House

From GridLAB-D Wiki

house - implements a single family home

Synopsis

```
class house {
        parent residential_enduse;
        function attach_enduse();
        object weather;
        double floor_area[sf];
        double gross_wall_area[sf];
        double ceiling_height[ft];
        double aspect_ratio;
        double envelope_UA[Btu/degF];
        double window_wall_ratio;
        double number_of_doors;
        double exterior_wall_fraction;
        double interior_exterior_wall_ratio;
        double exterior_ceiling_fraction;
        double exterior_floor_fraction;
        double window_shading;
        double window_exterior_transmission_coefficient;
        double solar_heatgain_factor;
        double airchange_per_hour;
        double airchange_UA[Btu/degF];
        double UA;
        double internal_gain[Btu/h];
        double solar_gain[Btu/h];
        double incident_solar_radiation[Btu/h];
        double heat_cool_gain[Btu/h];
        set {NONE=0,H=1,N=2,E=3,S=4,W=5} include_solar_quadrant;
        enumeration {DEFAULT=0,FLAT=1,LINEAR=2,CURVED=3} heating_cop_curve;
        double thermostat_deadband[degF];
        int16 thermostat_cycle_time;
        timestamp thermostat_last_cycle_time;
        double heating_setpoint[degF];
        double cooling_setpoint[degF];
        double design_heating_setpoint[degF];
        double design_cooling_setpoint[degF];
        double over_sizing_factor;
        double design_heating_capacity[Btu/h];
        double design_cooling_capacity[Btu/h];
        double cooling_design_temperature[degF];
        double heating_design_temperature[degF];
        double design_peak_solar[Btu/h];
        double design_internal_gains[W/sf];
        double air_heat_fraction[pu];
        double mass_solar_gain_fraction[pu];
        double mass_internal_gain_fraction[pu];
        double auxiliary_heat_capacity[Btu/h];
        double aux_heat_deadband[degF];
        double aux_heat_temperature_lockout[degF];
        double aux_heat_time_delay[s];
        double cooling_supply_air_temp[degF];
        double heating_supply_air_temp[degF];
        double duct_pressure_drop[inh2o];
        double fan_design_power[W];
        double fan_low_power_fraction[pu];
        double fan_power[kW];
        double fan_design_airflow[cfm];
        double fan_impedance_fraction[pu];
        double fan_power_fraction[pu];
        double fan_current_fraction[pu];
        double fan_power_factor[pu];
        double heating_demand;
        double cooling_demand;
        double heating_COP[pu];
        double cooling_COP[Btu/kWh];
        double air_temperature[degF];
        double outdoor_temperature[degF];
        double outdoor_rh[%];
        double mass_heat_capacity[Btu/degF];
        double mass_heat_coeff[Btu/degF];
        double mass_temperature[degF];
        double air_volume[cf];
        double air_mass[lb];
        double air_heat_capacity[Btu/degF];
        double latent_load_fraction[pu];
        double total_thermal_mass_per_floor_area[Btu/degF];
        double interior_surface_heat_transfer_coeff[Btu/h];
        double number_of_stories;
        double is_AUX_on;
        double is_HEAT_on;
        double is_COOL_on;
        double thermal_storage_present;
        double thermal_storage_in_use;
        set {RESISTIVE=16, TWOSTAGE=8, FORCEDAIR=4, AIRCONDITIONING=2, GAS=1} system_type;
        set {LOCKOUT=4, TIMER=2, DEADBAND=1, NONE=0} auxiliary_strategy;
```

```
        enumeration {AUX=3, COOL=4, OFF=1, HEAT=2, UNKNOWN=0} system_mode;
        enumeration {AUX=3, COOL=4, OFF=1, HEAT=2, UNKNOWN=0} last_system_mode;
        enumeration {RESISTANCE=4, HEAT_PUMP=3, GAS=2, NONE=1} heating_system_type;
        enumeration {HEAT_PUMP=2, ELECTRIC=2, NONE=1} cooling_system_type;
        enumeration {ELECTRIC=2, NONE=1} auxiliary_system_type;
        enumeration {TWO_SPEED=3, ONE_SPEED=2, NONE=1} fan_type;
        enumeration {UNKNOWN=7, VERY_GOOD=6, GOOD=5, ABOVE_NORMAL=4, NORMAL=3, BELOW_NORMAL=2, LITTLE=1, VERY_LITTLE=0} thermal_integrity_level;
        enumeration {LOW_E_GLASS=2, GLASS=1, OTHER=0} glass_type;
        enumeration {INSULATED=4, WOOD=3, THERMAL_BREAK=2, ALUMINIUM=1, ALUMINUM=1, NONE=0} window_frame;
        enumeration {HIGH_S=5, LOW_S=4, REFL=3, ABS=2, CLEAR=1, OTHER=0} glazing_treatment;
        enumeration {OTHER=4, THREE=3, TWO=2, ONE=1} glazing_layers;
        enumeration {FULL=2, BASIC=1, NONE=0} motor_model;
        enumeration {VERY_GOOD=4, |GOOD=3, AVERAGE=2, POOR=1, VERY_POOR=0} motor_efficiency;
        int64 last_mode_timer;
        double hvac_motor_efficiency[unit];
        double hvac_motor_loss_power_factor[unit];
        double Rroof[Btu/degF.h];
        double Rwall[Btu/degF.h];
        double Rfloor[Btu/degF.h];
        double Rwindows[Btu/degF.h];
        double Rdoors[Btu/degF.h];
        double hvac_breaker_rating[A];
        double hvac_power_factor[unit];
        double hvac_load;
        double last_heating_load;
        double last_cooling_load;
        complex hvac_power;
        double total_load;
        enduse panel;
        double design_internal_gain_density[W/sf];
        bool compressor_on;
        int64 compressor_count;
        timestamp hvac_last_on;
        timestamp hvac_last_off;
        double hvac_period_length;
        double hvac_duty_cycle;
        enumeration {NONE=2, BAND=1, FULL=0} thermostat_control;
}
```

Properties

Physical Design

Property name	Type	Unit	Description
floor_area	double	sf	Home conditioned floor area
gross_wall_area	double	sf	Gross outdoor wall area
ceiling_height	double	ft	Average ceiling height
aspect_ratio	double	none	Aspect ratio of the home's footprint
window_wall_ratio	double	none	Ratio of window area to wall area
number_of_doors	double	none	Ratio of door area to wall area
exterior_wall_fraction	double	none	Ratio of exterior wall ratio to wall area
interior_exterior_wall_ratio	double	none	Ratio of interior to exterior walls
exterior_ceiling_fraction	double	none	Ratio of external ceiling sf to floor area
exterior_floor_fraction	double	none	Ratio of floor area used in UA calculation
number_of_stories	double	none	Number of stories within the structure
Rroof	double	degF.sf.h/Btu	Roof R-value
Rwall	double	degF.sf.h/Btu	Wall R-value
Rfloor	double	degF.sf.h/Btu	Floor R-value
Rwindows	double	degF.sf.h/Btu	Window R-value
Rdoors	double	degF.sf.h/Btu	Door R-value
window_shading	double	none	Transmission coefficient through window due to glazing
window_exterior_transmission_coefficient	double	none	Coefficient for the amount of energy that passes through window

HVAC Design

Property name	Type	Unit	Description
cooling_design_temperature	double	degF	System cooling design temperature
heating_design_temperature	double	degF	System heating design temperature
design_peak_solar	double	Btu/h	System design solar load
design_internal_gains	double	W/sf	System design internal gains
cooling_supply_air_temp	double	degF	Temperature of air blown out of the cooling system
heating_supply_air_temp	double	degF	Temperature of air blown out of the heating system
duct_pressure_drop	double	in	End-to-end pressure drop for the ventilation ducts (inches of water)
heating_COP	double	pu	System heating performance coefficient
cooling_COP	double	Btu/kWh	System cooling performance coefficient
design_heating_capacity	double	Btu/h	System heating capacity
design_cooling_capacity	double	Btu/h	System cooling capacity
design_heating_setpoint	double	degF	System design heating setpoint
design_cooling_setpoint	double	degF	System design cooling setpoint
auxiliary_heat_capacity	double	Btu/h	Installed auxiliary heating capacity
over_sizing_factor	double	unit	Over sizes the heating and cooling system from standard specifications (0.2 = 120% sizing)

Heatflow

Property name	Type	Unit	Description
solar_heatgain_factor	double	none	Product of the window area, window transmitivity, and the window exterior transmission coefficient
airchange_per_hour	double	none	Number of air-changes per hour
internal_gain	double	Btu/h	Internal heat gains
solar_gain	double	Btu/h	Solar heat gains
incident_solar_radiation	double	Btu/h.sf	Average incident solar radiation hitting the house
heat_cool_gain	double	Btu/h	System heat gains(losses)
air_heat_fraction	double	pu	Fraction of the heat gain/loss that goes to air (as opposed to mass)
mass_heat_capacity	double	Btu/degF	Interior mass heat capacity
mass_heat_coeff	double	Btu/degF.h	Interior mass heat exchange coefficient
air_heat_capacity	double	Btu/degF	Air thermal mass
total_thermal_mass_per_floor_area	double	Btu/degF.sf	Total thermal mass per floor area
interior_surface_heat_transfer_coeff	double	Btu/h.degF.sf	Interior surface heat transfer coefficient
design_internal_gain_density	double	W/sf	Average density of heat generating devices in the house

Fan Design

Property name	Type	Unit	Description
fan_design_power	double	W	Designed maximum pwer draw of the ventilation fan
fan_low_power_fraction	double	pu	Fraction of ventilation fan power draw during low-power mode (two-speed only)
fan_power	double	kW	Current ventilation fan power draw
fan_design_airflow	double	cfm	Designed airflow for the ventilation system
fan_impedance_fraction	double	pu	Impedance component of fan ZIP load
fan_power_fraction	double	pu	Power component of fan ZIP load
fan_current_fraction	double	pu	Current component of fan ZIP load
fan_power_factor	double	pu	Power factor of the fan load
hvac_motor_efficiency	double	unit	Percent efficiency of HVAC motor when using motor model
hvac_motor_loss_power_factor	double	unit	Power factor of motor loasses when using motor model

Thermostat

Property name	Type	Unit	Description
heating_setpoint	double	degF	Thermostat heating setpoint
cooling_setpoint	double	degF	Thermostat cooling setpoint
aux_heat_deadband	double	degF	Temperature offset from standard heat activation to auxiliary heat activation
aux_heat_temperature_lockout	double	degF	Temperature at which auxiliary heat will not engage above
aux_heat_time_delay	double	s	Time required for heater to run until auxiliary heating engages
thermostat_deadband	double	degF	Deadband of thermostat control
thermostat_cycle_time	int16	none	Mimimum time in seconds between thermostat updates
thermostat_last_cycle_time	timestamp	none	Last time the thermostat changed state
last_mode_timer	int64	none	

Derived

Property name	Type	Unit	Description
air_temperature	double	degF	Indoor air temperature
outdoor_temperature	double	degF	Outdoor air temperature
mass_temperature	double	degF	Interior mass temperature
air_volume	double	cf	Air volume
air_mass	double	lb	Air mass
latent_load_fraction	double	pu	Fractional increase in cooling load due to latent heat
heating_demand	double	none	The current power draw to run the heating system
cooling_demand	double	none	The current power draw to run the cooling system
envelope_UA	double	Btu/degF.h	Overall UA of the home's envelope
airchange_UA	double	Btu/degF.h	Additional UA due to air infiltration

Load

Property name	Type	Unit	Description
panel	enduse	none	Total panel enduse load
hvac_breaker_rating	double	A	Determines the amount of curren the HVAC circuit breaker can handle
hvac_power_factor	double	unit	Power factor of HVAC
hvac_load	double	none	Heating/cooling system load
total_load	double	none	Total load

Enumerations

Property name	Type	Unit	Description
system_type	set	none	Describe HVAC system of house. (GAS, AIRCONDITIONING, FORCEDAIR, TWOSTAGE, RESISTIVE)
heating_system_type	enumeration	none	Set heating mechanism for house (RESISTANCE, HEAT_PUMP, GAS, NONE)
cooling_system_type	enumeration	none	Set cooling mechanism for hosue (HEAT_PUMP, ELECTRIC, NONE)
auxiliary_system_type	enumeration	none	Can be specified for HEAT_PUMP heating systems (ELECTRIC, NONE)
auxiliary_strategy	set	none	Control strategy for auxiliary heat (LOCKOUT, TIMER, DEADBAND, NONE)
system_mode	enumeration	none	Heating/cooling system operation state (UNKNOWN, HEAT, OFF, COOL, AUX)
fan_type	enumeration	none	Circulation fan (TWO_SPEED, ONE_SPEED, NONE)
thermal_integrity_level	enumeration	none	Default envelope UA settings (VERY_GOOD, GOOD, ABOVE_NORMAL, NORMAL, BELOW_NORMAL, LITTLE, VERY_LITTLE, UNKNOWN)
glass_type	enumeration	none	Type of window glass used (LOW_E_GLASS, GLASS, OTHER)
window_frame	enumeration	none	Type of window frame (INSULATED, WOOD, THERMAL_BREAK, ALUMINUM, NONE)
glazing_treatment	enumeration	none	Treatment that increases the reflectivity of exterior windows (HIGH_S, LOW_S, REFL, ABS, CLEAR, OTHER)
glazing_layers	enumeration	none	Number of layers of glass in each window (THREE, TWO, ONE, OTHER)
motor_model	enumeration	none	Indicates the level of detail used in modeling the HVAC motor parameters (FULL, BASIC, NONE)
motor_efficiency	enumeration	none	Describes efficiency of the motor when using a motor model (VERY_GOOD, GOOD, AVERAGE, POOR, VERY_POOR)

Default House

The default house does not require any parameters be set. Thus, the minimum allowed specification for a single family house is

```
house {
}
```

New houses are created with the following default values (meaning if the value is not set in the GLM file, it will be calculated automatically).

Default parameter values

Parameter	Default value
load.power_fraction	0.8
load.impedance_fraction	0.2
load.current_fraction	0.0
design_internal_gain_density	0.6 W/sf
thermal_integrity_level	UNKNOWN
hvac_breaker_rating	0.0 A
hvac_power_factor	0.0
Tmaterials	0.0 degF
cooling_supply_air_temp	50.0 degF
heating_supply_air_temp	150.0 degF
heating_system_type	HEAT_PUMP
cooling_system_type	UNKNOWN
auxiliary_system_type	UNKNOWN
fan_type	UNKNOWN
fan_power_factor	0.96
fan_current_fraction	0.7332
fan_impedance_fraction	0.2534
fan_power_fraction	0.0135
glazing_layers	TWO
glass_type	LOW_E_GLASS
glazing_treatment	CLEAR
window_frame	THERMAL_BREAK
motor_model	NONE
motor_efficiency	AVERAGE
hvac_motor_efficiency	1.0
hvac_motor_loss_power_factor	0.125
hvac_motor_real_loss	0.0
hvac_motor_reactive_loss	0.0
is_AUX_on	FALSE
is_HEAT_on	FALSE
is_COOL_on	FALSE
thermal_storage_present	FALSE
thermal_storage_inuse	FALSE

Certain parameters are calculated by default as follows

Thermal integrity levels

thermal_integrity_level	Rroof	Rwall	Rfloor	Rdoors	Rwindows	airchange_per_hour
VERY_LITTLE	11.0	4.0	4.0	3.0	1/1.27	1.5
LITTLE	19.0	11.0	4.0	3.0	1/0.81	1.5
BELOW_NORMAL	19.0	11.0	11.0	3.0	1/0.81	1.0
NORMAL	30.0	11.0	19.0	3.0	1/0.6	1.0
ABOVE_NORMAL	30.0	19.0	11.0	3.0	1/0.6	1.0
GOOD	30.0	19.0	22.0	5.0	1/0.47	0.5
VERY_GOOD	48.0	19.0	22.0	5.0	1/0.47	0.5
UNKNOWN	–	–	–	–	–	–

Glazing solar heat gain coefficient (glazing_shgc) by window frame type (window_frame)

glazing_treatment		CLEAR			ABS			REFL			LOW_S		HIGH_S	
glazing_layers		ONE	TWO	THREE	ONE	TWO	THREE	ONE	TWO	THREE	TWO	THREE	TWO	THREE
window_frame	NONE	0.86	0.76	0.68	0.73	0.62	0.34	0.31	0.29	0.34	0.41	0.27	0.70	0.62
	ALUMINUM	0.75	0.67	0.60	0.64	0.55	0.31	0.28	0.27	0.31	0.37	0.25	0.62	0.55
	THERMAL_BREAK	0.75	0.67	0.60	0.64	0.55	0.31	0.28	0.27	0.31	0.37	0.25	0.62	0.55
	WOOD	0.64	0.57	0.51	0.54	0.46	0.26	0.24	0.22	0.26	0.31	0.21	0.52	0.46
	INSULATED	0.64	0.57	0.51	0.54	0.46	0.26	0.24	0.22	0.26	0.31	0.21	0.52	0.46

Values for Rwindows.

glass_type		LOW_E_GLASS			GLASS			OTHER		
glazing_layers		ONE	TWO	THREE	ONE	TWO	THREE	ONE	TWO	THREE
window_frame	NONE	undef	1/0.30	1/0.27	1/1.04	1/0.48	1/0.31	2.0		
	ALUMINUM	undef	1/0.67	1/0.64	1/1.27	1/0.81	1/0.67			
	THERMAL_BREAK	undef	1/0.47	1/0.43	1/1.08	1/0.60	1/0.46			
	WOOD	undef	1/0.41	1/0.37	1/0.90	1/0.53	1/0.40			
	INSULATED	undef	1/0.33	1/0.31	1/0.81	1/0.44	1/0.34			

Automatically calculated defaults

Parameter	Default value
panel.max_amps	200 A
fan_type	heating_system_type==HEAT_PUMP ? ONE_SPEED : NONE
TODO:	Add rest of auto inits from house_e::init()

Example

```
module residential;
object house {
}
```

See Also

- Residential module
  - User's Guide
  - Appliances
  - **house** class – Single-family home model.

    - residential_enduse class – Abstract residential end-use class.
    - occupantload – Residential occupants (sensible and latent heat).
    - ZIPload – Generic constant impedance/current/power end-use load.
- Technical Documents
    - Requirements
    - Specifications
    - Developer notes
    - Technical support document
    - Validation

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