

# SSCHA input file cheatsheet

## &inputsscha

fildyn\_prefix : [REQUIRED] Location of the files with the dynamical matrices.

nqirr : [REQUIRED] The number of irreducible  $q$  points (just look how many dynamical-matrixes files are there).

t : [REQUIRED] The temperature used to generate the ensemble (in Kelvin).

tg : The temperature that will be used in the minimization (in Kelvin).

minim\_struc : Do SSCHA minimize the structure? [.true./.false.]

n\_random : The dimension of the ensemble

meaningful\_factor : The stopping criteria. The code will end the minimization after the gradient is lower than meaningful\_factor times its stochastic error.

n\_random\_eff : The Kong-Liu effective sample size. When this size becomes lower than the given threshold the minimization is stopped, and you should regenerate a new ensemble. Usually in the beginning you can choose 0.1 the original ensemble, and raise it to 0.4 or 0.5 when you are close to convergence.

root\_representation : Set root representation, a trick to increase the speed of the minimization and to avoid the imaginary frequency error. The python new code is not able to do simultaneously precondition and root\_representation. Options are:

- "normal" : normal minimization, can lead to imaginary frequencies
- "sqrt" : square root representation.
- "root4" : fourth-root representation, the best one (and the slowest).

precond\_wyck : Preconditioning variable [.true./.false.]

preconditioning : Preconditioning dynamical matrix variable for a very fast minimization [.true./.false.] (preconditioning can be used only if root\_representation = "normal")

load\_bin : \*\*\*\*\*

## &inputsscha

population : The population id. This is an integer that distinguishes different ensembles and allows for use of the same data\_dir for several minimizations.

supercell\_size : " The supercell size.

data\_dir : The position of the ensemble (where the data are stored). Unit of measurements must be in bohr for displacements and  $Ry/bohr$  for forces and  $Ry/bohr^3$  for stress tensors. Energy is in Ry.

eq\_energy : Set the equilibrium energy. It should be the energy of the structure without fluctuations, it is used to separate the electronic and the vibrational energy, since they are usually of different order of magnitude. It is measured in Ry.

lambda\_a : Force constant minimization step. Step for the force constant matrix

lambda\_w : Force constant minimization step. Step for the structure

max\_ka : Maximum number of steps after which the code is automatically stopped

stress\_offset : A number or a file with the stress offset.

gradi\_op : Which gradient is used to trigger the stopping condition. By default, both of them should satisfy the meaningful criteria. Options are:

- "all" - both the gradient should satisfy the meaningful (default)
- "gw" - only the wyckoff (i.e. structure) gradient.
- "gc" - only the force-constant matrix gradient.

print\_stress : Legacy flag, not used anymore, now it automatically prints the stress if it finds the stress tensor inside the ensemble.

use\_spglib : Use spglib for symmetrization. [.true./.false.]

neglect\_symmetries : Disable the symmetrization. Useful if we want to relax a structure. [.true./.false.]

## **&relax**

type : [REQUIRED] Relaxation options are:

- "relax" SSCHA Relaxation
- "vc-relax" Variable cell SSCHA relaxation

n\_configs : [REQUIRED] Number of configurations. This namespace is able to generate new ensembles to perform several minimizations

max\_pop\_id : Maximun population index before stop [INTEGER]

start\_pop : Initial population index [INTEGER]

ensemble\_datadir : Location to save the ensemble.

generate\_ensemble : If .false. will get the ensemble from 'inputscha'.

target\_pressure : In GPa

fix\_volume : [.true./.false.]

bulk\_modulus : In GPa

sobol\_sampling : Set the Sobol method for the extraction of the samples [.true./.false.]

sobol\_scatter : Set the scatter value for the Sobol sampling.

## **&calculator**

program : [REQUIRED] The calculator type (e.g. "quantum-espresso")

k\_points : [REQUIRED] k grid for the electronic calculation

k\_offset : Offset of the k grid

disable\_check : \*\*\*\*\*

binary : \*\*\*\*\*

pseudo\_ : Here the pseudopotentials. Note they are pseudo\_ followed by the atom name (not case sensitive)

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"quantum-espresso" accepted parameters:

"ecutrho", "ecutwfc", "smearing", "degauss", "occupations", "conv\_thr", "tstress", "tprnfor", "verbosity", "disk\_io", "input\_dft", "use\_all\_frac"

## **&utils**

save\_freq\_filename : Set the name of the frequencies file.

save\_rho\_filename : Set the name of the rho file.

mu\_lock\_start : This flag set the value for locking the modes.

mu\_lock\_end : This flag set the value for locking the modes.

mu\_free\_start : This flag set the value for unlockin the modes.

mu\_free\_end : This flag set the value for unlockin the modes.

project\_dyn : Project on the mode subspace the dynamical matrix. [.true./.false.]

project\_structure : Project on the structure [.true./.false.]

## **&cluster**

template : Look for a cluster template [.true./.false.]

SSCHA\_CLUSTERS\_DIR : Load cluster info from this file template

hostname : Set cluster hostname

pwd : Set work directory

account :

binary\_path :

mpicmd :

reconnect\_attempts : Set the maximun connection attempts

port :

shell :

submit\_cmd :

queue\_directive :

## &cluster

```
v_nodes :  
n_nodes :  
use_nodes :  
    v_cpu :  
    n_cpu :  
use_cpu :  
    v_time :  
    n_time :  
n_pools :  
use_time :  
v_memory :  
max_ram :  
    : "use_memory" "v_partition" "partition_name"  
      "use_partition" "init_script" "max_recalc"  
      "batch_size" "local_workdir" "v_account"  
      "use_account" "sshcmd" "scpcmd" "timeout"  
      "job_numbers" "n_together"  
      "workdir"
```

## Abstract

The input file perform the minimization.

To run the SSCHA code with the input file use:

```
>>> sscha -i simple_input.in --save-data simple_input.out
```

The file can have any name (often \*.in).

An example of an input file:

```
!
! * * * * *
! *
! *   VC - RELAX EXAMPLE   *
! *
! * * * * *
!
!
! This is the input to perform the sscha minimization, followed
! by the change of the unit cell given by the stress step.
!
! This is not the recommended way to do it (you can do everything automatically)
! But usefull if you want to control manually each submission
!

&relax
type = "vc-relax"
start_pop = 2
max_pop_id = 2
generate_ensemble = .false.
fix_volume = .false.
target_pressure = 0 ! [GPa]
bulk_modulus = 15 ! [GPa]
n_configs = 1000
&end

&inputscha
n_random = 1000
data_dir = "../ensemble_data_test"
population = 2
fildyn_prefix = "../ensemble_data_test/dyn"
nqirr = 1
supercell_size = 1 1 1
Tg = 0
T = 0
meaningful_factor = 1e-4
gradi_op = "all"
n_random_eff = 500
print_stress = .true.
eq_energy = -144.40680397
lambda_a = 1
lambda_w = 1
root_representation = "normal"
preconditioning = .true.
max_ka= 20
/
```