aren't worried about memory space and just want to do what is easiest, all three fonts will be loaded and the symbol names defined if you type the command `\UseAMSsymbols` in the preamble. This will load the file `amssym.tex`, in which all the symbol names (more than 200 of them) are defined. If only a few symbols from these fonts are needed, the commands `\loadmsam`, `\loadmsbm`, and `\loadeufm` will load the medium-weight versions of the two extra symbol fonts and Euler Fraktur respectively. The command `\newsymbol` can then be used to define just those symbols that are needed; its use is described in §7 **Using the extra symbols**.*

Two sizes of fonts, suitable for body text and for passages requiring smaller type (e.g. abstracts and footnotes), are incorporated in the preprint style `amsppt.sty`. These are accessed through the control sequences `\tenpoint` and `\eightpoint`, which are ordinarily referred to only by higher-level commands that identify the kind of text being input (e.g. `\title`, `\abstract`, `\footnote`). Most fonts in the AMSFonts collection have `\load...` instructions defined in $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX and will be accessed properly for use with the preprint style when the `\load` instructions are included in the preamble of the document input. If you are not using the preprint style, you can use the font definitions in `amsppt.sty` as a model.

4.1. Euler

The Euler fonts are defined only in math mode, in sizes appropriate for text and two orders of sub- and superscripts. They can be activated by invoking the proper `\load` instructions before the `\documentstyle` command, in the preamble of a paper in which the fonts are to be used. (The medium-weight Fraktur font is activated automatically by the preprint style.) The Euler fonts can be activated by the following commands:

`\loadeufm`	Euler Fraktur medium (automatic with the preprint style)
`\loadeufb`	Euler Fraktur bold
`\loadeurm`	Euler cursive medium
`\loadeurb`	Euler cursive bold
`\loadeusm`	Euler script medium
`\loadeusb`	Euler script bold

After the `eufm` font has been loaded, the medium-weight Fraktur letters can be produced by typing `\frak` followed by the desired letter. For example, `$\frak g \frak A$` yields $\mathfrak{g}\mathfrak{A}$. $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX 2.1 also defines `\eufm`, `\eufb`, `\eurm`, `\eurb`, `\eusm` and `\eusb`

4.2. Computer Modern bold math italic and symbols

The Computer Modern bold math italic (`cmmib`) and bold math symbol (`cmbsy`) fonts can both be loaded by the command `\loadbold`; there are no predefined commands to load them separately. `\loadbold` must be invoked in the preamble of the document input file.

A rather elaborate mechanism has been defined in $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX to simplify access to bold letters and symbols, in math mode only. Three control sequences are available, each of which affects a particular class of characters:

* Additional fonts from the AMSFonts collection can be accessed easily in $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX. However, users should be aware that TEX limits the number of math mode font families to 16, of which 11 are predefined in $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX. Only those additional families should be activated that will actually be used in a document, to avoid exceeding the limit.

`\bold`	for a single letter or numeral
`\boldkey`	for other symbols that appear on the keyboard
`\boldsymbol`	for a symbol specified by a single control sequence

These facilities are described in more detail in the *User's Guide to AMS-TEX Version 2.1* [AMS91] and editions of *Joy* published in 1990 or later [MDS90].

4.3. Computer Modern math extension font

Smaller sizes of the math extension font are appropriate for use in text smaller than ten-point and in sub- and superscripts. They are provided automatically for these environments in the preprint style. If you are not using the preprint style, you can use the font definitions in either `amsppt.sty` or Appendix E of *The TEXbook* [DEK86A] as a model.

4.4. Extra symbols

The medium-weight versions of the two extra symbol fonts are available automatically, including all the symbol names, if you are using the preprint style or if you have specified `\input amssym`. If you wish to load these fonts separately, use the appropriate control sequence `\loadmsam` or `\loadmsbm` in the preamble of your document. If you load the fonts separately, a few symbols will be defined when one of the fonts is loaded, but most must be defined using the `\newsymbol` command before they can be used. See §7 **Using the extra symbols** for information on both the symbol names and on using `\newsymbol` to define them.

4.5. Cyrillic

Cyrillic is not referred to in the AMS-TEX files as distributed. The cyrillic fonts included in AMSFonts are intended for use mainly in text, not as symbols in math. Detailed instructions for loading and using cyrillic appear below in §6 **Using cyrillic**.

4.6. Caps/small caps

Caps/small caps are loaded automatically by the AMS-TEX preprint style for use in ten-point and eight-point text. If you are not using the preprint style, you can use the font definitions in either `amsppt.sty` or Appendix E of *The TEXbook* [DEK86A] as a model.

4.7. Dummy font

No special action is needed to use the dummy font with AMS-TEX. It is already built into the syntax checking procedure.

5. How to use AMSFonts with plain TEX or other macro packages

If you are not using LATEX or AMS-TEX then there are too many variables for us to provide much specific guidance. It will be necessary to assume that you either have some experience with TEX macros or have a TEXnician available to help you. However, some general guidelines may be helpful.

Two models for defining fonts should be accessible to most users:

- Appendix E of *The TEXbook* contains size-specific font definitions for `\tenpoint`, `\ninepoint` and `\eightpoint` that permit size-switching, including support of mathematics.
- `amsppt.sty`, the file of macros supporting the $\mathcal{AMS}$-TEX preprint style, contains similar font definitions, `\tenpoint` and `\eightpoint`.

The font-size-switching facilities of LATEX are not recommended as a model because they include many features (such as loading fonts on demand) that make them too complex to be easily be copied for uses outside of LATEX except by someone with substantial TEX expertise.

Before attempting to load all available fonts into every TEX job, determine (if you can) how many fonts can be accommodated by the implementation of TEX you are using. It is generally a good idea to load seldom-used fonts selectively.

5.1. Euler

The following commands will load the medium-weight Euler Fraktur font, and can be used as a model for accessing the other Euler fonts.

```
\font\teneufm=eufm10
\font\seveneufm=eufm7
\font\fiveeufm=eufm5
\newfam\eufmfam
\textfont\eufmfam=\teneufm
\scriptfont\eufmfam=\seveneufm
\scriptscriptfont\eufmfam=\fiveeufm
\def\eufm#1{{\fam\eufmfam\relax#1}}
```

Individual letters in the Euler fonts are accessible by the ordinary letters on your keyboard, once the font has been loaded and named by a control sequence equivalent to `\eufm`.

The medium-weight Fraktur font, `eufm`, can also be loaded by `\input amssym.def`; this loads the two extra symbol fonts as well.

5.2. Computer Modern bold math italic and symbols

The `cmmib` and `cmbsy` fonts can be loaded and made accessible to math in ten-point environments by the following code:

```
\font\tencmmib=cmmib10  \skewchar\tencmmib='177
\font\sevencmmib=cmmib7 \skewchar\sevencmmib='177
\font\fivecmmib=cmmib5  \skewchar\fivecmmib='177
\newfam\cmmibfam
\textfont\cmmibfam=\tencmmib \scriptfont\cmmibfam=\sevencmmib
 \scriptscriptfont\cmmibfam=\fivecmmib
```

```
\font\tencmbsy=cmbsy10  \skewchar\tencmbsy='60
\font\sevencmbsy=cmbsy7 \skewchar\sevencmbsy='60
\font\fivecmbsy=cmbsy5  \skewchar\fivecmbsy='60
\newfam\cmbsyfam
\textfont\cmbsyfam=\tencmbsy \scriptfont\cmbsyfam=\sevencmbsy
 \scriptscriptfont\cmbsyfam=\fivecmbsy
```

The TEX primitive `\mathchar` must be used to access individual characters from a font in math mode. `\mathchar`, like the `\char` primitive, requires that you know the position in the font of the character you are accessing. However, `\mathchar` also requires that you specify the "class" and the family of the math character being accessed. See Chapter 17 of *The TEXbook* for more details on the use of `\mathchar`, as well as `\mathchardef`, which will allow you to define your own macro names for individual characters in these fonts.

> **Note:** The file `amssym.def` contains a convenient macro, `\hexnumber@`, to determine the family number of the font being accessed through `\mathchar`. For example, the `\mathchar` statement to properly access the bold alpha in the CMMIB font would be:
>
> ```
> \mathchar"0\hexnumber@\cmmibfam0B
> ```

5.3. Computer Modern math extension font

The 10-point `cmex` font is loaded by `plain.tex`. To install the 7-point size appropriate for sub- and superscripts in a ten-point math environment, include the following code in your file:

```
\font\sevenex=cmex7
\scriptfont3=\sevenex \scriptscriptfont3=\sevenex
```

To use other sizes implies the use of switchable-size fonts, which may be implemented according to the models cited at the beginning of this section.

5.4. Extra symbols

Detailed instructions for accessing the `msam` and `msbm` fonts are given in §7 **Using the extra symbols**.

5.5. Cyrillic

See §6 **Using cyrillic** for instructions.

5.6. Caps/small caps

The 10-point `cmcsc` font is loaded by `plain.tex`. To use the smaller versions implies the use of switchable-size fonts, which may be implemented according to the models cited at the beginning of this section.

5.7. Dummy font

The dummy font was designed to be used for syntax checking. The general technique is described in Appendix D of *The TEXbook*, p. 401. This has been implemented in the file `amstex.tex`, which can be used as a model.

6. Using cyrillic

The cyrillic fonts in the AMSFonts collection have been designed so that input using the transliteration conventions of *Mathematical Reviews* will be converted directly to cyrillic text. Other transliteration schemes exist, as well as methods for keying directly from the keyboard to access cyrillic characters. We have included two sets of virtual fonts in this distribution, which provide access to the characters of the cyrillic fonts through the KOI-8 or Alternativnyj Variant (AV) encodings. At the present time macro support is provided only for the *Mathematical Reviews* transliteration scheme; to use one of the other encodings, you must seek support from other sources. Also, the instructions in this section are unsuitable for LATEX; they apply only to AMS-TEX, plain TEX, and other macro packages that use plain TEX font loading methods.

The following cyrillic fonts are included:

`wncyr` (upright), in sizes 5, 6, 7, 8, 9, and 10 point

`wncyb` (bold), in the same range of sizes as `wncyr`

`wncyi` (italic), in the same range of sizes as `wncyr`

`wncysc` (caps and small caps), in size 10 point

`wncyss` (upright sans serif), in sizes 8, 9, and 10 point

The file `cyracc.def`, which is included in the AMSFonts collection, must be input to any document using the cyrillic fonts as defined with the AMS layout. Since the cyrillic alphabet contains more letters than the roman alphabet, some cyrillic letters are accessed by combinations of roman letters, accented letters, or control sequences. `cyracc.def` contains the definitions of these accents and control sequences. If this file is not input, some cyrillic letters will be inaccessible.

6.1. Making cyrillic available to a document

If you are using plain TEX, include the following instructions near the top of the document input file to make the 10-point cyrillic font available for use in text (see below for cyrillic in math):

```
\input cyracc.def
\font\tencyr=wncyr10
\def\cyr{\tencyr\cyracc}
```

If you require cyrillic text in more than one size, you must take a different approach in defining `\cyr`. An appropriate model appears in Appendix E of *The TEXbook* [DEK86A], pages 414–15. The definition of `\cyr` should be incorporated into size-specific macros such as `\tenpoint` and `\eightpoint` similarly to what is done there for `\bf`. Don't forget to include the command `\cyracc` in the definition.

If you are using $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX and the preprint style, the following instructions should be included in the preamble of your document input file to make cyrillic available in 10-point and 8-point text:

```
\input cyracc.def
\catcode`\@=11
\font@\tencyr=wncyr10
\font@\eightcyr=wncyr8
\catcode`\@=13
\addto\tenpoint{\def\cyr{\tencyr\cyracc}}
\addto\eightpoint{\def\cyr{\eightcyr\cyracc}}
```

(The `\font@` command not only loads the fonts, but also makes them behave properly during syntax checking.) If you are not using the preprint style, you can use the font definitions in either `amsppt.sty` or *The TEXbook* Appendix E as a model.

The macro definitions in `cyracc.def` govern the behavior of cyrillic-specific control sequences, including accents, in cyrillic and noncyrillic text. Definitions governing noncyrillic text are activated as soon as `cyracc.def` is `\input`. This will permit text input according to the scheme shown in Figure 2 to be typeset in transliterated form, according to the *MR* conventions. To produce actual cyrillic text, enclose the cyrillic input in a group that begins with the instruction `\cyr` *inside* the group, as

```
...{\cyr ...} ...
```

Enclosing in braces both the `\cyr` and the text to be set in cyrillic type, in the same way that an italic phrase would be indicated in a roman text, is particularly important for two reasons. First, like `\it`, `\cyr` must be explicitly terminated to return to roman text. And second, unlike `\it`, the special cyrillic control sequences invoked by `\cyracc` are interpreted differently by TEX depending on whether they are in a cyrillic or a noncyrillic environment. The "cyrillic" interpretation is not turned off simply by invoking `\rm`. Failure to follow this practice will yield gibberish.

6.2. Cyrillic input

The table in Figure 2 follows the alphabetical order of the table published in the 1983 MR author index. The three paired columns contain: (1) Cyrillic; (2) Input; (3) Transliteration.

The letters in the Cyrillic columns will appear in the typeset output when the corresponding codes from the Input columns are used in the `{\cyr ...}` context described above. The roman letters in the Transliteration columns will appear in the output when the corresponding codes from the Input columns are used in a noncyrillic environment, i.e., have not been preceded by `\cyr`.

FIGURE 2. Input conventions for AMS cyrillic

Cyrillic		Input		Translit.		Cyrillic		Input		Translit.	
А	а	`A`	`a`	A	a	Р	р	`R`	`r`	R	r
Б	б	`B`	`b`	B	b	С	с	`S`	`s`	S	s
В	в	`V`	`v`	V	v	Т	т	`T`	`t`	T	t
Г	г	`G`	`g`	G	g	Ћ	ћ	`\'C`	`\'c`	Ć	ć
Д	д	`D`	`d`	D	d	Ќ	ќ	`\'K`	`\'k`	Ḱ	ḱ
Ђ	ђ	`Dj`	`dj`	Dj	dj	У	у	`U`	`u`	U	u
Ѓ	ѓ	`\'G`	`\'g`	Ǵ	ǵ	Ў	ў	`\u U`	`\u u`	Ŭ	ŭ
Е	е	`E`	`e`	E	e	Ф	ф	`F`	`f`	F	f
Ё	ё	`\"E`	`\"e`	Ë	ë	Х	х	`Kh`	`kh`	Kh	kh
Є	є	`\=E`	`\=e`	Ē	ē	Ц	ц	`Ts`	`ts`	Ts	ts
Ж	ж	`Zh`	`zh`	Zh	zh	Ч	ч	`Ch`	`ch`	Ch	ch
З	з	`Z`	`z`	Z	z	Џ	џ	`\Dzh`	`\dzh`	Dzh·	dzh·
И	и	`I`	`i`	I	i	Ш	ш	`Sh`	`sh`	Sh	sh
І	і	`\=I`	`\=\i`	Ī	ī	Щ	щ	`Shch`	`shch`	Shch	shch
Ї	ї	`\"I`	`\"\i`	Ï	ï	Ъ	ъ	`\Cdprime`	`\cdprime`	″̲	″
Ј	ј	`J`	`j`	J	j	Ы	ы	`Y`	`y`	Y	y
Й	й	`\u I`	`\u\i`	Ĭ	ĭ	Ь	ь	`\Cprime`	`\cprime`	′	′
К	к	`K`	`k`	K	k	Э	э	`` \`E ``	`` \`e ``	È	è
Л	л	`L`	`l`	L	l	Ю	ю	`Yu`	`yu`	Yu	yu
Љ	љ	`Lj`	`lj`	Lj	lj	Я	я	`Ya`	`ya`	Ya	ya
М	м	`M`	`m`	M	m	Ѕ	ѕ	`\Dz`	`\dz`	Dz	dz
Н	н	`N`	`n`	N	n	№		`NO`		NO	
Њ	њ	`Nj`	`nj`	Nj	nj	«		`<`		¡	
О	о	`O`	`o`	O	o	»		`>`		¿	
П	п	`P`	`p`	P	p			`\cydot`		·	

Several points should be noted here.

- Input codes for uppercase cyrillic which consist of more than one letter, e.g. `Zh` ↦ Ж, can also be input in all caps, e.g. `ZH` ↦ Ж, if the context is entirely in caps.
- Particular care is necessary when the letter t ↦ т is followed by s ↦ с. The control sequence `\cydot` ("cyrillic dot") is provided as a separator to keep those letters distinct: `t\cydot s` (t·s) ↦ тс. Otherwise, they will be combined as ts ↦ ц.

  The t·s pair appears, for example, in the word `sovet\cydot ski\u\i` (sovet·skiĭ) ↦ советский and is not uncommon in the suffix of reflexive verbs, e.g. `nakhodyat\cydot sya` (nakhodyat·sya) ↦ находятся.
- Because there is not a one-to-one correspondence between cyrillic and roman letters, some cyrillic letters have been placed in locations where a roman letter

does not have a cyrillic counterpart. A user who is aware of this fact may be able to detect input keying that does not conform to the recommendations shown in Figure 2, and correct it more easily than otherwise. The following nonstandard assignments have been made:

`c` ↦ ц; `h` ↦ х; `q` ↦ ч; `w` ↦ щ; `x` ↦ ш.

- Some very strange effects can occur in cyrillic text hyphenated by the default English hyphenation rules; in particular, a cyrillic letter input as a group of letters can be decomposed. (Most multiple-letter input groups are converted to a single cyrillic letter by way of TeX's ligaturing mechanism.) For example, `shch` ↦ щ might, in especially unlucky circumstances, be decomposed as с-хч, ш-ч or 7-х. In other words, if there is any chance that cyrillic text might fall into a position where hyphenation could occur, the results should be checked very carefully, and discretionary hyphens used as appropriate.
- Hyphenation patterns do not exist for the AMS cyrillic font when the input conventions shown here are used. Furthermore, it is probably impracticable to attempt to develop such rules, since the rules to recognize control sequences and complicated ligatures, both used extensively by the AMS cyrillic input conventions, are not easily specified to TeX's hyphenation mechanism. Another approach to hyphenation, requiring some changes to the cyrillic `.tfm` files, has been described by Dimitri Vulis in a *TUGboat* article [DLV89].

6.3. Cyrillic in math

Although the cyrillic fonts are intended for use as text, the need occasionally arises to use one or two letters in math; for example, Ш may be used to represent the Shafarevich group. When cyrillic must also be made available to math mode, the following instructions (which will support the use of cyrillic in both text and math) should replace the definition of `\cyr` shown previously (which will work only for text):

```
\newfam\cyrfam
\font\tencyr=wncyr10
\font\sevencyr=wncyr7
\font\fivecyr=wncyr5
\def\cyr{\fam\cyrfam\tencyr\cyracc}
\textfont\cyrfam=\tencyr \scriptfont\cyrfam=\sevencyr
  \scriptscriptfont\cyrfam=\fivecyr
```

If only the 10-point cyrillic font has been accessed, the references to `\sevencyr` and `\fivecyr` can be changed to `\tencyr` to save memory. When using AMS-TeX and the preprint style, use `\font@` instead of `\font`, remembering to change the `\catcode` of the `@` appropriately, and embed the font family specifications in `\addto\tenpoint`, as shown above.

If other base text sizes are used besides ten point, the suggestions given above under **Making cyrillic available** apply here as well.

7. Using the extra symbols

Most users of the extra symbol fonts will probably want to make them accessible to their TEX jobs with the least possible fuss. For AMS-TEX users, these fonts are available automatically with the preprint style, and other methods of loading them for use with AMS-TEX are described above.

If you are not using AMS-TEX, the easiest method of loading these fonts and defining the control sequences for accessing the symbols is to place the command

```
\input amssym.tex
```

at the top of your input file. This will load the fonts `msam`, `msbm`, and `eufm` in sizes 10, 7, and 5 point, suitable for use in ordinary ten-point math environments, and define the names of all the symbols in these fonts. However, this assigns more than 200 control sequence names, so if you are limited for space, an alternative method may be preferred.

If you type just `\input amssym.def`, the fonts will be loaded, but only the names of the few special symbols listed below will be defined.

First there are four symbols that are normally used outside of math mode:

✓	`\checkmark`	®	`\circledR`
✠	`\maltese`	¥	`\yen`

These symbols, like ¶, §, †, and ‡, can also be used in math mode, and will change sizes correctly in subscripts and superscripts.

Next are four symbols that are "delimiters" (although there are no larger versions obtainable with `\left` and `\right`), so they must be used in math mode:

$\ulcorner$	`\ulcorner`	$\urcorner$	`\urcorner`
$\llcorner$	`\llcorner`	$\lrcorner$	`\lrcorner`

Finally, two dashed arrows are constructed from symbols in this family (note that one of them has two names; it can be accessed by either one):

$\dashrightarrow$	`\dashrightarrow`, `\dasharrow`	$\dashleftarrow$	`\dashleftarrow`

The Blackboard Bold letters $\mathbb{A}, \ldots, \mathbb{Z}$ can be accessed by typing (in math mode) `\Bbb A`,. . . ,`\Bbb Z`.

Wider versions of the `plain.tex` `\widehat` and `\widetilde` are now available.

Letters in the `eufm` font can be accessed (in math mode) by typing, for example, `\frak A \frak g` to get $\mathfrak{A}\mathfrak{g}$. For the other Euler fonts, see the various "Euler" subsections under the sections for different macro packages (LATEX, AMS-TEX, plain TEX).

7.1. The `\newsymbol` command

All other symbols of the `msam` and `msbm` fonts must be named by control sequences so that they can be used (in math mode only) when the fonts are loaded. If you are very short on space for control sequence names, and need only a few of these symbols, you can omit the loading of `amssym.tex` and instead assign only the names you will need by using the command `\newsymbol` for each symbol you need, to create a control sequence that will properly produce that symbol. The control sequence can be either the "standard" name, as listed below, or one of your own choosing.

The list of symbols below shows for each symbol the symbol itself, a four-character "ID," and the "standard" name of the symbol. (The first character of the ID identifies the font family in which a symbol resides. Symbols from the `msam` family have `1` as the first character; symbols from the `msbm` family have `2` as the first character.) For example, the symbol $\nleqslant$ appears as

$\nleqslant$ `230A \nleqslant`

To produce a control sequence with this name, the instruction

```
\newsymbol\nleqslant 230A
```

appears in the file `amssym.tex`. This same instruction can be typed by a user who is not using the $\mathcal{AMS}$-TEX preprint style and has chosen not to load all the symbols, and thereafter the control sequence `\nleqslant` will produce the symbol $\nleqslant$ (in math mode), and will act properly as a "binary relation."

A few symbols in these fonts replace symbols defined in `plain.tex` by combinations of symbols available in the Computer Modern fonts. These are `\angle` ($\angle$) and `\hbar` ($\hbar$) from the group "Miscellaneous symbols," and `\rightleftharpoons` ($\rightleftharpoons$) from the group "Arrows" below. The new symbols will change sizes correctly in subscripts and superscripts, provided that you are using appropriate redefinitions. In order to use `\newsymbol` to replace an existing definition, the name must first be "undefined." Here are the lines you must put in your file if you are not using the $\mathcal{AMS}$-TEX preprint style or `\input amssym` (which perform the redefinition automatically):

```
\undefine\angle
\newsymbol\angle 105C
\undefine\hbar
\newsymbol\hbar 207E
\undefine\rightleftharpoons
\newsymbol\rightleftharpoons 130A
```

These symbols are flagged in the tables below with a "(U)," as a reminder that they must be undefined.

Note in the tables that some symbols are shown with two names; in such a case, either one can be used to access the symbol.

- **Lowercase Greek letters**

$\digamma$	`207A \digamma`	$\varkappa$	`207B \varkappa`

- **Hebrew letters**

$\beth$	`2069 \beth`	$\gimel$	`206A \gimel`
$\daleth$	`206B \daleth`		

- **Miscellaneous symbols**

$\hbar$	207E	\hbar (U)	$\backprime$	1038	\backprime
$\hslash$	207D	\hslash	$\varnothing$	203F	\varnothing
$\vartriangle$	134D	\vartriangle	$\blacktriangle$	104E	\blacktriangle
$\triangledown$	104F	\triangledown	$\blacktriangledown$	1048	\blacktriangledown
$\square$	1003	\square	$\blacksquare$	1004	\blacksquare
$\lozenge$	1006	\lozenge	$\blacklozenge$	1007	\blacklozenge
$\circledS$	1073	\circledS	$\bigstar$	1046	\bigstar
$\angle$	105C	\angle (U)	$\sphericalangle$	105E	\sphericalangle
$\measuredangle$	105D	\measuredangle			
$\nexists$	2040	\nexists	$\complement$	107B	\complement
$\mho$	2066	\mho	$\eth$	2067	\eth
$\Finv$	2060	\Finv	$\diagup$	201E	\diagup
$\Game$	2061	\Game	$\diagdown$	201F	\diagdown
$\Bbbk$	207C	\Bbbk			

- **Binary operators**

$\dotplus$	1275	\dotplus	$\ltimes$	226E	\ltimes
$\smallsetminus$	2272	\smallsetminus	$\rtimes$	226F	\rtimes
$\Cap$	1265	\Cap, \doublecap	$\leftthreetimes$	1268	\leftthreetimes
$\Cup$	1264	\Cup, \doublecup	$\rightthreetimes$	1269	\rightthreetimes
$\barwedge$	125A	\barwedge	$\curlywedge$	1266	\curlywedge
$\veebar$	1259	\veebar	$\curlyvee$	1267	\curlyvee
$\doublebarwedge$	125B	\doublebarwedge			
$\boxminus$	120C	\boxminus	$\circleddash$	127F	\circleddash
$\boxtimes$	1202	\boxtimes	$\circledast$	127E	\circledast
$\boxdot$	1200	\boxdot	$\circledcirc$	127D	\circledcirc
$\boxplus$	1201	\boxplus	$\centerdot$	1205	\centerdot
$\divideontimes$	223E	\divideontimes	$\intercal$	127C	\intercal

- **Binary relations**

$\leqq$	1335	\leqq	$\geqq$	133D	\geqq
$\leqslant$	1336	\leqslant	$\geqslant$	133E	\geqslant
$\eqslantless$	1330	\eqslantless	$\eqslantgtr$	1331	\eqslantgtr
$\lesssim$	132E	\lesssim	$\gtrsim$	1326	\gtrsim
$\lessapprox$	132F	\lessapprox	$\gtrapprox$	1327	\gtrapprox
$\approxeq$	2375	\approxeq			
$\lessdot$	236C	\lessdot	$\gtrdot$	236D	\gtrdot
$\lll$	136E	\lll, \llless	$\ggg$	136F	\ggg, \gggtr
$\lessgtr$	1337	\lessgtr	$\gtrless$	133F	\gtrless
$\lesseqgtr$	1351	\lesseqgtr	$\gtreqless$	1352	\gtreqless
$\lesseqqgtr$	1353	\lesseqqgtr	$\gtreqqless$	1354	\gtreqqless
$\doteqdot$	132B	\doteqdot, \Doteq	$\eqcirc$	1350	\eqcirc
$\risingdotseq$	133A	\risingdotseq	$\circeq$	1324	\circeq
$\fallingdotseq$	133B	\fallingdotseq	$\triangleq$	132C	\triangleq

$\backsim$	1376	\backsim	$\thicksim$	2373	\thicksim
$\backsimeq$	1377	\backsimeq	$\thickapprox$	2374	\thickapprox
$\subseteqq$	136A	\subseteqq	$\supseteqq$	136B	\supseteqq
$\Subset$	1362	\Subset	$\Supset$	1363	\Supset
$\sqsubset$	1340	\sqsubset	$\sqsupset$	1341	\sqsupset
$\preccurlyeq$	1334	\preccurlyeq	$\succcurlyeq$	133C	\succcurlyeq
$\curlyeqprec$	1332	\curlyeqprec	$\curlyeqsucc$	1333	\curlyeqsucc
$\precsim$	132D	\precsim	$\succsim$	1325	\succsim
$\precapprox$	2377	\precapprox	$\succapprox$	2376	\succapprox
$\vartriangleleft$	1343	\vartriangleleft	$\vartriangleright$	1342	\vartriangleright
$\trianglelefteq$	1345	\trianglelefteq	$\trianglerighteq$	1344	\trianglerighteq
$\vDash$	130F	\vDash	$\Vdash$	130D	\Vdash
$\Vvdash$	130E	\Vvdash			
$\smallsmile$	1360	\smallsmile	$\shortmid$	2370	\shortmid
$\smallfrown$	1361	\smallfrown	$\shortparallel$	2371	\shortparallel
$\bumpeq$	136C	\bumpeq	$\between$	1347	\between
$\Bumpeq$	136D	\Bumpeq	$\pitchfork$	1374	\pitchfork
$\varpropto$	135F	\varpropto	$\backepsilon$	237F	\backepsilon
$\blacktriangleleft$	134A	\blacktriangleleft	$\blacktriangleright$	1349	\blacktriangleright
$\therefore$	1329	\therefore	$\because$	132A	\because

- **Negated relations**

$\nless$	2304	\nless	$\ngtr$	2305	\ngtr
$\nleq$	2302	\nleq	$\ngeq$	2303	\ngeq
$\nleqslant$	230A	\nleqslant	$\ngeqslant$	230B	\ngeqslant
$\nleqq$	2314	\nleqq	$\ngeqq$	2315	\ngeqq
$\lneq$	230C	\lneq	$\gneq$	230D	\gneq
$\lneqq$	2308	\lneqq	$\gneqq$	2309	\gneqq
$\lvertneqq$	2300	\lvertneqq	$\gvertneqq$	2301	\gvertneqq
$\lnsim$	2312	\lnsim	$\gnsim$	2313	\gnsim
$\lnapprox$	231A	\lnapprox	$\gnapprox$	231B	\gnapprox
$\nprec$	2306	\nprec	$\nsucc$	2307	\nsucc
$\npreceq$	230E	\npreceq	$\nsucceq$	230F	\nsucceq
$\precneqq$	2316	\precneqq	$\succneqq$	2317	\succneqq
$\precnsim$	2310	\precnsim	$\succnsim$	2311	\succnsim
$\precnapprox$	2318	\precnapprox	$\succnapprox$	2319	\succnapprox
$\nsim$	231C	\nsim	$\ncong$	231D	\ncong
$\nshortmid$	232E	\nshortmid	$\nshortparallel$	232F	\nshortparallel
$\nmid$	232D	\nmid	$\nparallel$	232C	\nparallel
$\nvdash$	2330	\nvdash	$\nvDash$	2332	\nvDash
$\nVdash$	2331	\nVdash	$\nVDash$	2333	\nVDash
$\ntriangleleft$	2336	\ntriangleleft	$\ntriangleright$	2337	\ntriangleright
$\ntrianglelefteq$	2335	\ntrianglelefteq	$\ntrianglerighteq$	2334	\ntrianglerighteq
$\nsubseteq$	232A	\nsubseteq	$\nsupseteq$	232B	\nsupseteq
$\nsubseteqq$	2322	\nsubseteqq	$\nsupseteqq$	2323	\nsupseteqq
$\subsetneq$	2328	\subsetneq	$\supsetneq$	2329	\supsetneq

$\varsubsetneq$	2320	`\varsubsetneq`	$\varsupsetneq$	2321	`\varsupsetneq`
$\subsetneqq$	2324	`\subsetneqq`	$\supsetneqq$	2325	`\supsetneqq`
$\varsubsetneqq$	2326	`\varsubsetneqq`	$\varsupsetneqq$	2327	`\varsupsetneqq`

- **Arrows**

$\leftleftarrows$	1312	`\leftleftarrows`	$\rightrightarrows$	1313	`\rightrightarrows`
$\leftrightarrows$	131C	`\leftrightarrows`	$\rightleftarrows$	131D	`\rightleftarrows`
$\Lleftarrow$	1357	`\Lleftarrow`	$\Rrightarrow$	1356	`\Rrightarrow`
$\twoheadleftarrow$	1311	`\twoheadleftarrow`	$\twoheadrightarrow$	1310	`\twoheadrightarrow`
$\leftarrowtail$	131B	`\leftarrowtail`	$\rightarrowtail$	131A	`\rightarrowtail`
$\looparrowleft$	1322	`\looparrowleft`	$\looparrowright$	1323	`\looparrowright`
$\leftrightharpoons$	130B	`\leftrightharpoons`	$\rightleftharpoons$	130A	`\rightleftharpoons` (U)
$\curvearrowleft$	2378	`\curvearrowleft`	$\curvearrowright$	2379	`\curvearrowright`
$\circlearrowleft$	1309	`\circlearrowleft`	$\circlearrowright$	1308	`\circlearrowright`
$\Lsh$	131E	`\Lsh`	$\Rsh$	131F	`\Rsh`
$\upuparrows$	1314	`\upuparrows`	$\downdownarrows$	1315	`\downdownarrows`
$\upharpoonleft$	1318	`\upharpoonleft`	$\upharpoonright$	1316	`\upharpoonright`, `\restriction`
$\downharpoonleft$	1319	`\downharpoonleft`	$\downharpoonright$	1317	`\downharpoonright`
$\multimap$	1328	`\multimap`	$\rightsquigarrow$	1320	`\rightsquigarrow`
$\leftrightsquigarrow$	1321	`\leftrightsquigarrow`			

- **Negated arrows**

$\nleftarrow$	2338	`\nleftarrow`	$\nrightarrow$	2339	`\nrightarrow`
$\nLeftarrow$	233A	`\nLeftarrow`	$\nRightarrow$	233B	`\nRightarrow`
$\nleftrightarrow$	233D	`\nleftrightarrow`	$\nLeftrightarrow$	233C	`\nLeftrightarrow`

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Appendix A
PC Installation Guide

A.1. Introduction

AMSFonts are a set of fonts which were developed at the American Mathematical Society (except the cyrillic fonts, which were developed at the University of Washington), for use with the TEX typesetting system. These fonts were intended for use with the AMS-TEX or AMS-LATEX macro packages, but they can be used with plain TEX, independently of these packages.

AMSFonts can be used with any full implementation of TEX. The installation procedure automatically installs the fonts on your IBM PC or compatible machine. In this guide, it is assumed that you have TEX installed on your PC, and that you have at least some familiarity with it.

A.2. If you have AMSFonts 2.2 but not AMS-TEX

If you obtained AMSFonts without the AMS-TEX 2.0+ macro package,* then you will first need to place the diskette labeled `AMSFonts 2.2 TFM files` into drive A (or drive B, in which case you will substitute “b” for “a” in the following command), and copy the TFM files into the directory where your other TFM files are stored. The name of that directory will vary depending on the implementation of TEX which you are using. For example, if you are using PCTEX, then you would enter

```
copy a:\tfm  c:\pctex\textfms    ⟨return⟩
```

to copy the TEX font metric (TFM) files to your hard disk. If you are using an implementation of TEX other than PCTEX, you will substitute the name of your TFM directory for `\pctex\textfms`, and if you have TEX installed on a drive other than C, you will substitute its drive name for “c:” in the above command. After copying the TFM files, proceed with Section A.4.

A.3. If you have AMS-TEX 2.0+

The TFM files are installed automatically as part of the installation of AMS-TEX 2.0+. If you have not yet installed AMS-TEX 2.0+, you should either install it or perform step A.2 above before you proceed with section A.4.

A.4. How much disk space do you need?

The amount of disk space required for installation of the AMSFonts depends on the resolution of your output device and on which families of fonts you choose to install. The fonts have been divided into five families for the installation, and you may choose any or all of these families to install. Also, you may choose to

* AMS-TEX 2.0+ refers to any release of AMS-TEX from version 2.0 forward.

install all of the magnifications or only magnifications 100%, 109.5% and 120% (TEX magsteps 0, $\frac{1}{2}$ and 1). For a more complete description of these families and magnifications, please see the appropriate sections of the *AMSFonts 2.2 User's Guide*. (Note: If you do not have a printed copy of the *User's Guide*, you may use the files `amsfndoc.*` on the TFM disk to produce it with TEX. However, you will not be able to print the entire document correctly until after you have installed AMSFonts.)

The following table lists all of the families and the disk space required for their installation. Before you begin the installation, decide which fonts and which magnifications you will choose, and make sure that you have enough disk space available.

Approximate Disk Space Required for AMSFonts Installation

		Extra CM	Euler Fraktur	Other Euler	Extra Symbols	Cyrillic	All Fonts
118dpi	100% thru 120%	200K	150K	350K	150K	250K	1100K
	all mags	550K	350K	850K	450K	750K	2950K
180dpi	100% thru 120%	250K	150K	350K	200K	300K	1250K
	all mags	750K	450K	950K	650K	1000K	3800K
240dpi	100% thru 120%	300K	150K	350K	250K	400K	1450K
	all mags	900K	500K	1000K	800K	1200K	4400K
300dpi	100% thru 120%	350K	200K	450K	350K	500K	1850K
	all mags	1100K	700K	1300K	1000K	1500K	5600K
400dpi	100% thru 120%	450K	250K	500K	400K	550K	2150K
	all mags	1450K	825K	1625K	1250K	1850K	7000K

A.5. Where do you put the fonts?

Now you will need to copy the .pk files which are the actual raster images for the fonts. These are spread over several disks (the actual number depends on the resolution of the output device), in seven directories. These seven directories represent the fonts at seven different magnifications available in TEX: \magstep 0, $\frac{1}{2}$, 1, 2, 3, 4, and 5. The directories are labeled `\amsfonts\dpiXXX`, where `XXX` is the resolution of the output device multiplied by the magnification. (The number is rounded to the nearest integer.) For example, the subdirectory containing raster images for 300 dot per inch output at \magstep1 (120%) will be called `\dpi360`, since 300 multiplied by 1.2 equals 360.

To install the fonts, find where the .pk files for your other fonts are stored on your hard disk. This is determined by the needs of the device driver which will read the fonts. If you are installing these fonts for screen previewing they should go where your previewer will find them. If you are installing the fonts for printing they should go where your printer driver can find them.

If you are using a device driver from Personal TEX, Inc., then most likely your other TEX fonts are stored in subdirectories of `\pctex\pixel`. If you are using a device driver from ArborText, then most likely your other TEX fonts are stored in subdirectories of `\texpixel\cmpixel`. If your device driver is made by someone other than these two companies you will need to consult the documentation of that device driver in order to find the directory where it looks for .pk files of the fonts which it uses.

A.6. Running the installation procedure

When you have determined where you are going to put the fonts, insert the first of the disks labeled `AMSFonts 2.2 XXXdpi` (where `XXX` is the resolution of your output device) into drive A or drive B, and type the following commands (if you put the disk in drive B, you will substitute 'b' for 'a' in the first command):

a:	⟨return⟩
install	⟨return⟩

You will be asked a number of questions. First, you will have to give the name of the hard drive on which you will install the fonts. Then, you will be asked for the name of the directory where you want the fonts to be placed. Next, you will be asked whether you wish to install all of the magnifications or only the magnifications 100%, 109.5%, and 120%. Finally, you will be asked whether you wish to install all of the families of fonts or only certain families. (If you skipped Section A.4 above, please go back and read it.)

Once you have answered all of the questions, you will be prompted to insert the remaining disks of the distribution. The .pk files will be placed in subdirectories of the specified font directory, named `\dpiXXX`, where `XXX` again represents the resolution multiplied by the magnification.

A.7. Font definition files for LaTeX

If you intend to use the AMSFonts collection with LaTeX then you will need to copy all the provided `.fd` files to your LaTeX input files area. The `.fd` files are font definition files that set up the correspondence between external font names and the naming scheme that is used internally by LaTeX.

Note that there are two sets of font definition files provided. The files that contain `57` in their names are tailored to a PostScript version of the AMSFonts collection produced jointly by Y&Y and Blue Sky Research. In that version, font sizes 6,8,9 are produced by interpolation from neighboring sizes instead of having separate font metric files. Selection of the PostScript or non-PostScript `.fd` files for individual documents is handled through the LaTeX package option mechanism, as described in §3 **How to use AMSFonts with LaTeX**.

A.8. Additional notes for users of AMSFonts

The device driver with which you are using these fonts may have a font table which needs to be updated in order for the driver to recognize the fonts. For instance, the TEX Preview software provided by ArborText has a file called `preview.fnt` which contains the names of all fonts which the Preview program is expected to find, and the effective resolutions (resolution multiplied by magnification) at which to find them. In order to use AMSFonts with this, or any other software which uses such a table, you must enter the names of each of the fonts in the AMSFonts package and the effective resolutions at which you have them installed. The file `amsfonts.lst` on the first distribution disk contains a list of all of the font names and all of the resolutions contained in your distribution. You may have to alter the format of this file to make it conform to your driver's needs or to reflect installation of only some of the fonts, but it provides you with the necessary data. See the documentation for your device driver to see what format is required. If your device driver does not depend on such a table, this step is not necessary.

Appendix B
Textures / Macintosh Installation Guide

B.1. Introduction

AMSFonts are a set of fonts which were developed at the American Mathematical Society (except the cyrillic fonts, which were developed at the University of Washington), for use with the TEX typesetting system. These fonts were intended for use with the AMS-TEX or AMS-LATEX macro packages, but they can be used with plain TEX, independently of these packages.

This distribution is designed for use with the *Textures* software on the Macintosh computer. These fonts require *Textures* version 1.2 or higher. If you have an earlier release of *Textures*, you must upgrade before using these fonts. To upgrade *Textures*, contact the manufacturer: Blue Sky Research, 534 SW Third Ave., Portland, OR 97204; (800) 622-8398. In this guide, it is assumed that you have a recent version of *Textures* installed on your Macintosh, and that you have at least some familiarity with it and with *The TEXbook*.

Before you begin the installation you should first backup to diskette all files from previous releases of AMSFonts that are on your hard disk. Once you are sure that you have backed up all files containing previous releases of AMSFonts, delete them from your hard disk. You may have serious font ID conflicts if you do not do this. (See Section B.4.2 for an explanation.)

B.2. Installation Procedure

B.2.1. What is on the diskettes?

The distribution contains three diskettes. The first disk contains a folder with some *Textures* files, the file `AMSFonts 2.2 metrics`, and the cyrillic text fonts. The `Textures files` folder contains eight files. Most of these files are explained in the *AMSFonts 2.2 User's Guide*. The TEX source for the user's guide is in the files `amsfndoc.*` in the `Textures files` folder. The file `amsfndoc.ins` is the TEX source for the installation guide you are now reading.

The second disk contains the extra CM fonts and the AMS Symbol fonts (MSAM and MSBM). The third disk contains the Euler fonts: Euler Fraktur (EUFB and EUFM), Euler Roman (EURB and EURM), Euler Script (EUSB and EUSM), and Euler Extension (EUEX).

B.2.2. How much space do you need?

Fonts take up lots of disk space. AMSFonts includes 89 fonts, each at either four or six resolutions (see Section B.4.1 for an explanation). The distribution takes up nearly four megabytes when installed. The table below shows the disk space required for each font suitcase file in this distribution. Consult it to make sure that you have enough space on your hard disk to install the fonts you need.

Approximate Disk Storage Requirements

1600K	Extra CM fonts and AMS Symbol fonts
288K	Euler Fraktur fonts
1150K	All other Euler fonts
986K	Cyrillic fonts

Since you will be installing new fonts it would be wise to review the portions of the *Textures* manual relating to fonts. *Textures* has a complex method of including fonts and you should understand it before attempting to install or use AMSFonts. You may also wish to read the *AMSFonts 2.2 User's Guide* to decide which families of fonts you need to install. If you retrieved this distribution electronically and have no printed copy of the user's guide, you can find the TEX source for that document in the files `amsfndoc.*` in the `Textures files` folder on the first distribution disk.

B.2.3. Installing the fonts.

1. Copy the file `AMSFonts 2.2 metrics` from the first distribution disk to the `TeX Fonts` folder inside the `Textures` folder on your hard disk.
2. Decide which families of fonts you want to install on your system. For a full description of these families, see the appropriate section of the *AMSFonts 2.2 User's Guide.*
3. Make sure you have enough space on your hard disk for the families which you wish to install. See the table above for the amount of space required.
4. Extract the font files from the compressed files for each of the families which are to be installed. This is done in the following way.
   - 4.1 Double-click on the icon for the compressed file.
   - 4.2 In the dialog box which appears, click the "Drive" button so that the name of your hard disk appears at the top.
   - 4.3 Double-click on the name of your `Textures` folder in the scroll box.
   - 4.4 Double-click on the name of the `TeX Fonts` folder in the scroll box.
   - 4.5 Click "Install". When the AutoUnStuffIt installer finishes, there will be a new font suitcase file in your `Tex Fonts` folder.

You are now able to use AMSFonts in *Textures*. However, please read the sections "Customizing Your Installation" and "Questions and Further Information" before attempting to use AMSFonts in *Textures*.

B.3. Customizing Your Own Installation

B.3.1. Defining macros for the symbol fonts.

The files `amssym.def` and `amssym.tex` are included in the `Textures files` folder on the first disk of your distribution. These files are for use with the AMS symbol fonts (MSAM and MSBM). If you will be using these fonts you should place both of these files in the `TeX inputs` folder within your `Textures` folder.

The use of these files is described in the *AMSFonts 2.2 User's Guide*.

B.3.2. Adding fonts for display and printing.

As is explained in the *Textures* manual, the Show Fonts command displays those fonts whose font metrics are currently available to *Textures*. Additionally, when a font is selected the two scroll boxes in the Show Fonts dialog box display the point sizes available for display or printing. When *Textures* has opened `AMSFonts 2.2 metrics`, this permits TeX to run without errors on files with references to AMSFonts. However, it does not enable their display or printing. To enable display and printing you may use Add Fonts to bring in raster information from any of the font suitcases which you created by unstuffing the files in the distribution.

It is not necessary to keep using the menu item Add Fonts to import AMSFonts. You will probably determine through your own use which fonts you frequently use. By opening a font suitcase file in the Finder and dragging its contents into another font suitcase file, you can combine fonts from different suitcases into a single suitcase file. (If you are unsure how to do this, consult the documentation for your Macintosh system.) Place the combined file in the `TeX fonts` folder inside your `Textures` folder, making sure that the file `AMSFonts 2.2 metrics` is also in this folder.

B.3.4. Consolidating AMSFonts suitcase files.

AMSFonts were distributed in several different suitcase files so they would fit on individual disks for distribution and installation. *Textures* and the Macintosh system will have a much easier time if you open fewer files. You should use your Macintosh system conventions for moving fonts between font suitcase files to create a new file which includes the contents of several of the font suitcases which were provided in the distribution.

You may consolidate all three of the distribution suitcase files into one. Another alternative would be to simply not install some of the suitcases. The file on disk 2 (which includes extra CM fonts and AMS symbol fonts), along with Euler Fraktur from disk 3, are all that the majority of users of AMSFonts will need.

Users who have not upgraded to System 7, please read Section B.4.3 for important information about *Font/DA Mover*.

B.4. Font definition files for LaTeX

If you intend to use the AMSFonts collection with LaTeX then you will need to copy all the provided `.fd` files to your LaTeX input files folder. The `.fd` files are font definition files that set up the correspondence between external font names and the naming scheme that is used internally by LaTeX.

There are two sets of font definition files provided. The files that contain `57` in their names are tailored to a PostScript version of the AMSFonts collection produced jointly by Y&Y and Blue Sky Research. In that version, font sizes 6,8,9 are produced by interpolation from neighboring sizes instead of having separate font metric files. Selection of the PostScript or non-PostScript `.fd` files for individual documents is handled through the LaTeX package option mechanism, as described in §3 **How to use AMSFonts with LaTeX**.

B.5. Questions and Further Information

B.5.1. Why are some fonts included at fewer sizes?

You may have noticed that all of the AMSFonts (except the extra CM fonts), are included at two fewer magnifications than the *Textures* distribution fonts. This is because several AMSFonts do not give good results when run through METAFONT at very low resolutions, such as the 72dpi Macintosh screen resolution.

Because of the way in which the Macintosh system scales fonts when it doesn't have a font in the exact size it wants, the magnifications included in the distribution give the best combination of screen previewing and ImageWriter output for the AMSFonts. LaserWriter output is not affected in any way by this. LaserWriter output is always determined from the fonts at 417% and higher, which are handled in the same manner for all AMSFonts.

B.5.2. Help! The font doesn't display correctly!

The Macintosh system has a very ingenious way of handling fonts. Unfortunately, this ingenious and complex system sometimes leads to problems. There is a resource ID number for every point size of every font. For NFNT resources (the kind used for AMSFonts 2.2), these ID numbers are assigned arbitrarily by Macintosh software when a resource is moved into a font suitcase file. Within a single file, the Macintosh software prevents any duplication of these ID numbers.

Conflicts of ID numbers can (and occasionally will) occur when you have many different suitcase files open at the same time. This is one of the reasons for the instructions in Section B.4.4 — the fewer suitcases you have, the less likelihood of conflicts.

When a font ID conflict does occur, a font which you didn't want will be substituted for the font you wanted, at only a single point size at a single magnification. If all other sizes and magnifications of that font are the correct font, and if the font displays correctly when you View the document on the screen at a different magnification, it is a font ID conflict. To remedy this problem, do the following:

A. If you **have** upgraded to System 7:
   1. Create a temporary folder on your hard disk.
   2. Double-click on the icon for the font suitcase file containing the font which you were not able to display.
   3. In the new window showing the contents of that file, select all sizes of the problem font and drag them into the temporary folder which you created.
   4. Open a window showing the contents of the temporary folder, select all of the contents, and drag them back into the font suitcase file. When asked if you want to replace existing ones, answer OK.

5. Delete the temporary folder.

B. If you **have not** upgraded to System 7:
   1. Double-click on the icon for the font suitcase file containing the font which you were not able to display.
   2. When *Font/DA Mover* starts, open a new temporary file on the right-hand side of the window.
   3. Copy all sizes of the problem font from the original file into the temporary file, and remove them from the original file.
   4. Copy the fonts back into the original file.
   5. Quit *Font/DA Mover*, and delete the temporary file which you created.

These steps will cause the Macintosh system software to assign new arbitrary numbers to the NFNT resources in question and should clear up the conflict.

B.5.3. Important information about *Font/DA Mover*.

If you are not using System 7, please take note of the following:

1. You must have *Font/DA Mover* Version 3.8 or later. Previous releases will not recognize font resources of the type used for AMSFonts 2.2.
2. Even Version 3.8 of *Font/DA Mover* has a bug of which you should be aware. If you copy a font of the type used for AMSFonts 2.2 into a file more than once, you will very likely end up with two copies of the font in that file. If you notice that this has occurred, simply delete one occurrence.

Appendix C
Unix Installation Guide

C.1. Introduction

AMSFonts are a set of fonts which were developed at the American Mathematical Society (except the cyrillic fonts, which were developed at the University of Washington), for use with the TEX typesetting system. These fonts were intended for use with the AMS-TEX or AMS-LATEX macro packages, but they can be used with plain TEX, independently of these packages.

AMSFonts can be used with any full implementation of TEX. In this guide, it is assumed that you have TEX installed on your Unix system, and that you have at least some familiarity with it.

C.2. If you have AMSFonts 2.2 but not AMS-TEX

If you obtained AMSFonts but have not obtained (or have not yet installed) the AMS-TEX 2.0+ macro package,* then you must place the `.tfm` files for AMSFonts 2.2 into the directory where your other TFM files are stored. The name of that directory will vary depending on the local installation of TEX which you are using.

If you are using the standard Unix TEX distribution, then it would probably be a directory in the path indicated by the environment variable `TEXFONTS` or one of the subdirectories in the path indicated by the environment variable `TEXFONTS_SUBDIR`. For example, if `TEXFONTS` indicates only the directory `/usr/lib/tex/fonts/tfm`, and if `TEXFONTS_SUBDIR` has no definition, then you would copy the `.tfm` files into `/usr/lib/tex/fonts/tfm`. If your environment is set up differently, then you will have to determine the correct directory in which to place them. After copying the TFM files, proceed with Section C.4.

C.3. If you have AMS-TEX 2.0+

The TFM files were installed as part of the installation of AMS-TEX 2.0+. If you have not yet installed AMS-TEX 2.0+, you should either install it or perform step C.2 above before you proceed with section C.4.

C.4. How much disk space do you need?

The amount of disk space required for installation of the AMSFonts depends on the resolution of your output device and on which families of fonts you choose to install. The fonts have been divided into five families for the installation, and you may choose any or all of these families to install. Also, you may choose to install all of the magnifications or only magnifications 100%, 109.5% and 120% (TEX magsteps 0, $\frac{1}{2}$ and 1). For a more complete description of these families and magnifications, please see the appropriate sections of the *AMSFonts 2.2 User's*

* AMS-TEX 2.0+ refers to any release of AMS-TEX from version 2.0 forward.

Guide. (Note: If you do not have a printed copy of the *User's Guide*, you may use the files `amsfndoc.*` on the TFM disk to produce it with TeX. However, you will not be able to print the entire document correctly until after you have installed AMSFonts.)

The installation guide for AMSFonts 2.2 in DOS includes a table which shows the approximate amount of space required for various families and sizes. These estimates are accurate for Unix also.

C.5. Where do you put the fonts?

Now you will need to install the `.pk` files which are the actual raster images for the fonts. You should place them in the directory where your device drivers (printer drivers and screen previewers) look for `.pk` files. The name of the environment variable which points to that directory or directories varies from one driver to another. Please check the documentation for your drivers to find where they look for `.pk` files. (For example, xdvi looks at an environment variable `XDVIFONTS`, while some drivers look at `TEXPKS` or yet another variable name.)

These files are named according to a convention which indicates the name of the font in the filename and the resolution multiplied by the magnification in the extension. For example, `eufm10` at 100% on a 300dpi printer would require a file named `eufm10.300pk`, while 120% would require a file named `eufm10.360pk`. Each font is supplied at the seven standard magnifications commonly used in TeX: \magstep 0, $\frac{1}{2}$, 1, 2, 3, 4, and 5.

If you obtained the files from an Internet archive or other Unix-like source, the files have the correct names for use in Unix. All you need do is place them in the directory where your drivers will find them (described above).

If you purchased the files on DOS diskettes, you will need to manipulate the filenames to make them compatible with Unix implementations of TeX-related device drivers. On the DOS diskettes, the extension on the filename is limited to no more than three characters, which means that something like `eufm10.300pk` is not allowed. The convention for accomodating this limitation in the TeX community is to give all such files the extension `.pk` and divide them up into different directories.

On the AMSFonts DOS diskette distribution, the directories are labeled `\amsfonts\dpiXXX`, where `XXX` is the resolution of the output device multiplied by the magnification (the number in the Unix filename extension described above). Once you have transferred the entire directory tree over to your Unix environment, you will need to rename the `.pk` files in each directory to the extension `.XXXpk`, where `XXX` is the number in the directory `dpiXXX` in which the file is located. Once you have thus renamed all of the files, you may place them all together in the directory where your drivers will find them (described above).

C.6. Font definition files for LaTeX

If you intend to use the AMSFonts collection with LaTeX then you will need to copy all the provided `.fd` files to your LaTeX input files area. The `.fd` files are font definition files that set up the correspondence between external font names and the naming scheme that is used internally by LaTeX.

Note that there are two sets of font definition files provided. The files that contain `57` in their names are tailored to a PostScript version of the AMSFonts collection produced jointly by Y&Y and Blue Sky Research. In that version, font sizes 6,8,9 are produced by interpolation from neighboring sizes instead of having separate font metric files. Selection of the PostScript or non-PostScript `.fd` files for individual documents is handled through the LaTeX package option mechanism, as described in §3 **How to use AMSFonts with LaTeX**.

C.7. Additional notes for users of AMSFonts

The device driver with which you are using these fonts may have a font table which needs to be updated in order for the driver to recognize the fonts. For instance, the preview software provided by ArborText has a file which contains the names of all fonts which the preview program is expected to find, and the effective resolutions (resolution multiplied by magnification) at which to find them. In order to use AMSFonts with this, or any other software which uses such a table, you must enter the names of each of the fonts in the AMSFonts package and the effective resolutions at which you have them installed. The file `amsfonts.lst`, which appears on the first distribution disk or at the top `/amsfonts` level in Unix archive distributinos, contains a list of all of the font names and all of the resolutions contained in your distribution. You may have to alter the format of this file to make it conform to your driver's needs or to reflect installation of only some of the fonts, but it provides you with the necessary data. See the documentation for your device driver to see what format is required. If your device driver does not depend on such a table, this step is not necessary.

Appendix D
For further information

The AMSFonts collection was implemented and packaged by the Society's Department of Electronic Products and Services. Questions or suggestions for improvements should be directed to that group at the following address:

Technical Support
Electronic Products and Services
American Mathematical Society
P. O. Box 6248
Providence, RI 02940

Phone: 800-321-4AMS or 401-455-4080
Internet: tech-support@math.ams.org

The cyrillic fonts included in the AMSFonts collection were developed at the Humanities and Arts Computing Center of the University of Washington. Questions regarding these cyrillic fonts should be directed to:

Director
Humanities and Arts Computing Center
DR-10
University of Washington
Seattle, WA 98195

Phone: 206-543-4218

Questions or comments concerning *Textures* can be directed to:

Blue Sky Research
534 Southwest Third Avenue
Portland, OR 97204

Phone: 800-622-8398 or 503-222-9571

The TEX Users Group is a good source of general information about fonts for use with TEX. Inquiries can be directed to:

TEX Users Group
P. O. Box 869
Santa Barbara, CA 93102-0869

Phone: 805-963-1338
Internet: tug@tug.org

D.1. Obtaining the METAFONT source files

The AMSFonts collection has been prepared for a number of different resolutions suitable for use on what the AMS staff has determined to be the most popular devices currently being used to prepare TEX output. More such devices continue to appear, many of them with characteristics different from the devices that are currently supported.

Users of unsupported devices who have access to an operating version of METAFONT and have some experience with generating METAFONT fonts may also wish to obtain the METAFONT source files for the AMSFonts collection. METAFONT source files are available on diskette from the Society, as well as via anonymous FTP from the Internet node e-MATH.ams.org.

METAFONT source files for the cyrillic fonts in the AMSFonts collection can be obtained either from the Society or directly from the University of Washington. The sources available from Washington also include other fonts in different layouts. Information can be obtained from the director of the Academic Computing Center at the address given above.

Appendix E
Font charts

Note: Row and column numbers are hexadecimal.

Extra symbols, group 1, medium weight – `msam10`

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	⊡	⊞	⊠	□	■	·	◊	⧫	↻	↺	⇌	⇋	⊟	⊩	⊪	⊨	0
1	↠	↞	⇇	⇉	⇈	⇊	↾	⇂	↿	⇃	↣	↢	⇆	⇄	↰	↱	1
2	⇝	↭	↫	↬	≗	≿	≳	⪆	⊸	∴	∵	≑	≜	≾	≲	⪅	2
3	⪕	⪖	⋞	⋟	≼	≦	⩽	≶	‵	‐	≓	≒	≽	≧	⩾	≷	3
4	⊏	⊐	⊳	⊲	⊵	⊴	★	≬	▼	▶	◀	⇢	⇠	△	▲	▽	4
5	≖	⋚	⋛	⪋	⪌	¥	⇛	⇚	✓	⊻	⊼	⩞	∠	∡	∢	∝	5
6	⌣	⌢	⋐	⋑	⋓	⋒	⋏	⋎	⋋	⋌	⫅	⫆	≏	≎	⋘	⋙	6
7	⌜	⌝	®	Ⓢ	⋔	∔	∽	⋍	⌞	⌟	✠	∁	⊺	⊚	⊛	⊝	7
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	

Extra symbols, group 2, medium weight – `msbm10`

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	$\lvertneqq$	$\gvertneqq$	≰	≱	≮	≯	⊀	⊁	≨	≩	$\nleqslant$	$\ngeqslant$	⪇	⪈	$\npreceq$	$\nsucceq$	0
1	⋨	⋩	⋦	⋧	$\nleqq$	$\ngeqq$	⪵	⪶	⪹	⪺	⪉	⪊	≁	≇	╱	╲	1
2	$\varsubsetneq$	$\varsupsetneq$	$\nsubseteqq$	$\nsupseteqq$	⫋	⫌	$\varsubsetneqq$	$\varsupsetneqq$	⊊	⊋	⊈	⊉	∦	∤	$\nshortmid$	$\nshortparallel$	2
3	⊬	⊮	⊭	⊯	⋭	⋬	⋪	⋫	↚	↛	⇍	⇏	⇎	↮	⋇	∅	3
4	∄	𝔸	𝔹	ℂ	𝔻	𝔼	𝔽	𝔾	ℍ	𝕀	𝕁	𝕂	𝕃	𝕄	ℕ	𝕆	4
5	ℙ	ℚ	ℝ	𝕊	𝕋	𝕌	𝕍	𝕎	𝕏	𝕐	ℤ	$\widehat{\ }$	$\widehat{\ }$	$\widetilde{\ }$	$\widetilde{\ }$		5
6	Ⅎ	⅁					℧	ð	≂	ℶ	ℷ	ℸ	⋖	⋗	⋉	⋊	6
7	$\shortmid$	$\shortparallel$	$\smallsetminus$	$\thicksim$	$\thickapprox$	≊	⪸	⪷	↶	↷	ϝ	ϰ	𝕜	ℏ	ħ	∍	7
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	

Euler Fraktur medium weight – `eufm10`

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	𝔡	𝔡	𝔣	𝔣	𝔤	𝔨	𝔱	𝔲									0
1			‘	’													1
2		!					&	'	(	)	*	+	,	−	.	/	2
3	0	1	2	3	4	5	6	7	8	9	:	;		=		?	3
4		𝔄	𝔅	ℭ	𝔇	𝔈	𝔉	𝔊	ℌ	ℑ	𝔍	𝔎	𝔏	𝔐	𝔑	𝔒	4
5	𝔓	𝔔	ℜ	𝔖	𝔗	𝔘	𝔙	𝔚	𝔛	𝔜	ℨ	[		]	^		5
6		𝔞	𝔟	𝔠	𝔡	𝔢	𝔣	𝔤	𝔥	𝔦	𝔧	𝔨	𝔩	𝔪	𝔫	𝔬	6
7	𝔭	𝔮	𝔯	𝔰	𝔱	𝔲	𝔳	𝔴	𝔵	𝔶	𝔷			"		1	7
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	

Euler cursive (roman) medium weight – `eurm10`

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ	Φ	Ψ	Ω	α	β	γ	δ	ϵ	0
1	ζ	η	θ	ι	κ	λ	μ	ν	ξ	π	ρ	σ	τ	υ	ϕ	χ	1
2	ψ	ω	ε	ϑ	ϖ			φ									2
3	0	1	2	3	4	5	6	7	8	9	.	,	<	/	>		3
4	∂	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	4
5	P	Q	R	S	T	U	V	W	X	Y	Z						5
6	ℓ	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	6
7	p	q	r	s	t	u	v	w	x	y	z	ı	ȷ	℘			7
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	

Euler script medium weight – `eusm10`

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	−																0
1									∼								1
2																	2
3											¬		ℜ	ℑ			3
4	ℵ	𝒜	ℬ	𝒞	𝒟	ℰ	ℱ	𝒢	ℋ	ℐ	𝒥	𝒦	ℒ	ℳ	𝒩	𝒪	4
5	𝒫	𝒬	ℛ	𝒮	𝒯	𝒰	𝒱	𝒲	𝒳	𝒴	𝒵				∧	∨	5
6							{	}			|				\		6
7									§								7
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	

Euler-compatible extension font – `euex10`

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0									{	}	{	}	{	}	{	}	0
1									↼	↽	⇀	⇁					1
2	←	→	↑	↓	↔	↗	↘		⇐	⇒	⇑	⇓	⇔	↖	↙		2
3		∞							⎛	⎞	⎝	⎠	⎨	⎬	⎪		3
4									∮	∮							4
5	∑	∏	∫						∑	∏	∫						5
6	∐	∐											↕	⇕			6
7											◜	◝	◟	◞			7
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	

Cyrillic, medium weight – `wncyr10`

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	Њ	Љ	Џ	Э	І	Є	Ъ	Ћ	њ	љ	џ	э	і	є	ђ	ћ	0
1	Ю	Ж	Й	Ё	V	Ѳ	S	Я	ю	ж	й	ё	v	ѳ	s	я	1
2	¨	!	”	Ђ	˘	%	´	’	(	)	*	ђ	,	-	.	/	2
3	0	1	2	3	4	5	6	7	8	9	:	;	«	ı	»	?	3
4	˘	А	Б	Ц	Д	Е	Ф	Г	Х	И	J	К	Л	М	Н	О	4
5	П	Ч	Р	С	Т	У	В	Щ	Ш	Ы	З	[	“	]	Ь	Ъ	5
6	‘	а	б	ц	д	е	ф	г	х	и	j	к	л	м	н	о	6
7	п	ч	р	с	т	у	в	щ	ш	ы	з	–	—	№	ь	ъ	7
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	

Italic Cyrillic, medium weight – `wncyi10`

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	*Њ*	*Љ*	*Џ*	*Э*	*І*	*Є*	*Ъ*	*Ћ*	*њ*	*љ*	*џ*	*э*	*і*	*є*	*ђ*	*ћ*	0
1	*Ю*	*Ж*	*Й*	*Ё*	*V*	*Ѳ*	*S*	*Я*	*ю*	*ж*	*й*	*ё*	*v*	*ѳ*	*s*	*я*	1
2	¨	*!*	”	*Ђ*	˘	*%*	´	’	*(*	*)*	*	*ђ*	,	-	.	*/*	2
3	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*:*	*;*	«	*ı*	»	*?*	3
4	˘	*А*	*Б*	*Ц*	*Д*	*Е*	*Ф*	*Г*	*Х*	*И*	*J*	*К*	*Л*	*М*	*Н*	*О*	4
5	*П*	*Ч*	*Р*	*С*	*Т*	*У*	*В*	*Щ*	*Ш*	*Ы*	*З*	*[*	“	*]*	*Ь*	*Ъ*	5
6	‘	*а*	*б*	*ц*	*д*	*е*	*ф*	*г*	*х*	*и*	*j*	*к*	*л*	*м*	*н*	*о*	6
7	*п*	*ч*	*р*	*с*	*т*	*у*	*в*	*щ*	*ш*	*ы*	*з*	–	—	*№*	*ь*	*ъ*	7
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	

Computer Modern caps and small caps – `cmcsc10`

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ	Φ	Ψ	Ω	↑	↓	'	¡	¿	0
1	I	J	`	´	ˇ	˘	¯	˚	¸	SS	Æ	Œ	Ø	Æ	Œ	Ø	1
2	-	!	”	#	$	%	&	’	(	)	*	+	,	-	.	/	2
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?	3
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	4
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	“	]	ˆ	˙	5
6	‘	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	6
7	P	Q	R	S	T	U	V	W	X	Y	Z	–	—	˝	˜	¨	7
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	

Computer Modern bold math italic – `cmmib10`

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ	Φ	Ψ	Ω	α	β	γ	δ	ϵ	0
1	ζ	η	θ	ι	κ	λ	μ	ν	ξ	π	ρ	σ	τ	υ	ϕ	χ	1
2	ψ	ω	ε	ϑ	ϖ	ϱ	ς	φ	$\leftharpoonup$	$\leftharpoondown$	$\rightharpoonup$	$\rightharpoondown$	‘	’	$\triangleright$	$\triangleleft$	2
3	0	1	2	3	4	5	6	7	8	9	.	,	$<$	$/$	$>$	$\star$	3
4	∂	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	4
5	P	Q	R	S	T	U	V	W	X	Y	Z	$\flat$	$\natural$	$\sharp$	$\smile$	$\frown$	5
6	ℓ	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	6
7	p	q	r	s	t	u	v	w	x	y	z	$\imath$	$\jmath$	$\wp$	$\vec{}$	$\frown$	7
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	

Computer Modern bold math symbols – `cmbsy10`

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	$-$	$\cdot$	$\times$	$\ast$	$\div$	$\diamond$	$\pm$	$\mp$	$\oplus$	$\ominus$	$\otimes$	$\oslash$	$\odot$	$\bigcirc$	$\circ$	$\bullet$	0
1	$\asymp$	$\equiv$	$\subseteq$	$\supseteq$	$\leq$	$\geq$	$\preceq$	$\succeq$	$\sim$	$\approx$	$\subset$	$\supset$	$\ll$	$\gg$	$\prec$	$\succ$	1
2	$\leftarrow$	$\rightarrow$	$\uparrow$	$\downarrow$	$\leftrightarrow$	$\nearrow$	$\searrow$	$\simeq$	$\Leftarrow$	$\Rightarrow$	$\Uparrow$	$\Downarrow$	$\Leftrightarrow$	$\nwarrow$	$\swarrow$	$\propto$	2
3	$\prime$	∞	$\in$	$\ni$	$\triangle$	$\triangledown$	$/$	$\mapstochar$	$\forall$	$\exists$	$\neg$	$\emptyset$	$\Re$	$\Im$	$\top$	$\bot$	3
4	$\aleph$	$\mathcal{A}$	$\mathcal{B}$	$\mathcal{C}$	$\mathcal{D}$	$\mathcal{E}$	$\mathcal{F}$	$\mathcal{G}$	$\mathcal{H}$	$\mathcal{I}$	$\mathcal{J}$	$\mathcal{K}$	$\mathcal{L}$	$\mathcal{M}$	$\mathcal{N}$	$\mathcal{O}$	4
5	$\mathcal{P}$	$\mathcal{Q}$	$\mathcal{R}$	$\mathcal{S}$	$\mathcal{T}$	$\mathcal{U}$	$\mathcal{V}$	$\mathcal{W}$	$\mathcal{X}$	$\mathcal{Y}$	$\mathcal{Z}$	$\cup$	$\cap$	$\uplus$	$\wedge$	$\vee$	5
6	$\vdash$	$\dashv$	$\lfloor$	$\rfloor$	$\lceil$	$\rceil$	$\{$	$\}$	$\langle$	$\rangle$	$\vert$	$\Vert$	$\updownarrow$	$\Updownarrow$	$\backslash$	$\wr$	6
7	$\surd$	$\amalg$	∇	$\smallint$	$\sqcup$	$\sqcap$	$\sqsubseteq$	$\sqsupseteq$	$\S$	$\dagger$	$\ddagger$	$\P$	$\clubsuit$	$\diamondsuit$	$\heartsuit$	$\spadesuit$	7
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	

Computer Modern math extension font – `cmex10`