

## OpenQASM 3 (legible) grammar

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<program> ::= <globalstmt|stmt>*

<globalstmt> ::=
| <subroutinedef>
| <externdef>
| <gatedef>
| <calibration>
| <qdecl>
| #pragma { <stmt>* }
<subroutinedef> ::= def <id>(<arg...>?) { <stmt>* <returnstmt>? }
| def <id>(<arg...>?) -> <ctype> { <stmt>* <returnstmt>? }
<externdef> ::= extern <id>(<ctype...>?);
| extern <id>(<ctype...>?) -> <ctype>;
<gatedef> ::= gate <id...> <qblock>
| gate (<id...>?) <id...> <qblock>
<calibration> ::= defcalgrammar "openpulse";
| defcalgrammar <string>;
| defcal <id> <id...> { .* }
| defcal <id> (<carg...>?) <id...> { .* }
| defcal <id> (<exp...>?) <id...> { .* }
| defcal <id> <id...> -> <ctype> { .* }
| defcal <id> (<carg...>?) <id...> -> <ctype> { .* }
| defcal <id> (<exp...>?) <id...> -> <ctype> { .* }
<qdecl> ::= qreg <id>; | qreg <id>[<exp>];
| qubit <id>; | qubit[<exp>] <id>;

<stmt> ::= <exp>;
| <id> <assignop> <exp>; | <id>[<exp>] <assignop> <exp>;
| measure <indexid> -> <indexid>;
| <indexid> = measure <indexid>;
| <classicdecl>
| if (<exp>) <prgmblock>
| if (<exp>) <prgmblock> else <prgmblock>
| for <id> in <setdecl> <prgmblock>;
| while (<exp>) <prgmblock>;
| end;
| let <id> = <indexid>;
| <qstmt>

<qstmt> ::= <gatemodifier>* <id> <indexid...>;
| <gatemodifier>* <id>(<exp...>) <indexid...>;
| <gatemodifier>* gphase(<exp>) <indexid...>;
| measure <indexid>;
| reset <indexid...>;
| barrier <indexid...>;
| <timestmt>

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<timestmt> ::= delay[<exp>] <indexid...>;
            | delay(<exp...>?)[<exp>] <indexid...>;
            | rotary[<exp>] <indexid...>;
            | rotary(<exp...>?)[<exp>] <indexid...>;
            | box <qblock>
            | box[<exp>] <qblock>

<prgmblock> ::= <stmt>
            | <control>
            | { <stmt|control>* }

<control> ::= break; | continue;
            | <returnstmt>

<returnstmt> ::= return;
              | return <exp>;
              | return measure <indexid>;

<qblock> ::= { <qstmt|qloop>* }
<qloop> ::= for <id> in <setdecl> <qstmt>
            | for <id> in <setdecl> { <qstmt>* }
            | while (<exp>) <qstmt>
            | while (<exp>) { <qstmt>* }

<arg> ::= <carg> | <qarg>
<carg> ::= <singledesignatortype>[<exp>] <id>
            | <nodesignatortype> <id>
            | creg <id> | creg <id>[<exp>]
            | bit <id> | bit[<exp>] <id>
            | complex[<singledesignatortype>[<exp>]] <id>
<qarg> ::= qreg <id> | qreg <id>[<exp>]
            | qubit <id> | qubit[<exp>] <id>

<ctype> ::= <singledesignatortype>[<exp>]
            | <nodesignatortype>
            | bit | bit[<exp>] | creg | creg[<exp>]
            | complex[<singledesignatortype>[<exp>]]

<singledesignatortype> ::= int | uint | float | angle
<nodesignatortype> ::= bool | duration | stretch

<indexid> ::= <id>[<exp>?:<exp>?]
            | <id>[<exp>?:<exp>?:<exp>]
            | <id>
            | <id>[<exp...>]
            | <indexid>||<indexid>

<setdecl> ::= { <exp...> }
            | [<exp>?:<exp>?] | [<exp>?:<exp>?:<exp>]
            | <id>

<equalsexp> ::= = <exp>
<classicdecl> ::= <singledesignatortype>[<exp>] <id> <equalsexp>;
                | <nodesignatortype> <id> <equalsexp>;
                | creg <id> <equalsexp>; | creg <id>[<exp>] <equalsexp>;
                | bit <id> <equalsexp>; | bit[<exp>] <id> <equalsexp>;

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| complex[<singledesignatortype>[<exp>]] <id> <equalsexp>;
| const <ctype> <id> <equalsexp>;

<exp> ::= <constant> | <int> | <real> | <imag>
| <bool> | <id> | <string>
| <math>(<exp...>)
| <ctype>(<exp...>)
| <id>(<exp...>?)
| <time> | durationof(<id>)
| durationof(<qblock>)
| (<exp>)
| <exp>[<exp>]
| <exp> <b-op> <exp>
| <u-op> <exp>

<math> ::= arcsin | sin | arccos | cos | arctan | tan
| exp | ln | sqrt | rotl | rotr | popcount
<b-op> ::= || && | | ^ | & | == | != | > | < | >= | <=
| << | >> | + | - | * | / | % | **
<u-op> ::= ~ | ! | -

<assignop> ::= = | += | -= | *= | /= | &= | |= | ^= | ^= | <<= | >>= | %= | **=

<gatemodifier> ::= inv @ | pow(<exp>) @
| ctrl @ | ctrl(<exp>) @
| negctrl @ | negctrl(<exp>) @

<uni> ::= [\p{Lu}\p{Ll}\p{Lt}\p{Lm}\p{Lo}\p{Nl}]
<id> ::= (_|$|<uni>|[A-Za-z])(_|$|<uni>|[A-Za-z]|[0-9])*
<int> ::= [0-9]+
<real> ::= ([0-9]+|[0-9]+\.[0-9]*)([eE][+-]?[0-9]+)?
<imag> ::= (<int>|<real>)im
<bool> ::= true|false
<time> ::= (<int>|<real>)(dt|ns|us|µs|ms|s)
<string> ::= "[^"\\r\\t\\n]*" | '^[^"\\r\\t\\n]*'
<constant> ::= pi | π | tau | τ | euler | ε

<comment> ::= // ...
| /* ... */

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