

qpp  
0.1

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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

Here is a list of all files with brief descriptions:

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## Chapter 5

# Namespace Documentation

### 5.1 qpp Namespace Reference

#### Namespaces

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

#### Classes

- class [Exception](#)
- 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 Scalar >  
double [shannon](#) (const [types::DynMat](#)< Scalar > &A)
- template<typename Scalar >  
double [renyi](#) (const double alpha, const [types::DynMat](#)< Scalar > &A)
- template<typename Scalar >  
double [renyi\\_inf](#) (const [types::DynMat](#)< Scalar > &A)
- template<typename Scalar >  
[types::DynMat](#)< Scalar > [transpose](#) (const [types::DynMat](#)< Scalar > &A)
- template<typename Scalar >  
[types::DynMat](#)< Scalar > [conjugate](#) (const [types::DynMat](#)< Scalar > &A)
- template<typename Scalar >  
[types::DynMat](#)< Scalar > [adjoint](#) (const [types::DynMat](#)< Scalar > &A)
- template<typename Scalar >  
Scalar [trace](#) (const [types::DynMat](#)< Scalar > &A)
- template<typename Scalar >  
Scalar [det](#) (const [types::DynMat](#)< Scalar > &A)
- template<typename Scalar >  
Scalar [sum](#) (const [types::DynMat](#)< Scalar > &A)

- `template<typename Scalar >`  
`double norm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat evals (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat evects (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat hevals (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat hevects (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat funm (const types::DynMat< Scalar > &A, types::cplx(*f)(const types::cplx &))`
- `template<typename Scalar >`  
`types::cmat absm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat expm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat logm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat sqrtm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat sinm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat cosm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat spectralpowm (const types::DynMat< Scalar > &A, const types::cplx z)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > powm (const types::DynMat< Scalar > &A, size_t n)`
- `template<typename InputScalar , typename OutputScalar >`  
`types::DynMat< OutputScalar > fun (const types::DynMat< InputScalar > &A, OutputScalar(*f)(const InputScalar &))`
- `template<typename Scalar >`  
`types::DynMat< Scalar > kron (const types::DynMat< Scalar > &A, const types::DynMat< Scalar > &B)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > kronlist (const std::vector< types::DynMat< Scalar > > &list)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > kronpow (const types::DynMat< Scalar > &A, size_t n)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > reshape (const types::DynMat< Scalar > &A, size_t rows, size_t cols)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > syspermute (const types::DynMat< Scalar > &A, const std::vector< size_t > perm, const std::vector< size_t > &dims)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > ptrace2 (const types::DynMat< Scalar > &A, const std::vector< size_t > dims)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > ptrace (const types::DynMat< Scalar > &A, const std::vector< size_t > &subsys, const std::vector< size_t > &dims)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > ptranspose (const types::DynMat< Scalar > &A, const std::vector< size_t > &subsys, const std::vector< size_t > &dims)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > comm (const types::DynMat< Scalar > &A, const types::DynMat< Scalar > &B)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > anticomm (const types::DynMat< Scalar > &A, const types::DynMat< Scalar > &B)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > proj (const types::DynMat< Scalar > &V)`

- `template<typename Scalar >`  
`types::DynMat< Scalar > expandout (const types::DynMat< Scalar > &A, size_t pos, const std::vector< size_t > &dims)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > grams (const std::vector< types::DynMat< Scalar >> &vecs)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > grams (const types::DynMat< Scalar > &A)`
- `template<typename T >`  
`void disp (const T &x, const std::string &separator=" ", const std::string &start="[" , const std::string &end="]", std::ostream &os=std::cout)`
- `template<typename T >`  
`void displn (const T &x, const std::string &separator=" ", const std::string &start="[" , const std::string &end="]", std::ostream &os=std::cout)`
- `template<typename T >`  
`void disp (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 displn (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 Scalar >`  
`void disp (const types::DynMat< Scalar > &A, double chop=ct::chop, std::ostream &os=std::cout)`
- `template<typename Scalar >`  
`void displn (const types::DynMat< Scalar > &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 Scalar >`  
`void save (const types::DynMat< Scalar > &A, const std::string &fname)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > load (const std::string &fname)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > loadMATLABmatrix (const std::string &mat_file, const std::string &var_name)`
- `template<>`  
`types::DynMat< double > loadMATLABmatrix (const std::string &mat_file, const std::string &var_name)`
- `template<>`  
`types::DynMat< types::cplx > loadMATLABmatrix (const std::string &mat_file, const std::string &var_name)`
- `template<typename Scalar >`  
`void saveMATLABmatrix (const types::DynMat< Scalar > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)`
- `template<>`  
`void saveMATLABmatrix (const types::DynMat< double > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)`
- `template<>`  
`void saveMATLABmatrix (const types::DynMat< types::cplx > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)`
- `int _init ()`
- `template<typename Scalar >`  
`types::DynMat< Scalar > rand (size_t rows, size_t cols, double a=0, double b=1)`
- `template<>`  
`types::DynMat< double > rand (size_t rows, size_t cols, double a, double b)`
- `template<>`  
`types::DynMat< types::cplx > rand (size_t rows, size_t cols, double a, double b)`
- `double rand (double a=0, double b=1)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > randn (size_t rows, size_t cols, double mean=0, double sigma=1)`
- `template<>`  
`types::DynMat< double > randn (size_t rows, size_t cols, double mean, double sigma)`

- `template<>`  
`types::DynMat< types::cplx > 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::cmat randket` (size\_t D)
- `types::cmat randrho` (size\_t D)

### 5.1.1 Function Documentation

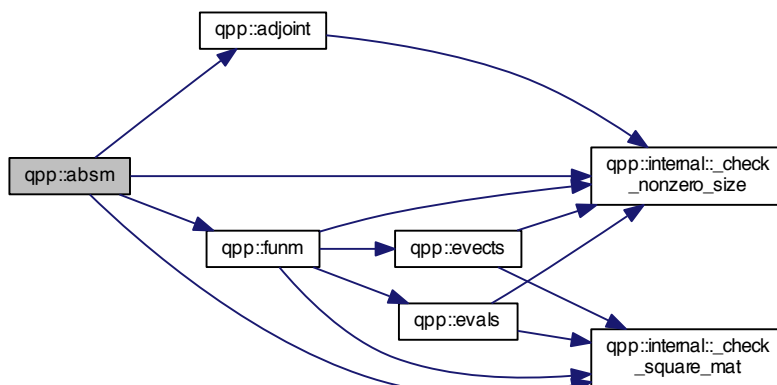
#### 5.1.1.1 `int qpp::_init ( )`

Here is the call graph for this function:



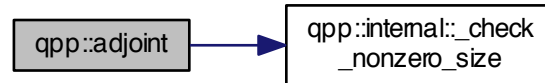
#### 5.1.1.2 `template<typename Scalar > types::cmat qpp::absm ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



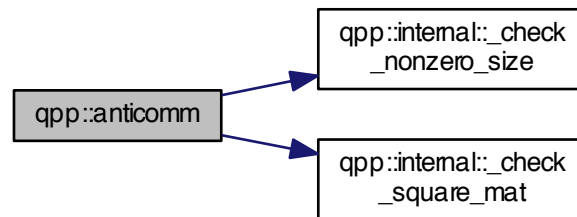
5.1.1.3 `template<typename Scalar > types::DynMat<Scalar> qpp::adjoint ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



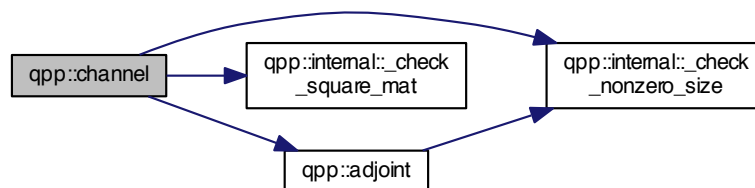
5.1.1.4 `template<typename Scalar > types::DynMat<Scalar> qpp::anticomm ( const types::DynMat< Scalar > & A, const types::DynMat< Scalar > & B )`

Here is the call graph for this function:



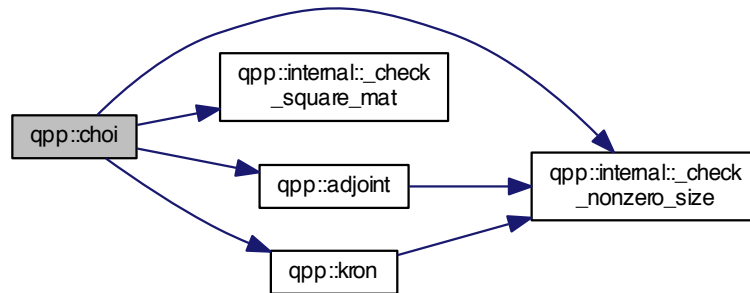
5.1.1.5 `types::cmat qpp::channel ( const types::cmat & rho, const std::vector< types::cmat > & Ks )`

Here is the call graph for this function:



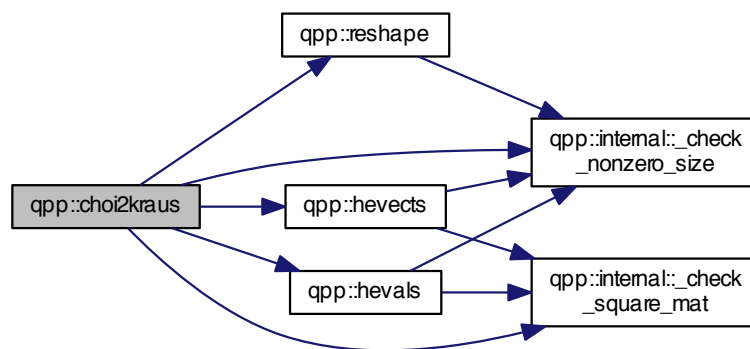
#### 5.1.1.6 `types::cmat qpp::choi ( const std::vector< types::cmat > & Ks )`

Here is the call graph for this function:



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

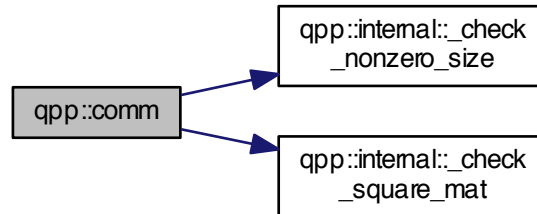
Here is the call graph for this function:





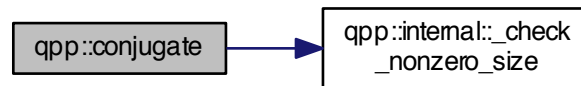
5.1.1.8 `template<typename Scalar > types::DynMat<Scalar> qpp::comm ( const types::DynMat< Scalar > & A, const types::DynMat< Scalar > & B )`

Here is the call graph for this function:



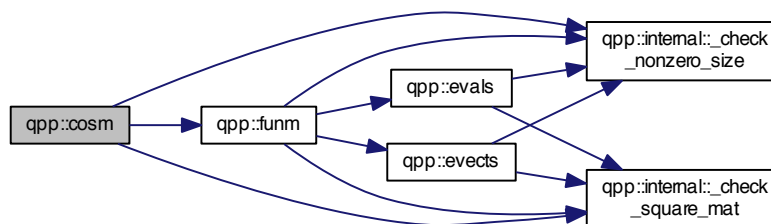
5.1.1.9 `template<typename Scalar > types::DynMat<Scalar> qpp::conjugate ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



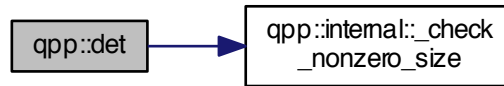
5.1.1.10 `template<typename Scalar > types::cmat qpp::cosm ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



5.1.1.11 `template<typename Scalar > Scalar qpp::det ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



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

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

5.1.1.14 `template<typename Scalar > void qpp::disp ( const types::DynMat< Scalar > & A, double chop = ct::chop, std::ostream & os = std::cout )`

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

Here is the call graph for this function:



5.1.1.16 `template<typename T > void qpp::displn ( 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:



5.1.1.17 `template<typename T> void qpp::displn ( 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:



5.1.1.18 `template<typename Scalar> void qpp::displn ( const types::DynMat< Scalar > & A, double chop = ct::chop, std::ostream & os = std::cout )`

Here is the call graph for this function:



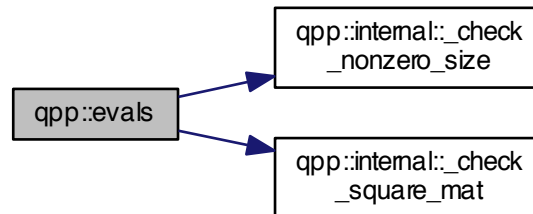
5.1.1.19 `void qpp::displn ( const types::cplx c, double chop = ct::chop, std::ostream & os = std::cout )`

Here is the call graph for this function:



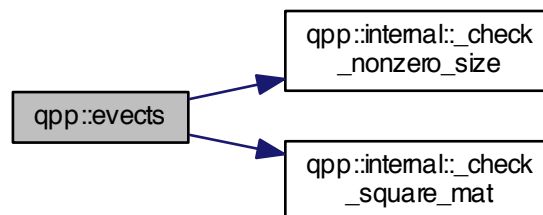
#### 5.1.1.20 `template<typename Scalar > types::cmat qpp::evals ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



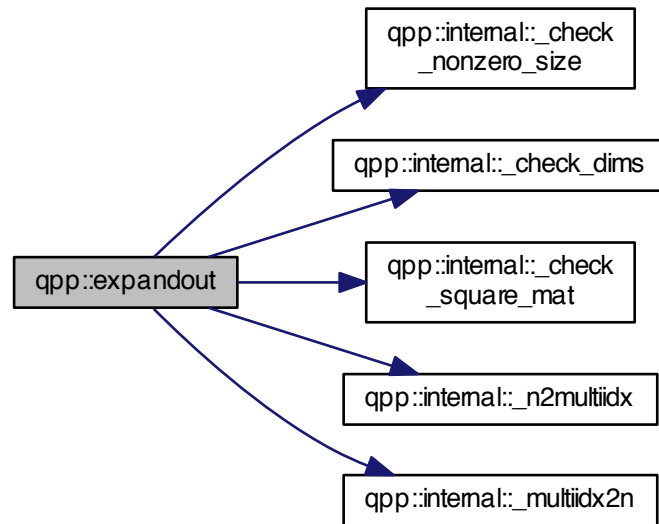
#### 5.1.1.21 `template<typename Scalar > types::cmat qpp::evecs ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



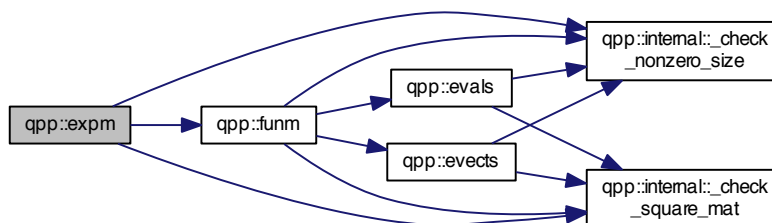
5.1.1.22 `template<typename Scalar > types::DynMat<Scalar> qpp::expandout ( const types::DynMat< Scalar > & A,  
size_t pos, const std::vector< size_t > & dims )`

Here is the call graph for this function:



5.1.1.23 `template<typename Scalar > types::cmat qpp::expm ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



5.1.1.24 `template<typename InputScalar , typename OutputScalar > types::DynMat<OutputScalar> qpp::fun ( const types::DynMat< InputScalar > & A, OutputScalar (*)(const InputScalar &) f )`

Here is the call graph for this function:



5.1.1.25 `template<typename Scalar > types::cmat qpp::funm ( const types::DynMat< Scalar > & A, types::cplx (*)(const types::cplx &) f )`

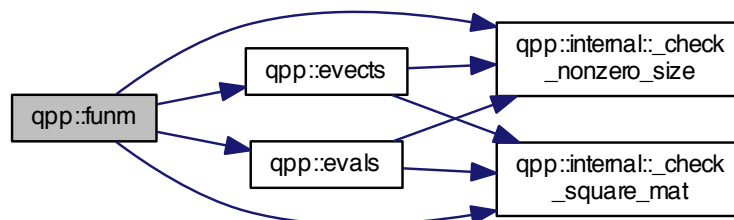
Parameters

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

Returns

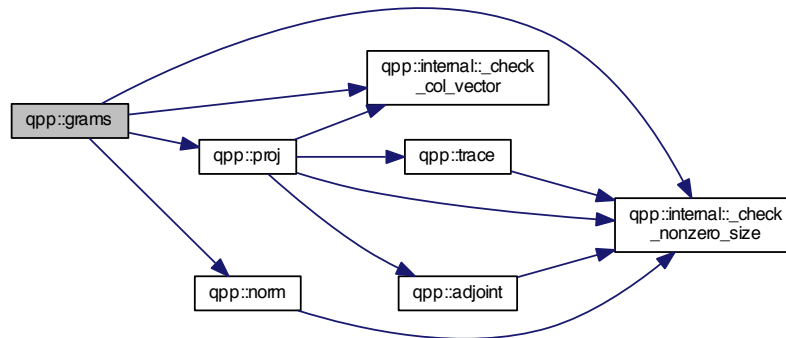
`types::cmat`

Here is the call graph for this function:



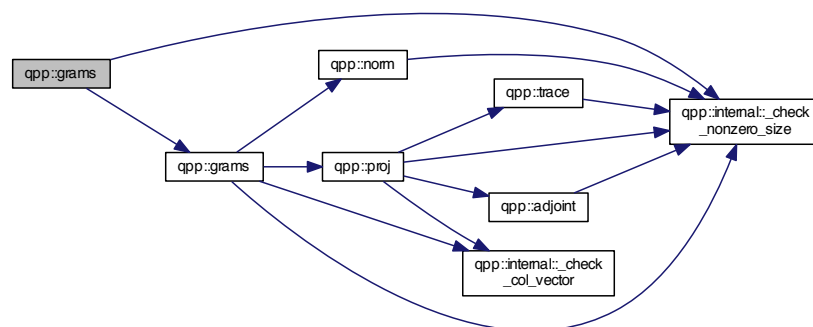
5.1.1.26 `template<typename Scalar> types::DynMat<Scalar> qpp::grams ( const std::vector< types::DynMat< Scalar>> & vecs )`

Here is the call graph for this function:



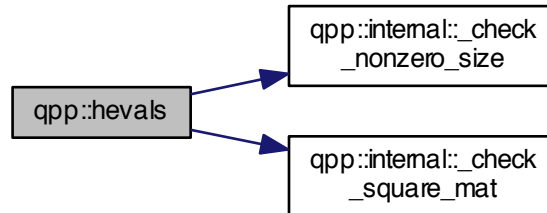
5.1.1.27 `template<typename Scalar> types::DynMat<Scalar> qpp::grams ( const types::DynMat< Scalar> & A )`

Here is the call graph for this function:



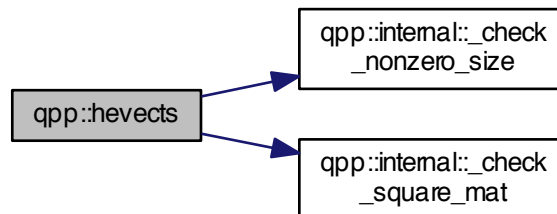
5.1.1.28 `template<typename Scalar > types::cmat qpp::hevals ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



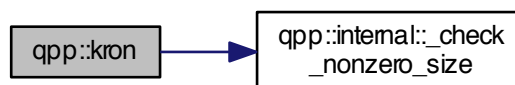
5.1.1.29 `template<typename Scalar > types::cmat qpp::hevects ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



5.1.1.30 `template<typename Scalar > types::DynMat<Scalar> qpp::kron ( const types::DynMat< Scalar > & A, const types::DynMat< Scalar > & B )`

Here is the call graph for this function:





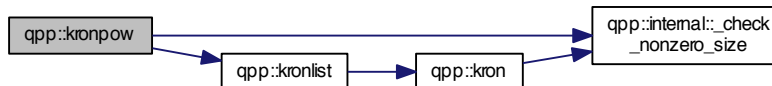
5.1.1.31 `template<typename Scalar > types::DynMat<Scalar> qpp::kronlist ( const std::vector< types::DynMat< Scalar >> & list )`

Here is the call graph for this function:



5.1.1.32 `template<typename Scalar > types::DynMat<Scalar> qpp::kronpow ( const types::DynMat< Scalar > & A, size_t n )`

Here is the call graph for this function:



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

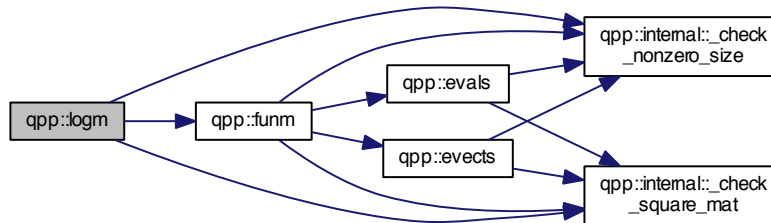
5.1.1.34 `template<typename Scalar > types::DynMat<Scalar> qpp::loadMATLABmatrix ( const std::string & mat_file, const std::string & var_name )`

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

5.1.1.36 `template<> types::DynMat<types::cplx> qpp::loadMATLABmatrix ( const std::string & mat_file, const std::string & var_name )`

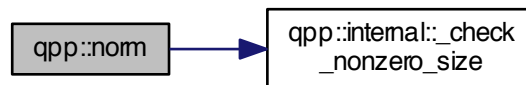
5.1.1.37 `template<typename Scalar > types::cmat qpp::logm ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



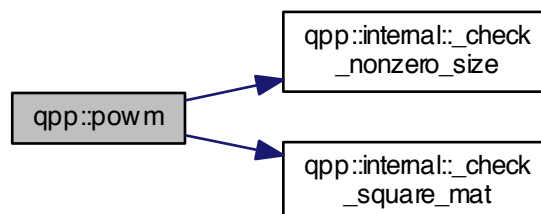
5.1.1.38 `template<typename Scalar > double qpp::norm ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



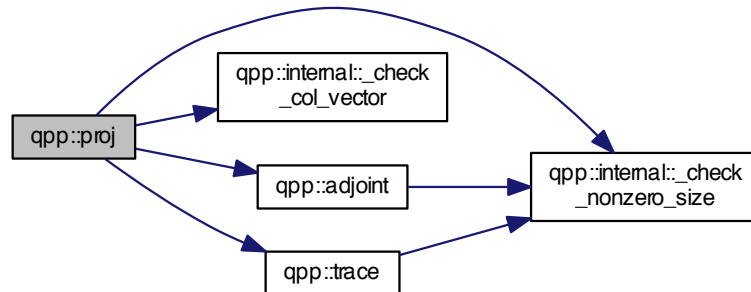
5.1.1.39 `template<typename Scalar > types::DynMat<Scalar> qpp::powm ( const types::DynMat< Scalar > & A, size_t n )`

Here is the call graph for this function:



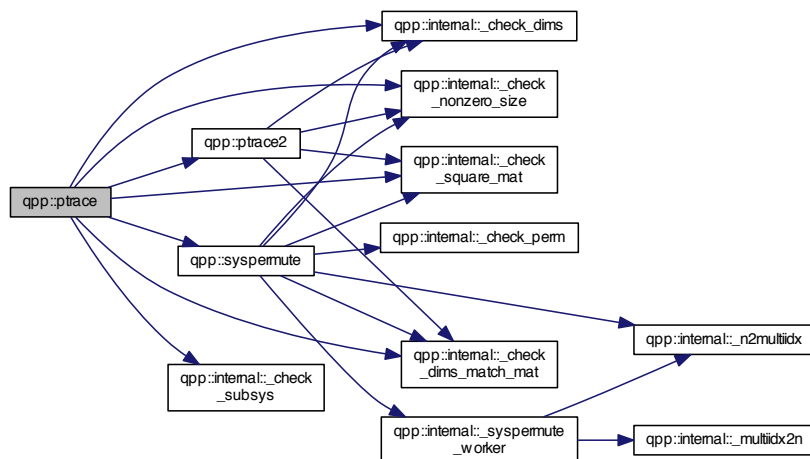
5.1.1.40 `template<typename Scalar> types::DynMat<Scalar> qpp::proj ( const types::DynMat< Scalar> & V )`

Here is the call graph for this function:



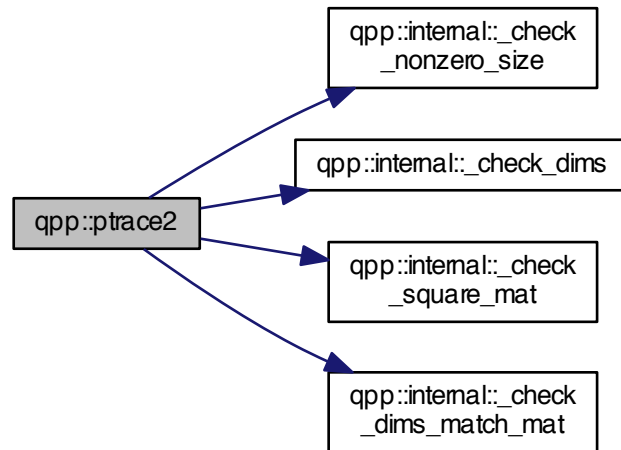
5.1.1.41 `template<typename Scalar> types::DynMat<Scalar> qpp::ptrace ( const types::DynMat< Scalar> & A, const std::vector< size_t> & subsys, const std::vector< size_t> & dims )`

Here is the call graph for this function:



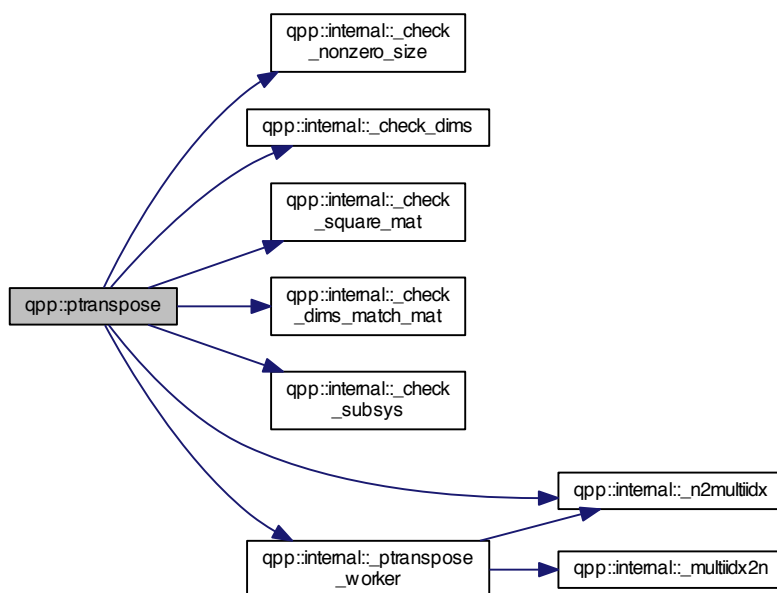
5.1.1.42 `template<typename Scalar > types::DynMat<Scalar> qpp::ptrace2 ( const types::DynMat< Scalar > & A, const std::vector< size_t > dims )`

Here is the call graph for this function:



5.1.1.43 `template<typename Scalar > types::DynMat<Scalar> qpp::ptranspose ( const types::DynMat< Scalar > & A, const std::vector< size_t > & subsys, const std::vector< size_t > & dims )`

Here is the call graph for this function:



5.1.1.44 `template<typename Scalar > types::DynMat<Scalar> qpp::rand ( size_t rows, size_t cols, double a = 0, double b = 1 )`

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

5.1.1.46 `template<> types::DynMat<types::cplx> qpp::rand ( size_t rows, size_t cols, double a, double b )`

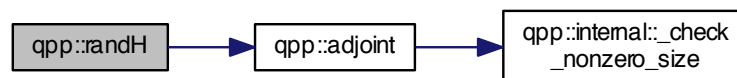
5.1.1.47 `double qpp::rand ( double a = 0, double b = 1 )`

Here is the call graph for this function:



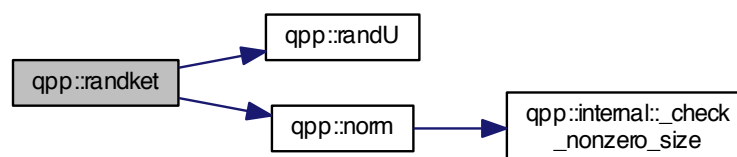
5.1.1.48 `types::cmat qpp::randH ( size_t D )`

Here is the call graph for this function:



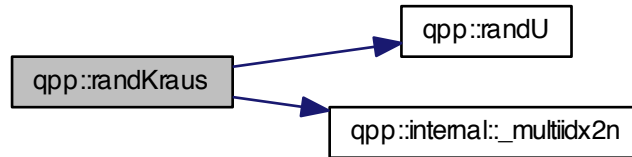
5.1.1.49 `types::cmat qpp::randket ( size_t D )`

Here is the call graph for this function:



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

Here is the call graph for this function:



5.1.1.51 `template<typename Scalar > types::DynMat<Scalar> qpp::randn ( size_t rows, size_t cols, double mean = 0, double sigma = 1 )`

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

Here is the call graph for this function:



5.1.1.53 `template<> types::DynMat<types::cplx> qpp::randn ( size_t rows, size_t cols, double mean, double sigma )`

Here is the call graph for this function:



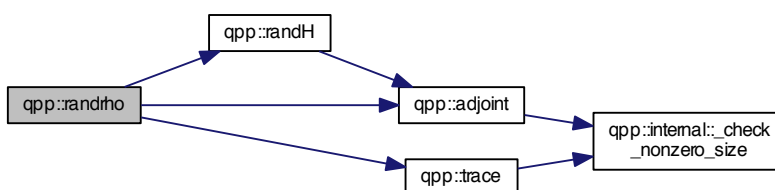
5.1.1.54 `double qpp::randn ( double mean = 0, double sigma = 1 )`

Here is the call graph for this function:



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

Here is the call graph for this function:



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

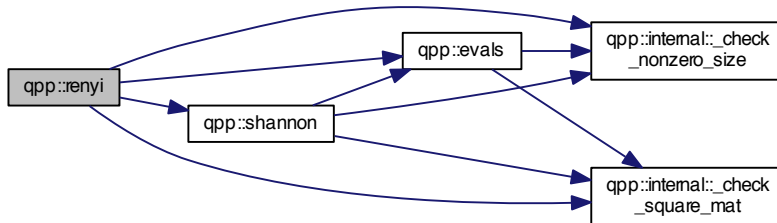
5.1.1.57 `types::cmat qpp::randV ( size_t Din, size_t Dout )`

Here is the call graph for this function:



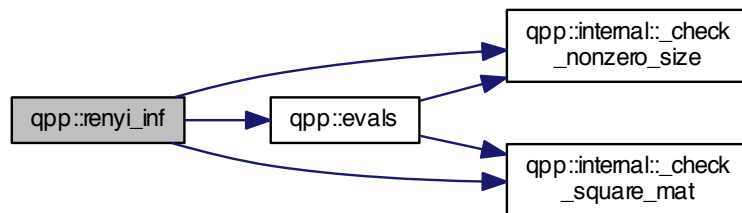
5.1.1.58 `template<typename Scalar > double qpp::renyi ( const double alpha, const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



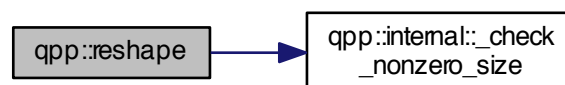
5.1.1.59 `template<typename Scalar > double qpp::renyi_inf ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



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

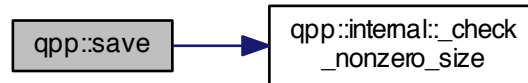
Here is the call graph for this function:





5.1.1.61 `template<typename Scalar > void qpp::save ( const types::DynMat< Scalar > & A, const std::string & fname )`

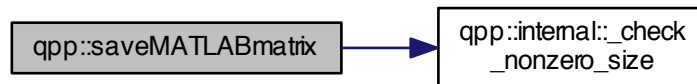
Here is the call graph for this function:



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

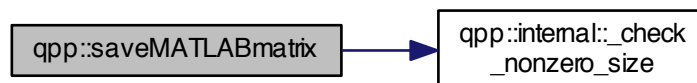
5.1.1.63 `template<> void qpp::saveMATLABmatrix ( const types::DynMat< double > & A, const std::string & mat_file, const std::string & var_name, const std::string & mode )`

Here is the call graph for this function:



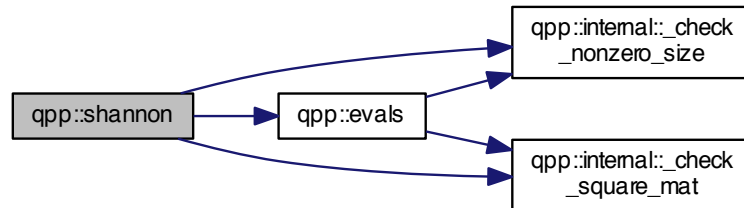
5.1.1.64 `template<> void qpp::saveMATLABmatrix ( const types::DynMat< types::cplx > & A, const std::string & mat_file, const std::string & var_name, const std::string & mode )`

Here is the call graph for this function:



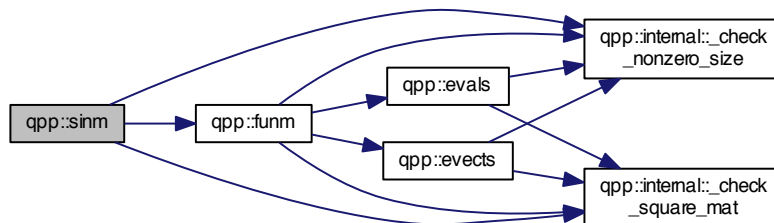
5.1.1.65 `template<typename Scalar > double qpp::shannon ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



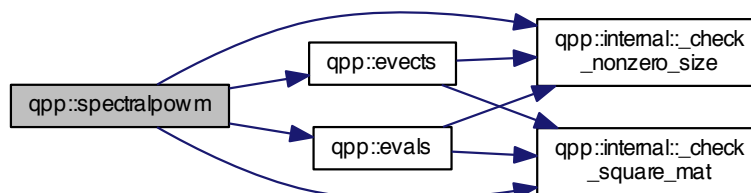
5.1.1.66 `template<typename Scalar > types::cmat qpp::sinm ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



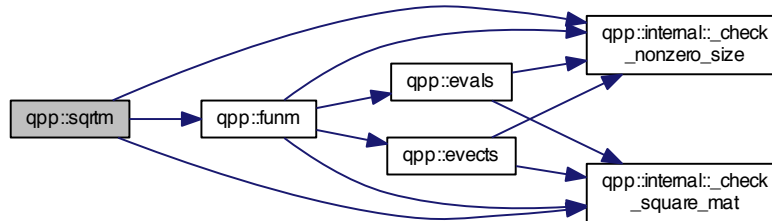
5.1.1.67 `template<typename Scalar > types::cmat qpp::spectralpowm ( const types::DynMat< Scalar > & A, const types::cplx z )`

Here is the call graph for this function:



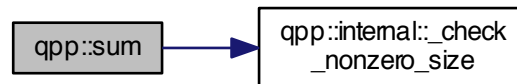
5.1.1.68 `template<typename Scalar > types::cmat qpp::sqrtm ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



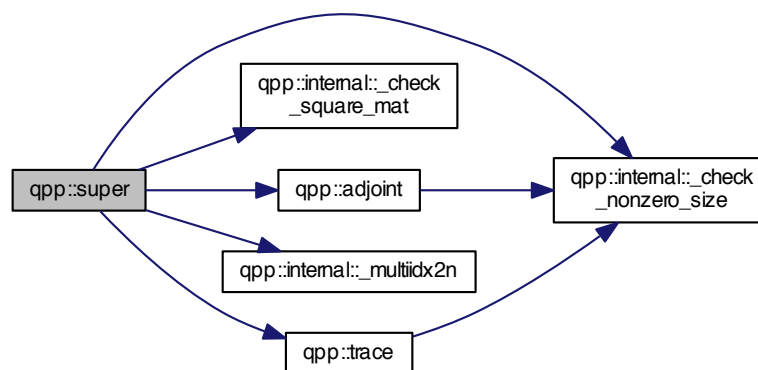
5.1.1.69 `template<typename Scalar > Scalar qpp::sum ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



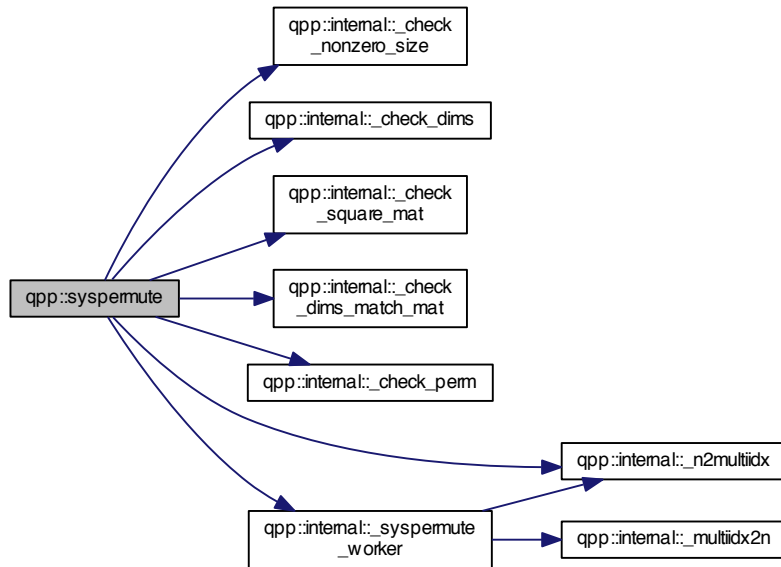
5.1.1.70 `types::cmat qpp::super ( const std::vector< types::cmat > & Ks )`

Here is the call graph for this function:



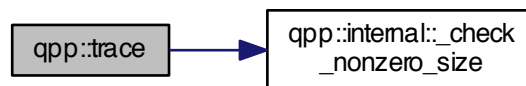
5.1.1.71 `template<typename Scalar > types::DynMat<Scalar> qpp::syspermute ( const types::DynMat< Scalar > & A,  
const std::vector< size_t > perm, const std::vector< size_t > & dims )`

Here is the call graph for this function:



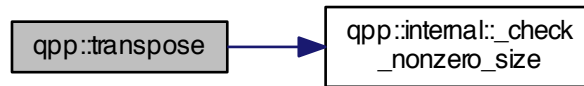
5.1.1.72 `template<typename Scalar > Scalar qpp::trace ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



5.1.1.73 `template<typename Scalar > types::DynMat<Scalar> qpp::transpose ( const types::DynMat< Scalar > & A )`

Here is the call graph for this function:



## 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::gt Namespace Reference

### Functions

- `void _init_gates ()`
- `types::cmat Rtheta (double theta)`
- `types::cmat Id (size_t D)`

- [types::cmat Zd](#) (size\_t D)
- [types::cmat Fd](#) (size\_t D)
- [types::cmat Xd](#) (size\_t D)
- [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)

## Variables

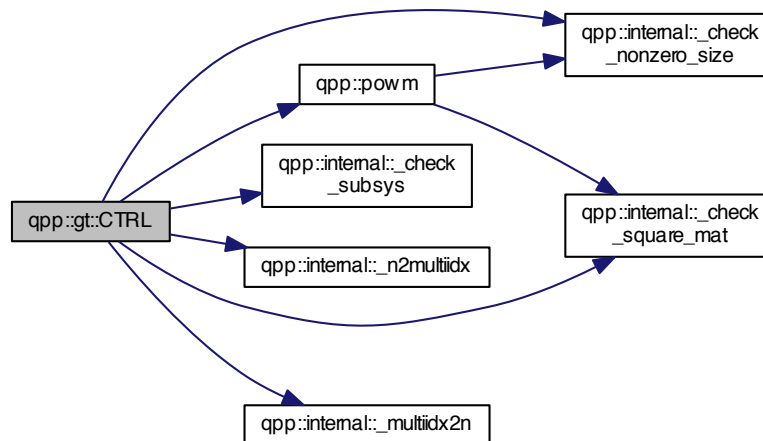
- [types::cmat Id2](#)
- [types::cmat H](#)
- [types::cmat X](#)
- [types::cmat Y](#)
- [types::cmat Z](#)
- [types::cmat S](#)
- [types::cmat T](#)
- [types::cmat CNOTab](#)
- [types::cmat CNOTba](#)
- [types::cmat CZ](#)
- [types::cmat CS](#)
- [types::cmat SWAP](#)
- [types::cmat TOF](#)
- [types::cmat FRED](#)
- [types::cmat x0](#)
- [types::cmat x1](#)
- [types::cmat y0](#)
- [types::cmat y1](#)
- [types::cmat z0](#)
- [types::cmat z1](#)
- [types::cmat b00](#)
- [types::cmat b01](#)
- [types::cmat b10](#)
- [types::cmat b11](#)

## 5.3.1 Function Documentation

### 5.3.1.1 void qpp::gt::\_init\_gates ( ) [inline]

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

Here is the call graph for this function:



5.3.1.3 `types::cmat qpp::gt::Fd ( size_t D ) [inline]`

Here is the call graph for this function:



5.3.1.4 `types::cmat qpp::gt::ld ( size_t D ) [inline]`

5.3.1.5 `types::cmat qpp::gt::Rtheta ( double theta ) [inline]`

#### 5.3.1.6 `types::cmat qpp::gt::Xd ( size_t D ) [inline]`

Here is the call graph for this function:



#### 5.3.1.7 `types::cmat qpp::gt::Zd ( size_t D ) [inline]`

Here is the call graph for this function:



### 5.3.2 Variable Documentation

#### 5.3.2.1 `types::cmat qpp::gt::b00`

#### 5.3.2.2 `types::cmat qpp::gt::b01`

#### 5.3.2.3 `types::cmat qpp::gt::b10`

#### 5.3.2.4 `types::cmat qpp::gt::b11`

#### 5.3.2.5 `types::cmat qpp::gt::CNOTab`

#### 5.3.2.6 `types::cmat qpp::gt::CNOTba`

#### 5.3.2.7 `types::cmat qpp::gt::CS`

#### 5.3.2.8 `types::cmat qpp::gt::CZ`

#### 5.3.2.9 `types::cmat qpp::gt::FRED`

#### 5.3.2.10 `types::cmat qpp::gt::H`

#### 5.3.2.11 `types::cmat qpp::gt::Id2`



5.3.2.12 `types::cmat qpp::gt::S`

5.3.2.13 `types::cmat qpp::gt::SWAP`

5.3.2.14 `types::cmat qpp::gt::T`

5.3.2.15 `types::cmat qpp::gt::TOF`

5.3.2.16 `types::cmat qpp::gt::X`

5.3.2.17 `types::cmat qpp::gt::x0`

5.3.2.18 `types::cmat qpp::gt::x1`

5.3.2.19 `types::cmat qpp::gt::Y`

5.3.2.20 `types::cmat qpp::gt::y0`

5.3.2.21 `types::cmat qpp::gt::y1`

5.3.2.22 `types::cmat qpp::gt::Z`

5.3.2.23 `types::cmat qpp::gt::z0`

5.3.2.24 `types::cmat qpp::gt::z1`

## 5.4 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 Scalar >`  
`bool _check_square_mat (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`bool _check_vector (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`bool _check_row_vector (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`bool _check_col_vector (const types::DynMat< Scalar > &A)`
- `template<typename T >`  
`bool _check_nonzero_size (const T &x)`
- `bool _check_dims (const std::vector< size_t > &dims)`
- `template<typename Scalar >`  
`bool _check_dims_match_mat (const std::vector< size_t > &dims, const types::DynMat< Scalar > &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)`

### 5.4.1 Function Documentation

5.4.1.1 `template<typename Scalar > bool qpp::internal::_check_col_vector ( const types::DynMat< Scalar > & A )`

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

5.4.1.3 `template<typename Scalar > bool qpp::internal::_check_dims_match_mat ( const std::vector< size_t > & dims, const types::DynMat< Scalar > & A )`

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

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

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

5.4.1.7 `template<typename Scalar > bool qpp::internal::_check_row_vector ( const types::DynMat< Scalar > & A )`

5.4.1.8 `template<typename Scalar > bool qpp::internal::_check_square_mat ( const types::DynMat< Scalar > & A )`

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

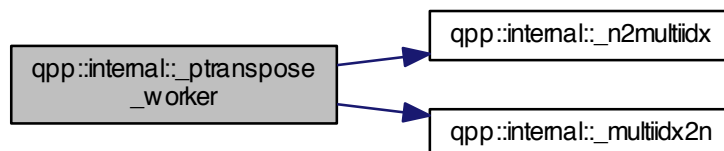
5.4.1.10 `template<typename Scalar > bool qpp::internal::_check_vector ( const types::DynMat< Scalar > & A )`

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

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

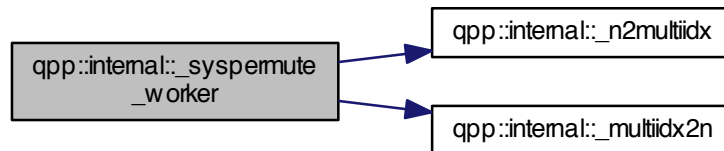
5.4.1.13 `template<typename Scalar > void qpp::internal::_ptranspose_worker ( const size_t * midxcol, size_t numdims, size_t numsubsys, const size_t * cdims, const size_t * csubsys, size_t i, size_t j, size_t iperm, size_t jperm, const types::DynMat< Scalar > & A, types::DynMat< Scalar > & result )`

Here is the call graph for this function:



5.4.1.14 `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:



## 5.5 qpp::stat Namespace Reference

### Classes

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

### Variables

- `std::random_device _rd`
- `std::mt19937 _rng`

### 5.5.1 Variable Documentation

5.5.1.1 `std::random_device qpp::stat::_rd`

5.5.1.2 `std::mt19937 qpp::stat::_rng`

## 5.6 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`
- `template<typename Expression > using Expression2DynMat = Eigen::Matrix< typename Expression::Scalar, Eigen::Dynamic, Eigen::Dynamic >`
- `template<typename Scalar > using DynMat = Eigen::Matrix< Scalar, Eigen::Dynamic, Eigen::Dynamic >`

## 5.6.1 Typedef Documentation

5.6.1.1 `typedef Eigen::MatrixXcd qpp::types::cmat`

5.6.1.2 `typedef std::complex<double> qpp::types::cplx`

5.6.1.3 `typedef Eigen::MatrixXd qpp::types::dmat`

5.6.1.4 `template<typename Scalar > using qpp::types::DynMat = typedef Eigen::Matrix<Scalar, Eigen::Dynamic, Eigen::Dynamic>`

5.6.1.5 `template<typename Expression > using qpp::types::Expression2DynMat = typedef Eigen::Matrix<typename Expression::Scalar, Eigen::Dynamic, Eigen::Dynamic>`

5.6.1.6 `typedef Eigen::MatrixXf qpp::types::fmat`

5.6.1.7 `typedef Eigen::MatrixXi qpp::types::imat`

## 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]`

#### 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

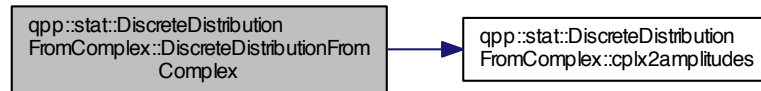
6.2.1.1 `template<typename InputIterator > qpp::stat::DiscreteDistributionFromComplex::DiscreteDistributionFromComplex (InputIterator first, InputIterator last )` `[inline]`

Here is the call graph for this function:



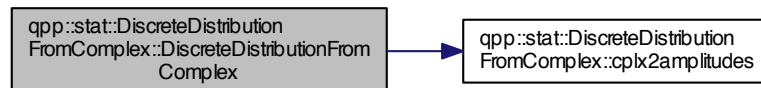
6.2.1.2 `qpp::stat::DiscreteDistributionFromComplex::DiscreteDistributionFromComplex ( std::initializer_list< types::cplx > amplitudes ) [inline]`

Here is the call graph for this function:



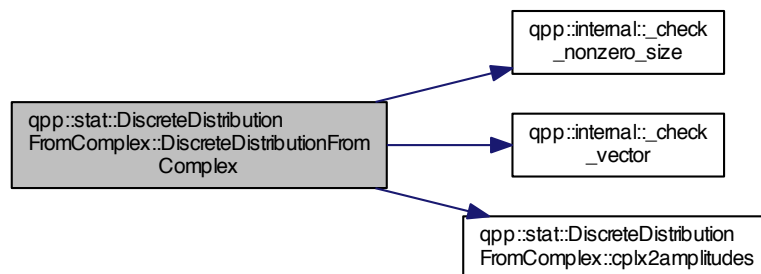
6.2.1.3 `qpp::stat::DiscreteDistributionFromComplex::DiscreteDistributionFromComplex ( std::vector< types::cplx > amplitudes ) [inline]`

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]`

### 6.2.3 Member Data Documentation

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

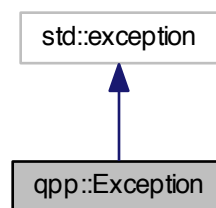
The documentation for this class was generated from the following file:

- include/[stat.h](#)

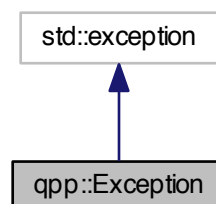
## 6.3 qpp::Exception Class Reference

```
#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::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]

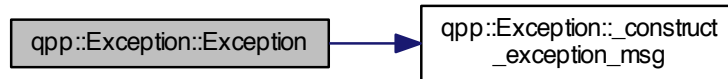
Enumerator

***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***  
***CUSTOM\_EXCEPTION***

### 6.3.2 Constructor & Destructor Documentation

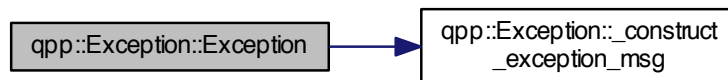
6.3.2.1 `qpp::Exception::Exception ( const std::string & where, const Type & type )` `[inline]`

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::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](#)

#### 6.4.1 Constructor & Destructor Documentation

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

#### 6.4.2 Member Function Documentation

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

#### 6.4.3 Member Data Documentation

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

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

- include/[stat.h](#)

## 6.5 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)

### 6.5.1 Constructor & Destructor Documentation

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

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

### 6.5.2 Member Function Documentation

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

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

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

### 6.5.3 Friends And Related Function Documentation

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

### 6.5.4 Member Data Documentation

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

6.5.4.2 `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`

## 6.6 `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`

### 6.6.1 Constructor & Destructor Documentation

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

### 6.6.2 Member Function Documentation

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

### 6.6.3 Member Data Documentation

### 6.6.3.1 std::uniform\_real\_distribution qpp::stat::UniformRealDistribution::\_d [protected]

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

- include/[stat.h](#)



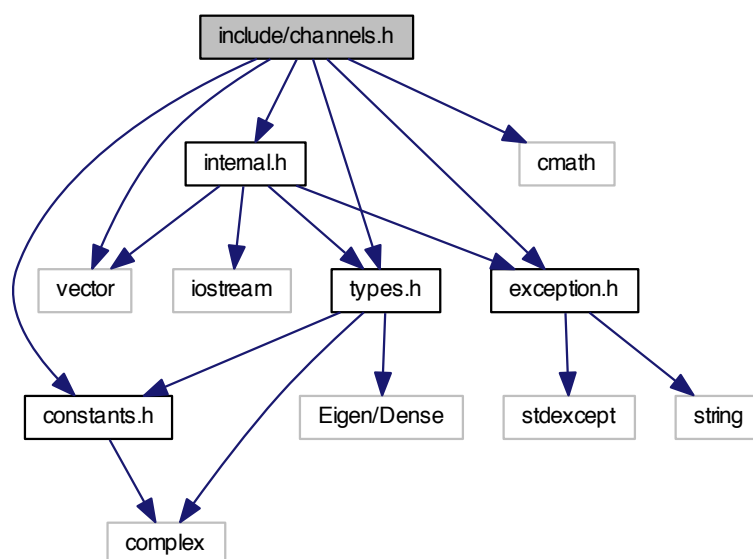
## Chapter 7

# File Documentation

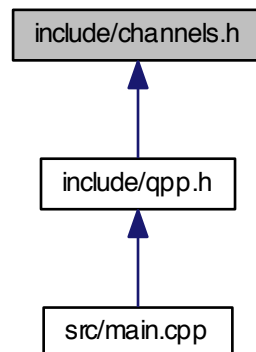
### 7.1 include/channels.h File Reference

```
#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](#)

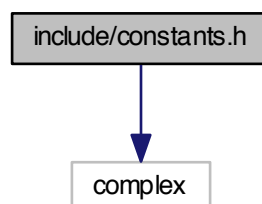
## Functions

- `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

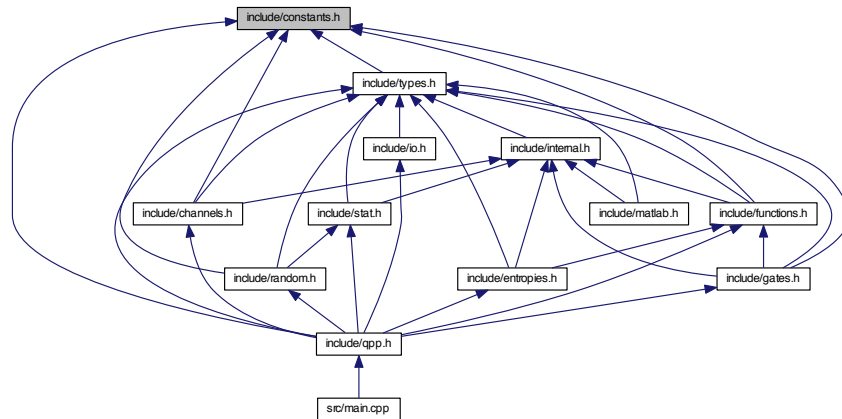
```
#include <complex>
```

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`

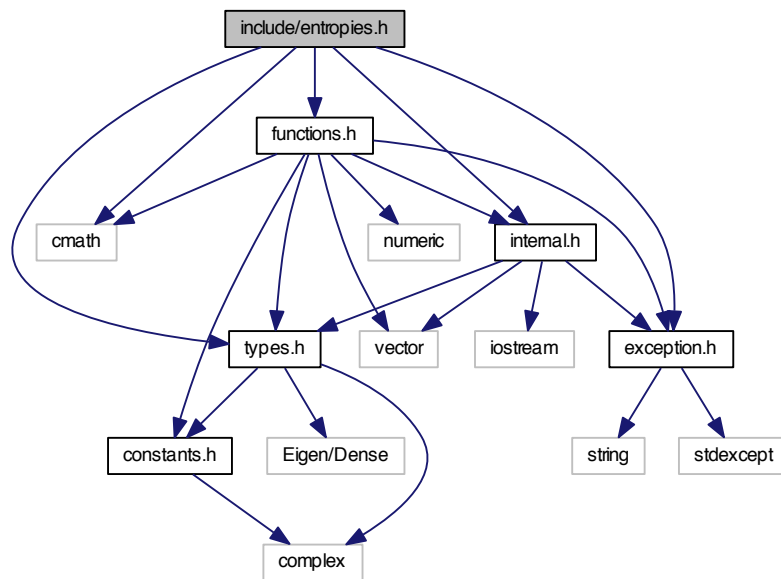
## 7.3 include/entropies.h File Reference

```

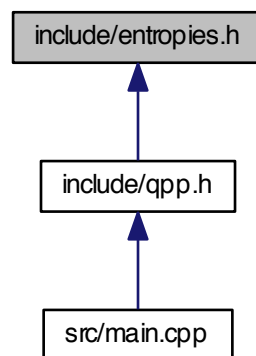
#include <cmath>
#include "types.h"
#include "functions.h"
#include "internal.h"
#include "exception.h"

```

Include dependency graph for entropies.h:



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



## Namespaces

- [qpp](#)

## Functions

- `template<typename Scalar >`  
`double qpp::shannon (const types::DynMat< Scalar > &A)`

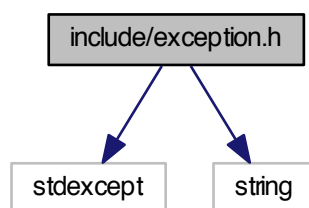
- `template<typename Scalar >`  
`double qpp::renyi (const double alpha, const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`double qpp::renyi\_inf (const types::DynMat< Scalar > &A)`

## 7.4 include/exception.h File Reference

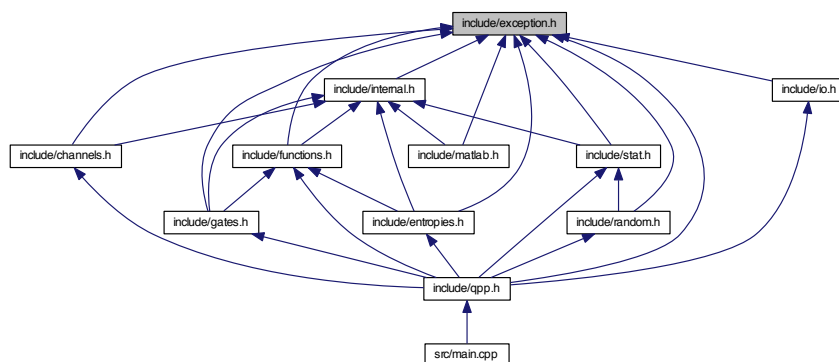
```
#include <stdexcept>
```

```
#include <string>
```

Include dependency graph for exception.h:



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



### Classes

- class [qpp::Exception](#)

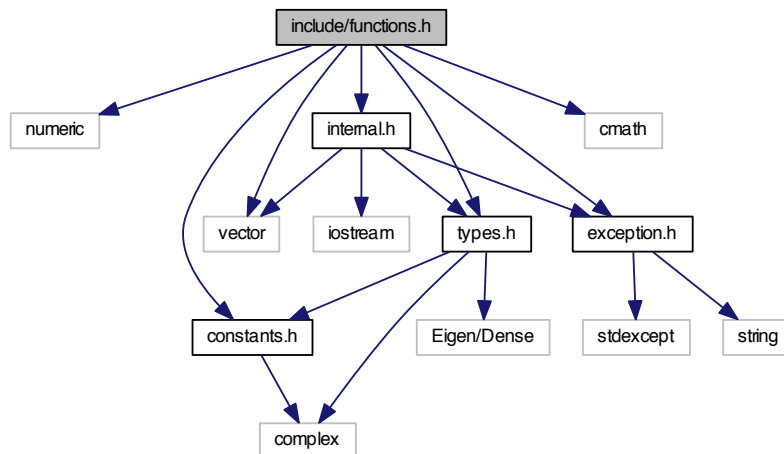
### Namespaces

- [qpp](#)

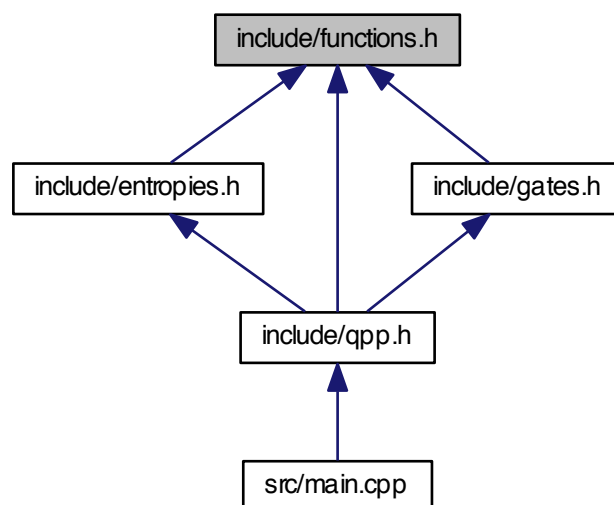
## 7.5 include/functions.h File Reference

```
#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

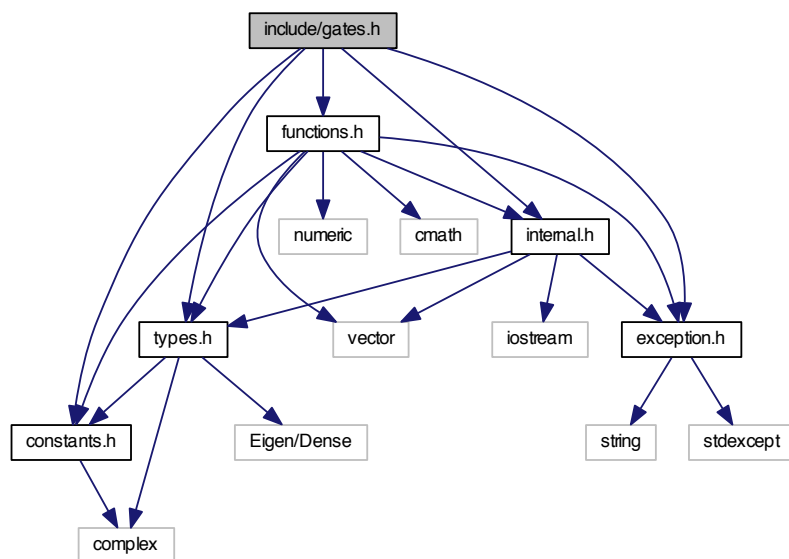
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::transpose (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::conjugate (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::adjoint (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`Scalar qpp::trace (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`Scalar qpp::det (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`Scalar qpp::sum (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`double qpp::norm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat qpp::evals (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat qpp::evecs (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat qpp::hevals (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat qpp::hevecs (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat qpp::funm (const types::DynMat< Scalar > &A, types::cplx(*f)(const types::cplx &))`
- `template<typename Scalar >`  
`types::cmat qpp::absm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat qpp::expm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat qpp::logm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat qpp::sqrtm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat qpp::sinm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat qpp::cosm (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`types::cmat qpp::spectralpowm (const types::DynMat< Scalar > &A, const types::cplx z)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::powm (const types::DynMat< Scalar > &A, size_t n)`
- `template<typename InputScalar , typename OutputScalar >`  
`types::DynMat< OutputScalar > qpp::fun (const types::DynMat< InputScalar > &A, OutputScalar(*f)(const InputScalar &))`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::kron (const types::DynMat< Scalar > &A, const types::DynMat< Scalar > &B)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::kronlist (const std::vector< types::DynMat< Scalar > > &list)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::kronpow (const types::DynMat< Scalar > &A, size_t n)`

- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::reshape (const types::DynMat< Scalar > &A, size_t rows, size_t cols)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::syspermute (const types::DynMat< Scalar > &A, const std::vector< size_t > perm, const std::vector< size_t > &dims)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::ptrace2 (const types::DynMat< Scalar > &A, const std::vector< size_t > dims)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::ptrace (const types::DynMat< Scalar > &A, const std::vector< size_t > &subsys, const std::vector< size_t > &dims)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::ptranspose (const types::DynMat< Scalar > &A, const std::vector< size_t > &subsys, const std::vector< size_t > &dims)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::comm (const types::DynMat< Scalar > &A, const types::DynMat< Scalar > &B)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::anticomm (const types::DynMat< Scalar > &A, const types::DynMat< Scalar > &B)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::proj (const types::DynMat< Scalar > &V)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::expandout (const types::DynMat< Scalar > &A, size_t pos, const std::vector< size_t > &dims)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::grams (const std::vector< types::DynMat< Scalar > > &vecs)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::grams (const types::DynMat< Scalar > &A)`

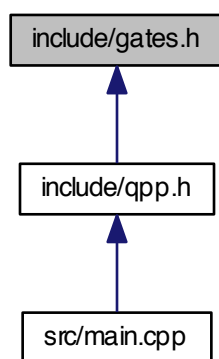
## 7.6 include/gates.h File Reference

```
#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:



## Namespaces

- `qpp`
- `qpp::gt`

## Functions

- void `qpp::gt::_init_gates()`
- `types::cmat` `qpp::gt::Rtheta` (double theta)

- `types::cmat qpp::gt::ld` (`size_t D`)
- `types::cmat qpp::gt::Zd` (`size_t D`)
- `types::cmat qpp::gt::Fd` (`size_t D`)
- `types::cmat qpp::gt::Xd` (`size_t D`)
- `types::cmat qpp::gt::CTRL` (`const types::cmat &A`, `const std::vector< size_t > &ctrl`, `const std::vector< size_t > &gate`, `size_t n`, `size_t D=2`)

## Variables

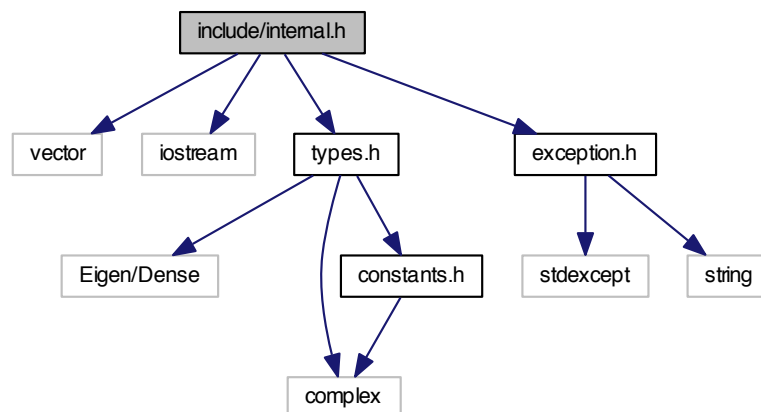
- `types::cmat qpp::gt::ld2`
- `types::cmat qpp::gt::H`
- `types::cmat qpp::gt::X`
- `types::cmat qpp::gt::Y`
- `types::cmat qpp::gt::Z`
- `types::cmat qpp::gt::S`
- `types::cmat qpp::gt::T`
- `types::cmat qpp::gt::CNOTab`
- `types::cmat qpp::gt::CNOTba`
- `types::cmat qpp::gt::CZ`
- `types::cmat qpp::gt::CS`
- `types::cmat qpp::gt::SWAP`
- `types::cmat qpp::gt::TOF`
- `types::cmat qpp::gt::FRED`
- `types::cmat qpp::gt::x0`
- `types::cmat qpp::gt::x1`
- `types::cmat qpp::gt::y0`
- `types::cmat qpp::gt::y1`
- `types::cmat qpp::gt::z0`
- `types::cmat qpp::gt::z1`
- `types::cmat qpp::gt::b00`
- `types::cmat qpp::gt::b01`
- `types::cmat qpp::gt::b10`
- `types::cmat qpp::gt::b11`

## 7.7 include/internal.h File Reference

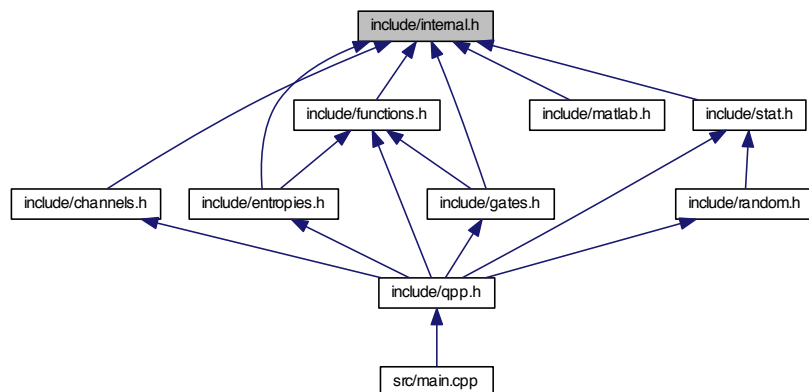
```
#include <vector>
#include <iostream>
#include "types.h"
#include "exception.h"
```



Include dependency graph for internal.h:



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



## Namespaces

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

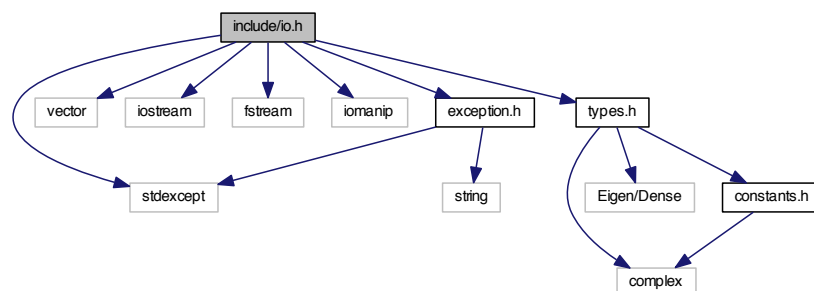
## Functions

- 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 Scalar >  
bool [qpp::internal::\\_check\\_square\\_mat](#) (const types::DynMat< Scalar > &A)
- template<typename Scalar >  
bool [qpp::internal::\\_check\\_vector](#) (const types::DynMat< Scalar > &A)

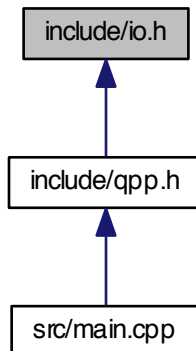
- `template<typename Scalar >`  
`bool qpp::internal::_check_row_vector (const types::DynMat< Scalar > &A)`
- `template<typename Scalar >`  
`bool qpp::internal::_check_col_vector (const types::DynMat< Scalar > &A)`
- `template<typename T >`  
`bool qpp::internal::_check_nonzero_size (const T &x)`
- `bool qpp::internal::_check_dims (const std::vector< size_t > &dims)`
- `template<typename Scalar >`  
`bool qpp::internal::_check_dims_match_mat (const std::vector< size_t > &dims, const types::DynMat< Scalar > &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::_pttranspose_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 <fstream>
#include <iomanip>
#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

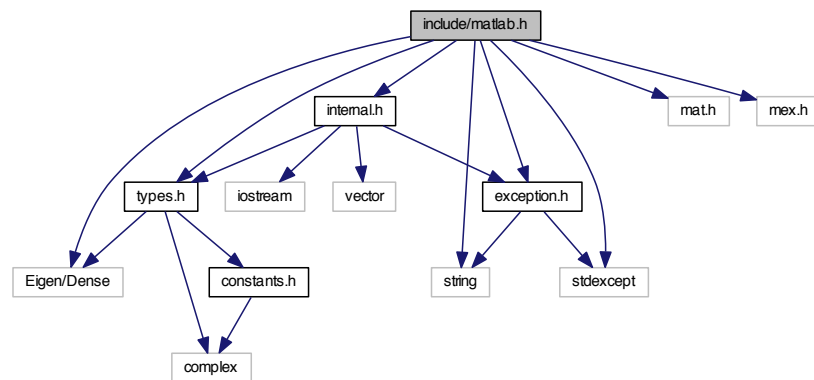
- `template<typename T >`  
`void qpp::disp (const T &x, const std::string &separator=" ", const std::string &start="[", const std::string &end="]", std::ostream &os=std::cout)`
- `template<typename T >`  
`void qpp::displn (const T &x, const std::string &separator=" ", const std::string &start="[", const std::string &end="]", std::ostream &os=std::cout)`
- `template<typename T >`  
`void qpp::disp (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::displn (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 Scalar >`  
`void qpp::disp (const types::DynMat< Scalar > &A, double chop=ct::chop, std::ostream &os=std::cout)`
- `template<typename Scalar >`  
`void qpp::displn (const types::DynMat< Scalar > &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 Scalar >`  
`void qpp::save (const types::DynMat< Scalar > &A, const std::string &fname)`
- `template<typename Scalar >`  
`types::DynMat< 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](#)

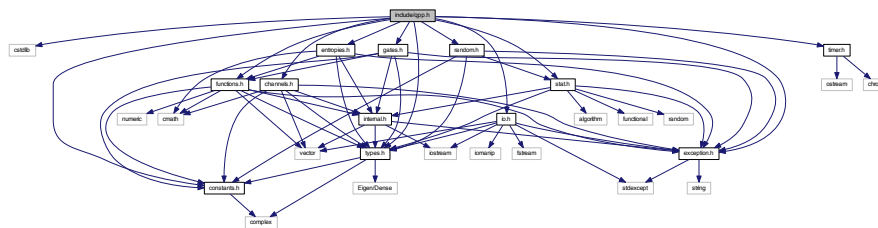
## Functions

- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::loadMATLABmatrix (const std::string &mat_file, const std::string &var_name)`
- `template<>`  
`types::DynMat< double > qpp::loadMATLABmatrix (const std::string &mat_file, const std::string &var_name)`
- `template<>`  
`types::DynMat< types::cplx > qpp::loadMATLABmatrix (const std::string &mat_file, const std::string &var_name)`
- `template<typename Scalar >`  
`void qpp::saveMATLABmatrix (const types::DynMat< Scalar > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)`
- `template<>`  
`void qpp::saveMATLABmatrix (const types::DynMat< double > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)`
- `template<>`  
`void qpp::saveMATLABmatrix (const types::DynMat< types::cplx > &A, const std::string &mat_file, const std::string &var_name, const std::string &mode)`

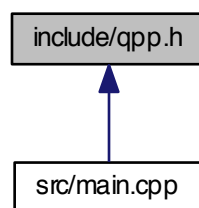
## 7.10 include/qpp.h File Reference

```
#include <cstdlib>
```

```
#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 dependency graph for qpp.h:
```



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



## Namespaces

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

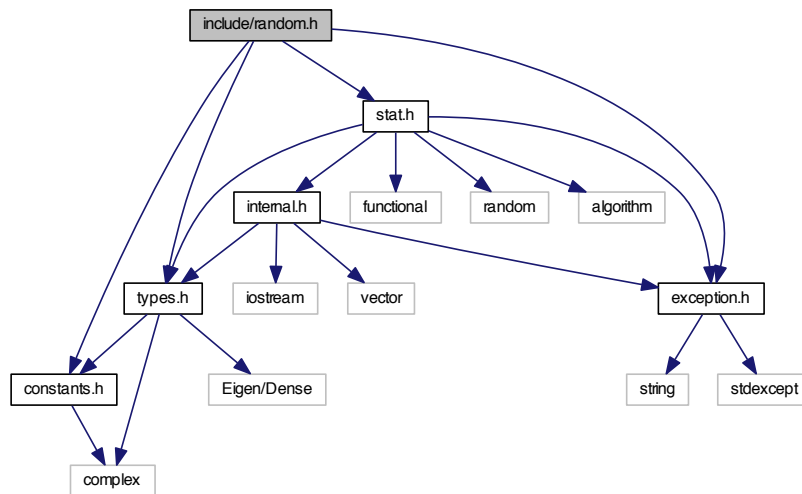
## Functions

- [int qpp::\\_init\(\)](#)

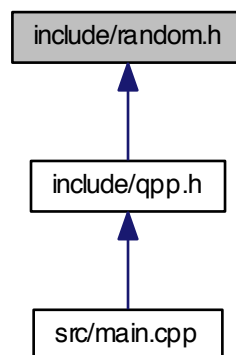
## 7.11 include/random.h File Reference

```
#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](#)

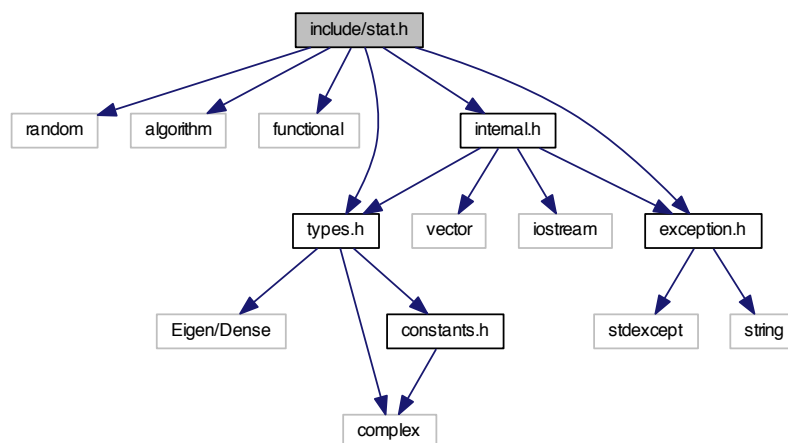
## Functions

- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::rand (size_t rows, size_t cols, double a=0, double b=1)`
- `template<>`  
`types::DynMat< double > qpp::rand (size_t rows, size_t cols, double a, double b)`

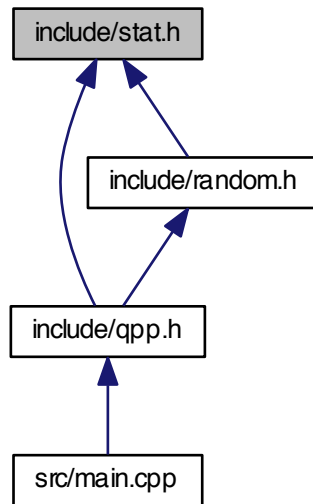
- `template<>`  
`types::DynMat< types::cplx > qpp::rand (size_t rows, size_t cols, double a, double b)`
- `double qpp::rand (double a=0, double b=1)`
- `template<typename Scalar >`  
`types::DynMat< Scalar > qpp::randn (size_t rows, size_t cols, double mean=0, double sigma=1)`
- `template<>`  
`types::DynMat< double > qpp::randn (size_t rows, size_t cols, double mean, double sigma)`
- `template<>`  
`types::DynMat< types::cplx > 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::cmat qpp::randket (size_t D)`
- `types::cmat qpp::randrho (size_t D)`

## 7.12 include/stat.h File Reference

```
#include <random>
#include <algorithm>
#include <functional>
#include "types.h"
#include "internal.h"
#include "exception.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](#)

## Variables

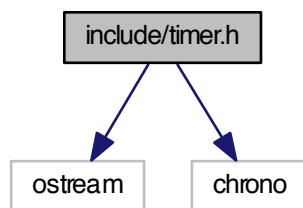
- `std::random_device` [qpp::stat::\\_rd](#)
- `std::mt19937` [qpp::stat::\\_rng](#)

## 7.13 include/timer.h File Reference

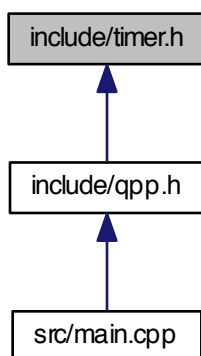
```
#include <ostream>
#include <chrono>
```



Include dependency graph for timer.h:



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



## Classes

- class [qpp::Timer](#)

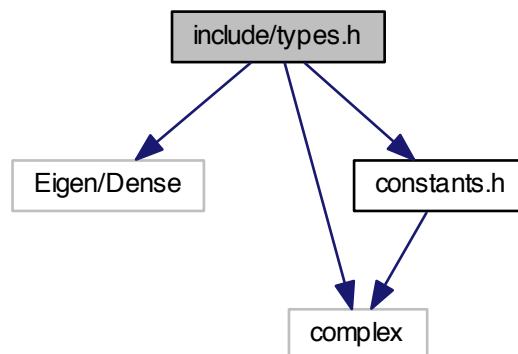
## Namespaces

- [qpp](#)

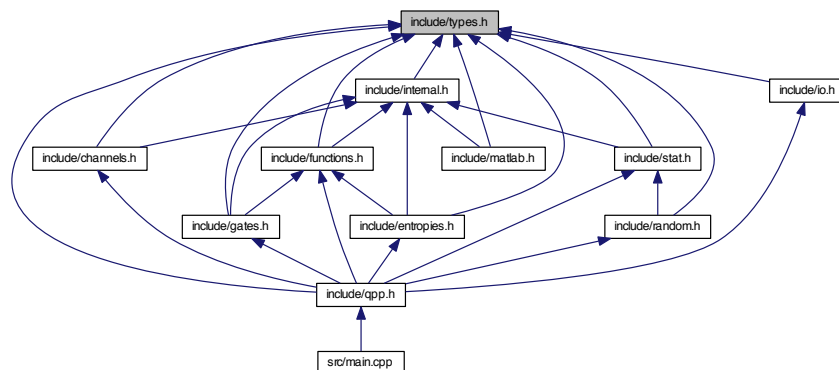
## 7.14 include/types.h File Reference

```
#include <Eigen/Dense>
#include <complex>
#include "constants.h"
```

Include dependency graph for types.h:



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



## Namespaces

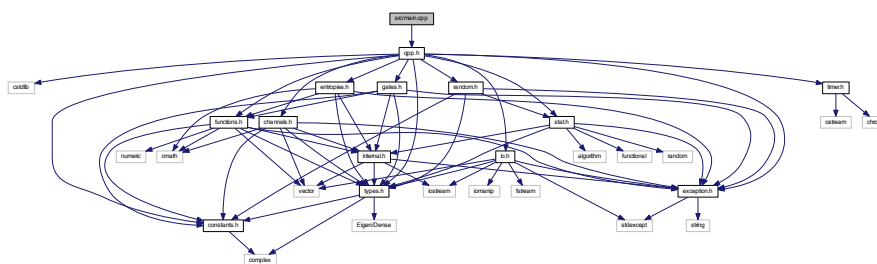
- `qpp`
- `qpp::types`

## 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`
- `template<typename Expression >`  
`using qpp::types::Expression2DynMat = Eigen::Matrix< typename Expression::Scalar, Eigen::Dynamic,`  
`Eigen::Dynamic >`

- ## 7.15 src/main.cpp File Reference

Include dependency graph for main.cpp:



- `int main ()`

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Here is the call graph for this function:

