IntegrationRoutines

5.3

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Files

- file generalized_second_order_ode_technique.hh

  Define the static class GeneralizedSecondOrderODETechnique.
- file integration_messages.hh

  Define the class IntegrationMessages, the class that specifies the message IDs used in the integration model.
- file jeod_integration_group.hh

  Define the extensible class IntegrationGroup, an instance of which is responsible for integrating the states of a set of DynBody objects.
- file jeod_integration_time.hh

  Define the class JeodIntegrationTime.
- file restartable_2d_second_order_integrator.hh

  Defines the class Restartable2DSecondOrderODEIntegrator.
- file restartable_state_integrator.hh

  Define classes that encapsulate the construction, destruction, checkpointing, and restarting of state integrators.
- file restartable_state_integrator_templates.hh

  Define template classes that encapsulate the construction, destruction, checkpointing, and restarting of state integrators.
- file time_change_subscriber.hh

  Define the class TimeChangeSubscriber.
- file generalized_second_order_ode_technique.cc

  Define class GeneralizedSecondOrderODETechnique methods.
- file integration_messages.cc

  Implement the class IntegrationMessages.
- file jeod_integration_group.cc

  Define JeodIntegrationGroup methods.
- file jeod_integration_time.cc

  Define JeodIntegrationTime methods.

Namespaces

- jeod

  Namespace jeod.

6.3.1 Detailed Description

6.4 GaussJackson

Files

- file gauss_jackson_coefficients_pair.hh

  Defines the class GaussJacksonCoefficientsPair, which contains summed Adams and Gauss-Jackson coefficient pair.
- file gauss_jackson_coeffs.hh

  Defines the class GaussJacksonCoeffs, which contains the Gauss-Jackson predictor and corrector coefficients.
- file gauss_jackson_config.hh

  Defines the class GaussJacksonConfig, which specifies Gauss-Jackson configuration data.
- file gauss_jackson_first_order_ode_integrator.hh

  Defines the class GaussJacksonFirstOrderODEIntegrator, which integrates a first order ODE using the summed Adams technique.
- file gauss_jackson_generalized_second_order_ode_integrator.hh

  Defines the class GaussJacksonGeneralizedDerivSecondOrderODEIntegrator, which integrates a generalized derivative second order ODE using Gauss-Jackson.
- file gauss_jackson_integration_controls.hh

  Defines the class GaussJacksonIntegrationControls, which controls Gauss-Jackson integration process.
- file gauss_jackson_integrator_base.hh

  Defines the template class GaussJacksonIntegratorBase, which provides the basis for Gauss-Jackson integration.
- file gauss_jackson_integrator_base_first.hh

  Defines the template specializations of GaussJacksonIntegratorBase for a first order ODE.
- file gauss_jackson_integrator_base_second.hh

  Defines the template specializations of GaussJacksonIntegratorBase for a first order ODE.
- file gauss_jackson_integrator_constructor.hh

  Defines the class GaussJacksonIntegratorConstructor, which constructs integrators that use Gauss-Jackson integration.
- file gauss_jackson_one_state.hh

  Defines the class GaussJacksonOneState, which contains a double∗ pointer.
- file gauss_jackson_rational_coeffs.hh

  Defines the class GaussJacksonRationalCoefficients, which contains a set of Adams or Stormer-Cowell coefficients.
- file gauss_jackson_simple_second_order_ode_integrator.hh

  Defines the class GaussJacksonSimpleSecondOrderODEIntegrator, which integrates a simple second order ODE using Gauss-Jackson.
- file gauss_jackson_state_machine.hh

  Defines the class GaussJacksonStateMachine, which guides the Gauss-Jackson integration process.
- file gauss_jackson_two_state.hh

  Defines the class GaussJacksonTwoState, which contains a pair of double∗ pointers.
- file two_d_array.hh

  Defines the template class er7_utils::TwoDArray, which implements an RAII rectangular 2D array.
- file gauss_jackson_coefficients_pair.cc

  Defines member functions for the class GaussJacksonCoefficientsPair.
- file gauss_jackson_coeffs.cc

  Defines member functions for the class GaussJacksonCoeffs.
- file gauss_jackson_config.cc

  Defines member functions for the class GaussJacksonIntegratorConstructor.
- file gauss_jackson_generalized_second_order_ode_integrator.cc

  Defines member functions for the class GaussJacksonGeneralizedDerivSecondOrderODEIntegrator.
- file gauss_jackson_integration_controls.cc

  Defines member functions for the class GaussJacksonIntegrationControls.
- file gauss_jackson_integrator_constructor.cc

Defines member functions for the class GaussJacksonIntegratorConstructor.

- file gauss_jackson_rational_coeffs.cc

  Defines member functions for the class GaussJacksonRationalCoefficients.

- file gauss_jackson_state_machine.cc

  Defines member functions for the class GaussJacksonStateMachine.

Namespaces

- jeod

  Namespace jeod.

- er7_utils

6.4.1 Detailed Description

6.5 Lsode

Files

- file lsode_control_data_interface.hh

  Define the class LsodeControlDataInterface.
- file lsode_data_classes.hh

  Define LSODE classes that contain just data members.
- file lsode_first_order_ode_integrator.hh

  Define the class LsodeFirstOrderODEIntegrator, the Jeod-compatible version of the Livermore ODE solver, LSODE.
- file lsode_generalized_second_order_ode_integrator.hh

  Define the class LsodeGeneralizedDerivSecondOrderODEIntegrator.
- file lsode_integration_controls.hh

  Define the class LsodeIntegrationControls.
- file lsode_integrator_constructor.hh

  Define the class LsodeIntegratorConstructor, the class that constructs the integration controls and the integrators for the LSODE method.
- file lsode_second_order_ode_integrator.hh

  Define the class LsodeSecondOrderODEIntegrator.
- file lsode_simple_second_order_ode_integrator.hh

  Define the class LsodeSimpleSecondOrderODEIntegrator.
- file lsode_control_data_interface.cc

  Define member functions for the class LsodeControlDataInterface.
- file lsode_data_classes.cc

  Define member functions for the data-grouping classes specified in lsode_data_classes.
- file lsode_first_order_ode_integrator__integrator.cc

  Define member functions for the class LsodeFirstOrderODEIntegrator.
- file lsode_first_order_ode_integrator__manager.cc

  Define member functions for the class LsodeFirstOrderODEIntegrator.
- file lsode_first_order_ode_integrator__support.cc

  Define member functions for the class LsodeFirstOrderODEIntegrator.
- file lsode_first_order_ode_integrator__utility.cc

  Define member functions for the class LsodeFirstOrderODEIntegrator.
- file lsode_generalized_second_order_ode_integrator.cc

  Define member functions for the class LsodeGeneralizedDerivSecondOrderODEIntegrator.
- file lsode_integration_controls.cc

  Define the methods for the class LsodeIntegrationControls.
- file lsode_integrator_constructor.cc

  Define the methods in the class LsodeIntegratorConstructor.
- file lsode_second_order_ode_integrator.cc

  Define member functions for the class LsodeSecondOrderODEIntegrator.
- file lsode_simple_second_order_ode_integrator.cc

  Define member functions for the class LsodeSimpleSecondOrderODEIntegrator.

Namespaces

- jeod

  Namespace jeod.

Functions

- jeod::LsodeControlDataInterface::LsodeControlDataInterface ()

    constructor
- void jeod::LsodeControlDataInterface::check_interface_data ()

    verifies that the input data has legal values.
- void jeod::LsodeControlDataInterface::allocate_arrays ()

    allocates space for vector-populated data to allow for restart
- void jeod::LsodeControlDataInterface::destroy_allocated_arrays ()

    De-allocates allocated array.
- void jeod::LsodeControlDataInterface::set_rel_tol (int index, double value)

    set values from external
- void jeod::LsodeControlDataInterface::set_abs_tol (int index, double value)
- void jeod::LsodeDataArrays::allocate_arrays (unsigned int num_odes, LsodeControlDataInterface::CorrectorMethod corrector_method)

    Allocates memory for the variable size arrays.
- void jeod::LsodeDataArrays::destroy_allocated_arrays ()

    Allows for refactoring and reallocation of newly sized arrays.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_core ()

    integrator_core provides the front-end to all of the integrator_∗i methods, which together perform one step of the integration of an initial value problem for a system of ordinary differential equations.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_reset_method_coeffs ()

    Sets/resets the method_coeffs_current array.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_test_stepsize_change ()

    Tests h against old h.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_reset_yh ()

    Resets history arrays and time-step.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_predict ()

    This section computes the predicted values by multiplying the history array by the Pascal Triangle matrix.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_reset_iteration_loop_part1 ()

    This method resets the iteration loop to the values generated by the integrator_predict method, which populated history[∗][0].
- void jeod::LsodeFirstOrderODEIntegrator::integrator_reset_iteration_loop_part2 ()

    This code follows part 1 after the break-out to get to the external calls, and completes the reset of the integration iteration loop.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_iteration ()

    Keeps looping through the iterations until convergence or failure.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part1 ()

    The corrector iteration failed to converge.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2 ()

    Retracts the history array in the case that the correction iteration failed to converge with either functional iteration or with an up-to-date Jacobian.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_converged ()

    Starts the processing of a converged iteration.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_error_test_failed ()

    Restores the history array following the failure of the corrector for exceeding local error bounds.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order_prep ()

    The first steps in computing whether the order of the integrator should be changed.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order ()

    Computes the step-size scaling factors that will result once it is determined what happens to the order at the next step.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order_check_step_error ()

- void jeod::LsodeFirstOrderODEIntegrator::integrator_set_new_order ()

  Sets the new order and the step-ratio for the next step - or the current step if redoing it.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_fail_reset_order_1_part1 ()

  Repopulates the y-array from history, recomputes the original first derivatives, sets the order back to 1, and reduces the step size by a factor of 10.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_fail_reset_order_1_part2 ()

  Continue reset, with derivatives now at hand.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_wrapup ()

  Wraps up the completion of the integrator.
- void jeod::LsodeFirstOrderODEIntegrator::integrator_terminate ()

  this is the only succesful path back from integrator to manager.
- er7_utils::IntegratorResult jeod::LsodeFirstOrderODEIntegrator::integrate (double dyn_dt, unsigned int target_stage, const double ∗y_dot, double ∗y) override

  Propagate state via Lsode's method.
- void jeod::LsodeFirstOrderODEIntegrator::process_entry_point_cycle_start ()

  The code block from the main integrate routine for re_entry_point=CycleStartFinish.
- void jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part1 ()

  Sets the values for the case with calculation_phase = 1.
- void jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part2 ()
- int jeod::LsodeFirstOrderODEIntegrator::manager_check_stop_conditions ()

  verifies whether the convergence conditions have been met to end the cycle.
- void jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part1 ()

  The iteration loop for the integration process.
- void jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part2 ()
- void jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part3 ()
- void jeod::LsodeFirstOrderODEIntegrator::reset_integrator () override

  Resets the integrator when the timestep changes or when identified as needing a reset.
- void jeod::LsodeFirstOrderODEIntegrator::manager_set_calculation_phase_eq_2_reload ()
- void jeod::LsodeFirstOrderODEIntegrator::calculate_epsilon ()

  Identify the smallest double precision value, epsilon, such that the computer can distinguish (1+epsilon) from 1.
- void jeod::LsodeFirstOrderODEIntegrator::calculate_integration_coefficients ()

  Modified from original DCFODE subroutine.
- void jeod::LsodeFirstOrderODEIntegrator::interpolate_y ()

  Interpolates the zeroth-derivative of y Adapted from subroutine DINTDY, which was a general method for interpolating the K-th derivative of the dependent variable vector, y.
- void jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init ()

  Modified from DPREPJ.
- bool jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_loop ()
- bool jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_wrap_up ()
- void jeod::LsodeFirstOrderODEIntegrator::linear_chord_iteration ()

  Modified from DSOLSY.
- void jeod::LsodeFirstOrderODEIntegrator::load_ew_values ()
- jeod::LsodeFirstOrderODEIntegrator::LsodeFirstOrderODEIntegrator ()

  LsodeFirstOrderODEIntegrator default constructor.
- jeod::LsodeFirstOrderODEIntegrator::LsodeFirstOrderODEIntegrator (const LsodeControlDataInterface &data_in, er7_utils::IntegrationControls &controls, unsigned int size)

  LsodeFirstOrderODEIntegrator non-default constructor.
- jeod::LsodeFirstOrderODEIntegrator::∼LsodeFirstOrderODEIntegrator () override

  LsodeFirstOrderODEIntegrator destructor.
- void jeod::LsodeFirstOrderODEIntegrator::update_control_data ()

  Gets the control data from where it can be populated in the constructor and verifies that the input control parameters are not out of sensible range.

- LsodeFirstOrderODEIntegrator ∗ jeod::LsodeFirstOrderODEIntegrator::create_copy () const override

  Create a copy of 'this' LsodeFirstOrderODEIntegrator object.
- double jeod::LsodeFirstOrderODEIntegrator::magnitude_of_weighted_array (const double ∗v)

  returns the RMS value of {V dot W}, where V and W are N-vectors.
- double jeod::LsodeFirstOrderODEIntegrator::magnitude_of_weighted_array (unsigned int ix, double ∗∗v)

  returns RMS value of v[∗][index]
- int jeod::LsodeFirstOrderODEIntegrator::gauss_elim_factor ()

  Factors a double array (arrays.lin_alg) by Gaussian elimination.
- void jeod::LsodeFirstOrderODEIntegrator::linear_solver ()

  Solves the equation Y' = A Y, with A = arrays.lin_alg.
- unsigned int jeod::LsodeFirstOrderODEIntegrator::index_of_max_magnitude (unsigned int num_points, double ∗∗mx, int starting_ix)

  Modified version of IDAMAX.
- void jeod::LsodeFirstOrderODEIntegrator::load_derivatives (double ∗derivs)

  Load the externally generated derivative values (incoming as y_dot)i into the array derivs.
- jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator::LsodeGeneralizedDerivSecondOrderODEIntegrator (const LsodeControlDataInterface &data_in, er7_utils::IntegrationControls &controls, const er7_utils::GeneralizedPositionDerivativeFunctions &deriv_funs, unsigned int position_size, unsigned int velocity_size)

  non-default constructor
- jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator::LsodeGeneralizedDerivSecondOrderODEIntegrator (const LsodeGeneralizedDerivSecondOrderODEIntegrator &src)

  LsodeGeneralizedDerivSecondOrderODEIntegrator copy constructor.
- LsodeGeneralizedDerivSecondOrderODEIntegrator ∗ jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator::create_copy () const override

  Clone a LsodeGeneralizedDerivSecondOrderODEIntegrator.
- jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator::∼LsodeGeneralizedDerivSecondOrderODEIntegrator () override

  LsodeGeneralizedDerivSecondOrderODEIntegrator destructor.
- er7_utils::IntegratorResult jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator::integrate (double dyn_dt, unsigned int target_stage, const double ∗accel, double ∗velocity, double ∗position) override

  Propagate state via Lsode's method.
- jeod::LsodeIntegrationControls::LsodeIntegrationControls (unsigned int num_stages)
- LsodeIntegrationControls ∗ jeod::LsodeIntegrationControls::create_copy () const override

  Create a copy of 'this' StandardIntegrationControls object.
- unsigned int jeod::LsodeIntegrationControls::integrate (double start_time, double sim_dt, er7_utils::TimeInterface &time_interface, er7_utils::IntegratorInterface &integ_interface, er7_utils::BaseIntegrationGroup &integ_group) override

  Perform one step of the integration process.
- jeod::LsodeIntegratorConstructor::LsodeIntegratorConstructor (const LsodeIntegratorConstructor &src)
- static er7_utils::IntegratorConstructor ∗ jeod::LsodeIntegratorConstructor::create_constructor ()

  Named constructor; create an LsodeIntegratorConstructor instance.
- er7_utils::IntegratorConstructor ∗ jeod::LsodeIntegratorConstructor::create_copy () const override

  Create a duplicate of the constructor.
- er7_utils::IntegrationControls ∗ jeod::LsodeIntegratorConstructor::create_integration_controls () const override

  Create an integration controls that guides the Lsode integration process.
- er7_utils::FirstOrderODEIntegrator ∗ jeod::LsodeIntegratorConstructor::create_first_order_ode_integrator (unsigned int size, er7_utils::IntegrationControls &controls) const override

  Create an Lsode state integrator for a first order ODE.
- er7_utils::SecondOrderODEIntegrator ∗ jeod::LsodeIntegratorConstructor::create_second_order_ode_integrator (unsigned int size, er7_utils::IntegrationControls &controls) const override

  Create an Lsode state integrator for a simple second order ODE.

- er7_utils::SecondOrderODEIntegrator * jeod::LsodeIntegratorConstructor::create_generalized_deriv_second_order_ode_integ (unsigned int position_size, unsigned int velocity_size, const er7_utils::GeneralizedPositionDerivative← Functions &deriv_funs, er7_utils::IntegrationControls &controls) const override

  Create an Lsode state integrator for a generalized second order ODE where generalized position is advanced with the use of the position derivative function.
- jeod::LsodeSecondOrderODEIntegrator::LsodeSecondOrderODEIntegrator (const LsodeControlDataInterface &data_in, er7_utils::IntegrationControls &controls, unsigned int size)

  LsodeSecondOrderODEIntegrator non-default constructor.
- jeod::LsodeSecondOrderODEIntegrator::LsodeSecondOrderODEIntegrator (const LsodeControlDataInterface &data_in, er7_utils::IntegrationControls &controls, const er7_utils::GeneralizedPositionDerivativeFunctions &deriv_funs, unsigned int position_size, unsigned int velocity_size)
- jeod::LsodeSecondOrderODEIntegrator::∼LsodeSecondOrderODEIntegrator () override

  LsodeSecondOrderODEIntegrator destructor.
- jeod::LsodeSimpleSecondOrderODEIntegrator::LsodeSimpleSecondOrderODEIntegrator (const LsodeControlDataInterface &data_in, er7_utils::IntegrationControls &controls, unsigned int size)

  LsodeSimpleSecondOrderODEIntegrator non-default constructor.
- LsodeSimpleSecondOrderODEIntegrator * jeod::LsodeSimpleSecondOrderODEIntegrator::create_copy () const override
- er7_utils::IntegratorResult jeod::LsodeSimpleSecondOrderODEIntegrator::integrate (double dyn_dt, unsigned int target_stage, const double *accel, double *velocity, double *position) override

  Propagate state via Lsode's method.

6.5.1 Detailed Description

6.5.2 Function Documentation

6.5.2.1 allocate_arrays() [1/2]

```
void LsodeDataArrays::allocate_arrays (
            unsigned int num_odes,
            LsodeControlDataInterface::CorrectorMethod corrector_method )
```

Allocates memory for the variable size arrays.

Definition at line 52 of file lsode_data_classes.cc.

References jeod::LsodeDataArrays::accum_correction, jeod::LsodeDataArrays::allocated, jeod::LsodeData← Arrays::error_weight, jeod::LsodeControlDataInterface::FunctionalIteration, jeod::LsodeDataArrays::history, jeod← ::LsodeControlDataInterface::JacobiNewtonInternalJac, jeod::LsodeDataArrays::lin_alg, jeod::LsodeDataArrays← ::lin_alg_index1, jeod::LsodeControlDataInterface::NewtonIterInternalJac, jeod::LsodeControlDataInterface::← NewtonIterUserJac, jeod::LsodeDataArrays::num_odes, jeod::LsodeDataArrays::pivots, and jeod::LsodeData← Arrays::save.

Referenced by jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part1().

6.5.2.2 allocate_arrays() [2/2]

```
void LsodeControlDataInterface::allocate_arrays ( )
```

allocates space for vector-populated data to allow for restart

Definition at line 260 of file lsode_control_data_interface.cc.

References jeod::LsodeControlDataInterface::abs_tolerance_error_control, jeod::LsodeControlDataInterface::abs_tolerance_error_control_vec, jeod::LsodeControlDataInterface::error_control_vector_copied_over, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeControlDataInterface::num_odes_at_alloc, jeod::LsodeControlDataInterface::rel_tolerance_error_control, and jeod::LsodeControlDataInterface::rel_tolerance_error_control_vec.

Referenced by jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part1().

6.5.2.3 calculate_epsilon()

```
void LsodeFirstOrderODEIntegrator::calculate_epsilon ( ) [protected]
```

Identify the smallest double precision value, epsilon, such that the computer can distinguish (1+epsilon) from 1.

Definition at line 58 of file lsode_first_order_ode_integrator__support.cc.

References jeod::LsodeFirstOrderODEIntegrator::epsilon, and jeod::LsodeFirstOrderODEIntegrator::sqrt_epsilon.

Referenced by jeod::LsodeFirstOrderODEIntegrator::LsodeFirstOrderODEIntegrator().

6.5.2.4 calculate_integration_coefficients()

```
void LsodeFirstOrderODEIntegrator::calculate_integration_coefficients ( ) [protected]
```

Modified from original DCFODE subroutine.

calculate_integration_coefficients is called by dstode to set coefficients needed there. The coefficients for the current method, as given by the value of integration_method, are set for all orders and saved. The maximum order assumed here is 12 if integration_method = ImplicitAdamsNonStiff and 5 if integration_method = ImplicitBackDiffStiff.

NOTE - A smaller value of the maximum order is also allowed and may be set by the user with the value control_data.max_order, which gets copied to the protected value max_order_internal.

calculate_integration_coefficients is called once at the beginning of the problem, and again only if integration_method is changed.

The coefficients are stored in two arrays: method_coeffs_complete is a 13x12 array that contains a complete set of coefficients for the method test_coeffs_complete is a 3x12 array that contains the coefficients for local error tests and selection of the step size and/or order. The 1st set of 12 coeffs is for order method_order_current - 1 The 2nd set of 12 coeffs is for order method_order_current The 3rd set of 12 coeffs is for order method_order_current + 1

The coefficients in method_coeffs_complete are computed by a genetrating polynomial. For a given order (note that order changes during the integration process up to the maximum allowable, and is identified in the integrator as the variable method_order_current), abbreviate method_coeffs_complete[i][order-1] to mcc[i]

Then l(x) = mcc[0] + (mcc[1] ∗ x) + (mcc[2] ∗ x^2) + ... + mcc[order] ∗ (x^order) For the implicit Adams methods, l(x) is given by dl/dx = (x+1)∗(x+2)∗...∗(x+order-1)/(order-1)!, l(-1) = 0.; For the BDF methods, l(x) is given by l(x) = (x+1)∗(x+2)∗ ... ∗(x+order) / ((order)! ∗ (1 + 1/2 + ... + 1/order))

(! represents factorial)

Note that while method_coeffs_compelte is a rectangular array for convenience, it is effectively a triangular array since method_coeffs_complete[i][order-1] has no meaning for i >= (order + 2) order=1: method_coeffs_complete[0-1][0] order=2: method_coeffs_complete[0-2][1] ... order=12: method_coeffs_complete[0-12][11] Hence a 13x12 array.

Definition at line 119 of file lsode_first_order_ode_integrator__support.cc.

References jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeControlDataInterface::ImplicitAdamsNonStiff, jeod::LsodeControlDataInterface::ImplicitBackDiffStiff, jeod::LsodeControlDataInterface::integration_method, jeod::LsodeFirstOrderODEIntegrator::method_coeffs_complete, and jeod::LsodeFirstOrderODEIntegrator::test_coeffs_complete.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_core().

6.5.2.5 check_interface_data()

```
void LsodeControlDataInterface::check_interface_data ( )
```

verifies that the input data has legal values.

Definition at line 59 of file lsode_control_data_interface.cc.

References jeod::LsodeControlDataInterface::abs_tolerance_error_control_vec, jeod::LsodeControlDataInterface::CommonAbsSpecificRel, jeod::LsodeControlDataInterface::corrector_method, jeod::LsodeControlDataInterface::error_control_indicator, jeod::LsodeControlDataInterface::error_control_vector_copied_over, jeod::LsodeControlDataInterface::integration_method, jeod::LsodeControlDataInterface::max_num_small_step_warnings, jeod::LsodeControlDataInterface::max_num_steps, jeod::LsodeControlDataInterface::max_order, jeod::LsodeControlDataInterface::max_step_size, jeod::LsodeControlDataInterface::min_step_size, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeControlDataInterface::rel_tolerance_error_control_vec, jeod::LsodeControlDataInterface::SpecificAbsCommonRel, and jeod::LsodeControlDataInterface::SpecificAbsSpecificRel.

Referenced by jeod::LsodeFirstOrderODEIntegrator::update_control_data().

6.5.2.6 create_constructor()

```
er7_utils::IntegratorConstructor * LsodeIntegratorConstructor::create_constructor ( )  [static]
```

Named constructor; create an LsodeIntegratorConstructor instance.

The caller is responsible for deleting the returned object.

Returns

Newly created LsodeIntegratorConstructor instance.

Definition at line 64 of file lsode_integrator_constructor.cc.

6.5.2.7 create_copy() [1/5]

LsodeIntegrationControls * LsodeIntegrationControls::create_copy ( ) const [override]

Create a copy of 'this' StandardIntegrationControls object.

Returns

Clone of 'this'.

Definition at line 56 of file lsode_integration_controls.cc.

6.5.2.8 create_copy() [2/5]

LsodeSimpleSecondOrderODEIntegrator * LsodeSimpleSecondOrderODEIntegrator::create_copy ( ) const [override]

Definition at line 57 of file lsode_simple_second_order_ode_integrator.cc.

6.5.2.9 create_copy() [3/5]

LsodeGeneralizedDerivSecondOrderODEIntegrator * LsodeGeneralizedDerivSecondOrderODEIntegrator↩ ::create_copy ( ) const [override]

Clone a LsodeGeneralizedDerivSecondOrderODEIntegrator.

Definition at line 81 of file lsode_generalized_second_order_ode_integrator.cc.

6.5.2.10 create_copy() [4/5]

er7_utils::IntegratorConstructor * LsodeIntegratorConstructor::create_copy ( ) const [override]

Create a duplicate of the constructor.

The caller is responsible for deleting the returned object.

Returns

Duplicated constructor.

Definition at line 70 of file lsode_integrator_constructor.cc.

6.5.2.11 create_copy() [5/5]

```
LsodeFirstOrderODEIntegrator * LsodeFirstOrderODEIntegrator::create_copy ( ) const  [override]
```

Create a copy of 'this' LsodeFirstOrderODEIntegrator object.

Returns

Clone of 'this'.

Definition at line 119 of file lsode_first_order_ode_integrator__utility.cc.

6.5.2.12 create_first_order_ode_integrator()

```
er7_utils::FirstOrderODEIntegrator * LsodeIntegratorConstructor::create_first_order_ode_↩
integrator (
            unsigned int size,
            er7_utils::IntegrationControls & controls ) const  [override]
```

Create an Lsode state integrator for a first order ODE.

The caller is responsible for deleting the created object.

Returns

State integrator

Parameters

in	*size*	State size
in,out	*controls*	Integration controls

Definition at line 82 of file lsode_integrator_constructor.cc.

References jeod::LsodeIntegratorConstructor::data_interface.

6.5.2.13 create_generalized_deriv_second_order_ode_integrator()

```
er7_utils::SecondOrderODEIntegrator * LsodeIntegratorConstructor::create_generalized_deriv_↩
second_order_ode_integrator (
            unsigned int position_size,
            unsigned int velocity_size,
            const er7_utils::GeneralizedPositionDerivativeFunctions & deriv_funs,
            er7_utils::IntegrationControls & controls ) const  [override]
```

Create an Lsode state integrator for a generalized second order ODE where generalized position is advanced with the use of the position derivative function.

The caller is responsible for deleting the created object.

Returns

State integrator

Parameters

in	*position_size*	Size of the generalized position
in	*velocity_size*	Size of the generalized velocity
in	*deriv_funs*	Position derivative functions container
in,out	*controls*	Integration controls

Definition at line 102 of file lsode_integrator_constructor.cc.

References jeod::LsodeIntegratorConstructor::data_interface.

6.5.2.14 create_integration_controls()

```
er7_utils::IntegrationControls * LsodeIntegratorConstructor::create_integration_controls ( )
const [override]
```

Create an integration controls that guides the Lsode integration process.

The caller is responsible for deleting the created object.

Returns

Integration controls object

Definition at line 76 of file lsode_integrator_constructor.cc.

6.5.2.15 create_second_order_ode_integrator()

```
er7_utils::SecondOrderODEIntegrator * LsodeIntegratorConstructor::create_second_order_ode_↩
integrator (
            unsigned int size,
            er7_utils::IntegrationControls & controls ) const [override]
```

Create an Lsode state integrator for a simple second order ODE.

The caller is responsible for deleting the created object.

Returns

State integrator

Parameters

in	*size*	State size
in,out	*controls*	Integration controls

Definition at line 92 of file lsode_integrator_constructor.cc.

References jeod::LsodeIntegratorConstructor::data_interface.

6.5.2.16 destroy_allocated_arrays() [1/2]

`void LsodeDataArrays::destroy_allocated_arrays ( )`

Allows for refactoring and reallocation of newly sized arrays.

Definition at line 148 of file lsode_data_classes.cc.

References jeod::LsodeDataArrays::accum_correction, jeod::LsodeDataArrays::allocated, jeod::LsodeDataArrays::error_weight, jeod::LsodeDataArrays::history, jeod::LsodeDataArrays::lin_alg, jeod::LsodeDataArrays::lin_alg_index1, jeod::LsodeDataArrays::num_odes, jeod::LsodeDataArrays::pivots, and jeod::LsodeDataArrays::save.

Referenced by jeod::LsodeDataArrays::∼LsodeDataArrays(), and jeod::LsodeFirstOrderODEIntegrator::∼LsodeFirstOrderODEIntegrator().

6.5.2.17 destroy_allocated_arrays() [2/2]

`void LsodeControlDataInterface::destroy_allocated_arrays ( )`

De-allocates allocated array.

Definition at line 312 of file lsode_control_data_interface.cc.

References jeod::LsodeControlDataInterface::abs_tolerance_error_control, jeod::LsodeControlDataInterface::error_control_vector_copied_over, and jeod::LsodeControlDataInterface::rel_tolerance_error_control.

Referenced by jeod::LsodeFirstOrderODEIntegrator::∼LsodeFirstOrderODEIntegrator().

6.5.2.18 gauss_elim_factor()

`int LsodeFirstOrderODEIntegrator::gauss_elim_factor ( ) [protected]`

Factors a double array (arrays.lin_alg) by Gaussian elimination.

Modified version of DGEFA.

Definition at line 175 of file lsode_first_order_ode_integrator__utility.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::index_of_max_magnitude(), jeod::LsodeDataArrays::lin_alg, jeod::LsodeControlDataInterface::num_odes, and jeod::LsodeDataArrays::pivots.

Referenced by jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_wrap_up().

6.5.2.19 index_of_max_magnitude()

```
unsigned int LsodeFirstOrderODEIntegrator::index_of_max_magnitude (
            unsigned int num_points,
            double ** array,
            int start_ix )  [protected]
```

Modified version of IDAMAX.

IDAMAX has 2 operations, one for situations in which the index increments by 1, and another for the converse. Since all instances in LSODE use the unit-increment method, that is the only one represented here. Search through matrix "array", starting at array[start_ix_1][start_ix_2] for the next "num_points" elements. The boolean search↩ _ix_1 controls whether to increment index#1 (true), or index#2 (false). Method returns the searched index that corresponds to the largest magnitude.

Note

The only call to this method passed "k" in for both indices, so I stripped the second argument. If DGBFA gets implemented, it will have to be added back in; the call from DGBFA is for array starting at (M,K)

Definition at line 338 of file lsode_first_order_ode_integrator__utility.cc.

Referenced by jeod::LsodeFirstOrderODEIntegrator::gauss_elim_factor().

6.5.2.20 integrate() [1/4]

```
unsigned int LsodeIntegrationControls::integrate (
            double start_time,
            double sim_dt,
            er7_utils::TimeInterface & time_interface,
            er7_utils::IntegratorInterface & integ_interface,
            er7_utils::BaseIntegrationGroup & integ_group )  [override]
```

Perform one step of the integration process.

Definition at line 69 of file lsode_integration_controls.cc.

6.5.2.21 integrate() [2/4]

```
er7_utils::IntegratorResult LsodeSimpleSecondOrderODEIntegrator::integrate (
            double dyn_dt,
            unsigned int target_stage,
            const double * accel,
            double * velocity,
            double * position )  [override]
```

Propagate state via Lsode's method.

Parameters

in	*dyn_dt*	Integration interval step, dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in	*accel*	Generalized acceleration vector.
in,out	*velocity*	Generalized velocity vector.
in,out	*position*	Generalized position vector.

Returns

The status (time advance, pass/fail status) of the integration.

Definition at line 67 of file lsode_simple_second_order_ode_integrator.cc.

References jeod::LsodeSecondOrderODEIntegrator::first_order_integrator, jeod::LsodeFirstOrderODEIntegrator::integrate(), jeod::LsodeSecondOrderODEIntegrator::y, jeod::LsodeSecondOrderODEIntegrator::y_dot, and jeod::LsodeSecondOrderODEIntegrator::zeroth_derivative_size.

6.5.2.22 integrate() [3/4]

```
er7_utils::IntegratorResult LsodeGeneralizedDerivSecondOrderODEIntegrator::integrate (
            double dyn_dt,
            unsigned int target_stage,
            const double * accel,
            double * velocity,
            double * position )  [override]
```

Propagate state via Lsode's method.

Parameters

in	*dyn_dt*	Integration interval step, dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in	*accel*	Generalized acceleration vector.
in,out	*velocity*	Generalized velocity vector.
in,out	*position*	Generalized position vector.

Returns

The status (time advance, pass/fail status) of the integration.

Definition at line 101 of file lsode_generalized_second_order_ode_integrator.cc.

References jeod::LsodeSecondOrderODEIntegrator::first_derivative_size, jeod::LsodeSecondOrderODEIntegrator::first_order_integrator, jeod::LsodeFirstOrderODEIntegrator::integrate(), jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator::posdot, jeod::LsodeSecondOrderODEIntegrator::y, jeod::LsodeSecondOrderODEIntegrator::y_dot, and jeod::LsodeSecondOrderODEIntegrator::zeroth_derivative_size.

6.5.2.23 integrate() [4/4]

```
er7_utils::IntegratorResult LsodeFirstOrderODEIntegrator::integrate (
            double dyn_dt,
            unsigned int target_stage,
            const double * y_dot,
            double * y ) [override]
```

Propagate state via Lsode's method.

Propagate state via the LSODE method.

Parameters

in	*dyn_dt*	Integration interval step, dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in,out	*y_dot*	Generalized velocity vector.
in,out	*y*	Generalized position vector.

Returns

The status (time advance, pass/fail status) of the integration.

Definition at line 60 of file lsode_first_order_ode_integrator__manager.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::cycle_target_↩time, jeod::LsodeFirstOrderODEIntegrator::CycleStartFinish, jeod::LsodeFirstOrderODEIntegrator::DstodeReset↩Step, jeod::LsodeFirstOrderODEIntegrator::InitCalc, jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_↩iteration(), jeod::LsodeFirstOrderODEIntegrator::integrator_fail_reset_order_1_part2(), jeod::LsodeFirstOrderOD↩EIntegrator::integrator_reset_iteration_loop_part2(), jeod::LsodeFirstOrderODEIntegrator::IterationLoop, jeod↩::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_↩loop(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_wrap_up(), jeod::LsodeFirstOrderODEIntegrator::↩JacobianPrep, jeod::LsodeFirstOrderODEIntegrator::load_derivatives(), jeod::LsodeFirstOrderODEIntegrator↩::manager_initialize_calculation_part2(), jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part2(), jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part3(), jeod::LsodeFirstOrderODEIntegrator↩::process_entry_point_cycle_start(), jeod::LsodeFirstOrderODEIntegrator::re_entry_point, jeod::LsodeFirstOrder↩ODEIntegrator::ResetIterLoop, jeod::LsodeDataArrays::save, jeod::LsodeFirstOrderODEIntegrator::stage_target↩_time, jeod::LsodeFirstOrderODEIntegrator::step_error, jeod::LsodeFirstOrderODEIntegrator::update_jacobian, jeod::LsodeFirstOrderODEIntegrator::y, and jeod::LsodeFirstOrderODEIntegrator::y_dot.

Referenced by jeod::LsodeSimpleSecondOrderODEIntegrator::integrate(), and jeod::LsodeGeneralizedDeriv↩SecondOrderODEIntegrator::integrate().

6.5.2.24 integrator_compute_new_order()

```
void LsodeFirstOrderODEIntegrator::integrator_compute_new_order ( ) [protected]
```

Computes the step-size scaling factors that will result once it is determined what happens to the order at the next step.

Definition at line 747 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeDataArrays::accum_correction, jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::LsodeDataStode::dsm, jeod::LsodeDataArrays::history, jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order_check_step_error(), jeod::LsodeFirstOrderODEIntegrator::integrator_set_new_order(), jeod::LsodeFirstOrderODEIntegrator::integrator_wrapup(), jeod::LsodeFirstOrderODEIntegrator::magnitude_of_weighted_array(), jeod::LsodeFirstOrderODEIntegrator::method_coeffs_current, jeod::LsodeFirstOrderODEIntegrator::method_order_current, jeod::LsodeDataStode::new_method_order, jeod::LsodeFirstOrderODEIntegrator::num_nordsiek_cols, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeFirstOrderODEIntegrator::order_select_para, jeod::LsodeDataStode::step_ratio, jeod::LsodeDataStode::step_ratio_order_inc, and jeod::LsodeFirstOrderODEIntegrator::test_coeffs_complete.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order_prep(), and jeod::LsodeFirstOrderODEIntegrator::integrator_error_test_failed().

6.5.2.25 integrator_compute_new_order_check_step_error()

`void LsodeFirstOrderODEIntegrator::integrator_compute_new_order_check_step_error ( ) [protected]`

Definition at line 817 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::LsodeFirstOrderODEIntegrator::integrator_set_new_order(), jeod::LsodeFirstOrderODEIntegrator::integrator_wrapup(), jeod::LsodeFirstOrderODEIntegrator::order_select_para, jeod::LsodeFirstOrderODEIntegrator::step_error, and jeod::LsodeDataStode::step_ratio.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order().

6.5.2.26 integrator_compute_new_order_prep()

`void LsodeFirstOrderODEIntegrator::integrator_compute_new_order_prep ( ) [protected]`

The first steps in computing whether the order of the integrator should be changed.

Regardless of the success or failure of the step, the step-ratio factors for an increase, decrease, or retention of the integrator order are computed. In the case of failure, the increase ratio (data_stode.step_ratio_order_inc) has already been set to 0.0 to prevent an order increase. The largest of these factors is determined and the new order chosen accordingly. In the unusual case of equality, the priority is given to:

1. retain the order
2. increase the order (if inc = dec $>$ same)

If the order is to be increased, we compute one additional scaled derivative.

This process is spread over four methods - integrator_compute_new_order_prep integrator_compute_new_order integrator_compute_new_order_check_step_error integrator_set_new_order

extracted from lines 520-540

Definition at line 725 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeDataArrays::accum_correction, jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::LsodeDataArrays::history, jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order(), jeod::LsodeFirstOrderODEIntegrator::magnitude_of_weighted_array(), jeod::LsodeFirstOrderODEIntegrator::max_history_size, jeod::LsodeFirstOrderODEIntegrator::method_order_current, jeod::LsodeFirstOrderODEIntegrator::num_nordsiek_cols, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeDataArrays::save, jeod::LsodeDataStode::step_ratio_order_inc, and jeod::LsodeFirstOrderODEIntegrator::test_coeffs_complete.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_converged().

6.5.2.27 integrator_core()

```
void LsodeFirstOrderODEIntegrator::integrator_core ( ) [protected]
```

integrator_core provides the front-end to all of the integrator_∗i methods, which together perform one step of the integration of an initial value problem for a system of ordinary differential equations.

Modified from DSTODE

NOTES: The entire integrator_∗ suite is independent of the value of the iteration method indicator, corrector_↩ method, when said is != 0, and hence is independent of the type of chord method used, or the Jacobian structure.

The value internal_state (JSTART) controls the direction that this method takes.

By commenting out substantial parts of the package that are not useful to the ER7 / JEOD / Trick implementation, the only viable values for internal_state are now 0 or 1. internal_state = 0 : take the first step. internal_state = 1 : take another step, continuing from the last. internal_state = -1 was associated with externally driven changes to the input aprameters, something we do not allow. internal_state = -2 is associated with the critical / singularity time avoidance, something we have not implemented.

Definition at line 78 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::calculate_↩ integration_coefficients(), jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODE↩ Integrator::convergence_factor, jeod::LsodeFirstOrderODEIntegrator::convergence_jacobian_flag, jeod::Lsode↩ FirstOrderODEIntegrator::convergence_rate, jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::Lsode↩ ControlDataInterface::integration_method, jeod::LsodeFirstOrderODEIntegrator::integrator_predict(), jeod::Lsode↩ FirstOrderODEIntegrator::integrator_reset_method_coeffs(), jeod::LsodeFirstOrderODEIntegrator::integrator↩ _reset_yh(), jeod::LsodeFirstOrderODEIntegrator::integrator_test_stepsize_change(), jeod::LsodeFirstOrder↩ ODEIntegrator::internal_state, jeod::LsodeDataStode::iredo, jeod::LsodeDataStode::iret, jeod::LsodeControl↩ DataInterface::is_corrector_method_functional_iteration(), jeod::LsodeFirstOrderODEIntegrator::iteration_↩ matrix_singular, jeod::LsodeFirstOrderODEIntegrator::jacobian_current, jeod::LsodeFirstOrderODEIntegrator↩ ::magnitude_of_weighted_array(), jeod::LsodeFirstOrderODEIntegrator::max_history_size, jeod::LsodeFirst↩ OrderODEIntegrator::max_order_internal, jeod::LsodeFirstOrderODEIntegrator::max_step_increase_ratio, jeod↩ ::LsodeFirstOrderODEIntegrator::method_coeff_first, jeod::LsodeFirstOrderODEIntegrator::method_coeffs_↩ complete, jeod::LsodeFirstOrderODEIntegrator::method_coeffs_current, jeod::LsodeFirstOrderODEIntegrator↩ ::method_order_current, jeod::LsodeControlDataInterface::min_step_size, jeod::LsodeFirstOrderODEIntegrator↩ ::modified_iteration_matrix_singular, jeod::LsodeDataStode::ncf, jeod::LsodeFirstOrderODEIntegrator::num↩ _equations, jeod::LsodeFirstOrderODEIntegrator::num_nordsiek_cols, jeod::LsodeFirstOrderODEIntegrator↩ ::num_predictor_elements, jeod::LsodeFirstOrderODEIntegrator::order_select_para, jeod::LsodeFirstOrderOD↩ EIntegrator::prev_integration_method, jeod::LsodeFirstOrderODEIntegrator::prev_step_size, jeod::LsodeFirst↩ OrderODEIntegrator::rel_change_since_jacobian, jeod::LsodeDataArrays::save, jeod::LsodeFirstOrderODE↩ Integrator::stage_target_time, jeod::LsodeFirstOrderODEIntegrator::step_at_last_jacobian_update, jeod::Lsode↩ FirstOrderODEIntegrator::step_error, jeod::LsodeDataStode::step_ratio, jeod::LsodeFirstOrderODEIntegrator↩ ::step_size, jeod::LsodeFirstOrderODEIntegrator::test_coeffs_complete, jeod::LsodeDataStode::told, and jeod::↩ LsodeFirstOrderODEIntegrator::update_jacobian.

Referenced by jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part2().

6.5.2.28 integrator_corrector_converged()

```
void LsodeFirstOrderODEIntegrator::integrator_corrector_converged ( ) [protected]
```

Starts the processing of a converged iteration.

Definition at line 588 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeDataArrays::accum_correction, jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::↩ LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::Lsode↩ DataStode::dsm, jeod::LsodeDataArrays::history, jeod::LsodeFirstOrderODEIntegrator::integrator_compute_↩ new_order_prep(), jeod::LsodeFirstOrderODEIntegrator::integrator_error_test_failed(), jeod::LsodeFirstOrder↩ ODEIntegrator::integrator_wrapup(), jeod::LsodeDataStode::iredo, jeod::LsodeFirstOrderODEIntegrator::iter↩ _delta, jeod::LsodeFirstOrderODEIntegrator::iteration_count, jeod::LsodeFirstOrderODEIntegrator::jacobian↩ _current, jeod::LsodeFirstOrderODEIntegrator::magnitude_of_weighted_array(), jeod::LsodeFirstOrderODE↩ Integrator::max_history_size, jeod::LsodeFirstOrderODEIntegrator::method_coeffs_current, jeod::LsodeFirst↩ OrderODEIntegrator::method_order_current, jeod::LsodeFirstOrderODEIntegrator::num_nordsiek_cols, jeod::↩ LsodeControlDataInterface::num_odes, jeod::LsodeFirstOrderODEIntegrator::num_steps_taken, jeod::Lsode↩ FirstOrderODEIntegrator::order_select_para, jeod::LsodeFirstOrderODEIntegrator::prev_good_step_size, jeod↩ ::LsodeFirstOrderODEIntegrator::prev_method_order, jeod::LsodeFirstOrderODEIntegrator::step_error, jeod::↩ LsodeFirstOrderODEIntegrator::step_size, and jeod::LsodeFirstOrderODEIntegrator::test_coeffs_complete.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_iteration().

6.5.2.29 integrator_corrector_failed_part1()

```
void LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part1 ( ) [protected]
```

The corrector iteration failed to converge.

If corrector_method != FunctionalIteration and the Jacobian is out of date, exit so that the Jacobian method can be called (externally) for the next try. Otherwise, try changing the step-size in part 2 of the failure recovery.

Extracted from DSTODE lines 410-430

Definition at line 516 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::convergence↩ _jacobian_flag, jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2(), jeod::LsodeFirstOrder↩ ODEIntegrator::integrator_reset_iteration_loop_part1(), jeod::LsodeControlDataInterface::is_corrector_method↩ _functional_iteration(), jeod::LsodeFirstOrderODEIntegrator::jacobian_current, and jeod::LsodeFirstOrderODE↩ Integrator::update_jacobian.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_iteration().

6.5.2.30 integrator_corrector_failed_part2()

```
void LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2 ( ) [protected]
```

Retracts the history array in the case that the correction iteration failed to converge with either functional iteration or with an up-to-date Jacobian.

If there are problems, the associated flags are set.

Definition at line 542 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::convergence_jacobian_flag, jeod::LsodeFirstOrderODEIntegrator::data_↩ stode, jeod::LsodeDataArrays::history, jeod::LsodeFirstOrderODEIntegrator::integrator_reset_yh(), jeod::Lsode↩ FirstOrderODEIntegrator::integrator_terminate(), jeod::LsodeDataStode::iredo, jeod::LsodeControlDataInterface↩ ::is_corrector_method_functional_iteration(), jeod::LsodeControlDataInterface::max_num_conv_failure, jeod::↩ LsodeFirstOrderODEIntegrator::max_step_increase_ratio, jeod::LsodeFirstOrderODEIntegrator::method_order↩ _current, jeod::LsodeControlDataInterface::min_step_size, jeod::LsodeDataStode::ncf, jeod::LsodeFirstOrderO↩ DEIntegrator::num_equations, jeod::LsodeFirstOrderODEIntegrator::stage_target_time, jeod::LsodeFirstOrder↩ ODEIntegrator::step_error, jeod::LsodeDataStode::step_ratio, jeod::LsodeFirstOrderODEIntegrator::step_size, jeod::LsodeDataStode::told, and jeod::LsodeFirstOrderODEIntegrator::update_jacobian.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part1(), and jeod::LsodeFirst↩ OrderODEIntegrator::jacobian_prep_wrap_up().

6.5.2.31 integrator_corrector_iteration()

```
void LsodeFirstOrderODEIntegrator::integrator_corrector_iteration ( ) [protected]
```

Keeps looping through the iterations until convergence or failure.

Definition at line 411 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeDataArrays::accum_correction, jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::↩ LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::convergence_factor, jeod↩ ::LsodeFirstOrderODEIntegrator::convergence_rate, jeod::LsodeDataArrays::history, jeod::LsodeFirstOrder↩ ODEIntegrator::integrator_corrector_converged(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_↩ failed_part1(), jeod::LsodeControlDataInterface::is_corrector_method_functional_iteration(), jeod::LsodeFirst↩ OrderODEIntegrator::iter_delta, jeod::LsodeFirstOrderODEIntegrator::iteration_count, jeod::LsodeFirstOrder↩ ODEIntegrator::IterationLoop, jeod::LsodeFirstOrderODEIntegrator::linear_chord_iteration(), jeod::LsodeFirst↩ OrderODEIntegrator::magnitude_of_weighted_array(), jeod::LsodeControlDataInterface::max_correction_iters, jeod::LsodeFirstOrderODEIntegrator::method_coeffs_current, jeod::LsodeFirstOrderODEIntegrator::method_↩ order_current, jeod::LsodeFirstOrderODEIntegrator::modified_iteration_matrix_singular, jeod::LsodeControlData↩ Interface::num_odes, jeod::LsodeFirstOrderODEIntegrator::prev_iter_delta, jeod::LsodeFirstOrderODEIntegrator↩ ::re_entry_point, jeod::LsodeDataArrays::save, jeod::LsodeFirstOrderODEIntegrator::step_size, jeod::LsodeFirst↩ OrderODEIntegrator::test_coeffs_complete, and jeod::LsodeFirstOrderODEIntegrator::y.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrate().

6.5.2.32 integrator_error_test_failed()

```
void LsodeFirstOrderODEIntegrator::integrator_error_test_failed ( ) [protected]
```

Restores the history array following the failure of the corrector for exceeding local error bounds.

Definition at line 663 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::LsodeDataArrays::history, jeod::LsodeFirstOrderODE←Integrator::integrator_compute_new_order(), jeod::LsodeFirstOrderODEIntegrator::integrator_fail_reset_order_1←_part1(), jeod::LsodeFirstOrderODEIntegrator::integrator_terminate(), jeod::LsodeDataStode::iredo, jeod::Lsode←FirstOrderODEIntegrator::max_step_increase_ratio, jeod::LsodeFirstOrderODEIntegrator::method_order_current, jeod::LsodeControlDataInterface::min_step_size, jeod::LsodeFirstOrderODEIntegrator::num_equations, jeod::←LsodeFirstOrderODEIntegrator::stage_target_time, jeod::LsodeFirstOrderODEIntegrator::step_error, jeod::Lsode←DataStode::step_ratio_order_inc, jeod::LsodeFirstOrderODEIntegrator::step_size, and jeod::LsodeDataStode::told.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_converged().

6.5.2.33 integrator_fail_reset_order_1_part1()

```
void LsodeFirstOrderODEIntegrator::integrator_fail_reset_order_1_part1 ( ) [protected]
```

Repopulates the y-array from history, recomputes the original first derivatives, sets the order back to 1, and reduces the step size by a factor of 10.

Called when 3 or more failures have occured. It is assumed that the derivatives that have accumulated in the history array have errors of the wrong order. Hence the first derivative is recomputed, and the order is set to 1. Then the step-size is reduced by a factor of 10, and the step is retried. Repeat until successful, or the step reaches the minimum step-size.

If 10 failures occur, exit with step_error = -1.

This method is divided in two by a call to calculate the derivatives. Part1 precedes that call, the execution exits from the integrator back to the sim control engine; then on return to the integrator, execution immediately proceeds with part2.

extracted from lines 640-

Definition at line 878 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::LsodeFirstOrderODEIntegrator::DstodeResetStep, jeod::←LsodeDataArrays::history, jeod::LsodeFirstOrderODEIntegrator::integrator_terminate(), jeod::LsodeControlData←Interface::min_step_size, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeFirstOrderODEIntegrator::re←_entry_point, jeod::LsodeFirstOrderODEIntegrator::step_error, jeod::LsodeDataStode::step_ratio, jeod::Lsode←FirstOrderODEIntegrator::step_size, and jeod::LsodeFirstOrderODEIntegrator::y.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_error_test_failed().

6.5.2.34 integrator_fail_reset_order_1_part2()

```
void LsodeFirstOrderODEIntegrator::integrator_fail_reset_order_1_part2 ( ) [protected]
```

Continue reset, with derivatives now at hand.

See integrator_fail_reset_order_1_part1 for details.

Definition at line 902 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::LsodeDataArrays::history, jeod::LsodeFirstOrderODE↩Integrator::integrator_predict(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_method_coeffs(), jeod::↩LsodeDataStode::iret, jeod::LsodeControlDataInterface::is_corrector_method_functional_iteration(), jeod::Lsode↩FirstOrderODEIntegrator::method_order_current, jeod::LsodeFirstOrderODEIntegrator::num_nordsiek_cols, jeod↩::LsodeControlDataInterface::num_odes, jeod::LsodeFirstOrderODEIntegrator::order_select_para, jeod::Lsode↩DataArrays::save, jeod::LsodeFirstOrderODEIntegrator::step_size, and jeod::LsodeFirstOrderODEIntegrator↩::update_jacobian.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrate().

6.5.2.35 integrator_predict()

```
void LsodeFirstOrderODEIntegrator::integrator_predict ( ) [protected]
```

This section computes the predicted values by multiplying the history array by the Pascal Triangle matrix.

Extracted from DSTODE lines 200-215

Definition at line 343 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeDataArrays::history, jeod::LsodeFirstOrderODEIntegrator::integrator_reset_iteration_loop_part1(), jeod::LsodeControlDataInterface::is_corrector_method_functional_iteration(), jeod::LsodeControlDataInterface↩::max_num_steps_jacobian, jeod::LsodeFirstOrderODEIntegrator::max_rel_change_without_jacobian, jeod↩::LsodeFirstOrderODEIntegrator::method_order_current, jeod::LsodeFirstOrderODEIntegrator::num_equations, jeod::LsodeFirstOrderODEIntegrator::num_steps_taken, jeod::LsodeFirstOrderODEIntegrator::rel_change_since↩_jacobian, jeod::LsodeFirstOrderODEIntegrator::stage_target_time, jeod::LsodeFirstOrderODEIntegrator::step↩_at_last_jacobian_update, jeod::LsodeFirstOrderODEIntegrator::step_size, and jeod::LsodeFirstOrderODE↩Integrator::update_jacobian.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_core(), jeod::LsodeFirstOrderODEIntegrator↩::integrator_fail_reset_order_1_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_method_coeffs(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_yh(), and jeod::LsodeFirstOrderODEIntegrator::integrator↩_test_stepsize_change().

6.5.2.36 integrator_reset_iteration_loop_part1()

```
void LsodeFirstOrderODEIntegrator::integrator_reset_iteration_loop_part1 ( ) [protected]
```

This method resets the iteration loop to the values generated by the integrator_predict method, which populated history[∗][0].

Definition at line 378 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeDataArrays::history, jeod::LsodeFirstOrderODEIntegrator::iteration_count, jeod::LsodeControlData←Interface::num_odes, jeod::LsodeFirstOrderODEIntegrator::re_entry_point, jeod::LsodeFirstOrderODEIntegrator←::ResetIterLoop, and jeod::LsodeFirstOrderODEIntegrator::y.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part1(), and jeod::LsodeFirst←OrderODEIntegrator::integrator_predict().

6.5.2.37 integrator_reset_iteration_loop_part2()

```
void LsodeFirstOrderODEIntegrator::integrator_reset_iteration_loop_part2 ( ) [protected]
```

This code follows part 1 after the break-out to get to the external calls, and completes the reset of the integration iteration loop.

Definition at line 395 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeDataArrays::accum_correction, jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::Lsode←FirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::iter_delta, jeod::LsodeControlData←Interface::num_odes, and jeod::LsodeFirstOrderODEIntegrator::prev_iter_delta.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrate().

6.5.2.38 integrator_reset_method_coeffs()

```
void LsodeFirstOrderODEIntegrator::integrator_reset_method_coeffs ( ) [protected]
```

Sets/resets the method_coeffs_current array.

Definition at line 238 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::convergence←_factor, jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::LsodeFirstOrderODEIntegrator::integrator_←predict(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_yh(), jeod::LsodeFirstOrderODEIntegrator←::integrator_test_stepsize_change(), jeod::LsodeDataStode::iret, jeod::LsodeFirstOrderODEIntegrator::method_←coeff_first, jeod::LsodeFirstOrderODEIntegrator::method_coeffs_complete, jeod::LsodeFirstOrderODEIntegrator←::method_coeffs_current, jeod::LsodeFirstOrderODEIntegrator::method_order_current, jeod::LsodeControlData←Interface::min_step_size, jeod::LsodeFirstOrderODEIntegrator::num_equations, jeod::LsodeFirstOrderODE←Integrator::num_nordsiek_cols, jeod::LsodeFirstOrderODEIntegrator::num_predictor_elements, jeod::LsodeFirst←OrderODEIntegrator::rel_change_since_jacobian, jeod::LsodeDataStode::step_ratio, and jeod::LsodeFirstOrder←ODEIntegrator::step_size.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_core(), jeod::LsodeFirstOrderODEIntegrator←::integrator_fail_reset_order_1_part2(), and jeod::LsodeFirstOrderODEIntegrator::integrator_set_new_order().

6.5.2.39 integrator_reset_yh()

```
void LsodeFirstOrderODEIntegrator::integrator_reset_yh ( ) [protected]
```

Resets history arrays and time-step.

Definition at line 303 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::LsodeDataArrays::history, jeod::LsodeFirstOrderODE↩ Integrator::integrator_predict(), jeod::LsodeFirstOrderODEIntegrator::integrator_wrapup(), jeod::LsodeDataStode↩ ::iredo, jeod::LsodeFirstOrderODEIntegrator::max_step_increase_ratio, jeod::LsodeFirstOrderODEIntegrator↩ ::max_step_size_inv, jeod::LsodeFirstOrderODEIntegrator::num_nordsiek_cols, jeod::LsodeControlDataInterface↩ ::num_odes, jeod::LsodeFirstOrderODEIntegrator::order_select_para, jeod::LsodeFirstOrderODEIntegrator::rel_↩ change_since_jacobian, jeod::LsodeDataStode::step_ratio, and jeod::LsodeFirstOrderODEIntegrator::step_size.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_core(), jeod::LsodeFirstOrderODEIntegrator↩ ::integrator_corrector_failed_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_method_coeffs(), jeod::LsodeFirstOrderODEIntegrator::integrator_set_new_order(), and jeod::LsodeFirstOrderODEIntegrator↩ ::integrator_test_stepsize_change().

6.5.2.40 integrator_set_new_order()

```
void LsodeFirstOrderODEIntegrator::integrator_set_new_order ( ) [protected]
```

Sets the new order and the step-ratio for the next step - or the current step if redoing it.

Definition at line 840 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::LsodeFirstOrderODEIntegrator::integrator_reset_method_coeffs(), jeod::LsodeFirstOrderODEIntegrator↩ ::integrator_reset_yh(), jeod::LsodeDataStode::iret, jeod::LsodeFirstOrderODEIntegrator::method_order_current, jeod::LsodeControlDataInterface::min_step_size, jeod::LsodeDataStode::new_method_order, jeod::LsodeFirst↩ OrderODEIntegrator::num_nordsiek_cols, jeod::LsodeDataStode::step_ratio, and jeod::LsodeFirstOrderODE↩ Integrator::step_size.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order(), and jeod::LsodeFirst↩ OrderODEIntegrator::integrator_compute_new_order_check_step_error().

6.5.2.41 integrator_terminate()

```
void LsodeFirstOrderODEIntegrator::integrator_terminate ( ) [protected]
```

this is the only succesful path back from integrator to manager.

All other returns from integrator_∗ back to manager_∗ are in response to a need for new derivatives and carry with them a modified re_entry_point to provide access back to the integrator on reentry. All returns with re_entry_point = CycleStartFinish should go through this method.

Definition at line 945 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::internal_state, jeod::LsodeFirstOrderODEIntegrator::prev_step↩ _size, and jeod::LsodeFirstOrderODEIntegrator::step_size.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2(), jeod::LsodeFirstOrderO↩ DEIntegrator::integrator_error_test_failed(), jeod::LsodeFirstOrderODEIntegrator::integrator_fail_reset_order_1_↩ part1(), and jeod::LsodeFirstOrderODEIntegrator::integrator_wrapup().

6.5.2.42 integrator_test_stepsize_change()

```
void LsodeFirstOrderODEIntegrator::integrator_test_stepsize_change ( ) [protected]
```

Tests h against old h.

Definition at line 280 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeFirstOrderODEIntegrator::data_stode, jeod::LsodeFirstOrderODEIntegrator::integrator_predict(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_yh(), jeod::LsodeDataStode::iredo, jeod::LsodeFirstOrderODEIntegrator::prev_step_size, jeod::LsodeDataStode::step_ratio, and jeod::LsodeFirstOrderODEIntegrator::step_size.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_core(), and jeod::LsodeFirstOrderODEIntegrator::integrator_reset_method_coeffs().

6.5.2.43 integrator_wrapup()

```
void LsodeFirstOrderODEIntegrator::integrator_wrapup ( ) [protected]
```

Wraps up the completion of the integrator.

Definition at line 925 of file lsode_first_order_ode_integrator__integrator.cc.

References jeod::LsodeDataArrays::accum_correction, jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::integrator_terminate(), jeod::LsodeControlDataInterface::num_odes, jeod::LsodeFirstOrderODEIntegrator::prev_method_order, and jeod::LsodeFirstOrderODEIntegrator::test_coeffs_complete.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order(), jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order_check_step_error(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_converged(), and jeod::LsodeFirstOrderODEIntegrator::integrator_reset_yh().

6.5.2.44 interpolate_y()

```
void LsodeFirstOrderODEIntegrator::interpolate_y ( ) [protected]
```

Interpolates the zeroth-derivative of y Adapted from subroutine DINTDY, which was a general method for interpolating the K-th derivative of the dependent variable vector, y.

Implementation notes - DINTDY was called exclusively with three input values that always matched.

1. Argument #1 T (time). Calls to DINTDY always passed TOUT (now cycle_target_time) in for T
2. Argument #2 K (order). Calls to DINTDY always passed 0 in for K
3. Argument #5 DKY (value). DKY is the value that DINTDY interpolates.i Calls to DINTDY always passed Y in for DKY. This routine uses y directly in place of DKY, so can only interpolate the 0-th derivative (since that is y), and always evaluates at cycle_target_time. replaced accordingly.

The computed values are gotten by interpolation using the Nordsieck history array, arrays.history. The formula for Y is:

Y[i] = sum {j=0 to method_order_current} { (cycle_target_time - stage_target_time)^(j) ∗ arrays.history[i-1][j] / h^j}

Definition at line 263 of file lsode_first_order_ode_integrator__support.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::cycle_target_time, jeod::LsodeFirstOrderODEIntegrator::epsilon, jeod::LsodeDataArrays::history, jeod::LsodeFirstOrderODEIntegrator::method_order_current, jeod::LsodeFirstOrderODEIntegrator::num_nordsiek_cols, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeFirstOrderODEIntegrator::prev_good_step_size, jeod::LsodeFirstOrderODEIntegrator::stage_target_time, jeod::LsodeFirstOrderODEIntegrator::step_size, and jeod::LsodeFirstOrderODEIntegrator::y.

Referenced by jeod::LsodeFirstOrderODEIntegrator::manager_check_stop_conditions(), and jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part3().

6.5.2.45 jacobian_prep_init()

```
void LsodeFirstOrderODEIntegrator::jacobian_prep_init ( )  [protected]
```

Modified from DPREPJ.

DPREPJ was called by DSTODE to compute and process the matrix P = I - h∗el(1)∗J , where J is an approximation to the Jacobian.

NOTES

DPREPJ has been split into 3 parts, book-ended by the external-calls. jacobian_prep_init contains the code that precededs the first external-call jacobian_prep_loop contains the code that continues to loop according to the limits as written is DPREPJ. jacobian_prep_wrap_up contains the code that follows successful completion of the looping section of DPREPJ.

Note that the division in this implementation is not linear with that in the original Fortran. The external calls within the original fortran are embedded within switch-blocks and for loops; the return points - to go to the next routine will pick up from one of several locations in the Fortran code, depending on the configuration at the time the external call was made.

For the ER7_Utils / JEOD / Trick implementation, the derivative/jac calls must be external to the integrate call, so we must fully back out and then reenter. Rentry goes to jacobian_prep_loop.

Some variables that were local have been moved to the class so that their value is not lost in going from jacobian_prep_init to jacobian_prep_loop. These are typically identified with ∗∗∗_dprepj to indicate that their sole purpose is within dprepj (the original name of the jacobian_prep_∗ routines).

Here the jacobian is computed by the user-supplied routine JAC if corrector_method = NewtonIterUserJac or NewtonIterUserBandJac, or by finite differencing if corrector_method = NewtonIterInternalJac, JacobiNewtonInternalJac, or NewtonIterInternalBandJac.

If corrector_method = JacobiNewtonInternalJac, a diagonal approximation to the Jacobian is used. The Jacobian is stored in arrays lin_alg

If corrector_method != JacobiNewtonInternalJac, P is subjected to LU decomposition in preparation for later solution of linear systems with P as coefficient matrix. This is done by gauss_elim_factor (DGEFA) if corrector_method =

NewtonIterUserJac or NewtonIterInternalJac, and by linear_solver (DGBFA) if corrector_method = NewtonIter←UserBandJac or NewtonIterInternalBandJac.

Note that the corrector_method using the banded Jacobians is not supported in this release, so linear_solver is not used.

FTEM and ACOR were effectively the same, now arrays.accum_correction. SAVF is now arrays.save. WM is now arrays.lin_alg

Definition at line 374 of file lsode_first_order_ode_integrator__support.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeControlDataInterface::corrector_method, jeod::LsodeFirstOrderODEIntegrator::data_prepj, jeod::←LsodeFirstOrderODEIntegrator::epsilon, jeod::LsodeDataArrays::error_weight, jeod::LsodeDataJacobianPrep::fac, jeod::LsodeControlDataInterface::FunctionalIteration, jeod::LsodeDataArrays::history, jeod::LsodeDataJacobian←Prep::hl0, jeod::LsodeDataJacobianPrep::index, jeod::LsodeDataJacobianPrep::index_max, jeod::LsodeFirst←OrderODEIntegrator::iteration_matrix_singular, jeod::LsodeFirstOrderODEIntegrator::jacobian_current, jeod::←LsodeFirstOrderODEIntegrator::JacobianPrep, jeod::LsodeControlDataInterface::JacobiNewtonInternalJac, jeod←::LsodeDataArrays::lin_alg, jeod::LsodeDataArrays::lin_alg_1, jeod::LsodeDataArrays::lin_alg_2, jeod::Lsode←FirstOrderODEIntegrator::magnitude_of_weighted_array(), jeod::LsodeFirstOrderODEIntegrator::method_coeff←_first, jeod::LsodeControlDataInterface::NewtonIterInternalBandJac, jeod::LsodeControlDataInterface::Newton←IterInternalJac, jeod::LsodeControlDataInterface::NewtonIterUserBandJac, jeod::LsodeControlDataInterface::←NewtonIterUserJac, jeod::LsodeFirstOrderODEIntegrator::num_jacobian_evals, jeod::LsodeControlDataInterface←::num_odes, jeod::LsodeDataJacobianPrep::r0, jeod::LsodeFirstOrderODEIntegrator::re_entry_point, jeod::←LsodeDataArrays::save, jeod::LsodeFirstOrderODEIntegrator::step_size, jeod::LsodeFirstOrderODEIntegrator::y, and jeod::LsodeDataJacobianPrep::yj.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrate().

6.5.2.46 jacobian_prep_loop()

```
bool LsodeFirstOrderODEIntegrator::jacobian_prep_loop ( )  [protected]
```

Definition at line 515 of file lsode_first_order_ode_integrator__support.cc.

References jeod::LsodeDataArrays::accum_correction, jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::Lsode←FirstOrderODEIntegrator::control_data, jeod::LsodeControlDataInterface::corrector_method, jeod::LsodeFirst←OrderODEIntegrator::data_prepj, jeod::LsodeDataArrays::error_weight, jeod::LsodeDataJacobianPrep::fac, jeod←::LsodeControlDataInterface::FunctionalIteration, jeod::LsodeDataJacobianPrep::hl0, jeod::LsodeDataJacobian←Prep::index, jeod::LsodeDataJacobianPrep::index_max, jeod::LsodeControlDataInterface::JacobiNewtonInternal←Jac, jeod::LsodeDataArrays::lin_alg, jeod::LsodeDataArrays::lin_alg_1, jeod::LsodeFirstOrderODEIntegrator←::load_derivatives(), jeod::LsodeControlDataInterface::NewtonIterInternalBandJac, jeod::LsodeControlData←Interface::NewtonIterInternalJac, jeod::LsodeControlDataInterface::NewtonIterUserBandJac, jeod::LsodeControl←DataInterface::NewtonIterUserJac, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeDataJacobianPrep←::r0, jeod::LsodeDataArrays::save, jeod::LsodeFirstOrderODEIntegrator::y, and jeod::LsodeDataJacobianPrep::yj.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrate().

6.5.2.47 jacobian_prep_wrap_up()

```
bool LsodeFirstOrderODEIntegrator::jacobian_prep_wrap_up ( ) [protected]
```

Definition at line 612 of file lsode_first_order_ode_integrator__support.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::convergence_rate, jeod::LsodeControlDataInterface::corrector_method, jeod::LsodeFirstOrderODEIntegrator::data_prepj, jeod::LsodeFirstOrderODEIntegrator::epsilon, jeod::LsodeDataArrays::error_weight, jeod::LsodeControlDataInterface::FunctionalIteration, jeod::LsodeFirstOrderODEIntegrator::gauss_elim_factor(), jeod::LsodeDataArrays::history, jeod::LsodeDataJacobianPrep::hl0, jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2(), jeod::LsodeFirstOrderODEIntegrator::iteration_matrix_singular, jeod::LsodeControlDataInterface::JacobiNewtonInternalJac, jeod::LsodeDataArrays::lin_alg, jeod::LsodeFirstOrderODEIntegrator::load_derivatives(), jeod::LsodeControlDataInterface::NewtonIterInternalBandJac, jeod::LsodeControlDataInterface::NewtonIterInternalJac, jeod::LsodeControlDataInterface::NewtonIterUserBandJac, jeod::LsodeControlDataInterface::NewtonIterUserJac, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeFirstOrderODEIntegrator::num_steps_taken, jeod::LsodeFirstOrderODEIntegrator::rel_change_since_jacobian, jeod::LsodeDataArrays::save, jeod::LsodeFirstOrderODEIntegrator::step_at_last_jacobian_update, jeod::LsodeFirstOrderODEIntegrator::step_size, and jeod::LsodeFirstOrderODEIntegrator::update_jacobian.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrate().

6.5.2.48 linear_chord_iteration()

```
void LsodeFirstOrderODEIntegrator::linear_chord_iteration ( ) [protected]
```

Modified from DSOLSY.

This routine manages the solution of the linear system arising from a chord iteration. It is called if corrector_method != FunctionalIteration.

If corrector_method == NewtonIterUserJac || NewtonIterInternalJac, it calls linear_solver (was DGESL). If corrector_method = JacobiNewtonInternalJac it updates the coefficient hl0 = step_size ∗ method_coeff_first (previously H∗EL0) in the diagonal matrix, and then computes the solution.

Definition at line 736 of file lsode_first_order_ode_integrator__support.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeControlDataInterface::corrector_method, jeod::LsodeControlDataInterface::FunctionalIteration, jeod::LsodeControlDataInterface::JacobiNewtonInternalJac, jeod::LsodeDataArrays::lin_alg, jeod::LsodeDataArrays::lin_alg_2, jeod::LsodeFirstOrderODEIntegrator::linear_solver(), jeod::LsodeFirstOrderODEIntegrator::method_coeff_first, jeod::LsodeFirstOrderODEIntegrator::modified_iteration_matrix_singular, jeod::LsodeControlDataInterface::NewtonIterInternalBandJac, jeod::LsodeControlDataInterface::NewtonIterInternalJac, jeod::LsodeControlDataInterface::NewtonIterUserBandJac, jeod::LsodeControlDataInterface::NewtonIterUserJac, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeFirstOrderODEIntegrator::step_size, and jeod::LsodeFirstOrderODEIntegrator::y.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_iteration().

6.5.2.49 linear_solver()

```
void LsodeFirstOrderODEIntegrator::linear_solver ( ) [protected]
```

Solves the equation Y' = A Y, with A = arrays.lin_alg.

Definition at line 254 of file lsode_first_order_ode_integrator__utility.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeDataArrays::lin_alg, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeDataArrays::pivots, and jeod::LsodeFirstOrderODEIntegrator::y.

Referenced by jeod::LsodeFirstOrderODEIntegrator::linear_chord_iteration().

6.5.2.50 load_derivatives()

```
void LsodeFirstOrderODEIntegrator::load_derivatives (
            double * derivs ) [protected]
```

Load the externally generated derivative values (incoming as y_dot)i into the array derivs.

Definition at line 361 of file lsode_first_order_ode_integrator__utility.cc.

References jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeControlDataInterface::num_odes, and jeod::LsodeFirstOrderODEIntegrator::y_dot.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrate(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_loop(), and jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_wrap_up().

6.5.2.51 load_ew_values()

```
void LsodeFirstOrderODEIntegrator::load_ew_values ( ) [protected]
```

Definition at line 800 of file lsode_first_order_ode_integrator__support.cc.

References jeod::LsodeControlDataInterface::abs_tolerance_error_control, jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeControlDataInterface::CommonAbsCommonRel, jeod::LsodeControlDataInterface::CommonAbsSpecificRel, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeControlDataInterface::error_control_indicator, jeod::LsodeDataArrays::error_weight, jeod::LsodeDataArrays::history, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeControlDataInterface::rel_tolerance_error_control, jeod::LsodeControlDataInterface::SpecificAbsCommonRel, and jeod::LsodeControlDataInterface::SpecificAbsSpecificRel.

Referenced by jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part2(), and jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part1().

6.5.2.52 LsodeControlDataInterface()

```
LsodeControlDataInterface::LsodeControlDataInterface ( )
```

constructor

Definition at line 50 of file lsode_control_data_interface.cc.

References jeod::LsodeControlDataInterface::abs_tolerance_error_control_vec, and jeod::LsodeControlDataInterface::rel_tolerance_error_control_vec.

6.5.2.53 LsodeFirstOrderODEIntegrator() [1/2]

```
LsodeFirstOrderODEIntegrator::LsodeFirstOrderODEIntegrator ( )
```

LsodeFirstOrderODEIntegrator default constructor.

Definition at line 52 of file lsode_first_order_ode_integrator__utility.cc.

References jeod::LsodeFirstOrderODEIntegrator::calculate_epsilon().

6.5.2.54 LsodeFirstOrderODEIntegrator() [2/2]

```
LsodeFirstOrderODEIntegrator::LsodeFirstOrderODEIntegrator (
            const LsodeControlDataInterface & data_in,
            er7_utils::IntegrationControls & controls,
            unsigned int size )
```

LsodeFirstOrderODEIntegrator non-default constructor.

Parameters

in	*data_in*	state variable data
in	*size*	State size
in,out	*controls*	Integration controls

Definition at line 59 of file lsode_first_order_ode_integrator__utility.cc.

References jeod::LsodeFirstOrderODEIntegrator::calculate_epsilon(), jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeControlDataInterface::num_odes, and jeod::LsodeFirstOrderODEIntegrator::update_control_data().

6.5.2.55 LsodeGeneralizedDerivSecondOrderODEIntegrator() [1/2]

```
LsodeGeneralizedDerivSecondOrderODEIntegrator::LsodeGeneralizedDerivSecondOrderODEIntegrator (
            const LsodeGeneralizedDerivSecondOrderODEIntegrator & src )
```

LsodeGeneralizedDerivSecondOrderODEIntegrator copy constructor.

Copy Constructor.

Parameters

in	*src*	Item to be copied.

Definition at line 67 of file lsode_generalized_second_order_ode_integrator.cc.

6.5.2.56 LsodeGeneralizedDerivSecondOrderODEIntegrator() [2/2]

```
LsodeGeneralizedDerivSecondOrderODEIntegrator::LsodeGeneralizedDerivSecondOrderODEIntegrator (
            const LsodeControlDataInterface & data_in,
            er7_utils::IntegrationControls & controls,
            const er7_utils::GeneralizedPositionDerivativeFunctions & deriv_funs,
            unsigned int position_size,
            unsigned int velocity_size )
```

non-default constructor

Definition at line 53 of file lsode_generalized_second_order_ode_integrator.cc.

References jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator::posdot.

6.5.2.57 LsodeIntegrationControls()

```
LsodeIntegrationControls::LsodeIntegrationControls (
            unsigned int num_stages )  [explicit]
```

Definition at line 51 of file lsode_integration_controls.cc.

6.5.2.58 LsodeIntegratorConstructor()

```
LsodeIntegratorConstructor::LsodeIntegratorConstructor (
            const LsodeIntegratorConstructor & src )
```

Definition at line 57 of file lsode_integrator_constructor.cc.

6.5.2.59 LsodeSecondOrderODEIntegrator() [1/2]

```
LsodeSecondOrderODEIntegrator::LsodeSecondOrderODEIntegrator (
            const LsodeControlDataInterface & data_in,
            er7_utils::IntegrationControls & controls,
            unsigned int size )  [protected]
```

LsodeSecondOrderODEIntegrator non-default constructor.

Parameters

in	*data_in*	LSODE-specific control data.
in,out	*controls*	Integration controls.
in	*size*	State size.

Definition at line 52 of file lsode_second_order_ode_integrator.cc.

References jeod::LsodeSecondOrderODEIntegrator::arrays_allocated, jeod::LsodeSecondOrderODEIntegrator::y, and jeod::LsodeSecondOrderODEIntegrator::y_dot.

6.5.2.60 LsodeSecondOrderODEIntegrator() [2/2]

```
LsodeSecondOrderODEIntegrator::LsodeSecondOrderODEIntegrator (
            const LsodeControlDataInterface & data_in,
            er7_utils::IntegrationControls & controls,
            const er7_utils::GeneralizedPositionDerivativeFunctions & deriv_funs,
            unsigned int position_size,
            unsigned int velocity_size )  [protected]
```

Definition at line 68 of file lsode_second_order_ode_integrator.cc.

References jeod::LsodeSecondOrderODEIntegrator::arrays_allocated, jeod::LsodeSecondOrderODEIntegrator::y, and jeod::LsodeSecondOrderODEIntegrator::y_dot.

6.5.2.61 LsodeSimpleSecondOrderODEIntegrator()

```
LsodeSimpleSecondOrderODEIntegrator::LsodeSimpleSecondOrderODEIntegrator (
            const LsodeControlDataInterface & data_in,
            er7_utils::IntegrationControls & controls,
            unsigned int size )
```

LsodeSimpleSecondOrderODEIntegrator non-default constructor.

Parameters

in	*data_in*	State Variable Data
in	*size*	State size
in,out	*controls*	Integration controls

Definition at line 49 of file lsode_simple_second_order_ode_integrator.cc.

6.5.2.62 magnitude_of_weighted_array() [1/2]

```
double LsodeFirstOrderODEIntegrator::magnitude_of_weighted_array (
            const double * v ) [protected]
```

returns the RMS value of {V dot W}, where V and W are N-vectors.

Modified version of DVNORM

The only places DVNORM is used, it is multiplying some array by the error_weight array (arrays.error_weight) across control_data.num_odes terms. These values are fixed for our application, and do not need to be passed in.

We provide two implementations, one for a one-dimensional array, and one for a two-dimensional array in which the first index is the variable.

Parameters

v	array

Definition at line 141 of file lsode_first_order_ode_integrator__utility.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeDataArrays::error_weight, and jeod::LsodeControlDataInterface::num_odes.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order(), jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order_prep(), jeod::LsodeFirstOrderODEIntegrator::integrator_core(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_converged(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_iteration(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part2(), and jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part2().

6.5.2.63 magnitude_of_weighted_array() [2/2]

```
double LsodeFirstOrderODEIntegrator::magnitude_of_weighted_array (
            unsigned int index,
            double ** v ) [protected]
```

returns RMS value of v[*][index]

Modified version of DVNORM, second implementation.

Parameters

index	use this index
v	array

Definition at line 159 of file lsode_first_order_ode_integrator__utility.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeDataArrays::error_weight, and jeod::LsodeControlDataInterface::num_odes.

6.5.2.64 manager_check_stop_conditions()

```
int LsodeFirstOrderODEIntegrator::manager_check_stop_conditions ( ) [protected]
```

verifies whether the convergence conditions have been met to end the cycle.

Definition at line 528 of file lsode_first_order_ode_integrator__manager.cc.

References jeod::LsodeFirstOrderODEIntegrator::calculation_task, jeod::LsodeFirstOrderODEIntegrator::CompleteCycle, jeod::LsodeFirstOrderODEIntegrator::cycle_target_time, jeod::LsodeFirstOrderODEIntegrator::interpolate_y(), jeod::LsodeFirstOrderODEIntegrator::Normal, jeod::LsodeFirstOrderODEIntegrator::NormalWithSingularity, jeod::LsodeFirstOrderODEIntegrator::num_steps_taken, jeod::LsodeFirstOrderODEIntegrator::OneStep, jeod::LsodeFirstOrderODEIntegrator::OneStepWithSingularity, jeod::LsodeFirstOrderODEIntegrator::prior_num_steps, jeod::LsodeFirstOrderODEIntegrator::stage_target_time, and jeod::LsodeFirstOrderODEIntegrator::step_size.

Referenced by jeod::LsodeFirstOrderODEIntegrator::process_entry_point_cycle_start().

6.5.2.65 manager_initialize_calculation_part1()

```
void LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part1 ( ) [protected]
```

Sets the values for the case with calculation_phase = 1.

Definition at line 342 of file lsode_first_order_ode_integrator__manager.cc.

References jeod::LsodeDataArrays::allocate_arrays(), jeod::LsodeControlDataInterface::allocate_arrays(), jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeControlDataInterface::corrector_method, jeod::LsodeFirstOrderODEIntegrator::InitCalc, jeod::LsodeFirstOrderODEIntegrator::internal_state, jeod::LsodeControlDataInterface::is_corrector_method_functional_iteration(), jeod::LsodeDataArrays::lin_alg_1, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeFirstOrderODEIntegrator::re_entry_point, and jeod::LsodeFirstOrderODEIntegrator::sqrt_epsilon.

Referenced by jeod::LsodeFirstOrderODEIntegrator::process_entry_point_cycle_start().

6.5.2.66 manager_initialize_calculation_part2()

```
void LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part2 ( ) [protected]
```

Definition at line 389 of file lsode_first_order_ode_integrator__manager.cc.

References jeod::LsodeControlDataInterface::abs_tolerance_error_control, jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeControlDataInterface::CommonAbsSpecificRel, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::cycle_target_time, jeod::LsodeFirstOrderODEIntegrator::epsilon, jeod::LsodeControlDataInterface::error_control_indicator, jeod::LsodeDataArrays::error_weight, jeod::LsodeDataArrays::history, jeod::LsodeControlDataInterface::initial_step_size, jeod::LsodeFirstOrderODEIntegrator::load_ew_values(), jeod::LsodeFirstOrderODEIntegrator::magnitude_of_weighted_array(), jeod::LsodeFirstOrderODEIntegrator::max_step_size_inv, jeod::LsodeFirstOrderODEIntegrator::method_order_current, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeControlDataInterface::rel_tolerance_error_control, jeod::LsodeControlDataInterface::SpecificAbsCommonRel, jeod::LsodeControlDataInterface::SpecificAbsSpecificRel, jeod::LsodeFirstOrderODEIntegrator::step_size, jeod::LsodeFirstOrderODEIntegrator::y, and jeod::LsodeFirstOrderODEIntegrator::y_dot.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrate().

6.5.2.67 manager_integration_loop_part1()

```
void LsodeFirstOrderODEIntegrator::manager_integration_loop_part1 ( ) [protected]
```

The iteration loop for the integration process.

Definition at line 644 of file lsode_first_order_ode_integrator__manager.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeDataArrays::error_weight, jeod::LsodeFirstOrderODEIntegrator::load_ew_values(), jeod::Lsode←FirstOrderODEIntegrator::manager_integration_loop_part2(), jeod::LsodeControlDataInterface::max_num_steps, jeod::LsodeControlDataInterface::num_odes, jeod::LsodeFirstOrderODEIntegrator::num_steps_taken, jeod::←LsodeFirstOrderODEIntegrator::prior_num_steps, and jeod::LsodeFirstOrderODEIntegrator::stage_target_time.

Referenced by jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part3(), and jeod::LsodeFirst←OrderODEIntegrator::process_entry_point_cycle_start().

6.5.2.68 manager_integration_loop_part2()

```
void LsodeFirstOrderODEIntegrator::manager_integration_loop_part2 ( ) [protected]
```

Definition at line 700 of file lsode_first_order_ode_integrator__manager.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::CycleStartFinish, jeod::LsodeFirstOrderODEIntegrator::epsilon, jeod::←LsodeDataArrays::history, jeod::LsodeFirstOrderODEIntegrator::integrator_core(), jeod::LsodeFirstOrderODE←Integrator::magnitude_of_weighted_array(), jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_←part3(), jeod::LsodeControlDataInterface::max_num_small_step_warnings, jeod::LsodeFirstOrderODEIntegrator←::num_small_step_warnings, jeod::LsodeFirstOrderODEIntegrator::re_entry_point, jeod::LsodeFirstOrderODE←Integrator::stage_target_time, and jeod::LsodeFirstOrderODEIntegrator::step_size.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrate(), and jeod::LsodeFirstOrderODEIntegrator←::manager_integration_loop_part1().

6.5.2.69 manager_integration_loop_part3()

```
void LsodeFirstOrderODEIntegrator::manager_integration_loop_part3 ( ) [protected]
```

Definition at line 765 of file lsode_first_order_ode_integrator__manager.cc.

References jeod::LsodeFirstOrderODEIntegrator::calculation_task, jeod::LsodeFirstOrderODEIntegrator::←CompleteCycle, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::cycle_←target_time, jeod::LsodeFirstOrderODEIntegrator::initialized, jeod::LsodeFirstOrderODEIntegrator::interpolate_y(), jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part1(), jeod::LsodeControlDataInterface::min←_step_size, jeod::LsodeFirstOrderODEIntegrator::Normal, jeod::LsodeFirstOrderODEIntegrator::NormalWith←Singularity, jeod::LsodeFirstOrderODEIntegrator::OneStep, jeod::LsodeFirstOrderODEIntegrator::OneStepWith←Singularity, jeod::LsodeFirstOrderODEIntegrator::stage_target_time, jeod::LsodeFirstOrderODEIntegrator::step_←error, and jeod::LsodeFirstOrderODEIntegrator::step_size.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrate(), and jeod::LsodeFirstOrderODEIntegrator←::manager_integration_loop_part2().

6.5.2.70 manager_set_calculation_phase_eq_2_reload()

```
void LsodeFirstOrderODEIntegrator::manager_set_calculation_phase_eq_2_reload ( ) [protected]
```

Definition at line 917 of file lsode_first_order_ode_integrator__manager.cc.

6.5.2.71 process_entry_point_cycle_start()

```
void LsodeFirstOrderODEIntegrator::process_entry_point_cycle_start ( ) [protected]
```

The code block from the main integrate routine for re_entry_point=CycleStartFinish.

Definition at line 269 of file lsode_first_order_ode_integrator__manager.cc.

References jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::cycle_↩ target_time, jeod::LsodeFirstOrderODEIntegrator::first_pass, jeod::LsodeControlDataInterface::initial_step_size, jeod::LsodeFirstOrderODEIntegrator::initialized, jeod::LsodeFirstOrderODEIntegrator::manager_check_stop_↩ conditions(), jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part1(), jeod::LsodeFirstOrder↩ ODEIntegrator::manager_integration_loop_part1(), jeod::LsodeFirstOrderODEIntegrator::num_equations, jeod::↩ LsodeControlDataInterface::num_odes, and jeod::LsodeFirstOrderODEIntegrator::stage_target_time.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrate().

6.5.2.72 reset_integrator()

```
void LsodeFirstOrderODEIntegrator::reset_integrator ( ) [override]
```

Resets the integrator when the timestep changes or when identified as needing a reset.

Definition at line 893 of file lsode_first_order_ode_integrator__manager.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeFirstOrderODEIntegrator::cycle_target_time, jeod::LsodeFirstOrderODEIntegrator::first_pass, jeod::↩ LsodeDataArrays::history, jeod::LsodeFirstOrderODEIntegrator::InitCalc, jeod::LsodeControlDataInterface::initial↩ _step_size, jeod::LsodeFirstOrderODEIntegrator::method_order_current, jeod::LsodeControlDataInterface::num↩ _odes, jeod::LsodeFirstOrderODEIntegrator::prev_good_step_size, jeod::LsodeFirstOrderODEIntegrator::re_↩ entry_point, and jeod::LsodeFirstOrderODEIntegrator::stage_target_time.

6.5.2.73 set_abs_tol()

```
void LsodeControlDataInterface::set_abs_tol (
            int index,
            double value )
```

Definition at line 382 of file lsode_control_data_interface.cc.

References jeod::LsodeControlDataInterface::abs_tolerance_error_control, jeod::LsodeControlDataInterface↩ ::abs_tolerance_error_control_vec, jeod::LsodeControlDataInterface::error_control_vector_copied_over, and jeod::LsodeControlDataInterface::num_odes_at_alloc.

6.5.2.74 set_rel_tol()

```
void LsodeControlDataInterface::set_rel_tol (
            int index,
            double value )
```

set values from external

Definition at line 325 of file lsode_control_data_interface.cc.

References jeod::LsodeControlDataInterface::error_control_vector_copied_over, jeod::LsodeControlData←Interface::num_odes_at_alloc, jeod::LsodeControlDataInterface::rel_tolerance_error_control, and jeod::Lsode←ControlDataInterface::rel_tolerance_error_control_vec.

6.5.2.75 update_control_data()

```
void LsodeFirstOrderODEIntegrator::update_control_data ( )
```

Gets the control data from where it can be populated in the constructor and verifies that the input control parameters are not out of sensible range.

Definition at line 88 of file lsode_first_order_ode_integrator__utility.cc.

References jeod::LsodeControlDataInterface::check_interface_data(), jeod::LsodeFirstOrderODEIntegrator←::control_data, jeod::LsodeControlDataInterface::ImplicitAdamsNonStiff, jeod::LsodeControlDataInterface←::integration_method, jeod::LsodeControlDataInterface::max_order, jeod::LsodeFirstOrderODEIntegrator::max←_order_internal, jeod::LsodeControlDataInterface::max_step_size, and jeod::LsodeFirstOrderODEIntegrator←::max_step_size_inv.

Referenced by jeod::LsodeFirstOrderODEIntegrator::LsodeFirstOrderODEIntegrator().

6.5.2.76 ∼LsodeFirstOrderODEIntegrator()

```
LsodeFirstOrderODEIntegrator::∼LsodeFirstOrderODEIntegrator ( )  [override]
```

LsodeFirstOrderODEIntegrator destructor.

Definition at line 74 of file lsode_first_order_ode_integrator__utility.cc.

References jeod::LsodeFirstOrderODEIntegrator::arrays, jeod::LsodeFirstOrderODEIntegrator::control_data, jeod::LsodeDataArrays::destroy_allocated_arrays(), jeod::LsodeControlDataInterface::destroy_allocated_arrays(), and jeod::LsodeFirstOrderODEIntegrator::first_pass.

6.5.2.77 ∼LsodeGeneralizedDerivSecondOrderODEIntegrator()

```
LsodeGeneralizedDerivSecondOrderODEIntegrator::~LsodeGeneralizedDerivSecondOrderODEIntegrator
( ) [override]
```

LsodeGeneralizedDerivSecondOrderODEIntegrator destructor.

Destructor.

Definition at line 95 of file lsode_generalized_second_order_ode_integrator.cc.

References jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator::posdot.

6.5.2.78 ∼LsodeSecondOrderODEIntegrator()

```
LsodeSecondOrderODEIntegrator::~LsodeSecondOrderODEIntegrator ( ) [override]
```

LsodeSecondOrderODEIntegrator destructor.

Definition at line 86 of file lsode_second_order_ode_integrator.cc.

References jeod::LsodeSecondOrderODEIntegrator::arrays_allocated, jeod::LsodeSecondOrderODEIntegrator::y, and jeod::LsodeSecondOrderODEIntegrator::y_dot.

Chapter 7

Namespace Documentation

7.1 er7_utils Namespace Reference

Data Structures

- class DoubleTwoDArray

  2D array, specialized for doubles.
- class TwoDArray

  RAII template class that implements a rectangular two dimensional array.

7.2 jeod Namespace Reference

Namespace jeod.

Data Structures

- class GaussJacksonCoefficientsPair

  Contains a summed Adams and Gauss-Jackson coefficient pair.
- class GaussJacksonCoeffs

  Contains the Gauss-Jackson predictor and corrector coefficients.
- class GaussJacksonConfig

  Contains Gauss-Jackson configuration data.
- class GaussJacksonFirstOrderODEIntegrator

  Integrates a first order ODE using the summed Adams technique that is embedded within the Gauss-Jackson technique.
- class GaussJacksonGeneralizedDerivSecondOrderODEIntegrator

  Integrates a generalized derivative second order ODE using Gauss-Jackson.
- class GaussJacksonIntegrationControls

  IntegrationControls specialized for Gauss-Jackson integration.
- class GaussJacksonIntegratorBase

  Base template class for integrating state via the Gauss-Jackson technique.
- class GaussJacksonIntegratorConstructor

  Create state and time integrators that propagate using Gauss-Jackson.

- class GaussJacksonOneState

  Essentially just a double∗.
- class GaussJacksonRationalCoefficients

  Contains a set of Adams or Stormer-Cowell coefficients.
- class GaussJacksonSimpleSecondOrderODEIntegrator

  Integrates a simple second order ODE using the Gauss-Jackson technique.
- class GaussJacksonStateMachine

  Guides the behavior of the Gauss-Jackson integration process via a finite state machine.
- class GaussJacksonTwoState

  Essentially just std::pair<double∗>.
- class GeneralizedSecondOrderODETechnique

  Enumerates the integration schemes, generalized Cartesian or Lie group integration, and provides simple utilities that work with this.
- class IntegrationMessages

  Declares messages associated with the integration test model.
- class JeodIntegrationGroup

  A JeodIntegrationGroup integrates the state of a set of objects over time.
- class JeodIntegrationGroupOwner

  The abstract class IntegrationGroupOwner contains an IntegrationGroup.
- class JeodIntegrationTime

  The class JeodIntegrationTime adds the concepts of timestamping and notification of changes in the nature of time to the ER7 numerical utilities TimeInterface class.
- class LsodeControlDataInterface

  Specifies controls for an LSODE integrator.
- class LsodeDataArrays

  The data arrays.
- class LsodeDataJacobianPrep

  Data associated with the method DPREPJ.
- class LsodeDataStode

  The data associated with method Dstode.
- class LsodeFirstOrderODEIntegrator

  Jeod-compatible version of the Livermore ODE solver, LSODE.
- class LsodeGeneralizedDerivSecondOrderODEIntegrator

  JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.
- class LsodeIntegrationControls

  Contains controls for an LSODE integrator.
- class LsodeIntegratorConstructor

  Create state and time integrators that propagate using standard Lsode.
- class LsodeSecondOrderODEIntegrator

  JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.
- class LsodeSimpleSecondOrderODEIntegrator

  JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.
- class Restartable2DSecondOrderIntegrator

  Integrates a second order ODE in two dimensional space, d^2x/dt^2 = a(x,t), where x is a two-vector.
- class RestartableFirstOrderODEIntegrator

  A RestartableFirstOrderODEIntegrator is-a RestartableStateIntegrator that manages an er7_utils::FirstOrderODE↩ Integrator.
- class RestartableGeneralizedDerivSecondOrderODEIntegrator

  A RestartableGeneralizedDerivSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a generalized second order ODE problem, one in which the time derivative of the generalized position is some function of the generalized position and the generalized velocity.
- class RestartableGeneralizedStepSecondOrderODEIntegrator

A RestartableGeneralizedStepSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a generalized second order ODE problem, one in which the time derivative of the generalized position is some function of the generalized position and the generalized velocity.

- class RestartableScalarFirstOrderODEIntegrator

  A RestartableScalarFirstOrderODEIntegrator integrates a first order ODE, dx/dt = v(x,t), where x is a scalar.
- class RestartableSecondOrderODEIntegrator

  A RestartableSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a second order ODE problem.
- class RestartableSimpleSecondOrderODEIntegrator

  A RestartableSimpleSecondOrderODEIntegrator is-a RestartableSecondOrderODEIntegrator that manages the integrator for a simple second order ODE problem, one in which the time derivative of the generalized position is the generalized velocity.
- class RestartableSO3SecondOrderODEIntegrator

  A RestartableSO3SecondOrderODEIntegrator integrates a generalized second order ODE that describes rotation in three space.
- class RestartableStateIntegrator

  A RestartableStateIntegrator establishes the basic capabilities needed to make a state integrator a managed resource.
- class RestartableT3SecondOrderODEIntegrator

  A RestartableT3SecondOrderODEIntegrator integrates a second order ODE in three space, d^2x/dt^2 = a(x,t), where x is a three-vector.
- class TimeChangeSubscriber

  A TimeChangeSubscriber is some object that wants to be notified of changes in the nature of time.

Typedefs

- using GaussJacksonIntegratorBaseFirst = GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator >

  Alias for a first order Gauss Jackson integrator.
- using GaussJacksonIntegratorBaseSecond = GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator >

  Alias for a second order Gauss Jackson integrator.

Functions

- std::ostream & operator<< (std::ostream &stream, const GaussJacksonCoeffs &coeff)
- static GaussJacksonConfig set_default_config_values (const GaussJacksonConfig &config)

  Swap the negative ones in the supplied config with the default values, some of which are computed.
- static unsigned int validate_config (const GaussJacksonConfig &config)

  Check for invalid values in the supplied config.
- static GaussJacksonIntegrationControls * cast_to_gj_controls (er7_utils::IntegrationControls &controls)

  Cast the provided integration controls to a GaussJacksonIntegrationControls.

7.2.1 Detailed Description

Namespace jeod.

7.2.2 Typedef Documentation

7.2.2.1 GaussJacksonIntegratorBaseFirst

```
using jeod::GaussJacksonIntegratorBaseFirst = typedef GaussJacksonIntegratorBase<GaussJacksonOneState,
er7_utils::FirstOrderODEIntegrator>
```

Alias for a first order Gauss Jackson integrator.

Definition at line 81 of file gauss_jackson_integrator_base_first.hh.

7.2.2.2 GaussJacksonIntegratorBaseSecond

```
using jeod::GaussJacksonIntegratorBaseSecond = typedef GaussJacksonIntegratorBase<GaussJacksonTwoState,
er7_utils::SecondOrderODEIntegrator>
```

Alias for a second order Gauss Jackson integrator.

Definition at line 81 of file gauss_jackson_integrator_base_second.hh.

7.2.3 Function Documentation

7.2.3.1 cast_to_gj_controls()

```
static GaussJacksonIntegrationControls* jeod::cast_to_gj_controls (
            er7_utils::IntegrationControls & controls )  [static]
```

Cast the provided integration controls to a GaussJacksonIntegrationControls.

Parameters

controls	Generic controls to be cast.

Returns

GaussJacksonIntegrationControls pointer, guaranteed to be non-null.

Definition at line 47 of file gauss_jackson_integrator_constructor.cc.

Referenced by jeod::GaussJacksonIntegratorConstructor::create_first_order_ode_integrator(), jeod::Gauss↩JacksonIntegratorConstructor::create_generalized_deriv_second_order_ode_integrator(), and jeod::Gauss↩JacksonIntegratorConstructor::create_second_order_ode_integrator().

7.2.3.2 operator<<()

```
std::ostream& jeod::operator<< (
            std::ostream & stream,
            const GaussJacksonCoeffs & coeff )
```

Parameters

stream	The stream to be printed to.
coeff	The coefficients to be printed.

Definition at line 130 of file gauss_jackson_coeffs.cc.

References jeod::GaussJacksonCoeffs::corrector, jeod::GaussJacksonCoeffs::order, jeod::GaussJacksonCoeffs↵ ::predictor, and jeod::GaussJacksonCoefficientsPair::printOut().

7.2.3.3 set_default_config_values()

```
static GaussJacksonConfig jeod::set_default_config_values (
            const GaussJacksonConfig & config )  [static]
```

Swap the negative ones in the supplied config with the default values, some of which are computed.

Definition at line 75 of file gauss_jackson_config.cc.

References jeod::GaussJacksonConfig::absolute_tolerance, jeod::GaussJacksonConfig::final_order, jeod::Gauss↵ JacksonConfig::initial_order, jeod::GaussJacksonConfig::max_correction_iterations, jeod::GaussJacksonConfig↵ ::ndoubling_steps, jeod::GaussJacksonConfig::priming_technique, and jeod::GaussJacksonConfig::relative_↵ tolerance.

Referenced by jeod::GaussJacksonConfig::validate_configuration().

7.2.3.4 validate_config()

```
static unsigned int jeod::validate_config (
            const GaussJacksonConfig & config )  [static]
```

Check for invalid values in the supplied config.

Definition at line 167 of file gauss_jackson_config.cc.

References jeod::GaussJacksonConfig::absolute_tolerance, jeod::GaussJacksonConfig::final_order, jeod::↵ GaussJacksonConfig::initial_order, jeod::GaussJacksonConfig::ndoubling_steps, and jeod::GaussJacksonConfig↵ ::relative_tolerance.

Referenced by jeod::GaussJacksonConfig::validate_configuration().

Chapter 8

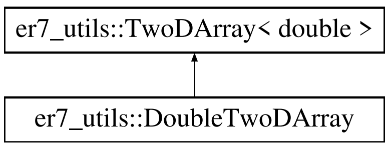
Data Structure Documentation

8.1 er7_utils::DoubleTwoDArray Class Reference

2D array, specialized for doubles.

```
#include <two_d_array.hh>
```

Inheritance diagram for er7_utils::DoubleTwoDArray:



Friends

- class InputProcessor
- void init_attrer7_utils__DoubleTwoDArray ()

Additional Inherited Members

8.1.1 Detailed Description

2D array, specialized for doubles.

Definition at line 403 of file two_d_array.hh.

8.1.2 Friends And Related Function Documentation

8.1.2.1 init_attrer7_utils__DoubleTwoDArray

```
void init_attrer7_utils__DoubleTwoDArray ( )  [friend]
```

8.1.2.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 405 of file two_d_array.hh.

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

- two_d_array.hh

8.2 jeod::GaussJacksonCoefficientsPair Class Reference

Contains a summed Adams and Gauss-Jackson coefficient pair.

```
#include <gauss_jackson_coefficients_pair.hh>
```

Public Member Functions

- GaussJacksonCoefficientsPair ()=default
  Default constructor.
- ∼GaussJacksonCoefficientsPair ()
  Destructor.
- void configure (int max_order)

  Allocate (re-allocate) memory for the coefficients.
- void swap (GaussJacksonCoefficientsPair &other)
  Non-throwing swap.
- void allocate_arrays (int size)
  Allocate space for the coefficients.
- void deallocate_arrays ()
  Release allocated memory.
- void apply (int nelem, int ncoeff, const double ∗const ∗acc_hist, const GaussJacksonTwoState &state_sum) const
  Apply both sets of coefficients to the supplied history data.
- void apply (int nelem, int ncoeff, const double ∗const ∗acc_hist, const GaussJacksonOneState &state_sum) const
  Apply just the Adams coefficients to the supplied history data.
- void printOut (int order, std::ostream &stream) const
  Print the coefficients.
- GaussJacksonCoefficientsPair (const GaussJacksonCoefficientsPair &)=delete
- GaussJacksonCoefficientsPair & operator= (const GaussJacksonCoefficientsPair &)=delete

Data Fields

- double * sa_coefs {}

  Summed Adams coefficients, in ordinate form.
- double * gj_coefs {}

  Gauss Jackson coefficients, in ordinate form.

Friends

- class InputProcessor
- void init_attrjeod__GaussJacksonCoefficientsPair ()

8.2.1 Detailed Description

Contains a summed Adams and Gauss-Jackson coefficient pair.

Definition at line 82 of file gauss_jackson_coefficients_pair.hh.

8.2.2 Constructor & Destructor Documentation

8.2.2.1 GaussJacksonCoefficientsPair() [1/2]

```
jeod::GaussJacksonCoefficientsPair::GaussJacksonCoefficientsPair ( )  [default]
```

Default constructor.

8.2.2.2 ∼GaussJacksonCoefficientsPair()

```
jeod::GaussJacksonCoefficientsPair::∼GaussJacksonCoefficientsPair ( )  [inline]
```

Destructor.

Definition at line 107 of file gauss_jackson_coefficients_pair.hh.

8.2.2.3 GaussJacksonCoefficientsPair() [2/2]

```
jeod::GaussJacksonCoefficientsPair::GaussJacksonCoefficientsPair (
            const GaussJacksonCoefficientsPair &  )  [delete]
```

8.2.3 Member Function Documentation

8.2.3.1 allocate_arrays()

```
void jeod::GaussJacksonCoefficientsPair::allocate_arrays (
            int size )
```

Allocate space for the coefficients.

Parameters

size	Array size.

Definition at line 34 of file gauss_jackson_coefficients_pair.cc.

References gj_coefs, and sa_coefs.

8.2.3.2 apply() [1/2]

```
void jeod::GaussJacksonCoefficientsPair::apply (
            int nelem,
            int ncoeff,
            const double *const * acc_hist,
            const GaussJacksonTwoState & state_sum ) const
```

Apply both sets of coefficients to the supplied history data.

The first element of the output state_sum is calculated as the inner products of the acceleration history with the summed Adams coefficients. The second element is calculated as the inner product with the Gauss-Jackson coefficients. (First = first integral; second = second integral.)

Parameters

nelem	Dimensionality of each acceleration history element
ncoeff	Number of elements in the acceleration history
acc_hist	Acceleration history
state_sum	Output inner products

Definition at line 52 of file gauss_jackson_coefficients_pair.cc.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_gj().

8.2.3.3 apply() [2/2]

```
void jeod::GaussJacksonCoefficientsPair::apply (
            int nelem,
            int ncoeff,
            const double *const * acc_hist,
            const GaussJacksonOneState & state_sum ) const
```

Apply just the Adams coefficients to the supplied history data.

Parameters

nelem	Dimensionality of each acceleration history element
ncoeff	Number of elements in the acceleration history
acc_hist	Acceleration history
state_sum	Output inner products

Definition at line 84 of file gauss_jackson_coefficients_pair.cc.

8.2.3.4 configure()

```
void jeod::GaussJacksonCoefficientsPair::configure (
            int max_order )  [inline]
```

Allocate (re-allocate) memory for the coefficients.

Arrays are size & to contain max_order+1 elements.

Parameters

max_order	Maximum order that will be used.

Definition at line 117 of file gauss_jackson_coefficients_pair.hh.

Referenced by jeod::GaussJacksonCoeffs::configure().

8.2.3.5 deallocate_arrays()

```
void jeod::GaussJacksonCoefficientsPair::deallocate_arrays ( )
```

Release allocated memory.

Definition at line 40 of file gauss_jackson_coefficients_pair.cc.

References gj_coefs, and sa_coefs.

8.2.3.6 operator=()

```
GaussJacksonCoefficientsPair& jeod::GaussJacksonCoefficientsPair::operator= (
            const GaussJacksonCoefficientsPair & )  [delete]
```

8.2.3.7 printOut()

```
void jeod::GaussJacksonCoefficientsPair::printOut (
            int order,
            std::ostream & stream ) const
```

Print the coefficients.

Parameters

order	Coefficients order
stream	Output stream

Definition at line 110 of file gauss_jackson_coefficients_pair.cc.

References gj_coefs, and sa_coefs.

Referenced by jeod::operator<<().

8.2.3.8 swap()

```
void jeod::GaussJacksonCoefficientsPair::swap (
            GaussJacksonCoefficientsPair & other )
```

Non-throwing swap.

Parameters

other	Coeffs pair with which contents are to be swapped.

Definition at line 46 of file gauss_jackson_coefficients_pair.cc.

References gj_coefs, and sa_coefs.

Referenced by jeod::GaussJacksonCoeffs::swap().

8.2.4 Friends And Related Function Documentation

8.2.4.1 init_attrjeod__GaussJacksonCoefficientsPair

```
void init_attrjeod__GaussJacksonCoefficientsPair ( ) [friend]
```

8.2.4.2 InputProcessor

```
friend class InputProcessor [friend]
```

Definition at line 84 of file gauss_jackson_coefficients_pair.hh.

8.2.5 Field Documentation

8.2.5.1 gj_coefs

`double* jeod::GaussJacksonCoefficientsPair::gj_coefs {}`

Gauss Jackson coefficients, in ordinate form.

trick_units(–)

Definition at line 95 of file gauss_jackson_coefficients_pair.hh.

Referenced by allocate_arrays(), jeod::GaussJacksonCoeffs::compute_coeffs(), deallocate_arrays(), printOut(), jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle(), and swap().

8.2.5.2 sa_coefs

`double* jeod::GaussJacksonCoefficientsPair::sa_coefs {}`

Summed Adams coefficients, in ordinate form.

trick_units(–)

Definition at line 90 of file gauss_jackson_coefficients_pair.hh.

Referenced by allocate_arrays(), jeod::GaussJacksonCoeffs::compute_coeffs(), deallocate_arrays(), printOut(), jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle(), and swap().

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

- gauss_jackson_coefficients_pair.hh
- gauss_jackson_coefficients_pair.cc

8.3 jeod::GaussJacksonCoeffs Class Reference

Contains the Gauss-Jackson predictor and corrector coefficients.

```
#include <gauss_jackson_coeffs.hh>
```

Public Member Functions

- GaussJacksonCoeffs ()=default

    Default constructor.
- GaussJacksonCoeffs (const GaussJacksonCoeffs &src)

    Copy constructor.
- ∼GaussJacksonCoeffs ()

    Destructor.
- GaussJacksonCoeffs & operator= (GaussJacksonCoeffs src)

    Copy-and-swap assignment operator.
- void swap (GaussJacksonCoeffs &src)

    Non-throwing swap.
- void configure (unsigned int max_order_in)

    Configure to enable coefficients up to the specified maximum order.
- void compute_coeffs (unsigned int order_in)

    Compute coefficients for the specified order.

Data Fields

- GaussJacksonCoefficientsPair predictor

    Summed Adams and Gauss-Jackson predictor coefficients.
- GaussJacksonCoefficientsPair ∗ corrector {}

    Summed Adams and Gauss-Jackson corrector coefficients.
- unsigned int max_order {}

    Maximum order; used for sizing.
- unsigned int order {}

    Current order; dictates the coefficient values.

Friends

- class InputProcessor
- void init_attrjeod__GaussJacksonCoeffs ()
- std::ostream & operator<< (std::ostream &stream, const GaussJacksonCoeffs &coeff)

    Print the coefficients.

8.3.1 Detailed Description

Contains the Gauss-Jackson predictor and corrector coefficients.

Definition at line 81 of file gauss_jackson_coeffs.hh.

8.3.2 Constructor & Destructor Documentation

8.3.2.1 GaussJacksonCoeffs() [1/2]

```
jeod::GaussJacksonCoeffs::GaussJacksonCoeffs ( )  [default]
```

Default constructor.

8.3.2.2 GaussJacksonCoeffs() [2/2]

```
jeod::GaussJacksonCoeffs::GaussJacksonCoeffs (
            const GaussJacksonCoeffs & src )  [inline]
```

Copy constructor.

Note that this doesn't copy; it recomputes. The end result is as if a copy had been made.

Parameters

src	Object to be copied.

Definition at line 119 of file gauss_jackson_coeffs.hh.

8.3.2.3 ∼GaussJacksonCoeffs()

```
jeod::GaussJacksonCoeffs::∼GaussJacksonCoeffs ( )
```

Destructor.

Definition at line 43 of file gauss_jackson_coeffs.cc.

References corrector.

8.3.3 Member Function Documentation

8.3.3.1 compute_coeffs()

```
void jeod::GaussJacksonCoeffs::compute_coeffs (
            unsigned int order_in )
```

Compute coefficients for the specified order.

Parameters

order←↩_in	The current order.

Definition at line 75 of file gauss_jackson_coeffs.cc.

References jeod::GaussJacksonRationalCoefficients::configure_adams_corrector(), jeod::GaussJackson←↩RationalCoefficients::construct_predictor(), jeod::GaussJacksonRationalCoefficients::construct_stormer_cowell_←↩corrector(), jeod::GaussJacksonRationalCoefficients::convert_to_ordinate_form(), corrector, jeod::GaussJackson←↩RationalCoefficients::discard_extra_terms(), jeod::GaussJacksonRationalCoefficients::displace_back(), jeod::←↩GaussJacksonCoefficientsPair::gj_coefs, max_order, order, predictor, and jeod::GaussJacksonCoefficientsPair←↩::sa_coefs.

Referenced by jeod::GaussJacksonIntegrationControls::GaussJacksonIntegrationControls(), and jeod::Gauss←↩JacksonIntegrationControls::start_cycle().

8.3.3.2 configure()

```
void jeod::GaussJacksonCoeffs::configure (
            unsigned int max_order_in )
```

Configure to enable coefficients up to the specified maximum order.

Parameters

max_order←↩_in	The maximum order to be used.

Definition at line 58 of file gauss_jackson_coeffs.cc.

References jeod::GaussJacksonCoefficientsPair::configure(), corrector, max_order, order, and predictor.

Referenced by jeod::GaussJacksonIntegrationControls::GaussJacksonIntegrationControls().

8.3.3.3 operator=()

```
GaussJacksonCoeffs& jeod::GaussJacksonCoeffs::operator= (
            GaussJacksonCoeffs src )  [inline]
```

Copy-and-swap assignment operator.

Parameters

src	Object to be copied.

Definition at line 141 of file gauss_jackson_coeffs.hh.

8.3.3.4 swap()

```
void jeod::GaussJacksonCoeffs::swap (
            GaussJacksonCoeffs & src )
```

Non-throwing swap.

Parameters

src	Object to swap contents with.

Definition at line 49 of file gauss_jackson_coeffs.cc.

References corrector, max_order, order, predictor, and jeod::GaussJacksonCoefficientsPair::swap().

8.3.4 Friends And Related Function Documentation

8.3.4.1 init_attrjeod__GaussJacksonCoeffs

```
void init_attrjeod__GaussJacksonCoeffs ( )  [friend]
```

8.3.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 83 of file gauss_jackson_coeffs.hh.

8.3.4.3 operator<<

```
std::ostream& operator<< (
            std::ostream & stream,
            const GaussJacksonCoeffs & coeff )  [friend]
```

Print the coefficients.

Parameters

stream	The stream to be printed to.
coeff	The coefficients to be printed.

Definition at line 130 of file gauss_jackson_coeffs.cc.

8.3.5 Field Documentation

8.3.5.1 corrector

```
GaussJacksonCoefficientsPair* jeod::GaussJacksonCoeffs::corrector {}
```

Summed Adams and Gauss-Jackson corrector coefficients.

trick_units(--)

Definition at line 94 of file gauss_jackson_coeffs.hh.

Referenced by compute_coeffs(), configure(), jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_gj(), jeod::operator<<(), jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle(), swap(), and ~Gauss↩JacksonCoeffs().

8.3.5.2 max_order

```
unsigned int jeod::GaussJacksonCoeffs::max_order {}
```

Maximum order; used for sizing.

trick_units(--)

Definition at line 99 of file gauss_jackson_coeffs.hh.

Referenced by compute_coeffs(), configure(), and swap().

8.3.5.3 order

```
unsigned int jeod::GaussJacksonCoeffs::order {}
```

Current order; dictates the coefficient values.

trick_units(--)

Definition at line 104 of file gauss_jackson_coeffs.hh.

Referenced by compute_coeffs(), configure(), jeod::operator<<(), and swap().

8.3.5.4 predictor

`GaussJacksonCoefficientsPair jeod::GaussJacksonCoeffs::predictor`

Summed Adams and Gauss-Jackson predictor coefficients.

trick_units(–)

Definition at line 89 of file gauss_jackson_coeffs.hh.

Referenced by compute_coeffs(), configure(), jeod::operator<<(), and swap().

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

- gauss_jackson_coeffs.hh
- gauss_jackson_coeffs.cc

8.4 jeod::GaussJacksonConfig Class Reference

Contains Gauss-Jackson configuration data.

`#include <gauss_jackson_config.hh>`

Public Member Functions

- GaussJacksonConfig ()

Static Public Member Functions

- static GaussJacksonConfig default_configuration ()

  Creates a GaussJacksonConfig with all members set to -1.
- static GaussJacksonConfig standard_configuration ()

  Creates a GaussJacksonConfig with all members set to their defaults.
- static GaussJacksonConfig validate_configuration (const GaussJacksonConfig &config)

  Creates a GaussJacksonConfig based on the supplied configuration.

Data Fields

- er7_utils::Integration::Technique priming_technique {er7_utils::Integration::Unspecified}

  The integration technique to be used to prime the Gauss-Jackson process.
- unsigned int initial_order {4}

  The order of the Gauss Jackson integrator immediately after priming.
- unsigned int final_order {12}

  The order of the Gauss Jackson integrator once it's operational.
- unsigned int ndoubling_steps

  The number of time doubling steps involved in the bootstrap operation.
- unsigned int max_correction_iterations {10}

  Maximum number of correction steps allowed before the integrator is deemed to be not converging.
- double relative_tolerance {1E-14}

  Number that indicates the allowable relative difference for two states to be considered converged.
- double absolute_tolerance {1E-10}

  Number that indicates the allowable absolute difference for two states to be considered converged.

Friends

- class InputProcessor
- void init_attrjeod__GaussJacksonConfig ()

8.4.1 Detailed Description

Contains Gauss-Jackson configuration data.

All member data are public; this is esentially a struct.

Definition at line 75 of file gauss_jackson_config.hh.

8.4.2 Constructor & Destructor Documentation

8.4.2.1 GaussJacksonConfig()

`jeod::GaussJacksonConfig::GaussJacksonConfig ( )  [inline]`

Definition at line 78 of file gauss_jackson_config.hh.

8.4.3 Member Function Documentation

8.4.3.1 default_configuration()

`GaussJacksonConfig jeod::GaussJacksonConfig::default_configuration ( )  [static]`

Creates a GaussJacksonConfig with all members set to -1.

This otherwise invalid value has a special meaning to the validation function. When encountered, the item is silently replaced with the default for that item.

Definition at line 39 of file gauss_jackson_config.cc.

References priming_technique.

8.4.3.2 standard_configuration()

```
GaussJacksonConfig jeod::GaussJacksonConfig::standard_configuration ( ) [static]
```

Creates a GaussJacksonConfig with all members set to their defaults.

Definition at line 55 of file gauss_jackson_config.cc.

References priming_technique.

Referenced by jeod::GaussJacksonIntegratorConstructor::create_integration_controls(), and validate_configuration().

8.4.3.3 validate_configuration()

```
GaussJacksonConfig jeod::GaussJacksonConfig::validate_configuration (
            const GaussJacksonConfig & config ) [static]
```

Creates a GaussJacksonConfig based on the supplied configuration.

Values of -1 are replaced with their defaults. The standard configuration is used if any invalid item is invalid.

Definition at line 236 of file gauss_jackson_config.cc.

References jeod::set_default_config_values(), standard_configuration(), and jeod::validate_config().

Referenced by jeod::GaussJacksonIntegratorConstructor::configure().

8.4.4 Friends And Related Function Documentation

8.4.4.1 init_attrjeod__GaussJacksonConfig

```
void init_attrjeod__GaussJacksonConfig ( ) [friend]
```

8.4.4.2 InputProcessor

```
friend class InputProcessor [friend]
```

Definition at line 77 of file gauss_jackson_config.hh.

8.4.5 Field Documentation

8.4.5.1 absolute_tolerance

```
double jeod::GaussJacksonConfig::absolute_tolerance {1E-10}
```

Number that indicates the allowable absolute difference for two states to be considered converged.

Defaults to 1e-10.trick_units(–)

Definition at line 157 of file gauss_jackson_config.hh.

Referenced by jeod::set_default_config_values(), and jeod::validate_config().

8.4.5.2 final_order

```
unsigned int jeod::GaussJacksonConfig::final_order {12}
```

The order of the Gauss Jackson integrator once it's operational.

This must be an even number between initial_order and 14, inclusive. Defaults to 12.trick_units(–)

Definition at line 126 of file gauss_jackson_config.hh.

Referenced by jeod::GaussJacksonStateMachine::configure(), jeod::GaussJacksonIntegrationControls::Gauss↩JacksonIntegrationControls(), jeod::set_default_config_values(), and jeod::validate_config().

8.4.5.3 initial_order

```
unsigned int jeod::GaussJacksonConfig::initial_order {4}
```

The order of the Gauss Jackson integrator immediately after priming.

This must be an even number and must be 14 or less. Defaults to 4.trick_units(–)

Definition at line 119 of file gauss_jackson_config.hh.

Referenced by jeod::GaussJacksonStateMachine::configure(), jeod::set_default_config_values(), and jeod↩::validate_config().

8.4.5.4 max_correction_iterations

```
unsigned int jeod::GaussJacksonConfig::max_correction_iterations {10}
```

Maximum number of correction steps allowed before the integrator is deemed to be not converging.

The algorithm is run in predict-only mode if this limit is zero. The corrector is applied but once with the limit is one. A one-time warning is issued if the limit is 2 or more and if the the algorithm would make more corrections were it not for this limit. Defaults to 10.trick_units(–)

Definition at line 143 of file gauss_jackson_config.hh.

Referenced by jeod::GaussJacksonStateMachine::configure(), and jeod::set_default_config_values().

8.4.5.5 ndoubling_steps

```
unsigned int jeod::GaussJacksonConfig::ndoubling_steps
```

The number of time doubling steps involved in the bootstrap operation.

Defaults to (final_order - initial_order)/2.trick_units(–)

Definition at line 132 of file gauss_jackson_config.hh.

Referenced by jeod::GaussJacksonStateMachine::configure(), jeod::set_default_config_values(), and jeod↩ ::validate_config().

8.4.5.6 priming_technique

```
er7_utils::Integration::Technique jeod::GaussJacksonConfig::priming_technique {er7_utils::↩
Integration::Unspecified}
```

The integration technique to be used to prime the Gauss-Jackson process.

Defaults to er7_utils::Integration::Unspecified, the interpretation of which depends on the initial order.trick_units(–)

Definition at line 112 of file gauss_jackson_config.hh.

Referenced by jeod::GaussJacksonIntegratorConstructor::configure(), default_configuration(), jeod::set_default_↩ config_values(), and standard_configuration().

8.4.5.7 relative_tolerance

```
double jeod::GaussJacksonConfig::relative_tolerance {1E-14}
```

Number that indicates the allowable relative difference for two states to be considered converged.

Defaults to 1e-14.trick_units(–)

Definition at line 150 of file gauss_jackson_config.hh.

Referenced by jeod::set_default_config_values(), and jeod::validate_config().

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

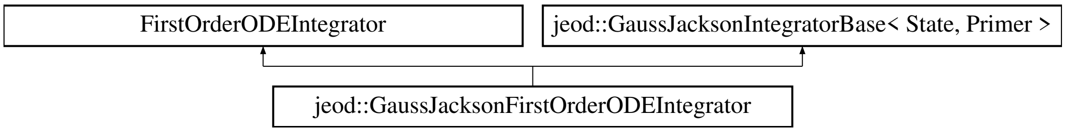
- gauss_jackson_config.hh
- gauss_jackson_config.cc

8.5 jeod::GaussJacksonFirstOrderODEIntegrator Class Reference

Integrates a first order ODE using the summed Adams technique that is embedded within the Gauss-Jackson technique.

```
#include <gauss_jackson_first_order_ode_integrator.hh>
```

Inheritance diagram for jeod::GaussJacksonFirstOrderODEIntegrator:



Private Member Functions

- JEOD_MAKE_SIM_INTERFACES(jeod, GaussJacksonFirstOrderODEIntegrator) public ~GaussJacksonFirstOrderODEIntegra
  () override=default
- GaussJacksonFirstOrderODEIntegrator (const er7_utils::IntegratorConstructor &priming_constructor, GaussJacksonIntegrationControls &controls, unsigned int size_in, er7_utils::IntegrationControls &priming_controls)

  Non-default constructor.
- GaussJacksonFirstOrderODEIntegrator (const GaussJacksonFirstOrderODEIntegrator &src)

  Copy constructor.
- GaussJacksonFirstOrderODEIntegrator & operator= (GaussJacksonFirstOrderODEIntegrator src)

  Assignment operator.
- void swap (GaussJacksonFirstOrderODEIntegrator &other)

  Non-throwing swap.
- er7_utils::FirstOrderODEIntegrator * create_copy () const override

  Replicate this.
- void reset_integrator () override

  Reset the integrator.
- er7_utils::IntegratorResult integrate (double dyn_dt, unsigned int target_stage, const double *ER7_UTILS_RESTRICT deriv, double *ER7_UTILS_RESTRICT state) override

  Integrate.
- void swap (GaussJacksonIntegratorBase &other)

  Non-throwing swap.

Additional Inherited Members

8.5.1 Detailed Description

Integrates a first order ODE using the summed Adams technique that is embedded within the Gauss-Jackson technique.

Definition at line 79 of file gauss_jackson_first_order_ode_integrator.hh.

8.5.2 Constructor & Destructor Documentation

8.5.2.1 ∼GaussJacksonFirstOrderODEIntegrator()

```
JEOD_MAKE_SIM_INTERFACES (jeod, GaussJacksonFirstOrderODEIntegrator) public jeod::Gauss←
JacksonFirstOrderODEIntegrator::∼GaussJacksonFirstOrderODEIntegrator ( ) [override], [private],
[default]
```

8.5.2.2 GaussJacksonFirstOrderODEIntegrator() [1/2]

```
jeod::GaussJacksonFirstOrderODEIntegrator::GaussJacksonFirstOrderODEIntegrator (
            const er7_utils::IntegratorConstructor & priming_constructor,
            GaussJacksonIntegrationControls & controls,
            unsigned int size_in,
            er7_utils::IntegrationControls & priming_controls ) [inline], [private]
```

Non-default constructor.

Parameters

priming_constructor	Integrator constructor for the technique used during priming.
controls	The Gauss-Jackson integration controls that drives this state integrator.
size_in	State size.
priming_controls	Integration controls used during priming.

Definition at line 98 of file gauss_jackson_first_order_ode_integrator.hh.

8.5.2.3 GaussJacksonFirstOrderODEIntegrator() [2/2]

```
jeod::GaussJacksonFirstOrderODEIntegrator::GaussJacksonFirstOrderODEIntegrator (
            const GaussJacksonFirstOrderODEIntegrator & src ) [inline], [private]
```

Copy constructor.

Definition at line 110 of file gauss_jackson_first_order_ode_integrator.hh.

8.5.3 Member Function Documentation

8.5.3.1 create_copy()

```
er7_utils::FirstOrderODEIntegrator* jeod::GaussJacksonFirstOrderODEIntegrator::create_copy ( )
const [inline], [override], [private]
```

Replicate this.

Definition at line 137 of file gauss_jackson_first_order_ode_integrator.hh.

8.5.3.2 integrate()

```
er7_utils::IntegratorResult jeod::GaussJacksonFirstOrderODEIntegrator::integrate (
            double dyn_dt,
            unsigned int target_stage,
            const double *ER7_UTILS_RESTRICT deriv,
            double *ER7_UTILS_RESTRICT state ) [inline], [override], [private]
```

Integrate.

Definition at line 153 of file gauss_jackson_first_order_ode_integrator.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate().

8.5.3.3 operator=()

```
GaussJacksonFirstOrderODEIntegrator& jeod::GaussJacksonFirstOrderODEIntegrator::operator= (
            GaussJacksonFirstOrderODEIntegrator src ) [inline], [private]
```

Assignment operator.

Definition at line 119 of file gauss_jackson_first_order_ode_integrator.hh.

References swap().

8.5.3.4 reset_integrator()

```
void jeod::GaussJacksonFirstOrderODEIntegrator::reset_integrator ( ) [inline], [override],
[private]
```

Reset the integrator.

Definition at line 145 of file gauss_jackson_first_order_ode_integrator.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::base_reset().

8.5.3.5 swap() [1/2]

```
void jeod::GaussJacksonFirstOrderODEIntegrator::swap (
            GaussJacksonFirstOrderODEIntegrator & other )  [inline], [private]
```

Non-throwing swap.

Definition at line 128 of file gauss_jackson_first_order_ode_integrator.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

Referenced by operator=(), and jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator::swap().

8.5.3.6 swap() [2/2]

```
void jeod::GaussJacksonIntegratorBase< State, Primer >::swap  [inline], [private]
```

Non-throwing swap.

Parameters

other	Item whose contents are to be swapped with this.

Definition at line 397 of file gauss_jackson_integrator_base.hh.

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

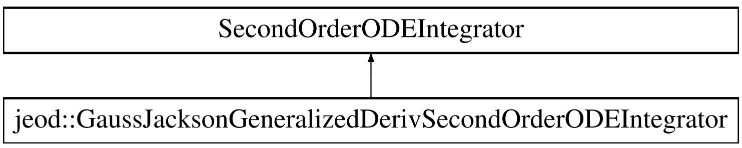
- gauss_jackson_first_order_ode_integrator.hh

8.6 jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator Class Reference

Integrates a generalized derivative second order ODE using Gauss-Jackson.

```
#include <gauss_jackson_generalized_second_order_ode_integrator.hh>
```

Inheritance diagram for jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator:



Public Member Functions

- GaussJacksonGeneralizedDerivSecondOrderODEIntegrator ()=default

  Default constructor.
- GaussJacksonGeneralizedDerivSecondOrderODEIntegrator (const er7_utils::IntegratorConstructor &priming↩ _constructor, GaussJacksonIntegrationControls &controls, unsigned int position_size, unsigned int velocity↩ _size, const er7_utils::GeneralizedPositionDerivativeFunctions &deriv_funs, er7_utils::IntegrationControls &priming_controls)

  Non-default constructor.
- GaussJacksonGeneralizedDerivSecondOrderODEIntegrator (const GaussJacksonGeneralizedDerivSecondOrderODEIntegrato &src)

  Copy constructor.
- ∼GaussJacksonGeneralizedDerivSecondOrderODEIntegrator () override

  Destructor.
- GaussJacksonGeneralizedDerivSecondOrderODEIntegrator & operator= (GaussJacksonGeneralizedDerivSecondOrderODEIn src)

  Assignment operator.
- void swap (GaussJacksonGeneralizedDerivSecondOrderODEIntegrator &other)

  Non-throwing swap.
- er7_utils::SecondOrderODEIntegrator ∗ create_copy () const override

  Replicate this.
- void reset_integrator () override

  Reset the integrator.
- er7_utils::IntegratorResult integrate (double dyn_dt, unsigned int target_stage, const double ∗acc, double ∗vel, double ∗pos) override

  Integrate state.

Private Attributes

- GaussJacksonFirstOrderODEIntegrator vel_integrator

  Integrator for the generalized velocity.
- GaussJacksonSimpleSecondOrderODEIntegrator pos_integrator

  Integrator for the generalized position.
- double ∗ posdot {}

  Generalized position time derivative.
- double ∗ posdotdot {}

  Generalized position second time derivative.

Friends

- class InputProcessor
- void init_attrjeod__GaussJacksonGeneralizedDerivSecondOrderODEIntegrator ()

8.6.1 Detailed Description

Integrates a generalized derivative second order ODE using Gauss-Jackson.

Generalized position is integrated via a simple second order Gauss-Jackson integrator. Generalized velocity is integrated via a first order summed Adams integrator.

Definition at line 82 of file gauss_jackson_generalized_second_order_ode_integrator.hh.

8.6.2 Constructor & Destructor Documentation

8.6.2.1 GaussJacksonGeneralizedDerivSecondOrderODEIntegrator() [1/3]

```
jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator::GaussJacksonGeneralizedDeriv←
SecondOrderODEIntegrator ( )  [default]
```

Default constructor.

8.6.2.2 GaussJacksonGeneralizedDerivSecondOrderODEIntegrator() [2/3]

```
jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator::GaussJacksonGeneralizedDeriv←
SecondOrderODEIntegrator (
            const er7_utils::IntegratorConstructor & priming_constructor,
            GaussJacksonIntegrationControls & controls,
            unsigned int position_size,
            unsigned int velocity_size,
            const er7_utils::GeneralizedPositionDerivativeFunctions & deriv_funs,
            er7_utils::IntegrationControls & priming_controls )
```

Non-default constructor.

Parameters

priming_constructor	Integrator constructor for the technique used during priming.
controls	The Gauss-Jackson integration controls that drives this state integrator.
position_size	Generalized position vector size.
velocity_size	Generalized velocity vector size.
deriv_funs	Position vector time deriv functions.
priming_controls	Integration controls used during priming.

Definition at line 34 of file gauss_jackson_generalized_second_order_ode_integrator.cc.

References posdot, and posdotdot.

8.6.2.3 GaussJacksonGeneralizedDerivSecondOrderODEIntegrator() [3/3]

```
jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator::GaussJacksonGeneralizedDeriv←
SecondOrderODEIntegrator (
            const GaussJacksonGeneralizedDerivSecondOrderODEIntegrator & src )
```

Copy constructor.

Definition at line 50 of file gauss_jackson_generalized_second_order_ode_integrator.cc.

References posdot, and posdotdot.

8.6.2.4 ∼GaussJacksonGeneralizedDerivSecondOrderODEIntegrator()

```
jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator::∼GaussJacksonGeneralizedDeriv←
SecondOrderODEIntegrator ( ) [override]
```

Destructor.

Definition at line 61 of file gauss_jackson_generalized_second_order_ode_integrator.cc.

References posdot, and posdotdot.

8.6.3 Member Function Documentation

8.6.3.1 create_copy()

```
er7_utils::SecondOrderODEIntegrator * jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator←
::create_copy ( ) const [override]
```

Replicate this.

Definition at line 81 of file gauss_jackson_generalized_second_order_ode_integrator.cc.

8.6.3.2 integrate()

```
er7_utils::IntegratorResult jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator::integrate
(
            double dyn_dt,
            unsigned int target_stage,
            const double * acc,
            double * vel,
            double * pos ) [inline], [override]
```

Integrate state.

Definition at line 154 of file gauss_jackson_generalized_second_order_ode_integrator.hh.

8.6.3.3 operator=()

```
GaussJacksonGeneralizedDerivSecondOrderODEIntegrator& jeod::GaussJacksonGeneralizedDeriv←
SecondOrderODEIntegrator::operator= (
            GaussJacksonGeneralizedDerivSecondOrderODEIntegrator src ) [inline]
```

Assignment operator.

Definition at line 123 of file gauss_jackson_generalized_second_order_ode_integrator.hh.

8.6.3.4 reset_integrator()

```
void jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator::reset_integrator ( )  [inline],
[override]
```

Reset the integrator.

Definition at line 145 of file gauss_jackson_generalized_second_order_ode_integrator.hh.

8.6.3.5 swap()

```
void jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator::swap (
            GaussJacksonGeneralizedDerivSecondOrderODEIntegrator & other )
```

Non-throwing swap.

Definition at line 68 of file gauss_jackson_generalized_second_order_ode_integrator.cc.

References pos_integrator, posdot, posdotdot, jeod::GaussJacksonFirstOrderODEIntegrator::swap(), jeod::GaussJacksonSimpleSecondOrderODEIntegrator::swap(), and vel_integrator.

8.6.4 Friends And Related Function Documentation

8.6.4.1 init_attrjeod__GaussJacksonGeneralizedDerivSecondOrderODEIntegrator

```
void init_attrjeod__GaussJacksonGeneralizedDerivSecondOrderODEIntegrator ( )  [friend]
```

8.6.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 84 of file gauss_jackson_generalized_second_order_ode_integrator.hh.

8.6.5 Field Documentation

8.6.5.1 pos_integrator

`GaussJacksonSimpleSecondOrderODEIntegrator jeod::GaussJacksonGeneralizedDerivSecondOrderODE↩ Integrator::pos_integrator [private]`

Integrator for the generalized position.

trick_units(--)

Definition at line 176 of file gauss_jackson_generalized_second_order_ode_integrator.hh.

Referenced by swap().

8.6.5.2 posdot

`double* jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator::posdot {} [private]`

Generalized position time derivative.

trick_units(--)

Definition at line 181 of file gauss_jackson_generalized_second_order_ode_integrator.hh.

Referenced by GaussJacksonGeneralizedDerivSecondOrderODEIntegrator(), swap(), and ∼GaussJackson↩ GeneralizedDerivSecondOrderODEIntegrator().

8.6.5.3 posdotdot

`double* jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator::posdotdot {} [private]`

Generalized position second time derivative.

trick_units(--)

Definition at line 186 of file gauss_jackson_generalized_second_order_ode_integrator.hh.

Referenced by GaussJacksonGeneralizedDerivSecondOrderODEIntegrator(), swap(), and ∼GaussJackson↩ GeneralizedDerivSecondOrderODEIntegrator().

8.6.5.4 vel_integrator

GaussJacksonFirstOrderODEIntegrator jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator↩
::vel_integrator [private]

Integrator for the generalized velocity.

trick_units(–)

Definition at line 171 of file gauss_jackson_generalized_second_order_ode_integrator.hh.

Referenced by swap().

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

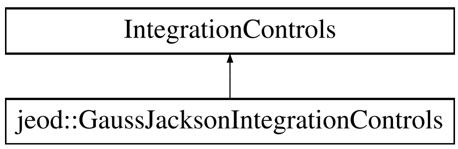
- gauss_jackson_generalized_second_order_ode_integrator.hh
- gauss_jackson_generalized_second_order_ode_integrator.cc

8.7 jeod::GaussJacksonIntegrationControls Class Reference

IntegrationControls specialized for Gauss-Jackson integration.

#include <gauss_jackson_integration_controls.hh>

Inheritance diagram for jeod::GaussJacksonIntegrationControls:



Public Member Functions

- GaussJacksonIntegrationControls ()

  Default constructor.
- GaussJacksonIntegrationControls (const er7_utils::IntegratorConstructor &priming_constructor, const GaussJacksonConfig &config_in)

  Non-default constructor.
- GaussJacksonIntegrationControls (const GaussJacksonIntegrationControls &src)

  Copy constructor.
- ∼GaussJacksonIntegrationControls () override

  Destructor.
- GaussJacksonIntegrationControls & operator= (GaussJacksonIntegrationControls src)

  Copy and swap assignment operator.
- er7_utils::IntegrationControls ∗ create_copy () const override

  Create a duplicate of this object.
- er7_utils::IntegrationControls & get_priming_controls () const

  Getter for the priming_controls data member.
- const GaussJacksonCoeffs & get_coeff () const

Getter for the coeff data member.

- const GaussJacksonConfig & get_config () const

    Getter for the config data member.

- const GaussJacksonStateMachine & get_state_machine () const

    Getter for the state_machine data member.

- void reset_integrator () override

    Reset the integration controls object.

- unsigned int integrate (double start_time, double sim_dt, er7_utils::TimeInterface &time_interface, er7_utils↵ ::IntegratorInterface &integ_interface, er7_utils::BaseIntegrationGroup &integ_group) override

    Make one step in the process that eventually integrates state from the start_time to start_time+sim_dt.

Protected Member Functions

- virtual void swap (GaussJacksonIntegrationControls &other)

    Non-throwing swap function.

Private Member Functions

- void start_cycle (double sim_dt)

    Perform start of integration cycle actions.

- void integrate_edit (er7_utils::TimeInterface &time_interface, er7_utils::BaseIntegrationGroup &integ_group)

    Guide integration while in BootstrapEdit mode.

- void integrate_gj (er7_utils::TimeInterface &time_interface, er7_utils::BaseIntegrationGroup &integ_group)

    Guide integration while in BootstrapStep or Operational mode.

Private Attributes

- er7_utils::IntegrationControls * priming_controls {}

    The integration controls object used to prime the Gauss-Jackson integration process.

- double cycle_starttime {}

    The simulation time of the start of the current integration cycle.

- double cycle_simdt {}

    The simulation time span of the current integration cycle.

- double cycle_dyndt {}

    The dynamic time span corresponding to cycle_simdt.

- double reset_time {}

    The simulation time of the most recent reset.

- GaussJacksonCoeffs coeff

    The Gauss-Jackson corrector and predictor coefficients.

- GaussJacksonConfig config

    The Gauss-Jackson configuration data.

- GaussJacksonStateMachine state_machine

    The Gauss-Jackson state machine.

- GaussJacksonStateMachine::FsmState fsm_state {GaussJacksonStateMachine::Reset}

    The state machine's finite state.

- unsigned int max_correction_iterations {}

    Maximum number of correction iterations allowed.

- unsigned int initial_order {}

    The order of the Gauss Jackson integrator immediately after priming.

- unsigned int order {}

  The current order of the Gauss Jackson integrator.
- unsigned int edit_count {}

  Number of times that the current set of history have been edited.
- bool at_end_of_tour {}

  Flag indicating that the current integration cycle is the last one in an integration tour (i.e., that a major time step will be completed).

Friends

- class InputProcessor
- void init_attrjeod__GaussJacksonIntegrationControls ()

8.7.1 Detailed Description

IntegrationControls specialized for Gauss-Jackson integration.

Definition at line 80 of file gauss_jackson_integration_controls.hh.

8.7.2 Constructor & Destructor Documentation

8.7.2.1 GaussJacksonIntegrationControls() [1/3]

```
jeod::GaussJacksonIntegrationControls::GaussJacksonIntegrationControls ( )
```

Default constructor.

Definition at line 40 of file gauss_jackson_integration_controls.cc.

8.7.2.2 GaussJacksonIntegrationControls() [2/3]

```
jeod::GaussJacksonIntegrationControls::GaussJacksonIntegrationControls (
            const er7_utils::IntegratorConstructor & priming_constructor,
            const GaussJacksonConfig & config_in )
```

Non-default constructor.

This is the constructor invoked by the GaussJacksonIntegratorConstructor.

Parameters

priming_constructor	Integrator constructor for the technique used during priming.
config_in	Gauss-Jackson configuration data.

Definition at line 46 of file gauss_jackson_integration_controls.cc.

References coeff, jeod::GaussJacksonCoeffs::compute_coeffs(), config, jeod::GaussJacksonCoeffs::configure(), jeod::GaussJacksonStateMachine::configure(), jeod::GaussJacksonConfig::final_order, initial_order, priming_↩controls, and state_machine.

8.7.2.3 GaussJacksonIntegrationControls() [3/3]

```
jeod::GaussJacksonIntegrationControls::GaussJacksonIntegrationControls (
            const GaussJacksonIntegrationControls & src )
```

Copy constructor.

Parameters

src	Object to be copied.

Definition at line 62 of file gauss_jackson_integration_controls.cc.

References priming_controls.

8.7.2.4 ∼GaussJacksonIntegrationControls()

```
jeod::GaussJacksonIntegrationControls::∼GaussJacksonIntegrationControls ( )  [override]
```

Destructor.

Definition at line 85 of file gauss_jackson_integration_controls.cc.

References priming_controls.

8.7.3 Member Function Documentation

8.7.3.1 create_copy()

```
er7_utils::IntegrationControls * jeod::GaussJacksonIntegrationControls::create_copy ( ) const
[override]
```

Create a duplicate of this object.

Returns

Replicated GaussJacksonIntegrationControls.

Definition at line 90 of file gauss_jackson_integration_controls.cc.

8.7.3.2 get_coeff()

```
const GaussJacksonCoeffs& jeod::GaussJacksonIntegrationControls::get_coeff ( ) const  [inline]
```

Getter for the coeff data member.

Returns

Reference to the Gauss-Jackson coefficients object.

Definition at line 138 of file gauss_jackson_integration_controls.hh.

8.7.3.3 get_config()

```
const GaussJacksonConfig& jeod::GaussJacksonIntegrationControls::get_config ( ) const  [inline]
```

Getter for the config data member.

Returns

Reference to the Gauss-Jackson configuration object.

Definition at line 147 of file gauss_jackson_integration_controls.hh.

8.7.3.4 get_priming_controls()

```
er7_utils::IntegrationControls& jeod::GaussJacksonIntegrationControls::get_priming_controls (
) const  [inline]
```

Getter for the priming_controls data member.

Returns

Reference to the integration controls used during priming.

Definition at line 129 of file gauss_jackson_integration_controls.hh.

Referenced by jeod::GaussJacksonIntegratorConstructor::create_first_order_ode_integrator(), jeod::GaussJacksonIntegratorConstructor::create_generalized_deriv_second_order_ode_integrator(), and jeod::GaussJacksonIntegratorConstructor::create_second_order_ode_integrator().

8.7.3.5 get_state_machine()

```
const GaussJacksonStateMachine& jeod::GaussJacksonIntegrationControls::get_state_machine ( )
const  [inline]
```

Getter for the state_machine data member.

Returns

Reference to the Gauss-Jackson state_machine object.

Definition at line 156 of file gauss_jackson_integration_controls.hh.

8.7.3.6 integrate()

```
unsigned int jeod::GaussJacksonIntegrationControls::integrate (
            double start_time,
            double sim_dt,
            er7_utils::TimeInterface & time_interface,
            er7_utils::IntegratorInterface & integ_interface,
            er7_utils::BaseIntegrationGroup & integ_group )  [override]
```

Make one step in the process that eventually integrates state from the start_time to start_time+sim_dt.

Returns

Step number; zero when finished.

Parameters

in	*start_time*	The simulation engine time at the start of the integration tour.
in	*sim_dt*	The difference between the simulation time at the end and start of the integration tour.
in,out	*time_interface*	Object external to the ER7 utilities suite that represents time.
in,out	*integ_interface*	Interface with the simulation engine for this integration controls.
in,out	*integ_group*	The integration group that contains this integration controls.

Definition at line 126 of file gauss_jackson_integration_controls.cc.

References at_end_of_tour, jeod::GaussJacksonStateMachine::BootstrapEdit, jeod::GaussJacksonState↩Machine::BootstrapStep, cycle_dyndt, cycle_simdt, cycle_starttime, fsm_state, jeod::GaussJacksonState↩Machine::get_cycle_scale(), integrate_edit(), integrate_gj(), jeod::GaussJacksonStateMachine::Operational, jeod↩::GaussJacksonStateMachine::Priming, priming_controls, jeod::GaussJacksonStateMachine::Reset, reset_↩integrator(), reset_time, start_cycle(), and state_machine.

8.7.3.7 integrate_edit()

```
void jeod::GaussJacksonIntegrationControls::integrate_edit (
            er7_utils::TimeInterface & time_interface,
            er7_utils::BaseIntegrationGroup & integ_group )  [private]
```

Guide integration while in BootstrapEdit mode.

Definition at line 222 of file gauss_jackson_integration_controls.cc.

References cycle_dyndt, cycle_starttime, edit_count, jeod::GaussJacksonStateMachine::get_history_length(), max_correction_iterations, order, jeod::GaussJacksonStateMachine::set_bootstrap_edit_redo_needed(), and state_machine.

Referenced by integrate().

8.7.3.8 integrate_gj()

```
void jeod::GaussJacksonIntegrationControls::integrate_gj (
            er7_utils::TimeInterface & time_interface,
            er7_utils::BaseIntegrationGroup & integ_group )  [private]
```

Guide integration while in BootstrapStep or Operational mode.

Definition at line 255 of file gauss_jackson_integration_controls.cc.

References cycle_dyndt, cycle_simdt, cycle_starttime, edit_count, and max_correction_iterations.

Referenced by integrate().

8.7.3.9 operator=()

```
GaussJacksonIntegrationControls& jeod::GaussJacksonIntegrationControls::operator= (
            GaussJacksonIntegrationControls src )  [inline]
```

Copy and swap assignment operator.

Parameters

src	Object to be copied.

Definition at line 113 of file gauss_jackson_integration_controls.hh.

8.7.3.10 reset_integrator()

```
void jeod::GaussJacksonIntegrationControls::reset_integrator ( )  [override]
```

Reset the integration controls object.

Definition at line 116 of file gauss_jackson_integration_controls.cc.

References at_end_of_tour, edit_count, fsm_state, initial_order, order, jeod::GaussJacksonStateMachine::Reset, jeod::GaussJacksonStateMachine::reset(), and state_machine.

Referenced by integrate().

8.7.3.11 start_cycle()

```
void jeod::GaussJacksonIntegrationControls::start_cycle (
            double sim_dt )  [private]
```

Perform start of integration cycle actions.

Definition at line 288 of file gauss_jackson_integration_controls.cc.

References at_end_of_tour, jeod::GaussJacksonStateMachine::BootstrapEdit, coeff, jeod::GaussJacksonCoeffs↩ ::compute_coeffs(), cycle_dyndt, cycle_simdt, cycle_starttime, edit_count, fsm_state, jeod::GaussJackson↩ StateMachine::get_at_downsample(), jeod::GaussJacksonStateMachine::get_at_end_of_tour(), jeod::Gauss↩ JacksonStateMachine::get_at_order_change(), jeod::GaussJacksonStateMachine::get_at_reinitialize(), jeod::↩ GaussJacksonStateMachine::get_current_order(), jeod::GaussJacksonStateMachine::get_cycle_scale(), jeod::↩ GaussJacksonStateMachine::get_cycle_start_time(), jeod::GaussJacksonStateMachine::get_fsm_state(), order, jeod::GaussJacksonStateMachine::perform_step(), reset_time, and state_machine.

Referenced by integrate().

8.7.3.12 swap()

```
void jeod::GaussJacksonIntegrationControls::swap (
            GaussJacksonIntegrationControls & other )  [protected], [virtual]
```

Non-throwing swap function.

Swap contents of 'this' with that of the other.

Parameters

in	*other*	Item with which contents are to be swapped.

Definition at line 96 of file gauss_jackson_integration_controls.cc.

References at_end_of_tour, coeff, config, cycle_dyndt, cycle_simdt, cycle_starttime, edit_count, fsm_state, initial↩ _order, max_correction_iterations, order, priming_controls, reset_time, and state_machine.

8.7.4 Friends And Related Function Documentation

8.7.4.1 init_attrjeod__GaussJacksonIntegrationControls

```
void init_attrjeod__GaussJacksonIntegrationControls ( ) [friend]
```

8.7.4.2 InputProcessor

```
friend class InputProcessor [friend]
```

Definition at line 82 of file gauss_jackson_integration_controls.hh.

8.7.5 Field Documentation

8.7.5.1 at_end_of_tour

```
bool jeod::GaussJacksonIntegrationControls::at_end_of_tour {} [private]
```

Flag indicating that the current integration cycle is the last one in an integration tour (i.e., that a major time step will be completed).

trick_units(--)

Definition at line 271 of file gauss_jackson_integration_controls.hh.

Referenced by integrate(), reset_integrator(), start_cycle(), and swap().

8.7.5.2 coeff

```
GaussJacksonCoeffs jeod::GaussJacksonIntegrationControls::coeff [private]
```

The Gauss-Jackson corrector and predictor coefficients.

trick_units(--)

Definition at line 230 of file gauss_jackson_integration_controls.hh.

Referenced by GaussJacksonIntegrationControls(), start_cycle(), and swap().

8.7.5.3 config

`GaussJacksonConfig jeod::GaussJacksonIntegrationControls::config [private]`

The Gauss-Jackson configuration data.

trick_units(–)

Definition at line 235 of file gauss_jackson_integration_controls.hh.

Referenced by GaussJacksonIntegrationControls(), and swap().

8.7.5.4 cycle_dyndt

`double jeod::GaussJacksonIntegrationControls::cycle_dyndt {} [private]`

The dynamic time span corresponding to cycle_simdt.

trick_units(s)

Definition at line 220 of file gauss_jackson_integration_controls.hh.

Referenced by integrate(), integrate_edit(), integrate_gj(), start_cycle(), and swap().

8.7.5.5 cycle_simdt

`double jeod::GaussJacksonIntegrationControls::cycle_simdt {} [private]`

The simulation time span of the current integration cycle.

trick_units(–)

Definition at line 215 of file gauss_jackson_integration_controls.hh.

Referenced by integrate(), integrate_gj(), start_cycle(), and swap().

8.7.5.6 cycle_starttime

`double jeod::GaussJacksonIntegrationControls::cycle_starttime {} [private]`

The simulation time of the start of the current integration cycle.

An integration cycle starts when cycle_stage is zero and ends when it reaches zero once again.trick_units(–)

Definition at line 210 of file gauss_jackson_integration_controls.hh.

Referenced by integrate(), integrate_edit(), integrate_gj(), start_cycle(), and swap().

8.7.5.7 edit_count

```
unsigned int jeod::GaussJacksonIntegrationControls::edit_count {}  [private]
```

Number of times that the current set of history have been edited.

trick_units(--)

Definition at line 265 of file gauss_jackson_integration_controls.hh.

Referenced by integrate_edit(), integrate_gj(), reset_integrator(), start_cycle(), and swap().

8.7.5.8 fsm_state

```
GaussJacksonStateMachine::FsmState jeod::GaussJacksonIntegrationControls::fsm_state {GaussJacksonStateMachine:
[private]
```

The state machine's finite state.

trick_units(--)

Definition at line 245 of file gauss_jackson_integration_controls.hh.

Referenced by integrate(), reset_integrator(), start_cycle(), and swap().

8.7.5.9 initial_order

```
unsigned int jeod::GaussJacksonIntegrationControls::initial_order {}  [private]
```

The order of the Gauss Jackson integrator immediately after priming.

trick_units(--)

Definition at line 255 of file gauss_jackson_integration_controls.hh.

Referenced by GaussJacksonIntegrationControls(), reset_integrator(), and swap().

8.7.5.10 max_correction_iterations

```
unsigned int jeod::GaussJacksonIntegrationControls::max_correction_iterations {}  [private]
```

Maximum number of correction iterations allowed.

trick_units(--)

Definition at line 250 of file gauss_jackson_integration_controls.hh.

Referenced by integrate_edit(), integrate_gj(), and swap().

8.7.5.11 order

```
unsigned int jeod::GaussJacksonIntegrationControls::order {} [private]
```

The current order of the Gauss Jackson integrator.

trick_units(–)

Definition at line 260 of file gauss_jackson_integration_controls.hh.

Referenced by integrate_edit(), reset_integrator(), start_cycle(), and swap().

8.7.5.12 priming_controls

```
er7_utils::IntegrationControls* jeod::GaussJacksonIntegrationControls::priming_controls {}
[private]
```

The integration controls object used to prime the Gauss-Jackson integration process.

trick_units(–)

Definition at line 203 of file gauss_jackson_integration_controls.hh.

Referenced by GaussJacksonIntegrationControls(), integrate(), swap(), and ∼GaussJacksonIntegrationControls().

8.7.5.13 reset_time

```
double jeod::GaussJacksonIntegrationControls::reset_time {} [private]
```

The simulation time of the most recent reset.

trick_units(–)

Definition at line 225 of file gauss_jackson_integration_controls.hh.

Referenced by integrate(), start_cycle(), and swap().

8.7.5.14 state_machine

```
GaussJacksonStateMachine jeod::GaussJacksonIntegrationControls::state_machine [private]
```

The Gauss-Jackson state machine.

trick_units(–)

Definition at line 240 of file gauss_jackson_integration_controls.hh.

Referenced by GaussJacksonIntegrationControls(), integrate(), integrate_edit(), reset_integrator(), start_cycle(), and swap().

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

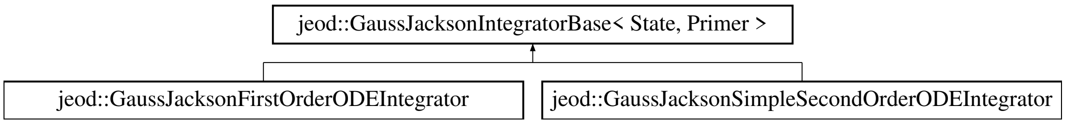
- gauss_jackson_integration_controls.hh
- gauss_jackson_integration_controls.cc

8.8 jeod::GaussJacksonIntegratorBase< State, Primer > Class Template Reference

Base template class for integrating state via the Gauss-Jackson technique.

```
#include <gauss_jackson_integrator_base.hh>
```

Inheritance diagram for jeod::GaussJacksonIntegratorBase< State, Primer >:



Public Member Functions

- GaussJacksonIntegratorBase ()=default

    Default constructor.
- GaussJacksonIntegratorBase (const er7_utils::IntegratorConstructor &priming_constructor, const GaussJacksonIntegrationCon &controls, unsigned int size_in, er7_utils::IntegrationControls &priming_controls)

    Non-default constructor.
- GaussJacksonIntegratorBase (const GaussJacksonIntegratorBase &src)

    Copy constructor.
- ∼GaussJacksonIntegratorBase ()

    Destructor.
- GaussJacksonIntegratorBase & operator= (const GaussJacksonIntegratorBase &)=delete

Data Fields

- const GaussJacksonCoeffs ∗ coeff {}

    The summed Adams and Gauss-Jackson coefficients, in ordinate form.
- const GaussJacksonStateMachine ∗ state_machine {}

    The Gauss-Jackson state machine.
- Primer ∗ primer {}

    The integrator used to prime the Gauss-Jackson integration process.
- State init_state

    The state at the time of the last reset.
- State delinv

    Inverse backward differences.
- State corrector_sum

    Speed hack for the corrector.
- er7_utils::DoubleTwoDArray acc_hist

    Acceleration history.
- er7_utils::DoubleTwoDArray pos_hist

    Position history (or velocity history in case of a first order ODE).
- double relative_tolerance {}

    Number that indicates the allowable relative difference for two states to be considered converged.
- double absolute_tolerance {}

    Number that indicates the allowable absolute difference for two states to be considered converged.
- double velocity_corrector {}

Correction coefficient for the first integral (velocity).

- double position_corrector {}

  Correction coefficient for the second integral (position).
- GaussJacksonStateMachine::FsmState fsm_state {GaussJacksonStateMachine::Reset}

  Finite state machine state.
- unsigned int max_history_size {}

  Maximum history size.
- unsigned int initial_order {}

  Initial order.
- unsigned int order {}

  Current order.
- unsigned int size {}

  State size.
- unsigned int history_length {}

  Current history length.

Protected Member Functions

- void base_reset ()

  Reset the integrator.
- er7_utils::IntegratorResult base_integrate (double dyn_dt, unsigned int target_stage, const double ∗deriv, State state)

  Propagate state to the specified target_stage.
- void swap (GaussJacksonIntegratorBase &other)

  Non-throwing swap.

Private Member Functions

- void start_cycle (double dt, const double ∗acc, const State &state)

  Start an integration cycle.
- bool edit_point (double dt, const double ∗acc, State &state)

  Edit the specified point using the mid-corrector that pertains to the point being edited, which is that at history_length.
- bool integrate_gj (double dt, unsigned int target_stage, int advance_index, int target_index, const double ∗acc, const double ∗const ∗ahist, State &state)

  Integrate using the Gauss-Jackson predictor and corrector.
- void downsample_hist ()

  Downsample the acceleration and position histories.
- void rotate_acc_hist ()

  Rotate the acceleration history.
- er7_utils::IntegratorResult integrate_primer (double dyn_dt, unsigned int target_stage, const double ∗deriv, State &state)

  Integrate state using the primer.
- void save_epoch_data (const double ∗acc, const State &state)

  Save epoch data.
- void save_comparison_data (const State &state, double ∗pos_hist_elem)

  Save comparison data.
- void initialize_edit_integration_constants (double dt)

  Initialize the integration constants (i.e., delinv).
- void initialize_predictor_integration_constants (double dt)

  Initialize the integration constants (i.e., delinv).

- void advance_edit_integration_constants (unsigned int index)

  Advance the integration constants by one cycle.
- void advance_predictor_integration_constants (unsigned int index)

  Advance the integration constants by one cycle.
- void mid_correct (unsigned int coeff_idx, double dt, State &state)

  Apply a mid-corrector.
- void predict (double dt, const double ∗const ∗ahist, State &state)

  Apply the predictor.
- void correct (double dt, const double ∗acc, State &state)

  Apply the corrector.
- bool test_for_convergence (const State &state, double ∗hist_data)

  Test for convergence.
- void swap_state (State &item, State &other_item)

  Swap state data with another of the same.
- void replicate_state (const State &source, State &target)

  Replicate state data.
- void allocate_state_contents (State &item)

  Allocate memory for a state item.
- void deallocate_state_contents (State &item)

  Deallocate state item memory.
- template<>
  er7_utils::FirstOrderODEIntegrator ∗ create_primer (const er7_utils::IntegratorConstructor &priming_↩ constructor, unsigned int size, er7_utils::IntegrationControls &priming_controls)

  Create the priming integrator.
- template<>
  er7_utils::FirstOrderODEIntegrator ∗ replicate_primer (const er7_utils::FirstOrderODEIntegrator ∗src)

  Replicate the priming integrator.
- template<>
  er7_utils::IntegratorResult integrate_primer (double dyn_dt, unsigned int target_stage, const double ∗deriv, GaussJacksonOneState &state)

  Integrate with the primer.
- template<>
  void save_epoch_data (const double ∗acc, const GaussJacksonOneState &state)

  Save epoch data.
- template<>
  void save_comparison_data (const GaussJacksonOneState &state, double ∗pos_hist_elem)

  Save comparison data.
- template<>
  void initialize_edit_integration_constants (double dt)

  Initialize the integration constants (i.e., delinv).
- template<>
  void advance_edit_integration_constants (unsigned int index)

  Advance the integration constants by one cycle.
- template<>
  void initialize_predictor_integration_constants (double dt)

  Initialize the integration constants (i.e., delinv).
- template<>
  void advance_predictor_integration_constants (unsigned int index)

  Advance the integration constants by one cycle.
- template<>
  void mid_correct (unsigned int coeff_idx, double dt, GaussJacksonOneState &state)

  Apply a mid-corrector.

- template<>
  void predict (double dt, const double ∗const ∗ahist, GaussJacksonOneState &state)

  Apply the predictor.
- template<>
  void correct (double dt, const double ∗acc, GaussJacksonOneState &state)

  Apply the corrector.
- template<>
  bool test_for_convergence (const GaussJacksonOneState &state, double ∗hist_data)

  Test for convergence.
- template<>
  void swap_state (GaussJacksonOneState &item, GaussJacksonOneState &other_item)

  Swap state data with another of the same.
- template<>
  void replicate_state (const GaussJacksonOneState &source, GaussJacksonOneState &target)

  Replicate state data.
- template<>
  void allocate_state_contents (GaussJacksonOneState &item)

  Allocate memory for a state item.
- template<>
  void deallocate_state_contents (GaussJacksonOneState &item)

  Deallocate state item memory.
- template<>
  er7_utils::SecondOrderODEIntegrator ∗ create_primer (const er7_utils::IntegratorConstructor &priming_↩
  constructor, unsigned int size, er7_utils::IntegrationControls &priming_controls)
- template<>
  er7_utils::SecondOrderODEIntegrator ∗ replicate_primer (const er7_utils::SecondOrderODEIntegrator ∗src)
- template<>
  er7_utils::IntegratorResult integrate_primer (double dyn_dt, unsigned int target_stage, const double ∗deriv,
  GaussJacksonTwoState &state)

  Integrate with the primer.
- template<>
  void save_epoch_data (const double ∗acc, const GaussJacksonTwoState &state)

  Save epoch data.
- template<>
  void save_comparison_data (const GaussJacksonTwoState &state, double ∗pos_hist_elem)

  Save comparison data.
- template<>
  void initialize_edit_integration_constants (double dt)

  Initialize the integration constants (i.e., delinv).
- template<>
  void advance_edit_integration_constants (unsigned int index)

  Advance the integration constants by one cycle.
- template<>
  void initialize_predictor_integration_constants (double dt)

  Initialize the integration constants (i.e., delinv).
- template<>
  void advance_predictor_integration_constants (unsigned int index)

  Advance the integration constants by one cycle.
- template<>
  void mid_correct (unsigned int coeff_idx, double dt, GaussJacksonTwoState &state)

  Apply a mid-corrector.
- template<>
  void predict (double dt, const double ∗const ∗ahist, GaussJacksonTwoState &state)

Apply the predictor.

- template<>
  void correct (double dt, const double ∗acc, GaussJacksonTwoState &state)

  Apply the corrector.
- template<>
  bool test_for_convergence (const GaussJacksonTwoState &state, double ∗hist_data)

  Test for convergence.
- template<>
  void swap_state (GaussJacksonTwoState &item, GaussJacksonTwoState &other_item)

  Swap state data with another of the same.
- template<>
  void replicate_state (const GaussJacksonTwoState &source, GaussJacksonTwoState &target)

  Replicate state data.
- template<>
  void allocate_state_contents (GaussJacksonTwoState &item)

  Allocate memory for a state item.
- template<>
  void deallocate_state_contents (GaussJacksonTwoState &item)

  Deallocate state item memory.

Static Private Member Functions

- static Primer ∗ create_primer (const er7_utils::IntegratorConstructor &priming_constructor, unsigned int size_in, er7_utils::IntegrationControls &priming_controls)

  Create the integrator to be used during priming.
- static Primer ∗ replicate_primer (const Primer ∗src)

  Create a replica of the provided primer.

8.8.1 Detailed Description

template<typename State, typename Primer>
class jeod::GaussJacksonIntegratorBase< State, Primer >

Base template class for integrating state via the Gauss-Jackson technique.

Template Parameters

State	Structure that contains the state.
Primer	Class for priming the Gauss-Jackson integrator.

Definition at line 87 of file gauss_jackson_integrator_base.hh.

8.8.2 Constructor & Destructor Documentation

8.8.2.1 GaussJacksonIntegratorBase() [1/3]

```
template<typename State , typename Primer >
jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase ( )  [default]
```

Default constructor.

8.8.2.2 GaussJacksonIntegratorBase() [2/3]

```
template<typename State , typename Primer >
jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase (
            const er7_utils::IntegratorConstructor & priming_constructor,
            const GaussJacksonIntegrationControls & controls,
            unsigned int size_in,
            er7_utils::IntegrationControls & priming_controls )  [inline]
```

Non-default constructor.

Parameters

priming_constructor	Integrator constructor for the technique used during priming.
controls	The Gauss-Jackson integration controls that drives this state integrator.
size_in	State size.
priming_controls	Integration controls used during priming.

Definition at line 201 of file gauss_jackson_integrator_base.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::acc_hist, er7_utils::TwoDArray< T >::allocate(), jeod::GaussJacksonIntegratorBase< State, Primer >::allocate_state_contents(), jeod::GaussJacksonIntegratorBase< State, Primer >::corrector_sum, jeod::GaussJacksonIntegratorBase< State, Primer >::create_primer(), jeod::GaussJacksonIntegratorBase< State, Primer >::delinv, jeod::GaussJacksonIntegratorBase< State, Primer >::init_state, jeod::GaussJacksonIntegratorBase< State, Primer >::max_history_size, jeod::GaussJacksonIntegratorBase< State, Primer >::pos_hist, jeod::GaussJacksonIntegratorBase< State, Primer >::primer, and jeod::GaussJacksonIntegratorBase< State, Primer >::size.

8.8.2.3 GaussJacksonIntegratorBase() [3/3]

```
template<typename State , typename Primer >
jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase (
            const GaussJacksonIntegratorBase< State, Primer > & src )  [inline]
```

Copy constructor.

Parameters

src	Item to be copied.

Definition at line 230 of file gauss_jackson_integrator_base.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::corrector_sum, jeod::GaussJacksonIntegrator↩ Base< State, Primer >::delinv, jeod::GaussJacksonIntegratorBase< State, Primer >::init_state, jeod::Gauss↩ JacksonIntegratorBase< State, Primer >::primer, jeod::GaussJacksonIntegratorBase< State, Primer >↩ ::replicate_primer(), and jeod::GaussJacksonIntegratorBase< State, Primer >::replicate_state().

8.8.2.4 ∼GaussJacksonIntegratorBase()

```
template<typename State , typename Primer >
jeod::GaussJacksonIntegratorBase< State, Primer >::∼GaussJacksonIntegratorBase ( )  [inline]
```

Destructor.

Definition at line 256 of file gauss_jackson_integrator_base.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::corrector_sum, jeod::GaussJacksonIntegrator↩ Base< State, Primer >::deallocate_state_contents(), jeod::GaussJacksonIntegratorBase< State, Primer >::delinv, jeod::GaussJacksonIntegratorBase< State, Primer >::init_state, and jeod::GaussJacksonIntegratorBase< State, Primer >::primer.

8.8.3 Member Function Documentation

8.8.3.1 advance_edit_integration_constants() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::advance_edit_integration_constants (
            unsigned int index )  [inline], [private]
```

Advance the integration constants by one cycle.

Definition at line 170 of file gauss_jackson_integrator_base_first.hh.

8.8.3.2 advance_edit_integration_constants() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::advance_edit_integration_constants (
            unsigned int index )  [inline], [private]
```

Advance the integration constants by one cycle.

Definition at line 171 of file gauss_jackson_integrator_base_second.hh.

8.8.3.3 advance_edit_integration_constants() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::advance_edit_integration_constants (
            unsigned int index )  [private]
```

Advance the integration constants by one cycle.

Parameters

index	Coefficient index.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::edit_point().

8.8.3.4 advance_predictor_integration_constants() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::advance_predictor_integration_constants (
            unsigned int index )  [inline], [private]
```

Advance the integration constants by one cycle.

Definition at line 201 of file gauss_jackson_integrator_base_first.hh.

8.8.3.5 advance_predictor_integration_constants() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::advance_predictor_integration_constants (
            unsigned int index )  [inline], [private]
```

Advance the integration constants by one cycle.

Definition at line 205 of file gauss_jackson_integrator_base_second.hh.

8.8.3.6 advance_predictor_integration_constants() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::advance_predictor_integration_constants
(
            unsigned int index )  [private]
```

Advance the integration constants by one cycle.

Parameters

index	Coefficient index.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_gj().

8.8.3.7 allocate_state_contents() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::allocate_state_contents (
            GaussJacksonOneState & item )  [inline], [private]
```

Allocate memory for a state item.

Definition at line 314 of file gauss_jackson_integrator_base_first.hh.

References jeod::GaussJacksonOneState::first.

8.8.3.8 allocate_state_contents() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::allocate_state_contents (
            GaussJacksonTwoState & item )  [inline], [private]
```

Allocate memory for a state item.

Definition at line 329 of file gauss_jackson_integrator_base_second.hh.

References jeod::GaussJacksonTwoState::first, and jeod::GaussJacksonTwoState::second.

8.8.3.9 allocate_state_contents() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::allocate_state_contents (
            State & item )  [private]
```

Allocate memory for a state item.

Parameters

item	State item to be allocated.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase().

8.8.3.10 base_integrate()

```
template<typename State , typename Primer >
er7_utils::IntegratorResult jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate
```

```
(
            double dyn_dt,
            unsigned int target_stage,
            const double * deriv,
            State state )  [inline], [protected]
```

Propagate state to the specified target_stage.

Parameters

in	*dyn_dt*	Dynamic time step, in dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in	*deriv*	Acceleration vector.
in,out	*state*	State vector(s).

Returns

The status (time advance, pass/fail status) of the integration.

Definition at line 288 of file gauss_jackson_integrator_base.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::acc_hist, jeod::GaussJacksonStateMachine↩ ::BootstrapEdit, jeod::GaussJacksonStateMachine::BootstrapStep, jeod::GaussJacksonIntegratorBase< State, Primer >::edit_point(), jeod::GaussJacksonIntegratorBase< State, Primer >::fsm_state, jeod::GaussJackson↩ IntegratorBase< State, Primer >::history_length, jeod::GaussJacksonIntegratorBase< State, Primer >↩ ::integrate_gj(), jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_primer(), jeod::GaussJackson↩ StateMachine::Operational, jeod::GaussJacksonIntegratorBase< State, Primer >::order, jeod::GaussJackson↩ IntegratorBase< State, Primer >::pos_hist, jeod::GaussJacksonStateMachine::Priming, jeod::GaussJackson↩ StateMachine::Reset, jeod::GaussJacksonIntegratorBase< State, Primer >::rotate_acc_hist(), jeod::Gauss↩ JacksonIntegratorBase< State, Primer >::save_comparison_data(), jeod::GaussJacksonIntegratorBase< State, Primer >::size, and jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle().

Referenced by jeod::GaussJacksonFirstOrderODEIntegrator::integrate().

8.8.3.11 base_reset()

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::base_reset ( )  [inline], [protected]
```

Reset the integrator.

Definition at line 271 of file gauss_jackson_integrator_base.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::fsm_state, jeod::GaussJacksonIntegratorBase< State, Primer >::history_length, jeod::GaussJacksonIntegratorBase< State, Primer >::initial_order, jeod::Gauss↩ JacksonIntegratorBase< State, Primer >::order, and jeod::GaussJacksonStateMachine::Reset.

Referenced by jeod::GaussJacksonFirstOrderODEIntegrator::reset_integrator().

8.8.3.12 correct() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::correct (
            double dt,
            const double * acc,
            GaussJacksonOneState & state ) [inline], [private]
```

Apply the corrector.

Definition at line 252 of file gauss_jackson_integrator_base_first.hh.

References jeod::GaussJacksonOneState::first.

8.8.3.13 correct() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::correct (
            double dt,
            const double * acc,
            GaussJacksonTwoState & state ) [inline], [private]
```

Apply the corrector.

Definition at line 258 of file gauss_jackson_integrator_base_second.hh.

References jeod::GaussJacksonTwoState::first, and jeod::GaussJacksonTwoState::second.

8.8.3.14 correct() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::correct (
            double dt,
            const double * acc,
            State & state ) [private]
```

Apply the corrector.

Parameters

dt	Dynamic time step.
acc	Acceleration data.
state	Corrected state.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_gj().

8.8.3.15 create_primer() [1/3]

```
template<>
er7_utils::SecondOrderODEIntegrator * jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState,
er7_utils::SecondOrderODEIntegrator >::create_primer (
            const er7_utils::IntegratorConstructor & priming_constructor,
            unsigned int size,
            er7_utils::IntegrationControls & priming_controls )  [inline], [private]
```

Definition at line 91 of file gauss_jackson_integrator_base_second.hh.

8.8.3.16 create_primer() [2/3]

```
template<>
er7_utils::FirstOrderODEIntegrator * jeod::GaussJacksonIntegratorBase< GaussJacksonOneState,
er7_utils::FirstOrderODEIntegrator >::create_primer (
            const er7_utils::IntegratorConstructor & priming_constructor,
            unsigned int size,
            er7_utils::IntegrationControls & priming_controls )  [inline], [private]
```

Create the priming integrator.

Definition at line 92 of file gauss_jackson_integrator_base_first.hh.

8.8.3.17 create_primer() [3/3]

```
template<typename State , typename Primer >
static Primer* jeod::GaussJacksonIntegratorBase< State, Primer >::create_primer (
            const er7_utils::IntegratorConstructor & priming_constructor,
            unsigned int size_in,
            er7_utils::IntegrationControls & priming_controls )  [static], [private]
```

Create the integrator to be used during priming.

Parameters

priming_constructor	Integrator constructor for the technique used during priming.
size_in	State size.
priming_controls	Integration controls used during priming.

Returns

Constructed primer.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase().

8.8.3.18 deallocate_state_contents() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::deallocate_state_contents (
            GaussJacksonOneState & item )  [inline], [private]
```

Deallocate state item memory.

Definition at line 325 of file gauss_jackson_integrator_base_first.hh.

References jeod::GaussJacksonOneState::first.

8.8.3.19 deallocate_state_contents() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::deallocate_state_contents (
            GaussJacksonTwoState & item )  [inline], [private]
```

Deallocate state item memory.

Definition at line 341 of file gauss_jackson_integrator_base_second.hh.

References jeod::GaussJacksonTwoState::first, and jeod::GaussJacksonTwoState::second.

8.8.3.20 deallocate_state_contents() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::deallocate_state_contents (
            State & item )  [private]
```

Deallocate state item memory.

Parameters

item	State item to be deallocated.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::~GaussJacksonIntegratorBase().

8.8.3.21 downsample_hist()

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::downsample_hist ( )  [inline], [private]
```

Downsample the acceleration and position histories.

Definition at line 559 of file gauss_jackson_integrator_base.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::acc_hist, er7_utils::TwoDArray< T >↩
::downsample(), jeod::GaussJacksonIntegratorBase< State, Primer >::history_length, and jeod::GaussJackson↩
IntegratorBase< State, Primer >::pos_hist.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle().

8.8.3.22 edit_point()

```
template<typename State , typename Primer >
bool jeod::GaussJacksonIntegratorBase< State, Primer >::edit_point (
            double dt,
            const double * acc,
            State & state ) [inline], [private]
```

Edit the specified point using the mid-corrector that pertains to the point being edited, which is that at history_length.

Parameters

in	*dt*	Dynamic time step, in dynamic time seconds.
in	*acc*	Acceleration vector.
out	*state*	State vector(s).

Definition at line 511 of file gauss_jackson_integrator_base.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::advance_edit_integration_constants(), jeod↩
::GaussJacksonIntegratorBase< State, Primer >::history_length, jeod::GaussJacksonIntegratorBase< State, Primer >::mid_correct(), jeod::GaussJacksonIntegratorBase< State, Primer >::order, jeod::GaussJackson↩
IntegratorBase< State, Primer >::pos_hist, and jeod::GaussJacksonIntegratorBase< State, Primer >::test_for_↩
convergence().

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate().

8.8.3.23 initialize_edit_integration_constants() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::initialize_edit_integration_constants (
            double dt ) [inline], [private]
```

Initialize the integration constants (i.e., delinv).

Definition at line 153 of file gauss_jackson_integrator_base_second.hh.

8.8.3.24 initialize_edit_integration_constants() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::initialize_edit_integration_constants (
            double dt ) [inline], [private]
```

Initialize the integration constants (i.e., delinv).

Definition at line 155 of file gauss_jackson_integrator_base_first.hh.

8.8.3.25 initialize_edit_integration_constants() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::initialize_edit_integration_constants
(
            double dt ) [private]
```

Initialize the integration constants (i.e., delinv).

Parameters

dt	Dynamic time step.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle().

8.8.3.26 initialize_predictor_integration_constants() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::initialize_predictor_integration_constants (
            double dt ) [inline], [private]
```

Initialize the integration constants (i.e., delinv).

Definition at line 185 of file gauss_jackson_integrator_base_second.hh.

8.8.3.27 initialize_predictor_integration_constants() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::initialize_predictor_integration_constants (
            double dt ) [inline], [private]
```

Initialize the integration constants (i.e., delinv).

Definition at line 186 of file gauss_jackson_integrator_base_first.hh.

8.8.3.28 initialize_predictor_integration_constants() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::initialize_predictor_integration_↩
constants (
            double dt ) [private]
```

Initialize the integration constants (i.e., delinv).

Parameters

dt	Dynamic time step.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle().

8.8.3.29 integrate_gj()

```
template<typename State , typename Primer >
bool jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_gj (
            double dt,
            unsigned int target_stage,
            int advance_index,
            int target_index,
            const double * acc,
            const double *const * ahist,
            State & state ) [inline], [private]
```

Integrate using the Gauss-Jackson predictor and corrector.

Parameters

in	*dt*	Dynamic time step, in dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in	*advance_index*	Acceleration history index.
in	*target_index*	Position history index.
in	*acc*	Acceleration vector.
in	*ahist*	Acceleration vector history.
out	*state*	State vector(s).

Returns

True if step was successful, false otherwise.

Definition at line 532 of file gauss_jackson_integrator_base.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::advance_predictor_integration_constants(), jeod::GaussJacksonCoefficientsPair::apply(), jeod::GaussJacksonIntegratorBase< State, Primer >::coeff, jeod↩ ::GaussJacksonIntegratorBase< State, Primer >::correct(), jeod::GaussJacksonCoeffs::corrector, jeod::Gauss↩ JacksonIntegratorBase< State, Primer >::corrector_sum, jeod::GaussJacksonIntegratorBase< State, Primer

>::order, jeod::GaussJacksonIntegratorBase< State, Primer >::pos_hist, jeod::GaussJacksonIntegratorBase< State, Primer >::predict(), jeod::GaussJacksonIntegratorBase< State, Primer >::save_comparison_data(), jeod↩ ::GaussJacksonIntegratorBase< State, Primer >::size, and jeod::GaussJacksonIntegratorBase< State, Primer >::test_for_convergence().

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate().

8.8.3.30 integrate_primer() [1/3]

```
template<>
er7_utils::IntegratorResult jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_↩
utils::SecondOrderODEIntegrator >::integrate_primer (
            double dyn_dt,
            unsigned int target_stage,
            const double * deriv,
            GaussJacksonTwoState & state )  [inline], [private]
```

Integrate with the primer.

Definition at line 121 of file gauss_jackson_integrator_base_second.hh.

References jeod::GaussJacksonTwoState::first, and jeod::GaussJacksonTwoState::second.

8.8.3.31 integrate_primer() [2/3]

```
template<>
er7_utils::IntegratorResult jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_↩
utils::FirstOrderODEIntegrator >::integrate_primer (
            double dyn_dt,
            unsigned int target_stage,
            const double * deriv,
            GaussJacksonOneState & state )  [inline], [private]
```

Integrate with the primer.

Definition at line 123 of file gauss_jackson_integrator_base_first.hh.

References jeod::GaussJacksonOneState::first.

8.8.3.32 integrate_primer() [3/3]

```
template<typename State , typename Primer >
er7_utils::IntegratorResult jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_↩
primer (
            double dyn_dt,
            unsigned int target_stage,
            const double * deriv,
            State & state )  [private]
```

Integrate state using the primer.

Parameters

in	*dyn_dt*	Dynamic time step, in dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in	*deriv*	Acceleration vector.
in,out	*state*	State vector(s).

Returns

The status (time advance, pass/fail status) of the integration.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate().

8.8.3.33 mid_correct() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::mid_correct (
            unsigned int coeff_idx,
            double dt,
            GaussJacksonOneState & state )  [inline], [private]
```

Apply a mid-corrector.

Definition at line 216 of file gauss_jackson_integrator_base_first.hh.

References jeod::GaussJacksonOneState::first.

8.8.3.34 mid_correct() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::mid_correct (
            unsigned int coeff_idx,
            double dt,
            GaussJacksonTwoState & state )  [inline], [private]
```

Apply a mid-corrector.

Definition at line 218 of file gauss_jackson_integrator_base_second.hh.

References jeod::GaussJacksonTwoState::first, and jeod::GaussJacksonTwoState::second.

8.8.3.35 mid_correct() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::mid_correct (
            unsigned int coeff_idx,
            double dt,
            State & state )  [private]
```

Apply a mid-corrector.

Parameters

coeff_idx	Coefficient index; item to be corrected.
dt	Dynamic time step.
state	Corrected state.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::edit_point().

8.8.3.36 operator=()

```
template<typename State , typename Primer >
GaussJacksonIntegratorBase& jeod::GaussJacksonIntegratorBase< State, Primer >::operator= (
            const GaussJacksonIntegratorBase< State, Primer > &  )  [delete]
```

8.8.3.37 predict() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::predict (
            double dt,
            const double *const * ahist,
            GaussJacksonOneState & state )  [inline], [private]
```

Apply the predictor.

Definition at line 234 of file gauss_jackson_integrator_base_first.hh.

References jeod::GaussJacksonOneState::first.

8.8.3.38 predict() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::predict (
            double dt,
            const double *const * ahist,
            GaussJacksonTwoState & state )  [inline], [private]
```

Apply the predictor.

Definition at line 236 of file gauss_jackson_integrator_base_second.hh.

References jeod::GaussJacksonTwoState::first, and jeod::GaussJacksonTwoState::second.

8.8.3.39 predict() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::predict (
            double dt,
            const double *const * ahist,
            State & state )  [private]
```

Apply the predictor.

Parameters

dt	Dynamic time step.
ahist	Acceleration history.
state	Corrected state.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_gj().

8.8.3.40 replicate_primer() [1/3]

```
template<>
er7_utils::SecondOrderODEIntegrator * jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState,
er7_utils::SecondOrderODEIntegrator >::replicate_primer (
            const er7_utils::SecondOrderODEIntegrator * src )  [inline], [private]
```

Definition at line 103 of file gauss_jackson_integrator_base_second.hh.

8.8.3.41 replicate_primer() [2/3]

```
template<>
er7_utils::FirstOrderODEIntegrator * jeod::GaussJacksonIntegratorBase< GaussJacksonOneState,
er7_utils::FirstOrderODEIntegrator >::replicate_primer (
            const er7_utils::FirstOrderODEIntegrator * src )  [inline], [private]
```

Replicate the priming integrator.

Definition at line 105 of file gauss_jackson_integrator_base_first.hh.

8.8.3.42 replicate_primer() [3/3]

```
template<typename State , typename Primer >
static Primer* jeod::GaussJacksonIntegratorBase< State, Primer >::replicate_primer (
            const Primer * src )  [static], [private]
```

Create a replica of the provided primer.

Parameters

src	Primer to be replicated.

Returns

Constructed primer.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase().

8.8.3.43 replicate_state() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::replicate_state (
            const GaussJacksonOneState & source,
            GaussJacksonOneState & target ) [inline], [private]
```

Replicate state data.

Definition at line 303 of file gauss_jackson_integrator_base_first.hh.

References jeod::GaussJacksonOneState::first.

8.8.3.44 replicate_state() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::replicate_state (
            const GaussJacksonTwoState & source,
            GaussJacksonTwoState & target ) [inline], [private]
```

Replicate state data.

Definition at line 317 of file gauss_jackson_integrator_base_second.hh.

References jeod::GaussJacksonTwoState::first, and jeod::GaussJacksonTwoState::second.

8.8.3.45 replicate_state() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::replicate_state (
            const State & source,
            State & target ) [private]
```

Replicate state data.

Parameters

source	State item to be copied.
target	Replicated state item.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase().

8.8.3.46 rotate_acc_hist()

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::rotate_acc_hist ( ) [inline], [private]
```

Rotate the acceleration history.

Definition at line 571 of file gauss_jackson_integrator_base.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::acc_hist, jeod::GaussJacksonIntegratorBase< State, Primer >::order, and er7_utils::TwoDArray< T >::rotate_down().

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate().

8.8.3.47 save_comparison_data() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::save_comparison_data (
            const GaussJacksonTwoState & state,
            double * pos_hist_elem ) [inline], [private]
```

Save comparison data.

Definition at line 142 of file gauss_jackson_integrator_base_second.hh.

References jeod::GaussJacksonTwoState::second.

8.8.3.48 save_comparison_data() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::save_comparison_data (
            const GaussJacksonOneState & state,
            double * pos_hist_elem ) [inline], [private]
```

Save comparison data.

Definition at line 144 of file gauss_jackson_integrator_base_first.hh.

References jeod::GaussJacksonOneState::first.

8.8.3.49 save_comparison_data() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::save_comparison_data (
            const State & state,
            double * pos_hist_elem ) [private]
```

Save comparison data.

Parameters

state	State to be saved.
pos_hist_elem	Element of the position history to be updated.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate(), and jeod::GaussJackson↩
IntegratorBase< State, Primer >::integrate_gj().

8.8.3.50 save_epoch_data() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::save_epoch_data (
            const double * acc,
            const GaussJacksonTwoState & state )  [inline], [private]
```

Save epoch data.

Definition at line 131 of file gauss_jackson_integrator_base_second.hh.

References jeod::GaussJacksonTwoState::first, and jeod::GaussJacksonTwoState::second.

8.8.3.51 save_epoch_data() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::save_epoch_data (
            const double * acc,
            const GaussJacksonOneState & state )  [inline], [private]
```

Save epoch data.

Definition at line 133 of file gauss_jackson_integrator_base_first.hh.

References jeod::GaussJacksonOneState::first.

8.8.3.52 save_epoch_data() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::save_epoch_data (
            const double * acc,
            const State & state )  [private]
```

Save epoch data.

Parameters

acc	Acceleration to be saved.
state	State to be saved.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle().

8.8.3.53 start_cycle()

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle (
            double dt,
            const double * acc,
            const State & state ) [inline], [private]
```

Start an integration cycle.

Parameters

in	*dt*	Dynamic time step, in dynamic time seconds.
in	*acc*	Acceleration vector.
in	*state*	State vector(s).

Definition at line 456 of file gauss_jackson_integrator_base.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::acc_hist, jeod::GaussJacksonStateMachine::BootstrapEdit, jeod::GaussJacksonIntegratorBase< State, Primer >::coeff, jeod::GaussJacksonCoeffs::corrector, jeod::GaussJacksonIntegratorBase< State, Primer >::downsample_hist(), jeod::GaussJacksonIntegratorBase< State, Primer >::fsm_state, jeod::GaussJacksonStateMachine::get_at_downsample(), jeod::GaussJacksonStateMachine::get_at_order_change(), jeod::GaussJacksonStateMachine::get_at_reinitialize(), jeod::GaussJacksonStateMachine::get_current_order(), jeod::GaussJacksonStateMachine::get_fsm_state(), jeod::GaussJacksonCoefficientsPair::gj_coefs, jeod::GaussJacksonIntegratorBase< State, Primer >::history_length, jeod::GaussJacksonIntegratorBase< State, Primer >::initialize_edit_integration_constants(), jeod::GaussJacksonIntegratorBase< State, Primer >::initialize_predictor_integration_constants(), jeod::GaussJacksonIntegratorBase< State, Primer >::order, jeod::GaussJacksonIntegratorBase< State, Primer >::position_corrector, jeod::GaussJacksonStateMachine::Reset, jeod::GaussJacksonCoefficientsPair::sa_coefs, jeod::GaussJacksonIntegratorBase< State, Primer >::save_epoch_data(), jeod::GaussJacksonIntegratorBase< State, Primer >::size, jeod::GaussJacksonIntegratorBase< State, Primer >::state_machine, and jeod::GaussJacksonIntegratorBase< State, Primer >::velocity_corrector.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate().

8.8.3.54 swap()

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::swap (
            GaussJacksonIntegratorBase< State, Primer > & other ) [inline], [protected]
```

Non-throwing swap.

Parameters

other	Item whose contents are to be swapped with this.

Definition at line 397 of file gauss_jackson_integrator_base.hh.

References jeod::GaussJacksonIntegratorBase< State, Primer >::absolute_tolerance, jeod::GaussJacksonIntegratorBase< State, Primer >::acc_hist, jeod::GaussJacksonIntegratorBase< State, Primer >::coeff, jeod::GaussJacksonIntegratorBase< State, Primer >::corrector_sum, jeod::GaussJacksonIntegratorBase< State, Primer >::delinv, jeod::GaussJacksonIntegratorBase< State, Primer >::fsm_state, jeod::GaussJacksonIntegratorBase< State, Primer >::history_length, jeod::GaussJacksonIntegratorBase< State, Primer >::init_state, jeod::GaussJacksonIntegratorBase< State, Primer >::initial_order, jeod::GaussJacksonIntegratorBase< State, Primer >::max_history_size, jeod::GaussJacksonIntegratorBase< State, Primer >::order, jeod::GaussJacksonIntegratorBase< State, Primer >::pos_hist, jeod::GaussJacksonIntegratorBase< State, Primer >::position_corrector, jeod::GaussJacksonIntegratorBase< State, Primer >::primer, jeod::GaussJacksonIntegratorBase< State, Primer >::relative_tolerance, jeod::GaussJacksonIntegratorBase< State, Primer >::size, jeod::GaussJacksonIntegratorBase< State, Primer >::state_machine, er7_utils::TwoDArray< T >::swap(), jeod::GaussJacksonIntegratorBase< State, Primer >::swap_state(), and jeod::GaussJacksonIntegratorBase< State, Primer >::velocity_corrector.

Referenced by jeod::GaussJacksonFirstOrderODEIntegrator::swap().

8.8.3.55 swap_state() [1/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::swap_state (
            GaussJacksonOneState & item,
            GaussJacksonOneState & other_item )  [inline], [private]
```

Swap state data with another of the same.

Definition at line 293 of file gauss_jackson_integrator_base_first.hh.

References jeod::GaussJacksonOneState::first.

8.8.3.56 swap_state() [2/3]

```
template<>
void jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::swap_state (
            GaussJacksonTwoState & item,
            GaussJacksonTwoState & other_item )  [inline], [private]
```

Swap state data with another of the same.

Definition at line 306 of file gauss_jackson_integrator_base_second.hh.

References jeod::GaussJacksonTwoState::first, and jeod::GaussJacksonTwoState::second.

8.8.3.57 swap_state() [3/3]

```
template<typename State , typename Primer >
void jeod::GaussJacksonIntegratorBase< State, Primer >::swap_state (
            State & item,
            State & other_item )  [private]
```

Swap state data with another of the same.

Parameters

item	State item.
other_item	The other state item.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.3.58 test_for_convergence() [1/3]

```
template<>
bool jeod::GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator
>::test_for_convergence (
            const GaussJacksonOneState & state,
            double * hist_data )  [inline], [private]
```

Test for convergence.

Definition at line 271 of file gauss_jackson_integrator_base_first.hh.

References jeod::GaussJacksonOneState::first.

8.8.3.59 test_for_convergence() [2/3]

```
template<>
bool jeod::GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator
>::test_for_convergence (
            const GaussJacksonTwoState & state,
            double * hist_data )  [inline], [private]
```

Test for convergence.

Definition at line 285 of file gauss_jackson_integrator_base_second.hh.

References jeod::GaussJacksonTwoState::second.

8.8.3.60 test_for_convergence() [3/3]

```
template<typename State , typename Primer >
bool jeod::GaussJacksonIntegratorBase< State, Primer >::test_for_convergence (
            const State & state,
            double * hist_data )  [private]
```

Test for convergence.

Parameters

state	Item to be compared.
hist_data	Previous state value.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::edit_point(), and jeod::GaussJackson↩
IntegratorBase< State, Primer >::integrate_gj().

8.8.4 Field Documentation

8.8.4.1 absolute_tolerance

```
template<typename State , typename Primer >
double jeod::GaussJacksonIntegratorBase< State, Primer >::absolute_tolerance {}
```

Number that indicates the allowable absolute difference for two states to be considered converged.

trick_units(–)

Definition at line 143 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.2 acc_hist

```
template<typename State , typename Primer >
er7_utils::DoubleTwoDArray jeod::GaussJacksonIntegratorBase< State, Primer >::acc_hist
```

Acceleration history.

trick_units(–)

Definition at line 126 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate(), jeod::GaussJackson↩
IntegratorBase< State, Primer >::downsample_hist(), jeod::GaussJacksonIntegratorBase< State, Primer >::↩
GaussJacksonIntegratorBase(), jeod::GaussJacksonIntegratorBase< State, Primer >::rotate_acc_hist(), jeod↩
::GaussJacksonIntegratorBase< State, Primer >::start_cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.3 coeff

```
template<typename State , typename Primer >
const GaussJacksonCoeffs* jeod::GaussJacksonIntegratorBase< State, Primer >::coeff {}
```

The summed Adams and Gauss-Jackson coefficients, in ordinate form.

trick_units(–)

Definition at line 96 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_gj(), jeod::GaussJackson↩ IntegratorBase< State, Primer >::start_cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.4 corrector_sum

```
template<typename State , typename Primer >
State jeod::GaussJacksonIntegratorBase< State, Primer >::corrector_sum
```

Speed hack for the corrector.

trick_units(–)

Definition at line 121 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase(), jeod::↩ GaussJacksonIntegratorBase< State, Primer >::integrate_gj(), jeod::GaussJacksonIntegratorBase< State, Primer >::swap(), and jeod::GaussJacksonIntegratorBase< State, Primer >::∼GaussJacksonIntegratorBase().

8.8.4.5 delinv

```
template<typename State , typename Primer >
State jeod::GaussJacksonIntegratorBase< State, Primer >::delinv
```

Inverse backward differences.

trick_units(–)

Definition at line 116 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase(), jeod::↩ GaussJacksonIntegratorBase< State, Primer >::swap(), and jeod::GaussJacksonIntegratorBase< State, Primer >::∼GaussJacksonIntegratorBase().

8.8.4.6 fsm_state

```
template<typename State , typename Primer >
GaussJacksonStateMachine::FsmState jeod::GaussJacksonIntegratorBase< State, Primer >::fsm_←
state {GaussJacksonStateMachine::Reset}
```

Finite state machine state.

trick_units(–)

Definition at line 158 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate(), jeod::GaussJackson←IntegratorBase< State, Primer >::base_reset(), jeod::GaussJacksonIntegratorBase< State, Primer >::start_←cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.7 history_length

```
template<typename State , typename Primer >
unsigned int jeod::GaussJacksonIntegratorBase< State, Primer >::history_length {}
```

Current history length.

trick_units(–)

Definition at line 183 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate(), jeod::GaussJackson←IntegratorBase< State, Primer >::base_reset(), jeod::GaussJacksonIntegratorBase< State, Primer >←::downsample_hist(), jeod::GaussJacksonIntegratorBase< State, Primer >::edit_point(), jeod::GaussJackson←IntegratorBase< State, Primer >::start_cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.8 init_state

```
template<typename State , typename Primer >
State jeod::GaussJacksonIntegratorBase< State, Primer >::init_state
```

The state at the time of the last reset.

trick_units(–)

Definition at line 111 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase(), jeod::←GaussJacksonIntegratorBase< State, Primer >::swap(), and jeod::GaussJacksonIntegratorBase< State, Primer >::~GaussJacksonIntegratorBase().

8.8.4.9 initial_order

```
template<typename State , typename Primer >
unsigned int jeod::GaussJacksonIntegratorBase< State, Primer >::initial_order {}
```

Initial order.

trick_units(--)

Definition at line 168 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_reset(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.10 max_history_size

```
template<typename State , typename Primer >
unsigned int jeod::GaussJacksonIntegratorBase< State, Primer >::max_history_size {}
```

Maximum history size.

trick_units(--)

Definition at line 163 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.11 order

```
template<typename State , typename Primer >
unsigned int jeod::GaussJacksonIntegratorBase< State, Primer >::order {}
```

Current order.

trick_units(--)

Definition at line 173 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate(), jeod::GaussJacksonIntegratorBase< State, Primer >::base_reset(), jeod::GaussJacksonIntegratorBase< State, Primer >::edit_point(), jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_gj(), jeod::GaussJacksonIntegratorBase< State, Primer >::rotate_acc_hist(), jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.12 pos_hist

```
template<typename State , typename Primer >
er7_utils::DoubleTwoDArray jeod::GaussJacksonIntegratorBase< State, Primer >::pos_hist
```

Position history (or velocity history in case of a first order ODE).

trick_units(–)

Definition at line 131 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate(), jeod::GaussJackson↩ IntegratorBase< State, Primer >::downsample_hist(), jeod::GaussJacksonIntegratorBase< State, Primer >::edit↩ _point(), jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase(), jeod::Gauss↩ JacksonIntegratorBase< State, Primer >::integrate_gj(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.13 position_corrector

```
template<typename State , typename Primer >
double jeod::GaussJacksonIntegratorBase< State, Primer >::position_corrector {}
```

Correction coefficient for the second integral (position).

trick_units(–)

Definition at line 153 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle(), and jeod::GaussJackson↩ IntegratorBase< State, Primer >::swap().

8.8.4.14 primer

```
template<typename State , typename Primer >
Primer* jeod::GaussJacksonIntegratorBase< State, Primer >::primer {}
```

The integrator used to prime the Gauss-Jackson integration process.

trick_units(–)

Definition at line 106 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase(), jeod::↩ GaussJacksonIntegratorBase< State, Primer >::swap(), and jeod::GaussJacksonIntegratorBase< State, Primer >::∼GaussJacksonIntegratorBase().

8.8.4.15 relative_tolerance

```
template<typename State , typename Primer >
double jeod::GaussJacksonIntegratorBase< State, Primer >::relative_tolerance {}
```

Number that indicates the allowable relative difference for two states to be considered converged.

trick_units(–)

Definition at line 137 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.16 size

```
template<typename State , typename Primer >
unsigned int jeod::GaussJacksonIntegratorBase< State, Primer >::size {}
```

State size.

trick_units(–)

Definition at line 178 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::base_integrate(), jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase(), jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_gj(), jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.17 state_machine

```
template<typename State , typename Primer >
const GaussJacksonStateMachine* jeod::GaussJacksonIntegratorBase< State, Primer >::state_machine {}
```

The Gauss-Jackson state machine.

trick_units(–)

Definition at line 101 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.8.4.18 velocity_corrector

```
template<typename State , typename Primer >
double jeod::GaussJacksonIntegratorBase< State, Primer >::velocity_corrector {}
```

Correction coefficient for the first integral (velocity).

trick_units(–)

Definition at line 148 of file gauss_jackson_integrator_base.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle(), and jeod::GaussJackson↩
IntegratorBase< State, Primer >::swap().

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

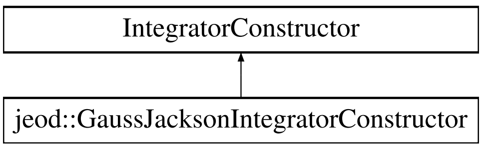
- gauss_jackson_integrator_base.hh

8.9 jeod::GaussJacksonIntegratorConstructor Class Reference

Create state and time integrators that propagate using Gauss-Jackson.

```
#include <gauss_jackson_integrator_constructor.hh>
```

Inheritance diagram for jeod::GaussJacksonIntegratorConstructor:



Public Member Functions

- GaussJacksonIntegratorConstructor ()=default

  GaussJackson default constructor.
- GaussJacksonIntegratorConstructor (const GaussJacksonIntegratorConstructor &src)

  GaussJacksonIntegratorConstructor copy constructor.
- ∼GaussJacksonIntegratorConstructor () override

  GaussJacksonIntegratorConstructor destructor.
- GaussJacksonIntegratorConstructor & operator= (GaussJacksonIntegratorConstructor src)

  GaussJacksonIntegratorConstructor assignment operator.
- void configure (const GaussJacksonConfig &config_in, er7_utils::Integration::Technique priming_↩
technique=er7_utils::Integration::Unspecified)

  Configure the Gauss-Jackson integrator constructor.
- void configure (const GaussJacksonConfig &config_in, const er7_utils::IntegratorConstructor &priming_↩
cotr_in)

  Configure the Gauss-Jackson integrator constructor.
- const char ∗ get_class_name () const override

  Return the class name.
- bool implements (er7_utils::Integration::ODEProblemType problem_type) const override

GaussJackson does not implement a 2nd order generalized step integrator.
- bool provides (er7_utils::Integration::ODEProblemType problem_type) const override

    GaussJackson does not provide a 2nd order generalized step integrator.
- virtual void swap (GaussJacksonIntegratorConstructor &src)

    Non-throwing swap.
- er7_utils::IntegratorConstructor ∗ create_copy () const override

    Create a duplicate of the constructor.
- er7_utils::IntegrationControls ∗ create_integration_controls () const override

    Create an integration controls that guides the GaussJackson integration process.
- er7_utils::FirstOrderODEIntegrator ∗ create_first_order_ode_integrator (unsigned int size, er7_utils::↩ IntegrationControls &controls) const override

    Create a GaussJackson state integrator for a first order ODE.
- er7_utils::SecondOrderODEIntegrator ∗ create_second_order_ode_integrator (unsigned int size, er7_utils↩ ::IntegrationControls &controls) const override

    Create a GaussJackson state integrator for a simple second order ODE.
- er7_utils::SecondOrderODEIntegrator ∗ create_generalized_deriv_second_order_ode_integrator (unsigned int position_size, unsigned int velocity_size, const er7_utils::GeneralizedPositionDerivativeFunctions &deriv↩ _funs, er7_utils::IntegrationControls &controls) const override

    Create a GaussJackson state integrator for a generalized second order ODE where generalized position is advanced with the use of the position derivative function.
- unsigned int get_buffer_size () const override

    GaussJackson can use a large number of steps per Trick cycle.
- unsigned int get_transition_table_size () const override

    GaussJackson uses two steps per cycle once primed.

Static Public Member Functions

- static er7_utils::IntegratorConstructor ∗ create_constructor ()

    Named constructor; create an GaussJacksonIntegratorConstructor instance.

Private Attributes

- er7_utils::IntegratorConstructor ∗ priming_constructor {}

    The integrator constructor that creates the priming integrators.
- GaussJacksonConfig config

    Data used to configure the Gauss-Jackson integration process.

Friends

- class InputProcessor
- void init_attrjeod__GaussJacksonIntegratorConstructor ()

8.9.1 Detailed Description

Create state and time integrators that propagate using Gauss-Jackson.

Definition at line 80 of file gauss_jackson_integrator_constructor.hh.

8.9.2 Constructor & Destructor Documentation

8.9.2.1 GaussJacksonIntegratorConstructor() [1/2]

```
jeod::GaussJacksonIntegratorConstructor::GaussJacksonIntegratorConstructor ( )  [default]
```

GaussJackson default constructor.

8.9.2.2 GaussJacksonIntegratorConstructor() [2/2]

```
jeod::GaussJacksonIntegratorConstructor::GaussJacksonIntegratorConstructor (
            const GaussJacksonIntegratorConstructor & src )
```

GaussJacksonIntegratorConstructor copy constructor.

Definition at line 69 of file gauss_jackson_integrator_constructor.cc.

References priming_constructor.

8.9.2.3 ∼GaussJacksonIntegratorConstructor()

```
jeod::GaussJacksonIntegratorConstructor::∼GaussJacksonIntegratorConstructor ( )  [override]
```

GaussJacksonIntegratorConstructor destructor.

Definition at line 80 of file gauss_jackson_integrator_constructor.cc.

References priming_constructor.

8.9.3 Member Function Documentation

8.9.3.1 configure() [1/2]

```
void jeod::GaussJacksonIntegratorConstructor::configure (
            const GaussJacksonConfig & config_in,
            er7_utils::Integration::Technique priming_technique = er7_utils::Integration:↩
:Unspecified )
```

Configure the Gauss-Jackson integrator constructor.

Definition at line 93 of file gauss_jackson_integrator_constructor.cc.

References config, priming_constructor, jeod::GaussJacksonConfig::priming_technique, and jeod::Gauss↩
JacksonConfig::validate_configuration().

8.9.3.2 configure() [2/2]

```
void jeod::GaussJacksonIntegratorConstructor::configure (
            const GaussJacksonConfig & config_in,
            const er7_utils::IntegratorConstructor & priming_cotr_in )
```

Configure the Gauss-Jackson integrator constructor.

Definition at line 107 of file gauss_jackson_integrator_constructor.cc.

References config, priming_constructor, and jeod::GaussJacksonConfig::validate_configuration().

8.9.3.3 create_constructor()

```
er7_utils::IntegratorConstructor * jeod::GaussJacksonIntegratorConstructor::create_constructor
( ) [static]
```

Named constructor; create an GaussJacksonIntegratorConstructor instance.

The caller is responsible for deleting the returned object.

Returns

Newly created GaussJacksonIntegratorConstructor instance.

Definition at line 63 of file gauss_jackson_integrator_constructor.cc.

8.9.3.4 create_copy()

```
er7_utils::IntegratorConstructor * jeod::GaussJacksonIntegratorConstructor::create_copy ( )
const [override]
```

Create a duplicate of the constructor.

The caller is responsible for deleting the returned object.

Returns

Duplicated constructor.

Definition at line 115 of file gauss_jackson_integrator_constructor.cc.

8.9.3.5 create_first_order_ode_integrator()

```
er7_utils::FirstOrderODEIntegrator * jeod::GaussJacksonIntegratorConstructor::create_first_↩
order_ode_integrator (
            unsigned int size,
            er7_utils::IntegrationControls & controls ) const [override]
```

Create a GaussJackson state integrator for a first order ODE.

The caller is responsible for deleting the created object.

Returns

State integrator

Parameters

in	*size*	State size
in,out	*controls*	Integration controls

Definition at line 136 of file gauss_jackson_integrator_constructor.cc.

References jeod::cast_to_gj_controls(), jeod::GaussJacksonIntegrationControls::get_priming_controls(), and priming_constructor.

8.9.3.6 create_generalized_deriv_second_order_ode_integrator()

```
er7_utils::SecondOrderODEIntegrator * jeod::GaussJacksonIntegratorConstructor::create_generalized↩
_deriv_second_order_ode_integrator (
            unsigned int position_size,
            unsigned int velocity_size,
            const er7_utils::GeneralizedPositionDerivativeFunctions & deriv_funs,
            er7_utils::IntegrationControls & controls ) const [override]
```

Create a GaussJackson state integrator for a generalized second order ODE where generalized position is advanced with the use of the position derivative function.

The caller is responsible for deleting the created object.

Returns

State integrator

Parameters

in	*position_size*	Size of the generalized position
in	*velocity_size*	Size of the generalized velocity
in	*deriv_funs*	Position derivative functions container
in,out	*controls*	Integration controls

Definition at line 169 of file gauss_jackson_integrator_constructor.cc.

References jeod::cast_to_gj_controls(), jeod::GaussJacksonIntegrationControls::get_priming_controls(), and priming_constructor.

8.9.3.7 create_integration_controls()

```
er7_utils::IntegrationControls * jeod::GaussJacksonIntegratorConstructor::create_integration_↩
controls ( ) const [override]
```

Create an integration controls that guides the GaussJackson integration process.

The caller is responsible for deleting the created object.

Returns

Integration controls object

Definition at line 121 of file gauss_jackson_integrator_constructor.cc.

References config, priming_constructor, and jeod::GaussJacksonConfig::standard_configuration().

8.9.3.8 create_second_order_ode_integrator()

```
er7_utils::SecondOrderODEIntegrator * jeod::GaussJacksonIntegratorConstructor::create_second_↩
order_ode_integrator (
            unsigned int size,
            er7_utils::IntegrationControls & controls ) const  [override]
```

Create a GaussJackson state integrator for a simple second order ODE.

The caller is responsible for deleting the created object.

Returns

State integrator

Parameters

in	*size*	State size
in,out	*controls*	Integration controls

Definition at line 152 of file gauss_jackson_integrator_constructor.cc.

References jeod::cast_to_gj_controls(), jeod::GaussJacksonIntegrationControls::get_priming_controls(), and priming_constructor.

8.9.3.9 get_buffer_size()

```
unsigned int jeod::GaussJacksonIntegratorConstructor::get_buffer_size ( ) const  [inline],
[override]
```

GaussJackson can use a large number of steps per Trick cycle.

The magic number 192 is for order=16, ndboubling=6.

Returns

Always returns 192.

Definition at line 217 of file gauss_jackson_integrator_constructor.hh.

8.9.3.10 get_class_name()

```
const char* jeod::GaussJacksonIntegratorConstructor::get_class_name ( ) const [inline], [override]
```

Return the class name.

Definition at line 134 of file gauss_jackson_integrator_constructor.hh.

8.9.3.11 get_transition_table_size()

```
unsigned int jeod::GaussJacksonIntegratorConstructor::get_transition_table_size ( ) const
[inline], [override]
```

GaussJackson uses two steps per cycle once primed.

Returns

Always returns 2.

Definition at line 226 of file gauss_jackson_integrator_constructor.hh.

8.9.3.12 implements()

```
bool jeod::GaussJacksonIntegratorConstructor::implements (
            er7_utils::Integration::ODEProblemType problem_type ) const [inline], [override]
```

GaussJackson does not implement a 2nd order generalized step integrator.

Definition at line 142 of file gauss_jackson_integrator_constructor.hh.

8.9.3.13 operator=()

```
GaussJacksonIntegratorConstructor& jeod::GaussJacksonIntegratorConstructor::operator= (
            GaussJacksonIntegratorConstructor src ) [inline]
```

GaussJacksonIntegratorConstructor assignment operator.

Definition at line 112 of file gauss_jackson_integrator_constructor.hh.

8.9.3.14 provides()

```
bool jeod::GaussJacksonIntegratorConstructor::provides (
            er7_utils::Integration::ODEProblemType problem_type ) const [inline], [override]
```

GaussJackson does not provide a 2nd order generalized step integrator.

Definition at line 150 of file gauss_jackson_integrator_constructor.hh.

8.9.3.15 swap()

```
void jeod::GaussJacksonIntegratorConstructor::swap (
            GaussJacksonIntegratorConstructor & src ) [virtual]
```

Non-throwing swap.

Parameters

in,out	*src*	Object with which contents are to be swapped.

Definition at line 86 of file gauss_jackson_integrator_constructor.cc.

References config, and priming_constructor.

8.9.4 Friends And Related Function Documentation

8.9.4.1 init_attrjeod__GaussJacksonIntegratorConstructor

`void init_attrjeod__GaussJacksonIntegratorConstructor ( ) [friend]`

8.9.4.2 InputProcessor

`friend class InputProcessor [friend]`

Definition at line 82 of file gauss_jackson_integrator_constructor.hh.

8.9.5 Field Documentation

8.9.5.1 config

`GaussJacksonConfig jeod::GaussJacksonIntegratorConstructor::config [private]`

Data used to configure the Gauss-Jackson integration process.

trick_units(--)

Definition at line 240 of file gauss_jackson_integrator_constructor.hh.

Referenced by configure(), create_integration_controls(), and swap().

8.9.5.2 priming_constructor

```
er7_utils::IntegratorConstructor* jeod::GaussJacksonIntegratorConstructor::priming_constructor
{} [private]
```

The integrator constructor that creates the priming integrators.

trick_units(–)

Definition at line 235 of file gauss_jackson_integrator_constructor.hh.

Referenced by configure(), create_first_order_ode_integrator(), create_generalized_deriv_second_order_ode↩_integrator(), create_integration_controls(), create_second_order_ode_integrator(), GaussJacksonIntegrator↩Constructor(), swap(), and ∼GaussJacksonIntegratorConstructor().

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

- gauss_jackson_integrator_constructor.hh
- gauss_jackson_integrator_constructor.cc

8.10 jeod::GaussJacksonOneState Class Reference

Essentially just a double∗.

`#include <gauss_jackson_one_state.hh>`

Public Member Functions

- GaussJacksonOneState ()=default

  Default constructor.
- GaussJacksonOneState (double ∗first_in)

  Conversion constructor.

Data Fields

- double ∗ first {}

  The pointed-to data.

Friends

- class InputProcessor
- void init_attrjeod__GaussJacksonOneState ()

8.10.1 Detailed Description

Essentially just a double∗.

Definition at line 71 of file gauss_jackson_one_state.hh.

8.10.2 Constructor & Destructor Documentation

8.10.2.1 GaussJacksonOneState() [1/2]

```
jeod::GaussJacksonOneState::GaussJacksonOneState ( )  [default]
```

Default constructor.

8.10.2.2 GaussJacksonOneState() [2/2]

```
jeod::GaussJacksonOneState::GaussJacksonOneState (
            double * first_in )  [inline], [explicit]
```

Conversion constructor.

Parameters

first←_in	The pointed-to data.

Definition at line 88 of file gauss_jackson_one_state.hh.

8.10.3 Friends And Related Function Documentation

8.10.3.1 init_attrjeod__GaussJacksonOneState

```
void init_attrjeod__GaussJacksonOneState ( )  [friend]
```

8.10.3.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 73 of file gauss_jackson_one_state.hh.

8.10.4 Field Documentation

8.10.4.1 first

```
double* jeod::GaussJacksonOneState::first {}
```

The pointed-to data.

trick_units(–)

Definition at line 77 of file gauss_jackson_one_state.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::allocate_state_contents(), jeod::GaussJacksonIntegratorBase< State, Primer >::correct(), jeod::GaussJacksonIntegratorBase< State, Primer >::deallocate_state_contents(), jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_primer(), jeod::GaussJacksonIntegratorBase< State, Primer >::mid_correct(), jeod::GaussJacksonIntegratorBase< State, Primer >::predict(), jeod::GaussJacksonIntegratorBase< State, Primer >::replicate_state(), jeod::GaussJacksonIntegratorBase< State, Primer >::save_comparison_data(), jeod::GaussJacksonIntegratorBase< State, Primer >::save_epoch_data(), jeod::GaussJacksonIntegratorBase< State, Primer >::swap_state(), and jeod::GaussJacksonIntegratorBase< State, Primer >::test_for_convergence().

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

- gauss_jackson_one_state.hh

8.11 jeod::GaussJacksonRationalCoefficients Class Reference

Contains a set of Adams or Stormer-Cowell coefficients.

```
#include <gauss_jackson_rational_coeffs.hh>
```

Public Member Functions

- GaussJacksonRationalCoefficients ()=default
  Default constructor.
- void configure_adams_corrector (unsigned int nelem)
  Configure the coefficients as an Adams corrector in difference form.
- GaussJacksonRationalCoefficients construct_stormer_cowell_corrector () const
  Construct a GaussJacksonRationalCoefficients that contains the Stormer-Cowell corrector coefficients.
- GaussJacksonRationalCoefficients construct_predictor () const
  Construct a GaussJacksonRationalCoefficients that contains a set of predictor coefficients.
- void convert_to_ordinate_form (er7_utils::NChooseM &n_choose_m, double *result) const
  Convert the coefficients to ordinate form.
- void discard_extra_terms (unsigned int nfront, unsigned int nback)
  Discard the specified number of terms from the front and back of the coefficients array.
- void displace_back ()
  Displace the corrector coefficients back one time step.

Data Fields

- std::vector< er7_utils::Ratio128 > coefficients
  The coefficients.

Friends

- class InputProcessor
- void init_attrjeod__GaussJacksonRationalCoefficients ()

8.11.1 Detailed Description

Contains a set of Adams or Stormer-Cowell coefficients.

Definition at line 78 of file gauss_jackson_rational_coeffs.hh.

8.11.2 Constructor & Destructor Documentation

8.11.2.1 GaussJacksonRationalCoefficients()

```
jeod::GaussJacksonRationalCoefficients::GaussJacksonRationalCoefficients ( )  [default]
```

Default constructor.

8.11.3 Member Function Documentation

8.11.3.1 configure_adams_corrector()

```
void jeod::GaussJacksonRationalCoefficients::configure_adams_corrector (
            unsigned int nelem )
```

Configure the coefficients as an Adams corrector in difference form.

Parameters

nelem	The number of elements in the coefficients vector.

Definition at line 32 of file gauss_jackson_rational_coeffs.cc.

References coefficients.

Referenced by jeod::GaussJacksonCoeffs::compute_coeffs().

8.11.3.2 construct_predictor()

```
GaussJacksonRationalCoefficients jeod::GaussJacksonRationalCoefficients::construct_predictor (
) const
```

Construct a GaussJacksonRationalCoefficients that contains a set of predictor coefficients.

The coefficients are assumed to be configured as either Adams or Stormer-Cowell corrector coefficients.

Returns

A GaussJacksonRationalCoefficients object with the coefficients configured as Adams or Stormer-Cowell predictor coefficients.

Definition at line 78 of file gauss_jackson_rational_coeffs.cc.

References coefficients.

Referenced by jeod::GaussJacksonCoeffs::compute_coeffs().

8.11.3.3 construct_stormer_cowell_corrector()

```
GaussJacksonRationalCoefficients jeod::GaussJacksonRationalCoefficients::construct_stormer_↩
cowell_corrector ( ) const
```

Construct a GaussJacksonRationalCoefficients that contains the Stormer-Cowell corrector coefficients.

The coefficients are assumed to be configured as Adams coefficients in difference form.

Returns

A GaussJacksonRationalCoefficients object with the coefficients configured as Stormer-Cowell corrector coefficients.

Definition at line 54 of file gauss_jackson_rational_coeffs.cc.

References coefficients.

Referenced by jeod::GaussJacksonCoeffs::compute_coeffs().

8.11.3.4 convert_to_ordinate_form()

```
void jeod::GaussJacksonRationalCoefficients::convert_to_ordinate_form (
            er7_utils::NChooseM & n_choose_m,
            double * result ) const
```

Convert the coefficients to ordinate form.

Parameters

n_choose←_m	An NChooseM object that computes N choose M.
result	The output ordinate form coefficients.

Definition at line 101 of file gauss_jackson_rational_coeffs.cc.

References coefficients.

Referenced by jeod::GaussJacksonCoeffs::compute_coeffs().

8.11.3.5 discard_extra_terms()

```
void jeod::GaussJacksonRationalCoefficients::discard_extra_terms (
            unsigned int nfront,
            unsigned int nback )
```

Discard the specified number of terms from the front and back of the coefficients array.

Parameters

nfront	The number of terms to be discarded from the front of the coefficients vector.
nback	The number of terms to be discarded from the back of the coefficients vector.

Definition at line 133 of file gauss_jackson_rational_coeffs.cc.

References coefficients.

Referenced by jeod::GaussJacksonCoeffs::compute_coeffs().

8.11.3.6 displace_back()

```
void jeod::GaussJacksonRationalCoefficients::displace_back ( )
```

Displace the corrector coefficients back one time step.

Definition at line 146 of file gauss_jackson_rational_coeffs.cc.

References coefficients.

Referenced by jeod::GaussJacksonCoeffs::compute_coeffs().

8.11.4 Friends And Related Function Documentation

8.11.4.1 init_attrjeod__GaussJacksonRationalCoefficients

```
void init_attrjeod__GaussJacksonRationalCoefficients ( ) [friend]
```

8.11.4.2 InputProcessor

```
friend class InputProcessor [friend]
```

Definition at line 80 of file gauss_jackson_rational_coeffs.hh.

8.11.5 Field Documentation

8.11.5.1 coefficients

```
std::vector<er7_utils::Ratio128> jeod::GaussJacksonRationalCoefficients::coefficients
```

The coefficients.

trick_units(--)

Definition at line 84 of file gauss_jackson_rational_coeffs.hh.

Referenced by configure_adams_corrector(), construct_predictor(), construct_stormer_cowell_corrector(), convert_to_ordinate_form(), discard_extra_terms(), and displace_back().

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

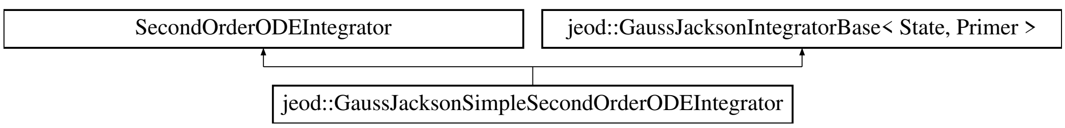
- gauss_jackson_rational_coeffs.hh
- gauss_jackson_rational_coeffs.cc

8.12 jeod::GaussJacksonSimpleSecondOrderODEIntegrator Class Reference

Integrates a simple second order ODE using the Gauss-Jackson technique.

```
#include <gauss_jackson_simple_second_order_ode_integrator.hh>
```

Inheritance diagram for jeod::GaussJacksonSimpleSecondOrderODEIntegrator:



Public Member Functions

- GaussJacksonSimpleSecondOrderODEIntegrator ()=default
- ∼GaussJacksonSimpleSecondOrderODEIntegrator () override=default
- GaussJacksonSimpleSecondOrderODEIntegrator (const er7_utils::IntegratorConstructor &priming_↩ constructor, GaussJacksonIntegrationControls &controls, unsigned int size_in, er7_utils::IntegrationControls &priming_controls)

    Non-default constructor.
- GaussJacksonSimpleSecondOrderODEIntegrator (const GaussJacksonSimpleSecondOrderODEIntegrator &src)

    Copy constructor.
- GaussJacksonSimpleSecondOrderODEIntegrator & operator= (GaussJacksonSimpleSecondOrderODEIntegrator src)

    Copy and swap assignment operator.
- void swap (GaussJacksonSimpleSecondOrderODEIntegrator &other)

    Non-throwing swap.
- er7_utils::SecondOrderODEIntegrator ∗ create_copy () const override

    Replicate this.
- void reset_integrator () override

    Reset the integrator.
- er7_utils::IntegratorResult integrate (double dyn_dt, unsigned int target_stage, const double ∗acc, double ∗vel, double ∗pos) override

    Propagate state using Gauss-Jackson.

Private Member Functions

- void swap (GaussJacksonIntegratorBase &other)

    Non-throwing swap.

Friends

- class InputProcessor
- void init_attrjeod__GaussJacksonSimpleSecondOrderODEIntegrator ()

Additional Inherited Members

8.12.1 Detailed Description

Integrates a simple second order ODE using the Gauss-Jackson technique.

The class inherits from er7_utils::SecondOrderODEIntegrator as an is-a relationship (public inheritance) and from GaussJacksonIntegratorBaseSecond as an is-implemented-by relationship (private inheritance). Using composition instead of private inheritance would make Trick 13 checkpoint/restart a lot trickier to implement. With private inheritance, the Trick 13 io_src file contains all the necessary information.

Definition at line 83 of file gauss_jackson_simple_second_order_ode_integrator.hh.

8.12.2 Constructor & Destructor Documentation

8.12.2.1 GaussJacksonSimpleSecondOrderODEIntegrator() [1/3]

```
jeod::GaussJacksonSimpleSecondOrderODEIntegrator::GaussJacksonSimpleSecondOrderODEIntegrator (
) [default]
```

8.12.2.2 ∼GaussJacksonSimpleSecondOrderODEIntegrator()

```
jeod::GaussJacksonSimpleSecondOrderODEIntegrator::∼GaussJacksonSimpleSecondOrderODEIntegrator
( ) [override], [default]
```

8.12.2.3 GaussJacksonSimpleSecondOrderODEIntegrator() [2/3]

```
jeod::GaussJacksonSimpleSecondOrderODEIntegrator::GaussJacksonSimpleSecondOrderODEIntegrator (
            const er7_utils::IntegratorConstructor & priming_constructor,
            GaussJacksonIntegrationControls & controls,
            unsigned int size_in,
            er7_utils::IntegrationControls & priming_controls ) [inline]
```

Non-default constructor.

This is the constructor invoked by the GaussJacksonIntegratorConstructor.

Parameters

priming_constructor	Integrator constructor for the technique used during priming.
controls	The Gauss-Jackson integration controls that drives this state integrator.
size_in	State size.
priming_controls	Integration controls used during priming.

Definition at line 100 of file gauss_jackson_simple_second_order_ode_integrator.hh.

8.12.2.4 GaussJacksonSimpleSecondOrderODEIntegrator() [3/3]

```
jeod::GaussJacksonSimpleSecondOrderODEIntegrator::GaussJacksonSimpleSecondOrderODEIntegrator (
            const GaussJacksonSimpleSecondOrderODEIntegrator & src ) [inline]
```

Copy constructor.

Parameters

src	Item to be copied.

Definition at line 113 of file gauss_jackson_simple_second_order_ode_integrator.hh.

8.12.3 Member Function Documentation

8.12.3.1 create_copy()

```
er7_utils::SecondOrderODEIntegrator* jeod::GaussJacksonSimpleSecondOrderODEIntegrator::create←
_copy ( ) const [inline], [override]
```

Replicate this.

Returns

Replicate of this.

Definition at line 143 of file gauss_jackson_simple_second_order_ode_integrator.hh.

8.12.3.2 integrate()

```
er7_utils::IntegratorResult jeod::GaussJacksonSimpleSecondOrderODEIntegrator::integrate (
            double dyn_dt,
            unsigned int target_stage,
            const double * acc,
            double * vel,
            double * pos ) [inline], [override]
```

Propagate state using Gauss-Jackson.

Parameters

in	*dyn_dt*	Dynamic time step, in dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in	*acc*	Acceleration vector.
in,out	*vel*	Velocity vector.
in,out	*pos*	Position vector.

Returns

The status (time advance, pass/fail status) of the integration.

Definition at line 167 of file gauss_jackson_simple_second_order_ode_integrator.hh.

8.12.3.3 operator=()

```
GaussJacksonSimpleSecondOrderODEIntegrator& jeod::GaussJacksonSimpleSecondOrderODEIntegrator←
::operator= (
            GaussJacksonSimpleSecondOrderODEIntegrator src ) [inline]
```

Copy and swap assignment operator.

Parameters

src	Item to be copied.

Definition at line 123 of file gauss_jackson_simple_second_order_ode_integrator.hh.

8.12.3.4 reset_integrator()

```
void jeod::GaussJacksonSimpleSecondOrderODEIntegrator::reset_integrator ( )  [inline], [override]
```

Reset the integrator.

Definition at line 151 of file gauss_jackson_simple_second_order_ode_integrator.hh.

8.12.3.5 swap() [1/2]

```
void jeod::GaussJacksonSimpleSecondOrderODEIntegrator::swap (
            GaussJacksonSimpleSecondOrderODEIntegrator & other )  [inline]
```

Non-throwing swap.

Parameters

other	Item whose contents are to be swapped with this.

Definition at line 133 of file gauss_jackson_simple_second_order_ode_integrator.hh.

Referenced by jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator::swap().

8.12.3.6 swap() [2/2]

```
void jeod::GaussJacksonIntegratorBase< State, Primer >::swap  [inline], [private]
```

Non-throwing swap.

Parameters

other	Item whose contents are to be swapped with this.

Definition at line 397 of file gauss_jackson_integrator_base.hh.

8.12.4 Friends And Related Function Documentation

8.12.4.1 init_attrjeod__GaussJacksonSimpleSecondOrderODEIntegrator

```
void init_attrjeod__GaussJacksonSimpleSecondOrderODEIntegrator ( ) [friend]
```

8.12.4.2 InputProcessor

```
friend class InputProcessor [friend]
```

Definition at line 86 of file gauss_jackson_simple_second_order_ode_integrator.hh.

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

- gauss_jackson_simple_second_order_ode_integrator.hh

8.13 jeod::GaussJacksonStateMachine Class Reference

Guides the behavior of the Gauss-Jackson integration process via a finite state machine.

```
#include <gauss_jackson_state_machine.hh>
```

Public Types

- enum FsmState {
  Reset, Priming, BootstrapEdit, BootstrapStep,
  Operational }

  Specifies the Gauss-Jackson finite state machine states.

Public Member Functions

- GaussJacksonStateMachine ()=default
  Default constructor.
- FsmState get_fsm_state () const
  Get the finite state machine state.
- unsigned int get_max_history_size () const
  Get the maximum history size.
- unsigned int get_current_order () const
  Get the current order.
- unsigned int get_history_length () const
  Get the current history length.
- double get_cycle_scale () const
  Get the current time scale factor.
- double get_cycle_start_time () const
  Get the current cycle start time.
- bool get_at_downsample () const
  Get the at_downsample flag.
- bool get_at_reinitialize () const
  Get the at_reinitialize flag.
- bool get_at_order_change () const
  Get the at_order_change flag.
- bool get_at_end_of_tour () const
  Get the at_end_of_tour flag.
- void set_bootstrap_edit_redo_needed ()
  Tell the state machine that the edit did not pass a convergence test.
- void configure (const GaussJacksonConfig &config)
  Configure (or reconfigure) the Gauss-Jackson state machine.
- void reset ()
  Reset the Gauss-Jackson state machine.
- void perform_step ()
  Advance the state machine by one step.

Static Public Member Functions

- static std::string state_name (FsmState state)
  Translates a finite state machine state value to a string.

Private Member Functions

- void transition_state ()
  Make a state transition.
- void exit_priming ()
  Make the transition out of Priming.
- void exit_bootstrap_edit ()
  Make a transition out of BootstrapEdit.
- void exit_bootstrap_step ()
  Make a transition out of BootstrapStep.

Private Attributes

- unsigned int initial_order {}

  The order to be used immediately after priming is complete.
- unsigned int final_order {}

  The order to be used in operational mode.
- unsigned int ndoubling_steps {}

  The number of times the time step is to be doubled between priming and operational modes.
- unsigned int max_correction_iterations {}

  The maximum number of corrections to be performed.
- unsigned int max_history_size {}

  The maximum history size.
- unsigned int tour_count {}

  The number of small steps that represent a step to the simulation engine, 2∗∗n_doubling_steps.
- FsmState fsm_state {Reset}

  The finite state machine state.
- unsigned int current_order {}

  The current order.
- unsigned int history_size {}

  The current history size, the number of history elements that must be be accumulated to transition to the next state.
- unsigned int history_length {}

  The current history length, the number of history elements that have been accumulated so far.
- unsigned int scale_factor {}

  A power of two that starts at 2∗∗ndoubling_steps and is halved with each downsample.
- unsigned int step_increment {}

  A power of two that starts at 1 and is doubled with each downsample.
- unsigned int steps_since_reset {}

  The number of steps since the reset, measured in units of priming cycle steps.
- unsigned int correction_iterations {}

  The number of correction iterations made during BoostrapEdit.
- double cycle_scale {}

  The unitless time step size of the current integration cycle, measured in integration tour time step units.
- double cycle_start_time {}

  The unitless start time of the current integration cycle, measured in integration tour time step units.
- bool bootstrap_edit_redo_needed {}

  Flag indicating that the current edit sequence has failed to converge.
- bool at_downsample {}

  Flag indicating that history data are to be downsampled and the time step is to be doubled.
- bool at_reinitialize {}

  Flag indicating that the Gauss-Jackson integration constants are to be reinitialized.
- bool at_order_change {}

  Flag indicating that the order is to be increased.
- bool at_end_of_tour {}

  Flag indicating that the current integration cycle is the last one in an integration tour (i.e., that a major time step will be completed).

Friends

- class InputProcessor
- void init_attrjeod__GaussJacksonStateMachine ()

8.13.1 Detailed Description

Guides the behavior of the Gauss-Jackson integration process via a finite state machine.

The Gauss-Jackson integration process comprises four distinct modes:

- Priming: Using an alternate integrator, the primer, to build the requisite number of data points needed by the initial Gauss-Jackson algorithm.
- Editing: Using a Gauss-Jackson mid-corrector to make the collected data consistent with the Gauss-Jackson technique.
- Stepping: Using a Gauss-Jackson predictor/corrector to build the requisite number of data points needed by the next step of the Gauss-Jackson algorithm.
- Operational: Using the Gauss-Jackson predictor/corrector at the final user-specified time step and order.

Definition at line 89 of file gauss_jackson_state_machine.hh.

8.13.2 Member Enumeration Documentation

8.13.2.1 FsmState

`enum jeod::GaussJacksonStateMachine::FsmState`

Specifies the Gauss-Jackson finite state machine states.

Enumerator

Reset	Module was just commanded to reset itself.
Priming	Using primer to build initial set of data.
BootstrapEdit	Editing primer / lower-level Gauss-Jackson data.
BootstrapStep	Building toward downsample / change in order.
Operational	At desired rate and order.

Definition at line 95 of file gauss_jackson_state_machine.hh.

8.13.3 Constructor & Destructor Documentation

8.13.3.1 GaussJacksonStateMachine()

`jeod::GaussJacksonStateMachine::GaussJacksonStateMachine ( ) [default]`

Default constructor.

8.13.4 Member Function Documentation

8.13.4.1 configure()

```
void jeod::GaussJacksonStateMachine::configure (
            const GaussJacksonConfig & config )
```

Configure (or reconfigure) the Gauss-Jackson state machine.

Definition at line 55 of file gauss_jackson_state_machine.cc.

References jeod::GaussJacksonConfig::final_order, final_order, jeod::GaussJacksonConfig::initial_order, initial_order, jeod::GaussJacksonConfig::max_correction_iterations, max_correction_iterations, max_history_size, jeod::GaussJacksonConfig::ndoubling_steps, ndoubling_steps, and tour_count.

Referenced by jeod::GaussJacksonIntegrationControls::GaussJacksonIntegrationControls().

8.13.4.2 exit_bootstrap_edit()

```
void jeod::GaussJacksonStateMachine::exit_bootstrap_edit ( )  [private]
```

Make a transition out of BootstrapEdit.

Definition at line 197 of file gauss_jackson_state_machine.cc.

References at_reinitialize, bootstrap_edit_redo_needed, BootstrapEdit, BootstrapStep, correction_iterations, current_order, final_order, fsm_state, history_length, history_size, Operational, scale_factor, step_increment, and steps_since_reset.

Referenced by exit_bootstrap_step(), exit_priming(), and transition_state().

8.13.4.3 exit_bootstrap_step()

```
void jeod::GaussJacksonStateMachine::exit_bootstrap_step ( )  [private]
```

Make a transition out of BootstrapStep.

Definition at line 252 of file gauss_jackson_state_machine.cc.

References at_downsample, at_order_change, at_reinitialize, bootstrap_edit_redo_needed, BootstrapEdit, correction_iterations, current_order, cycle_scale, exit_bootstrap_edit(), final_order, fsm_state, history_length, history_size, max_correction_iterations, scale_factor, and step_increment.

Referenced by transition_state().

8.13.4.4 exit_priming()

```
void jeod::GaussJacksonStateMachine::exit_priming ( ) [private]
```

Make the transition out of Priming.

Definition at line 174 of file gauss_jackson_state_machine.cc.

References at_order_change, at_reinitialize, bootstrap_edit_redo_needed, BootstrapEdit, correction_iterations, current_order, exit_bootstrap_edit(), fsm_state, history_length, initial_order, and max_correction_iterations.

Referenced by transition_state().

8.13.4.5 get_at_downsample()

```
bool jeod::GaussJacksonStateMachine::get_at_downsample ( ) const [inline]
```

Get the at_downsample flag.

Definition at line 171 of file gauss_jackson_state_machine.hh.

Referenced by jeod::GaussJacksonIntegrationControls::start_cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle().

8.13.4.6 get_at_end_of_tour()

```
bool jeod::GaussJacksonStateMachine::get_at_end_of_tour ( ) const [inline]
```

Get the at_end_of_tour flag.

Definition at line 195 of file gauss_jackson_state_machine.hh.

Referenced by jeod::GaussJacksonIntegrationControls::start_cycle().

8.13.4.7 get_at_order_change()

```
bool jeod::GaussJacksonStateMachine::get_at_order_change ( ) const [inline]
```

Get the at_order_change flag.

Definition at line 187 of file gauss_jackson_state_machine.hh.

Referenced by jeod::GaussJacksonIntegrationControls::start_cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle().

8.13.4.8 get_at_reinitialize()

```
bool jeod::GaussJacksonStateMachine::get_at_reinitialize ( ) const [inline]
```

Get the at_reinitialize flag.

Definition at line 179 of file gauss_jackson_state_machine.hh.

Referenced by jeod::GaussJacksonIntegrationControls::start_cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle().

8.13.4.9 get_current_order()

```
unsigned int jeod::GaussJacksonStateMachine::get_current_order ( ) const [inline]
```

Get the current order.

Definition at line 139 of file gauss_jackson_state_machine.hh.

Referenced by jeod::GaussJacksonIntegrationControls::start_cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle().

8.13.4.10 get_cycle_scale()

```
double jeod::GaussJacksonStateMachine::get_cycle_scale ( ) const [inline]
```

Get the current time scale factor.

Definition at line 155 of file gauss_jackson_state_machine.hh.

Referenced by jeod::GaussJacksonIntegrationControls::integrate(), and jeod::GaussJacksonIntegrationControls↩ ::start_cycle().

8.13.4.11 get_cycle_start_time()

```
double jeod::GaussJacksonStateMachine::get_cycle_start_time ( ) const [inline]
```

Get the current cycle start time.

Definition at line 163 of file gauss_jackson_state_machine.hh.

Referenced by jeod::GaussJacksonIntegrationControls::start_cycle().

8.13.4.12 get_fsm_state()

`FsmState jeod::GaussJacksonStateMachine::get_fsm_state ( ) const [inline]`

Get the finite state machine state.

Definition at line 123 of file gauss_jackson_state_machine.hh.

Referenced by jeod::GaussJacksonIntegrationControls::start_cycle(), and jeod::GaussJacksonIntegratorBase< State, Primer >::start_cycle().

8.13.4.13 get_history_length()

`unsigned int jeod::GaussJacksonStateMachine::get_history_length ( ) const [inline]`

Get the current history length.

Definition at line 147 of file gauss_jackson_state_machine.hh.

Referenced by jeod::GaussJacksonIntegrationControls::integrate_edit().

8.13.4.14 get_max_history_size()

`unsigned int jeod::GaussJacksonStateMachine::get_max_history_size ( ) const [inline]`

Get the maximum history size.

Definition at line 131 of file gauss_jackson_state_machine.hh.

8.13.4.15 perform_step()

`void jeod::GaussJacksonStateMachine::perform_step ( )`

Advance the state machine by one step.

Definition at line 103 of file gauss_jackson_state_machine.cc.

References at_downsample, at_end_of_tour, at_order_change, at_reinitialize, BootstrapEdit, cycle_start_time, fsm_state, history_length, history_size, step_increment, steps_since_reset, tour_count, and transition_state().

Referenced by jeod::GaussJacksonIntegrationControls::start_cycle().

8.13.4.16 reset()

```
void jeod::GaussJacksonStateMachine::reset ( )
```

Reset the Gauss-Jackson state machine.

Definition at line 71 of file gauss_jackson_state_machine.cc.

References at_downsample, at_end_of_tour, at_order_change, at_reinitialize, current_order, cycle_scale, cycle_↩ start_time, fsm_state, history_length, history_size, initial_order, Reset, scale_factor, step_increment, steps_since↩ _reset, and tour_count.

Referenced by jeod::GaussJacksonIntegrationControls::reset_integrator().

8.13.4.17 set_bootstrap_edit_redo_needed()

```
void jeod::GaussJacksonStateMachine::set_bootstrap_edit_redo_needed ( )
```

Tell the state machine that the edit did not pass a convergence test.

Definition at line 96 of file gauss_jackson_state_machine.cc.

References bootstrap_edit_redo_needed, BootstrapEdit, correction_iterations, fsm_state, and max_correction_↩ iterations.

Referenced by jeod::GaussJacksonIntegrationControls::integrate_edit().

8.13.4.18 state_name()

```
std::string jeod::GaussJacksonStateMachine::state_name (
            FsmState state )  [static]
```

Translates a finite state machine state value to a string.

Definition at line 30 of file gauss_jackson_state_machine.cc.

References BootstrapEdit, BootstrapStep, Operational, Priming, and Reset.

8.13.4.19 transition_state()

```
void jeod::GaussJacksonStateMachine::transition_state ( )  [private]
```

Make a state transition.

Definition at line 131 of file gauss_jackson_state_machine.cc.

References BootstrapEdit, BootstrapStep, current_order, exit_bootstrap_edit(), exit_bootstrap_step(), exit_↩ priming(), fsm_state, history_size, initial_order, Operational, Priming, Reset, and steps_since_reset.

Referenced by perform_step().

8.13.5 Friends And Related Function Documentation

8.13.5.1 init_attrjeod__GaussJacksonStateMachine

```
void init_attrjeod__GaussJacksonStateMachine ( )  [friend]
```

8.13.5.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 91 of file gauss_jackson_state_machine.hh.

8.13.6 Field Documentation

8.13.6.1 at_downsample

```
bool jeod::GaussJacksonStateMachine::at_downsample {}  [private]
```

Flag indicating that history data are to be downsampled and the time step is to be doubled.

The flag is set on transitions from BootstrapStep to BootstrapEdit when the step size has not yet reached the desired value, clear otherwise.trick_units(–)

Definition at line 330 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_step(), perform_step(), and reset().

8.13.6.2 at_end_of_tour

```
bool jeod::GaussJacksonStateMachine::at_end_of_tour {}  [private]
```

Flag indicating that the current integration cycle is the last one in an integration tour (i.e., that a major time step will be completed).

The flag is set at the start of the cycle that completes the tour, clear otherwise. This flag is never set during BootstrapEdit.trick_units(–)

Definition at line 352 of file gauss_jackson_state_machine.hh.

Referenced by perform_step(), and reset().

8.13.6.3 at_order_change

```
bool jeod::GaussJacksonStateMachine::at_order_change {}  [private]
```

Flag indicating that the order is to be increased.

The flag is set on on transitions from BootstrapStep to BootstrapEdit when the order has has not yet reached the desired value, clear otherwise.trick_units(–)

Definition at line 344 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_step(), exit_priming(), perform_step(), and reset().

8.13.6.4 at_reinitialize

```
bool jeod::GaussJacksonStateMachine::at_reinitialize {}  [private]
```

Flag indicating that the Gauss-Jackson integration constants are to be reinitialized.

The flag is set on entry to any state except Reset and Priming, clear otherwise.trick_units(–)

Definition at line 337 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_edit(), exit_bootstrap_step(), exit_priming(), perform_step(), and reset().

8.13.6.5 bootstrap_edit_redo_needed

```
bool jeod::GaussJacksonStateMachine::bootstrap_edit_redo_needed {}  [private]
```

Flag indicating that the current edit sequence has failed to converge.

This flag is set externally by the Gauss-Jackson integration controls.trick_units(–)

Definition at line 322 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_edit(), exit_bootstrap_step(), exit_priming(), and set_bootstrap_edit_redo_needed().

8.13.6.6 correction_iterations

```
unsigned int jeod::GaussJacksonStateMachine::correction_iterations {}  [private]
```

The number of correction iterations made during BoostrapEdit.

trick_units(–)

Definition at line 303 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_edit(), exit_bootstrap_step(), exit_priming(), and set_bootstrap_edit_redo_needed().

8.13.6.7 current_order

```
unsigned int jeod::GaussJacksonStateMachine::current_order {} [private]
```

The current order.

This is incremented by two on transitions from BootstrapStep to BootstrapEdit until the final_order is reached.trick↩_units(–)

Definition at line 267 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_edit(), exit_bootstrap_step(), exit_priming(), reset(), and transition_state().

8.13.6.8 cycle_scale

```
double jeod::GaussJacksonStateMachine::cycle_scale {} [private]
```

The unitless time step size of the current integration cycle, measured in integration tour time step units.

This starts at 2∗∗(-ndoubling_steps) and doubles with each downsample.trick_units(–)

Definition at line 310 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_step(), and reset().

8.13.6.9 cycle_start_time

```
double jeod::GaussJacksonStateMachine::cycle_start_time {} [private]
```

The unitless start time of the current integration cycle, measured in integration tour time step units.

trick_units(–)

Definition at line 316 of file gauss_jackson_state_machine.hh.

Referenced by perform_step(), and reset().

8.13.6.10 final_order

```
unsigned int jeod::GaussJacksonStateMachine::final_order {} [private]
```

The order to be used in operational mode.

This must be an even integer and must not be less than initial_order.trick_units(–)

Definition at line 233 of file gauss_jackson_state_machine.hh.

Referenced by configure(), exit_bootstrap_edit(), and exit_bootstrap_step().

8.13.6.11 fsm_state

`FsmState jeod::GaussJacksonStateMachine::fsm_state {Reset} [private]`

The finite state machine state.

trick_units(–)

Definition at line 261 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_edit(), exit_bootstrap_step(), exit_priming(), perform_step(), reset(), set_bootstrap↩_edit_redo_needed(), and transition_state().

8.13.6.12 history_length

`unsigned int jeod::GaussJacksonStateMachine::history_length {} [private]`

The current history length, the number of history elements that have been accumulated so far.

trick_units(–)

Definition at line 279 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_edit(), exit_bootstrap_step(), exit_priming(), perform_step(), and reset().

8.13.6.13 history_size

`unsigned int jeod::GaussJacksonStateMachine::history_size {} [private]`

The current history size, the number of history elements that must be be accumulated to transition to the next state.

trick_units(–)

Definition at line 273 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_edit(), exit_bootstrap_step(), perform_step(), reset(), and transition_state().

8.13.6.14 initial_order

`unsigned int jeod::GaussJacksonStateMachine::initial_order {} [private]`

The order to be used immediately after priming is complete.

This must be an even, non-negative integer.trick_units(–)

Definition at line 227 of file gauss_jackson_state_machine.hh.

Referenced by configure(), exit_priming(), reset(), and transition_state().

8.13.6.15 max_correction_iterations

`unsigned int jeod::GaussJacksonStateMachine::max_correction_iterations {} [private]`

The maximum number of corrections to be performed.

trick_units(–)

Definition at line 244 of file gauss_jackson_state_machine.hh.

Referenced by configure(), exit_bootstrap_step(), exit_priming(), and set_bootstrap_edit_redo_needed().

8.13.6.16 max_history_size

`unsigned int jeod::GaussJacksonStateMachine::max_history_size {} [private]`

The maximum history size.

This is calculated for the benefit of state integrators.trick_units(–)

Definition at line 250 of file gauss_jackson_state_machine.hh.

Referenced by configure().

8.13.6.17 ndoubling_steps

`unsigned int jeod::GaussJacksonStateMachine::ndoubling_steps {} [private]`

The number of times the time step is to be doubled between priming and operational modes.

trick_units(–)

Definition at line 239 of file gauss_jackson_state_machine.hh.

Referenced by configure().

8.13.6.18 scale_factor

`unsigned int jeod::GaussJacksonStateMachine::scale_factor {} [private]`

A power of two that starts at 2∗∗ndoubling_steps and is halved with each downsample.

When the scale_factor reaches 1 it is time to transition to operational mode.trick_units(–)

Definition at line 286 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_edit(), exit_bootstrap_step(), and reset().

8.13.6.19 step_increment

`unsigned int jeod::GaussJacksonStateMachine::step_increment {} [private]`

A power of two that starts at 1 and is doubled with each downsample.

trick_units(–)

Definition at line 291 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_edit(), exit_bootstrap_step(), perform_step(), and reset().

8.13.6.20 steps_since_reset

`unsigned int jeod::GaussJacksonStateMachine::steps_since_reset {} [private]`

The number of steps since the reset, measured in units of priming cycle steps.

The counter is incremented by the step_increment upon completion of a cycle and is reset to zero on entry into BootstrapEdit.trick_units(–)

Definition at line 298 of file gauss_jackson_state_machine.hh.

Referenced by exit_bootstrap_edit(), perform_step(), reset(), and transition_state().

8.13.6.21 tour_count

`unsigned int jeod::GaussJacksonStateMachine::tour_count {} [private]`

The number of small steps that represent a step to the simulation engine, 2**n_doubling_steps.

trick_units(–)

Definition at line 256 of file gauss_jackson_state_machine.hh.

Referenced by configure(), perform_step(), and reset().

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

- gauss_jackson_state_machine.hh
- gauss_jackson_state_machine.cc

8.14 jeod::GaussJacksonTwoState Class Reference

Essentially just std::pair<double*>.

`#include <gauss_jackson_two_state.hh>`

Public Member Functions

- GaussJacksonTwoState ()=default
  Default constructor.
- GaussJacksonTwoState (double ∗first_in, double ∗second_in)
  Non-default constructor.

Data Fields

- double ∗ first {}
  The first element of the pair.
- double ∗ second {}
  The second element of the pair.

Friends

- class InputProcessor
- void init_attrjeod__GaussJacksonTwoState ()

8.14.1 Detailed Description

Essentially just std::pair<double∗>.

Definition at line 72 of file gauss_jackson_two_state.hh.

8.14.2 Constructor & Destructor Documentation

8.14.2.1 GaussJacksonTwoState() [1/2]

```
jeod::GaussJacksonTwoState::GaussJacksonTwoState ( )  [default]
```

Default constructor.

8.14.2.2 GaussJacksonTwoState() [2/2]

```
jeod::GaussJacksonTwoState::GaussJacksonTwoState (
            double * first_in,
            double * second_in )  [inline]
```

Non-default constructor.

Parameters

first_in	The first element of the pair.
second↩ _in	The second element of the pair.

Definition at line 95 of file gauss_jackson_two_state.hh.

8.14.3 Friends And Related Function Documentation

8.14.3.1 init_attrjeod__GaussJacksonTwoState

```
void init_attrjeod__GaussJacksonTwoState ( )  [friend]
```

8.14.3.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 74 of file gauss_jackson_two_state.hh.

8.14.4 Field Documentation

8.14.4.1 first

```
double* jeod::GaussJacksonTwoState::first {}
```

The first element of the pair.

trick_units(--)

Definition at line 78 of file gauss_jackson_two_state.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::allocate_state_contents(), jeod::Gauss↩ JacksonIntegratorBase< State, Primer >::correct(), jeod::GaussJacksonIntegratorBase< State, Primer >↩ ::deallocate_state_contents(), jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_primer(), jeod↩ ::GaussJacksonIntegratorBase< State, Primer >::mid_correct(), jeod::GaussJacksonIntegratorBase< State, Primer >::predict(), jeod::GaussJacksonIntegratorBase< State, Primer >::replicate_state(), jeod::GaussJackson↩ IntegratorBase< State, Primer >::save_epoch_data(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap_state().

8.14.4.2 second

```
double* jeod::GaussJacksonTwoState::second {}
```

The second element of the pair.

trick_units(--)

Definition at line 83 of file gauss_jackson_two_state.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::allocate_state_contents(), jeod::GaussJacksonIntegratorBase< State, Primer >::correct(), jeod::GaussJacksonIntegratorBase< State, Primer >::deallocate_state_contents(), jeod::GaussJacksonIntegratorBase< State, Primer >::integrate_primer(), jeod::GaussJacksonIntegratorBase< State, Primer >::mid_correct(), jeod::GaussJacksonIntegratorBase< State, Primer >::predict(), jeod::GaussJacksonIntegratorBase< State, Primer >::replicate_state(), jeod::GaussJacksonIntegratorBase< State, Primer >::save_comparison_data(), jeod::GaussJacksonIntegratorBase< State, Primer >::save_epoch_data(), jeod::GaussJacksonIntegratorBase< State, Primer >::swap_state(), and jeod::GaussJacksonIntegratorBase< State, Primer >::test_for_convergence().

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

- gauss_jackson_two_state.hh

8.15 jeod::GeneralizedSecondOrderODETechnique Class Reference

Enumerates the integration schemes, generalized Cartesian or Lie group integration, and provides simple utilities that work with this.

```
#include <generalized_second_order_ode_technique.hh>
```

Public Types

- enum TechniqueType { Unspecified, Cartesian, LieGroup }

  Enumerates the types of second order ODE solvers that can be used to integrate a generalized second order ODE.

Public Member Functions

- GeneralizedSecondOrderODETechnique ()=delete
- GeneralizedSecondOrderODETechnique (const GeneralizedSecondOrderODETechnique &)=delete
- GeneralizedSecondOrderODETechnique & operator= (const GeneralizedSecondOrderODETechnique &)=delete

Static Public Member Functions

- static bool is_provided_by (const er7_utils::IntegratorConstructor &generator, TechniqueType technique)

  Test whether an integration method provides an integrator for the specified technique.
- static TechniqueType validate_technique (const er7_utils::IntegratorConstructor &generator, TechniqueType technique, const char *file, unsigned int line, const char *requester, const char *name)

  Validate the specified technique with respect to the integration method.

Private Member Functions

- ∼GeneralizedSecondOrderODETechnique ()

8.15.1 Detailed Description

Enumerates the integration schemes, generalized Cartesian or Lie group integration, and provides simple utilities that work with this.

Definition at line 78 of file generalized_second_order_ode_technique.hh.

8.15.2 Member Enumeration Documentation

8.15.2.1 TechniqueType

```
enum jeod::GeneralizedSecondOrderODETechnique::TechniqueType
```

Enumerates the types of second order ODE solvers that can be used to integrate a generalized second order ODE.

Enumerator

Unspecified	No technique specified (an error).
Cartesian	Integrate using a generalized derivative scheme. The integrator treats generalized position as if it lives in some Cartesian space.
LieGroup	Integrate using a generalized step scheme. The integrator treats generalized position as if it lives in some Lie group.

Definition at line 91 of file generalized_second_order_ode_technique.hh.

8.15.3 Constructor & Destructor Documentation

8.15.3.1 GeneralizedSecondOrderODETechnique() [1/2]

```
jeod::GeneralizedSecondOrderODETechnique::GeneralizedSecondOrderODETechnique ( )  [delete]
```

8.15.3.2 GeneralizedSecondOrderODETechnique() [2/2]

```
jeod::GeneralizedSecondOrderODETechnique::GeneralizedSecondOrderODETechnique (
            const GeneralizedSecondOrderODETechnique &  )  [delete]
```

8.15.3.3 ∼GeneralizedSecondOrderODETechnique()

```
jeod::GeneralizedSecondOrderODETechnique::∼GeneralizedSecondOrderODETechnique ( ) [private]
```

8.15.4 Member Function Documentation

8.15.4.1 is_provided_by()

```
bool jeod::GeneralizedSecondOrderODETechnique::is_provided_by (
            const er7_utils::IntegratorConstructor & generator,
            TechniqueType technique ) [static]
```

Test whether an integration method provides an integrator for the specified technique.

Parameters

in	*generator*	Integrator constructor for the integration technique.
in	*technique*	Technique to be queried.

Returns

True if the constructor can create an integrator for the specified technique, false otherwise.

Definition at line 41 of file generalized_second_order_ode_technique.cc.

References Cartesian, jeod::IntegrationMessages::invalid_request, LieGroup, and Unspecified.

Referenced by validate_technique().

8.15.4.2 operator=()

```
GeneralizedSecondOrderODETechnique& jeod::GeneralizedSecondOrderODETechnique::operator= (
            const GeneralizedSecondOrderODETechnique & ) [delete]
```

8.15.4.3 validate_technique()

```
GeneralizedSecondOrderODETechnique::TechniqueType jeod::GeneralizedSecondOrderODETechnique↩
::validate_technique (
            const er7_utils::IntegratorConstructor & generator,
            TechniqueType technique,
            const char * file,
            unsigned int line,
            const char * requester,
            const char * name ) [static]
```

Validate the specified technique with respect to the integration method.

Possible outcomes are:

- Failure if the generator doesn't provide either of the generalized second order ODE integrators.
- Switch to plan B if the generator doesn't provide the requested integrator but does provide the alternate technique.
- Nothing happens if the generator does provide the requested integrator.

Parameters

in	*generator*	Integrator constructor for the integration technique.
in	*technique*	Technique to be queried.
in	*file*	Typically **FILE**
in	*line*	Typically **LINE**
in	*requester*	Something to identify the caller.
in	*name*	The name of the object associated with the caller.

Returns

Input technique if supported, alternate if not. The function does not return is neither of the options is supported.

Definition at line 65 of file generalized_second_order_ode_technique.cc.

References Cartesian, jeod::IntegrationMessages::invalid_request, is_provided_by(), LieGroup, and jeod::↩
IntegrationMessages::unsupported_option.

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

- generalized_second_order_ode_technique.hh
- generalized_second_order_ode_technique.cc

8.16 jeod::IntegrationMessages Class Reference

Declares messages associated with the integration test model.

```
#include <integration_messages.hh>
```

Public Member Functions

- IntegrationMessages ()=delete
- IntegrationMessages (const IntegrationMessages &)=delete
- IntegrationMessages & operator= (const IntegrationMessages &)=delete

Static Public Attributes

- static const char * unsupported_option = "utils/integration/" "unsupported_option"

    Issued when some user input is invalid.
- static const char * invalid_item = "utils/integration/" "invalid_item"

    Issued when an item is somehow invalid; a duplicate entry for example.
- static const char * internal_error = "utils/integration/" "internal_error"

    Issued when the JEOD programmer messed up.
- static const char * invalid_request = "utils/integration/" "invalid_request"

    Issued when a non-JEOD programmer messed up.
- static const char * information = "utils/integration/" "information"

    Issued in non-error messages.

Friends

- class InputProcessor
- void init_attrjeod__IntegrationMessages ()

8.16.1 Detailed Description

Declares messages associated with the integration test model.

Definition at line 82 of file integration_messages.hh.

8.16.2 Constructor & Destructor Documentation

8.16.2.1 IntegrationMessages() [1/2]

```
jeod::IntegrationMessages::IntegrationMessages ( )  [delete]
```

8.16.2.2 IntegrationMessages() [2/2]

```
jeod::IntegrationMessages::IntegrationMessages (
            const IntegrationMessages & )  [delete]
```

8.16.3 Member Function Documentation

8.16.3.1 operator=()

```
IntegrationMessages& jeod::IntegrationMessages::operator= (
            const IntegrationMessages & )  [delete]
```

8.16.4 Friends And Related Function Documentation

8.16.4.1 init_attrjeod__IntegrationMessages

```
void init_attrjeod__IntegrationMessages ( )  [friend]
```

8.16.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 84 of file integration_messages.hh.

8.16.5 Field Documentation

8.16.5.1 information

```
char const * jeod::IntegrationMessages::information = "utils/integration/" "information"  [static]
```

Issued in non-error messages.

trick_units(–)

Definition at line 110 of file integration_messages.hh.

8.16.5.2 internal_error

```
char const * jeod::IntegrationMessages::internal_error = "utils/integration/" "internal_error"
[static]
```

Issued when the JEOD programmer messed up.

trick_units(–)

Definition at line 100 of file integration_messages.hh.

8.16.5.3 invalid_item

```
char const * jeod::IntegrationMessages::invalid_item = "utils/integration/" "invalid_item"
[static]
```

Issued when an item is somehow invalid; a duplicate entry for example.

trick_units(–)

Definition at line 95 of file integration_messages.hh.

Referenced by jeod::JeodIntegrationGroup::remove_integrable_object().

8.16.5.4 invalid_request

```
char const * jeod::IntegrationMessages::invalid_request = "utils/integration/" "invalid_↩
request" [static]
```

Issued when a non-JEOD programmer messed up.

trick_units(–)

Definition at line 105 of file integration_messages.hh.

Referenced by jeod::JeodIntegrationTime::add_time_change_subscriber(), jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >::create_integrator(), jeod::GeneralizedSecondOrderODETechnique::is↩ _provided_by(), jeod::JeodIntegrationTime::remove_time_change_subscriber(), and jeod::GeneralizedSecond↩ OrderODETechnique::validate_technique().

8.16.5.5 unsupported_option

```
char const * jeod::IntegrationMessages::unsupported_option = "utils/integration/" "unsupported←
_option"  [static]
```

Issued when some user input is invalid.

trick_units(–)

Definition at line 90 of file integration_messages.hh.

Referenced by jeod::GeneralizedSecondOrderODETechnique::validate_technique().

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

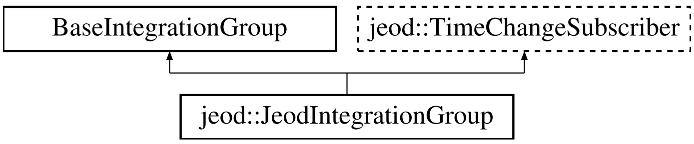
- integration_messages.hh
- integration_messages.cc

8.17 jeod::JeodIntegrationGroup Class Reference

A JeodIntegrationGroup integrates the state of a set of objects over time.

```
#include <jeod_integration_group.hh>
```

Inheritance diagram for jeod::JeodIntegrationGroup:



Public Member Functions

- JeodIntegrationGroup ()

  JeodIntegrationGroup default constructor, needed for checkpoint/restart, and to support derived classes' default constructors.
- JeodIntegrationGroup (JeodIntegrationGroupOwner &owner, er7_utils::IntegratorConstructor &integ_cotr, JeodIntegratorInterface &integ_inter, JeodIntegrationTime &time_mngr)

  JeodIntegrationGroup non-default constructor.
- ∼JeodIntegrationGroup () override

  JeodIntegrationGroup destructor.
- JeodIntegrationGroup (const JeodIntegrationGroup &)=delete
- JeodIntegrationGroup & operator= (const JeodIntegrationGroup &)=delete
- bool need_first_step_derivatives () const

  Indicate whether derivatives need to be calculated on the initial step of an integration cycle.
- void update_from_owner ()

  Update the group via its owner.
- bool merge_integrator_result (const er7_utils::IntegratorResult &new_result, er7_utils::IntegratorResult &merged_result) const

  Merge an IntegratorResult into another.

- void respond_to_time_change () override

  Respond to a change in the nature of time.
- void initialize_group () override

  Initialize the integration group.
- void reset_body_integrators () override

  Reset the integrators for the integrable objects managed by this group.
- er7_utils::IntegratorResult integrate_bodies (double cycle_dyndt, unsigned int target_stage) override

  Integrate the states of the integrable objects managed by this group.
- virtual void add_integrable_object (er7_utils::IntegrableObject &integrable_object)

  Add an integrable object to the vector of such.
- virtual void remove_integrable_object (er7_utils::IntegrableObject &integrable_object)

  Remove an integrable object from the vector of such.

Static Public Member Functions

- static void register_classes ()

  Register classes associated with integration.

Protected Member Functions

- template< typename T >
  void reset_container (const T &container)

  Issue a reset to each member of a container.
- template< typename T >
  er7_utils::IntegratorResult integrate_container (double dyn_dt, unsigned int target_stage, const T &container)

  Integrate each member of a collection.

Protected Attributes

- JeodIntegrationGroupOwner *const group_owner {}

  The object that owns this integration group, typically by containment.
- er7_utils::IntegratorResultMergerContainer integ_merger

  The object that merges results from multiple integrators.
- JeodIntegratorInterface *const jeod_integ_interface {}

  The interface between the integration module and the simulation engine's integration structure.
- JeodIntegrationTime *const jeod_time_manager {}

  The interface between the integration module and the object that represents time.
- JeodPointerVector< er7_utils::IntegrableObject >::type integrable_objects

  The objects whose states are integrated by this integration group.

Friends

- class InputProcessor
- void init_attrjeod__JeodIntegrationGroup ()

8.17.1 Detailed Description

A JeodIntegrationGroup integrates the state of a set of objects over time.

This class is designed for extensibility. Authors of derived classes should follow the extension notes in the source file.

Definition at line 115 of file jeod_integration_group.hh.

8.17.2 Constructor & Destructor Documentation

8.17.2.1 JeodIntegrationGroup() [1/3]

```
jeod::JeodIntegrationGroup::JeodIntegrationGroup ( )
```

JeodIntegrationGroup default constructor, needed for checkpoint/restart, and to support derived classes' default constructors.

Definition at line 60 of file jeod_integration_group.cc.

References integrable_objects, and register_classes().

8.17.2.2 JeodIntegrationGroup() [2/3]

```
jeod::JeodIntegrationGroup::JeodIntegrationGroup (
            JeodIntegrationGroupOwner & owner,
            er7_utils::IntegratorConstructor & integ_cotr,
            JeodIntegratorInterface & integ_inter,
            JeodIntegrationTime & time_mngr )
```

JeodIntegrationGroup non-default constructor.

Parameters

in	*owner*	The object that contains this group.
in	*integ_cotr*	Integrator constructor
in	*integ_inter*	Integrator interface
in	*time_mngr*	Time manager

Definition at line 68 of file jeod_integration_group.cc.

References jeod::JeodIntegrationTime::add_time_change_subscriber(), integ_merger, integrable_objects, and register_classes().

8.17.2.3 ∼JeodIntegrationGroup()

```
jeod::JeodIntegrationGroup::∼JeodIntegrationGroup ( )  [override]
```

JeodIntegrationGroup destructor.

Definition at line 86 of file jeod_integration_group.cc.

References integrable_objects, jeod_time_manager, and jeod::JeodIntegrationTime::remove_time_change_↩
subscriber().

8.17.2.4 JeodIntegrationGroup() [3/3]

```
jeod::JeodIntegrationGroup::JeodIntegrationGroup (
            const JeodIntegrationGroup & )  [delete]
```

8.17.3 Member Function Documentation

8.17.3.1 add_integrable_object()

```
void jeod::JeodIntegrationGroup::add_integrable_object (
            er7_utils::IntegrableObject & integrable_object )  [virtual]
```

Add an integrable object to the vector of such.

Parameters

in	*integrable_object*	Object to be added.

Definition at line 97 of file jeod_integration_group.cc.

References integrable_objects.

8.17.3.2 initialize_group()

```
void jeod::JeodIntegrationGroup::initialize_group ( )  [override]
```

Initialize the integration group.

Some integration techniques are configurable by user input, and thus the creation of the controls and integrators needs to be delayed a bit.

Definition at line 153 of file jeod_integration_group.cc.

References integrable_objects.

8.17.3.3 integrate_bodies()

```
er7_utils::IntegratorResult jeod::JeodIntegrationGroup::integrate_bodies (
            double cycle_dyndt,
            unsigned int target_stage ) [inline], [override]
```

Integrate the states of the integrable objects managed by this group.

This function should only be called by IntegrationControls::integrate or by an override of that function. Derived classes are free to override this default implementation. However, those derived class overrides either must call this method to integrate the states of the registered integrable bodies or must somehow take on the burden of integrating those states.

Parameters

in	*cycle_dyndt*	Dynamic time step, in dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.

Returns

The status (time advance, pass/fail status) of the integration.

Definition at line 234 of file jeod_integration_group.hh.

8.17.3.4 integrate_container()

```
template<typename T >
er7_utils::IntegratorResult jeod::JeodIntegrationGroup::integrate_container (
            double dyn_dt,
            unsigned int target_stage,
            const T & container ) [inline], [protected]
```

Integrate each member of a collection.

Template Parameters

T	The container type.

Parameters

in	*dyn_dt*	Dynamic time step, in dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in,out	*container*	The container to be integrated.

Definition at line 277 of file jeod_integration_group.hh.

References integ_merger.

8.17.3.5 merge_integrator_result()

```
bool jeod::JeodIntegrationGroup::merge_integrator_result (
            const er7_utils::IntegratorResult & new_result,
            er7_utils::IntegratorResult & merged_result ) const  [inline]
```

Merge an IntegratorResult into another.

Returns

True if merger was successful, false if some error occurred.

Parameters

in	*new_result*	Size of the generalized position vector
in,out	*merged_result*	Size of the generalized position vector

Definition at line 182 of file jeod_integration_group.hh.

8.17.3.6 need_first_step_derivatives()

```
bool jeod::JeodIntegrationGroup::need_first_step_derivatives ( ) const  [inline]
```

Indicate whether derivatives need to be calculated on the initial step of an integration cycle.

Returns

Desired flag.

Definition at line 163 of file jeod_integration_group.hh.

8.17.3.7 operator=()

```
JeodIntegrationGroup& jeod::JeodIntegrationGroup::operator= (
            const JeodIntegrationGroup & )  [delete]
```

8.17.3.8 register_classes()

```
void jeod::JeodIntegrationGroup::register_classes ( )  [static]
```

Register classes associated with integration.

This is a static method, and is best called prior to initialization time.

Definition at line 51 of file jeod_integration_group.cc.

Referenced by JeodIntegrationGroup().

8.17.3.9 remove_integrable_object()

```
void jeod::JeodIntegrationGroup::remove_integrable_object (
            er7_utils::IntegrableObject & integrable_object )  [virtual]
```

Remove an integrable object from the vector of such.

Parameters

in	*integrable_object*	Object to be removed.

Definition at line 125 of file jeod_integration_group.cc.

References integrable_objects, and jeod::IntegrationMessages::invalid_item.

8.17.3.10 reset_body_integrators()

```
void jeod::JeodIntegrationGroup::reset_body_integrators ( )  [inline], [override]
```

Reset the integrators for the integrable objects managed by this group.

Resets can occur when time changes behavior (call is internal to the integration process) or when some external event would render an integrator's history invalid (call comes from outside). When either happens, integrators that depend on history need to reset their internal state to indicate that the saved data are invalid.)

Definition at line 216 of file jeod_integration_group.hh.

8.17.3.11 reset_container()

```
template<typename T >
void jeod::JeodIntegrationGroup::reset_container (
            const T & container )  [inline], [protected]
```

Issue a reset to each member of a container.

Template Parameters

T	The container type.

Parameters

in,out	*container*	The container to be reset.

Definition at line 259 of file jeod_integration_group.hh.

8.17.3.12 respond_to_time_change()

```
void jeod::JeodIntegrationGroup::respond_to_time_change ( )  [inline], [override], [virtual]
```

Respond to a change in the nature of time.

Implements jeod::TimeChangeSubscriber.

Definition at line 193 of file jeod_integration_group.hh.

8.17.3.13 update_from_owner()

```
void jeod::JeodIntegrationGroup::update_from_owner ( )  [inline]
```

Update the group via its owner.

Definition at line 171 of file jeod_integration_group.hh.

8.17.4 Friends And Related Function Documentation

8.17.4.1 init_attrjeod__JeodIntegrationGroup

```
void init_attrjeod__JeodIntegrationGroup ( )  [friend]
```

8.17.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 118 of file jeod_integration_group.hh.

8.17.5 Field Documentation

8.17.5.1 group_owner

```
JeodIntegrationGroupOwner* const jeod::JeodIntegrationGroup::group_owner {}  [protected]
```

The object that owns this integration group, typically by containment.

trick_units(--)

Definition at line 298 of file jeod_integration_group.hh.

8.17.5.2 integ_merger

`er7_utils::IntegratorResultMergerContainer jeod::JeodIntegrationGroup::integ_merger [protected]`

The object that merges results from multiple integrators.

trick_units(–)

Definition at line 303 of file jeod_integration_group.hh.

Referenced by integrate_container(), and JeodIntegrationGroup().

8.17.5.3 integrable_objects

`JeodPointerVector<er7_utils::IntegrableObject>::type jeod::JeodIntegrationGroup::integrable_↩ objects [protected]`

The objects whose states are integrated by this integration group.

trick_io(**)

Definition at line 320 of file jeod_integration_group.hh.

Referenced by add_integrable_object(), initialize_group(), JeodIntegrationGroup(), remove_integrable_object(), and ∼JeodIntegrationGroup().

8.17.5.4 jeod_integ_interface

`JeodIntegratorInterface* const jeod::JeodIntegrationGroup::jeod_integ_interface {} [protected]`

The interface between the integration module and the simulation engine's integration structure.

trick_units(–)

Definition at line 309 of file jeod_integration_group.hh.

8.17.5.5 jeod_time_manager

`JeodIntegrationTime* const jeod::JeodIntegrationGroup::jeod_time_manager {} [protected]`

The interface between the integration module and the object that represents time.

trick_units(–)

Definition at line 315 of file jeod_integration_group.hh.

Referenced by ∼JeodIntegrationGroup().

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

- jeod_integration_group.hh
- jeod_integration_group.cc

8.18 jeod::JeodIntegrationGroupOwner Class Reference

The abstract class IntegrationGroupOwner contains an IntegrationGroup.

`#include <jeod_integration_group.hh>`

Public Member Functions

- virtual ~JeodIntegrationGroupOwner ()=default

  Destructor.
- virtual void update_integration_group (JeodIntegrationGroup &group)=0

  Somehow update the specified integration group.

8.18.1 Detailed Description

The abstract class IntegrationGroupOwner contains an IntegrationGroup.

This simple interface class has no data members.

Definition at line 95 of file jeod_integration_group.hh.

8.18.2 Constructor & Destructor Documentation

8.18.2.1 ~JeodIntegrationGroupOwner()

```
virtual jeod::JeodIntegrationGroupOwner::~JeodIntegrationGroupOwner ( )  [virtual], [default]
```

Destructor.

8.18.3 Member Function Documentation

8.18.3.1 update_integration_group()

```
virtual void jeod::JeodIntegrationGroupOwner::update_integration_group (
            JeodIntegrationGroup & group )  [pure virtual]
```

Somehow update the specified integration group.

Parameters

in,out	*group*	Integration group to be updated.

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

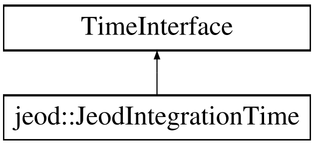
- jeod_integration_group.hh

8.19 jeod::JeodIntegrationTime Class Reference

The class JeodIntegrationTime adds the concepts of timestamping and notification of changes in the nature of time to the ER7 numerical utilities TimeInterface class.

```
#include <jeod_integration_time.hh>
```

Inheritance diagram for jeod::JeodIntegrationTime:



Public Member Functions

- JeodIntegrationTime ()
  JeodIntegrationTime constructor.
- ∼JeodIntegrationTime () override
  JeodIntegrationTime destructor.
- JeodIntegrationTime (const JeodIntegrationTime &)=delete
- JeodIntegrationTime & operator= (const JeodIntegrationTime &)=delete
- virtual double get_timestamp_time () const =0
  Get the time used to timestamp some object.
- void add_time_change_subscriber (TimeChangeSubscriber &subscriber)
  Add a time change subscriber.
- void remove_time_change_subscriber (TimeChangeSubscriber &subscriber)
  Remove a time change subscriber.

Protected Member Functions

- void notify_time_change_subscribers ()
  Notify subscribers that the nature of time has changed.

Private Attributes

- JeodPointerVector< TimeChangeSubscriber >::type time_change_subscribers
  List of pointers to objects that wish to be notified of a change in the nature of time.

Friends

- class InputProcessor
- void init_attrjeod__JeodIntegrationTime ()

8.19.1 Detailed Description

The class JeodIntegrationTime adds the concepts of timestamping and notification of changes in the nature of time to the ER7 numerical utilities TimeInterface class.

Definition at line 84 of file jeod_integration_time.hh.

8.19.2 Constructor & Destructor Documentation

8.19.2.1 JeodIntegrationTime() [1/2]

```
jeod::JeodIntegrationTime::JeodIntegrationTime ( )
```

JeodIntegrationTime constructor.

Definition at line 45 of file jeod_integration_time.cc.

References time_change_subscribers.

8.19.2.2 ∼JeodIntegrationTime()

```
jeod::JeodIntegrationTime::∼JeodIntegrationTime ( )  [override]
```

JeodIntegrationTime destructor.

Definition at line 57 of file jeod_integration_time.cc.

References time_change_subscribers.

8.19.2.3 JeodIntegrationTime() [2/2]

```
jeod::JeodIntegrationTime::JeodIntegrationTime (
            const JeodIntegrationTime & )  [delete]
```

8.19.3 Member Function Documentation

8.19.3.1 add_time_change_subscriber()

```
void jeod::JeodIntegrationTime::add_time_change_subscriber (
            TimeChangeSubscriber & subscriber )
```

Add a time change subscriber.

Parameters

subscriber	Object to be added to list of subscribers.

Definition at line 68 of file jeod_integration_time.cc.

References jeod::IntegrationMessages::invalid_request, and time_change_subscribers.

Referenced by jeod::JeodIntegrationGroup::JeodIntegrationGroup().

8.19.3.2 get_timestamp_time()

```
virtual double jeod::JeodIntegrationTime::get_timestamp_time ( ) const  [pure virtual]
```

Get the time used to timestamp some object.

8.19.3.3 notify_time_change_subscribers()

```
void jeod::JeodIntegrationTime::notify_time_change_subscribers ( )  [protected]
```

Notify subscribers that the nature of time has changed.

Definition at line 108 of file jeod_integration_time.cc.

References time_change_subscribers.

8.19.3.4 operator=()

```
JeodIntegrationTime& jeod::JeodIntegrationTime::operator= (
            const JeodIntegrationTime & )  [delete]
```

8.19.3.5 remove_time_change_subscriber()

```
void jeod::JeodIntegrationTime::remove_time_change_subscriber (
            TimeChangeSubscriber & subscriber )
```

Remove a time change subscriber.

Parameters

subscriber	Object to be removed from list of subscribers.

Definition at line 88 of file jeod_integration_time.cc.

References jeod::IntegrationMessages::invalid_request, and time_change_subscribers.

Referenced by jeod::JeodIntegrationGroup::∼JeodIntegrationGroup().

8.19.4 Friends And Related Function Documentation

8.19.4.1 init_attrjeod__JeodIntegrationTime

```
void init_attrjeod__JeodIntegrationTime ( )  [friend]
```

8.19.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 86 of file jeod_integration_time.hh.

8.19.5 Field Documentation

8.19.5.1 time_change_subscribers

```
JeodPointerVector<TimeChangeSubscriber>::type jeod::JeodIntegrationTime::time_change_subscribers
[private]
```

List of pointers to objects that wish to be notified of a change in the nature of time.

trick_io(**)

Definition at line 116 of file jeod_integration_time.hh.

Referenced by add_time_change_subscriber(), JeodIntegrationTime(), notify_time_change_subscribers(), remove_time_change_subscriber(), and ∼JeodIntegrationTime().

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

- jeod_integration_time.hh
- jeod_integration_time.cc

8.20 jeod::LsodeControlDataInterface Class Reference

Specifies controls for an LSODE integrator.

```
#include <lsode_control_data_interface.hh>
```

Public Types

- enum IntegrationMethod { ImplicitAdamsNonStiff = 1, ImplicitBackDiffStiff = 2 }
- enum CorrectorMethod {
  FunctionalIteration = 0, NewtonIterUserJac = 1, NewtonIterInternalJac = 2, JacobiNewtonInternalJac = 3,
  NewtonIterUserBandJac = 4, NewtonIterInternalBandJac = 5 }
- enum ErrorControlIndicator { CommonAbsCommonRel = 1, SpecificAbsCommonRel = 2, CommonAbsSpecificRel = 3, SpecificAbsSpecificRel = 4 }

Public Member Functions

- LsodeControlDataInterface ()

  constructor
- virtual ∼LsodeControlDataInterface ()
- LsodeControlDataInterface (const LsodeControlDataInterface &)=default
- LsodeControlDataInterface & operator= (const LsodeControlDataInterface &)=delete
- void check_interface_data ()

  verifies that the input data has legal values.
- void set_rel_tol (int index, double value)

  set values from external
- void set_abs_tol (int index, double value)
- void allocate_arrays ()

  allocates space for vector-populated data to allow for restart
- void destroy_allocated_arrays ()

  De-allocates allocated array.
- bool is_corrector_method_functional_iteration ()

  Tests whether corrector is functional iteration.

Data Fields

- ErrorControlIndicator error_control_indicator {CommonAbsCommonRel}

  Was ITOL.
- std::vector< double > abs_tolerance_error_control_vec

  Temporary pre-initialized place to store loaded error values.
- std::vector< double > rel_tolerance_error_control_vec

  Temporary pre-initialized place to store loaded error values.
- bool error_control_vector_copied_over {}
- unsigned int num_odes_at_alloc {}
- double ∗ abs_tolerance_error_control {}

  Was ATOL.
- double ∗ rel_tolerance_error_control {}

  Was RTOL.
- unsigned int num_odes {3}

Was N, in DLS001 common block.
- IntegrationMethod integration_method {ImplicitAdamsNonStiff}

  Was METH, in DLS001 common block.
- CorrectorMethod corrector_method {FunctionalIteration}

  Was MITER, in DLS001 common block.
- double min_step_size {}

  was HMIN, in DLS001 common block.
- double max_step_size {}

  was HMAX.
- double initial_step_size {}

  Was H0.
- unsigned int max_order {12}

  Was MAXORD, in DLS001 common block.
- unsigned int max_num_small_step_warnings {10}

  Was MXHNILI, in DLS001 common block.
- unsigned int max_correction_iters {3}

  Was MAXCOR, in DLS001 common block Maximum number of corrector-iterations to attempt on any step.
- unsigned int max_num_steps_jacobian {20}

  Was MSBP, in DLS001 common block.
- unsigned int max_num_conv_failure {10}

  Was MXNCF, in DLS001 common block.
- unsigned int max_num_steps {500}

  Was MXSTEP, in DLS001 common block.

Friends

- class InputProcessor
- void init_attrjeod__LsodeControlDataInterface ()

8.20.1 Detailed Description

Specifies controls for an LSODE integrator.

Definition at line 82 of file lsode_control_data_interface.hh.

8.20.2 Member Enumeration Documentation

8.20.2.1 CorrectorMethod

```
enum jeod::LsodeControlDataInterface::CorrectorMethod
```

Enumerator

FunctionalIteration	Functional iteration.
NewtonIterUserJac	Modified Newton iteration with.
NewtonIterInternalJac	Modified Newton iteration with internally.
JacobiNewtonInternalJac	Modified Jacobi-Newton iteration with.
NewtonIterUserBandJac	Modified Newton iteration with.
NewtonIterInternalBandJac	Modified Newton iteration with internally.

Definition at line 100 of file lsode_control_data_interface.hh.

8.20.2.2 ErrorControlIndicator

```
enum jeod::LsodeControlDataInterface::ErrorControlIndicator
```

Enumerator

CommonAbsCommonRel	Use the same absolute and relative values.
SpecificAbsCommonRel	Use separate absolute values for each.
CommonAbsSpecificRel	Use a common absolute values and separate.
SpecificAbsSpecificRel	Use separate absolute and relative values.

Definition at line 120 of file lsode_control_data_interface.hh.

8.20.2.3 IntegrationMethod

```
enum jeod::LsodeControlDataInterface::IntegrationMethod
```

Enumerator

ImplicitAdamsNonStiff	Variable-step, variable-order, implicit Adams.
ImplicitBackDiffStiff	Variable-step, variable-order, implicit.

Definition at line 88 of file lsode_control_data_interface.hh.

8.20.3 Constructor & Destructor Documentation

8.20.3.1 ∼LsodeControlDataInterface()

```
virtual jeod::LsodeControlDataInterface::~LsodeControlDataInterface ( ) [inline], [virtual]
```

Definition at line 134 of file lsode_control_data_interface.hh.

8.20.3.2 LsodeControlDataInterface()

```
jeod::LsodeControlDataInterface::LsodeControlDataInterface (
            const LsodeControlDataInterface & ) [default]
```

8.20.4 Member Function Documentation

8.20.4.1 is_corrector_method_functional_iteration()

```
bool jeod::LsodeControlDataInterface::is_corrector_method_functional_iteration ( ) [inline]
```

Tests whether corrector is functional iteration.

Definition at line 151 of file lsode_control_data_interface.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_core(), jeod::LsodeFirstOrderODEIntegrator↩::integrator_corrector_failed_part1(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_iteration(), jeod::LsodeFirstOrderODEIntegrator↩::integrator_fail_reset_order_1_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_predict(), and jeod::↩LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part1().

8.20.4.2 operator=()

```
LsodeControlDataInterface& jeod::LsodeControlDataInterface::operator= (
            const LsodeControlDataInterface & ) [delete]
```

8.20.5 Friends And Related Function Documentation

8.20.5.1 init_attrjeod__LsodeControlDataInterface

```
void init_attrjeod__LsodeControlDataInterface ( ) [friend]
```

8.20.5.2 InputProcessor

```
friend class InputProcessor [friend]
```

Definition at line 84 of file lsode_control_data_interface.hh.

8.20.6 Field Documentation

8.20.6.1 abs_tolerance_error_control

`double* jeod::LsodeControlDataInterface::abs_tolerance_error_control {}`

Was ATOL.

Vector of the absolute error tolerances.trick_units(--)

Definition at line 177 of file lsode_control_data_interface.hh.

Referenced by allocate_arrays(), destroy_allocated_arrays(), jeod::LsodeFirstOrderODEIntegrator::load_ew_values(), jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part2(), and set_abs_tol().

8.20.6.2 abs_tolerance_error_control_vec

`std::vector<double> jeod::LsodeControlDataInterface::abs_tolerance_error_control_vec`

Temporary pre-initialized place to store loaded error values.

trick_units(--)

Definition at line 165 of file lsode_control_data_interface.hh.

Referenced by allocate_arrays(), check_interface_data(), LsodeControlDataInterface(), and set_abs_tol().

8.20.6.3 corrector_method

`CorrectorMethod jeod::LsodeControlDataInterface::corrector_method {FunctionalIteration}`

Was MITER, in DLS001 common block.

trick_units(--)

Definition at line 200 of file lsode_control_data_interface.hh.

Referenced by check_interface_data(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_loop(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_wrap_up(), jeod::LsodeFirstOrderODEIntegrator::linear_chord_iteration(), and jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part1().

8.20.6.4 error_control_indicator

`ErrorControlIndicator jeod::LsodeControlDataInterface::error_control_indicator {CommonAbsCommonRel}`

Was ITOL.

trick_units(--)

Definition at line 160 of file lsode_control_data_interface.hh.

Referenced by check_interface_data(), jeod::LsodeFirstOrderODEIntegrator::load_ew_values(), and jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part2().

8.20.6.5 error_control_vector_copied_over

```
bool jeod::LsodeControlDataInterface::error_control_vector_copied_over {}
```

Definition at line 172 of file lsode_control_data_interface.hh.

Referenced by allocate_arrays(), check_interface_data(), destroy_allocated_arrays(), set_abs_tol(), and set_rel_tol().

8.20.6.6 initial_step_size

```
double jeod::LsodeControlDataInterface::initial_step_size {}
```

Was H0.

Initial guess at the step size. May be input, will be calculated if not. Note - this is the actual step, not the magnitude of the step. whereas max_step_size and min_step_size are magnitudes.trick_units(--)

Definition at line 220 of file lsode_control_data_interface.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part2(), jeod::LsodeFirstOrderODEIntegrator::process_entry_point_cycle_start(), and jeod::LsodeFirstOrderODEIntegrator::reset_integrator().

8.20.6.7 integration_method

```
IntegrationMethod jeod::LsodeControlDataInterface::integration_method {ImplicitAdamsNonStiff}
```

Was METH, in DLS001 common block.

trick_units(--)

Definition at line 195 of file lsode_control_data_interface.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::calculate_integration_coefficients(), check_interface_data(), jeod::LsodeFirstOrderODEIntegrator::integrator_core(), and jeod::LsodeFirstOrderODEIntegrator::update_control_data().

8.20.6.8 max_correction_iters

```
unsigned int jeod::LsodeControlDataInterface::max_correction_iters {3}
```

Was MAXCOR, in DLS001 common block Maximum number of corrector-iterations to attempt on any step.

trick_units(--)

Definition at line 236 of file lsode_control_data_interface.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_iteration().

8.20.6.9 max_num_conv_failure

```
unsigned int jeod::LsodeControlDataInterface::max_num_conv_failure {10}
```

Was MXNCF, in DLS001 common block.

Maximum number of convergence failures on one step.trick_units(–)

Definition at line 246 of file lsode_control_data_interface.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2().

8.20.6.10 max_num_small_step_warnings

```
unsigned int jeod::LsodeControlDataInterface::max_num_small_step_warnings {10}
```

Was MXHNILI, in DLS001 common block.

Populated from IWORK[7[Maximum number of small-step warnings that may be printed.trick_units(–)

Definition at line 231 of file lsode_control_data_interface.hh.

Referenced by check_interface_data(), and jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part2().

8.20.6.11 max_num_steps

```
unsigned int jeod::LsodeControlDataInterface::max_num_steps {500}
```

Was MXSTEP, in DLS001 common block.

Maximum number of steps that the integrator may take. Default = 500.trick_units(–)

Definition at line 251 of file lsode_control_data_interface.hh.

Referenced by check_interface_data(), and jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part1().

8.20.6.12 max_num_steps_jacobian

```
unsigned int jeod::LsodeControlDataInterface::max_num_steps_jacobian {20}
```

Was MSBP, in DLS001 common block.

Populated from IWORK[6] Maximum number of steps for which the same Jacobian can be used.trick_units(–)

Definition at line 241 of file lsode_control_data_interface.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_predict().

8.20.6.13 max_order

```
unsigned int jeod::LsodeControlDataInterface::max_order {12}
```

Was MAXORD, in DLS001 common block.

Populated from IWORK[5] Maximum order allowable.trick_units(–)

Definition at line 226 of file lsode_control_data_interface.hh.

Referenced by check_interface_data(), and jeod::LsodeFirstOrderODEIntegrator::update_control_data().

8.20.6.14 max_step_size

```
double jeod::LsodeControlDataInterface::max_step_size {}
```

was HMAX.

RWORK[6] Maximum absolute value of step size allowable. Default to 0.0, interpreted as infinity. user-specified otherwise.trick_units(–)

Definition at line 213 of file lsode_control_data_interface.hh.

Referenced by check_interface_data(), and jeod::LsodeFirstOrderODEIntegrator::update_control_data().

8.20.6.15 min_step_size

```
double jeod::LsodeControlDataInterface::min_step_size {}
```

was HMIN, in DLS001 common block.

Minimum absolute value of step size allowable. Default to 0.0, user-specified otherwise.trick_units(–)

Definition at line 207 of file lsode_control_data_interface.hh.

Referenced by check_interface_data(), jeod::LsodeFirstOrderODEIntegrator::integrator_core(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_error_test_failed(), jeod::LsodeFirstOrderODEIntegrator::integrator_fail_reset_order_1_part1(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_method_coeffs(), jeod::LsodeFirstOrderODEIntegrator::integrator_set_new_order(), and jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part3().

8.20.6.16 num_odes

```
unsigned int jeod::LsodeControlDataInterface::num_odes {3}
```

Was N, in DLS001 common block.

Number of ODEs to be solved at next step. In this implementation, num_odes = num_equations. In original implementation, num_odes (N) was set to NEQ at the start, the some subset could be identified, NYH and solved for.trick_units(–)

Definition at line 190 of file lsode_control_data_interface.hh.

Referenced by allocate_arrays(), check_interface_data(), jeod::LsodeFirstOrderODEIntegrator::gauss_elim_↩ factor(), jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order(), jeod::LsodeFirstOrderODE↩ Integrator::integrator_compute_new_order_prep(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_↩ converged(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_iteration(), jeod::LsodeFirstOrderOD↩ EIntegrator::integrator_fail_reset_order_1_part1(), jeod::LsodeFirstOrderODEIntegrator::integrator_fail_reset_↩ order_1_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_iteration_loop_part1(), jeod::LsodeFirst↩ OrderODEIntegrator::integrator_reset_iteration_loop_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator↩ _reset_yh(), jeod::LsodeFirstOrderODEIntegrator::integrator_wrapup(), jeod::LsodeFirstOrderODEIntegrator↩ ::interpolate_y(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), jeod::LsodeFirstOrderODEIntegrator↩ ::jacobian_prep_loop(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_wrap_up(), jeod::LsodeFirstOrder↩ ODEIntegrator::linear_chord_iteration(), jeod::LsodeFirstOrderODEIntegrator::linear_solver(), jeod::LsodeFirst↩ OrderODEIntegrator::load_derivatives(), jeod::LsodeFirstOrderODEIntegrator::load_ew_values(), jeod::Lsode↩ FirstOrderODEIntegrator::LsodeFirstOrderODEIntegrator(), jeod::LsodeFirstOrderODEIntegrator::magnitude_↩ of_weighted_array(), jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part1(), jeod::Lsode↩ FirstOrderODEIntegrator::manager_initialize_calculation_part2(), jeod::LsodeFirstOrderODEIntegrator::manager↩ _integration_loop_part1(), jeod::LsodeFirstOrderODEIntegrator::process_entry_point_cycle_start(), and jeod::↩ LsodeFirstOrderODEIntegrator::reset_integrator().

8.20.6.17 num_odes_at_alloc

```
unsigned int jeod::LsodeControlDataInterface::num_odes_at_alloc {}
```

Definition at line 173 of file lsode_control_data_interface.hh.

Referenced by allocate_arrays(), set_abs_tol(), and set_rel_tol().

8.20.6.18 rel_tolerance_error_control

```
double* jeod::LsodeControlDataInterface::rel_tolerance_error_control {}
```

Was RTOL.

Vector of the relative error tolerances.trick_units(–)

Definition at line 181 of file lsode_control_data_interface.hh.

Referenced by allocate_arrays(), destroy_allocated_arrays(), jeod::LsodeFirstOrderODEIntegrator::load_ew_↩ values(), jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part2(), and set_rel_tol().

8.20.6.19 rel_tolerance_error_control_vec

```
std::vector<double> jeod::LsodeControlDataInterface::rel_tolerance_error_control_vec
```

Temporary pre-initialized place to store loaded error values.

trick_units(--)

Definition at line 170 of file lsode_control_data_interface.hh.

Referenced by allocate_arrays(), check_interface_data(), LsodeControlDataInterface(), and set_rel_tol().

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

- lsode_control_data_interface.hh
- lsode_control_data_interface.cc

8.21 jeod::LsodeDataArrays Class Reference

The data arrays.

```
#include <lsode_data_classes.hh>
```

Public Member Functions

- LsodeDataArrays ()=default
- virtual ~LsodeDataArrays ()
- LsodeDataArrays & operator= (const LsodeDataArrays &)=delete
- LsodeDataArrays (const LsodeDataArrays &)=delete
- void allocate_arrays (unsigned int num_odes, LsodeControlDataInterface::CorrectorMethod corrector_↩ method)

    Allocates memory for the variable size arrays.
- void destroy_allocated_arrays ()

    Allows for refactoring and reallocation of newly sized arrays.

Data Fields

- int * pivots {}

    Was IWM(21) or IPVT.
- double ** history {}

    was RWORK[LYH:LYH+NYH(MAXORD+1)-1].*
- double lin_alg_1 {}
- double lin_alg_2 {}
- double ** lin_alg {}

    was RWORK[LWM:LWM+LENWM-1].
- double * error_weight {}

    was RWORK[LEWT:LEWT+N-1].
- double * save {}

    was RWORK[LSAVF:LSAVF+N-1].
- double * accum_correction {}

    was RWORK[LACOR:LACOR+N-1].
- unsigned int lin_alg_index1 {}

    Number of record, this is the value used for data allocation.
- unsigned int num_odes {3}

    Number of record, this is the value used for data allocation.
- bool allocated {}

    Indicator of whether the arrays have been allocated.

Friends

- class InputProcessor
- void init_attrjeod__LsodeDataArrays ()

8.21.1 Detailed Description

The data arrays.

Definition at line 107 of file lsode_data_classes.hh.

8.21.2 Constructor & Destructor Documentation

8.21.2.1 LsodeDataArrays() [1/2]

```
jeod::LsodeDataArrays::LsodeDataArrays ( )  [default]
```

8.21.2.2 ∼LsodeDataArrays()

```
virtual jeod::LsodeDataArrays::∼LsodeDataArrays ( )  [inline], [virtual]
```

Definition at line 112 of file lsode_data_classes.hh.

References destroy_allocated_arrays().

8.21.2.3 LsodeDataArrays() [2/2]

```
jeod::LsodeDataArrays::LsodeDataArrays (
            const LsodeDataArrays & )  [delete]
```

8.21.3 Member Function Documentation

8.21.3.1 operator=()

```
LsodeDataArrays& jeod::LsodeDataArrays::operator= (
            const LsodeDataArrays & )  [delete]
```

8.21.4 Friends And Related Function Documentation

8.21.4.1 init_attrjeod__LsodeDataArrays

```
void init_attrjeod__LsodeDataArrays ( )  [friend]
```

8.21.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 109 of file lsode_data_classes.hh.

8.21.5 Field Documentation

8.21.5.1 accum_correction

```
double* jeod::LsodeDataArrays::accum_correction {}
```

was RWORK[LACOR:LACOR+N-1].

LACOR = LSAVF + N acum_correction[i] = rwork[lacor+i].trick_units(–)

Definition at line 173 of file lsode_data_classes.hh.

Referenced by allocate_arrays(), destroy_allocated_arrays(), jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order(), jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order_prep(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_converged(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_iteration(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_iteration_loop_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_wrapup(), and jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_loop().

8.21.5.2 allocated

```
bool jeod::LsodeDataArrays::allocated {}
```

Indicator of whether the arrays have been allocated.

trick_units(–)

Definition at line 187 of file lsode_data_classes.hh.

Referenced by allocate_arrays(), and destroy_allocated_arrays().

8.21.5.3 error_weight

```
double* jeod::LsodeDataArrays::error_weight {}
```

was RWORK[LEWT:LEWT+N-1].

LEWT = LWM + LENWM error_weight[i] = rwork[lewt+i].trick_units(–)

Definition at line 163 of file lsode_data_classes.hh.

Referenced by allocate_arrays(), destroy_allocated_arrays(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_loop(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_wrap_up(), jeod::LsodeFirstOrderODEIntegrator::load_ew_values(), jeod::LsodeFirstOrderODEIntegrator::magnitude_of_weighted_array(), jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part2(), and jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part1().

8.21.5.4 history

```
double** jeod::LsodeDataArrays::history {}
```

was RWORK[LYH:LYH+NYH∗(MAXORD+1)-1].

LYH = 21 First index is to "i" in y_i, second index is to history order. history[i,j] = rwork[LYH + j∗nyh + i], with lyh = 21 typically.trick_units(–)

Definition at line 142 of file lsode_data_classes.hh.

Referenced by allocate_arrays(), destroy_allocated_arrays(), jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order(), jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order_prep(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_converged(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_iteration(), jeod::LsodeFirstOrderODEIntegrator::integrator_error_test_failed(), jeod::LsodeFirstOrderODEIntegrator::integrator_fail_reset_order_1_part1(), jeod::LsodeFirstOrderODEIntegrator::integrator_fail_reset_order_1_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_predict(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_iteration_loop_part1(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_yh(), jeod::LsodeFirstOrderODEIntegrator::interpolate_y(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_wrap_up(), jeod::LsodeFirstOrderODEIntegrator::load_ew_values(), jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part2(), jeod::LsodeFirstOrderODEIntegrator::manager_integration_loop_part2(), and jeod::LsodeFirstOrderODEIntegrator::reset_integrator().

8.21.5.5 lin_alg

```
double** jeod::LsodeDataArrays::lin_alg {}
```

was RWORK[LWM:LWM+LENWM-1].

LWM = LYH + (NYH∗(MAXORD+1)) lin_alg_1 = rwork[lwm] lin_alg_2 = rwork[lwm + 1] lin_alg[i,j] = rwork[lwm+ j∗n + i + 2]. The first two elements are treated differently, then it goes to an array that is sized based on the correction_method. The array sizes are as follows, ordered by value of correction_method: 0: 0 1,2: n x n 3: 1 x n 4,5: (2∗ml+mu+1) x n.trick_units(–)

Definition at line 158 of file lsode_data_classes.hh.

Referenced by allocate_arrays(), destroy_allocated_arrays(), jeod::LsodeFirstOrderODEIntegrator::gauss_elim_factor(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_loop(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_wrap_up(), jeod::LsodeFirstOrderODEIntegrator::linear_chord_iteration(), and jeod::LsodeFirstOrderODEIntegrator::linear_solver().

8.21.5.6 lin_alg_1

```
double jeod::LsodeDataArrays::lin_alg_1 {}
```

Definition at line 143 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), jeod::LsodeFirstOrderODEIntegrator↩
::jacobian_prep_loop(), and jeod::LsodeFirstOrderODEIntegrator::manager_initialize_calculation_part1().

8.21.5.7 lin_alg_2

```
double jeod::LsodeDataArrays::lin_alg_2 {}
```

Definition at line 144 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), and jeod::LsodeFirstOrderODE↩
Integrator::linear_chord_iteration().

8.21.5.8 lin_alg_index1

```
unsigned int jeod::LsodeDataArrays::lin_alg_index1 {}
```

Number of record, this is the value used for data allocation.

trick_units(–)

Definition at line 178 of file lsode_data_classes.hh.

Referenced by allocate_arrays(), and destroy_allocated_arrays().

8.21.5.9 num_odes

```
unsigned int jeod::LsodeDataArrays::num_odes {3}
```

Number of record, this is the value used for data allocation.

trick_units(–)

Definition at line 182 of file lsode_data_classes.hh.

Referenced by allocate_arrays(), and destroy_allocated_arrays().

8.21.5.10 pivots

```
int* jeod::LsodeDataArrays::pivots {}
```

Was IWM(21) or IPVT.

Pivot vector generated in dgefa, and used in dgesl.trick_units(–)

Definition at line 127 of file lsode_data_classes.hh.

Referenced by allocate_arrays(), destroy_allocated_arrays(), jeod::LsodeFirstOrderODEIntegrator::gauss_elim_↩ factor(), and jeod::LsodeFirstOrderODEIntegrator::linear_solver().

8.21.5.11 save

```
double* jeod::LsodeDataArrays::save {}
```

was RWORK[LSAVF:LSAVF+N-1].

LSAVF = LEWT + N save[i] = rwork[lsavf+i].trick_units(–)

Definition at line 168 of file lsode_data_classes.hh.

Referenced by allocate_arrays(), destroy_allocated_arrays(), jeod::LsodeFirstOrderODEIntegrator::integrate(), jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order_prep(), jeod::LsodeFirstOrderODE↩ Integrator::integrator_core(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_iteration(), jeod::Lsode↩ FirstOrderODEIntegrator::integrator_fail_reset_order_1_part2(), jeod::LsodeFirstOrderODEIntegrator::jacobian_↩ prep_init(), jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_loop(), and jeod::LsodeFirstOrderODEIntegrator↩ ::jacobian_prep_wrap_up().

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

- lsode_data_classes.hh
- lsode_data_classes.cc

8.22 jeod::LsodeDataJacobianPrep Class Reference

Data associated with the method DPREPJ.

```
#include <lsode_data_classes.hh>
```

Public Member Functions

- LsodeDataJacobianPrep ()=default
- virtual ∼LsodeDataJacobianPrep ()=default
- LsodeDataJacobianPrep & operator= (const LsodeDataJacobianPrep &)=delete
- LsodeDataJacobianPrep (const LsodeDataJacobianPrep &)=delete

Data Fields

- double fac {}
- double hl0 {}
- int index {}
- int index_max {}
- double r0 {}
- double yj {}

Friends

- class InputProcessor
- void init_attrjeod__LsodeDataJacobianPrep ()

8.22.1 Detailed Description

Data associated with the method DPREPJ.

Definition at line 86 of file lsode_data_classes.hh.

8.22.2 Constructor & Destructor Documentation

8.22.2.1 LsodeDataJacobianPrep() [1/2]

```
jeod::LsodeDataJacobianPrep::LsodeDataJacobianPrep ( )  [default]
```

8.22.2.2 ∼LsodeDataJacobianPrep()

```
virtual jeod::LsodeDataJacobianPrep::∼LsodeDataJacobianPrep ( )  [virtual], [default]
```

8.22.2.3 LsodeDataJacobianPrep() [2/2]

```
jeod::LsodeDataJacobianPrep::LsodeDataJacobianPrep (
            const LsodeDataJacobianPrep & )  [delete]
```

8.22.3 Member Function Documentation

8.22.3.1 operator=()

```
LsodeDataJacobianPrep& jeod::LsodeDataJacobianPrep::operator= (
            const LsodeDataJacobianPrep & )  [delete]
```

8.22.4 Friends And Related Function Documentation

8.22.4.1 init_attrjeod__LsodeDataJacobianPrep

```
void init_attrjeod__LsodeDataJacobianPrep ( )  [friend]
```

8.22.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 88 of file lsode_data_classes.hh.

8.22.5 Field Documentation

8.22.5.1 fac

```
double jeod::LsodeDataJacobianPrep::fac {}
```

Definition at line 96 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), and jeod::LsodeFirstOrderODE↩ Integrator::jacobian_prep_loop().

8.22.5.2 hl0

```
double jeod::LsodeDataJacobianPrep::hl0 {}
```

Definition at line 97 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), jeod::LsodeFirstOrderODEIntegrator↩ ::jacobian_prep_loop(), and jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_wrap_up().

8.22.5.3 index

```
int jeod::LsodeDataJacobianPrep::index {}
```

Definition at line 98 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), and jeod::LsodeFirstOrderODE↩ Integrator::jacobian_prep_loop().

8.22.5.4 index_max

```
int jeod::LsodeDataJacobianPrep::index_max {}
```

Definition at line 99 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), and jeod::LsodeFirstOrderODE↩ Integrator::jacobian_prep_loop().

8.22.5.5 r0

```
double jeod::LsodeDataJacobianPrep::r0 {}
```

Definition at line 100 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), and jeod::LsodeFirstOrderODE↩ Integrator::jacobian_prep_loop().

8.22.5.6 yj

```
double jeod::LsodeDataJacobianPrep::yj {}
```

Definition at line 101 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::jacobian_prep_init(), and jeod::LsodeFirstOrderODE↩ Integrator::jacobian_prep_loop().

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

- lsode_data_classes.hh

8.23 jeod::LsodeDataStode Class Reference

The data associated with method Dstode.

```
#include <lsode_data_classes.hh>
```

Public Member Functions

- LsodeDataStode ()=default
- virtual ∼LsodeDataStode ()=default
- LsodeDataStode & operator= (const LsodeDataStode &)=delete
- LsodeDataStode (const LsodeDataStode &)=delete

Data Fields

- double step_ratio {}
- double step_ratio_order_inc {}
- double told {}
- double dsm {}
- int iredo {}
- int iret {}
- unsigned int ncf {}
- unsigned int new_method_order {}

Friends

- class InputProcessor
- void init_attrjeod__LsodeDataStode ()

8.23.1 Detailed Description

The data associated with method Dstode.

Definition at line 193 of file lsode_data_classes.hh.

8.23.2 Constructor & Destructor Documentation

8.23.2.1 LsodeDataStode() [1/2]

```
jeod::LsodeDataStode::LsodeDataStode ( )   [default]
```

8.23.2.2 ∼LsodeDataStode()

```
virtual jeod::LsodeDataStode::∼LsodeDataStode ( )   [virtual], [default]
```

8.23.2.3 LsodeDataStode() [2/2]

```
jeod::LsodeDataStode::LsodeDataStode (
            const LsodeDataStode & )  [delete]
```

8.23.3 Member Function Documentation

8.23.3.1 operator=()

```
LsodeDataStode& jeod::LsodeDataStode::operator= (
            const LsodeDataStode & )  [delete]
```

8.23.4 Friends And Related Function Documentation

8.23.4.1 init_attrjeod__LsodeDataStode

```
void init_attrjeod__LsodeDataStode ( )  [friend]
```

8.23.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 195 of file lsode_data_classes.hh.

8.23.5 Field Documentation

8.23.5.1 dsm

```
double jeod::LsodeDataStode::dsm {}
```

Definition at line 207 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order(), and jeod::LsodeFirst↩OrderODEIntegrator::integrator_corrector_converged().

8.23.5.2 iredo

```
int jeod::LsodeDataStode::iredo {}
```

Definition at line 208 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_core(), jeod::LsodeFirstOrderODEIntegrator↩ ::integrator_corrector_converged(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_error_test_failed(), jeod::LsodeFirstOrderODEIntegrator↩ ::integrator_reset_yh(), and jeod::LsodeFirstOrderODEIntegrator::integrator_test_stepsize_change().

8.23.5.3 iret

```
int jeod::LsodeDataStode::iret {}
```

Definition at line 209 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_core(), jeod::LsodeFirstOrderODEIntegrator↩ ::integrator_fail_reset_order_1_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_method_coeffs(), and jeod::LsodeFirstOrderODEIntegrator::integrator_set_new_order().

8.23.5.4 ncf

```
unsigned int jeod::LsodeDataStode::ncf {}
```

Definition at line 210 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_core(), and jeod::LsodeFirstOrderODEIntegrator↩ ::integrator_corrector_failed_part2().

8.23.5.5 new_method_order

```
unsigned int jeod::LsodeDataStode::new_method_order {}
```

Definition at line 211 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order(), and jeod::LsodeFirst↩ OrderODEIntegrator::integrator_set_new_order().

8.23.5.6 step_ratio

```
double jeod::LsodeDataStode::step_ratio {}
```

Definition at line 204 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order(), jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order_check_step_error(), jeod::LsodeFirstOrderODEIntegrator::integrator_core(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2(), jeod::LsodeFirstOrderODEIntegrator::integrator_fail_reset_order_1_part1(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_method_coeffs(), jeod::LsodeFirstOrderODEIntegrator::integrator_reset_yh(), jeod::LsodeFirstOrderODEIntegrator::integrator_set_new_order(), and jeod::LsodeFirstOrderODEIntegrator::integrator_test_stepsize_change().

8.23.5.7 step_ratio_order_inc

```
double jeod::LsodeDataStode::step_ratio_order_inc {}
```

Definition at line 205 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order(), jeod::LsodeFirstOrderODEIntegrator::integrator_compute_new_order_prep(), and jeod::LsodeFirstOrderODEIntegrator::integrator_error_test_failed().

8.23.5.8 told

```
double jeod::LsodeDataStode::told {}
```

Definition at line 206 of file lsode_data_classes.hh.

Referenced by jeod::LsodeFirstOrderODEIntegrator::integrator_core(), jeod::LsodeFirstOrderODEIntegrator::integrator_corrector_failed_part2(), and jeod::LsodeFirstOrderODEIntegrator::integrator_error_test_failed().

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

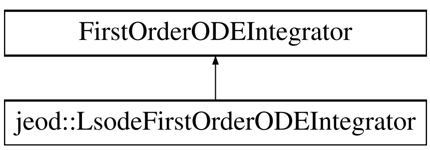
- lsode_data_classes.hh

8.24 jeod::LsodeFirstOrderODEIntegrator Class Reference

Jeod-compatible version of the Livermore ODE solver, LSODE.

```
#include <lsode_first_order_ode_integrator.hh>
```

Inheritance diagram for jeod::LsodeFirstOrderODEIntegrator:



Public Types

- enum EntryPoint {
  CycleStartFinish = 0, InitCalc = 1, JacobianPrep = 2, ResetIterLoop = 3,
  IterationLoop = 4, DstodeResetStep = 5 }
- enum CalculationTask {
  Normal = 1, OneStep = 2, CompleteCycle = 3, NormalWithSingularity = 4,
  OneStepWithSingularity = 5 }

Public Member Functions

- LsodeFirstOrderODEIntegrator ()

  LsodeFirstOrderODEIntegrator default constructor.
- LsodeFirstOrderODEIntegrator (const LsodeControlDataInterface &data_in, er7_utils::IntegrationControls &controls, unsigned int size)

  LsodeFirstOrderODEIntegrator non-default constructor.
- ∼LsodeFirstOrderODEIntegrator () override

  LsodeFirstOrderODEIntegrator destructor.
- LsodeFirstOrderODEIntegrator & operator= (const LsodeFirstOrderODEIntegrator &)=delete
- LsodeFirstOrderODEIntegrator (const LsodeFirstOrderODEIntegrator &)=delete
- LsodeFirstOrderODEIntegrator ∗ create_copy () const override

  Create a copy of 'this' LsodeFirstOrderODEIntegrator object.
- EntryPoint get_re_entry_point ()

  Get re_entry_point member.
- er7_utils::IntegratorResult integrate (double dyn_dt, unsigned int target_stage, const double ∗y_dot, double ∗y) override

  Propagate state via Lsode's method.
- void reset_integrator () override

  Resets the integrator when the timestep changes or when identified as needing a reset.
- void update_control_data ()

  Gets the control data from where it can be populated in the constructor and verifies that the input control parameters are not out of sensible range.

Data Fields

- double ∗ y {}

  Was Y.
- const double ∗ y_dot {}

  Was .
- double cycle_target_time {}

  Was TOUT.
- double convergence_factor {}

  was CONIT, in DLS001 common block.
- double convergence_rate {}

  was CRATE, in DLS001 common block.
- unsigned int order_select_para {}

  Was IALTH, in DLS001 common block.
- unsigned int num_equations {1}

  Was NYH, in DLS001 common block.
- unsigned int num_nordsiek_cols {1}

  Was L, in DLS001 common block Number of columns in Nordsiek array.

- unsigned int max_history_size {12}

  Was LMAX, in DLS001 common block Maximum allowable number of histories.
- unsigned int num_predictor_elements {1}

  Was NQNYH, in DLS001 common block.
- unsigned int method_order_current {}

  Was NQ, in DLS001 common block.
- double stage_target_time {}

  was TN, in DLS001 common block.
- double max_step_increase_ratio {1.0}

  was RMAX, in DLS001 common block.
- double max_rel_change_without_jacobian {0.3}

  was CCMAX, in DLS001 common block.

Protected Member Functions

- void process_entry_point_cycle_start ()

  The code block from the main integrate routine for re_entry_point=CycleStartFinish.
- void manager_initialize_calculation_part1 ()

  Sets the values for the case with calculation_phase = 1.
- void manager_initialize_calculation_part2 ()
- int manager_check_stop_conditions ()

  verifies whether the convergence conditions have been met to end the cycle.
- void manager_integration_loop_part1 ()

  The iteration loop for the integration process.
- void manager_integration_loop_part2 ()
- void manager_integration_loop_part3 ()
- void manager_set_calculation_phase_eq_2_reload ()
- void integrator_core ()

  integrator_core provides the front-end to all of the integrator_∗i methods, which together perform one step of the integration of an initial value problem for a system of ordinary differential equations.
- void integrator_reset_method_coeffs ()

  Sets/resets the method_coeffs_current array.
- void integrator_test_stepsize_change ()

  Tests h against old h.
- void integrator_reset_yh ()

  Resets history arrays and time-step.
- void integrator_predict ()

  This section computes the predicted values by multiplying the history array by the Pascal Triangle matrix.
- void integrator_reset_iteration_loop_part1 ()

  This method resets the iteration loop to the values generated by the integrator_predict method, which populated history[∗][0].
- void integrator_reset_iteration_loop_part2 ()

  This code follows part 1 after the break-out to get to the external calls, and completes the reset of the integration iteration loop.
- void integrator_corrector_iteration ()

  Keeps looping through the iterations until convergence or failure.
- void integrator_corrector_failed_part1 ()

  The corrector iteration failed to converge.
- void integrator_corrector_failed_part2 ()

  Retracts the history array in the case that the correction iteration failed to converge with either functional iteration or with an up-to-date Jacobian.

- void integrator_corrector_converged ()

  Starts the processing of a converged iteration.
- void integrator_error_test_failed ()

  Restores the history array following the failure of the corrector for exceeding local error bounds.
- void integrator_compute_new_order_prep ()

  The first steps in computing whether the order of the integrator should be changed.
- void integrator_compute_new_order ()

  Computes the step-size scaling factors that will result once it is determined what happens to the order at the next step.
- void integrator_compute_new_order_check_step_error ()
- void integrator_set_new_order ()

  Sets the new order and the step-ratio for the next step - or the current step if redoing it.
- void integrator_fail_reset_order_1_part1 ()

  Repopulates the y-array from history, recomputes the original first derivatives, sets the order back to 1, and reduces the step size by a factor of 10.
- void integrator_fail_reset_order_1_part2 ()

  Continue reset, with derivatives now at hand.
- void integrator_wrapup ()

  Wraps up the completion of the integrator.
- void integrator_terminate ()

  this is the only succesful path back from integrator to manager.
- void calculate_epsilon ()

  Identify the smallest double precision value, epsilon, such that the computer can distinguish (1+epsilon) from 1.
- void calculate_integration_coefficients ()

  Modified from original DCFODE subroutine.
- void interpolate_y ()

  Interpolates the zeroth-derivative of y Adapted from subroutine DINTDY, which was a general method for interpolating the K-th derivative of the dependent variable vector, y.
- void jacobian_prep_init ()

  Modified from DPREPJ.
- bool jacobian_prep_loop ()
- bool jacobian_prep_wrap_up ()
- void linear_chord_iteration ()

  Modified from DSOLSY.
- void load_ew_values ()
- double magnitude_of_weighted_array (const double ∗v)

  returns the RMS value of {V dot W}, where V and W are N-vectors.
- double magnitude_of_weighted_array (unsigned int ix, double ∗∗v)

  returns RMS value of v[∗][index]
- int gauss_elim_factor ()

  Factors a double array (arrays.lin_alg) by Gaussian elimination.
- void linear_solver ()

  Solves the equation Y' = A Y, with A = arrays.lin_alg.
- unsigned int index_of_max_magnitude (unsigned int num_points, double ∗∗mx, int starting_ix)

  Modified version of IDAMAX.
- void load_derivatives (double ∗derivs)

  Load the externally generated derivative values (incoming as y_dot)i into the array derivs.

Protected Attributes

- LsodeDataJacobianPrep data_prepj

  data used exclusively for the DPREPJ method.
- LsodeDataArrays arrays

  data arrays, multiple purposes.
- LsodeDataStode data_stode

  data used exclusively for the DSTODE method.
- unsigned int num_steps_taken {}

  Was NST, in DLS001 common block.
- unsigned int prior_num_steps {}

  Was NSLAST, in DLS001 common block.
- int step_error {}

  Was KFLAG, in DLS001 common block 0: step was successful -1: requested accuracy could not be achieved.
- unsigned int num_small_step_warnings {}

  Was NHNIL, in DLS001 common block.
- unsigned int num_jacobian_evals {}

  Was NJE, in DLS001 common block Number of jacobian evaluations so far for the problem.
- double iter_delta {}

  Was DEL, in DSTODE, local variable.
- double prev_iter_delta {}

  Was DELP, in DSTODE, local variable.
- bool first_pass {true}

  was ISTATE.
- EntryPoint re_entry_point {CycleStartFinish}

  Indicates where in the integrator to return to following an exit to gether new derivatives.
- bool initialized {}

  was INIT, in DLS001 common block.
- int internal_state {}

  Was JSTART, in DLS001 common block.
- CalculationTask calculation_task {Normal}

  Was ITASK.
- unsigned int max_order_internal {}

  Was MAXORD.
- LsodeControlDataInterface control_data
- LsodeControlDataInterface::IntegrationMethod prev_integration_method

  Was MEO, in DLS001 common block Integration method used in previous call (see integration_method).
- unsigned int prev_method_order {}

  Was NQU, in DLS001 common block.
- double method_coeff_first {}

  was EL0, in DLS001 common block.
- double method_coeffs_current [13] {}

  was EL, in DLS001 common block.
- double method_coeffs_complete [13][12] {}

  was ELCO, in DLS001 common block.
- double test_coeffs_complete [3][12] {}

  was TESCO, in DLS001 common block.
- double step_size {}

  was H, in DLS001 common block.
- double prev_step_size {}

  was HOLD, in DLS001 common block.

- double prev_good_step_size {}

  was HU, in DLS001 common block.
- double max_step_size_inv {}

  was HMXI.
- bool jacobian_current {}

  Was JCUR, in DLS001 common block Is the jacobian current.
- bool update_jacobian {true}

  Was IPUP, in DLS001 common block.
- unsigned int step_at_last_jacobian_update {}

  Was NSLP, in DLS001 common block.
- unsigned int convergence_jacobian_flag {}

  Was ICF, in DLS001 common block.
- double rel_change_since_jacobian {}

  was RC, in DLS001 common block.
- bool iteration_matrix_singular {}

  Was IERPJ, in DLS001 common block.
- bool modified_iteration_matrix_singular {}

  Was IERSL, in DLS001 common block.
- unsigned int iteration_count {}
- double epsilon {1.0E-12}

  was UROUND, in DLS001 common block.
- double sqrt_epsilon {1.0E-6}

  NEW.

Friends

- class InputProcessor
- void init_attrjeod__LsodeFirstOrderODEIntegrator ()

8.24.1 Detailed Description

Jeod-compatible version of the Livermore ODE solver, LSODE.

Definition at line 95 of file lsode_first_order_ode_integrator.hh.

8.24.2 Member Enumeration Documentation

8.24.2.1 CalculationTask

`enum jeod::LsodeFirstOrderODEIntegrator::CalculationTask`

Enumerator

Normal	Normal operation. Interpolate to target.
OneStep	Take only one step and return.
CompleteCycle	Stop at first mesh point at or beyond.
NormalWithSingularity	Normal computation, with safeguard on.
OneStepWithSingularity	Take one step without passing t_crit.

Definition at line 126 of file lsode_first_order_ode_integrator.hh.

8.24.2.2 EntryPoint

```
enum jeod::LsodeFirstOrderODEIntegrator::EntryPoint
```

Enumerator

CycleStartFinish	Default value. Assumption is that the current.
InitCalc	Reset during initialization. Valid only during.
JacobianPrep	Set at the end of the initialization of the.
ResetIterLoop	Set when the iteration loop (part of DSTODE) has.
IterationLoop	Set during the routine operation of the iteration.
DstodeResetStep	Set in dstode_640 when there have been too many.

Definition at line 103 of file lsode_first_order_ode_integrator.hh.

8.24.3 Constructor & Destructor Documentation

8.24.3.1 LsodeFirstOrderODEIntegrator()

```
jeod::LsodeFirstOrderODEIntegrator::LsodeFirstOrderODEIntegrator (
            const LsodeFirstOrderODEIntegrator & ) [delete]
```

8.24.4 Member Function Documentation

8.24.4.1 get_re_entry_point()

```
EntryPoint jeod::LsodeFirstOrderODEIntegrator::get_re_entry_point ( ) [inline]
```

Get re_entry_point member.

Definition at line 180 of file lsode_first_order_ode_integrator.hh.

8.24.4.2 operator=()

```
LsodeFirstOrderODEIntegrator& jeod::LsodeFirstOrderODEIntegrator::operator= (
            const LsodeFirstOrderODEIntegrator & ) [delete]
```

8.24.5 Friends And Related Function Documentation

8.24.5.1 init_attrjeod__LsodeFirstOrderODEIntegrator

`void init_attrjeod__LsodeFirstOrderODEIntegrator ( ) [friend]`

8.24.5.2 InputProcessor

`friend class InputProcessor [friend]`

Definition at line 98 of file lsode_first_order_ode_integrator.hh.

8.24.6 Field Documentation

8.24.6.1 arrays

`LsodeDataArrays jeod::LsodeFirstOrderODEIntegrator::arrays [protected]`

data arrays, multiple purposes.

trick_units(–)

Definition at line 392 of file lsode_first_order_ode_integrator.hh.

Referenced by gauss_elim_factor(), integrate(), integrator_compute_new_order(), integrator_compute_new_↩order_prep(), integrator_core(), integrator_corrector_converged(), integrator_corrector_failed_part2(), integrator↩_corrector_iteration(), integrator_error_test_failed(), integrator_fail_reset_order_1_part1(), integrator_fail_reset↩_order_1_part2(), integrator_predict(), integrator_reset_iteration_loop_part1(), integrator_reset_iteration_loop_↩part2(), integrator_reset_yh(), integrator_wrapup(), interpolate_y(), jacobian_prep_init(), jacobian_prep_loop(), jacobian_prep_wrap_up(), linear_chord_iteration(), linear_solver(), load_ew_values(), magnitude_of_weighted↩_array(), manager_initialize_calculation_part1(), manager_initialize_calculation_part2(), manager_integration_↩loop_part1(), manager_integration_loop_part2(), reset_integrator(), and ∼LsodeFirstOrderODEIntegrator().

8.24.6.2 calculation_task

`CalculationTask jeod::LsodeFirstOrderODEIntegrator::calculation_task {Normal} [protected]`

Was ITASK.

1: Normal 2:Take one step and return. 3:Stop at first mesh point at or beyond cycle_target_time and return 4:Normal computation, with safeguard on singularity time, t_crit 5:Take one step without passing t_crit. This implementaiton only allows for calculation_task = 1, so it is a protected variable until such time as it is exended to include additional options.

Only case 1 is supported.trick_units(–)

Definition at line 480 of file lsode_first_order_ode_integrator.hh.

Referenced by manager_check_stop_conditions(), and manager_integration_loop_part3().

8.24.6.3 control_data

`LsodeControlDataInterface jeod::LsodeFirstOrderODEIntegrator::control_data [protected]`

Definition at line 487 of file lsode_first_order_ode_integrator.hh.

Referenced by calculate_integration_coefficients(), gauss_elim_factor(), integrator_compute_new_order(), integrator_compute_new_order_prep(), integrator_core(), integrator_corrector_converged(), integrator_corrector_failed_part1(), integrator_corrector_failed_part2(), integrator_corrector_iteration(), integrator_error_test_failed(), integrator_fail_reset_order_1_part1(), integrator_fail_reset_order_1_part2(), integrator_predict(), integrator_reset_iteration_loop_part1(), integrator_reset_iteration_loop_part2(), integrator_reset_method_coeffs(), integrator_reset_yh(), integrator_set_new_order(), integrator_wrapup(), interpolate_y(), jacobian_prep_init(), jacobian_prep_loop(), jacobian_prep_wrap_up(), linear_chord_iteration(), linear_solver(), load_derivatives(), load_ew_values(), LsodeFirstOrderODEIntegrator(), magnitude_of_weighted_array(), manager_initialize_calculation_part1(), manager_initialize_calculation_part2(), manager_integration_loop_part1(), manager_integration_loop_part2(), manager_integration_loop_part3(), process_entry_point_cycle_start(), reset_integrator(), update_control_data(), and ∼LsodeFirstOrderODEIntegrator().

8.24.6.4 convergence_factor

`double jeod::LsodeFirstOrderODEIntegrator::convergence_factor {}`

was CONIT, in DLS001 common block.

trick_units(–)

Definition at line 296 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_corrector_iteration(), and integrator_reset_method_coeffs().

8.24.6.5 convergence_jacobian_flag

`unsigned int jeod::LsodeFirstOrderODEIntegrator::convergence_jacobian_flag {} [protected]`

Was ICF, in DLS001 common block.

0: Solution converged 1: Convergence failed; Jacobian is not current. 2: Convergence failed; Jacobian is current or not needed.trick_units(–)

Definition at line 568 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_corrector_failed_part1(), and integrator_corrector_failed_part2().

8.24.6.6 convergence_rate

```
double jeod::LsodeFirstOrderODEIntegrator::convergence_rate {}
```

was CRATE, in DLS001 common block.

trick_units(--)

Definition at line 300 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_corrector_iteration(), and jacobian_prep_wrap_up().

8.24.6.7 cycle_target_time

```
double jeod::LsodeFirstOrderODEIntegrator::cycle_target_time {}
```

Was TOUT.

The overall integration target time, reset on each externally-commanded cycle.trick_units(--)

Definition at line 288 of file lsode_first_order_ode_integrator.hh.

Referenced by integrate(), interpolate_y(), manager_check_stop_conditions(), manager_initialize_calculation_↩ part2(), manager_integration_loop_part3(), process_entry_point_cycle_start(), and reset_integrator().

8.24.6.8 data_prepj

```
LsodeDataJacobianPrep jeod::LsodeFirstOrderODEIntegrator::data_prepj [protected]
```

data used exclusively for the DPREPJ method.

trick_units(--)

Definition at line 388 of file lsode_first_order_ode_integrator.hh.

Referenced by jacobian_prep_init(), jacobian_prep_loop(), and jacobian_prep_wrap_up().

8.24.6.9 data_stode

```
LsodeDataStode jeod::LsodeFirstOrderODEIntegrator::data_stode [protected]
```

data used exclusively for the DSTODE method.

trick_units(--)

Definition at line 396 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_compute_new_order(), integrator_compute_new_order_check_step_error(), integrator↩ _compute_new_order_prep(), integrator_core(), integrator_corrector_converged(), integrator_corrector_failed↩ _part2(), integrator_error_test_failed(), integrator_fail_reset_order_1_part1(), integrator_fail_reset_order_1_↩ part2(), integrator_reset_method_coeffs(), integrator_reset_yh(), integrator_set_new_order(), and integrator_test↩ _stepsize_change().

8.24.6.10 epsilon

`double jeod::LsodeFirstOrderODEIntegrator::epsilon {1.0E-12} [protected]`

was UROUND, in DLS001 common block.

Small number.trick_units(–)

Definition at line 603 of file lsode_first_order_ode_integrator.hh.

Referenced by calculate_epsilon(), interpolate_y(), jacobian_prep_init(), jacobian_prep_wrap_up(), manager_↩ initialize_calculation_part2(), and manager_integration_loop_part2().

8.24.6.11 first_pass

`bool jeod::LsodeFirstOrderODEIntegrator::first_pass {true} [protected]`

was ISTATE.

true: was IASTATE = 1: first call for the problem, require initialization. false: was IASTATE = 2: subsequent call, no change to input parameters. not covered:IASTATE = 3: subsequent call, input parameters have changed.trick↩ _units(–)

Definition at line 446 of file lsode_first_order_ode_integrator.hh.

Referenced by process_entry_point_cycle_start(), reset_integrator(), and ∼LsodeFirstOrderODEIntegrator().

8.24.6.12 initialized

`bool jeod::LsodeFirstOrderODEIntegrator::initialized {} [protected]`

was INIT, in DLS001 common block.

Flag representing whether the problem has been initialized.trick_units(–)

Definition at line 456 of file lsode_first_order_ode_integrator.hh.

Referenced by manager_integration_loop_part3(), and process_entry_point_cycle_start().

8.24.6.13 internal_state

`int jeod::LsodeFirstOrderODEIntegrator::internal_state {} [protected]`

Was JSTART, in DLS001 common block.

0: First step for problem 1: Continue normal calculation -1: Next step has new values of step-size, order, or methods. -2: Undocumented.trick_units(–)

Definition at line 464 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_terminate(), and manager_initialize_calculation_part1().

8.24.6.14 iter_delta

```
double jeod::LsodeFirstOrderODEIntegrator::iter_delta {} [protected]
```

Was DEL, in DSTODE, local variable.

RMS value of {y dot error_weight_data}trick_units(–)

Definition at line 430 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_corrector_converged(), integrator_corrector_iteration(), and integrator_reset_iteration_↩ loop_part2().

8.24.6.15 iteration_count

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::iteration_count {} [protected]
```

Definition at line 597 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_corrector_converged(), integrator_corrector_iteration(), and integrator_reset_iteration_↩ loop_part1().

8.24.6.16 iteration_matrix_singular

```
bool jeod::LsodeFirstOrderODEIntegrator::iteration_matrix_singular {} [protected]
```

Was IERPJ, in DLS001 common block.

false: Iteration matrix was successfully LU-decomposed (iteration-method = 1,2,4,5) or inverted (iteration-method = 3). true: Matrix is singular.trick_units(–)

Definition at line 589 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), jacobian_prep_init(), and jacobian_prep_wrap_up().

8.24.6.17 jacobian_current

```
bool jeod::LsodeFirstOrderODEIntegrator::jacobian_current {} [protected]
```

Was JCUR, in DLS001 common block Is the jacobian current.

trick_units(–)

Definition at line 551 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_corrector_converged(), integrator_corrector_failed_part1(), and jacobian_prep_init().

8.24.6.18 max_history_size

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::max_history_size {12}
```

Was LMAX, in DLS001 common block Maximum allowable number of histories.

trick_units(–)

Definition at line 328 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_compute_new_order_prep(), integrator_core(), and integrator_corrector_converged().

8.24.6.19 max_order_internal

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::max_order_internal {} [protected]
```

Was MAXORD.

Populated from IWORK[5] Maximum order allowable.trick_units(–)

Definition at line 485 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), and update_control_data().

8.24.6.20 max_rel_change_without_jacobian

```
double jeod::LsodeFirstOrderODEIntegrator::max_rel_change_without_jacobian {0.3}
```

was CCMAX, in DLS001 common block.

Max relative change to (step_size $*$ method_coeff_first) before Jacobian matrix is updated. see also rel_change_since_jacobian. // This value was set in DLSODE (line 1385) to 0.3 without any explanation. It can be changed, but takes 0.3 as default.trick_units(–)

Definition at line 364 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_predict().

8.24.6.21 max_step_increase_ratio

```
double jeod::LsodeFirstOrderODEIntegrator::max_step_increase_ratio {1.0}
```

was RMAX, in DLS001 common block.

Max ratio by which step size may be increased.trick_units(–)

Definition at line 354 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_corrector_failed_part2(), integrator_error_test_failed(), and integrator_reset_yh().

8.24.6.22 max_step_size_inv

```
double jeod::LsodeFirstOrderODEIntegrator::max_step_size_inv {} [protected]
```

was HMXI.

Inverse of maximum absolute step size allowable. Default to 0.0 (i.e. there is no upper bound), calculated from max_step_size if max_step_size is user-specified.trick_units(–)

Definition at line 544 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_reset_yh(), manager_initialize_calculation_part2(), and update_control_data().

8.24.6.23 method_coeff_first

```
double jeod::LsodeFirstOrderODEIntegrator::method_coeff_first {} [protected]
```

was EL0, in DLS001 common block.

method coefficient l_0 for current method and order.trick_units(–)

Definition at line 507 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_reset_method_coeffs(), jacobian_prep_init(), and linear_chord_↩ iteration().

8.24.6.24 method_coeffs_complete

```
double jeod::LsodeFirstOrderODEIntegrator::method_coeffs_complete[13][12] {} [protected]
```

was ELCO, in DLS001 common block.

The array of all of the method coefficients.trick_units(–)

Definition at line 516 of file lsode_first_order_ode_integrator.hh.

Referenced by calculate_integration_coefficients(), integrator_core(), and integrator_reset_method_coeffs().

8.24.6.25 method_coeffs_current

```
double jeod::LsodeFirstOrderODEIntegrator::method_coeffs_current[13] {} [protected]
```

was EL, in DLS001 common block.

trick_units(–)

Definition at line 511 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_compute_new_order(), integrator_core(), integrator_corrector_converged(), integrator_↩ corrector_iteration(), and integrator_reset_method_coeffs().

8.24.6.26 method_order_current

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::method_order_current {}
```

Was NQ, in DLS001 common block.

Method order being tried on this or next step.trick_units(–)

Definition at line 340 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_compute_new_order(), integrator_compute_new_order_prep(), integrator_core(), integrator_corrector_converged(), integrator_corrector_failed_part2(), integrator_corrector_iteration(), integrator↩_error_test_failed(), integrator_fail_reset_order_1_part2(), integrator_predict(), integrator_reset_method_coeffs(), integrator_set_new_order(), interpolate_y(), manager_initialize_calculation_part2(), and reset_integrator().

8.24.6.27 modified_iteration_matrix_singular

```
bool jeod::LsodeFirstOrderODEIntegrator::modified_iteration_matrix_singular {} [protected]
```

Was IERSL, in DLS001 common block.

Like iteration_matrix_singular, only applied to the iteration matrix that has been modified to account for the new step for iteration-method 3.trick_units(–)

Definition at line 596 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_corrector_iteration(), and linear_chord_iteration().

8.24.6.28 num_equations

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::num_equations {1}
```

Was NYH, in DLS001 common block.

Number of ODEs to be solved in the current problem. In this implementation, num_odes = num_equations.trick_↩units(–)

Definition at line 316 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_corrector_failed_part2(), integrator_error_test_failed(), integrator_↩predict(), integrator_reset_method_coeffs(), and process_entry_point_cycle_start().

8.24.6.29 num_jacobian_evals

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::num_jacobian_evals {}  [protected]
```

Was NJE, in DLS001 common block Number of jacobian evaluations so far for the problem.

trick_units(–)

Definition at line 425 of file lsode_first_order_ode_integrator.hh.

Referenced by jacobian_prep_init().

8.24.6.30 num_nordsiek_cols

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::num_nordsiek_cols {1}
```

Was L, in DLS001 common block Number of columns in Nordsiek array.

This appears to be a variable that s equal to the current order of the integrator + 1.trick_units(–)

Definition at line 323 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_compute_new_order(), integrator_compute_new_order_prep(), integrator_core(), integrator_corrector_converged(), integrator_fail_reset_order_1_part2(), integrator_reset_method_coeffs(), integrator_reset_yh(), integrator_set_new_order(), and interpolate_y().

8.24.6.31 num_predictor_elements

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::num_predictor_elements {1}
```

Was NQNYH, in DLS001 common block.

Number of elements of history array that are changed by predictor.trick_units(–)

Definition at line 333 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), and integrator_reset_method_coeffs().

8.24.6.32 num_small_step_warnings

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::num_small_step_warnings {}  [protected]
```

Was NHNIL, in DLS001 common block.

Number of small-step encounters fo the problem so far.trick_units(–)

Definition at line 420 of file lsode_first_order_ode_integrator.hh.

Referenced by manager_integration_loop_part2().

8.24.6.33 num_steps_taken

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::num_steps_taken {}  [protected]
```

Was NST, in DLS001 common block.

Number of steps taken for this problem.trick_units(–)

Definition at line 403 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_corrector_converged(), integrator_predict(), jacobian_prep_wrap_up(), manager_check←_stop_conditions(), and manager_integration_loop_part1().

8.24.6.34 order_select_para

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::order_select_para {}
```

Was IALTH, in DLS001 common block.

0: Select optimal step size and method order 1: If prev_success_order $<$ maximum_order, save vector so that an increase can be considered. $>$1: Perform neither.trick_units(–)

Definition at line 308 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_compute_new_order(), integrator_compute_new_order_check_step_error(), integrator←_core(), integrator_corrector_converged(), integrator_fail_reset_order_1_part2(), and integrator_reset_yh().

8.24.6.35 prev_good_step_size

```
double jeod::LsodeFirstOrderODEIntegrator::prev_good_step_size {}  [protected]
```

was HU, in DLS001 common block.

The size of the last successful step.trick_units(–)

Definition at line 537 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_corrector_converged(), interpolate_y(), and reset_integrator().

8.24.6.36 prev_integration_method

```
LsodeControlDataInterface::IntegrationMethod jeod::LsodeFirstOrderODEIntegrator::prev_integration←
_method [protected]
```

Initial value:

```
{
        LsodeControlDataInterface::ImplicitAdamsNonStiff}
```

Was MEO, in DLS001 common block Integration method used in previous call (see integration_method).

trick_units(–)

Definition at line 494 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core().

8.24.6.37 prev_iter_delta

```
double jeod::LsodeFirstOrderODEIntegrator::prev_iter_delta {} [protected]
```

Was DELP, in DSTODE, local variable.

Previous value of iter_delta, used for comparison to identify rate at which iteration is converging / identifying divergence of iteration.trick_units(–)

Definition at line 437 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_corrector_iteration(), and integrator_reset_iteration_loop_part2().

8.24.6.38 prev_method_order

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::prev_method_order {} [protected]
```

Was NQU, in DLS001 common block.

Method order used in last successful step.trick_units(–)

Definition at line 500 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_corrector_converged(), and integrator_wrapup().

8.24.6.39 prev_step_size

```
double jeod::LsodeFirstOrderODEIntegrator::prev_step_size {} [protected]
```

was HOLD, in DLS001 common block.

trick_units(–)

Definition at line 532 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_terminate(), and integrator_test_stepsize_change().

8.24.6.40 prior_num_steps

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::prior_num_steps {} [protected]
```

Was NSLAST, in DLS001 common block.

Number of steps taken for the problem prior to this call to Lsode.trick_units(–)

Definition at line 408 of file lsode_first_order_ode_integrator.hh.

Referenced by manager_check_stop_conditions(), and manager_integration_loop_part1().

8.24.6.41 re_entry_point

```
EntryPoint jeod::LsodeFirstOrderODEIntegrator::re_entry_point {CycleStartFinish} [protected]
```

Indicates where in the integrator to return to following an exit to gether new derivatives.

trick_units(–)

Definition at line 451 of file lsode_first_order_ode_integrator.hh.

Referenced by integrate(), integrator_corrector_iteration(), integrator_fail_reset_order_1_part1(), integrator_reset_iteration_loop_part1(), jacobian_prep_init(), manager_initialize_calculation_part1(), manager_integration_loop_part2(), and reset_integrator().

8.24.6.42 rel_change_since_jacobian

```
double jeod::LsodeFirstOrderODEIntegrator::rel_change_since_jacobian {} [protected]
```

was RC, in DLS001 common block.

Relative change to (step_size ∗ method_coeff_first) since last update to Jacobian matrix.trick_units(–)

Definition at line 574 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_predict(), integrator_reset_method_coeffs(), integrator_reset_yh(), and jacobian_prep_wrap_up().

8.24.6.43 sqrt_epsilon

```
double jeod::LsodeFirstOrderODEIntegrator::sqrt_epsilon {1.0E-6}  [protected]
```

NEW.

square root of epsilon.trick_units(–)

Definition at line 608 of file lsode_first_order_ode_integrator.hh.

Referenced by calculate_epsilon(), and manager_initialize_calculation_part1().

8.24.6.44 stage_target_time

```
double jeod::LsodeFirstOrderODEIntegrator::stage_target_time {}
```

was TN, in DLS001 common block.

Value of the independent variable, typically time, to which the integrator has successfully advanced, or to which it will advance in the next step/stage.trick_units(–)

Definition at line 349 of file lsode_first_order_ode_integrator.hh.

Referenced by integrate(), integrator_core(), integrator_corrector_failed_part2(), integrator_error_test_failed(), integrator_predict(), interpolate_y(), manager_check_stop_conditions(), manager_integration_loop_part1(), manager_integration_loop_part2(), manager_integration_loop_part3(), process_entry_point_cycle_start(), and reset_integrator().

8.24.6.45 step_at_last_jacobian_update

```
unsigned int jeod::LsodeFirstOrderODEIntegrator::step_at_last_jacobian_update {}  [protected]
```

Was NSLP, in DLS001 common block.

Step number at last Jacobian update.trick_units(–)

Definition at line 561 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_predict(), and jacobian_prep_wrap_up().

8.24.6.46 step_error

```
int jeod::LsodeFirstOrderODEIntegrator::step_error {}  [protected]
```

Was KFLAG, in DLS001 common block 0: step was successful -1: requested accuracy could not be achieved.

<=-2: repeated convergence failures.trick_units(–)

Definition at line 415 of file lsode_first_order_ode_integrator.hh.

Referenced by integrate(), integrator_compute_new_order_check_step_error(), integrator_core(), integrator_corrector_converged(), integrator_corrector_failed_part2(), integrator_error_test_failed(), integrator_fail_reset_order_1_part1(), and manager_integration_loop_part3().

8.24.6.47 step_size

```
double jeod::LsodeFirstOrderODEIntegrator::step_size {}  [protected]
```

was H, in DLS001 common block.

Step size used on this step, or to be attempted on next.trick_units(–)

Definition at line 528 of file lsode_first_order_ode_integrator.hh.

Referenced by integrator_core(), integrator_corrector_converged(), integrator_corrector_failed_part2(), integrator_corrector_iteration(), integrator_error_test_failed(), integrator_fail_reset_order_1_part1(), integrator_fail_reset_order_1_part2(), integrator_predict(), integrator_reset_method_coeffs(), integrator_reset_yh(), integrator_set_new_order(), integrator_terminate(), integrator_test_stepsize_change(), interpolate_y(), jacobian_prep_init(), jacobian_prep_wrap_up(), linear_chord_iteration(), manager_check_stop_conditions(), manager_initialize_calculation_part2(), manager_integration_loop_part2(), and manager_integration_loop_part3().

8.24.6.48 test_coeffs_complete

```
double jeod::LsodeFirstOrderODEIntegrator::test_coeffs_complete[3][12] {}  [protected]
```

was TESCO, in DLS001 common block.

The array of all of the test coefficientstrick_units(–)

Definition at line 521 of file lsode_first_order_ode_integrator.hh.

Referenced by calculate_integration_coefficients(), integrator_compute_new_order(), integrator_compute_new_order_prep(), integrator_core(), integrator_corrector_converged(), integrator_corrector_iteration(), and integrator_wrapup().

8.24.6.49 update_jacobian

```
bool jeod::LsodeFirstOrderODEIntegrator::update_jacobian {true} [protected]
```

Was IPUP, in DLS001 common block.

Flag to indicate whether it is necessary to update the Jacobian.trick_units(–)

Definition at line 556 of file lsode_first_order_ode_integrator.hh.

Referenced by integrate(), integrator_core(), integrator_corrector_failed_part1(), integrator_corrector_failed_↩ part2(), integrator_fail_reset_order_1_part2(), integrator_predict(), and jacobian_prep_wrap_up().

8.24.6.50 y

```
double* jeod::LsodeFirstOrderODEIntegrator::y {}
```

Was Y.

State vector (zeroth derivative).trick_units(–)

Definition at line 276 of file lsode_first_order_ode_integrator.hh.

Referenced by integrate(), integrator_corrector_iteration(), integrator_fail_reset_order_1_part1(), integrator_↩ reset_iteration_loop_part1(), interpolate_y(), jacobian_prep_init(), jacobian_prep_loop(), linear_chord_iteration(), linear_solver(), and manager_initialize_calculation_part2().

8.24.6.51 y_dot

```
const double* jeod::LsodeFirstOrderODEIntegrator::y_dot {}
```

Was .

State vector (first derivative).trick_units(–)

Definition at line 281 of file lsode_first_order_ode_integrator.hh.

Referenced by integrate(), load_derivatives(), and manager_initialize_calculation_part2().

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

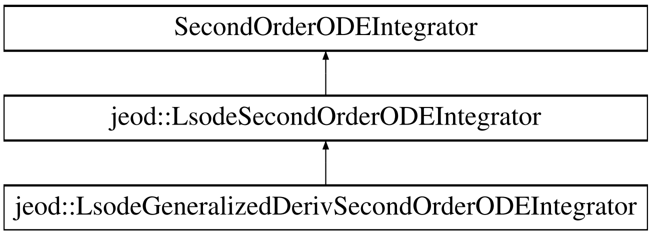
- lsode_first_order_ode_integrator.hh
- lsode_first_order_ode_integrator__integrator.cc
- lsode_first_order_ode_integrator__manager.cc
- lsode_first_order_ode_integrator__support.cc
- lsode_first_order_ode_integrator__utility.cc

8.25 jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator Class Reference

JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.

#include <lsode_generalized_second_order_ode_integrator.hh>

Inheritance diagram for jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator:



Public Member Functions

- LsodeGeneralizedDerivSecondOrderODEIntegrator ()=default

  LsodeGeneralizedDerivSecondOrderODEIntegrator default constructor.
- LsodeGeneralizedDerivSecondOrderODEIntegrator (const LsodeGeneralizedDerivSecondOrderODEIntegrator &src)

  LsodeGeneralizedDerivSecondOrderODEIntegrator copy constructor.
- LsodeGeneralizedDerivSecondOrderODEIntegrator (const LsodeControlDataInterface &data_in, er7_utils↩ ::IntegrationControls &controls, const er7_utils::GeneralizedPositionDerivativeFunctions &deriv_funs, unsigned int position_size, unsigned int velocity_size)

  non-default constructor
- ∼LsodeGeneralizedDerivSecondOrderODEIntegrator () override

  LsodeGeneralizedDerivSecondOrderODEIntegrator destructor.
- LsodeGeneralizedDerivSecondOrderODEIntegrator ∗ create_copy () const override

  Clone a LsodeGeneralizedDerivSecondOrderODEIntegrator.
- er7_utils::IntegratorResult integrate (double dyn_dt, unsigned int target_stage, const double ∗accel, double ∗velocity, double ∗position) override

  Propagate state via Lsode's method.
- LsodeGeneralizedDerivSecondOrderODEIntegrator & operator= (const LsodeGeneralizedDerivSecondOrderODEIntegrator &)=delete

Data Fields

- double ∗ posdot {}

  Stash space for the result of the computation of the derivative of the zeroth-derivative.

Friends

- class InputProcessor
- void init_attrjeod__LsodeGeneralizedDerivSecondOrderODEIntegrator ()

Additional Inherited Members

8.25.1 Detailed Description

JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.

Definition at line 90 of file lsode_generalized_second_order_ode_integrator.hh.

8.25.2 Constructor & Destructor Documentation

8.25.2.1 LsodeGeneralizedDerivSecondOrderODEIntegrator()

```
jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator::LsodeGeneralizedDerivSecondOrderODE←↩
Integrator ( )  [default]
```

LsodeGeneralizedDerivSecondOrderODEIntegrator default constructor.

8.25.3 Member Function Documentation

8.25.3.1 operator=()

```
LsodeGeneralizedDerivSecondOrderODEIntegrator& jeod::LsodeGeneralizedDerivSecondOrderODE←↩
Integrator::operator= (
            const LsodeGeneralizedDerivSecondOrderODEIntegrator &  )  [delete]
```

8.25.4 Friends And Related Function Documentation

8.25.4.1 init_attrjeod__LsodeGeneralizedDerivSecondOrderODEIntegrator

```
void init_attrjeod__LsodeGeneralizedDerivSecondOrderODEIntegrator ( )  [friend]
```

8.25.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 92 of file lsode_generalized_second_order_ode_integrator.hh.

8.25.5 Field Documentation

8.25.5.1 posdot

```
double* jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator::posdot {}
```

Stash space for the result of the computation of the derivative of the zeroth-derivative.

Used with the Generalized derivative form, in which the deriviative of the zeroth derivative is not equal to the first-derivative.trick_units(–)

Definition at line 149 of file lsode_generalized_second_order_ode_integrator.hh.

Referenced by integrate(), LsodeGeneralizedDerivSecondOrderODEIntegrator(), and ∼LsodeGeneralizedDeriv↩SecondOrderODEIntegrator().

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

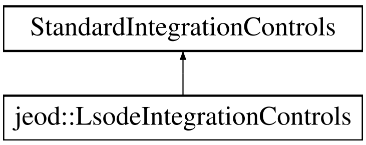
- lsode_generalized_second_order_ode_integrator.hh
- lsode_generalized_second_order_ode_integrator.cc

8.26 jeod::LsodeIntegrationControls Class Reference

Contains controls for an LSODE integrator.

```
#include <lsode_integration_controls.hh>
```

Inheritance diagram for jeod::LsodeIntegrationControls:



Public Member Functions

- LsodeIntegrationControls ()=default
- LsodeIntegrationControls (unsigned int num_stages)
- ∼LsodeIntegrationControls () override=default
- LsodeIntegrationControls & operator= (const LsodeIntegrationControls &)=delete
- LsodeIntegrationControls (const LsodeIntegrationControls &)=delete
- unsigned int integrate (double start_time, double sim_dt, er7_utils::TimeInterface &time_interface, er7_utils↩::IntegratorInterface &integ_interface, er7_utils::BaseIntegrationGroup &integ_group) override

    Perform one step of the integration process.
- LsodeIntegrationControls ∗ create_copy () const override

    Create a copy of 'this' StandardIntegrationControls object.

Friends

- class InputProcessor
- void init_attrjeod__LsodeIntegrationControls ()

8.26.1 Detailed Description

Contains controls for an LSODE integrator.

Definition at line 87 of file lsode_integration_controls.hh.

8.26.2 Constructor & Destructor Documentation

8.26.2.1 LsodeIntegrationControls() [1/2]

```
jeod::LsodeIntegrationControls::LsodeIntegrationControls ( )  [default]
```

8.26.2.2 ∼LsodeIntegrationControls()

```
jeod::LsodeIntegrationControls::∼LsodeIntegrationControls ( )  [override], [default]
```

8.26.2.3 LsodeIntegrationControls() [2/2]

```
jeod::LsodeIntegrationControls::LsodeIntegrationControls (
            const LsodeIntegrationControls &  )  [delete]
```

8.26.3 Member Function Documentation

8.26.3.1 operator=()

```
LsodeIntegrationControls& jeod::LsodeIntegrationControls::operator= (
            const LsodeIntegrationControls &  )  [delete]
```

8.26.4 Friends And Related Function Documentation

8.26.4.1 init_attrjeod__LsodeIntegrationControls

```
void init_attrjeod__LsodeIntegrationControls ( )  [friend]
```

8.26.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 90 of file lsode_integration_controls.hh.

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

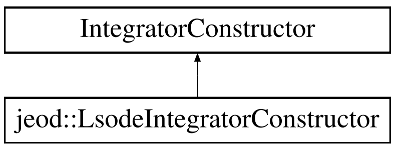
- lsode_integration_controls.hh
- lsode_integration_controls.cc

8.27 jeod::LsodeIntegratorConstructor Class Reference

Create state and time integrators that propagate using standard Lsode.

```
#include <lsode_integrator_constructor.hh>
```

Inheritance diagram for jeod::LsodeIntegratorConstructor:



Public Member Functions

- LsodeIntegratorConstructor ()=default
- LsodeIntegratorConstructor (const LsodeIntegratorConstructor &src)
- LsodeIntegratorConstructor & operator= (const LsodeIntegratorConstructor &)=delete
- const char ∗ get_class_name () const override

    Return the class name.
- bool implements (er7_utils::Integration::ODEProblemType problem_type) const override

    Lsode currently does not implement a second order generalized step integrator.
- bool provides (er7_utils::Integration::ODEProblemType problem_type) const override

    Lsode currently does not provide a second order generalized step integrator.
- er7_utils::IntegratorConstructor ∗ create_copy () const override

    Create a duplicate of the constructor.
- er7_utils::IntegrationControls ∗ create_integration_controls () const override

    Create an integration controls that guides the Lsode integration process.
- er7_utils::FirstOrderODEIntegrator ∗ create_first_order_ode_integrator (unsigned int size, er7_utils::↩ IntegrationControls &controls) const override

    Create an Lsode state integrator for a first order ODE.

- er7_utils::SecondOrderODEIntegrator ∗ create_second_order_ode_integrator (unsigned int size, er7_utils↩ ::IntegrationControls &controls) const override

    Create an Lsode state integrator for a simple second order ODE.
- er7_utils::SecondOrderODEIntegrator ∗ create_generalized_deriv_second_order_ode_integrator (unsigned int position_size, unsigned int velocity_size, const er7_utils::GeneralizedPositionDerivativeFunctions &deriv↩ _funs, er7_utils::IntegrationControls &controls) const override

    Create an Lsode state integrator for a generalized second order ODE where generalized position is advanced with the use of the position derivative function.
- unsigned int get_transition_table_size () const override

    Lsode dioes not use a linear transition table.

Static Public Member Functions

- static er7_utils::IntegratorConstructor ∗ create_constructor ()

    Named constructor; create an LsodeIntegratorConstructor instance.

Data Fields

- LsodeControlDataInterface data_interface

Friends

- class InputProcessor
- void init_attrjeod__LsodeIntegratorConstructor ()

8.27.1 Detailed Description

Create state and time integrators that propagate using standard Lsode.

Definition at line 96 of file lsode_integrator_constructor.hh.

8.27.2 Constructor & Destructor Documentation

8.27.2.1 LsodeIntegratorConstructor()

```
jeod::LsodeIntegratorConstructor::LsodeIntegratorConstructor ( )  [default]
```

8.27.3 Member Function Documentation

8.27.3.1 get_class_name()

```
const char* jeod::LsodeIntegratorConstructor::get_class_name ( ) const  [inline], [override]
```

Return the class name.

Definition at line 121 of file lsode_integrator_constructor.hh.

8.27.3.2 get_transition_table_size()

```
unsigned int jeod::LsodeIntegratorConstructor::get_transition_table_size ( ) const  [inline],
[override]
```

Lsode dioes not use a linear transition table.

Returns

Always returns 0.

Definition at line 201 of file lsode_integrator_constructor.hh.

8.27.3.3 implements()

```
bool jeod::LsodeIntegratorConstructor::implements (
            er7_utils::Integration::ODEProblemType problem_type ) const  [inline], [override]
```

Lsode currently does not implement a second order generalized step integrator.

Definition at line 130 of file lsode_integrator_constructor.hh.

8.27.3.4 operator=()

```
LsodeIntegratorConstructor& jeod::LsodeIntegratorConstructor::operator= (
            const LsodeIntegratorConstructor &  )  [delete]
```

8.27.3.5 provides()

```
bool jeod::LsodeIntegratorConstructor::provides (
            er7_utils::Integration::ODEProblemType problem_type ) const  [inline], [override]
```

Lsode currently does not provide a second order generalized step integrator.

Definition at line 140 of file lsode_integrator_constructor.hh.

8.27.4 Friends And Related Function Documentation

8.27.4.1 init_attrjeod__LsodeIntegratorConstructor

```
void init_attrjeod__LsodeIntegratorConstructor ( )  [friend]
```

8.27.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 98 of file lsode_integrator_constructor.hh.

8.27.5 Field Documentation

8.27.5.1 data_interface

```
LsodeControlDataInterface jeod::LsodeIntegratorConstructor::data_interface
```

Definition at line 206 of file lsode_integrator_constructor.hh.

Referenced by create_first_order_ode_integrator(), create_generalized_deriv_second_order_ode_integrator(), and create_second_order_ode_integrator().

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

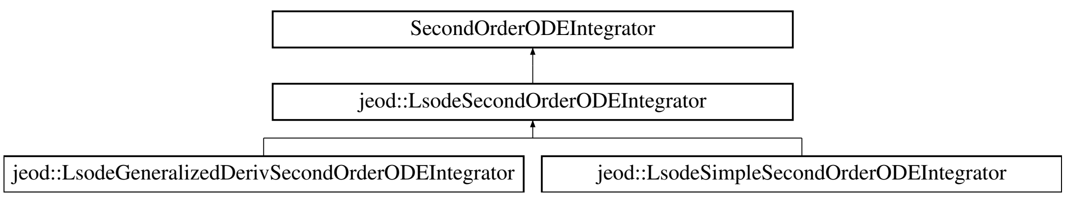
- lsode_integrator_constructor.hh
- lsode_integrator_constructor.cc

8.28 jeod::LsodeSecondOrderODEIntegrator Class Reference

JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.

```
#include <lsode_second_order_ode_integrator.hh>
```

Inheritance diagram for jeod::LsodeSecondOrderODEIntegrator:



Public Member Functions

- ∼LsodeSecondOrderODEIntegrator () override

    LsodeSecondOrderODEIntegrator destructor.
- LsodeSecondOrderODEIntegrator & operator= (const LsodeSecondOrderODEIntegrator &)=delete
- LsodeSecondOrderODEIntegrator (const LsodeSecondOrderODEIntegrator &)=delete
- int get_re_entry_point ()

    Get the integrator's reentry point.

Data Fields

- double ∗ y {}

    State vector (zeroth derivative).
- double ∗ y_dot {}

    State vector (first derivative).
- unsigned int zeroth_derivative_size {}
- unsigned int first_derivative_size {}
- LsodeFirstOrderODEIntegrator first_order_integrator
- bool arrays_allocated {}

Protected Member Functions

- LsodeSecondOrderODEIntegrator ()=default
- LsodeSecondOrderODEIntegrator (const LsodeControlDataInterface &data_in, er7_utils::IntegrationControls &controls, unsigned int size)

    LsodeSecondOrderODEIntegrator non-default constructor.
- LsodeSecondOrderODEIntegrator (const LsodeControlDataInterface &data_in, er7_utils::IntegrationControls &controls, const er7_utils::GeneralizedPositionDerivativeFunctions &deriv_funs, unsigned int position_size, unsigned int velocity_size)
- void reset_integrator () override

    Reset the integrator.

Friends

- class InputProcessor
- void init_attrjeod__LsodeSecondOrderODEIntegrator ()

8.28.1 Detailed Description

JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.

Definition at line 90 of file lsode_second_order_ode_integrator.hh.

8.28.2 Constructor & Destructor Documentation

8.28.2.1 LsodeSecondOrderODEIntegrator() [1/2]

```
jeod::LsodeSecondOrderODEIntegrator::LsodeSecondOrderODEIntegrator (
            const LsodeSecondOrderODEIntegrator & ) [delete]
```

8.28.2.2 LsodeSecondOrderODEIntegrator() [2/2]

```
jeod::LsodeSecondOrderODEIntegrator::LsodeSecondOrderODEIntegrator ( ) [protected], [default]
```

8.28.3 Member Function Documentation

8.28.3.1 get_re_entry_point()

```
int jeod::LsodeSecondOrderODEIntegrator::get_re_entry_point ( ) [inline]
```

Get the integrator's reentry point.

Definition at line 107 of file lsode_second_order_ode_integrator.hh.

8.28.3.2 operator=()

```
LsodeSecondOrderODEIntegrator& jeod::LsodeSecondOrderODEIntegrator::operator= (
            const LsodeSecondOrderODEIntegrator & ) [delete]
```

8.28.3.3 reset_integrator()

```
void jeod::LsodeSecondOrderODEIntegrator::reset_integrator ( ) [inline], [override], [protected]
```

Reset the integrator.

Definition at line 134 of file lsode_second_order_ode_integrator.hh.

8.28.4 Friends And Related Function Documentation

8.28.4.1 init_attrjeod__LsodeSecondOrderODEIntegrator

```
void init_attrjeod__LsodeSecondOrderODEIntegrator ( ) [friend]
```

8.28.4.2 InputProcessor

```
friend class InputProcessor [friend]
```

Definition at line 92 of file lsode_second_order_ode_integrator.hh.

8.28.5 Field Documentation

8.28.5.1 arrays_allocated

```
bool jeod::LsodeSecondOrderODEIntegrator::arrays_allocated {}
```

Definition at line 158 of file lsode_second_order_ode_integrator.hh.

Referenced by LsodeSecondOrderODEIntegrator(), and ∼LsodeSecondOrderODEIntegrator().

8.28.5.2 first_derivative_size

```
unsigned int jeod::LsodeSecondOrderODEIntegrator::first_derivative_size {}
```

Definition at line 154 of file lsode_second_order_ode_integrator.hh.

Referenced by jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator::integrate().

8.28.5.3 first_order_integrator

```
LsodeFirstOrderODEIntegrator jeod::LsodeSecondOrderODEIntegrator::first_order_integrator
```

Definition at line 156 of file lsode_second_order_ode_integrator.hh.

Referenced by jeod::LsodeSimpleSecondOrderODEIntegrator::integrate(), and jeod::LsodeGeneralizedDeriv↩
SecondOrderODEIntegrator::integrate().

8.28.5.4 y

```
double* jeod::LsodeSecondOrderODEIntegrator::y {}
```

State vector (zeroth derivative).

trick_units(–)

Definition at line 146 of file lsode_second_order_ode_integrator.hh.

Referenced by jeod::LsodeSimpleSecondOrderODEIntegrator::integrate(), jeod::LsodeGeneralizedDerivSecond↩OrderODEIntegrator::integrate(), LsodeSecondOrderODEIntegrator(), and ∼LsodeSecondOrderODEIntegrator().

8.28.5.5 y_dot

```
double* jeod::LsodeSecondOrderODEIntegrator::y_dot {}
```

State vector (first derivative).

trick_units(–)

Definition at line 151 of file lsode_second_order_ode_integrator.hh.

Referenced by jeod::LsodeSimpleSecondOrderODEIntegrator::integrate(), jeod::LsodeGeneralizedDerivSecond↩OrderODEIntegrator::integrate(), LsodeSecondOrderODEIntegrator(), and ∼LsodeSecondOrderODEIntegrator().

8.28.5.6 zeroth_derivative_size

```
unsigned int jeod::LsodeSecondOrderODEIntegrator::zeroth_derivative_size {}
```

Definition at line 153 of file lsode_second_order_ode_integrator.hh.

Referenced by jeod::LsodeSimpleSecondOrderODEIntegrator::integrate(), and jeod::LsodeGeneralizedDeriv↩SecondOrderODEIntegrator::integrate().

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

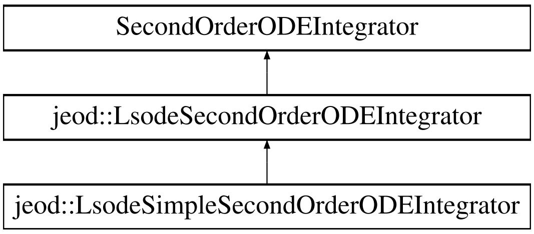
- lsode_second_order_ode_integrator.hh
- lsode_second_order_ode_integrator.cc

8.29 jeod::LsodeSimpleSecondOrderODEIntegrator Class Reference

JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.

#include <lsode_simple_second_order_ode_integrator.hh>

Inheritance diagram for jeod::LsodeSimpleSecondOrderODEIntegrator:



Public Member Functions

- LsodeSimpleSecondOrderODEIntegrator ()=default
- ∼LsodeSimpleSecondOrderODEIntegrator () override=default
- LsodeSimpleSecondOrderODEIntegrator & operator= (const LsodeSimpleSecondOrderODEIntegrator &)=delete
- LsodeSimpleSecondOrderODEIntegrator (const LsodeSimpleSecondOrderODEIntegrator &)=delete
- LsodeSimpleSecondOrderODEIntegrator (const LsodeControlDataInterface &data_in, er7_utils::↩ IntegrationControls &controls, unsigned int size)

    LsodeSimpleSecondOrderODEIntegrator non-default constructor.
- LsodeSimpleSecondOrderODEIntegrator ∗ create_copy () const override
- er7_utils::IntegratorResult integrate (double dyn_dt, unsigned int target_stage, const double ∗accel, double ∗velocity, double ∗position) override

    Propagate state via Lsode's method.

Friends

- class InputProcessor
- void init_attrjeod__LsodeSimpleSecondOrderODEIntegrator ()

Additional Inherited Members

8.29.1 Detailed Description

JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.

Definition at line 93 of file lsode_simple_second_order_ode_integrator.hh.

8.29.2 Constructor & Destructor Documentation

8.29.2.1 LsodeSimpleSecondOrderODEIntegrator() [1/2]

```
jeod::LsodeSimpleSecondOrderODEIntegrator::LsodeSimpleSecondOrderODEIntegrator ( )  [default]
```

8.29.2.2 ∼LsodeSimpleSecondOrderODEIntegrator()

```
jeod::LsodeSimpleSecondOrderODEIntegrator::~LsodeSimpleSecondOrderODEIntegrator ( )  [override],
[default]
```

8.29.2.3 LsodeSimpleSecondOrderODEIntegrator() [2/2]

```
jeod::LsodeSimpleSecondOrderODEIntegrator::LsodeSimpleSecondOrderODEIntegrator (
            const LsodeSimpleSecondOrderODEIntegrator &  )  [delete]
```

8.29.3 Member Function Documentation

8.29.3.1 operator=()

```
LsodeSimpleSecondOrderODEIntegrator& jeod::LsodeSimpleSecondOrderODEIntegrator::operator= (
            const LsodeSimpleSecondOrderODEIntegrator &  )  [delete]
```

8.29.4 Friends And Related Function Documentation

8.29.4.1 init_attrjeod__LsodeSimpleSecondOrderODEIntegrator

```
void init_attrjeod__LsodeSimpleSecondOrderODEIntegrator ( )  [friend]
```

8.29.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 95 of file lsode_simple_second_order_ode_integrator.hh.

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

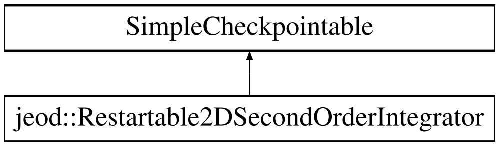
- lsode_simple_second_order_ode_integrator.hh
- lsode_simple_second_order_ode_integrator.cc

8.30 jeod::Restartable2DSecondOrderIntegrator Class Reference

Integrates a second order ODE in two dimensional space, d^2x/dt^2 = a(x,t), where x is a two-vector.

```
#include <restartable_2d_second_order_integrator.hh>
```

Inheritance diagram for jeod::Restartable2DSecondOrderIntegrator:



Public Member Functions

- Restartable2DSecondOrderIntegrator ()

    Default constructor.
- ∼Restartable2DSecondOrderIntegrator () override

    Destructor.
- void create_integrator (const er7_utils::IntegratorConstructor &generator, er7_utils::IntegrationControls &controls)

    Create the integrator to be managed.
- void destroy_integrator ()

    Destroy the integrator.
- er7_utils::IntegratorResult integrate (double dyn_dt, unsigned int target_stage, const double ∗accel, double ∗velocity, double ∗position)

    Propagate state to the specified stage of the integration process for an overall integration time interval of dyn_dt.
- void reset_integrator ()

    Tell the integrator to reset itself.
- void simple_restore () override

    Restore the integrator on restart.
- Restartable2DSecondOrderIntegrator (const Restartable2DSecondOrderIntegrator &)=delete
- Restartable2DSecondOrderIntegrator & operator= (const Restartable2DSecondOrderIntegrator &)=delete

Private Attributes

- er7_utils::SecondOrderODEIntegrator ∗ integrator {}

    The pointer to the object that performs integration.
- RestartableSimpleSecondOrderODEIntegrator< 2 > integrator_manager

    The object that creates and manages the integrator object.

Friends

- class InputProcessor
- void init_attrjeod__Restartable2DSecondOrderIntegrator ()

8.30.1 Detailed Description

Integrates a second order ODE in two dimensional space, d^2x/dt^2 = a(x,t), where x is a two-vector.

Definition at line 82 of file restartable_2d_second_order_integrator.hh.

8.30.2 Constructor & Destructor Documentation

8.30.2.1 Restartable2DSecondOrderIntegrator() [1/2]

```
jeod::Restartable2DSecondOrderIntegrator::Restartable2DSecondOrderIntegrator ( )  [inline]
```

Default constructor.

Definition at line 88 of file restartable_2d_second_order_integrator.hh.

8.30.2.2 ∼Restartable2DSecondOrderIntegrator()

```
jeod::Restartable2DSecondOrderIntegrator::~Restartable2DSecondOrderIntegrator ( )  [inline],
[override]
```

Destructor.

Definition at line 97 of file restartable_2d_second_order_integrator.hh.

8.30.2.3 Restartable2DSecondOrderIntegrator() [2/2]

```
jeod::Restartable2DSecondOrderIntegrator::Restartable2DSecondOrderIntegrator (
            const Restartable2DSecondOrderIntegrator &  )  [delete]
```

8.30.3 Member Function Documentation

8.30.3.1 create_integrator()

```
void jeod::Restartable2DSecondOrderIntegrator::create_integrator (
            const er7_utils::IntegratorConstructor & generator,
            er7_utils::IntegrationControls & controls )  [inline]
```

Create the integrator to be managed.

Parameters

in	*generator*	Generator used to create the integrator.
in,out	*controls*	Controls to be passed to the generator.

Definition at line 107 of file restartable_2d_second_order_integrator.hh.

8.30.3.2 destroy_integrator()

```
void jeod::Restartable2DSecondOrderIntegrator::destroy_integrator ( )  [inline]
```

Destroy the integrator.

Definition at line 116 of file restartable_2d_second_order_integrator.hh.

8.30.3.3 integrate()

```
er7_utils::IntegratorResult jeod::Restartable2DSecondOrderIntegrator::integrate (
            double dyn_dt,
            unsigned int target_stage,
            const double * accel,
            double * velocity,
            double * position )  [inline]
```

Propagate state to the specified stage of the integration process for an overall integration time interval of dyn_dt.

Note that this is a pass-through to the encapsulated integrator object. See er7_utils::SecondOrderODEIntegrator↩
::integrate for details.

Parameters

in	*dyn_dt*	Dynamic time step, in dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in	*accel*	Time derivative of the generalized velocity.
in,out	*velocity*	Generalized velocity vector.
in,out	*position*	Generalized position vector.

Returns

The status (time advance, pass/fail status) of the integration.

Definition at line 138 of file restartable_2d_second_order_integrator.hh.

8.30.3.4 operator=()

```
Restartable2DSecondOrderIntegrator& jeod::Restartable2DSecondOrderIntegrator::operator= (
            const Restartable2DSecondOrderIntegrator & ) [delete]
```

8.30.3.5 reset_integrator()

```
void jeod::Restartable2DSecondOrderIntegrator::reset_integrator ( ) [inline]
```

Tell the integrator to reset itself.

This should be called when the time step or time direction changes or upon a discrete change in state such docking/undocking. Such events invalidate saved state (if any). The integrator needs to restart from scratch when such events occur.

Definition at line 153 of file restartable_2d_second_order_integrator.hh.

8.30.3.6 simple_restore()

```
void jeod::Restartable2DSecondOrderIntegrator::simple_restore ( ) [inline], [override]
```

Restore the integrator on restart.

Definition at line 161 of file restartable_2d_second_order_integrator.hh.

8.30.4 Friends And Related Function Documentation

8.30.4.1 init_attrjeod__Restartable2DSecondOrderIntegrator

```
void init_attrjeod__Restartable2DSecondOrderIntegrator ( ) [friend]
```

8.30.4.2 InputProcessor

```
friend class InputProcessor [friend]
```

Definition at line 84 of file restartable_2d_second_order_integrator.hh.

8.30.5 Field Documentation

8.30.5.1 integrator

```
er7_utils::SecondOrderODEIntegrator* jeod::Restartable2DSecondOrderIntegrator::integrator {}
[private]
```

The pointer to the object that performs integration.

This object is created managed by the integrator manager.trick_units(–)

Definition at line 176 of file restartable_2d_second_order_integrator.hh.

8.30.5.2 integrator_manager

```
RestartableSimpleSecondOrderODEIntegrator<2> jeod::Restartable2DSecondOrderIntegrator::integrator←
_manager [private]
```

The object that creates and manages the integrator object.

trick_io(∗∗)

Definition at line 181 of file restartable_2d_second_order_integrator.hh.

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

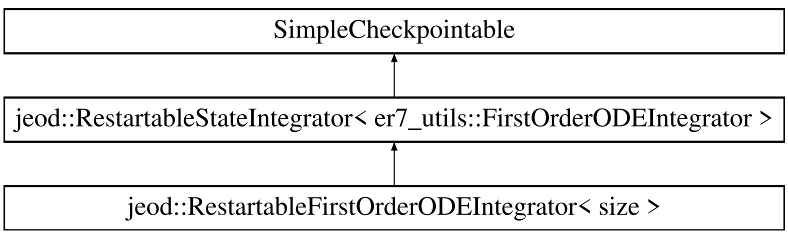
- restartable_2d_second_order_integrator.hh

8.31 jeod::RestartableFirstOrderODEIntegrator< size > Class Template Reference

A RestartableFirstOrderODEIntegrator is-a RestartableStateIntegrator that manages an er7_utils::FirstOrderOD←
EIntegrator.

```
#include <restartable_state_integrator_templates.hh>
```

Inheritance diagram for jeod::RestartableFirstOrderODEIntegrator< size >:



Public Member Functions

- RestartableFirstOrderODEIntegrator ()=default
- ∼RestartableFirstOrderODEIntegrator () override=default
- RestartableFirstOrderODEIntegrator (const RestartableFirstOrderODEIntegrator &)=delete
- RestartableFirstOrderODEIntegrator & operator= (const RestartableFirstOrderODEIntegrator &)=delete
- RestartableFirstOrderODEIntegrator (er7_utils::FirstOrderODEIntegrator ∗&integ_ref)

    Non-default constructor.

Private Member Functions

- er7_utils::FirstOrderODEIntegrator * create_integrator_internal (const er7_utils::IntegratorConstructor &generator, er7_utils::IntegrationControls &controls) override

    Create the integrator to be managed.

Additional Inherited Members

8.31.1 Detailed Description

template<unsigned int size>
class jeod::RestartableFirstOrderODEIntegrator< size >

A RestartableFirstOrderODEIntegrator is-a RestartableStateIntegrator that manages an er7_utils::FirstOrderODEIntegrator.

Template Parameters

size	Dimensionality of the state vector.

Definition at line 306 of file restartable_state_integrator_templates.hh.

8.31.2 Constructor & Destructor Documentation

8.31.2.1 RestartableFirstOrderODEIntegrator() [1/3]

```
template<unsigned int size>
jeod::RestartableFirstOrderODEIntegrator< size >::RestartableFirstOrderODEIntegrator ( )
[default]
```

8.31.2.2 ∼RestartableFirstOrderODEIntegrator()

```
template<unsigned int size>
jeod::RestartableFirstOrderODEIntegrator< size >::~RestartableFirstOrderODEIntegrator ( )
[override], [default]
```

8.31.2.3 RestartableFirstOrderODEIntegrator() [2/3]

```
template<unsigned int size>
jeod::RestartableFirstOrderODEIntegrator< size >::RestartableFirstOrderODEIntegrator (
            const RestartableFirstOrderODEIntegrator< size > & ) [delete]
```

8.31.2.4 RestartableFirstOrderODEIntegrator() [3/3]

```
template<unsigned int size>
jeod::RestartableFirstOrderODEIntegrator< size >::RestartableFirstOrderODEIntegrator (
            er7_utils::FirstOrderODEIntegrator *& integ_ref ) [inline], [explicit]
```

Non-default constructor.

Parameters

in,out	*integ_ref*	Reference to the pointer to the integrator that is to be managed.

Definition at line 319 of file restartable_state_integrator_templates.hh.

8.31.3 Member Function Documentation

8.31.3.1 create_integrator_internal()

```
template<unsigned int size>
er7_utils::FirstOrderODEIntegrator* jeod::RestartableFirstOrderODEIntegrator< size >::create←
_integrator_internal (
            const er7_utils::IntegratorConstructor & generator,
            er7_utils::IntegrationControls & controls ) [inline], [override], [private],
[virtual]
```

Create the integrator to be managed.

Parameters

in	*generator*	Integrator constructor used to create the integrator.
in,out	*controls*	Integration controls to be passed to the generator.

Implements jeod::RestartableStateIntegrator< er7_utils::FirstOrderODEIntegrator >.

Definition at line 332 of file restartable_state_integrator_templates.hh.

8.31.3.2 operator=()

```
template<unsigned int size>
RestartableFirstOrderODEIntegrator& jeod::RestartableFirstOrderODEIntegrator< size >::operator=
(
            const RestartableFirstOrderODEIntegrator< size > & ) [delete]
```

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

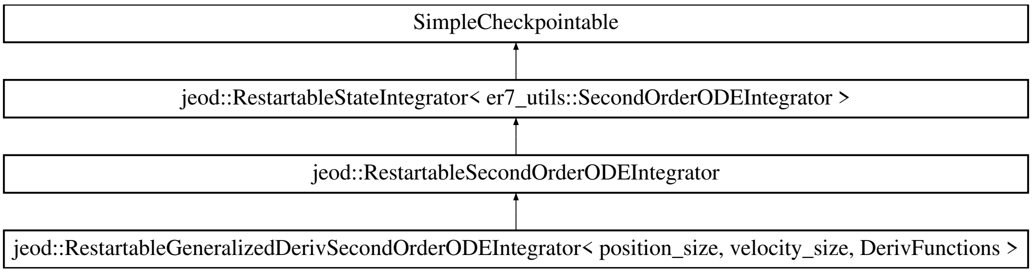
- restartable_state_integrator_templates.hh

8.32 jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity_size, DerivFunctions > Class Template Reference

A RestartableGeneralizedDerivSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a generalized second order ODE problem, one in which the time derivative of the generalized position is some function of the generalized position and the generalized velocity.

```
#include <restartable_state_integrator_templates.hh>
```

Inheritance diagram for jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity_↩
size, DerivFunctions >:



Public Member Functions

- RestartableGeneralizedDerivSecondOrderODEIntegrator ()=default
- ∼RestartableGeneralizedDerivSecondOrderODEIntegrator () override=default
- RestartableGeneralizedDerivSecondOrderODEIntegrator (const RestartableGeneralizedDerivSecondOrderODEIntegrator &)=delete
- RestartableGeneralizedDerivSecondOrderODEIntegrator & operator= (const RestartableGeneralizedDerivSecondOrderODEInt &)=delete
- RestartableGeneralizedDerivSecondOrderODEIntegrator (er7_utils::SecondOrderODEIntegrator ∗&integ_↩
ref)

    Non-default constructor.

Private Member Functions

- er7_utils::SecondOrderODEIntegrator ∗ create_integrator_internal (const er7_utils::IntegratorConstructor &generator, er7_utils::IntegrationControls &controls) override

    Create the integrator to be managed.
- void simple_restore_internal (er7_utils::SecondOrderODEIntegrator ∗integrator_ptr) override

    Perform technique-specific restart actions.

Additional Inherited Members

8.32.1 Detailed Description

template<unsigned int position_size, unsigned int velocity_size, typename DerivFunctions>
class jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity_size, DerivFunctions >

A RestartableGeneralizedDerivSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a generalized second order ODE problem, one in which the time derivative of the generalized position is some function of the generalized position and the generalized velocity.

Template Parameters

position_size	The dimensionality of the generalized position.
velocity_size	The dimensionality of the generalized velocity.
DerivFunctions	Class that derives from the class er7_utils::GeneralizedPositionDerivativeFunctions.

Definition at line 418 of file restartable_state_integrator_templates.hh.

8.32.2 Constructor & Destructor Documentation

8.32.2.1 RestartableGeneralizedDerivSecondOrderODEIntegrator() [1/3]

```
template<unsigned int position_size, unsigned int velocity_size, typename DerivFunctions>
jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity_size, Deriv↩
Functions >::RestartableGeneralizedDerivSecondOrderODEIntegrator ( )  [default]
```

8.32.2.2 ∼RestartableGeneralizedDerivSecondOrderODEIntegrator()

```
template<unsigned int position_size, unsigned int velocity_size, typename DerivFunctions>
jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity_size, Deriv↩
Functions >::~RestartableGeneralizedDerivSecondOrderODEIntegrator ( )  [override], [default]
```

8.32.2.3 RestartableGeneralizedDerivSecondOrderODEIntegrator() [2/3]

```
template<unsigned int position_size, unsigned int velocity_size, typename DerivFunctions>
jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity_size, Deriv↩
Functions >::RestartableGeneralizedDerivSecondOrderODEIntegrator (
             const RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity↩
_size, DerivFunctions > &  )  [delete]
```

8.32.2.4 RestartableGeneralizedDerivSecondOrderODEIntegrator() [3/3]

```
template<unsigned int position_size, unsigned int velocity_size, typename DerivFunctions>
jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity_size, Deriv↩
Functions >::RestartableGeneralizedDerivSecondOrderODEIntegrator (
             er7_utils::SecondOrderODEIntegrator *& integ_ref )  [inline], [explicit]
```

Non-default constructor.

Parameters

in,out	*integ_ref*	Reference to the pointer to the integrator that is to be managed.

Definition at line 433 of file restartable_state_integrator_templates.hh.

8.32.3 Member Function Documentation

8.32.3.1 create_integrator_internal()

```
template<unsigned int position_size, unsigned int velocity_size, typename DerivFunctions>
er7_utils::SecondOrderODEIntegrator* jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator<
position_size, velocity_size, DerivFunctions >::create_integrator_internal (
            const er7_utils::IntegratorConstructor & generator,
            er7_utils::IntegrationControls & controls ) [inline], [override], [private],
[virtual]
```

Create the integrator to be managed.

Parameters

in	*generator*	Integrator constructor used to create the integrator.
in,out	*controls*	Integration controls to be passed to the generator.

Implements jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >.

Definition at line 446 of file restartable_state_integrator_templates.hh.

8.32.3.2 operator=()

```
template<unsigned int position_size, unsigned int velocity_size, typename DerivFunctions>
RestartableGeneralizedDerivSecondOrderODEIntegrator& jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator<
position_size, velocity_size, DerivFunctions >::operator= (
            const RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity↩
_size, DerivFunctions > & ) [delete]
```

8.32.3.3 simple_restore_internal()

```
template<unsigned int position_size, unsigned int velocity_size, typename DerivFunctions>
void jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity_size,
DerivFunctions >::simple_restore_internal (
```

```
            er7_utils::SecondOrderODEIntegrator * integrator_ptr )  [inline], [override],
[private], [virtual]
```

Perform technique-specific restart actions.

The generalized second order ODE integrators need the pointer to the derivative function to be restored.

Parameters

in,out	*integrator_ptr*	The base class's integrator data member

Reimplemented from jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >.

Definition at line 461 of file restartable_state_integrator_templates.hh.

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

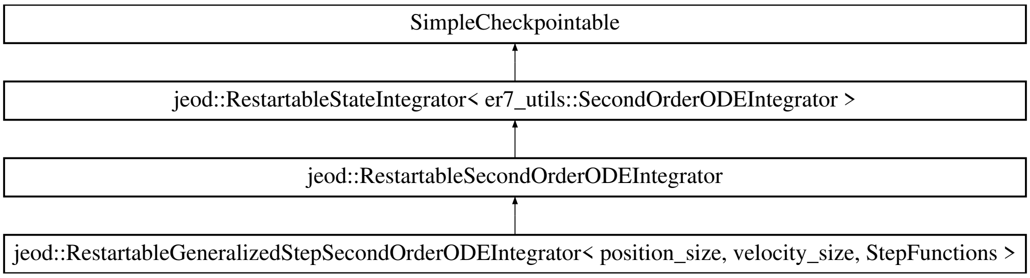
- restartable_state_integrator_templates.hh

8.33 jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity_size, StepFunctions > Class Template Reference

A RestartableGeneralizedStepSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a generalized second order ODE problem, one in which the time derivative of the generalized position is some function of the generalized position and the generalized velocity.

```
#include <restartable_state_integrator_templates.hh>
```

Inheritance diagram for jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity_↩ size, StepFunctions >:



Public Member Functions

- RestartableGeneralizedStepSecondOrderODEIntegrator ()=default
- ∼RestartableGeneralizedStepSecondOrderODEIntegrator () override=default
- RestartableGeneralizedStepSecondOrderODEIntegrator (const RestartableGeneralizedStepSecondOrderODEIntegrator &)=delete
- RestartableGeneralizedStepSecondOrderODEIntegrator & operator= (const RestartableGeneralizedStepSecondOrderODEInte &)=delete
- RestartableGeneralizedStepSecondOrderODEIntegrator (er7_utils::SecondOrderODEIntegrator ∗&integ_↩ ref)

  Non-default constructor.

Private Member Functions

- er7_utils::SecondOrderODEIntegrator ∗ create_integrator_internal (const er7_utils::IntegratorConstructor &generator, er7_utils::IntegrationControls &controls) override

  Create the integrator to be managed.
- void simple_restore_internal (er7_utils::SecondOrderODEIntegrator ∗integrator_ptr) override

  Perform technique-specific restart actions.

Additional Inherited Members

8.33.1 Detailed Description

template<unsigned int position_size, unsigned int velocity_size, typename StepFunctions>
class jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity_size, StepFunctions >

A RestartableGeneralizedStepSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a generalized second order ODE problem, one in which the time derivative of the generalized position is some function of the generalized position and the generalized velocity.

Template Parameters

position_size	The dimensionality of the generalized position.
velocity_size	The dimensionality of the generalized velocity.
StepFunctions	Class that derives from er7_utils::GeneralizedPositionStepFunctions.

Definition at line 482 of file restartable_state_integrator_templates.hh.

8.33.2 Constructor & Destructor Documentation

8.33.2.1 RestartableGeneralizedStepSecondOrderODEIntegrator() [1/3]

```
template<unsigned int position_size, unsigned int velocity_size, typename StepFunctions>
jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity_size, Step↩
Functions >::RestartableGeneralizedStepSecondOrderODEIntegrator ( )  [default]
```

8.33.2.2 ∼RestartableGeneralizedStepSecondOrderODEIntegrator()

```
template<unsigned int position_size, unsigned int velocity_size, typename StepFunctions>
jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity_size, Step↩
Functions >::∼RestartableGeneralizedStepSecondOrderODEIntegrator ( )  [override], [default]
```

8.33.2.3 RestartableGeneralizedStepSecondOrderODEIntegrator() [2/3]

```
template<unsigned int position_size, unsigned int velocity_size, typename StepFunctions>
jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity_size, Step↩
Functions >::RestartableGeneralizedStepSecondOrderODEIntegrator (
             const RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity↩
_size, StepFunctions > & )  [delete]
```

8.33.2.4 RestartableGeneralizedStepSecondOrderODEIntegrator() [3/3]

```
template<unsigned int position_size, unsigned int velocity_size, typename StepFunctions>
jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity_size, Step↩
Functions >::RestartableGeneralizedStepSecondOrderODEIntegrator (
            er7_utils::SecondOrderODEIntegrator *& integ_ref )  [inline], [explicit]
```

Non-default constructor.

Parameters

in,out	*integ_ref*	Reference to the pointer to the integrator that is to be managed.

Definition at line 497 of file restartable_state_integrator_templates.hh.

8.33.3 Member Function Documentation

8.33.3.1 create_integrator_internal()

```
template<unsigned int position_size, unsigned int velocity_size, typename StepFunctions>
er7_utils::SecondOrderODEIntegrator* jeod::RestartableGeneralizedStepSecondOrderODEIntegrator<
position_size, velocity_size, StepFunctions >::create_integrator_internal (
            const er7_utils::IntegratorConstructor & generator,
            er7_utils::IntegrationControls & controls )  [inline], [override], [private],
[virtual]
```

Create the integrator to be managed.

Parameters

in	*generator*	Integrator constructor used to create the integrator.
in,out	*controls*	Integration controls to be passed to the generator.

Implements jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >.

Definition at line 510 of file restartable_state_integrator_templates.hh.

8.33.3.2 operator=()

```
template<unsigned int position_size, unsigned int velocity_size, typename StepFunctions>
RestartableGeneralizedStepSecondOrderODEIntegrator& jeod::RestartableGeneralizedStepSecondOrderODEIntegrator<
position_size, velocity_size, StepFunctions >::operator= (
            const RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity↩
_size, StepFunctions > & )  [delete]
```

8.33.3.3 simple_restore_internal()

```
template<unsigned int position_size, unsigned int velocity_size, typename StepFunctions>
void jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity_size,
StepFunctions >::simple_restore_internal (
            er7_utils::SecondOrderODEIntegrator * integrator_ptr )  [inline], [override],
[private], [virtual]
```

Perform technique-specific restart actions.

The generalized second order ODE integrators need the pointer to the derivative function to be restored.

Parameters

`in,out`	*integrator_ptr*	The base class's integrator data member

Reimplemented from jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >.

Definition at line 525 of file restartable_state_integrator_templates.hh.

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

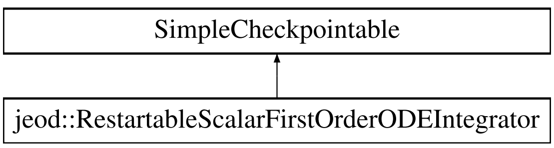
- restartable_state_integrator_templates.hh

8.34 jeod::RestartableScalarFirstOrderODEIntegrator Class Reference

A RestartableScalarFirstOrderODEIntegrator integrates a first order ODE, dx/dt = v(x,t), where x is a scalar.

```
#include <restartable_state_integrator.hh>
```

Inheritance diagram for jeod::RestartableScalarFirstOrderODEIntegrator:



Public Member Functions

- RestartableScalarFirstOrderODEIntegrator ()
  Default constructor.
- ∼RestartableScalarFirstOrderODEIntegrator () override=default
- RestartableScalarFirstOrderODEIntegrator (const RestartableScalarFirstOrderODEIntegrator &)=delete
- RestartableScalarFirstOrderODEIntegrator & operator= (const RestartableScalarFirstOrderODEIntegrator &)=delete
- void create_integrator (const er7_utils::IntegratorConstructor &generator, er7_utils::IntegrationControls &controls)
  Create the integrator to be managed.

- void destroy_integrator ()

    Destroy the integrator.
- er7_utils::IntegratorResult integrate (double dyn_dt, unsigned int target_stage, double ∗xdot, double ∗x)

    Propagate state to the specified stage of the integration process for an overall integration time interval of dyn_dt.
- void reset_integrator ()

    Tell the integrator to reset itself.
- void simple_restore () override

    Restore the integrator on restart.

Private Attributes

- er7_utils::FirstOrderODEIntegrator ∗ integrator {}

    Pointer to the object that performs integration.
- RestartableFirstOrderODEIntegrator< 1 > integrator_manager

    Object that creates and manages the integrator object.

Friends

- class InputProcessor
- void init_attrjeod__RestartableScalarFirstOrderODEIntegrator ()

8.34.1 Detailed Description

A RestartableScalarFirstOrderODEIntegrator integrates a first order ODE, dx/dt = v(x,t), where x is a scalar.

Definition at line 89 of file restartable_state_integrator.hh.

8.34.2 Constructor & Destructor Documentation

8.34.2.1 RestartableScalarFirstOrderODEIntegrator() [1/2]

```
jeod::RestartableScalarFirstOrderODEIntegrator::RestartableScalarFirstOrderODEIntegrator ( )
[inline]
```

Default constructor.

Definition at line 95 of file restartable_state_integrator.hh.

8.34.2.2 ∼RestartableScalarFirstOrderODEIntegrator()

```
jeod::RestartableScalarFirstOrderODEIntegrator::~RestartableScalarFirstOrderODEIntegrator ( )
[override], [default]
```

8.34.2.3 RestartableScalarFirstOrderODEIntegrator() [2/2]

```
jeod::RestartableScalarFirstOrderODEIntegrator::RestartableScalarFirstOrderODEIntegrator (
            const RestartableScalarFirstOrderODEIntegrator & ) [delete]
```

8.34.3 Member Function Documentation

8.34.3.1 create_integrator()

```
void jeod::RestartableScalarFirstOrderODEIntegrator::create_integrator (
            const er7_utils::IntegratorConstructor & generator,
            er7_utils::IntegrationControls & controls ) [inline]
```

Create the integrator to be managed.

Parameters

in	*generator*	Integrator constructor used to create the integrator.
in,out	*controls*	Integration controls to be passed to the generator.

Definition at line 110 of file restartable_state_integrator.hh.

8.34.3.2 destroy_integrator()

```
void jeod::RestartableScalarFirstOrderODEIntegrator::destroy_integrator ( ) [inline]
```

Destroy the integrator.

Definition at line 119 of file restartable_state_integrator.hh.

8.34.3.3 integrate()

```
er7_utils::IntegratorResult jeod::RestartableScalarFirstOrderODEIntegrator::integrate (
            double dyn_dt,
            unsigned int target_stage,
            double * xdot,
            double * x ) [inline]
```

Propagate state to the specified stage of the integration process for an overall integration time interval of dyn_dt.

Note that this is a pass-through to the encapsulated integrator object. See er7_utils::FirstOrderODEIntegrator↩::integrate for details.

Parameters

in	*dyn_dt*	Dynamic time step, in dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in	*xdot*	Time derivative of x.
in,out	*x*	Item to be integrated.

Returns

The status (time advance, pass/fail status) of the integration.

Definition at line 139 of file restartable_state_integrator.hh.

8.34.3.4 operator=()

```
RestartableScalarFirstOrderODEIntegrator& jeod::RestartableScalarFirstOrderODEIntegrator↩
::operator= (
            const RestartableScalarFirstOrderODEIntegrator & ) [delete]
```

8.34.3.5 reset_integrator()

```
void jeod::RestartableScalarFirstOrderODEIntegrator::reset_integrator ( ) [inline]
```

Tell the integrator to reset itself.

This should be called when the time step or time direction changes or upon a discrete change in state such docking/undocking. Such events invalidate saved state (if any). The integrator needs to restart from scratch when such events occur.

Definition at line 153 of file restartable_state_integrator.hh.

8.34.3.6 simple_restore()

```
void jeod::RestartableScalarFirstOrderODEIntegrator::simple_restore ( ) [inline], [override]
```

Restore the integrator on restart.

Definition at line 161 of file restartable_state_integrator.hh.

8.34.4 Friends And Related Function Documentation

8.34.4.1 init_attrjeod__RestartableScalarFirstOrderODEIntegrator

```
void init_attrjeod__RestartableScalarFirstOrderODEIntegrator ( ) [friend]
```

8.34.4.2 InputProcessor

```
friend class InputProcessor [friend]
```

Definition at line 91 of file restartable_state_integrator.hh.

8.34.5 Field Documentation

8.34.5.1 integrator

```
er7_utils::FirstOrderODEIntegrator* jeod::RestartableScalarFirstOrderODEIntegrator::integrator
{} [private]
```

Pointer to the object that performs integration.

The object is created managed by the integrator manager.trick_units(–)

Definition at line 172 of file restartable_state_integrator.hh.

8.34.5.2 integrator_manager

```
RestartableFirstOrderODEIntegrator<1> jeod::RestartableScalarFirstOrderODEIntegrator::integrator↩
_manager [private]
```

Object that creates and manages the integrator object.

trick_io(**)

Definition at line 177 of file restartable_state_integrator.hh.

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

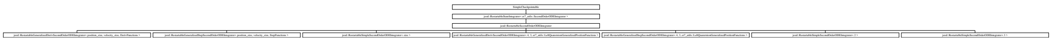
- restartable_state_integrator.hh

8.35 jeod::RestartableSecondOrderODEIntegrator Class Reference

A RestartableSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a second order ODE problem.

`#include <restartable_state_integrator_templates.hh>`

Inheritance diagram for jeod::RestartableSecondOrderODEIntegrator:



Public Member Functions

- ∼RestartableSecondOrderODEIntegrator () override=default
- RestartableSecondOrderODEIntegrator (const RestartableSecondOrderODEIntegrator &)=delete
- RestartableSecondOrderODEIntegrator & operator= (const RestartableSecondOrderODEIntegrator &)=delete

Protected Member Functions

- RestartableSecondOrderODEIntegrator ()=default
- RestartableSecondOrderODEIntegrator (er7_utils::SecondOrderODEIntegrator ∗&integ_ref)

  Non-default constructor.

8.35.1 Detailed Description

A RestartableSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a second order ODE problem.

Definition at line 344 of file restartable_state_integrator_templates.hh.

8.35.2 Constructor & Destructor Documentation

8.35.2.1 ∼RestartableSecondOrderODEIntegrator()

```
jeod::RestartableSecondOrderODEIntegrator::∼RestartableSecondOrderODEIntegrator ( ) [override],
[default]
```

8.35.2.2 RestartableSecondOrderODEIntegrator() [1/3]

```
jeod::RestartableSecondOrderODEIntegrator::RestartableSecondOrderODEIntegrator (
            const RestartableSecondOrderODEIntegrator & ) [delete]
```

8.35.2.3 RestartableSecondOrderODEIntegrator() [2/3]

```
jeod::RestartableSecondOrderODEIntegrator::RestartableSecondOrderODEIntegrator ( ) [protected],
[default]
```

8.35.2.4 RestartableSecondOrderODEIntegrator() [3/3]

```
jeod::RestartableSecondOrderODEIntegrator::RestartableSecondOrderODEIntegrator (
            er7_utils::SecondOrderODEIntegrator *& integ_ref ) [inline], [explicit], [protected]
```

Non-default constructor.

Parameters

in,out	*integ_ref*	Reference to the pointer to the integrator that is to be managed.

Definition at line 360 of file restartable_state_integrator_templates.hh.

8.35.3 Member Function Documentation

8.35.3.1 operator=()

```
RestartableSecondOrderODEIntegrator& jeod::RestartableSecondOrderODEIntegrator::operator= (
            const RestartableSecondOrderODEIntegrator & ) [delete]
```

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

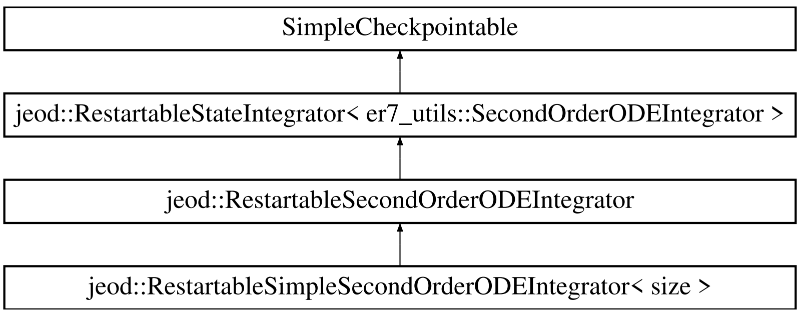
- restartable_state_integrator_templates.hh

8.36 jeod::RestartableSimpleSecondOrderODEIntegrator< size > Class Template Reference

A RestartableSimpleSecondOrderODEIntegrator is-a RestartableSecondOrderODEIntegrator that manages the integrator for a simple second order ODE problem, one in which the time derivative of the generalized position is the generalized velocity.

`#include <restartable_state_integrator_templates.hh>`

Inheritance diagram for jeod::RestartableSimpleSecondOrderODEIntegrator< size >:



Public Member Functions

- RestartableSimpleSecondOrderODEIntegrator ()=default
- ∼RestartableSimpleSecondOrderODEIntegrator () override=default
- RestartableSimpleSecondOrderODEIntegrator (const RestartableSimpleSecondOrderODEIntegrator &)=delete
- RestartableSimpleSecondOrderODEIntegrator & operator= (const RestartableSimpleSecondOrderODEIntegrator &)=delete
- RestartableSimpleSecondOrderODEIntegrator (er7_utils::SecondOrderODEIntegrator ∗&integ_ref)

  Non-default constructor.

Private Member Functions

- er7_utils::SecondOrderODEIntegrator ∗ create_integrator_internal (const er7_utils::IntegratorConstructor &generator, er7_utils::IntegrationControls &controls) override

  Create the integrator to be managed.

Additional Inherited Members

8.36.1 Detailed Description

template<unsigned int size>
class jeod::RestartableSimpleSecondOrderODEIntegrator< size >

A RestartableSimpleSecondOrderODEIntegrator is-a RestartableSecondOrderODEIntegrator that manages the integrator for a simple second order ODE problem, one in which the time derivative of the generalized position is the generalized velocity.

Template Parameters

size	Size of the position vector (and also of velocity).

Definition at line 373 of file restartable_state_integrator_templates.hh.

8.36.2 Constructor & Destructor Documentation

8.36.2.1 RestartableSimpleSecondOrderODEIntegrator() [1/3]

```
template<unsigned int size>
jeod::RestartableSimpleSecondOrderODEIntegrator< size >::RestartableSimpleSecondOrderODEIntegrator
( ) [default]
```

8.36.2.2 ∼RestartableSimpleSecondOrderODEIntegrator()

```
template<unsigned int size>
jeod::RestartableSimpleSecondOrderODEIntegrator< size >::~RestartableSimpleSecondOrderODEIntegrator
( ) [override], [default]
```

8.36.2.3 RestartableSimpleSecondOrderODEIntegrator() [2/3]

```
template<unsigned int size>
jeod::RestartableSimpleSecondOrderODEIntegrator< size >::RestartableSimpleSecondOrderODEIntegrator
(
            const RestartableSimpleSecondOrderODEIntegrator< size > & ) [delete]
```

8.36.2.4 RestartableSimpleSecondOrderODEIntegrator() [3/3]

```
template<unsigned int size>
jeod::RestartableSimpleSecondOrderODEIntegrator< size >::RestartableSimpleSecondOrderODEIntegrator
(
            er7_utils::SecondOrderODEIntegrator *& integ_ref ) [inline], [explicit]
```

Non-default constructor.

Parameters

in,out	*integ_ref*	Reference to the pointer to the integrator that is to be managed.

Definition at line 386 of file restartable_state_integrator_templates.hh.

8.36.3 Member Function Documentation

8.36.3.1 create_integrator_internal()

```
template<unsigned int size>
er7_utils::SecondOrderODEIntegrator* jeod::RestartableSimpleSecondOrderODEIntegrator< size >↩
::create_integrator_internal (
            const er7_utils::IntegratorConstructor & generator,
            er7_utils::IntegrationControls & controls ) [inline], [override], [private],
[virtual]
```

Create the integrator to be managed.

Parameters

in	*generator*	Integrator constructor used to create the integrator.
in,out	*controls*	Integration controls to be passed to the generator.

Implements jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >.

Definition at line 399 of file restartable_state_integrator_templates.hh.

8.36.3.2 operator=()

```
template<unsigned int size>
RestartableSimpleSecondOrderODEIntegrator& jeod::RestartableSimpleSecondOrderODEIntegrator<
size >::operator= (
            const RestartableSimpleSecondOrderODEIntegrator< size > & )  [delete]
```

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

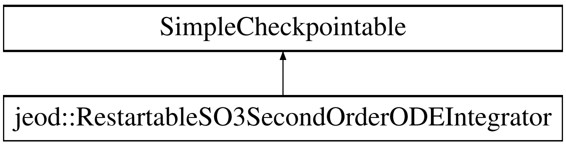
- restartable_state_integrator_templates.hh

8.37 jeod::RestartableSO3SecondOrderODEIntegrator Class Reference

A RestartableSO3SecondOrderODEIntegrator integrates a generalized second order ODE that describes rotation in three space.

```
#include <restartable_state_integrator.hh>
```

Inheritance diagram for jeod::RestartableSO3SecondOrderODEIntegrator:



Public Member Functions

- RestartableSO3SecondOrderODEIntegrator ()

  Default constructor.
- ∼RestartableSO3SecondOrderODEIntegrator () override

  Destructor.
- RestartableSO3SecondOrderODEIntegrator (const RestartableSO3SecondOrderODEIntegrator &)=delete
- RestartableSO3SecondOrderODEIntegrator & operator= (const RestartableSO3SecondOrderODEIntegrator &)=delete
- void create_integrator (GeneralizedSecondOrderODETechnique::TechniqueType technique_in, const er7_utils::IntegratorConstructor &generator, er7_utils::IntegrationControls &controls)

  Create the integrator to be managed.

- void destroy_integrator ()

    Destroy the integrator.
- er7_utils::IntegratorResult integrate (double dyn_dt, unsigned int target_stage, const double *accel, double *velocity, double *position)

    Propagate state to the specified stage of the integration process for an overall integration time interval of dyn_dt.
- void reset_integrator ()

    Tell the integrator to reset itself.
- void simple_restore () override

    Restore the integrator on restart.

Private Attributes

- GeneralizedSecondOrderODETechnique::TechniqueType technique

    Specifies the mechanism for integrating rotational state.
- er7_utils::SecondOrderODEIntegrator * integrator {}

    Pointer to the object that performs integration.
- RestartableGeneralizedDerivSecondOrderODEIntegrator< 4, 3, er7_utils::LeftQuaternionGeneralized↩ PositionFunctions > generalized_deriv_integrator_manager

    SO3 generalized derivative integrator.
- RestartableGeneralizedStepSecondOrderODEIntegrator< 4, 3, er7_utils::LeftQuaternionGeneralized↩ PositionFunctions > generalized_step_integrator_manager

    SO3 Lie Group integrator.

Friends

- class InputProcessor
- void init_attrjeod__RestartableSO3SecondOrderODEIntegrator ()

8.37.1 Detailed Description

A RestartableSO3SecondOrderODEIntegrator integrates a generalized second order ODE that describes rotation in three space.

Definition at line 281 of file restartable_state_integrator.hh.

8.37.2 Constructor & Destructor Documentation

8.37.2.1 RestartableSO3SecondOrderODEIntegrator() [1/2]

```
jeod::RestartableSO3SecondOrderODEIntegrator::RestartableSO3SecondOrderODEIntegrator ( )  [inline]
```

Default constructor.

Definition at line 287 of file restartable_state_integrator.hh.

8.37.2.2 ∼RestartableSO3SecondOrderODEIntegrator()

```
jeod::RestartableSO3SecondOrderODEIntegrator::~RestartableSO3SecondOrderODEIntegrator ( )
[inline], [override]
```

Destructor.

Definition at line 295 of file restartable_state_integrator.hh.

8.37.2.3 RestartableSO3SecondOrderODEIntegrator() [2/2]

```
jeod::RestartableSO3SecondOrderODEIntegrator::RestartableSO3SecondOrderODEIntegrator (
            const RestartableSO3SecondOrderODEIntegrator & ) [delete]
```

8.37.3 Member Function Documentation

8.37.3.1 create_integrator()

```
void jeod::RestartableSO3SecondOrderODEIntegrator::create_integrator (
            GeneralizedSecondOrderODETechnique::TechniqueType technique_in,
            const er7_utils::IntegratorConstructor & generator,
            er7_utils::IntegrationControls & controls ) [inline]
```

Create the integrator to be managed.

Parameters

in	*technique_in*	Integration technique; generalized step vs deriv.
in	*generator*	Integrator constructor used to create the integrator.
in,out	*controls*	Integration controls to be passed to the generator.

Definition at line 309 of file restartable_state_integrator.hh.

8.37.3.2 destroy_integrator()

```
void jeod::RestartableSO3SecondOrderODEIntegrator::destroy_integrator ( ) [inline]
```

Destroy the integrator.

Definition at line 339 of file restartable_state_integrator.hh.

8.37.3.3 integrate()

```
er7_utils::IntegratorResult jeod::RestartableSO3SecondOrderODEIntegrator::integrate (
            double dyn_dt,
            unsigned int target_stage,
            const double * accel,
            double * velocity,
            double * position )  [inline]
```

Propagate state to the specified stage of the integration process for an overall integration time interval of dyn_dt.

Note that this is a pass-through to the encapsulated integrator object. See er7_utils::SecondOrderODEIntegrator↩ ::integrate for details.

Parameters

in	*dyn_dt*	Dynamic time step, in dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in	*accel*	Time derivative of the generalized velocity.
in,out	*velocity*	Generalized velocity vector.
in,out	*position*	Generalized position vector.

Returns

The status (time advance, pass/fail status) of the integration.

Definition at line 363 of file restartable_state_integrator.hh.

8.37.3.4 operator=()

```
RestartableSO3SecondOrderODEIntegrator& jeod::RestartableSO3SecondOrderODEIntegrator::operator=
(
            const RestartableSO3SecondOrderODEIntegrator & )  [delete]
```

8.37.3.5 reset_integrator()

```
void jeod::RestartableSO3SecondOrderODEIntegrator::reset_integrator ( )  [inline]
```

Tell the integrator to reset itself.

This should be called when the time step or time direction changes or upon a discrete change in state such docking/undocking. Such events invalidate saved state (if any). The integrator needs to restart from scratch when such events occur.

Definition at line 378 of file restartable_state_integrator.hh.

8.37.3.6 simple_restore()

```
void jeod::RestartableSO3SecondOrderODEIntegrator::simple_restore ( ) [inline], [override]
```

Restore the integrator on restart.

Definition at line 386 of file restartable_state_integrator.hh.

8.37.4 Friends And Related Function Documentation

8.37.4.1 init_attrjeod__RestartableSO3SecondOrderODEIntegrator

```
void init_attrjeod__RestartableSO3SecondOrderODEIntegrator ( ) [friend]
```

8.37.4.2 InputProcessor

```
friend class InputProcessor [friend]
```

Definition at line 283 of file restartable_state_integrator.hh.

8.37.5 Field Documentation

8.37.5.1 generalized_deriv_integrator_manager

```
RestartableGeneralizedDerivSecondOrderODEIntegrator<4, 3, er7_utils::LeftQuaternionGeneralized↩
PositionFunctions> jeod::RestartableSO3SecondOrderODEIntegrator::generalized_deriv_integrator↩
_manager [private]
```

SO3 generalized derivative integrator.

trick_io(**)

Definition at line 423 of file restartable_state_integrator.hh.

8.37.5.2 generalized_step_integrator_manager

```
RestartableGeneralizedStepSecondOrderODEIntegrator<4, 3, er7_utils::LeftQuaternionGeneralized←
PositionFunctions> jeod::RestartableSO3SecondOrderODEIntegrator::generalized_step_integrator←
_manager [private]
```

SO3 Lie Group integrator.

trick_io(**)

Definition at line 429 of file restartable_state_integrator.hh.

8.37.5.3 integrator

```
er7_utils::SecondOrderODEIntegrator* jeod::RestartableSO3SecondOrderODEIntegrator::integrator
{} [private]
```

Pointer to the object that performs integration.

This object is created and managed by one of the integrator managers defined below. The techique dictates which of the two is used.trick_units(--)

Definition at line 417 of file restartable_state_integrator.hh.

8.37.5.4 technique

```
GeneralizedSecondOrderODETechnique::TechniqueType jeod::RestartableSO3SecondOrderODEIntegrator←
::technique [private]
```

Initial value:

```
{
       GeneralizedSecondOrderODETechnique::Unspecified}
```

Specifies the mechanism for integrating rotational state.

trick_units(--)

Definition at line 409 of file restartable_state_integrator.hh.

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

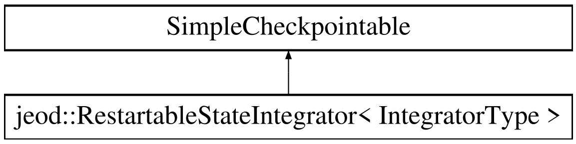
- restartable_state_integrator.hh

8.38 jeod::RestartableStateIntegrator< IntegratorType > Class Template Reference

A RestartableStateIntegrator establishes the basic capabilities needed to make a state integrator a managed resource.

```
#include <restartable_state_integrator_templates.hh>
```

Inheritance diagram for jeod::RestartableStateIntegrator< IntegratorType >:



Public Member Functions

- ∼RestartableStateIntegrator () override

    Destructor.
- void create_integrator (const er7_utils::IntegratorConstructor &generator, er7_utils::IntegrationControls &controls)

    Create the integrator to be managed.
- void destroy_integrator ()

    Destroy the integrator.
- void clear_integrator_reference ()

    Clear the pointer to the external integrator object.
- void set_integrator_reference (IntegratorType ∗&integ_ptr)

    Set the pointer to the external integrator object.
- void simple_restore () override

    Restore the integrator on restart.
- RestartableStateIntegrator (const RestartableStateIntegrator &)=delete
- RestartableStateIntegrator & operator= (const RestartableStateIntegrator &)=delete

Protected Member Functions

- RestartableStateIntegrator ()=default
- RestartableStateIntegrator (IntegratorType ∗&integ_ref)

    Non-default constructor.

Private Member Functions

- virtual IntegratorType ∗ create_integrator_internal (const er7_utils::IntegratorConstructor &generator, er7_utils::IntegrationControls &controls)=0

    Create the integrator to be managed.
- virtual void simple_restore_internal (IntegratorType ∗integrator_ptr)

    Perform technique-specific restart actions.

Private Attributes

- IntegratorType ** integrator_handle {}

    Pointer to the containing object's integrator pointer.

8.38.1 Detailed Description

template<typename IntegratorType>
class jeod::RestartableStateIntegrator< IntegratorType >

A RestartableStateIntegrator establishes the basic capabilities needed to make a state integrator a managed resource.

This includes

- Creating the integrator object,
- Restoring the integrator's derivative function on restart, and
- Destroying the integrator when the RestartableStateIntegrator instance goes out of scope.

Template Parameters

IntegratorType	The type of integrator to be managed, either er7_utils::FirstOrderODEIntegrator or er7_utils::SecondOrderODEIntegrator.

Usage:

This base class template is not directly usable. One must instead use one of the three class templates that derive from this class template:

- RestartableFirstOrderODEIntegrator to manage an er7_utils::FirstOrderODEIntegrator pointer;
- RestartableGeneralizedDerivSecondOrderODEIntegrator to manage an er7_utils::SecondOrderODE↩ Integrator pointer for a generalized second order ODE, one in which the time derivative of generalized position is a function of generalized position and generalized velocity; and
- RestartableGeneralizedStepSecondOrderODEIntegrator to manage an er7_utils::SecondOrderODE↩ Integrator pointer for a generalized second order ODE, one in which the time derivative of generalized position is a function of generalized position and generalized velocity; and
- RestartableSimpleSecondOrderODEIntegrator to manage an er7_utils::SecondOrderODEIntegrator pointer for a simple second order ODE, one in which the time derivative of generalized position is the generalized velocity.

Each state integrator to be used in some class needs a pair of data members declared in the definition of that class. The first of these pairs is a pointer to the appropriate state integrator type (either er7_utils::FirstOrderODE↩ Integrator or er7_utils::SecondOrderODEIntegrator). The second of the pairs of data members is an instance of the appropriate derived class of RestartableStateIntegrator that will manage the pointer. An example:

```
class MyClass {
   ...
   er7_utils::SecondOrderODEIntegrator * integrator;
   RestartableSimpleSecondOrderODEIntegrator\<3\> integ_manager;
   ...
};
```

The pointer itself must be exposed to Trick for checkpoint and restart. The RestartableStateIntegrator-derived object should be hidden from Trick.

The connection between the pointer and the manager for that pointer is made in the initializer lists of the constructors for the class. Use the RestartableStateIntegrator non-default constructor to tie the RestartableStateIntegrator object with the pointer it is to manage:

```
MyClass::MyClass ()
:
   ...
   integrator(nullptr),
   integ_manager(integrator),
   ...
{
   // Body of MyClass constructor
}
```

Note that there the RestartableStateIntegrator default constructors exist only for the sake of the simulation engine. The default constructors do not create viable instances. One must use the non-default constructor to initialize RestartableStateIntegrator instances.

The integrator itself is not created at construction time. Creating the integrator is the job of the create_integrator method. This method should be called at initialization time after having created the integration constructor and the integration controls objects.

The counterpart to the create_integrator method is destroy_integrator. This method must be called prior to calling create_integrator if the integrator has already been created via a previous call to create_integrator. (For example, switching to a different integration technique). The destroy_integrator can be called at shutdown or destruction time, but this call is not essential. The RestartableStateIntegrator object will call this method internally when it goes out of scope.

Class Design

This class template uses the non-virtual interface (NVI) design pattern, aka the template method design pattern (no relation to C++ class templates). The public create_integrator and simple_restore member functions use the private virtual create_integrator_internal and simple_restore_internal functions to create and restore the integrators.

Definition at line 171 of file restartable_state_integrator_templates.hh.

8.38.2 Constructor & Destructor Documentation

8.38.2.1 ∼RestartableStateIntegrator()

`template<typename IntegratorType>`
`jeod::RestartableStateIntegrator< IntegratorType >::∼RestartableStateIntegrator ( ) [inline], [override]`

Destructor.

Definition at line 179 of file restartable_state_integrator_templates.hh.

8.38.2.2 RestartableStateIntegrator() [1/3]

```
template<typename IntegratorType>
jeod::RestartableStateIntegrator< IntegratorType >::RestartableStateIntegrator (
            const RestartableStateIntegrator< IntegratorType > & ) [delete]
```

8.38.2.3 RestartableStateIntegrator() [2/3]

```
template<typename IntegratorType>
jeod::RestartableStateIntegrator< IntegratorType >::RestartableStateIntegrator ( ) [protected],
[default]
```

8.38.2.4 RestartableStateIntegrator() [3/3]

```
template<typename IntegratorType>
jeod::RestartableStateIntegrator< IntegratorType >::RestartableStateIntegrator (
            IntegratorType *& integ_ref ) [inline], [explicit], [protected]
```

Non-default constructor.

Parameters

in,out	*integ_ref*	Reference to the pointer to the integrator that is to be managed.

Definition at line 268 of file restartable_state_integrator_templates.hh.

8.38.3 Member Function Documentation

8.38.3.1 clear_integrator_reference()

```
template<typename IntegratorType>
void jeod::RestartableStateIntegrator< IntegratorType >::clear_integrator_reference ( ) [inline]
```

Clear the pointer to the external integrator object.

This currently (pre-Trick 13.0) needs to be called on restart because both pointers point to invalid objects.

Definition at line 225 of file restartable_state_integrator_templates.hh.

8.38.3.2 create_integrator()

```
template<typename IntegratorType>
void jeod::RestartableStateIntegrator< IntegratorType >::create_integrator (
            const er7_utils::IntegratorConstructor & generator,
            er7_utils::IntegrationControls & controls ) [inline]
```

Create the integrator to be managed.

Parameters

in	*generator*	Integrator constructor used to create the integrator.
in,out	*controls*	Integration controls to be passed to the generator.

Definition at line 189 of file restartable_state_integrator_templates.hh.

8.38.3.3 create_integrator_internal()

```
template<typename IntegratorType>
virtual IntegratorType* jeod::RestartableStateIntegrator< IntegratorType >::create_integrator↩
_internal (
            const er7_utils::IntegratorConstructor & generator,
            er7_utils::IntegrationControls & controls )  [private], [pure virtual]
```

Create the integrator to be managed.

Parameters

in	*generator*	Integrator constructor used to create the integrator.
in,out	*controls*	Integration controls to be passed to the generator.

Returns

The constructed integrator.

Implemented in jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity_size, StepFunctions >, jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< 4, 3, er7_utils::LeftQuaternionGeneralizedPositionFunctions >, jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity_size, DerivFunctions >, jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< 4, 3, er7_utils::LeftQuaternionGeneralizedPositionFunctions >, jeod::RestartableSimpleSecondOrderODEIntegrator< size >, jeod::RestartableSimpleSecondOrderODEIntegrator< 2 >, jeod::RestartableSimpleSecondOrderODEIntegrator< 3 >, jeod::RestartableFirstOrderODEIntegrator< size >, and jeod::RestartableFirstOrderODEIntegrator< 1 >.

Referenced by jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >::create_integrator().

8.38.3.4 destroy_integrator()

```
template<typename IntegratorType>
void jeod::RestartableStateIntegrator< IntegratorType >::destroy_integrator ( )  [inline]
```

Destroy the integrator.

Definition at line 212 of file restartable_state_integrator_templates.hh.

Referenced by jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >::create_integrator(), jeod::RestartableT3SecondOrderODEIntegrator::destroy_integrator(), and jeod::RestartableStateIntegrator< er7↩
_utils::SecondOrderODEIntegrator >::~RestartableStateIntegrator().

8.38.3.5 operator=()

```
template<typename IntegratorType>
RestartableStateIntegrator& jeod::RestartableStateIntegrator< IntegratorType >::operator= (
            const RestartableStateIntegrator< IntegratorType > & ) [delete]
```

8.38.3.6 set_integrator_reference()

```
template<typename IntegratorType>
void jeod::RestartableStateIntegrator< IntegratorType >::set_integrator_reference (
            IntegratorType *& integ_ptr ) [inline]
```

Set the pointer to the external integrator object.

This currently (pre-Trick 13.0) needs to be called on restart because the integrator_handle is not properly restored by checkpoint.

Parameters

in,out	*integ_ptr*	Reference to the external integrator object.

Definition at line 236 of file restartable_state_integrator_templates.hh.

Referenced by jeod::RestartableT3SecondOrderODEIntegrator::simple_restore().

8.38.3.7 simple_restore()

```
template<typename IntegratorType>
void jeod::RestartableStateIntegrator< IntegratorType >::simple_restore ( ) [inline], [override]
```

Restore the integrator on restart.

This currently (pre-Trick 13.0) needs to be called after calling set_integrator_reference.

Definition at line 246 of file restartable_state_integrator_templates.hh.

Referenced by jeod::RestartableT3SecondOrderODEIntegrator::simple_restore().

8.38.3.8 simple_restore_internal()

```
template<typename IntegratorType>
virtual void jeod::RestartableStateIntegrator< IntegratorType >::simple_restore_internal (
            IntegratorType * integrator_ptr ) [inline], [private], [virtual]
```

Perform technique-specific restart actions.

The default is to do nothing.

Parameters

`in,out`	*integrator_ptr*	The integrator object to be restored

Reimplemented in jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity_size, StepFunctions >, jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< 4, 3, er7_utils::LeftQuaternionGeneralizedPositionFunctions >, jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity_size, DerivFunctions >, and jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< 4, 3, er7_utils::LeftQuaternionGeneralizedPositionFunctions >.

Definition at line 290 of file restartable_state_integrator_templates.hh.

Referenced by jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >::simple_restore().

8.38.4 Field Documentation

8.38.4.1 integrator_handle

```
template<typename IntegratorType>
IntegratorType** jeod::RestartableStateIntegrator< IntegratorType >::integrator_handle {}
[private]
```

Pointer to the containing object's integrator pointer.

trick_io(**)

Definition at line 297 of file restartable_state_integrator_templates.hh.

Referenced by jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >::clear_integrator_reference(), jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >::create_integrator(), jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >::destroy_integrator(), jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >::set_integrator_reference(), and jeod::RestartableStateIntegrator< er7_utils::SecondOrderODEIntegrator >::simple_restore().

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

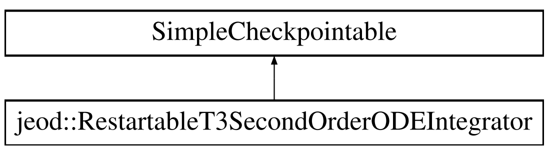
- restartable_state_integrator_templates.hh

8.39 jeod::RestartableT3SecondOrderODEIntegrator Class Reference

A RestartableT3SecondOrderODEIntegrator integrates a second order ODE in three space, d^2x/dt^2 = a(x,t), where x is a three-vector.

```
#include <restartable_state_integrator.hh>
```

Inheritance diagram for jeod::RestartableT3SecondOrderODEIntegrator:



Public Member Functions

- RestartableT3SecondOrderODEIntegrator ()

  Default constructor.
- ∼RestartableT3SecondOrderODEIntegrator () override=default
- RestartableT3SecondOrderODEIntegrator (const RestartableT3SecondOrderODEIntegrator &)=delete
- RestartableT3SecondOrderODEIntegrator & operator= (const RestartableT3SecondOrderODEIntegrator &)=delete
- void create_integrator (const er7_utils::IntegratorConstructor &generator, er7_utils::IntegrationControls &controls)

  Create the integrator to be managed.
- void destroy_integrator ()

  Destroy the integrator.
- er7_utils::IntegratorResult integrate (double dyn_dt, unsigned int target_stage, const double ∗accel, double ∗velocity, double ∗position)

  Propagate state to the specified stage of the integration process for an overall integration time interval of dyn_dt.
- void reset_integrator ()

  Tell the integrator to reset itself.
- void simple_restore () override

  Restore the integrator on restart.

Private Attributes

- er7_utils::SecondOrderODEIntegrator ∗ integrator {}

  Pointer to the object that performs integration.
- RestartableSimpleSecondOrderODEIntegrator< 3 > integrator_manager

  Object that creates and manages the integrator object.

Friends

- class InputProcessor
- void init_attrjeod__RestartableT3SecondOrderODEIntegrator ()

8.39.1 Detailed Description

A RestartableT3SecondOrderODEIntegrator integrates a second order ODE in three space, d^2x/dt^2 = a(x,t), where x is a three-vector.

Definition at line 184 of file restartable_state_integrator.hh.

8.39.2 Constructor & Destructor Documentation

8.39.2.1 RestartableT3SecondOrderODEIntegrator() [1/2]

```
jeod::RestartableT3SecondOrderODEIntegrator::RestartableT3SecondOrderODEIntegrator ( )  [inline]
```

Default constructor.

Definition at line 190 of file restartable_state_integrator.hh.

8.39.2.2 ∼RestartableT3SecondOrderODEIntegrator()

```
jeod::RestartableT3SecondOrderODEIntegrator::~RestartableT3SecondOrderODEIntegrator ( )  [override],
[default]
```

8.39.2.3 RestartableT3SecondOrderODEIntegrator() [2/2]

```
jeod::RestartableT3SecondOrderODEIntegrator::RestartableT3SecondOrderODEIntegrator (
            const RestartableT3SecondOrderODEIntegrator &  )  [delete]
```

8.39.3 Member Function Documentation

8.39.3.1 create_integrator()

```
void jeod::RestartableT3SecondOrderODEIntegrator::create_integrator (
            const er7_utils::IntegratorConstructor & generator,
            er7_utils::IntegrationControls & controls )  [inline]
```

Create the integrator to be managed.

Parameters

in	*generator*	Integrator constructor used to create the integrator.
in,out	*controls*	Integration controls to be passed to the generator.

Definition at line 205 of file restartable_state_integrator.hh.

8.39.3.2 destroy_integrator()

```
void jeod::RestartableT3SecondOrderODEIntegrator::destroy_integrator ( )  [inline]
```

Destroy the integrator.

Definition at line 214 of file restartable_state_integrator.hh.

References jeod::RestartableStateIntegrator< IntegratorType >::destroy_integrator(), and integrator_manager.

8.39.3.3 integrate()

```
er7_utils::IntegratorResult jeod::RestartableT3SecondOrderODEIntegrator::integrate (
            double dyn_dt,
            unsigned int target_stage,
            const double * accel,
            double * velocity,
            double * position ) [inline]
```

Propagate state to the specified stage of the integration process for an overall integration time interval of dyn_dt.

Note that this is a pass-through to the encapsulated integrator object. See er7_utils::SecondOrderODEIntegrator↩
::integrate for details.

Parameters

in	*dyn_dt*	Dynamic time step, in dynamic time seconds.
in	*target_stage*	The stage of the integration process that the integrator should try to attain.
in	*accel*	Time derivative of the generalized velocity.
in,out	*velocity*	Generalized velocity vector.
in,out	*position*	Generalized position vector.

Returns

The status (time advance, pass/fail status) of the integration.

Definition at line 235 of file restartable_state_integrator.hh.

8.39.3.4 operator=()

```
RestartableT3SecondOrderODEIntegrator& jeod::RestartableT3SecondOrderODEIntegrator::operator=
(
            const RestartableT3SecondOrderODEIntegrator & ) [delete]
```

8.39.3.5 reset_integrator()

```
void jeod::RestartableT3SecondOrderODEIntegrator::reset_integrator ( )  [inline]
```

Tell the integrator to reset itself.

This should be called when the time step or time direction changes or upon a discrete change in state such docking/undocking. Such events invalidate saved state (if any). The integrator needs to restart from scratch when such events occur.

Definition at line 250 of file restartable_state_integrator.hh.

8.39.3.6 simple_restore()

```
void jeod::RestartableT3SecondOrderODEIntegrator::simple_restore ( )  [inline], [override]
```

Restore the integrator on restart.

Definition at line 258 of file restartable_state_integrator.hh.

References integrator, integrator_manager, jeod::RestartableStateIntegrator$<$ IntegratorType $>$::set_integrator_↩
reference(), and jeod::RestartableStateIntegrator$<$ IntegratorType $>$::simple_restore().

8.39.4 Friends And Related Function Documentation

8.39.4.1 init_attrjeod__RestartableT3SecondOrderODEIntegrator

```
void init_attrjeod__RestartableT3SecondOrderODEIntegrator ( )  [friend]
```

8.39.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 186 of file restartable_state_integrator.hh.

8.39.5 Field Documentation

8.39.5.1 integrator

```
er7_utils::SecondOrderODEIntegrator* jeod::RestartableT3SecondOrderODEIntegrator::integrator
{} [private]
```

Pointer to the object that performs integration.

The object is created managed by the integrator manager.trick_units(–)

Definition at line 269 of file restartable_state_integrator.hh.

Referenced by simple_restore().

8.39.5.2 integrator_manager

```
RestartableSimpleSecondOrderODEIntegrator<3> jeod::RestartableT3SecondOrderODEIntegrator↩
::integrator_manager [private]
```

Object that creates and manages the integrator object.

trick_io(**)

Definition at line 274 of file restartable_state_integrator.hh.

Referenced by destroy_integrator(), and simple_restore().

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

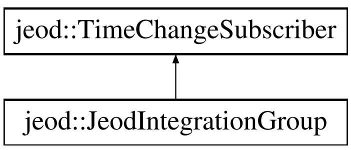
- restartable_state_integrator.hh

8.40 jeod::TimeChangeSubscriber Class Reference

A TimeChangeSubscriber is some object that wants to be notified of changes in the nature of time.

```
#include <time_change_subscriber.hh>
```

Inheritance diagram for jeod::TimeChangeSubscriber:



Public Member Functions

- TimeChangeSubscriber ()=default
- virtual ∼TimeChangeSubscriber ()=default
- TimeChangeSubscriber (const TimeChangeSubscriber &)=default
- TimeChangeSubscriber & operator= (const TimeChangeSubscriber &)=default
- virtual void respond_to_time_change ()=0

    Somehow respond to a change in the nature of time.

Friends

- class InputProcessor
- void init_attrjeod__TimeChangeSubscriber ()

8.40.1 Detailed Description

A TimeChangeSubscriber is some object that wants to be notified of changes in the nature of time.

Definition at line 74 of file time_change_subscriber.hh.

8.40.2 Constructor & Destructor Documentation

8.40.2.1 TimeChangeSubscriber() [1/2]

```
jeod::TimeChangeSubscriber::TimeChangeSubscriber ( )  [default]
```

8.40.2.2 ∼TimeChangeSubscriber()

```
virtual jeod::TimeChangeSubscriber::∼TimeChangeSubscriber ( )  [virtual], [default]
```

8.40.2.3 TimeChangeSubscriber() [2/2]

```
jeod::TimeChangeSubscriber::TimeChangeSubscriber (
            const TimeChangeSubscriber & )  [default]
```

8.40.3 Member Function Documentation

8.40.3.1 operator=()

```
TimeChangeSubscriber& jeod::TimeChangeSubscriber::operator= (
            const TimeChangeSubscriber & )  [default]
```

8.40.3.2 respond_to_time_change()

```
virtual void jeod::TimeChangeSubscriber::respond_to_time_change ( )  [pure virtual]
```

Somehow respond to a change in the nature of time.

Implemented in jeod::JeodIntegrationGroup.

8.40.4 Friends And Related Function Documentation

8.40.4.1 init_attrjeod__TimeChangeSubscriber

```
void init_attrjeod__TimeChangeSubscriber ( )  [friend]
```

8.40.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 76 of file time_change_subscriber.hh.

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

- time_change_subscriber.hh

8.41 er7_utils::TwoDArray< T > Class Template Reference

RAII template class that implements a rectangular two dimensional array.

```
#include <two_d_array.hh>
```

Public Member Functions

- TwoDArray ()=default
  Default constructor.
- TwoDArray (const TwoDArray< T > &src)
  Copy constructor.
- ∼TwoDArray ()
  Destructor.
- TwoDArray< T > & operator= (TwoDArray< T > src)
  Copy and swap assignment constructor.
- const T ∗ operator[ ] (int N) const
  Const overloaded index operator.
- T ∗ operator[ ] (int N)
  Non-const overloaded index operator.
- const T & operator() (int N, int M) const
  Const overloaded function operator.
- T & operator() (int N, int M)
  Non-const overloaded function operator.
- operator const T ∗const ∗ () const
  Const conversion operator to T const∗ const∗.
- operator T∗const ∗ ()
  Non-const conversion operator to T∗const∗.
- const T ∗ at (int N) const
  Range-checked equivalent of const T∗ operator[ ](int N) const.
- T ∗ at (int N)
  Range-checked equivalent of T∗ operator[ ](int N).
- const T & at (int N, int M) const
  Range-checked equivalent of const T& operator()(int N, int M) const.
- T & at (int N, int M)
  Range-checked equivalent of T& operator()(int N, int M).
- void allocate (std::size_t N, std::size_t M)
  Allocate the array.
- void rotate_down (int limit)
  Rotate elements 0 to limit downward, with array element 0 moved to array element limit.
- void rotate_up (int limit)
  Rotate elements 0 to limit upward, with array element limit moved to array element 0.
- void downsample (int limit)
  Downsample the array by swapping pointers.
- void swap (TwoDArray< T > &other)
  Swap the contents of ∗this with the other.

Protected Attributes

- int n {}
  The number of rows in the array.
- int m {}
  The number of columns in the array.
- T ∗ data_array {}
  The array data, as an NxM array of T.
- T ∗∗ row_array {}
  The rows in the array.

Private Member Functions

- void allocate_internal ()

  Allocate memory for the array.
- void deallocate_internal ()

  Deallocate memory for the array.

Friends

- void swap (TwoDArray< T > &first, TwoDArray< T > &second)

  Swap the contents of the two provided arrays.

8.41.1 Detailed Description

template<typename T>
class er7_utils::TwoDArray< T >

RAII template class that implements a rectangular two dimensional array.

The implementation provides two special-purpose features that are needed by some of the ER7 utilities and JEOD integrators. The rows of the array can be rotated and downsampled.

Template Parameters

T	Type of each element of the array.

Definition at line 79 of file two_d_array.hh.

8.41.2 Constructor & Destructor Documentation

8.41.2.1 TwoDArray() [1/2]

```
template<typename T>
er7_utils::TwoDArray< T >::TwoDArray ( )  [default]
```

Default constructor.

8.41.2.2 TwoDArray() [2/2]

```
template<typename T>
er7_utils::TwoDArray< T >::TwoDArray (
            const TwoDArray< T > & src )  [inline]
```

Copy constructor.

Parameters

src	Item to be copied.

Definition at line 91 of file two_d_array.hh.

8.41.2.3 ∼TwoDArray()

```
template<typename T>
er7_utils::TwoDArray< T >::∼TwoDArray ( )  [inline]
```

Destructor.

Definition at line 109 of file two_d_array.hh.

8.41.3 Member Function Documentation

8.41.3.1 allocate()

```
template<typename T>
void er7_utils::TwoDArray< T >::allocate (
            std::size_t N,
            std::size_t M )  [inline]
```

Allocate the array.

Parameters

N	Number of rows in the array.
M	Number of columns in the array.

Exceptions

std::domain_error	N and/or M won't fit in a signed int.

Definition at line 252 of file two_d_array.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::GaussJacksonIntegratorBase(), and er7_↩ utils::TwoDArray< double >::TwoDArray().

8.41.3.2 allocate_internal()

```
template<typename T>
void er7_utils::TwoDArray< T >::allocate_internal ( ) [inline], [private]
```

Allocate memory for the array.

Definition at line 384 of file two_d_array.hh.

Referenced by er7_utils::TwoDArray< double >::allocate().

8.41.3.3 at() [1/4]

```
template<typename T>
const T* er7_utils::TwoDArray< T >::at (
            int N ) const [inline]
```

Range-checked equivalent of const T∗ operator[ ](int N) const.

Parameters

N	Row index.

Returns

Const pointer to the Nth row in the array.

Exceptions

std::out_of_range	If *N* is an invalid index.

Definition at line 190 of file two_d_array.hh.

8.41.3.4 at() [2/4]

```
template<typename T>
T* er7_utils::TwoDArray< T >::at (
            int N ) [inline]
```

Range-checked equivalent of T∗ operator[ ](int N).

Parameters

N	Row index.

Returns

Modifiable pointer to the Nth row in the array.

Exceptions

std::out_of_range	If *N* is an invalid index.

Definition at line 205 of file two_d_array.hh.

8.41.3.5 at() [3/4]

```
template<typename T>
const T& er7_utils::TwoDArray< T >::at (
            int N,
            int M ) const [inline]
```

Range-checked equivalent of const T& operator()(int N, int M) const.

Parameters

N	Row index.
M	Column index.

Returns

Const reference to the N,M element of the array.

Exceptions

std::out_of_range	If *N* or *M* is an invalid index.

Definition at line 221 of file two_d_array.hh.

8.41.3.6 at() [4/4]

```
template<typename T>
T& er7_utils::TwoDArray< T >::at (
            int N,
            int M ) [inline]
```

Range-checked equivalent of T& operator()(int N, int M).

Parameters

N	Row index.
M	Column index.

Returns

Reference to the N,M element of the array.

Exceptions

std::out_of_range	If *N* or *M* is an invalid index.

Definition at line 237 of file two_d_array.hh.

8.41.3.7 deallocate_internal()

```
template<typename T>
void er7_utils::TwoDArray< T >::deallocate_internal ( )  [inline], [private]
```

Deallocate memory for the array.

Definition at line 393 of file two_d_array.hh.

Referenced by er7_utils::TwoDArray< double >::allocate(), and er7_utils::TwoDArray< double >::~TwoDArray().

8.41.3.8 downsample()

```
template<typename T>
void er7_utils::TwoDArray< T >::downsample (
            int limit )  [inline]
```

Downsample the array by swapping pointers.

Parameters

limit	Number of usable rows after downsample.

Exceptions

std::out_of_range	If *limit* represents an invalid index.

Definition at line 321 of file two_d_array.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::downsample_hist().

8.41.3.9 operator const T *const *()

```
template<typename T>
er7_utils::TwoDArray< T >::operator const T *const * ( ) const [inline]
```

Const conversion operator to T const* const*.

Returns

Non-modifiable pointer to the array.

Definition at line 170 of file two_d_array.hh.

References er7_utils::TwoDArray< T >::row_array.

8.41.3.10 operator T*const *()

```
template<typename T>
er7_utils::TwoDArray< T >::operator T*const * ( ) [inline]
```

Non-const conversion operator to T*const*.

Returns

Modifiable pointer to the array.

Definition at line 179 of file two_d_array.hh.

References er7_utils::TwoDArray< T >::row_array.

8.41.3.11 operator()() [1/2]

```
template<typename T>
const T& er7_utils::TwoDArray< T >::operator() (
            int N,
            int M ) const [inline]
```

Const overloaded function operator.

Parameters

N	Row index.
M	Column index.

Returns

Const reference to the N,M element of the array.

Definition at line 150 of file two_d_array.hh.

8.41.3.12 operator()() [2/2]

```
template<typename T>
T& er7_utils::TwoDArray< T >::operator() (
            int N,
            int M )  [inline]
```

Non-const overloaded function operator.

Parameters

N	Row index.
M	Column index.

Returns

Reference to the N,M element of the array.

Definition at line 161 of file two_d_array.hh.

8.41.3.13 operator=()

```
template<typename T>
TwoDArray<T>& er7_utils::TwoDArray< T >::operator= (
            TwoDArray< T > src )  [inline]
```

Copy and swap assignment constructor.

Parameters

src	Item to be copied.

Definition at line 118 of file two_d_array.hh.

8.41.3.14 operator[]() [1/2]

```
template<typename T>
const T* er7_utils::TwoDArray< T >::operator[] (
            int N ) const  [inline]
```

Const overloaded index operator.

Parameters

N	Row index.

Returns

Const pointer to the Nth row in the array.

Definition at line 129 of file two_d_array.hh.

8.41.3.15 operator[]() [2/2]

```
template<typename T>
T* er7_utils::TwoDArray< T >::operator[] (
            int N ) [inline]
```

Non-const overloaded index operator.

Parameters

N	Row index.

Returns

Modifiable pointer to the Nth row in the array.

Definition at line 139 of file two_d_array.hh.

8.41.3.16 rotate_down()

```
template<typename T>
void er7_utils::TwoDArray< T >::rotate_down (
            int limit ) [inline]
```

Rotate elements 0 to limit downward, with array element 0 moved to array element limit.

Parameters

limit	Index of last element participating in the rotation.

Exceptions

std::out_of_range	If *limit* is an invalid index.

Definition at line 280 of file two_d_array.hh.

Referenced by jeod::GaussJacksonIntegratorBase< State, Primer >::rotate_acc_hist().

8.41.3.17 rotate_up()

```
template<typename T>
void er7_utils::TwoDArray< T >::rotate_up (
            int limit ) [inline]
```

Rotate elements 0 to limit upward, with array element limit moved to array element 0.

Parameters

limit	Index of last element participating in the rotation.

Exceptions

std::out_of_range	If *limit* is an invalid index.

Definition at line 301 of file two_d_array.hh.

8.41.3.18 swap()

```
template<typename T>
void er7_utils::TwoDArray< T >::swap (
            TwoDArray< T > & other ) [inline]
```

Swap the contents of ∗this with the other.

Parameters

other	Other array.

Definition at line 338 of file two_d_array.hh.

Referenced by er7_utils::TwoDArray< double >::operator=(), and jeod::GaussJacksonIntegratorBase< State, Primer >::swap().

8.41.4 Friends And Related Function Documentation

8.41.4.1 swap

```
template<typename T>
void swap (
            TwoDArray< T > & first,
            TwoDArray< T > & second )  [friend]
```

Swap the contents of the two provided arrays.

Parameters

first	First array.
second	Second array.

Definition at line 351 of file two_d_array.hh.

8.41.5 Field Documentation

8.41.5.1 data_array

```
template<typename T>
T* er7_utils::TwoDArray< T >::data_array {}  [protected]
```

The array data, as an NxM array of T.

trick_units(–)

Definition at line 373 of file two_d_array.hh.

Referenced by er7_utils::TwoDArray< double >::allocate(), er7_utils::TwoDArray< double >::allocate_internal(), er7_utils::TwoDArray< double >::deallocate_internal(), and er7_utils::TwoDArray< double >::swap().

8.41.5.2 m

```
template<typename T>
int er7_utils::TwoDArray< T >::m {}  [protected]
```

The number of columns in the array.

trick_units(–)

Definition at line 368 of file two_d_array.hh.

Referenced by er7_utils::TwoDArray< double >::allocate(), er7_utils::TwoDArray< double >::allocate_internal(), er7_utils::TwoDArray< double >::at(), er7_utils::TwoDArray< double >::swap(), and er7_utils::TwoDArray< double >::TwoDArray().

8.41.5.3 n

```
template<typename T>
int er7_utils::TwoDArray< T >::n {} [protected]
```

The number of rows in the array.

trick_units(–)

Definition at line 363 of file two_d_array.hh.

Referenced by er7_utils::TwoDArray< double >::allocate(), er7_utils::TwoDArray< double >::allocate_internal(), er7_utils::TwoDArray< double >::at(), er7_utils::TwoDArray< double >::downsample(), er7_utils::TwoDArray< double >::rotate_down(), er7_utils::TwoDArray< double >::rotate_up(), er7_utils::TwoDArray< double >::swap(), and er7_utils::TwoDArray< double >::TwoDArray().

8.41.5.4 row_array

```
template<typename T>
T** er7_utils::TwoDArray< T >::row_array {} [protected]
```

The rows in the array.

trick_units(–)

Definition at line 378 of file two_d_array.hh.

Referenced by er7_utils::TwoDArray< double >::allocate(), er7_utils::TwoDArray< double >::allocate_internal(), er7_utils::TwoDArray< double >::at(), er7_utils::TwoDArray< double >::deallocate_internal(), er7_utils::TwoDArray< double >::downsample(), er7_utils::TwoDArray< T >::operator const T *const *(), er7_utils::TwoDArray< T >::operator T*const *(), er7_utils::TwoDArray< double >::operator()(), er7_utils::TwoDArray< double >::operator[ ](), er7_utils::TwoDArray< double >::rotate_down(), er7_utils::TwoDArray< double >::rotate_up(), er7_utils::TwoDArray< double >::swap(), and er7_utils::TwoDArray< double >::TwoDArray().

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

- two_d_array.hh

Chapter 9

File Documentation

9.1 gauss_jackson_coefficients_pair.cc File Reference

Defines member functions for the class GaussJacksonCoefficientsPair.

```
#include "../include/gauss_jackson_coefficients_pair.hh"
#include "../include/gauss_jackson_two_state.hh"
#include "er7_utils/interface/include/alloc.hh"
#include <algorithm>
#include <iostream>
```

Namespaces

- jeod

  Namespace jeod.

9.1.1 Detailed Description

Defines member functions for the class GaussJacksonCoefficientsPair.

9.2 gauss_jackson_coefficients_pair.hh File Reference

Defines the class GaussJacksonCoefficientsPair, which contains summed Adams and Gauss-Jackson coefficient pair.

```
#include "gauss_jackson_one_state.hh"
#include "gauss_jackson_two_state.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/interface/include/config.hh"
#include <cstddef>
#include <iosfwd>
```

Data Structures

- class jeod::GaussJacksonCoefficientsPair

    Contains a summed Adams and Gauss-Jackson coefficient pair.

Namespaces

- jeod

    Namespace jeod.

9.2.1 Detailed Description

Defines the class GaussJacksonCoefficientsPair, which contains summed Adams and Gauss-Jackson coefficient pair.

9.3 gauss_jackson_coeffs.cc File Reference

Defines member functions for the class GaussJacksonCoeffs.

```
#include "../include/gauss_jackson_coeffs.hh"
#include "../include/gauss_jackson_coefficients_pair.hh"
#include "../include/gauss_jackson_rational_coeffs.hh"
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/math/include/n_choose_m.hh"
#include <algorithm>
#include <cassert>
#include <iostream>
```

Namespaces

- jeod

    Namespace jeod.

Functions

- std::ostream & jeod::operator<< (std::ostream &stream, const GaussJacksonCoeffs &coeff)

9.3.1 Detailed Description

Defines member functions for the class GaussJacksonCoeffs.

9.4 gauss_jackson_coeffs.hh File Reference

Defines the class GaussJacksonCoeffs, which contains the Gauss-Jackson predictor and corrector coefficients.

```
#include "gauss_jackson_coefficients_pair.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include <iosfwd>
```

Data Structures

- class jeod::GaussJacksonCoeffs

  Contains the Gauss-Jackson predictor and corrector coefficients.

Namespaces

- jeod

  Namespace jeod.

9.4.1 Detailed Description

Defines the class GaussJacksonCoeffs, which contains the Gauss-Jackson predictor and corrector coefficients.

9.5 gauss_jackson_config.cc File Reference

Defines member functions for the class GaussJacksonIntegratorConstructor.

```
#include "utils/math/include/numerical.hh"
#include "../include/gauss_jackson_config.hh"
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include <algorithm>
#include <string>
```

Namespaces

- jeod

  Namespace jeod.

Functions

- static GaussJacksonConfig jeod::set_default_config_values (const GaussJacksonConfig &config)

  Swap the negative ones in the supplied config with the default values, some of which are computed.
- static unsigned int jeod::validate_config (const GaussJacksonConfig &config)

  Check for invalid values in the supplied config.

9.5.1 Detailed Description

Defines member functions for the class GaussJacksonIntegratorConstructor.

9.6 gauss_jackson_config.hh File Reference

Defines the class GaussJacksonConfig, which specifies Gauss-Jackson configuration data.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/integration_technique.hh"
```

Data Structures

- class jeod::GaussJacksonConfig

  Contains Gauss-Jackson configuration data.

Namespaces

- jeod

  Namespace jeod.

9.6.1 Detailed Description

Defines the class GaussJacksonConfig, which specifies Gauss-Jackson configuration data.

9.7 gauss_jackson_first_order_ode_integrator.hh File Reference

Defines the class GaussJacksonFirstOrderODEIntegrator, which integrates a first order ODE using the summed Adams technique.

```
#include "gauss_jackson_integrator_base_first.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/first_order_ode_integrator.hh"
```

Data Structures

- class jeod::GaussJacksonFirstOrderODEIntegrator

  Integrates a first order ODE using the summed Adams technique that is embedded within the Gauss-Jackson technique.

Namespaces

- jeod

  Namespace jeod.

9.7.1 Detailed Description

Defines the class GaussJacksonFirstOrderODEIntegrator, which integrates a first order ODE using the summed Adams technique.

- Note: This is a header-only implementation. There is no source file that corresponds to this header.

9.8 gauss_jackson_generalized_second_order_ode_integrator.cc File Reference

Defines member functions for the class GaussJacksonGeneralizedDerivSecondOrderODEIntegrator.

```
#include "../include/gauss_jackson_generalized_second_order_ode_integrator.↩
hh"
#include "er7_utils/interface/include/alloc.hh"
#include <algorithm>
```

Namespaces

- jeod

  Namespace jeod.

9.8.1 Detailed Description

Defines member functions for the class GaussJacksonGeneralizedDerivSecondOrderODEIntegrator.

9.9 gauss_jackson_generalized_second_order_ode_integrator.hh File Reference

Defines the class GaussJacksonGeneralizedDerivSecondOrderODEIntegrator, which integrates a generalized derivative second order ODE using Gauss-Jackson.

```
#include "gauss_jackson_first_order_ode_integrator.hh"
#include "gauss_jackson_simple_second_order_ode_integrator.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/second_order_ode_integrator.↩
hh"
```

Data Structures

- class jeod::GaussJacksonGeneralizedDerivSecondOrderODEIntegrator

  Integrates a generalized derivative second order ODE using Gauss-Jackson.

Namespaces

- jeod

  Namespace jeod.

9.9.1 Detailed Description

Defines the class GaussJacksonGeneralizedDerivSecondOrderODEIntegrator, which integrates a generalized derivative second order ODE using Gauss-Jackson.

9.10 gauss_jackson_integration_controls.cc File Reference

Defines member functions for the class GaussJacksonIntegrationControls.

```
#include "utils/math/include/numerical.hh"
#include "../include/gauss_jackson_integration_controls.hh"
#include "er7_utils/integration/core/include/base_integration_group.hh"
#include "er7_utils/integration/core/include/integrator_constructor.hh"
#include "er7_utils/integration/core/include/integrator_result.hh"
#include "er7_utils/integration/core/include/time_interface.hh"
#include "er7_utils/interface/include/alloc.hh"
#include <cassert>
```

Namespaces

- jeod

  Namespace jeod.

9.10.1 Detailed Description

Defines member functions for the class GaussJacksonIntegrationControls.

9.11 gauss_jackson_integration_controls.hh File Reference

Defines the class GaussJacksonIntegrationControls, which controls Gauss-Jackson integration process.

```
#include "gauss_jackson_coeffs.hh"
#include "gauss_jackson_config.hh"
#include "gauss_jackson_state_machine.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/integration_controls.hh"
#include "er7_utils/integration/core/include/integrator_constructor.hh"
```

Data Structures

- class jeod::GaussJacksonIntegrationControls

  IntegrationControls specialized for Gauss-Jackson integration.

Namespaces

- jeod

  Namespace jeod.

9.11.1 Detailed Description

Defines the class GaussJacksonIntegrationControls, which controls Gauss-Jackson integration process.

9.12 gauss_jackson_integrator_base.hh File Reference

Defines the template class GaussJacksonIntegratorBase, which provides the basis for Gauss-Jackson integration.

```
#include "gauss_jackson_coeffs.hh"
#include "gauss_jackson_config.hh"
#include "gauss_jackson_integration_controls.hh"
#include "gauss_jackson_state_machine.hh"
#include "two_d_array.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/integ_utils.hh"
#include "er7_utils/integration/core/include/integrator_result.hh"
#include "er7_utils/interface/include/alloc.hh"
#include <algorithm>
#include <cassert>
```

Data Structures

- class jeod::GaussJacksonIntegratorBase< State, Primer >

  Base template class for integrating state via the Gauss-Jackson technique.

Namespaces

- jeod

  Namespace jeod.

9.12.1 Detailed Description

Defines the template class GaussJacksonIntegratorBase, which provides the basis for Gauss-Jackson integration.

9.13 gauss_jackson_integrator_base_first.hh File Reference

Defines the template specializations of GaussJacksonIntegratorBase for a first order ODE.

```
#include "gauss_jackson_integrator_base.hh"
#include "gauss_jackson_one_state.hh"
#include "er7_utils/integration/core/include/first_order_ode_integrator.hh"
#include "er7_utils/integration/core/include/integrator_constructor.hh"
#include "er7_utils/interface/include/alloc.hh"
#include <algorithm>
#include <cmath>
```

Namespaces

- jeod

  Namespace jeod.

Typedefs

- using jeod::GaussJacksonIntegratorBaseFirst = GaussJacksonIntegratorBase< GaussJacksonOneState, er7_utils::FirstOrderODEIntegrator >

  Alias for a first order Gauss Jackson integrator.

9.13.1 Detailed Description

Defines the template specializations of GaussJacksonIntegratorBase for a first order ODE.

9.14 gauss_jackson_integrator_base_second.hh File Reference

Defines the template specializations of GaussJacksonIntegratorBase for a first order ODE.

```
#include "gauss_jackson_integrator_base.hh"
#include "gauss_jackson_two_state.hh"
#include "er7_utils/integration/core/include/integrator_constructor.hh"
#include "er7_utils/integration/core/include/second_order_ode_integrator.↩
hh"
#include "er7_utils/interface/include/alloc.hh"
#include <algorithm>
#include <cmath>
```

Namespaces

- jeod

  Namespace jeod.

Typedefs

- using jeod::GaussJacksonIntegratorBaseSecond = GaussJacksonIntegratorBase< GaussJacksonTwoState, er7_utils::SecondOrderODEIntegrator >

  Alias for a second order Gauss Jackson integrator.

9.14.1 Detailed Description

Defines the template specializations of GaussJacksonIntegratorBase for a first order ODE.

9.15 gauss_jackson_integrator_constructor.cc File Reference

Defines member functions for the class GaussJacksonIntegratorConstructor.

```
#include "../include/gauss_jackson_integrator_constructor.hh"
#include "../include/gauss_jackson_first_order_ode_integrator.hh"
#include "../include/gauss_jackson_generalized_second_order_ode_integrator.↩
hh"
#include "../include/gauss_jackson_simple_second_order_ode_integrator.hh"
#include "er7_utils/integration/core/include/integration_controls.hh"
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/integration/core/include/integrator_constructor_factory.↩
hh"
#include "er7_utils/integration/core/include/integrator_constructor_utils.↩
hh"
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include <algorithm>
```

Namespaces

- jeod

  Namespace jeod.

Functions

- static GaussJacksonIntegrationControls * jeod::cast_to_gj_controls (er7_utils::IntegrationControls &controls)

  Cast the provided integration controls to a GaussJacksonIntegrationControls.

9.15.1 Detailed Description

Defines member functions for the class GaussJacksonIntegratorConstructor.

9.16 gauss_jackson_integrator_constructor.hh File Reference

Defines the class GaussJacksonIntegratorConstructor, which constructs integrators that use Gauss-Jackson integration.

```
#include "gauss_jackson_config.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/integrator_constructor.hh"
#include <string>
```

Data Structures

- class jeod::GaussJacksonIntegratorConstructor

  Create state and time integrators that propagate using Gauss-Jackson.

Namespaces

- jeod

  Namespace jeod.

9.16.1 Detailed Description

Defines the class GaussJacksonIntegratorConstructor, which constructs integrators that use Gauss-Jackson integration.

9.17 gauss_jackson_one_state.hh File Reference

Defines the class GaussJacksonOneState, which contains a double∗ pointer.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include <cstddef>
```

Data Structures

- class jeod::GaussJacksonOneState

  Essentially just a double∗.

Namespaces

- jeod

  Namespace jeod.

9.17.1 Detailed Description

Defines the class GaussJacksonOneState, which contains a double* pointer.

9.18 gauss_jackson_rational_coeffs.cc File Reference

Defines member functions for the class GaussJacksonRationalCoefficients.

```
#include "../include/gauss_jackson_rational_coeffs.hh"
#include <cassert>
```

Namespaces

- jeod

  Namespace jeod.

9.18.1 Detailed Description

Defines member functions for the class GaussJacksonRationalCoefficients.

9.19 gauss_jackson_rational_coeffs.hh File Reference

Defines the class GaussJacksonRationalCoefficients, which contains a set of Adams or Stormer-Cowell coefficients.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/math/include/n_choose_m.hh"
#include "er7_utils/math/include/ratio128.hh"
#include <vector>
```

Data Structures

- class jeod::GaussJacksonRationalCoefficients

  Contains a set of Adams or Stormer-Cowell coefficients.

Namespaces

- jeod

  Namespace jeod.

9.19.1 Detailed Description

Defines the class GaussJacksonRationalCoefficients, which contains a set of Adams or Stormer-Cowell coefficients.

9.20 gauss_jackson_simple_second_order_ode_integrator.hh File Reference

Defines the class GaussJacksonSimpleSecondOrderODEIntegrator, which integrates a simple second order ODE using Gauss-Jackson.

```
#include "gauss_jackson_integrator_base_second.hh"
#include "gauss_jackson_two_state.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/second_order_ode_integrator.↩
hh"
```

Data Structures

- class jeod::GaussJacksonSimpleSecondOrderODEIntegrator

  Integrates a simple second order ODE using the Gauss-Jackson technique.

Namespaces

- jeod

  Namespace jeod.

9.20.1 Detailed Description

Defines the class GaussJacksonSimpleSecondOrderODEIntegrator, which integrates a simple second order ODE using Gauss-Jackson.

9.21 gauss_jackson_state_machine.cc File Reference

Defines member functions for the class GaussJacksonStateMachine.

```
#include "../include/gauss_jackson_state_machine.hh"
#include "../include/gauss_jackson_config.hh"
#include <algorithm>
#include <cassert>
#include <string>
```

Namespaces

- jeod

  Namespace jeod.

9.21.1 Detailed Description

Defines member functions for the class GaussJacksonStateMachine.

9.22 gauss_jackson_state_machine.hh File Reference

Defines the class GaussJacksonStateMachine, which guides the Gauss-Jackson integration process.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include <string>
```

Data Structures

- class jeod::GaussJacksonStateMachine

  Guides the behavior of the Gauss-Jackson integration process via a finite state machine.

Namespaces

- jeod

  Namespace jeod.

9.22.1 Detailed Description

Defines the class GaussJacksonStateMachine, which guides the Gauss-Jackson integration process.

9.23 gauss_jackson_two_state.hh File Reference

Defines the class GaussJacksonTwoState, which contains a pair of double∗ pointers.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include <cstddef>
```

Data Structures

- class jeod::GaussJacksonTwoState

  Essentially just std::pair<double∗>.

Namespaces

- jeod

  Namespace jeod.

9.23.1 Detailed Description

Defines the class GaussJacksonTwoState, which contains a pair of double∗ pointers.

9.24 generalized_second_order_ode_technique.cc File Reference

Define class GeneralizedSecondOrderODETechnique methods.

```
#include <cstddef>
#include "utils/message/include/message_handler.hh"
#include "../include/generalized_second_order_ode_technique.hh"
#include "../include/integration_messages.hh"
```

Namespaces

- jeod

  Namespace jeod.

9.24.1 Detailed Description

Define class GeneralizedSecondOrderODETechnique methods.

9.25 generalized_second_order_ode_technique.hh File Reference

Define the static class GeneralizedSecondOrderODETechnique.

```
#include "er7_utils/integration/core/include/integration_technique.hh"
#include "er7_utils/integration/core/include/integrator_constructor.hh"
```

Data Structures

- class jeod::GeneralizedSecondOrderODETechnique

  Enumerates the integration schemes, generalized Cartesian or Lie group integration, and provides simple utilities that work with this.

Namespaces

- jeod

  Namespace jeod.

9.25.1 Detailed Description

Define the static class GeneralizedSecondOrderODETechnique.

9.26 integration_messages.cc File Reference

Implement the class IntegrationMessages.

```
#include "utils/message/include/make_message_code.hh"
#include "../include/integration_messages.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define MAKE_INTEGRATION_MESSAGE_CODE(id) JEOD_MAKE_MESSAGE_CODE(Integration←Messages, "utils/integration/", id)

9.26.1 Detailed Description

Implement the class IntegrationMessages.

9.26.2 Macro Definition Documentation

9.26.2.1 MAKE_INTEGRATION_MESSAGE_CODE

```
#define MAKE_INTEGRATION_MESSAGE_CODE(
            id ) JEOD_MAKE_MESSAGE_CODE(IntegrationMessages, "utils/integration/", id)
```

Definition at line 37 of file integration_messages.cc.

9.27 integration_messages.hh File Reference

Define the class IntegrationMessages, the class that specifies the message IDs used in the integration model.

```
#include "utils/sim_interface/include/jeod_class.hh"
```

Data Structures

- class jeod::IntegrationMessages

  Declares messages associated with the integration test model.

Namespaces

- jeod

  Namespace jeod.

9.27.1 Detailed Description

Define the class IntegrationMessages, the class that specifies the message IDs used in the integration model.

9.28 jeod_integration_group.cc File Reference

Define JeodIntegrationGroup methods.

```
#include "../include/jeod_integration_group.hh"
#include "../include/integration_messages.hh"
#include "../include/jeod_integration_time.hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/message/include/message_handler.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/integrable_object.hh"
#include "er7_utils/integration/core/include/integrator_constructor.hh"
#include <algorithm>
#include <cstddef>
```

Namespaces

- jeod

  Namespace jeod.

9.28.1 Detailed Description

Define JeodIntegrationGroup methods.

9.29 jeod_integration_group.hh File Reference

Define the extensible class IntegrationGroup, an instance of which is responsible for integrating the states of a set of DynBody objects.

```
#include "time_change_subscriber.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "utils/container/include/pointer_vector.hh"
#include "utils/sim_interface/include/jeod_integrator_interface.hh"
#include "er7_utils/integration/core/include/base_integration_group.hh"
#include "er7_utils/integration/core/include/integrable_object.hh"
#include "er7_utils/integration/core/include/integrator_constructor.hh"
#include "er7_utils/integration/core/include/integrator_result_merger_←
container.hh"
#include <cstddef>
```

Data Structures

- class jeod::JeodIntegrationGroupOwner

  The abstract class IntegrationGroupOwner contains an IntegrationGroup.
- class jeod::JeodIntegrationGroup

  A JeodIntegrationGroup integrates the state of a set of objects over time.

Namespaces

- jeod

  Namespace jeod.

9.29.1 Detailed Description

Define the extensible class IntegrationGroup, an instance of which is responsible for integrating the states of a set of DynBody objects.

9.30 jeod_integration_time.cc File Reference

Define JeodIntegrationTime methods.

```
#include <algorithm>
#include <cstddef>
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/message/include/message_handler.hh"
#include "../include/integration_messages.hh"
#include "../include/jeod_integration_time.hh"
#include "../include/time_change_subscriber.hh"
```

Namespaces

- jeod

  Namespace jeod.

9.30.1 Detailed Description

Define JeodIntegrationTime methods.

9.31 jeod_integration_time.hh File Reference

Define the class JeodIntegrationTime.

```
#include "er7_utils/integration/core/include/time_interface.hh"
#include "utils/container/include/pointer_vector.hh"
#include "utils/sim_interface/include/jeod_class.hh"
```

Data Structures

- class jeod::JeodIntegrationTime

  The class JeodIntegrationTime adds the concepts of timestamping and notification of changes in the nature of time to the ER7 numerical utilities TimeInterface class.

Namespaces

- jeod

  Namespace jeod.

9.31.1 Detailed Description

Define the class JeodIntegrationTime.

9.32 lsode_control_data_interface.cc File Reference

Define member functions for the class LsodeControlDataInterface.

```
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include "../include/lsode_control_data_interface.hh"
```

9.32.1 Detailed Description

Define member functions for the class LsodeControlDataInterface.

9.33 lsode_control_data_interface.hh File Reference

Define the class LsodeControlDataInterface.

```
#include <vector>
#include "utils/sim_interface/include/jeod_class.hh"
```

Data Structures

- class jeod::LsodeControlDataInterface

  Specifies controls for an LSODE integrator.

Namespaces

- jeod

    Namespace jeod.

9.33.1 Detailed Description

Define the class LsodeControlDataInterface.

9.34 lsode_data_classes.cc File Reference

Define member functions for the data-grouping classes specified in lsode_data_classes.

```
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include "er7_utils/interface/include/alloc.hh"
#include "../include/lsode_data_classes.hh"
```

9.34.1 Detailed Description

Define member functions for the data-grouping classes specified in lsode_data_classes.

9.35 lsode_data_classes.hh File Reference

Define LSODE classes that contain just data members.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "lsode_control_data_interface.hh"
```

Data Structures

- class jeod::LsodeDataJacobianPrep

    Data associated with the method DPREPJ.
- class jeod::LsodeDataArrays

    The data arrays.
- class jeod::LsodeDataStode

    The data associated with method Dstode.

Namespaces

- jeod

    Namespace jeod.

9.35.1 Detailed Description

Define LSODE classes that contain just data members.

9.36 lsode_first_order_ode_integrator.hh File Reference

Define the class LsodeFirstOrderODEIntegrator, the Jeod-compatible version of the Livermore ODE solver, LSODE.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/first_order_ode_integrator.hh"
#include "er7_utils/integration/core/include/integration_controls.hh"
#include "er7_utils/integration/core/include/integrator_result.hh"
#include "lsode_control_data_interface.hh"
#include "lsode_data_classes.hh"
#include "lsode_integration_controls.hh"
```

Data Structures

- class jeod::LsodeFirstOrderODEIntegrator

  Jeod-compatible version of the Livermore ODE solver, LSODE.

Namespaces

- jeod

  Namespace jeod.

9.36.1 Detailed Description

Define the class LsodeFirstOrderODEIntegrator, the Jeod-compatible version of the Livermore ODE solver, LSODE.

9.37 lsode_first_order_ode_integrator__integrator.cc File Reference

Define member functions for the class LsodeFirstOrderODEIntegrator.

```
#include <cmath>
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/integration/core/include/integ_utils.hh"
#include "er7_utils/integration/core/include/integration_controls.hh"
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include "utils/math/include/numerical.hh"
#include "../include/lsode_first_order_ode_integrator.hh"
```

9.37.1 Detailed Description

Define member functions for the class LsodeFirstOrderODEIntegrator.

9.38 lsode_first_order_ode_integrator__manager.cc File Reference

Define member functions for the class LsodeFirstOrderODEIntegrator.

```
#include <cmath>
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/integration/core/include/integ_utils.hh"
#include "er7_utils/integration/core/include/integration_controls.hh"
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include "utils/math/include/numerical.hh"
#include "../include/lsode_first_order_ode_integrator.hh"
```

9.38.1 Detailed Description

Define member functions for the class LsodeFirstOrderODEIntegrator.

9.39 lsode_first_order_ode_integrator__support.cc File Reference

Define member functions for the class LsodeFirstOrderODEIntegrator.

```
#include <cmath>
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/integration/core/include/integ_utils.hh"
#include "er7_utils/integration/core/include/integration_controls.hh"
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include "utils/math/include/numerical.hh"
#include "../include/lsode_first_order_ode_integrator.hh"
```

9.39.1 Detailed Description

Define member functions for the class LsodeFirstOrderODEIntegrator.

9.40 lsode_first_order_ode_integrator__utility.cc File Reference

Define member functions for the class LsodeFirstOrderODEIntegrator.

```
#include <cmath>
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/integration/core/include/integ_utils.hh"
#include "er7_utils/integration/core/include/integration_controls.hh"
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include "../include/lsode_first_order_ode_integrator.hh"
```

9.40.1 Detailed Description

Define member functions for the class LsodeFirstOrderODEIntegrator.

9.41 lsode_generalized_second_order_ode_integrator.cc File Reference

Define member functions for the class LsodeGeneralizedDerivSecondOrderODEIntegrator.

```
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/integration/core/include/integ_utils.hh"
#include "er7_utils/integration/core/include/integration_controls.hh"
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include "../include/lsode_control_data_interface.hh"
#include "../include/lsode_generalized_second_order_ode_integrator.hh"
```

9.41.1 Detailed Description

Define member functions for the class LsodeGeneralizedDerivSecondOrderODEIntegrator.

9.42 lsode_generalized_second_order_ode_integrator.hh File Reference

Define the class LsodeGeneralizedDerivSecondOrderODEIntegrator.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/second_order_ode_integrator.↩
hh"
#include "lsode_second_order_ode_integrator.hh"
```

Data Structures

- class jeod::LsodeGeneralizedDerivSecondOrderODEIntegrator

  JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.

Namespaces

- jeod

  Namespace jeod.

9.42.1 Detailed Description

Define the class LsodeGeneralizedDerivSecondOrderODEIntegrator.

9.43 lsode_integration_controls.cc File Reference

Define the methods for the class LsodeIntegrationControls.

```
#include "er7_utils/integration/core/include/base_integration_group.hh"
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/integration/core/include/integrator_interface.hh"
#include "er7_utils/integration/core/include/time_interface.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include "utils/math/include/numerical.hh"
#include "../include/lsode_integration_controls.hh"
```

9.43.1 Detailed Description

Define the methods for the class LsodeIntegrationControls.

9.44 lsode_integration_controls.hh File Reference

Define the class LsodeIntegrationControls.

```
#include "er7_utils/interface/include/alloc.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/generalized_position_derivative.↩
hh"
#include "er7_utils/integration/core/include/standard_integration_controls.↩
hh"
```

Data Structures

- class jeod::LsodeIntegrationControls

  Contains controls for an LSODE integrator.

Namespaces

- jeod

  Namespace jeod.

9.44.1 Detailed Description

Define the class LsodeIntegrationControls.

9.45 lsode_integrator_constructor.cc File Reference

Define the methods in the class LsodeIntegratorConstructor.

```
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/integration/core/include/integrator_constructor_utils.↩
hh"
#include "er7_utils/interface/include/message_handler.hh"
#include "../include/lsode_first_order_ode_integrator.hh"
#include "../include/lsode_generalized_second_order_ode_integrator.hh"
#include "../include/lsode_integration_controls.hh"
#include "../include/lsode_integrator_constructor.hh"
#include "../include/lsode_second_order_ode_integrator.hh"
#include "../include/lsode_simple_second_order_ode_integrator.hh"
```

9.45.1 Detailed Description

Define the methods in the class LsodeIntegratorConstructor.

9.46 lsode_integrator_constructor.hh File Reference

Define the class LsodeIntegratorConstructor, the class that constructs the integration controls and the integrators for the LSODE method.

```
#include <vector>
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/integrator_constructor.hh"
#include "lsode_control_data_interface.hh"
#include "lsode_first_order_ode_integrator.hh"
#include "lsode_generalized_second_order_ode_integrator.hh"
#include "lsode_second_order_ode_integrator.hh"
#include "lsode_simple_second_order_ode_integrator.hh"
```

Data Structures

- class jeod::LsodeIntegratorConstructor

  Create state and time integrators that propagate using standard Lsode.

Namespaces

- jeod

  Namespace jeod.

9.46.1 Detailed Description

Define the class LsodeIntegratorConstructor, the class that constructs the integration controls and the integrators for the LSODE method.

9.47 lsode_second_order_ode_integrator.cc File Reference

Define member functions for the class LsodeSecondOrderODEIntegrator.

```
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/integration/core/include/integ_utils.hh"
#include "er7_utils/integration/core/include/integration_controls.hh"
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include "../include/lsode_control_data_interface.hh"
#include "../include/lsode_second_order_ode_integrator.hh"
```

9.47.1 Detailed Description

Define member functions for the class LsodeSecondOrderODEIntegrator.

9.48 lsode_second_order_ode_integrator.hh File Reference

Define the class LsodeSecondOrderODEIntegrator.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/second_order_ode_integrator.←
hh"
#include "lsode_first_order_ode_integrator.hh"
#include "lsode_integration_controls.hh"
```

Data Structures

- class jeod::LsodeSecondOrderODEIntegrator

  JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.

Namespaces

- jeod

  Namespace jeod.

9.48.1 Detailed Description

Define the class LsodeSecondOrderODEIntegrator.

9.49 lsode_simple_second_order_ode_integrator.cc File Reference

Define member functions for the class LsodeSimpleSecondOrderODEIntegrator.

```
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/integration/core/include/integration_messages.hh"
#include "er7_utils/interface/include/message_handler.hh"
#include "../include/lsode_control_data_interface.hh"
#include "../include/lsode_simple_second_order_ode_integrator.hh"
```

9.49.1 Detailed Description

Define member functions for the class LsodeSimpleSecondOrderODEIntegrator.

9.50 lsode_simple_second_order_ode_integrator.hh File Reference

Define the class LsodeSimpleSecondOrderODEIntegrator.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/second_order_ode_integrator.↩
hh"
#include "lsode_second_order_ode_integrator.hh"
```

Data Structures

- class jeod::LsodeSimpleSecondOrderODEIntegrator

  JEOD-compatible version of the Livermore ODE solver, LSODE, capable of integrating second-order ODEs.

Namespaces

- jeod

  Namespace jeod.

9.50.1 Detailed Description

Define the class LsodeSimpleSecondOrderODEIntegrator.

9.51 restartable_2d_second_order_integrator.hh File Reference

Defines the class Restartable2DSecondOrderODEIntegrator.

```
#include "generalized_second_order_ode_technique.hh"
#include "integration_messages.hh"
#include "restartable_state_integrator_templates.hh"
#include "utils/container/include/simple_checkpointable.hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/message/include/message_handler.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/first_order_ode_integrator.hh"
#include "er7_utils/integration/core/include/left_quaternion_functions.hh"
#include "er7_utils/integration/core/include/second_order_ode_integrator.↩
hh"
#include <cstddef>
```

Data Structures

- class jeod::Restartable2DSecondOrderIntegrator

  Integrates a second order ODE in two dimensional space, d^2x/dt^2 = a(x,t), where x is a two-vector.

Namespaces

- jeod

  Namespace jeod.

9.51.1 Detailed Description

Defines the class Restartable2DSecondOrderODEIntegrator.

9.52 restartable_state_integrator.hh File Reference

Define classes that encapsulate the construction, destruction, checkpointing, and restarting of state integrators.

```
#include "generalized_second_order_ode_technique.hh"
#include "integration_messages.hh"
#include "restartable_state_integrator_templates.hh"
#include "utils/container/include/simple_checkpointable.hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/message/include/message_handler.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "er7_utils/integration/core/include/first_order_ode_integrator.hh"
#include "er7_utils/integration/core/include/left_quaternion_functions.hh"
#include "er7_utils/integration/core/include/second_order_ode_integrator.↩
hh"
#include <cstddef>
```

Data Structures

- class jeod::RestartableScalarFirstOrderODEIntegrator

  A RestartableScalarFirstOrderODEIntegrator integrates a first order ODE, dx/dt = v(x,t), where x is a scalar.
- class jeod::RestartableT3SecondOrderODEIntegrator

  A RestartableT3SecondOrderODEIntegrator integrates a second order ODE in three space, d^2x/dt^2 = a(x,t), where x is a three-vector.
- class jeod::RestartableSO3SecondOrderODEIntegrator

  A RestartableSO3SecondOrderODEIntegrator integrates a generalized second order ODE that describes rotation in three space.

Namespaces

- jeod

  Namespace jeod.

9.52.1 Detailed Description

Define classes that encapsulate the construction, destruction, checkpointing, and restarting of state integrators.

9.53 restartable_state_integrator_templates.hh File Reference

Define template classes that encapsulate the construction, destruction, checkpointing, and restarting of state integrators.

```
#include <cstddef>
#include "er7_utils/integration/core/include/first_order_ode_integrator.hh"
#include "er7_utils/integration/core/include/integrator_constructor.hh"
#include "er7_utils/integration/core/include/second_order_ode_integrator.↩
hh"
#include "utils/container/include/simple_checkpointable.hh"
#include "utils/message/include/message_handler.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "integration_messages.hh"
```

Data Structures

- class jeod::RestartableStateIntegrator< IntegratorType >

  A RestartableStateIntegrator establishes the basic capabilities needed to make a state integrator a managed resource.
- class jeod::RestartableFirstOrderODEIntegrator< size >

  A RestartableFirstOrderODEIntegrator is-a RestartableStateIntegrator that manages an er7_utils::FirstOrderODE↩ Integrator.
- class jeod::RestartableSecondOrderODEIntegrator

  A RestartableSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a second order ODE problem.
- class jeod::RestartableSimpleSecondOrderODEIntegrator< size >

A RestartableSimpleSecondOrderODEIntegrator is-a RestartableSecondOrderODEIntegrator that manages the integrator for a simple second order ODE problem, one in which the time derivative of the generalized position is the generalized velocity.

- class jeod::RestartableGeneralizedDerivSecondOrderODEIntegrator< position_size, velocity_size, DerivFunctions >

  A RestartableGeneralizedDerivSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a generalized second order ODE problem, one in which the time derivative of the generalized position is some function of the generalized position and the generalized velocity.
- class jeod::RestartableGeneralizedStepSecondOrderODEIntegrator< position_size, velocity_size, StepFunctions >

  A RestartableGeneralizedStepSecondOrderODEIntegrator is-a RestartableStateIntegrator that manages the integrator for a generalized second order ODE problem, one in which the time derivative of the generalized position is some function of the generalized position and the generalized velocity.

Namespaces

- jeod

  Namespace jeod.

9.53.1 Detailed Description

Define template classes that encapsulate the construction, destruction, checkpointing, and restarting of state integrators.

9.54 time_change_subscriber.hh File Reference

Define the class TimeChangeSubscriber.

```
#include "utils/sim_interface/include/jeod_class.hh"
```

Data Structures

- class jeod::TimeChangeSubscriber

  A TimeChangeSubscriber is some object that wants to be notified of changes in the nature of time.

Namespaces

- jeod

  Namespace jeod.

9.54.1 Detailed Description

Define the class TimeChangeSubscriber.

9.55 two_d_array.hh File Reference

Defines the template class er7_utils::TwoDArray, which implements an RAII rectangular 2D array.

```
#include "er7_utils/interface/include/alloc.hh"
#include "er7_utils/interface/include/er7_class.hh"
#include "utils/sim_interface/include/config.hh"
#include <algorithm>
#include <cstddef>
#include <cstring>
#include <limits>
#include <stdexcept>
```

Data Structures

- class er7_utils::TwoDArray< T >

  RAII template class that implements a rectangular two dimensional array.
- class er7_utils::DoubleTwoDArray

  2D array, specialized for doubles.

Namespaces

- er7_utils

9.55.1 Detailed Description

Defines the template class er7_utils::TwoDArray, which implements an RAII rectangular 2D array.

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