

qpp
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Chapter 1

Namespace Index

1.1 Namespace List

Here is a list of all namespaces with brief descriptions:

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Chapter 2

Hierarchical Index

2.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

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Chapter 3

Class Index

3.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

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Chapter 4

File Index

4.1 File List

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Chapter 5

Namespace Documentation

5.1 qpp Namespace Reference

Namespaces

- [ct](#)
- [internal](#)
- [stat](#)
- [types](#)

Classes

- class [Exception](#)
- class [Gates](#)
- class [Measurement](#)
- class [Qudit](#)
- class [RandomDevices](#)
- class [Timer](#)

Functions

- [types::cmat channel](#) (const [types::cmat](#) &rho, const std::vector< [types::cmat](#) > &Ks)
- [types::cmat super](#) (const std::vector< [types::cmat](#) > &Ks)
- [types::cmat choi](#) (const std::vector< [types::cmat](#) > &Ks)
- std::vector< [types::cmat](#) > [choi2kraus](#) (const [types::cmat](#) &A)
- template<typename Derived >
double [shannon](#) (const Eigen::MatrixBase< Derived > &A)
- template<typename Derived >
double [renyi](#) (const double alpha, const Eigen::MatrixBase< Derived > &A)
- template<typename Derived >
double [renyi_inf](#) (const Eigen::MatrixBase< Derived > &A)
- template<typename Derived >
[types::DynMat](#)< typename
Derived::Scalar > [transpose](#) (const Eigen::MatrixBase< Derived > &A)
- template<typename Derived >
[types::DynMat](#)< typename
Derived::Scalar > [conjugate](#) (const Eigen::MatrixBase< Derived > &A)
- template<typename Derived >
[types::DynMat](#)< typename
Derived::Scalar > [adjoint](#) (const Eigen::MatrixBase< Derived > &A)

- `template<typename Derived >`
`Derived::Scalar trace` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`Derived::Scalar det` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`Derived::Scalar sum` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`double norm` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`types::cmat evals` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`types::cmat evecs` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`types::cmat hevals` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`types::cmat hevecs` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`types::cmat funm` (const Eigen::MatrixBase< Derived > &A, `types::cplx`(*)(const `types::cplx` &))
- `template<typename Derived >`
`types::cmat sqrtm` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`types::cmat absm` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`types::cmat expm` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`types::cmat logm` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`types::cmat sinm` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`types::cmat cosm` (const Eigen::MatrixBase< Derived > &A)
- `template<typename Derived >`
`types::cmat spectralpowm` (const Eigen::MatrixBase< Derived > &A, const `types::cplx` z)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > powm` (const Eigen::MatrixBase< Derived > &A, `size_t` n)
- `template<typename OutputScalar , typename Derived >`
`types::DynMat< OutputScalar > fun` (const Eigen::MatrixBase< Derived > &A, `OutputScalar`(*)(const `typename Derived::Scalar` &))
- `template<typename Derived1 , typename Derived2 >`
`types::DynMat< typename`
`Derived1::Scalar > kron` (const Eigen::MatrixBase< Derived1 > &A, const Eigen::MatrixBase< Derived2 > &B)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > kronlist` (const `std::vector< types::DynMat< typename Derived::Scalar > >` &As)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > kronpow` (const Eigen::MatrixBase< Derived > &A, `size_t` n)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > reshape` (const Eigen::MatrixBase< Derived > &A, `size_t` rows, `size_t` cols)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > syspermute` (const Eigen::MatrixBase< Derived > &A, const `std::vector< size_t >` perm, const `std::vector< size_t >` &dims)

- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > ptrace2` (const Eigen::MatrixBase< Derived > &A, const std::vector< size_t > dims)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > ptrace` (const Eigen::MatrixBase< Derived > &A, const std::vector< size_t > &subs, const std::vector< size_t > &dims)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > ptranspose` (const Eigen::MatrixBase< Derived > &A, const std::vector< size_t > &subs, const std::vector< size_t > &dims)
- `template<typename Derived1 , typename Derived2 >`
`types::DynMat< typename`
`Derived1::Scalar > comm` (const Eigen::MatrixBase< Derived1 > &A, const Eigen::MatrixBase< Derived2 > &B)
- `template<typename Derived1 , typename Derived2 >`
`types::DynMat< typename`
`Derived1::Scalar > anticomm` (const Eigen::MatrixBase< Derived1 > &A, const Eigen::MatrixBase< Derived2 > &B)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > proj` (const Eigen::MatrixBase< Derived > &V)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > expandout` (const Eigen::MatrixBase< Derived > &A, size_t pos, const std::vector< size_t > &dims)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > grams` (const std::vector< types::DynMat< typename Derived::Scalar > > &Vs)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > grams` (const Eigen::MatrixBase< Derived > &A)
- `template<typename T >`
`void dispSTL` (const T &x, const std::string &separator=" ", const std::string &start="[" , const std::string &end="]", std::ostream &os=std::cout)
- `template<typename T >`
`void displnSTL` (const T &x, const std::string &separator=" ", const std::string &start="[" , const std::string &end="]", std::ostream &os=std::cout)
- `template<typename T >`
`void dispSTL` (const T *x, const size_t n, const std::string &separator=" ", const std::string &start="[" , const std::string &end="]", std::ostream &os=std::cout)
- `template<typename T >`
`void displnSTL` (const T *x, const size_t n, const std::string &separator=" ", const std::string &start="[" , const std::string &end="]", std::ostream &os=std::cout)
- `template<typename Derived >`
`void disp` (const Eigen::MatrixBase< Derived > &A, double chop=ct::chop, std::ostream &os=std::cout)
- `template<typename Derived >`
`void displn` (const Eigen::MatrixBase< Derived > &A, double chop=ct::chop, std::ostream &os=std::cout)
- `void disp` (const types::cplx c, double chop=ct::chop, std::ostream &os=std::cout)
- `void displn` (const types::cplx c, double chop=ct::chop, std::ostream &os=std::cout)
- `template<typename Derived >`
`void save` (const Eigen::MatrixBase< Derived > &A, const std::string &fname)
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > load` (const std::string &fname)
- `template<typename Derived >`
`Derived loadMATLABmatrix` (const std::string &mat_file, const std::string &var_name)

- `template<>`
`types::dmat loadMATLABmatrix` (const std::string &mat_file, const std::string &var_name)
- `template<>`
`types::cmat loadMATLABmatrix` (const std::string &mat_file, const std::string &var_name)
- `template<typename Derived >`
void `saveMATLABmatrix` (const Eigen::MatrixBase< Derived > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)
- `template<>`
void `saveMATLABmatrix` (const Eigen::MatrixBase< typename `types::dmat` > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)
- `template<>`
void `saveMATLABmatrix` (const Eigen::MatrixBase< typename `types::cmat` > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)
- `template<typename Derived >`
Derived `rand` (size_t rows, size_t cols, double a=0, double b=1)
- `template<>`
`types::dmat rand` (size_t rows, size_t cols, double a, double b)
- `template<>`
`types::cmat rand` (size_t rows, size_t cols, double a, double b)
- double `rand` (double a=0, double b=1)
- `template<typename Derived >`
Derived `randn` (size_t rows, size_t cols, double mean=0, double sigma=1)
- `template<>`
`types::dmat randn` (size_t rows, size_t cols, double mean, double sigma)
- `template<>`
`types::cmat randn` (size_t rows, size_t cols, double mean, double sigma)
- double `randn` (double mean=0, double sigma=1)
- `types::cmat randU` (size_t D)
- `types::cmat randV` (size_t Din, size_t Dout)
- std::vector< `types::cmat` > `randKraus` (size_t n, size_t D)
- `types::cmat randH` (size_t D)
- `types::ket randket` (size_t D)
- `types::cmat randrho` (size_t D)

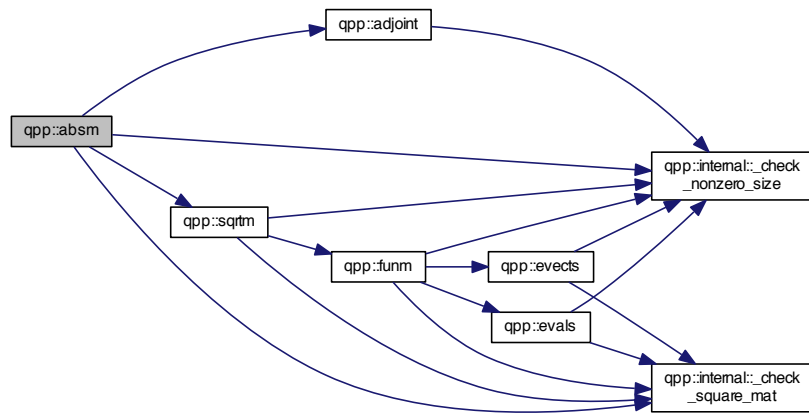
Variables

- `RandomDevices` & `rdevs` = `RandomDevices::getInstance()`
- const `Gates` & `gt` = `Gates::getInstance()`

5.1.1 Function Documentation

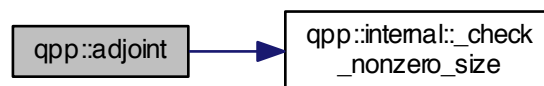
5.1.1.1 `template<typename Derived > types::cmat qpp::absm (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



5.1.1.2 `template<typename Derived > types::DynMat<typename Derived::Scalar> qpp::adjoint (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



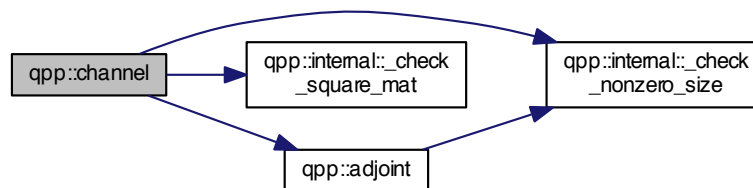
5.1.1.3 `template<typename Derived1 , typename Derived2 > types::DynMat<typename Derived1::Scalar> qpp::anticomm (const Eigen::MatrixBase< Derived1 > & A, const Eigen::MatrixBase< Derived2 > & B)`

Here is the call graph for this function:



5.1.1.4 `types::cmat qpp::channel (const types::cmat & rho, const std::vector< types::cmat > & Ks)`

Here is the call graph for this function:



5.1.1.5 `types::cmat qpp::choi (const std::vector< types::cmat > & Ks)`

Here is the call graph for this function:



5.1.1.6 `std::vector<types::cmat> qpp::choi2kraus (const types::cmat & A)`

Here is the call graph for this function:



5.1.1.7 `template<typename Derived1 , typename Derived2 > types::DynMat<typename Derived1::Scalar> qpp::comm (const Eigen::MatrixBase< Derived1 > & A, const Eigen::MatrixBase< Derived2 > & B)`

Here is the call graph for this function:



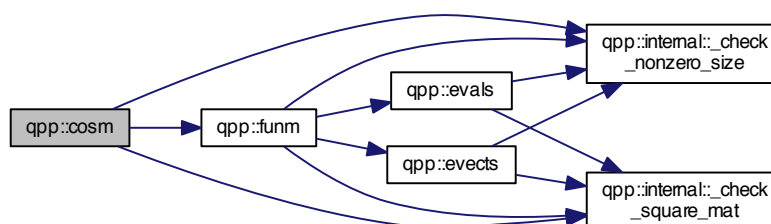
5.1.1.8 `template<typename Derived > types::DynMat<typename Derived::Scalar> qpp::conjugate (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



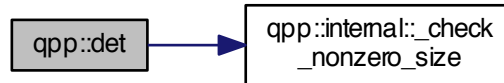
5.1.1.9 `template<typename Derived > types::cmat qpp::cosm (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



5.1.1.10 `template<typename Derived> Derived::Scalar qpp::det (const Eigen::MatrixBase< Derived> & A)`

Here is the call graph for this function:



5.1.1.11 `template<typename Derived> void qpp::disp (const Eigen::MatrixBase< Derived> & A, double chop = ct::chop, std::ostream & os = std::cout)`

5.1.1.12 `void qpp::disp (const types::cplx c, double chop = ct::chop, std::ostream & os = std::cout)`

Here is the call graph for this function:



5.1.1.13 `template<typename Derived> void qpp::displn (const Eigen::MatrixBase< Derived> & A, double chop = ct::chop, std::ostream & os = std::cout)`

Here is the call graph for this function:



5.1.1.14 `void qpp::displn (const types::cplx c, double chop = ct : : chop, std::ostream & os = std : : cout)`

Here is the call graph for this function:



5.1.1.15 `template<typename T> void qpp::displnSTL (const T & x, const std::string & separator = " ", const std::string & start = " [", const std::string & end = "] ", std::ostream & os = std : : cout)`

Here is the call graph for this function:



5.1.1.16 `template<typename T> void qpp::displnSTL (const T * x, const size_t n, const std::string & separator = " ", const std::string & start = " [", const std::string & end = "] ", std::ostream & os = std : : cout)`

Here is the call graph for this function:

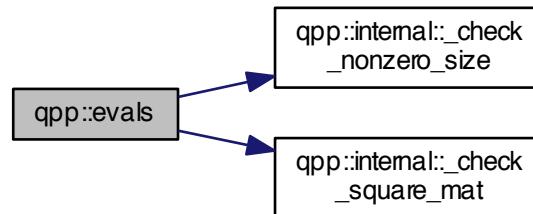


5.1.1.17 `template<typename T> void qpp::dispSTL (const T & x, const std::string & separator = " ", const std::string & start = " [", const std::string & end = "] ", std::ostream & os = std : : cout)`

5.1.1.18 `template<typename T> void qpp::dispSTL (const T * x, const size_t n, const std::string & separator = " ", const std::string & start = " [", const std::string & end = "] ", std::ostream & os = std : : cout)`

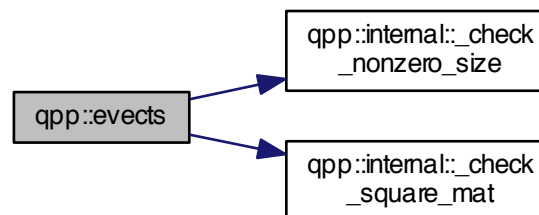
5.1.1.19 `template<typename Derived > types::cmat qpp::evals (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



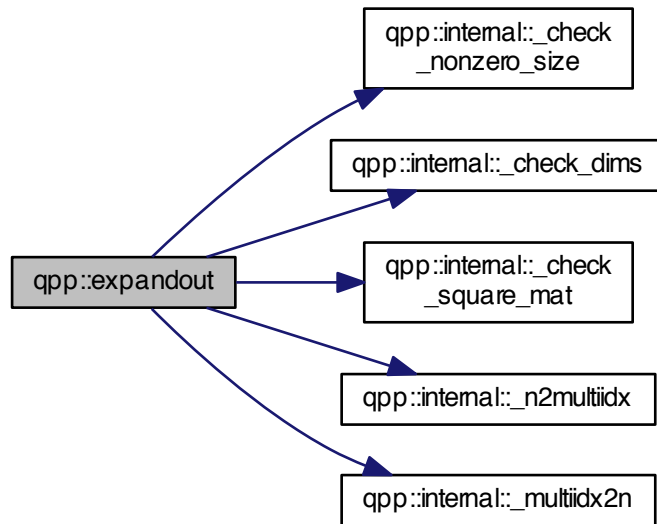
5.1.1.20 `template<typename Derived > types::cmat qpp::evecs (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



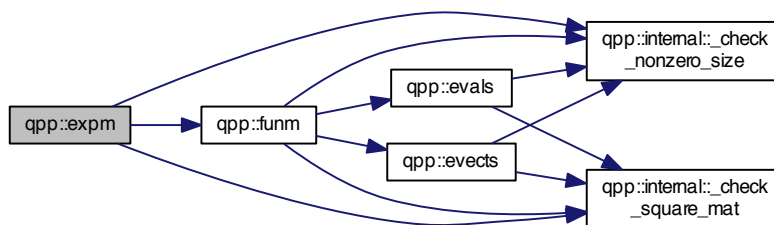
5.1.1.21 `template<typename Derived> types::DynMat<typename Derived::Scalar> qpp::expandout (const Eigen::MatrixBase< Derived> & A, size_t pos, const std::vector< size_t> & dims)`

Here is the call graph for this function:



5.1.1.22 `template<typename Derived> types::cmat qpp::expm (const Eigen::MatrixBase< Derived> & A)`

Here is the call graph for this function:



5.1.1.23 `template<typename OutputScalar , typename Derived > types::DynMat<OutputScalar> qpp::fun (const Eigen::MatrixBase< Derived > & A, OutputScalar*)(const typename Derived::Scalar &) f)`

Here is the call graph for this function:



5.1.1.24 `template<typename Derived > types::cmat qpp::funm (const Eigen::MatrixBase< Derived > & A, types::cplx*)(const types::cplx &) f)`

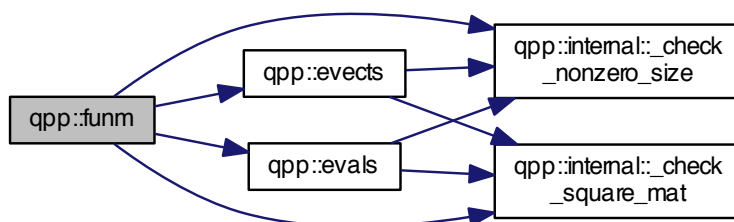
Parameters

<i>A</i>	input matrix
<i>f</i>	function pointer

Returns

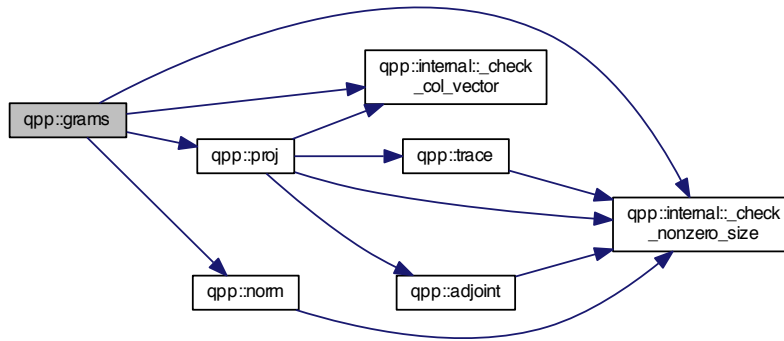
`types::cmat`

Here is the call graph for this function:



5.1.1.25 `template<typename Derived > types::DynMat<typename Derived::Scalar> qpp::grams (const std::vector< types::DynMat< typename Derived::Scalar > > & Vs)`

Here is the call graph for this function:



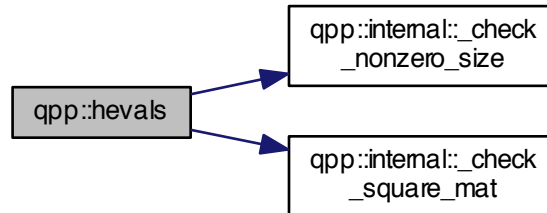
5.1.1.26 `template<typename Derived > types::DynMat<typename Derived::Scalar> qpp::grams (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



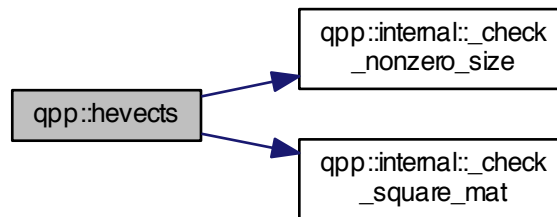
5.1.1.27 `template<typename Derived> types::cmat qpp::hevals (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



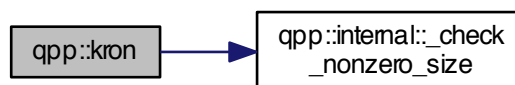
5.1.1.28 `template<typename Derived> types::cmat qpp::hevects (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



5.1.1.29 `template<typename Derived1, typename Derived2> types::DynMat<typename Derived1::Scalar> qpp::kron (const Eigen::MatrixBase< Derived1 > & A, const Eigen::MatrixBase< Derived2 > & B)`

Here is the call graph for this function:



5.1.1.30 `template<typename Derived> types::DynMat<typename Derived::Scalar> qpp::kronlist (const std::vector< types::DynMat< typename Derived::Scalar> > & As)`

Here is the call graph for this function:



5.1.1.31 `template<typename Derived> types::DynMat<typename Derived::Scalar> qpp::kronpow (const Eigen::MatrixBase< Derived> & A, size_t n)`

Here is the call graph for this function:



5.1.1.32 `template<typename Derived> types::DynMat<typename Derived::Scalar> qpp::load (const std::string & fname)`

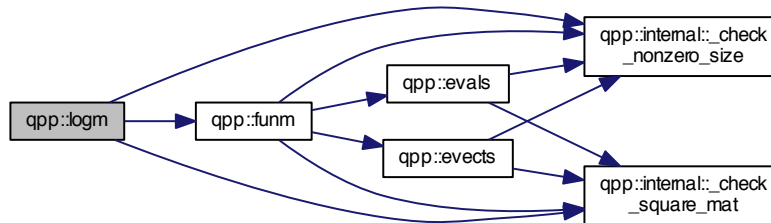
5.1.1.33 `template<typename Derived> Derived qpp::loadMATLABmatrix (const std::string & mat_file, const std::string & var_name)`

5.1.1.34 `template<> types::dmat qpp::loadMATLABmatrix (const std::string & mat_file, const std::string & var_name)`

5.1.1.35 `template<> types::cmat qpp::loadMATLABmatrix (const std::string & mat_file, const std::string & var_name)`

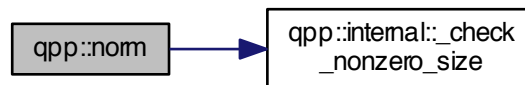
5.1.1.36 `template<typename Derived> types::cmat qpp::logm (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



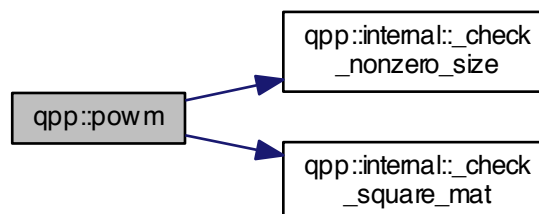
5.1.1.37 `template<typename Derived> double qpp::norm (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



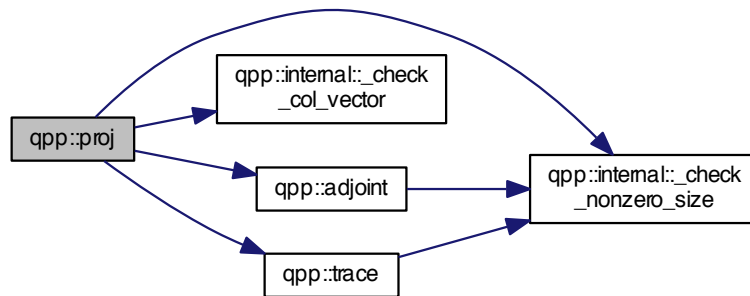
5.1.1.38 `template<typename Derived> types::DynMat<typename Derived::Scalar> qpp::powm (const Eigen::MatrixBase< Derived > & A, size_t n)`

Here is the call graph for this function:



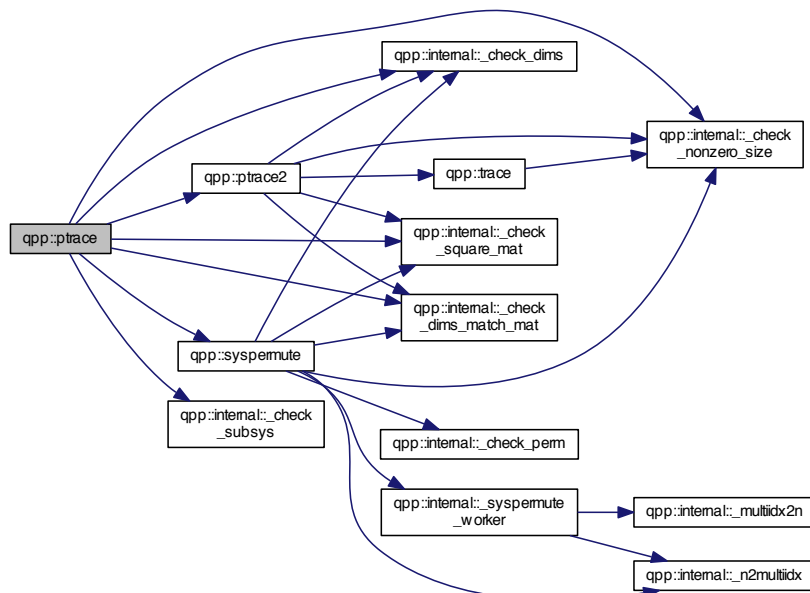
5.1.1.39 `template<typename Derived> types::DynMat<typename Derived::Scalar> qpp::proj (const Eigen::MatrixBase<Derived> & V)`

Here is the call graph for this function:



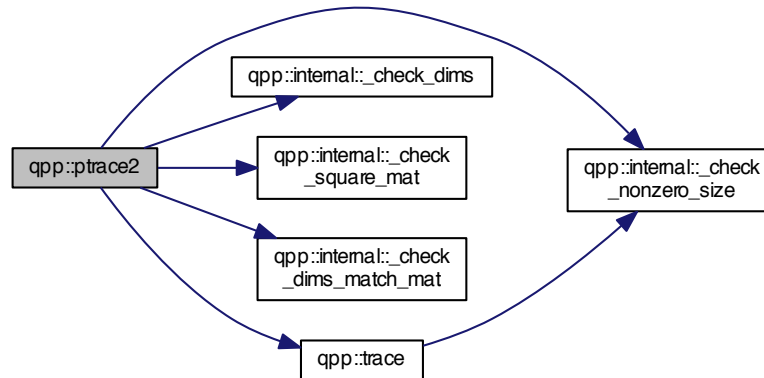
5.1.1.40 `template<typename Derived> types::DynMat<typename Derived::Scalar> qpp::ptrace (const Eigen::MatrixBase<Derived> & A, const std::vector<size_t> & subsys, const std::vector<size_t> & dims)`

Here is the call graph for this function:



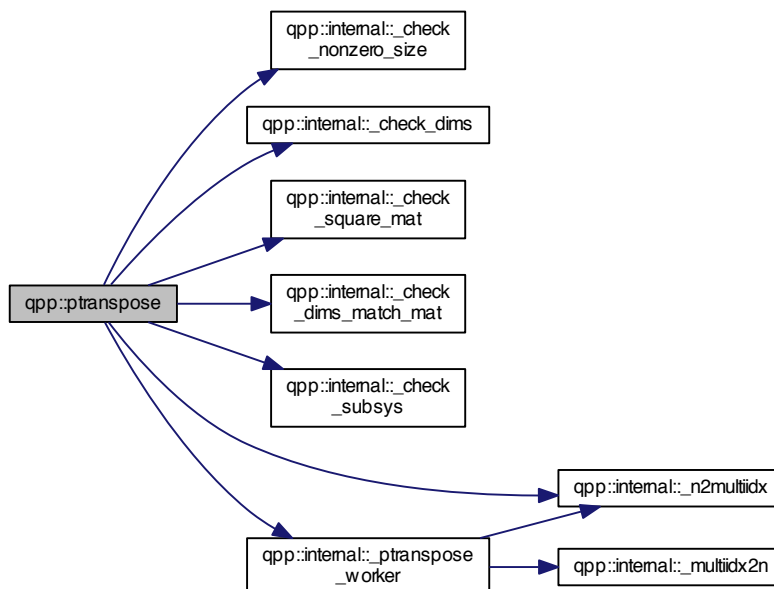
5.1.1.41 `template<typename Derived> types::DynMat<typename Derived::Scalar> qpp::ptrace2 (const Eigen::MatrixBase< Derived> & A, const std::vector< size_t> dims)`

Here is the call graph for this function:



5.1.1.42 `template<typename Derived> types::DynMat<typename Derived::Scalar> qpp::ptrtranspose (const Eigen::MatrixBase< Derived> & A, const std::vector< size_t> & subsys, const std::vector< size_t> & dims)`

Here is the call graph for this function:



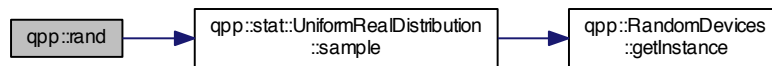
5.1.1.43 `template<typename Derived > Derived qpp::rand (size_t rows, size_t cols, double a = 0, double b = 1)`

5.1.1.44 `template<> types::dmat qpp::rand (size_t rows, size_t cols, double a, double b)`

5.1.1.45 `template<> types::cmat qpp::rand (size_t rows, size_t cols, double a, double b)`

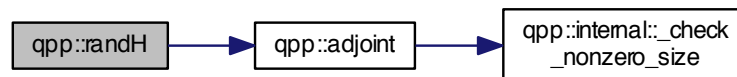
5.1.1.46 `double qpp::rand (double a = 0, double b = 1)`

Here is the call graph for this function:



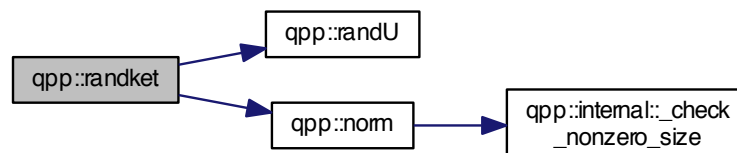
5.1.1.47 `types::cmat qpp::randH (size_t D)`

Here is the call graph for this function:



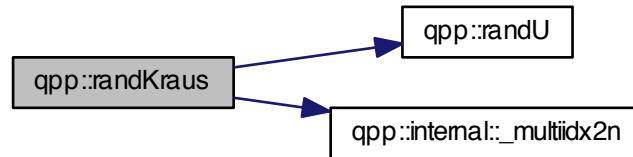
5.1.1.48 `types::ket qpp::randket (size_t D)`

Here is the call graph for this function:



5.1.1.49 `std::vector<types::cmat> qpp::randKraus (size_t n, size_t D)`

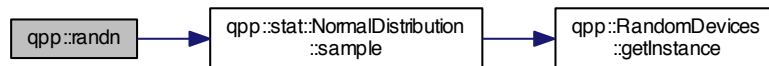
Here is the call graph for this function:



5.1.1.50 `template<typename Derived> Derived qpp::randn (size_t rows, size_t cols, double mean = 0, double sigma = 1)`

5.1.1.51 `template<> types::dmat qpp::randn (size_t rows, size_t cols, double mean, double sigma)`

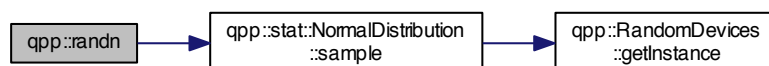
Here is the call graph for this function:



5.1.1.52 `template<> types::cmat qpp::randn (size_t rows, size_t cols, double mean, double sigma)`

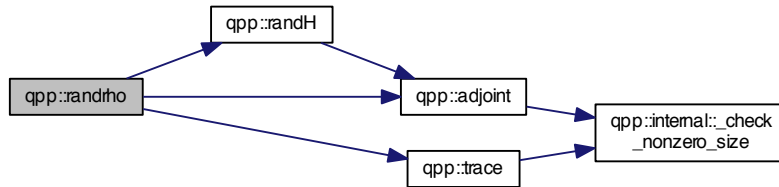
5.1.1.53 `double qpp::randn (double mean = 0, double sigma = 1)`

Here is the call graph for this function:



5.1.1.54 `types::cmat qpp::randrho (size_t D)`

Here is the call graph for this function:



5.1.1.55 `types::cmat qpp::randU (size_t D)`

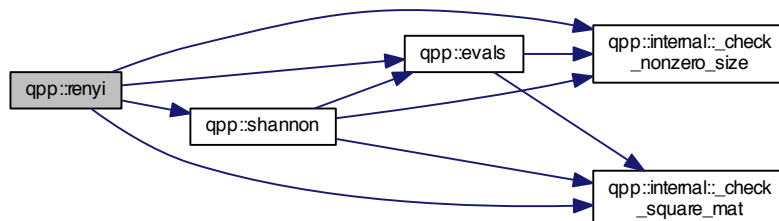
5.1.1.56 `types::cmat qpp::randV (size_t Din, size_t Dout)`

Here is the call graph for this function:



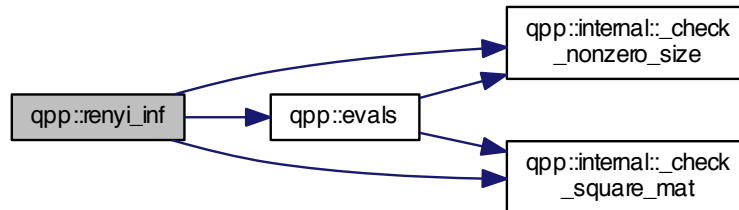
5.1.1.57 `template<typename Derived> double qpp::renyi (const double alpha, const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



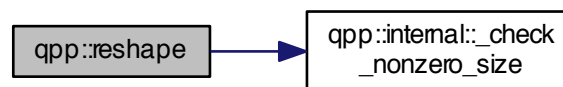
5.1.1.58 `template<typename Derived > double qpp::renyi_inf (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



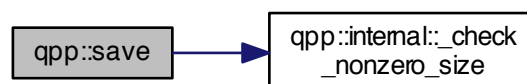
5.1.1.59 `template<typename Derived > types::DynMat<typename Derived::Scalar> qpp::reshape (const Eigen::MatrixBase< Derived > & A, size_t rows, size_t cols)`

Here is the call graph for this function:



5.1.1.60 `template<typename Derived > void qpp::save (const Eigen::MatrixBase< Derived > & A, const std::string & fname)`

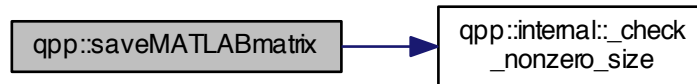
Here is the call graph for this function:



5.1.1.61 `template<typename Derived > void qpp::saveMATLABmatrix (const Eigen::MatrixBase< Derived > & A, const std::string & mat_file, const std::string & var_name, const std::string & mode)`

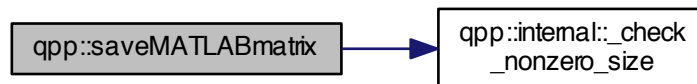
5.1.1.62 `template<> void qpp::saveMATLABmatrix (const Eigen::MatrixBase< typename types::dmat > & A, const std::string & mat_file, const std::string & var_name, const std::string & mode)`

Here is the call graph for this function:



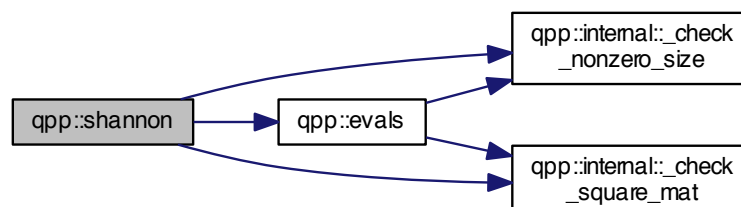
5.1.1.63 `template<> void qpp::saveMATLABmatrix (const Eigen::MatrixBase< typename types::cmat > & A, const std::string & mat_file, const std::string & var_name, const std::string & mode)`

Here is the call graph for this function:



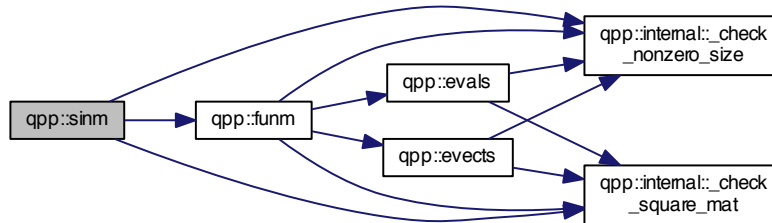
5.1.1.64 `template<typename Derived > double qpp::shannon (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



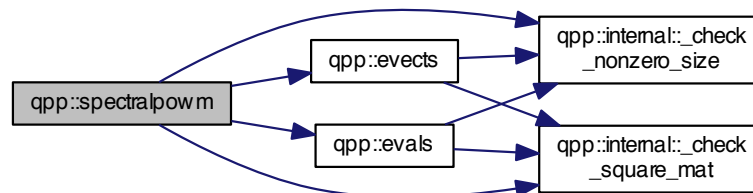
5.1.1.65 `template<typename Derived> types::cmat qpp::sinm (const Eigen::MatrixBase< Derived> & A)`

Here is the call graph for this function:



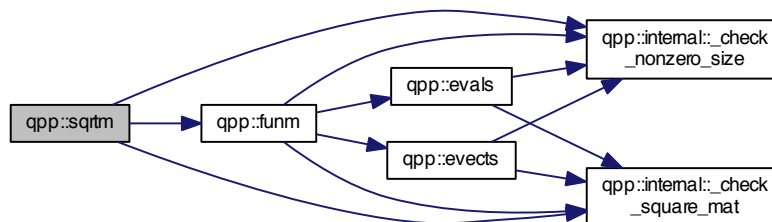
5.1.1.66 `template<typename Derived> types::cmat qpp::spectralpowm (const Eigen::MatrixBase< Derived> & A, const types::cplx z)`

Here is the call graph for this function:



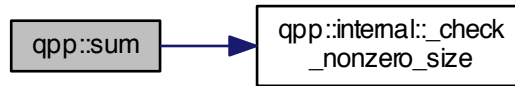
5.1.1.67 `template<typename Derived> types::cmat qpp::sqrtm (const Eigen::MatrixBase< Derived> & A)`

Here is the call graph for this function:



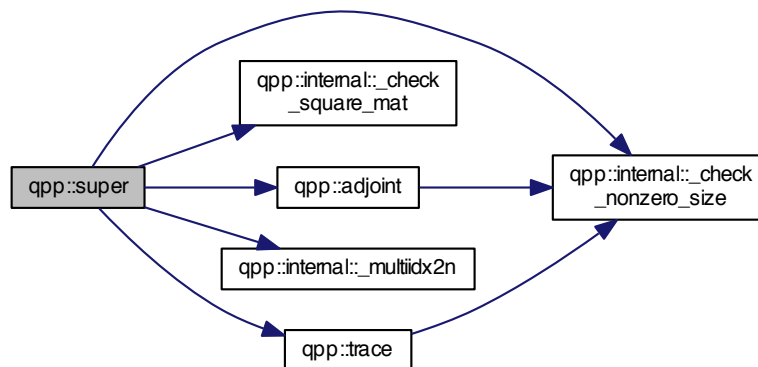
5.1.1.68 `template<typename Derived > Derived::Scalar qpp::sum (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



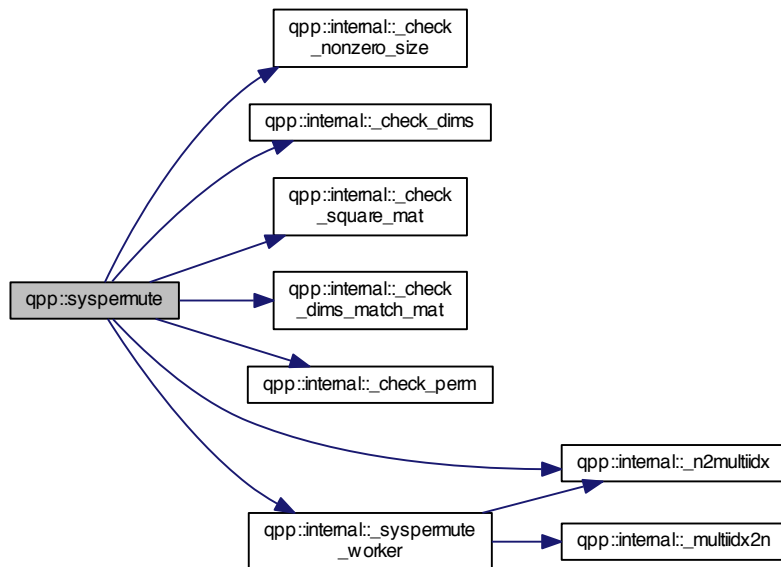
5.1.1.69 `types::cmat qpp::super (const std::vector< types::cmat > & Ks)`

Here is the call graph for this function:



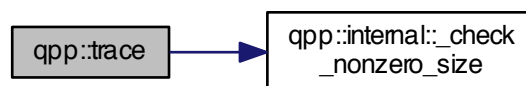
5.1.1.70 `template<typename Derived> types::DynMat<typename Derived::Scalar> qpp::syspermute (const Eigen::MatrixBase< Derived> & A, const std::vector< size_t> perm, const std::vector< size_t> & dims)`

Here is the call graph for this function:



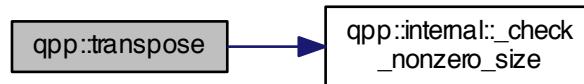
5.1.1.71 `template<typename Derived> Derived::Scalar qpp::trace (const Eigen::MatrixBase< Derived> & A)`

Here is the call graph for this function:



5.1.1.72 `template<typename Derived > types::DynMat<typename Derived::Scalar> qpp::transpose (const Eigen::MatrixBase< Derived > & A)`

Here is the call graph for this function:



5.1.2 Variable Documentation

5.1.2.1 `const Gates& qpp::gt = Gates::getInstance()`

5.1.2.2 `RandomDevices& qpp::rdevs = RandomDevices::getInstance()`

5.2 qpp::ct Namespace Reference

Functions

- `std::complex< double > omega (size_t D)`

Variables

- `const double chop = 1e-10`
- `const double eps = 1e-14`
- `const std::complex< double > ii = { 0, 1 }`
- `const double pi = 3.141592653589793238462643383279502884`
- `const double ee = 2.718281828459045235360287471352662497`

5.2.1 Function Documentation

5.2.1.1 `std::complex<double> qpp::ct::omega (size_t D)`

5.2.2 Variable Documentation

5.2.2.1 `const double qpp::ct::chop = 1e-10`

5.2.2.2 `const double qpp::ct::ee = 2.718281828459045235360287471352662497`

5.2.2.3 `const double qpp::ct::eps = 1e-14`

5.2.2.4 `const std::complex<double> qpp::ct::ii = { 0, 1 }`

5.2.2.5 `const double qpp::ct::pi = 3.141592653589793238462643383279502884`

5.3 qpp::internal Namespace Reference

Functions

- void [_n2multiidx](#) (size_t n, size_t numdims, const size_t *dims, size_t *result)
- size_t [_multiidx2n](#) (const size_t *midx, size_t numdims, const size_t *dims)
- template<typename Derived >
bool [_check_square_mat](#) (const Eigen::MatrixBase< Derived > &A)
- template<typename Derived >
bool [_check_vector](#) (const Eigen::MatrixBase< Derived > &A)
- template<typename Derived >
bool [_check_row_vector](#) (const Eigen::MatrixBase< Derived > &A)
- template<typename Derived >
bool [_check_col_vector](#) (const Eigen::MatrixBase< Derived > &A)
- template<typename T >
bool [_check_nonzero_size](#) (const T &x)
- bool [_check_dims](#) (const std::vector< size_t > &dims)
- template<typename Derived >
bool [_check_dims_match_mat](#) (const std::vector< size_t > &dims, const Eigen::MatrixBase< Derived > &A)
- bool [_check_eq_dims](#) (const std::vector< size_t > &dims, size_t dim)
- bool [_check_subsys](#) (const std::vector< size_t > &subsys, const std::vector< size_t > &dims)
- bool [_check_perm](#) (const std::vector< size_t > &perm, const std::vector< size_t > &dims)
- template<typename Scalar >
void [_syspermute_worker](#) (const size_t *midxcol, size_t numdims, const size_t *cdims, const size_t *cperm, size_t i, size_t j, size_t &iperm, size_t &jperm, const [types::DynMat](#)< Scalar > &A, [types::DynMat](#)< Scalar > &result)
- template<typename Scalar >
void [_ptranspose_worker](#) (const size_t *midxcol, size_t numdims, size_t numsubsys, const size_t *cdims, const size_t *csubsys, size_t i, size_t j, size_t &iperm, size_t &jperm, const [types::DynMat](#)< Scalar > &A, [types::DynMat](#)< Scalar > &result)

5.3.1 Function Documentation

5.3.1.1 template<typename Derived > bool qpp::internal::_check_col_vector (const Eigen::MatrixBase< Derived > &A)

5.3.1.2 bool qpp::internal::_check_dims (const std::vector< size_t > &dims)

5.3.1.3 template<typename Derived > bool qpp::internal::_check_dims_match_mat (const std::vector< size_t > &dims, const Eigen::MatrixBase< Derived > &A)

5.3.1.4 bool qpp::internal::_check_eq_dims (const std::vector< size_t > &dims, size_t dim)

5.3.1.5 template<typename T > bool qpp::internal::_check_nonzero_size (const T &x)

5.3.1.6 bool qpp::internal::_check_perm (const std::vector< size_t > &perm, const std::vector< size_t > &dims)

5.3.1.7 template<typename Derived > bool qpp::internal::_check_row_vector (const Eigen::MatrixBase< Derived > &A)

5.3.1.8 template<typename Derived > bool qpp::internal::_check_square_mat (const Eigen::MatrixBase< Derived > &A)

5.3.1.9 bool qpp::internal::_check_subsys (const std::vector< size_t > &subsys, const std::vector< size_t > &dims)

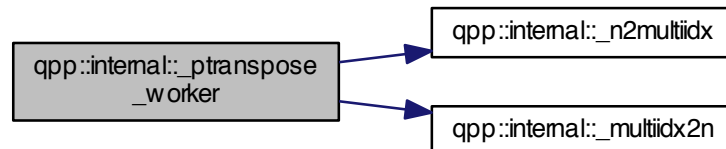
5.3.1.10 template<typename Derived > bool qpp::internal::_check_vector (const Eigen::MatrixBase< Derived > &A)

5.3.1.11 size_t qpp::internal::_multiidx2n (const size_t * midx, size_t numdims, const size_t * dims)

5.3.1.12 `void qpp::internal::_n2multiidx (size_t n, size_t numdims, const size_t * dims, size_t * result)`

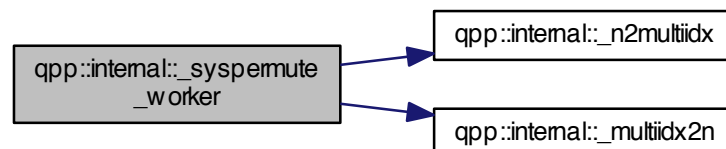
5.3.1.13 `template<typename Scalar > void qpp::internal::_ptranpose_worker (const size_t * midxcol, size_t numdims, size_t numsubsys, const size_t * cdims, const size_t * csubsys, size_t i, size_t j, size_t & iperm, size_t & jperm, const types::DynMat< Scalar > & A, types::DynMat< Scalar > & result)`

Here is the call graph for this function:



5.3.1.14 `template<typename Scalar > void qpp::internal::_syspermute_worker (const size_t * midxcol, size_t numdims, const size_t * cdims, const size_t * cperm, size_t i, size_t j, size_t & iperm, size_t & jperm, const types::DynMat< Scalar > & A, types::DynMat< Scalar > & result)`

Here is the call graph for this function:



5.4 qpp::stat Namespace Reference

Classes

- class [NormalDistribution](#)
- class [UniformRealDistribution](#)
- class [DiscreteDistribution](#)
- class [DiscreteDistributionFromComplex](#)

5.5 qpp::types Namespace Reference

Typedefs

- typedef std::complex< double > [cplx](#)
- typedef Eigen::MatrixXcd [cmat](#)
- typedef Eigen::MatrixXd [dmat](#)
- typedef Eigen::MatrixXf [fmat](#)
- typedef Eigen::MatrixXi [imat](#)
- typedef Eigen::Matrix< [cplx](#), Eigen::Dynamic, 1 > [ket](#)
- typedef Eigen::Matrix< [cplx](#), 1, Eigen::Dynamic > [bra](#)
- template<typename Scalar > using [DynMat](#) = Eigen::Matrix< Scalar, Eigen::Dynamic, Eigen::Dynamic >

5.5.1 Typedef Documentation

5.5.1.1 typedef Eigen::Matrix<[cplx](#), 1, Eigen::Dynamic> [qpp::types::bra](#)

5.5.1.2 typedef Eigen::MatrixXcd [qpp::types::cmat](#)

5.5.1.3 typedef std::complex<double> [qpp::types::cplx](#)

5.5.1.4 typedef Eigen::MatrixXd [qpp::types::dmat](#)

5.5.1.5 template<typename Scalar > using [qpp::types::DynMat](#) = typedef Eigen::Matrix<Scalar, Eigen::Dynamic, Eigen::Dynamic>

5.5.1.6 typedef Eigen::MatrixXf [qpp::types::fmat](#)

5.5.1.7 typedef Eigen::MatrixXi [qpp::types::imat](#)

5.5.1.8 typedef Eigen::Matrix<[cplx](#), Eigen::Dynamic, 1> [qpp::types::ket](#)

Chapter 6

Class Documentation

6.1 qpp::stat::DiscreteDistribution Class Reference

```
#include <stat.h>
```

Public Member Functions

- `template<typename InputIterator > DiscreteDistribution (InputIterator first, InputIterator last)`
- `DiscreteDistribution (std::initializer_list< double > weights)`
- `DiscreteDistribution (std::vector< double > weights)`
- `size_t sample ()`
- `std::vector< double > probabilities ()`

Protected Attributes

- `std::discrete_distribution
< size_t > _d`

6.1.1 Constructor & Destructor Documentation

6.1.1.1 `template<typename InputIterator > qpp::stat::DiscreteDistribution::DiscreteDistribution (InputIterator first, InputIterator last) [inline]`

6.1.1.2 `qpp::stat::DiscreteDistribution::DiscreteDistribution (std::initializer_list< double > weights) [inline]`

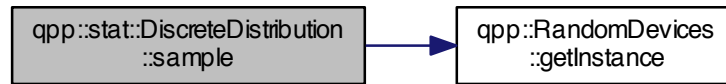
6.1.1.3 `qpp::stat::DiscreteDistribution::DiscreteDistribution (std::vector< double > weights) [inline]`

6.1.2 Member Function Documentation

6.1.2.1 `std::vector<double> qpp::stat::DiscreteDistribution::probabilities () [inline]`

6.1.2.2 `size_t qpp::stat::DiscreteDistribution::sample ()` [inline]

Here is the call graph for this function:



6.1.3 Member Data Documentation

6.1.3.1 `std::discrete_distribution<size_t> qpp::stat::DiscreteDistribution::_d` [protected]

The documentation for this class was generated from the following file:

- include/[stat.h](#)

6.2 `qpp::stat::DiscreteDistributionFromComplex` Class Reference

```
#include <stat.h>
```

Public Member Functions

- `template<typename InputIterator > DiscreteDistributionFromComplex (InputIterator first, InputIterator last)`
- `DiscreteDistributionFromComplex (std::initializer_list< types::cplx > amplitudes)`
- `DiscreteDistributionFromComplex (std::vector< types::cplx > amplitudes)`
- `DiscreteDistributionFromComplex (const types::cmat &V)`
- `size_t sample ()`
- `std::vector< double > probabilities ()`

Protected Member Functions

- `template<typename InputIterator > std::vector< double > cplx2amplitudes (InputIterator first, InputIterator last)`

Protected Attributes

- `std::discrete_distribution< size_t > _d`

6.2.1 Constructor & Destructor Documentation

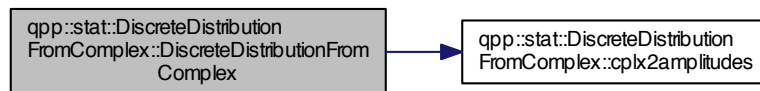
6.2.1.1 `template<typename InputIterator> qpp::stat::DiscreteDistributionFromComplex::DiscreteDistributionFromComplex (InputIterator first, InputIterator last) [inline]`

Here is the call graph for this function:



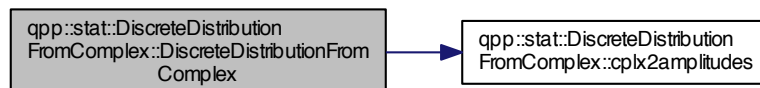
6.2.1.2 `qpp::stat::DiscreteDistributionFromComplex::DiscreteDistributionFromComplex (std::initializer_list< types::cplx > amplitudes) [inline]`

Here is the call graph for this function:



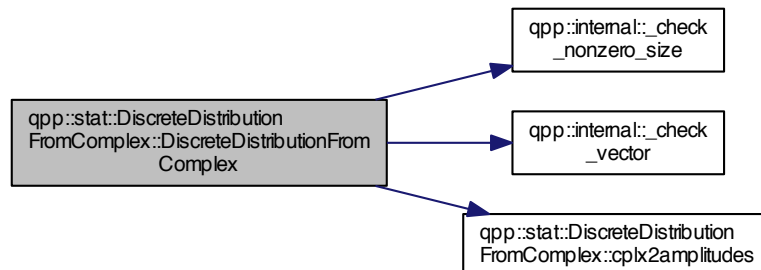
6.2.1.3 `qpp::stat::DiscreteDistributionFromComplex::DiscreteDistributionFromComplex (std::vector< types::cplx > amplitudes) [inline]`

Here is the call graph for this function:



6.2.1.4 `qpp::stat::DiscreteDistributionFromComplex::DiscreteDistributionFromComplex (const types::cmat & V)`
`[inline]`

Here is the call graph for this function:



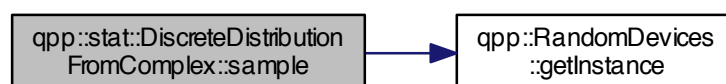
6.2.2 Member Function Documentation

6.2.2.1 `template<typename InputIterator > std::vector<double> qpp::stat::DiscreteDistributionFromComplex::cplx2amplitudes (InputIterator first, InputIterator last)` `[inline]`,
`[protected]`

6.2.2.2 `std::vector<double> qpp::stat::DiscreteDistributionFromComplex::probabilities ()` `[inline]`

6.2.2.3 `size_t qpp::stat::DiscreteDistributionFromComplex::sample ()` `[inline]`

Here is the call graph for this function:



6.2.3 Member Data Documentation

6.2.3.1 `std::discrete_distribution<size_t> qpp::stat::DiscreteDistributionFromComplex::_d` `[protected]`

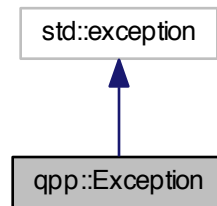
The documentation for this class was generated from the following file:

- [include/stat.h](#)

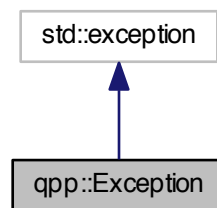
6.3 qpp::Exception Class Reference

```
#include <exception.h>
```

Inheritance diagram for qpp::Exception:



Collaboration diagram for qpp::Exception:



Public Types

- enum `Type` {
`Type::UNKNOWN_EXCEPTION = 0`, `Type::ZERO_SIZE`, `Type::MATRIX_NOT_SQUARE`, `Type::MATRIX_NOT_CVECTOR`,
`Type::MATRIX_NOT_RVECTOR`, `Type::MATRIX_NOT_VECTOR`, `Type::DIMS_INVALID`, `Type::DIMS_NOT_EQUAL`,
`Type::DIMS_MISMATCH_MATRIX`, `Type::SUBSYS_MISMATCH_DIMS`, `Type::PERM_MISMATCH_DIMS`,
`Type::NOT_QUBIT_GATE`,
`Type::NOT_QUBIT_SUBSYS`, `Type::OUT_OF_RANGE`, `Type::UNDEFINED_TYPE`, `Type::TYPE_MISMATCH`,
`Type::CUSTOM_EXCEPTION` }

Public Member Functions

- `Exception` (const std::string &where, const `Type` &type)
- `Exception` (const std::string &where, const std::string &custom)
- virtual const char * `what` () const noexcept override
- virtual `~Exception` () noexcept

Private Member Functions

- `std::string _construct_exception_msg ()`

Private Attributes

- `std::string _where`
- `std::string _msg`
- `Type _type`
- `std::string _custom`

6.3.1 Member Enumeration Documentation

6.3.1.1 `enum qpp::Exception::Type` `[strong]`

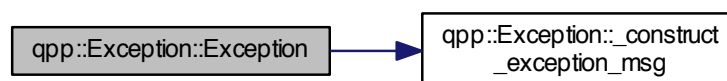
Enumerator

UNKNOWN_EXCEPTION
ZERO_SIZE
MATRIX_NOT_SQUARE
MATRIX_NOT_CVECTOR
MATRIX_NOT_RVECTOR
MATRIX_NOT_VECTOR
DIMS_INVALID
DIMS_NOT_EQUAL
DIMS_MISMATCH_MATRIX
SUBSYS_MISMATCH_DIMS
PERM_MISMATCH_DIMS
NOT_QUBIT_GATE
NOT_QUBIT_SUBSYS
OUT_OF_RANGE
UNDEFINED_TYPE
TYPE_MISMATCH
CUSTOM_EXCEPTION

6.3.2 Constructor & Destructor Documentation

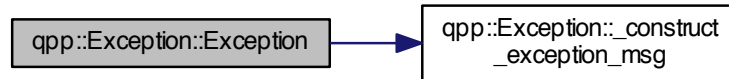
6.3.2.1 `qpp::Exception::Exception (const std::string & where, const Type & type)` `[inline]`

Here is the call graph for this function:



6.3.2.2 `qpp::Exception::Exception (const std::string & where, const std::string & custom)` `[inline]`

Here is the call graph for this function:



6.3.2.3 `virtual qpp::Exception::~~Exception ()` `[inline],[virtual],[noexcept]`

6.3.3 Member Function Documentation

6.3.3.1 `std::string qpp::Exception::_construct_exception_msg ()` `[inline],[private]`

6.3.3.2 `virtual const char* qpp::Exception::what () const` `[inline],[override],[virtual],[noexcept]`

6.3.4 Member Data Documentation

6.3.4.1 `std::string qpp::Exception::_custom` `[private]`

6.3.4.2 `std::string qpp::Exception::_msg` `[private]`

6.3.4.3 `Type qpp::Exception::_type` `[private]`

6.3.4.4 `std::string qpp::Exception::_where` `[private]`

The documentation for this class was generated from the following file:

- [include/exception.h](#)

6.4 qpp::Gates Class Reference

```
#include <gates.h>
```

Public Member Functions

- [Gates](#) (const [Gates](#) &)=delete
- [Gates](#) & [operator=](#) (const [Gates](#) &)=delete
- virtual [~Gates](#) ()=default
- [types::cmat Rtheta](#) (double theta) const
- [types::cmat Id](#) (size_t D) const
- [types::cmat Zd](#) (size_t D) const
- [types::cmat Fd](#) (size_t D) const
- [types::cmat Xd](#) (size_t D) const
- [types::cmat CTRL](#) (const [types::cmat](#) &A, const std::vector< size_t > &ctrl, const std::vector< size_t > &gate, size_t n, size_t D=2) const

Static Public Member Functions

- static const [Gates](#) & [getInstance](#) ()

Public Attributes

- [types::cmat](#) [Id2](#)
- [types::cmat](#) [H](#)
- [types::cmat](#) [X](#)
- [types::cmat](#) [Y](#)
- [types::cmat](#) [Z](#)
- [types::cmat](#) [S](#)
- [types::cmat](#) [T](#)
- [types::cmat](#) [CNOTab](#)
- [types::cmat](#) [CZ](#)
- [types::cmat](#) [CS](#)
- [types::cmat](#) [CNOTba](#)
- [types::cmat](#) [SWAP](#)
- [types::cmat](#) [TOF](#)
- [types::cmat](#) [FRED](#)
- [types::ket](#) [x0](#)
- [types::ket](#) [x1](#)
- [types::ket](#) [y0](#)
- [types::ket](#) [y1](#)
- [types::ket](#) [z0](#)
- [types::ket](#) [z1](#)
- [types::cmat](#) [px0](#)
- [types::cmat](#) [px1](#)
- [types::cmat](#) [py0](#)
- [types::cmat](#) [py1](#)
- [types::cmat](#) [pz0](#)
- [types::cmat](#) [pz1](#)
- [types::ket](#) [b00](#)
- [types::ket](#) [b01](#)
- [types::ket](#) [b10](#)
- [types::ket](#) [b11](#)
- [types::cmat](#) [pb00](#)
- [types::cmat](#) [pb01](#)
- [types::cmat](#) [pb10](#)
- [types::cmat](#) [pb11](#)

Private Member Functions

- [Gates](#) ()

6.4.1 Constructor & Destructor Documentation

6.4.1.1 `qpp::Gates::Gates ()` [inline],[private]

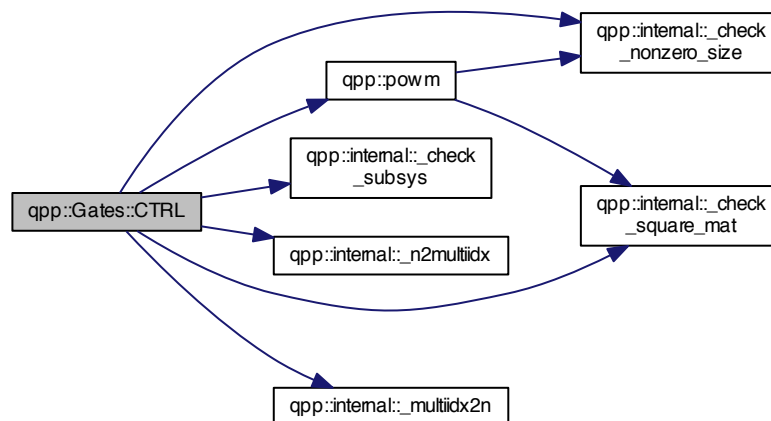
6.4.1.2 `qpp::Gates::Gates (const Gates &)` [delete]

6.4.1.3 `virtual qpp::Gates::~~Gates ()` [virtual],[default]

6.4.2 Member Function Documentation

6.4.2.1 `types::cmat qpp::Gates::CTRL (const types::cmat & A, const std::vector< size_t > & ctrl, const std::vector< size_t > & gate, size_t n, size_t D = 2) const` [inline]

Here is the call graph for this function:



6.4.2.2 `types::cmat qpp::Gates::Fd (size_t D) const` [inline]

Here is the call graph for this function:



6.4.2.3 `static const Gates& qpp::Gates::getInstance ()` [inline],[static]

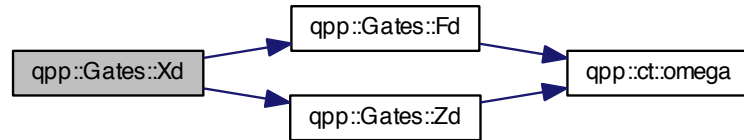
6.4.2.4 `types::cmat qpp::Gates::Id (size_t D) const` [inline]

6.4.2.5 `Gates& qpp::Gates::operator= (const Gates &)` [delete]

6.4.2.6 `types::cmat qpp::Gates::Rtheta (double theta) const` [inline]

6.4.2.7 `types::cmat qpp::Gates::Xd (size_t D) const` `[inline]`

Here is the call graph for this function:



6.4.2.8 `types::cmat qpp::Gates::Zd (size_t D) const` `[inline]`

Here is the call graph for this function:



6.4.3 Member Data Documentation

6.4.3.1 `types::ket qpp::Gates::b00`

6.4.3.2 `types::ket qpp::Gates::b01`

6.4.3.3 `types::ket qpp::Gates::b10`

6.4.3.4 `types::ket qpp::Gates::b11`

6.4.3.5 `types::cmat qpp::Gates::CNOTab`

6.4.3.6 `types::cmat qpp::Gates::CNOTba`

6.4.3.7 `types::cmat qpp::Gates::CS`

6.4.3.8 `types::cmat qpp::Gates::CZ`

6.4.3.9 `types::cmat qpp::Gates::FRED`

6.4.3.10 `types::cmat qpp::Gates::H`

6.4.3.11 `types::cmat qpp::Gates::Id2`

- 6.4.3.12 `types::cmat qpp::Gates::pb00`
- 6.4.3.13 `types::cmat qpp::Gates::pb01`
- 6.4.3.14 `types::cmat qpp::Gates::pb10`
- 6.4.3.15 `types::cmat qpp::Gates::pb11`
- 6.4.3.16 `types::cmat qpp::Gates::px0`
- 6.4.3.17 `types::cmat qpp::Gates::px1`
- 6.4.3.18 `types::cmat qpp::Gates::py0`
- 6.4.3.19 `types::cmat qpp::Gates::py1`
- 6.4.3.20 `types::cmat qpp::Gates::pz0`
- 6.4.3.21 `types::cmat qpp::Gates::pz1`
- 6.4.3.22 `types::cmat qpp::Gates::S`
- 6.4.3.23 `types::cmat qpp::Gates::SWAP`
- 6.4.3.24 `types::cmat qpp::Gates::T`
- 6.4.3.25 `types::cmat qpp::Gates::TOF`
- 6.4.3.26 `types::cmat qpp::Gates::X`
- 6.4.3.27 `types::ket qpp::Gates::x0`
- 6.4.3.28 `types::ket qpp::Gates::x1`
- 6.4.3.29 `types::cmat qpp::Gates::Y`
- 6.4.3.30 `types::ket qpp::Gates::y0`
- 6.4.3.31 `types::ket qpp::Gates::y1`
- 6.4.3.32 `types::cmat qpp::Gates::Z`
- 6.4.3.33 `types::ket qpp::Gates::z0`
- 6.4.3.34 `types::ket qpp::Gates::z1`

The documentation for this class was generated from the following file:

- [include/gates.h](#)

6.5 qpp::Measurement Class Reference

```
#include <measurement.h>
```

Public Member Functions

- [Measurement](#) ()
- virtual [~Measurement](#) ()

6.5.1 Constructor & Destructor Documentation

6.5.1.1 `qpp::Measurement::Measurement ()`

6.5.1.2 `virtual qpp::Measurement::~~Measurement ()` [virtual]

The documentation for this class was generated from the following file:

- include/[measurement.h](#)

6.6 qpp::stat::NormalDistribution Class Reference

```
#include <stat.h>
```

Public Member Functions

- [NormalDistribution](#) (double mean=0, double sigma=1)
- double [sample](#) ()

Protected Attributes

- `std::normal_distribution _d`

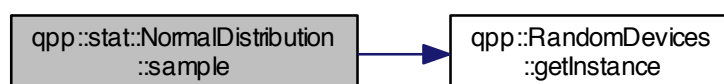
6.6.1 Constructor & Destructor Documentation

6.6.1.1 `qpp::stat::NormalDistribution::NormalDistribution (double mean = 0, double sigma = 1)` [inline]

6.6.2 Member Function Documentation

6.6.2.1 `double qpp::stat::NormalDistribution::sample ()` [inline]

Here is the call graph for this function:



6.6.3 Member Data Documentation

6.6.3.1 `std::normal_distribution qpp::stat::NormalDistribution::_d` `[protected]`

The documentation for this class was generated from the following file:

- `include/stat.h`

6.7 qpp::Qudit Class Reference

```
#include <qudit.h>
```

Public Member Functions

- throw [Exception](#) ("Qudit::Qudit", `Exception::Type::MATRIX_NOT_SQUARE`)
- `size_t measure` (const [types::cmat](#) &U, bool destructive=false)
- `size_t measure` (bool destructive=false)
- [types::cmat getRho](#) () const
- `size_t getD` () const
- virtual `~Qudit` ()=default

Public Attributes

- `_D` = rho.rows()
- `_rho` = rho

Private Attributes

- [types::cmat _rho](#)
- `size_t _D`

6.7.1 Constructor & Destructor Documentation

6.7.1.1 `virtual qpp::Qudit::~~Qudit ()` `[virtual],[default]`

6.7.2 Member Function Documentation

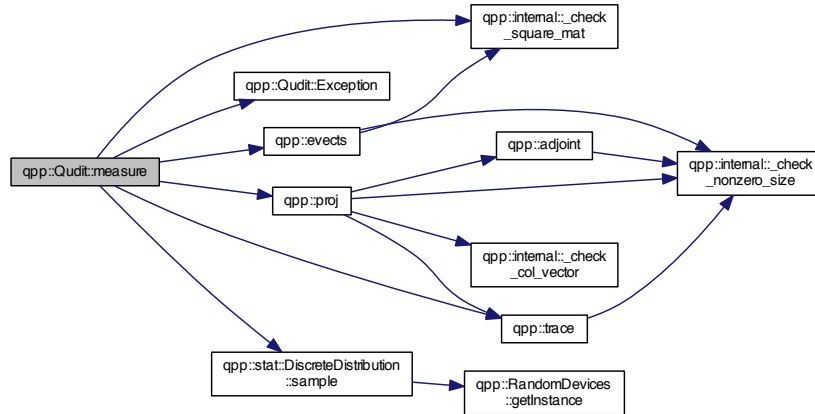
6.7.2.1 `throw qpp::Qudit::Exception ("Qudit::Qudit", Exception::Type::MATRIX_NOT_SQUARE)`

6.7.2.2 `size_t qpp::Qudit::getD () const` `[inline]`

6.7.2.3 `types::cmat qpp::Qudit::getRho () const` `[inline]`

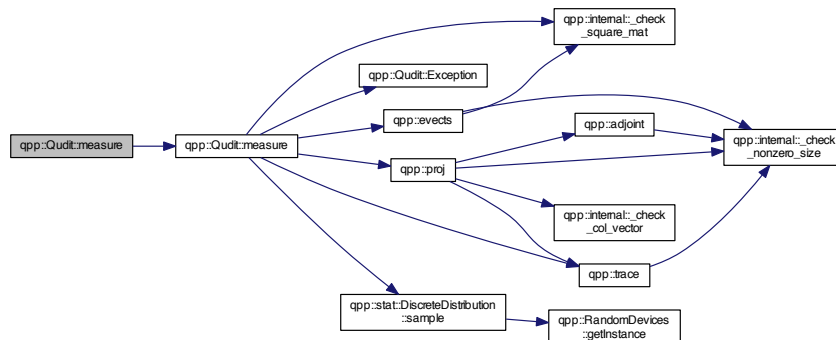
6.7.2.4 `size_t qpp::Qudit::measure (const types::cmat & U, bool destructive = false) [inline]`

Here is the call graph for this function:



6.7.2.5 `size_t qpp::Qudit::measure (bool destructive = false) [inline]`

Here is the call graph for this function:



6.7.3 Member Data Documentation

6.7.3.1 `size_t qpp::Qudit::_D [private]`

6.7.3.2 `qpp::Qudit::_D = rho.rows()`

6.7.3.3 `types::cmat qpp::Qudit::_rho [private]`

6.7.3.4 `qpp::Qudit::_rho = rho`

The documentation for this class was generated from the following file:

- [include/qudit.h](#)

6.8 qpp::RandomDevices Class Reference

```
#include <randevs.h>
```

Public Member Functions

- [RandomDevices](#) (const [RandomDevices](#) &)=delete
- [RandomDevices](#) & [operator=](#) (const [RandomDevices](#) &)=delete
- virtual [~RandomDevices](#) ()=default

Static Public Member Functions

- static [RandomDevices](#) & [getInstance](#) ()

Public Attributes

- std::random_device [_rd](#)
- std::mt19937 [_rng](#)

Private Member Functions

- [RandomDevices](#) ()

6.8.1 Constructor & Destructor Documentation

6.8.1.1 [qpp::RandomDevices::RandomDevices](#) () [inline],[private]

6.8.1.2 [qpp::RandomDevices::RandomDevices](#) (const [RandomDevices](#) &) [delete]

6.8.1.3 virtual [qpp::RandomDevices::~~RandomDevices](#) () [virtual],[default]

6.8.2 Member Function Documentation

6.8.2.1 static [RandomDevices&](#) [qpp::RandomDevices::getInstance](#) () [inline],[static]

6.8.2.2 [RandomDevices&](#) [qpp::RandomDevices::operator=](#) (const [RandomDevices](#) &) [delete]

6.8.3 Member Data Documentation

6.8.3.1 std::random_device [qpp::RandomDevices::_rd](#)

6.8.3.2 std::mt19937 [qpp::RandomDevices::_rng](#)

The documentation for this class was generated from the following file:

- include/[randevs.h](#)

6.9 qpp::Timer Class Reference

```
#include <timer.h>
```

Public Member Functions

- [Timer](#) ()
- void [tic](#) ()
- void [toc](#) ()
- double [seconds](#) () const
- virtual [~Timer](#) ()=default

Protected Attributes

- std::chrono::high_resolution_clock::time_point [_start](#)
- std::chrono::high_resolution_clock::time_point [_end](#)

Friends

- std::ostream & [operator<<](#) (std::ostream &os, const [Timer](#) &rhs)

6.9.1 Constructor & Destructor Documentation

6.9.1.1 `qpp::Timer::Timer ()` `[inline]`

6.9.1.2 `virtual qpp::Timer::~~Timer ()` `[virtual],[default]`

6.9.2 Member Function Documentation

6.9.2.1 `double qpp::Timer::seconds () const` `[inline]`

6.9.2.2 `void qpp::Timer::tic ()` `[inline]`

6.9.2.3 `void qpp::Timer::toc ()` `[inline]`

6.9.3 Friends And Related Function Documentation

6.9.3.1 `std::ostream& operator<< (std::ostream & os, const Timer & rhs)` `[friend]`

6.9.4 Member Data Documentation

6.9.4.1 `std::chrono::high_resolution_clock::time_point qpp::Timer::_end` `[protected]`

6.9.4.2 `std::chrono::high_resolution_clock::time_point qpp::Timer::_start` `[protected]`

The documentation for this class was generated from the following file:

- include/[timer.h](#)

6.10 qpp::stat::UniformRealDistribution Class Reference

```
#include <stat.h>
```

Public Member Functions

- [UniformRealDistribution](#) (double a=0, double b=1)
- double [sample](#) ()

Protected Attributes

- `std::uniform_real_distribution _d`

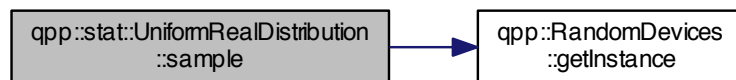
6.10.1 Constructor & Destructor Documentation

6.10.1.1 `qpp::stat::UniformRealDistribution::UniformRealDistribution (double a = 0, double b = 1)` `[inline]`

6.10.2 Member Function Documentation

6.10.2.1 `double qpp::stat::UniformRealDistribution::sample ()` `[inline]`

Here is the call graph for this function:



6.10.3 Member Data Documentation

6.10.3.1 `std::uniform_real_distribution qpp::stat::UniformRealDistribution::_d` `[protected]`

The documentation for this class was generated from the following file:

- `include/stat.h`

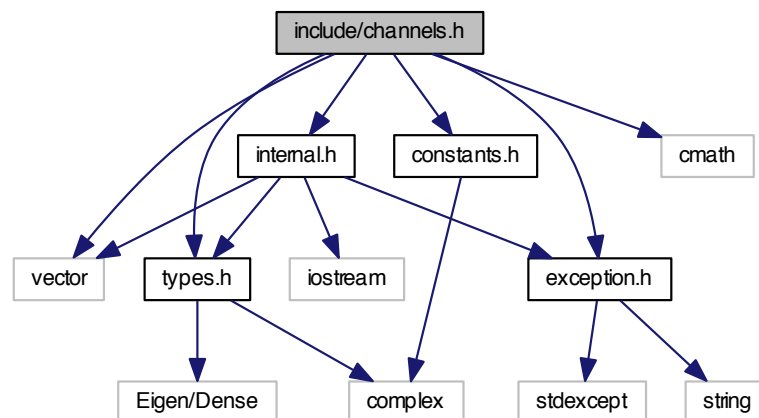
Chapter 7

File Documentation

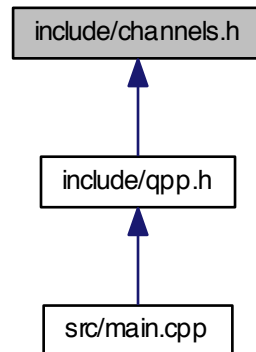
7.1 include/channels.h File Reference

```
#include <vector>
#include <cmath>
#include "types.h"
#include "internal.h"
#include "exception.h"
#include "constants.h"
```

Include dependency graph for channels.h:



This graph shows which files directly or indirectly include this file:



Namespaces

- [qpp](#)

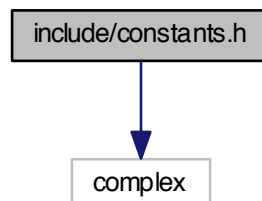
Functions

- `types::cmat` [qpp::channel](#) (`const types::cmat &rho`, `const std::vector< types::cmat > &Ks`)
- `types::cmat` [qpp::super](#) (`const std::vector< types::cmat > &Ks`)
- `types::cmat` [qpp::choi](#) (`const std::vector< types::cmat > &Ks`)
- `std::vector< types::cmat >` [qpp::choi2kraus](#) (`const types::cmat &A`)

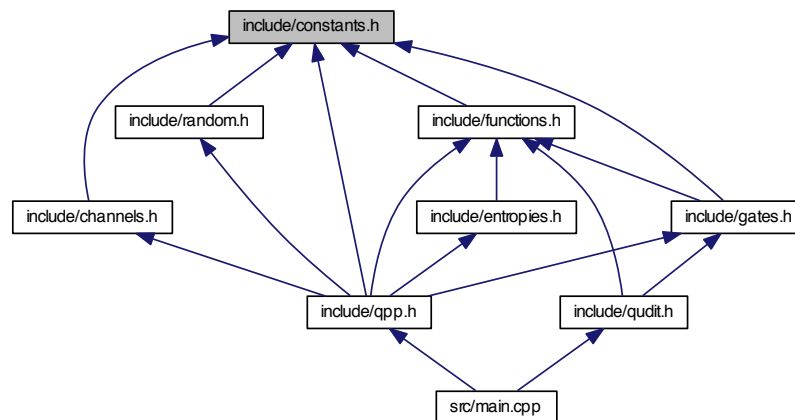
7.2 include/constants.h File Reference

```
#include <complex>
```

Include dependency graph for constants.h:



This graph shows which files directly or indirectly include this file:



Namespaces

- [qpp](#)
- [qpp::ct](#)

Functions

- `std::complex< double > qpp::ct::omega (size_t D)`

Variables

- `const double qpp::ct::chop = 1e-10`
- `const double qpp::ct::eps = 1e-14`
- `const std::complex< double > qpp::ct::ii = { 0, 1 }`
- `const double qpp::ct::pi = 3.141592653589793238462643383279502884`
- `const double qpp::ct::ee = 2.718281828459045235360287471352662497`

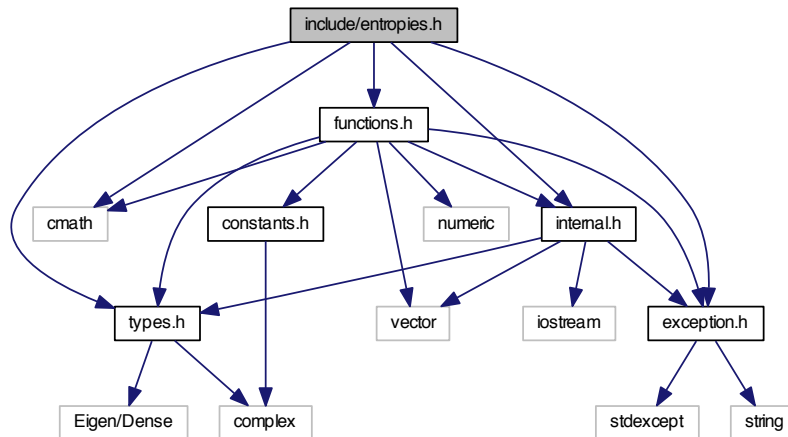
7.3 include/entropies.h File Reference

```

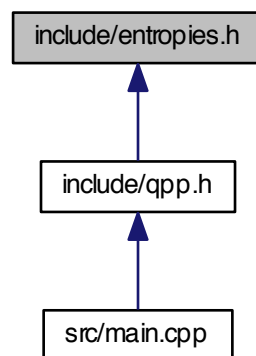
#include <cmath>
#include "types.h"
#include "functions.h"
#include "internal.h"
#include "exception.h"

```

Include dependency graph for entropies.h:



This graph shows which files directly or indirectly include this file:



Namespaces

- [qpp](#)

Functions

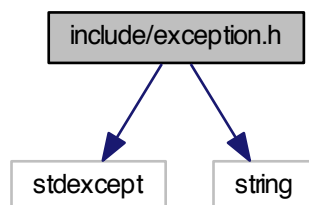
- `template<typename Derived >`
`double qpp::shannon (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`double qpp::renyi (const double alpha, const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`double qpp::renyi_inf (const Eigen::MatrixBase< Derived > &A)`

7.4 include/exception.h File Reference

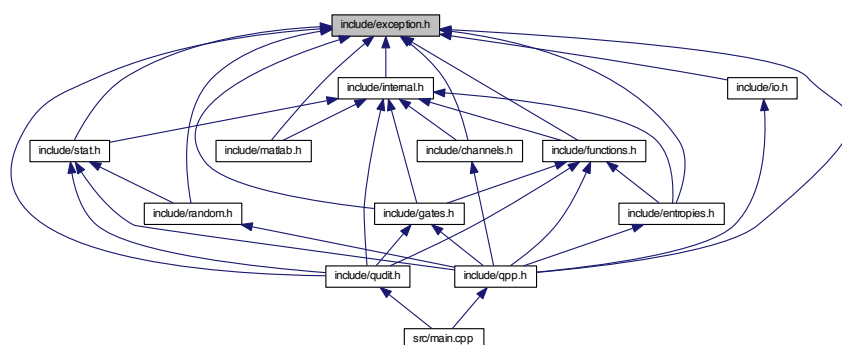
```
#include <stdexcept>
```

```
#include <string>
```

Include dependency graph for exception.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [qpp::Exception](#)

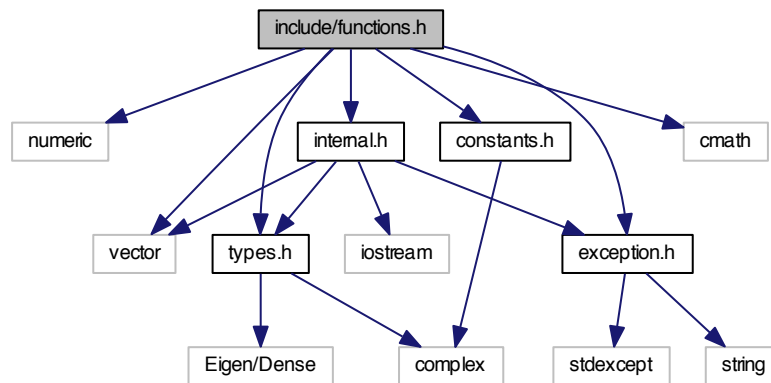
Namespaces

- [qpp](#)

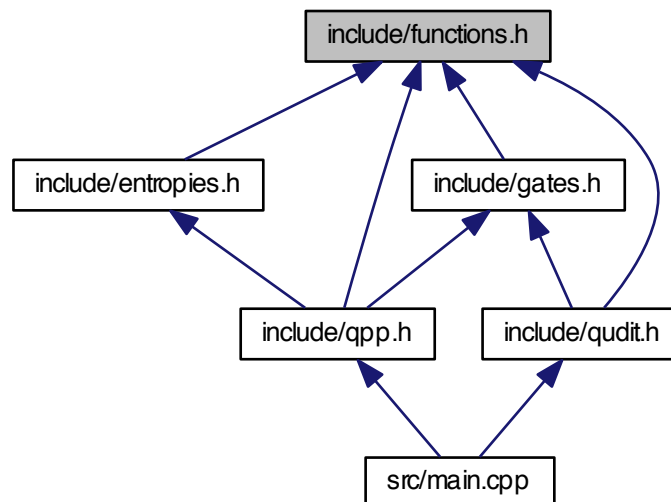
7.5 include/functions.h File Reference

```
#include <numeric>
```

```
#include <vector>
#include <cmath>
#include "types.h"
#include "internal.h"
#include "exception.h"
#include "constants.h"
Include dependency graph for functions.h:
```



This graph shows which files directly or indirectly include this file:



Namespaces

- [qpp](#)

Functions

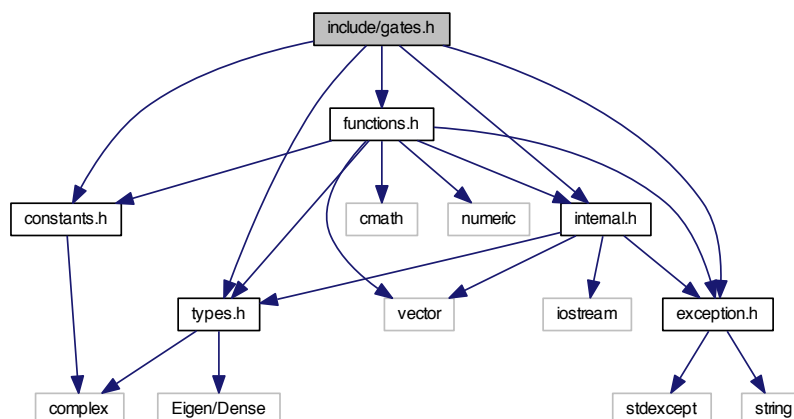
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::transpose (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::conjugate (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::adjoint (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`Derived::Scalar qpp::trace (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`Derived::Scalar qpp::det (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`Derived::Scalar qpp::sum (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`double qpp::norm (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::cmat qpp::evals (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::cmat qpp::evecs (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::cmat qpp::hevals (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::cmat qpp::hevecs (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::cmat qpp::funm (const Eigen::MatrixBase< Derived > &A, types::cplx(*f)(const types::cplx &))`
- `template<typename Derived >`
`types::cmat qpp::sqrtm (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::cmat qpp::absm (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::cmat qpp::expm (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::cmat qpp::logm (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::cmat qpp::sinm (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::cmat qpp::cosm (const Eigen::MatrixBase< Derived > &A)`
- `template<typename Derived >`
`types::cmat qpp::spectralpwm (const Eigen::MatrixBase< Derived > &A, const types::cplx z)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::pwm (const Eigen::MatrixBase< Derived > &A, size_t n)`
- `template<typename OutputScalar , typename Derived >`
`types::DynMat< OutputScalar > qpp::fun (const Eigen::MatrixBase< Derived > &A, OutputScalar(*f)(const`
`typename Derived::Scalar &))`
- `template<typename Derived1 , typename Derived2 >`
`types::DynMat< typename`
`Derived1::Scalar > qpp::kron (const Eigen::MatrixBase< Derived1 > &A, const Eigen::MatrixBase< De-`
`derived2 > &B)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::kronlist (const std::vector< types::DynMat< typename Derived::Scalar > > &As)`

- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::kronpow (const Eigen::MatrixBase< Derived > &A, size_t n)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::reshape (const Eigen::MatrixBase< Derived > &A, size_t rows, size_t cols)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::syspermute (const Eigen::MatrixBase< Derived > &A, const std::vector< size_t >`
`perm, const std::vector< size_t > &dims)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::ptrace2 (const Eigen::MatrixBase< Derived > &A, const std::vector< size_t > dims)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::ptrace (const Eigen::MatrixBase< Derived > &A, const std::vector< size_t > &sub-`
`sys, const std::vector< size_t > &dims)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::ptranspose (const Eigen::MatrixBase< Derived > &A, const std::vector< size_t >`
`&subsys, const std::vector< size_t > &dims)`
- `template<typename Derived1 , typename Derived2 >`
`types::DynMat< typename`
`Derived1::Scalar > qpp::comm (const Eigen::MatrixBase< Derived1 > &A, const Eigen::MatrixBase< De-`
`derived2 > &B)`
- `template<typename Derived1 , typename Derived2 >`
`types::DynMat< typename`
`Derived1::Scalar > qpp::anticomm (const Eigen::MatrixBase< Derived1 > &A, const Eigen::MatrixBase<`
`Derived2 > &B)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::proj (const Eigen::MatrixBase< Derived > &V)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::expandout (const Eigen::MatrixBase< Derived > &A, size_t pos, const std::vector<`
`size_t > &dims)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::grams (const std::vector< types::DynMat< typename Derived::Scalar > > &Vs)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::grams (const Eigen::MatrixBase< Derived > &A)`

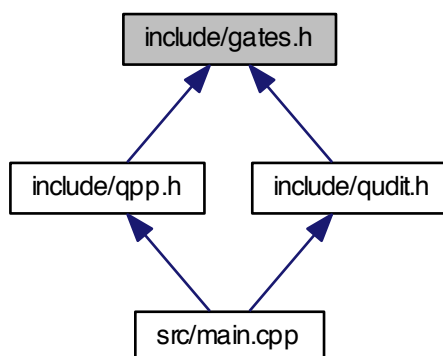
7.6 include/gates.h File Reference

```
#include "types.h"
#include "constants.h"
#include "functions.h"
#include "internal.h"
#include "exception.h"
```

Include dependency graph for gates.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [qpp::Gates](#)

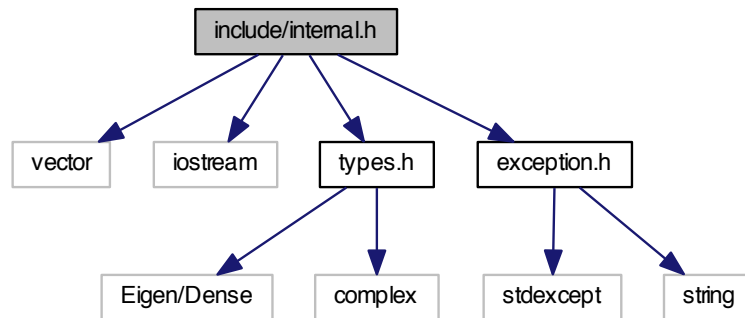
Namespaces

- [qpp](#)

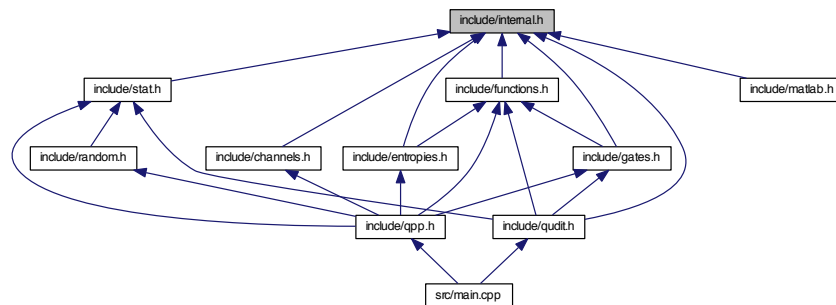
7.7 include/internal.h File Reference

```
#include <vector>
```

```
#include <iostream>
#include "types.h"
#include "exception.h"
Include dependency graph for internal.h:
```



This graph shows which files directly or indirectly include this file:



Namespaces

- `qpp`
- `qpp::internal`

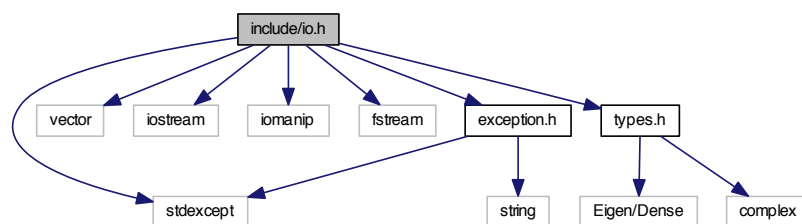
Functions

- void `qpp::internal::_n2multiidx` (size_t n, size_t numdims, const size_t *dims, size_t *result)
- size_t `qpp::internal::_multiidx2n` (const size_t *midx, size_t numdims, const size_t *dims)
- template<typename Derived >
bool `qpp::internal::_check_square_mat` (const Eigen::MatrixBase< Derived > &A)
- template<typename Derived >
bool `qpp::internal::_check_vector` (const Eigen::MatrixBase< Derived > &A)
- template<typename Derived >
bool `qpp::internal::_check_row_vector` (const Eigen::MatrixBase< Derived > &A)
- template<typename Derived >
bool `qpp::internal::_check_col_vector` (const Eigen::MatrixBase< Derived > &A)

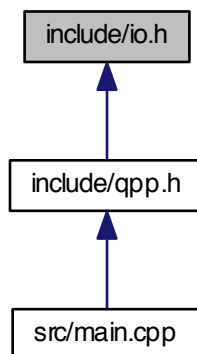
- `template<typename T >`
`bool qpp::internal::_check_nonzero_size (const T &x)`
- `bool qpp::internal::_check_dims (const std::vector< size_t > &dims)`
- `template<typename Derived >`
`bool qpp::internal::_check_dims_match_mat (const std::vector< size_t > &dims, const Eigen::MatrixBase< Derived > &A)`
- `bool qpp::internal::_check_eq_dims (const std::vector< size_t > &dims, size_t dim)`
- `bool qpp::internal::_check_subsys (const std::vector< size_t > &subsys, const std::vector< size_t > &dims)`
- `bool qpp::internal::_check_perm (const std::vector< size_t > &perm, const std::vector< size_t > &dims)`
- `template<typename Scalar >`
`void qpp::internal::_syspermute_worker (const size_t *midxcol, size_t numdims, const size_t *cdims, const size_t *cperm, size_t i, size_t j, size_t &iperm, size_t &jperm, const types::DynMat< Scalar > &A, types::DynMat< Scalar > &result)`
- `template<typename Scalar >`
`void qpp::internal::_ptranspose_worker (const size_t *midxcol, size_t numdims, size_t numsubsys, const size_t *cdims, const size_t *csubsys, size_t i, size_t j, size_t &iperm, size_t &jperm, const types::DynMat< Scalar > &A, types::DynMat< Scalar > &result)`

7.8 include/io.h File Reference

```
#include <stdexcept>
#include <vector>
#include <iostream>
#include <iomanip>
#include <fstream>
#include "types.h"
#include "exception.h"
Include dependency graph for io.h:
```



This graph shows which files directly or indirectly include this file:



Namespaces

- [qpp](#)

Functions

- `template<typename T >`
`void qpp::dispSTL (const T &x, const std::string &separator=" ", const std::string &start="[" , const std::string &end="]", std::ostream &os=std::cout)`
- `template<typename T >`
`void qpp::displnSTL (const T &x, const std::string &separator=" ", const std::string &start="[" , const std::string &end="]", std::ostream &os=std::cout)`
- `template<typename T >`
`void qpp::dispSTL (const T *x, const size_t n, const std::string &separator=" ", const std::string &start="[" , const std::string &end="]", std::ostream &os=std::cout)`
- `template<typename T >`
`void qpp::displnSTL (const T *x, const size_t n, const std::string &separator=" ", const std::string &start="[" , const std::string &end="]", std::ostream &os=std::cout)`
- `template<typename Derived >`
`void qpp::disp (const Eigen::MatrixBase< Derived > &A, double chop=ct::chop, std::ostream &os=std::cout)`
- `template<typename Derived >`
`void qpp::displn (const Eigen::MatrixBase< Derived > &A, double chop=ct::chop, std::ostream &os=std::cout)`
- `void qpp::disp (const types::cplx c, double chop=ct::chop, std::ostream &os=std::cout)`
- `void qpp::displn (const types::cplx c, double chop=ct::chop, std::ostream &os=std::cout)`
- `template<typename Derived >`
`void qpp::save (const Eigen::MatrixBase< Derived > &A, const std::string &fname)`
- `template<typename Derived >`
`types::DynMat< typename`
`Derived::Scalar > qpp::load (const std::string &fname)`

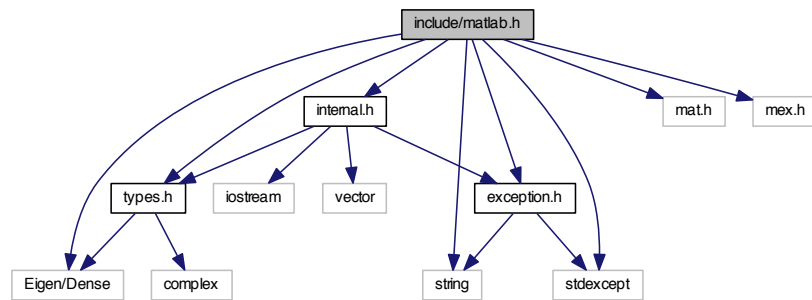
7.9 include/matlab.h File Reference

```
#include <Eigen/Dense>
```



```
#include <string>
#include <stdexcept>
#include "types.h"
#include "internal.h"
#include "exception.h"
#include "mat.h"
#include "mex.h"
```

Include dependency graph for matlab.h:



Namespaces

- [qpp](#)

Functions

- `template<typename Derived >`
Derived [qpp::loadMATLABmatrix](#) (const std::string &mat_file, const std::string &var_name)
- `template<>`
types::dmat [qpp::loadMATLABmatrix](#) (const std::string &mat_file, const std::string &var_name)
- `template<>`
types::cmat [qpp::loadMATLABmatrix](#) (const std::string &mat_file, const std::string &var_name)
- `template<typename Derived >`
void [qpp::saveMATLABmatrix](#) (const Eigen::MatrixBase< Derived > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)
- `template<>`
void [qpp::saveMATLABmatrix](#) (const Eigen::MatrixBase< typename types::dmat > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)
- `template<>`
void [qpp::saveMATLABmatrix](#) (const Eigen::MatrixBase< typename types::cmat > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)

7.10 include/measurement.h File Reference

Classes

- class [qpp::Measurement](#)

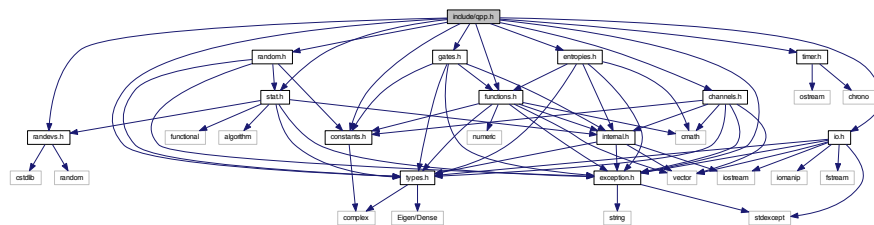
Namespaces

- [qpp](#)

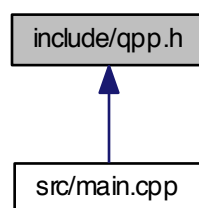
7.11 include/qpp.h File Reference

```
#include "types.h"
#include "constants.h"
#include "gates.h"
#include "stat.h"
#include "functions.h"
#include "random.h"
#include "entropies.h"
#include "io.h"
#include "timer.h"
#include "exception.h"
#include "channels.h"
#include "randevs.h"
```

Include dependency graph for qpp.h:



This graph shows which files directly or indirectly include this file:



Namespaces

- [qpp](#)

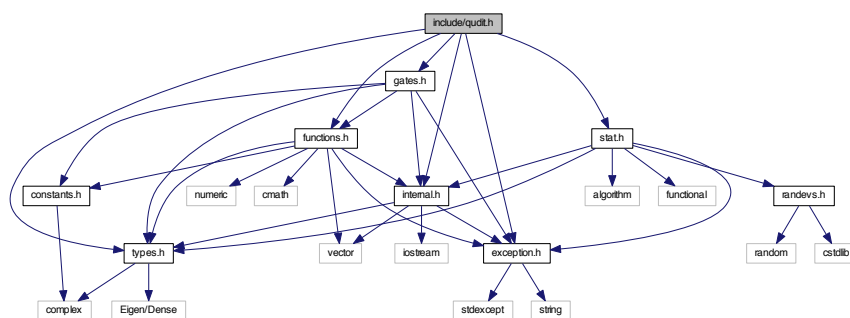
Variables

- RandomDevices & [qpp::rdevs](#) = RandomDevices::getInstance()
- const Gates & [qpp::gt](#) = Gates::getInstance()

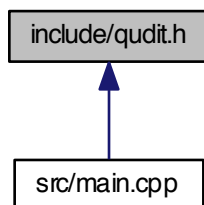
7.12 include/qudit.h File Reference

```
#include "types.h"
#include "gates.h"
#include "internal.h"
#include "exception.h"
#include "stat.h"
```

Include dependency graph for qudit.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [qpp::Qudit](#)

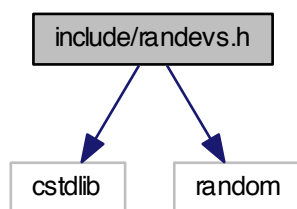
Namespaces

- [qpp](#)

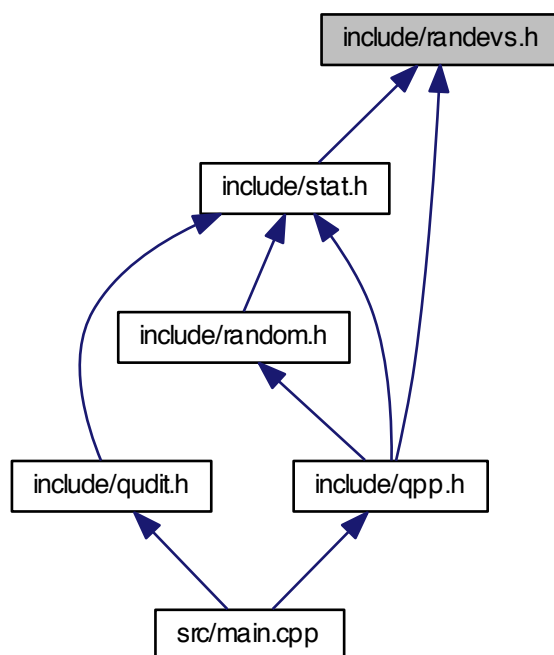
7.13 include/randevs.h File Reference

```
#include <cstdlib>
#include <random>
```

Include dependency graph for randevs.h:



This graph shows which files directly or indirectly include this file:



Classes

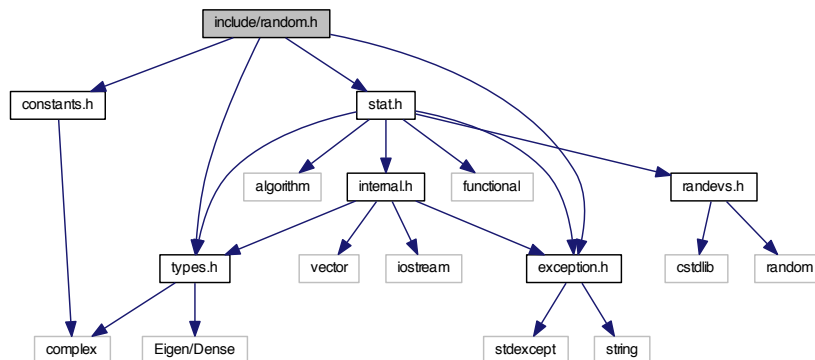
- class [qpp::RandomDevices](#)

Namespaces

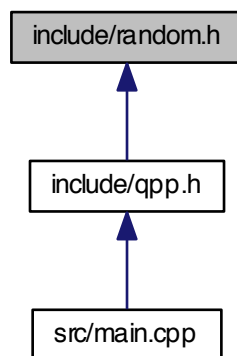
- [qpp](#)

7.14 include/random.h File Reference

```
#include "types.h"
#include "stat.h"
#include "constants.h"
#include "exception.h"
Include dependency graph for random.h:
```



This graph shows which files directly or indirectly include this file:



Namespaces

- [qpp](#)

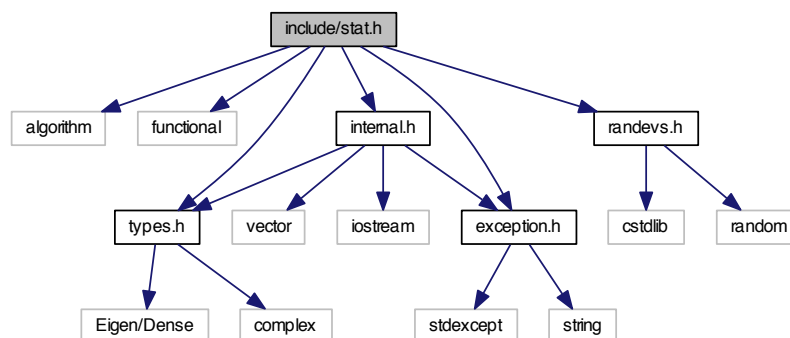
Functions

- `template<typename Derived >`
Derived [qpp::rand](#) (size_t rows, size_t cols, double a=0, double b=1)
- `template<>`
`types::dmat` [qpp::rand](#) (size_t rows, size_t cols, double a, double b)

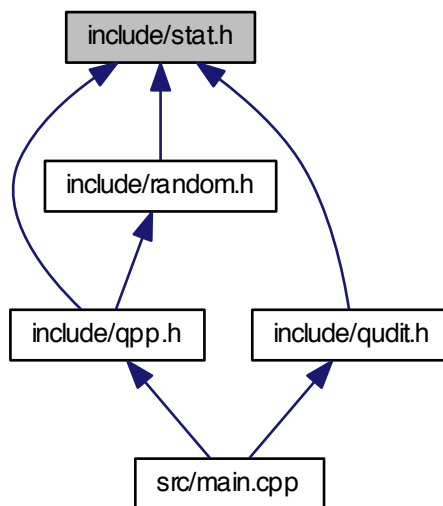
- `template<>`
`types::cmat qpp::rand (size_t rows, size_t cols, double a, double b)`
- `double qpp::rand (double a=0, double b=1)`
- `template<typename Derived >`
`Derived qpp::randn (size_t rows, size_t cols, double mean=0, double sigma=1)`
- `template<>`
`types::dmat qpp::randn (size_t rows, size_t cols, double mean, double sigma)`
- `template<>`
`types::cmat qpp::randn (size_t rows, size_t cols, double mean, double sigma)`
- `double qpp::randn (double mean=0, double sigma=1)`
- `types::cmat qpp::randU (size_t D)`
- `types::cmat qpp::randV (size_t Din, size_t Dout)`
- `std::vector< types::cmat > qpp::randKraus (size_t n, size_t D)`
- `types::cmat qpp::randH (size_t D)`
- `types::ket qpp::randket (size_t D)`
- `types::cmat qpp::randrho (size_t D)`

7.15 include/stat.h File Reference

```
#include <algorithm>
#include <functional>
#include "types.h"
#include "internal.h"
#include "exception.h"
#include "randevs.h"
Include dependency graph for stat.h:
```



This graph shows which files directly or indirectly include this file:



Classes

- class [qpp::stat::NormalDistribution](#)
- class [qpp::stat::UniformRealDistribution](#)
- class [qpp::stat::DiscreteDistribution](#)
- class [qpp::stat::DiscreteDistributionFromComplex](#)

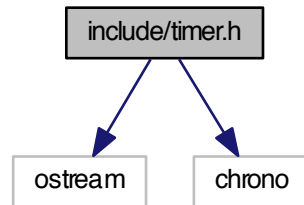
Namespaces

- [qpp](#)
- [qpp::stat](#)

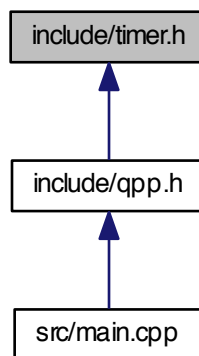
7.16 include/timer.h File Reference

```
#include <ostream>
#include <chrono>
```

Include dependency graph for timer.h:



This graph shows which files directly or indirectly include this file:



Classes

- class `qpp::Timer`

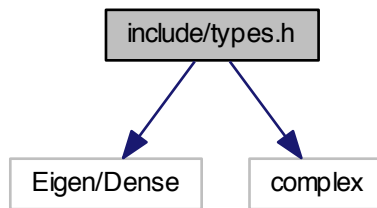
Namespaces

- `qpp`

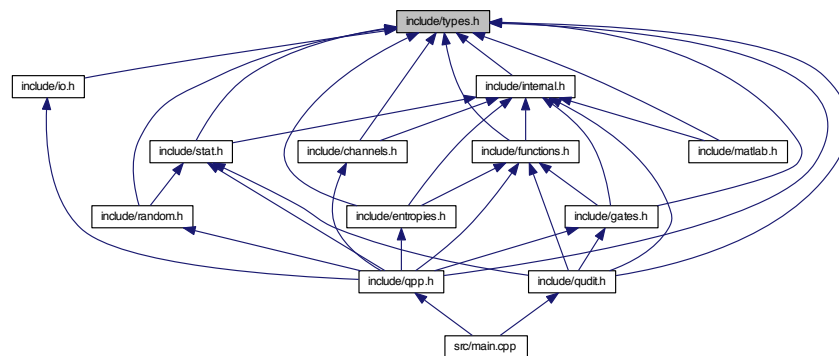
7.17 include/types.h File Reference

```
#include <Eigen/Dense>
#include <complex>
```


Include dependency graph for types.h:



This graph shows which files directly or indirectly include this file:



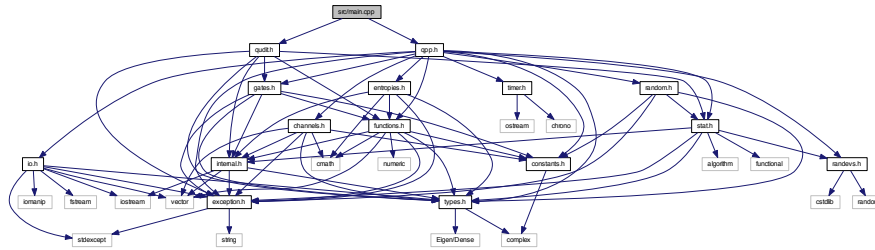
Namespaces

- [qpp](#)
- [qpp::types](#)

Typedefs

- `typedef std::complex< double > qpp::types::cplx`
- `typedef Eigen::MatrixXcd qpp::types::cmat`
- `typedef Eigen::MatrixXd qpp::types::dmat`
- `typedef Eigen::MatrixXf qpp::types::fmat`
- `typedef Eigen::MatrixXi qpp::types::imat`
- `typedef Eigen::Matrix< cplx,
Eigen::Dynamic, 1 > qpp::types::ket`
- `typedef Eigen::Matrix< cplx,
1, Eigen::Dynamic > qpp::types::bra`
- `template<typename Scalar >
using qpp::types::DynMat = Eigen::Matrix< Scalar, Eigen::Dynamic, Eigen::Dynamic >`

```
#include "qpp.h"
#include "qudit.h"
Include dependency graph for main.cpp:
```



- `int main ()`

7.18.1.1 int main ()

```

graph LR
    main[main] --> qpp_randU[qpp::randU]
    main --> qpp_Qudit_measure[qpp::Qudit::measure]
    main --> qpp_proj[qpp::proj]
    main --> qpp_adjoint[qpp::adjoint]
    main --> qpp_trace[qpp::trace]
    main --> qpp_internal_check_col_vector[qpp::internal::_check_col_vector]
    main --> qpp_internal_check_square_mat[qpp::internal::_check_square_mat]
    main --> qpp_internal_check_nonzero_size[qpp::internal::_check_nonzero_size]
    main --> qpp_Gates_Xd[qpp::Gates::Xd]
    main --> qpp_Gates_Zd[qpp::Gates::Zd]
    main --> qpp_Gates_Fd[qpp::Gates::Fd]
    main --> qpp_ct_omega[qpp::ct::omega]
    main --> qpp_stat_DiscreteDistribution_sample[qpp::stat::DiscreteDistribution::sample]
    main --> qpp_RandomDevices_getInstance[qpp::RandomDevices::getInstance]
    main --> qpp_evecs[qpp::evecs]
    main --> qpp_Qudit_Exception[qpp::Qudit::Exception]
    qpp_Qudit_measure --> qpp_randU
    qpp_Qudit_measure --> qpp_Qudit_Exception
    qpp_Qudit_measure --> qpp_evecs
    qpp_Qudit_measure --> qpp_internal_check_square_mat
    qpp_Qudit_measure --> qpp_internal_check_nonzero_size
    qpp_proj --> qpp_internal_check_col_vector
    qpp_proj --> qpp_adjoint
    qpp_proj --> qpp_trace
    qpp_internal_check_col_vector --> qpp_internal_check_nonzero_size
    qpp_adjoint --> qpp_internal_check_nonzero_size
    qpp_trace --> qpp_internal_check_nonzero_size
    qpp_Gates_Xd --> qpp_Gates_Zd
    qpp_Gates_Xd --> qpp_Gates_Fd
    qpp_Gates_Zd --> qpp_ct_omega
    qpp_Gates_Fd --> qpp_ct_omega
    qpp_stat_DiscreteDistribution_sample --> qpp_RandomDevices_getInstance
  
```