



Linux Ubuntu 26.04 Manual Pages on command 'eqn.1'

\$ man eqn.1

eqn(1) General Commands Manual eqn(1)

Name

eqn - format mathematics (equations) for groff or MathML

Synopsis

eqn [-CNrR] [-d xy] [-f F] [-m n] [-M dir] [-p n] [-s n] [-T dev] [file ...]

eqn --help

eqn -v

eqn --version

Description

The GNU implementation of eqn is part of the groff(7) document formatting system. eqn is a troff(1) preprocessor that translates expressions in its own language, embedded in roff(7) input files, into mathematical notation typeset by troff(1). It copies each file's contents to the standard output stream, translating each equation between lines starting with .EQ and .EN, or within a pair of user-specified delimiters. Normally, eqn is not executed directly by the user, but invoked by specifying the -e option to groff(1). While GNU eqn's input syntax is highly compatible with AT&T eqn, the output eqn produces cannot be processed by AT&T troff; GNU troff (or a troff implementing relevant GNU extensions) must be used. If no file operands are given on the command line, or if file is ?-?, eqn reads the standard input stream.

Unless the -R option is used, eqn searches for the file eqnrc in the directories given with the -M option first, then in /usr/share/groff/site-tmac, and finally in the standard macro directory /usr/share/groff/1.23.0/tmac. If it exists and is readable, eqn processes it before any input files.

This man page primarily discusses the differences between GNU eqn and AT&T eqn. Most of the new features of the GNU eqn input language are based on TeX. There are some references to the differences between TeX and GNU eqn below; these may safely be ignored if you do not know TeX.

Three points are worth special note.

? GNU eqn emits Presentation MathML output when invoked with the ?-T MathML? option.

? GNU eqn does not support terminal devices well, though it may suffice for simple inputs.

? GNU eqn sets the input token ?...? as an ellipsis on the text baseline, not the three centered dots of AT&T eqn. Set an ellipsis on the math axis with the GNU extension macro `cdots`.

Anatomy of an equation

eqn input consists of tokens. Consider a form of Newton's second law of motion. The input

```
.EQ
F =
m a
.EN
```

becomes $F=ma$. Each of `F`, `=`, `m`, and `a` is a token. Spaces and newlines are interchangeable; they separate tokens but do not break lines or produce space in the output.

The following input characters not only separate tokens, but manage their grouping and spacing as well.

`{ }` Braces perform grouping. Whereas `?e sup a b?` expresses $(e \text{ to the } a) \text{ times } b$, `?e sup { a b }?` means $e \text{ to the } (a \text{ times } b)$. When immediately preceded by a `?left?` or `?right?` primitive, a brace loses its special meaning.

`^ ~` are the half space and full space, respectively. Use them to tune the appearance of the output.

`Tab` and `leader` characters separate tokens as well as advancing the drawing position to the next `tab stop`, but are seldom used in eqn input. When they occur, they must appear at the outermost lexical scope. This roughly means that they can't appear within braces that are necessary to disambiguate the input; eqn will diagnose an error in this event. (See subsection `?Macros?` below for additional token separation rules.)

Other tokens are primitives, macros, an argument to either of the foregoing, or components of an equation.

Primitives are fundamental keywords of the eqn language. They can configure an aspect of

the preprocessor's state, as when setting a ?global? font selection or type size (gfont and gsize), or declaring or deleting macros (?define? and undef); these are termed commands. Other primitives perform formatting operations on the tokens after them (as with fat, over, sqrt, or up).

Equation components include mathematical variables, constants, numeric literals, and operators. eqn remaps some input character sequences to groff special character escape sequences for economy in equation entry and to ensure that glyphs from an unstyled font are used; see groff_char(7).

+	<code>\[p]</code>	'	<code>\[fm]</code>
-	<code>\[mi]</code>	<=	<code>\[<=]</code>
=	<code>\[eq]</code>	>=	<code>\[>=]</code>

Macros permit primitives, components, and other macros to be collected and referred to by a single token. Predefined macros make convenient the preparation of eqn input in a form resembling its spoken expression; for example, consider cos, hat, inf, and lim.

Spacing and typeface

GNU eqn imputes types to the components of an equation, adjusting the spacing between them accordingly. Recognized types are as follows; most affect spacing only, whereas the ?letter? subtype of ?ordinary? also assigns a style.

ordinary	character such as ?1?, ?a?, or ?!?
letter	character to be italicized by default
digit	n/a
operator	large operator such as ???
binary	binary operator such as ?+?
relation	relational operator such as ?=?
opening	opening bracket such as ?(?
closing	closing bracket such as ?)?
punctuation	punctuation character such as ?,?
inner	sub-formula contained within brackets
suppress	component to which automatic spacing is not applied

Two primitives apply types to equation components.

type t e

Apply type t to expression e.

chartype t text

Assign each character in (unquoted) text type t, persistently.

eqn sets up spacings and styles as if by the following commands.

```
chartype "letter"    abcdefghiklmnopqrstuvwxyz
chartype "letter"    ABCDEFGHIJKLMNOPQRSTUVWXYZ
chartype "letter"    \[*a\[*b\[*g\[*d\[*e\[*z]
chartype "letter"    \[*y\[*h\[*i\[*k\[*l\[*m]
chartype "letter"    \[*n\[*c\[*o\[*p\[*r\[*s]
chartype "letter"    \[*t\[*u\[*f\[*x\[*q\[*w]
chartype "binary"    *\[p\[*i]
chartype "relation"  <>\[eq\[*<=\[*>=]
chartype "opening"   {[
chartype "closing"   ]}]
chartype "punctuation" ,;:.
chartype "suppress"  ^~
```

eqn assigns all other ordinary and special roff characters, including numerals 0?9, the ?ordinary? type. (The ?digit? type is not used, but is available for customization.) In keeping with common practice in mathematical typesetting, lowercase, but not uppercase, Greek letters are assigned the ?letter? type to style them in italics. The macros for producing ellipses, ?...?, cdots, and ldots, use the ?inner? type.

Primitives

eqn supports without alteration the AT&T eqn primitives above, back, bar, bold, define, down, fat, font, from, fwd, gfont, gsize, italic, left, lineup, mark, matrix, ndefine, over, right, roman, size, sqrt, sub, sup, tdefine, to, under, and up.

New primitives

The GNU extension primitives ?type? and chartype are discussed in subsection ?Spacing and typeface? above; ?set? in subsection ?Customization? below; and gfont and gbfont in subsection ?Fonts? below. In the following synopses, X can be any character not appearing in the parameter thus bracketed.

e1 accent e2

Set e2 as an accent over e1. e2 is assumed to be at the appropriate height for a lowercase letter without an ascender; eqn vertically shifts it depending on e1's height. For example, hat is defined as follows.

```
accent { "^" }
```

dotdot, dot, tilde, vec, and dyad are also defined using the accent primitive.

big e Enlarge the expression e; semantics like those of CSS `?large?` are intended. In troff output, the type size is increased by 5 scaled points. MathML output emits the following.

```
<mstyle mathsize='big'>
```

copy file

include file

Interpolate the contents of file, omitting lines beginning with `.EQ` or `.EN`. If a relative path name, file is sought relative to the current working directory.

ifdef name X anything X

If name is defined as a primitive or macro, interpret anything.

nosplit text

As "text", but since text is not quoted it is subject to macro expansion; it is not split up and the spacing between characters not adjusted per subsection `?Spacing` and `typeface?` above.

e opprime

As prime, but set the prime symbol as an operator on e. In the input `?A opprime sub 1?`, the `?1?` is tucked under the prime as a subscript to the `?A?` (as is conventional in mathematical typesetting), whereas when prime is used, the `?1?` is a subscript to the prime character. The precedence of opprime is the same as that of bar and `?under?`, and higher than that of other primitives except accent and uaccent. In unquoted text, a neutral apostrophe (') that is not the first character on the input line is treated like opprime.

sdefine name X anything X

As `?define?`, but name is not recognized as a macro if called with arguments.

e1 smallover e2

As over, but reduces the type size of e1 and e2, and puts less vertical space between e1 and e2 and the fraction bar. The over primitive corresponds to the TeX `\over` primitive in displayed equation styles; smallover corresponds to `\over` in non-display (`?inline?`) styles.

space n

Set extra vertical spacing around the equation, replacing the default values, where n is an integer in hundredths of an em. If positive, n increases vertical spacing

before the equation; if negative, it does so after the equation. This primitive provides an interface to groff's \x escape sequence, but with the opposite sign convention. It has no effect if the equation is part of a pic(1) picture.

special troff-macro e

Construct an object by calling troff-macro on e. The troff string 0s contains the eqn output for e, and the registers 0w, 0h, 0d, 0skern, and 0skew the width, height, depth, subscript kern, and skew of e, respectively. (The subscript kern of an object indicates how much a subscript on that object should be "tucked in", or placed to the left relative to a non-subscripted glyph of the same size. The skew of an object is how far to the right of the center of the object an accent over it should be placed.) The macro must modify 0s so that it outputs the desired result, returns the drawing position to the text baseline at the beginning of e, and updates the foregoing registers to correspond to the new dimensions of the result.

Suppose you want a construct that "cancels" an expression by drawing a diagonal line through it.

```
.de Ca
. ds 0s \
\Z'\\"*(0s'\
\v'\n(0du'\
\D'I \n(0wu -\n(0hu-\n(0du'\
\v'\n(0hu'
..
.EQ
special Ca "x \[mi] 3 \[pl] x" ~ 3
.EN
```

We use the \[mi] and \[pl] special characters instead of + and - because they are part of the argument to a troff macro, so eqn does not transform them to mathematical glyphs for us. Here's a more complicated construct that draws a box around an expression; the bottom of the box rests on the text baseline. We define the eqn macro box to wrap the call of the troff macro Bx.

```
.de Bx
.ds 0s \
\Z'\h'1n'\\"*[0s]'
```

```

\v'\n(0du+1n\
\l'\n(0wu+2n 0\
\l'\n(0hu-\n(0du-2n\
\l'\n(0wu-2n 0\
\l'\n(0hu+\n(0du+2n\
\h'\n(0wu+2n'
.nr 0w +2n
.nr 0d +1n
.nr 0h +1n
..
.EQ
define box ' special Bx $1 '
box(foo) ~ "bar"
.EN

```

split "text"

As text, but since text is quoted, it is not subject to macro expansion; it is split up and the spacing between characters adjusted per subsection ?Spacing and typeface? above.

e1 uaccent e2

Set e2 as an accent under e1. e2 is assumed to be at the appropriate height for a letter without a descender; eqn vertically shifts it depending on whether e1 has a descender. tilde is predefined using uaccent as a tilde accent below the baseline.

undef name

Remove definition of macro or primitive name, making it undefined.

vcenter e

Vertically center e about the math axis, a horizontal line upon which fraction bars and characters such as ?+? and ??? are aligned. MathML already behaves this way, so eqn ignores this primitive when producing that output format. The built-in sum macro is defined as if by the following.

```
define sum ! { type "operator" vcenter size +5 \(*S } !
```

Extended primitives

GNU eqn extends the syntax of some AT&T eqn primitives, introducing one deliberate incompatibility.

delim on

eqn recognizes an `?on?` argument to the `delim` primitive specially, restoring any `de?` limiters previously disabled with `?delim off?`. If delimiters haven't been specified, neither command has effect. Few eqn documents are expected to use `?o?` and `?n?` as left and right delimiters, respectively. If yours does, consider swapping them, or select others.

`col n { ... }`

`ccol n { ... }`

`lcol n { ... }`

`rcol n { ... }`

`pile n { ... }`

`cpile n { ... }`

`lpile n { ... }`

`rpile n { ... }`

The integer value `n` (in hundredths of an em) increases the vertical spacing between rows, using groff's `\x` escape sequence (the value has no effect in MathML mode). Negative values are accepted but have no effect. If more than one `n` occurs in a `ma?` trix or pile, the largest is used.

Customization

When eqn generates troff input, the appearance of equations is controlled by a large number of parameters. They have no effect when generating MathML, which delegates typesetting to a MathML rendering engine. Configure these parameters with the `set` primitive.

`set p n`

assigns parameter `p` the integer value `n`; `n` is interpreted in units of hundredths of an em unless otherwise stated. For example,

```
set x_height 45
```

says that eqn should assume that the font's x-height is 0.45 ems.

Available parameters are as follows; defaults are shown in parentheses. We intend these descriptions to be expository rather than rigorous.

`minimum_size` sets a floor for the type size (in scaled points) at which equations are set (5).

`fat_offset` The fat primitive emboldens an equation by overprinting two copies of the equation horizontally offset by this amount (4). In MathML

mode, components to which `fat_offset` applies instead use the following.

`<mstyle mathvariant='double-struck'>`

`over_hang` A fraction bar is longer by twice this amount than the maximum of the widths of the numerator and denominator; in other words, it overhangs the numerator and denominator by at least this amount (0).

`accent_width` When bar or under is applied to a single character, the line is this long (31). Normally, bar or under produces a line whose length is the width of the object to which it applies; in the case of a single character, this tends to produce a line that looks too long.

`delimiter_factor` Extensible delimiters produced with the left and right primitives have a combined height and depth of at least this many thousandths of twice the maximum amount by which the sub-equation that the delimiters enclose extends away from the axis (900).

`delimiter_shortfall`

Extensible delimiters produced with the left and right primitives have a combined height and depth not less than the difference of twice the maximum amount by which the sub-equation that the delimiters enclose extends away from the axis and this amount (50).

`null_delimiter_space`

This much horizontal space is inserted on each side of a fraction (12).

`script_space` The width of subscripts and superscripts is increased by this amount (5).

`thin_space` This amount of space is automatically inserted after punctuation characters. It also configures the width of the space produced by the `^` token (17).

`medium_space` This amount of space is automatically inserted on either side of binary operators (22).

`thick_space` This amount of space is automatically inserted on either side of relational tokens. It also configures the width of the space produced by the `~` token (28).

`x_height` The height of lowercase letters without ascenders such as `x` (45).

`axis_height` The height above the baseline of the center of characters such as `?+?` and `???` (26). It is important that this value is correct for the font you are using.

`default_rule_thickness`

This should be set to the thickness of the `\[ru]` character, or the thickness of horizontal lines produced with the `\D` escape sequence (4).

`num1` The over primitive shifts up the numerator by at least this amount (70).

`num2` The smallover primitive shifts up the numerator by at least this amount (36).

`denom1` The over primitive shifts down the denominator by at least this amount (70).

`denom2` The smallover primitive shifts down the denominator by at least this amount (36).

`sup1` Normally superscripts are shifted up by at least this amount (42).

`sup2` Superscripts within superscripts or upper limits or numerators of smallover fractions are shifted up by at least this amount (37). Conventionally, this is less than `sup1`.

`sup3` Superscripts within denominators or square roots or subscripts or lower limits are shifted up by at least this amount (28). Conventionally, this is less than `sup2`.

`sub1` Subscripts are normally shifted down by at least this amount (20).

`sub2` When there is both a subscript and a superscript, the subscript is shifted down by at least this amount (23).

`sup_drop` The baseline of a superscript is no more than this much below the top of the object on which the superscript is set (38).

`sub_drop` The baseline of a subscript is at least this much below the bottom of the object on which the subscript is set (5).

`big_op_spacing1` The baseline of an upper limit is at least this much above the top of the object on which the limit is set (11).

`big_op_spacing2` The baseline of a lower limit is at least this much below the bottom of the object on which the limit is set (17).

`big_op_spacing3` The bottom of an upper limit is at least this much above the top of the object on which the limit is set (20).

`big_op_spacing4` The top of a lower limit is at least this much below the bottom of the object on which the limit is set (60).

`big_op_spacing5` This much vertical space is added above and below limits (10).

`baseline_sep` The baselines of the rows in a pile or matrix are normally this far apart (140). Usually equal to the sum of `num1` and `denom1`.

`shift_down` The midpoint between the top baseline and the bottom baseline in a matrix or pile is shifted down by this much from the axis (26).
Usually equal to `axis_height`.

`column_sep` This much space is added between columns in a matrix (100).

`matrix_side_sep` This much space is added at each side of a matrix (17).

`draw_lines` If non-zero, `eqn` draws lines using the troff `\D` escape sequence, rather than the `\l` escape sequence and the `\[ru]` special character.
The `eqnrc` file sets the default: 1 on ps, html, and the X11 devices, otherwise 0.

`body_height` is the presumed height of an equation above the text baseline; `eqn` adds any excess as extra pre-vertical line spacing with troff's `\x` escape sequence (85).

`body_depth` is the presumed depth of an equation below the text baseline; `eqn` adds any excess as extra post-vertical line spacing with troff's `\x` escape sequence (35).

`nroff` If non-zero, then `ndefine` behaves like `define` and `tdefine` is ignored, otherwise `tdefine` behaves like `define` and `ndefine` is ignored.
The `eqnrc` file sets the default: 1 on ascii, latin1, utf8, and cp1047 devices, otherwise 0.

Macros

In GNU `eqn`, macros can take arguments. A word defined by any of the `define`, `ndefine`, or `tdefine` primitives followed immediately by a left parenthesis is treated as a parameterized macro call: subsequent tokens up to a matching right parenthesis are treated as comma-separated arguments. In this context only, commas and parentheses also serve as token separators. A macro argument is not terminated by a comma inside parentheses nested within it.

In a macro definition, `$n`, where `n` is between 1 and 9 inclusive, is replaced by the `n`th argument.

gument; if there are fewer than n arguments, it is replaced by nothing.

Predefined macros

GNU eqn supports the predefined macros offered by AT&T eqn: and, approx, arc, cos, cosh, del, det, dot, dotdot, dyad, exp, for, grad, half, hat, if, inter, lm, inf, int, lim, ln, log, max, min, nothing, partial, prime, prod, Re, sin, sinh, sum, tan, tanh, tilde, times, union, vec, ==, !=, +=, ->, <-, <<, >>, and ?...?. The lowercase classical Greek letters are available as alpha, beta, chi, delta, epsilon, eta, gamma, iota, kappa, lambda, mu, nu, omega, omicron, phi, pi, psi, rho, sigma, tau, theta, upsilon, xi, and zeta. Spell them with an initial capital letter (Alpha) or in full capitals (ALPHA) to obtain uppercase forms.

GNU eqn further defines the macros cdot, cdots, and utilde (all discussed above), dollar, which sets a dollar sign, and ldots, which sets an ellipsis on the text baseline.

Fonts

eqn uses up to three typefaces to set an equation: italic (oblique), roman (upright), and bold. Assign each a groff typeface with the primitives gfont, grfont, and gbfont. The defaults are the styles I, R, and B (applied to the current font family). The chartype primitive (see above) sets a character's type, which determines the face used to set it. The ?letter? type is set in italics; others are set in roman. Use the bold primitive to select an (upright) bold style.

gbfont f

Select f as the bold font. This is a GNU extension.

gfont f

Select f as the italic font.

grfont f

Select f as the roman font. This is a GNU extension.

Options

--help displays a usage message, while -v and --version show version information; all exit afterward.

-C Recognize .EQ and .EN even when followed by a character other than space or newline.

-d xy Specify delimiters x for left and y for right ends of equations not bracketed by .EQ/.EN. x and y need not be distinct. Any ?delim xy? statements in the source file override this option.

-f F is equivalent to ?gfont F?.

- m n is equivalent to `?set minimum_size n?`.
- M dir Search dir for eqnrc before those listed in section `?Description?` above.
- N Prohibit newlines within delimiters. This option allows eqn to recover better from missing closing delimiters.
- p n Set sub- and superscripts n points smaller than the surrounding text. This option is deprecated. eqn normally sets sub- and superscripts at 70% of the type size of the surrounding text.
- r Reduce the type size of subscripts at most once relative to the base type size for the equation.
- R Don't load eqnrc.
- s n is equivalent to `?gsize n?`. This option is deprecated.
- T dev Prepare output for the device dev. In most cases, the effect of this is to define a macro dev with a value of 1; eqnrc uses this to provide definitions appropriate for the device. However, if the specified driver is `?MathML?`, the output is MathML markup rather than troff input, and eqnrc is not loaded at all. The default output device is ps.

Files

`/usr/share/groff/1.23.0/tmac/eqnrc`

Initialization file.

MathML mode limitations

MathML is designed on the assumption that it cannot know the exact physical characteristics of the media and devices on which it will be rendered. It does not support control of motions and sizes to the same degree troff does.

`?eqn` customization parameters have no effect on generated MathML.

`?The special, up, down, fwd, and back primitives cannot be implemented, and yield a MathML ?<merror> message instead.`

`?The vcenter primitive is silently ignored, as centering on the math axis is the MathML default.`

`?Characters that eqn sets extra large in troff mode?notably the integral sign?may appear too small and need to have their ?<mstyle> wrappers adjusted by hand.`

As in its troff mode, eqn in MathML mode leaves the `.EQ` and `.EN` tokens in place, but emits nothing corresponding to `delim` delimiters. They can, however, be recognized as character sequences that begin with `?<math>`, end with `?</math>`, and do not cross line boundaries.

Caveats

Tokens must be double-quoted in eqn input if they are not to be recognized as names of macros or primitives, or if they are to be interpreted by troff. In particular, short ones, like `?pi?` and `?PI?`, can collide with troff identifiers. For instance, the eqn command `?gfont PI?` does not select groff's Palatino italic font for the global italic face; you must use `?gfont "PI"?` instead.

Delimited equations are set at the type size current at the beginning of the input line, not necessarily that immediately preceding the opening delimiter.

Unlike TeX, eqn does not inherently distinguish displayed and inline equation styles; see the `smallover` primitive above. However, macro packages frequently define EQ and EN macros such that the equation within is displayed. These macros may accept arguments permitting the equation to be labeled or captioned; see the package's documentation.

Bugs

eqn abuses terminology; its "equations" can be inequalities, bare expressions, or unintelligible gibberish. But there's no changing it now.

In nroff mode, lowercase Greek letters are rendered in roman instead of italic style.

In MathML mode, the mark and lineup features don't work. These could, in theory, be implemented with `<maligngroup>` elements.

In MathML mode, each digit of a numeric literal gets a separate `<mn></mn>` pair, and decimal points are tagged with `<mo></mo>`. This is allowed by the specification, but inefficient.

Examples

We first illustrate eqn usage with a trigonometric identity.

```
.EQ
```

```
sin ( alpha + beta ) = sin alpha cos beta + cos alpha sin beta
```

```
.EN
```

It can be convenient to set up delimiters if mathematical content will appear frequently in running text.

```
.EQ
```

```
delim $$
```

```
.EN
```

Having cached a table of logarithms,

the property $\ln (x y) = \ln x + \ln y$ sped calculations.

The quadratic formula illustrates use of fractions and radicals, and affords an opportunity to use the full space token $\sim$.

.EQ

$$x = \frac{-b \sim \sqrt{b^2 - 4ac}}{2a}$$

.EN

Alternatively, we could define the plus-minus sign as a binary operator. Automatic spacing puts 0.06 em less space on either side of the plus-minus than $\sim$ does, this being the difference between the widths of the medium_space parameter used by binary operators and that of the full space. Independently, we can define a macro `\frac` for setting fractions.

.EQ

```
chartype "binary" \[+-]
define frac ! { $1 } over { $2 } !
x = frac(- b \[+-] sqrt { b sup 2 - 4 a c }, 2 a)
```

.EN

See also

`\Typesetting Mathematics?User's Guide?` (2nd edition), by Brian W. Kernighan and Lorinda L. Cherry, 1978, AT&T Bell Laboratories Computing Science Technical Report No. 17.

`The TeXbook`, by Donald E. Knuth, 1984, Addison-Wesley Professional. Appendix G discusses many of the parameters from section `\Customization?` above in greater detail.

`groff_char(7)`, particularly subsections `\Logical symbols?`, `\Mathematical symbols?`, and `\Greek glyphs?`, documents a variety of special character escape sequences useful in mathematical typesetting.

`groff(1)`, `troff(1)`, `pic(1)`, `groff_font(5)`

groff 1.23.0

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