Epics Tutorial 4: Using IOC and Creating PV's

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- In this tutorial, we are going through basic concepts about epics, more specifically:
  - IOC's
  - PV's
- We will build a simple calculator. I recommend you to do this tutorial in full before going on because the others tutorials might use this one as an example.
- **I assume you have an IOC named *myCalculator* in your Epics folder. Check previous tutorial for more information.**
- Epics is a set of software tools and applications that helps you to build control system. I highly recommend you to read the about page at epics website - http://www.aps.anl.gov/epics/about.php.
- Don't hesitate to send me questions, comments and suggestions.

Preparing the IOC

Enter the IOC's top folder and run the make command (note I am using variables defined in the previous tutorial - WORKINGNAME in this case is myCalculator).

```
cd $EPICS_BASE/$WORKINGNAME
```

It's good practice to create a folder to store your database (records).

```
mkdir db
```

Creating PV's and records

Epics has process variables (or PV's). A PV is any value related to your process like temperature, status, etc... For example: You have a motor, the velocity of the motor is a process variable. Any simple process has several PV's.

Records and PV's are almost the same thing. I Guess you could say PV's can be used to reference a record field, ie: We have a record "motor1", then we have a process variable "motor1.powerValue" related to that record, but I'm not sure if this is the right convention.

Records are stored in db files. There are several types of records, Analogic Inputs (ai), Calculation (calc), etc. The dbd file (dataBaseDefinitions) is a file that define each type of record. The dbd file is tells the IOC what types of record there are, what values they store, what are the valid fields, etc.

There are two way of creating records, using a text editor or using visualDCT. First we will use VisualDCT. VisualDCT is a record editor, there are other editors, but this particular one is simple to use.

First, download the program. This link has the instructions:

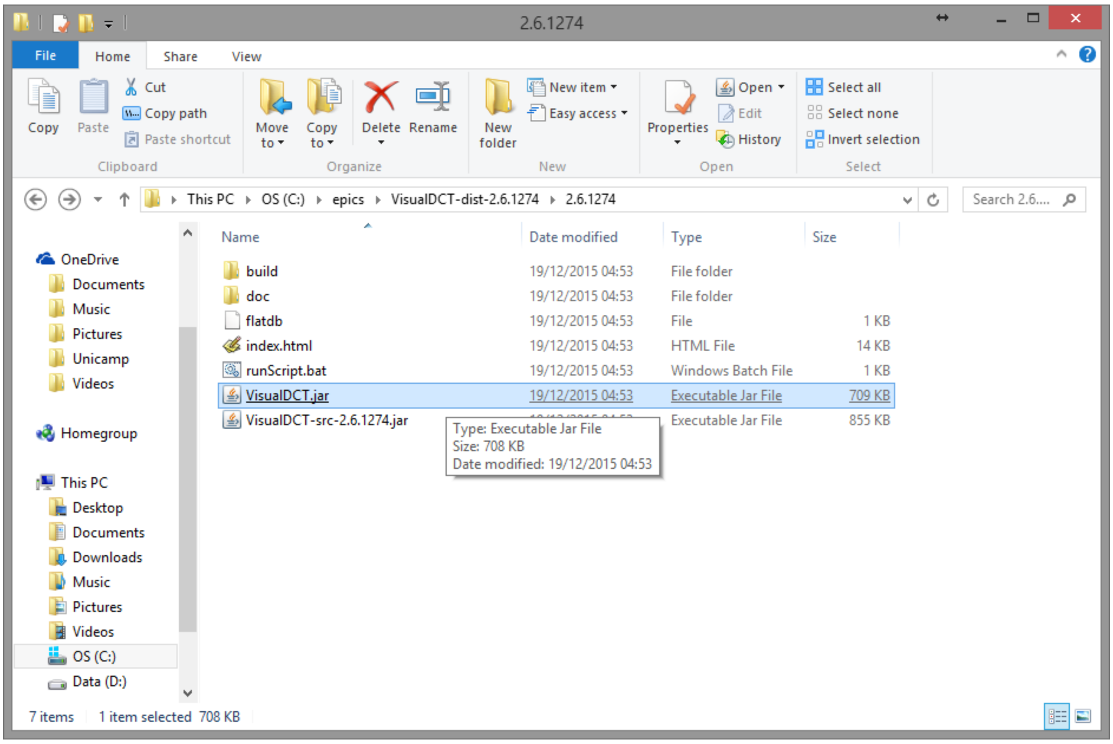
https://wiki-ext.aps.anl.gov/epics/index.php/VDCT_Status_Page

Take a time to read about visualDCT in the website.

On linux open visualDCT through the terminal:

```
java /opt/epics/VisualDCT-dist-2.6.1274/2.6.1274/VisualDCT.jar
```

On windows, just click on VisualDCT.jar.

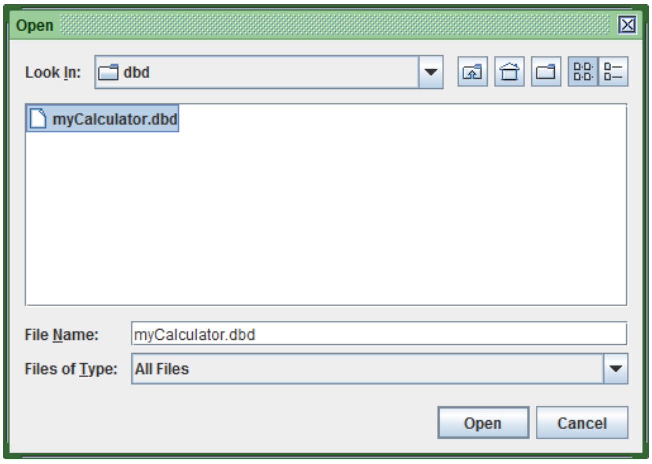


Name	Date modified	Type	Size
build	19/12/2015 04:53	File folder	
doc	19/12/2015 04:53	File folder	
flatdb	19/12/2015 04:53	File	1 KB
index.html	19/12/2015 04:53	HTML File	14 KB
runScript.bat	19/12/2015 04:53	Windows Batch File	1 KB
VisualDCT.jar	19/12/2015 04:53	Executable Jar File	709 KB
VisualDCT-src-2.6.1274.jar		Executable Jar File	855 KB

Type: Executable Jar File
Size: 708 KB
Date modified: 19/12/2015 04:53

7 items 1 item selected 708 KB

Select the dbd folder in our IOC (C:\epics\myCalculator\dbd\myCalculator.dbd):

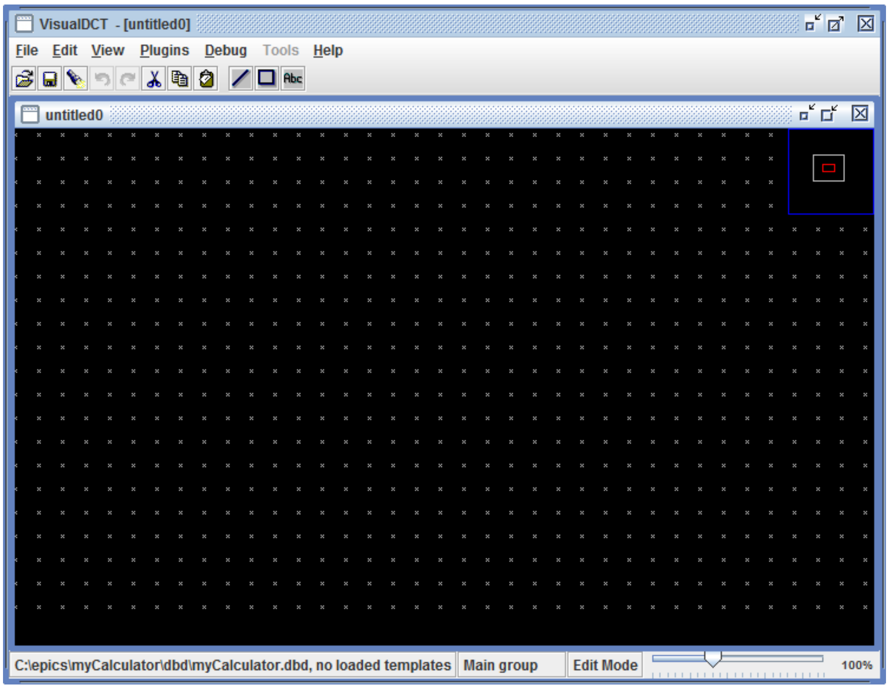


Look In: dbd

File Name: myCalculator.dbd

Files of Type: All Files

VisualDCT will open:



C:\epics\myCalculator\dbd\myCalculator.dbd, no loaded templates | Main group | Edit Mode | 100%

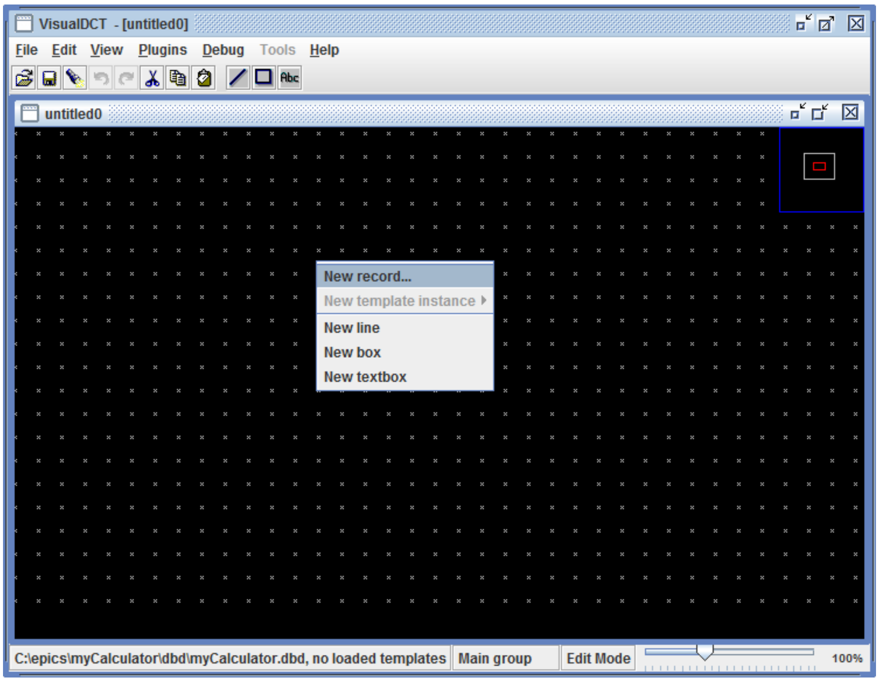
We will build 3 records for our calculator:

number1 (first number)

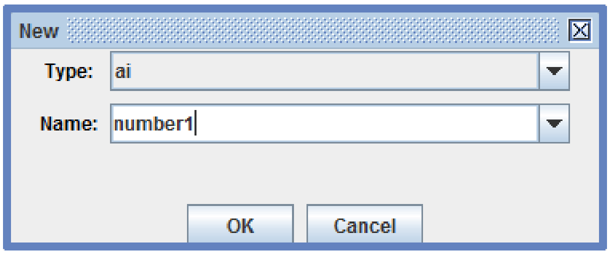
number2 (second number)

number3 (Does the calculation and shows the result)

Right click and New record.



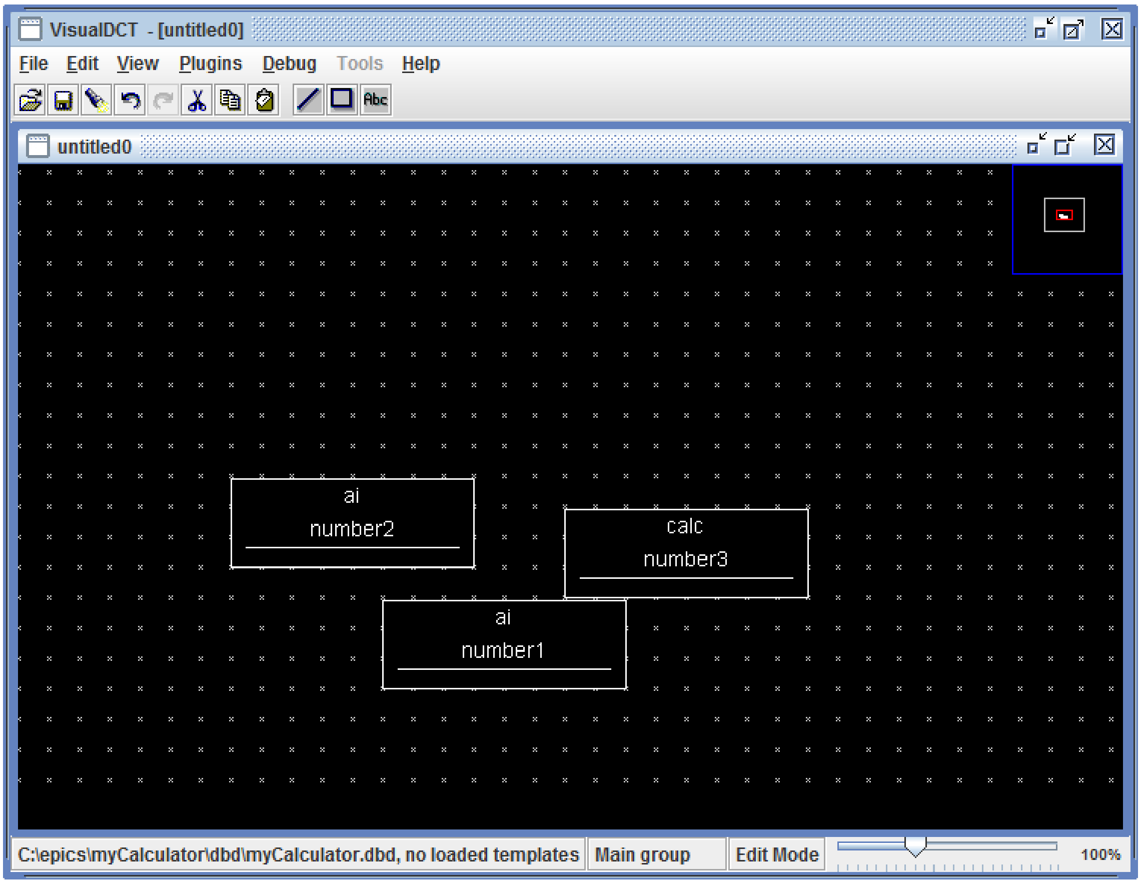
Select analogic input (ai) and name it Number1. Check epics wiki - https://wiki-ext.aps.anl.gov/epics/index.php/RRM_3-14 - to read about all types of records.


New

Type: ai

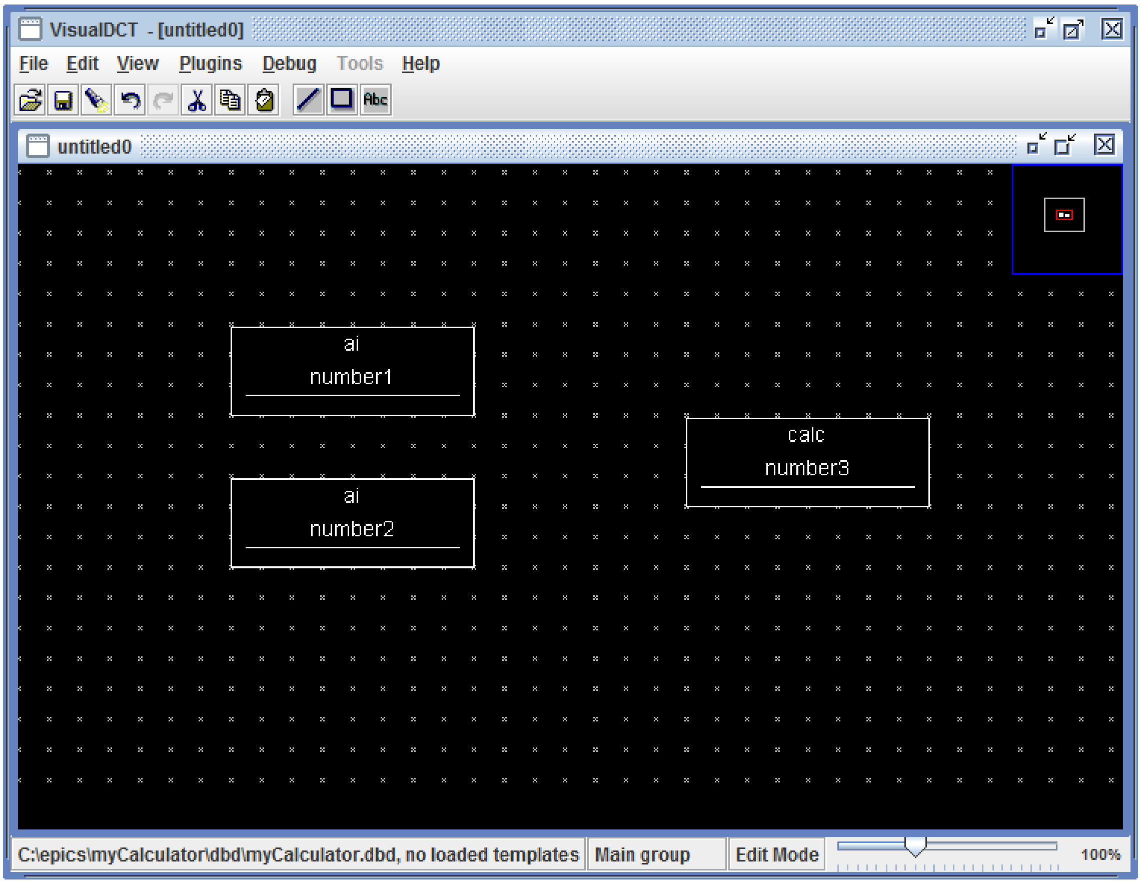
Name: number1

Do it again for number2 (ai) and number3 (calc). Now we have 3 records.



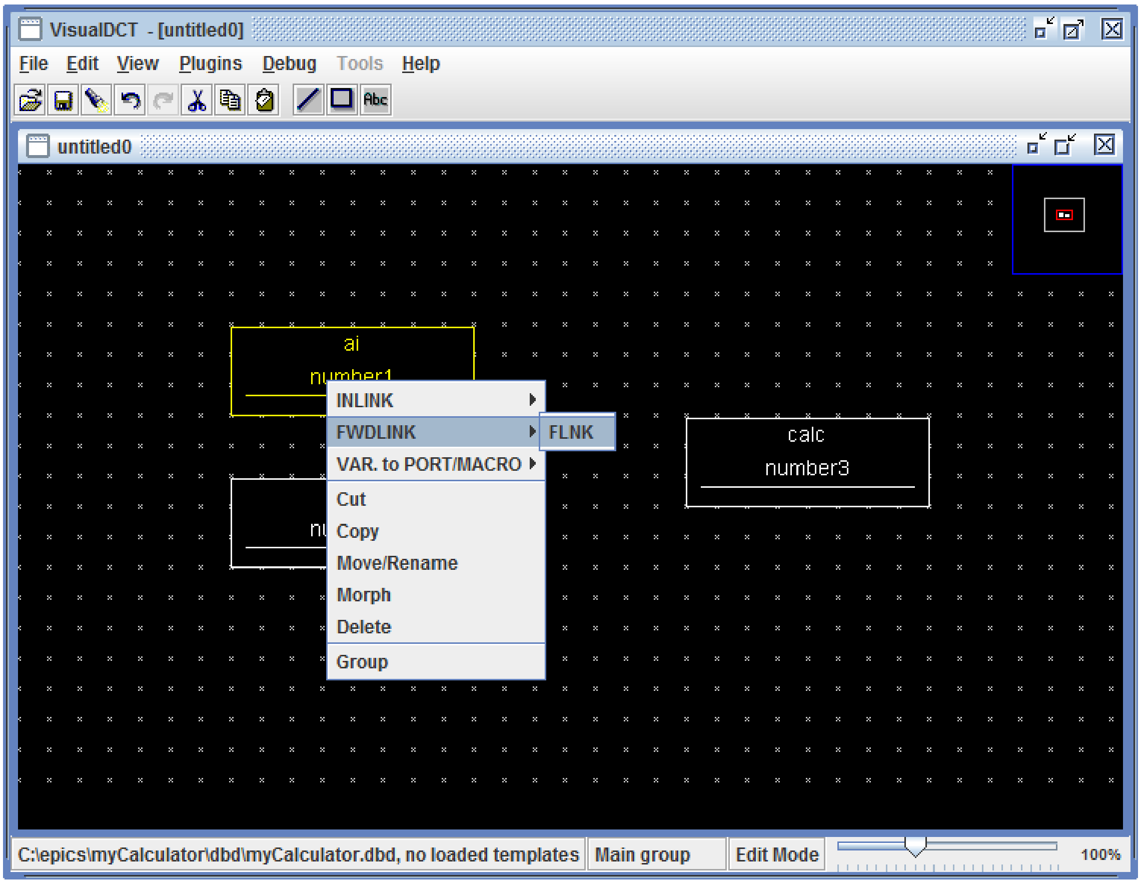
VisualDCT - [untitled0]
File Edit View Plugins Debug Tools Help
untitled0
ai
number2
calc
number3
ai
number1
C:\epics\myCalculator\dbd\myCalculator.dbd, no loaded templates
Main group
Edit Mode
100%

You can rearrange it the way you want using click and drag functionality.



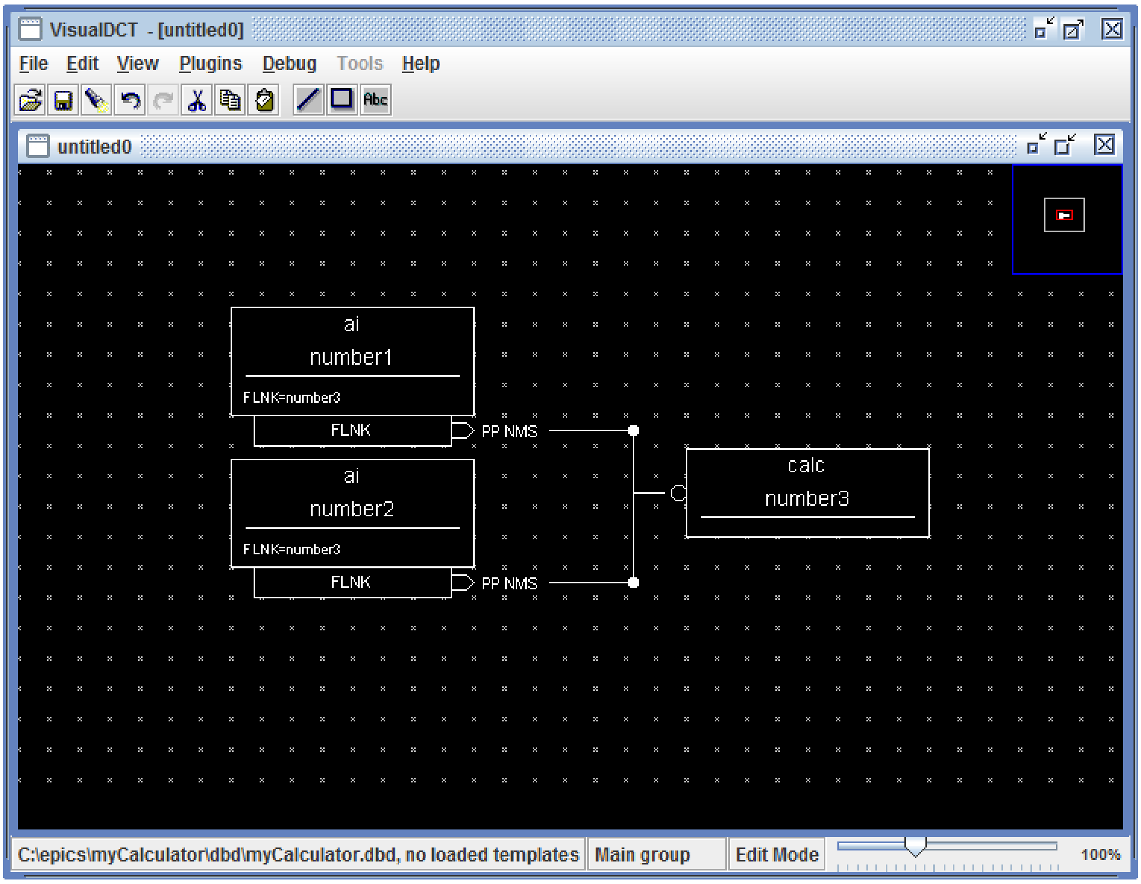
VisualDCT - [untitled0]
File Edit View Plugins Debug Tools Help
untitled0
ai
number1
ai
number2
calc
number3
C:\epics\myCalculator\dbd\myCalculator.dbd, no loaded templates
Main group
Edit Mode
100%

Now we build a forward link btween number1 and number3. Right click on number1 >> then FWDLINK (forward link) >> FLNK



And left click on number3.

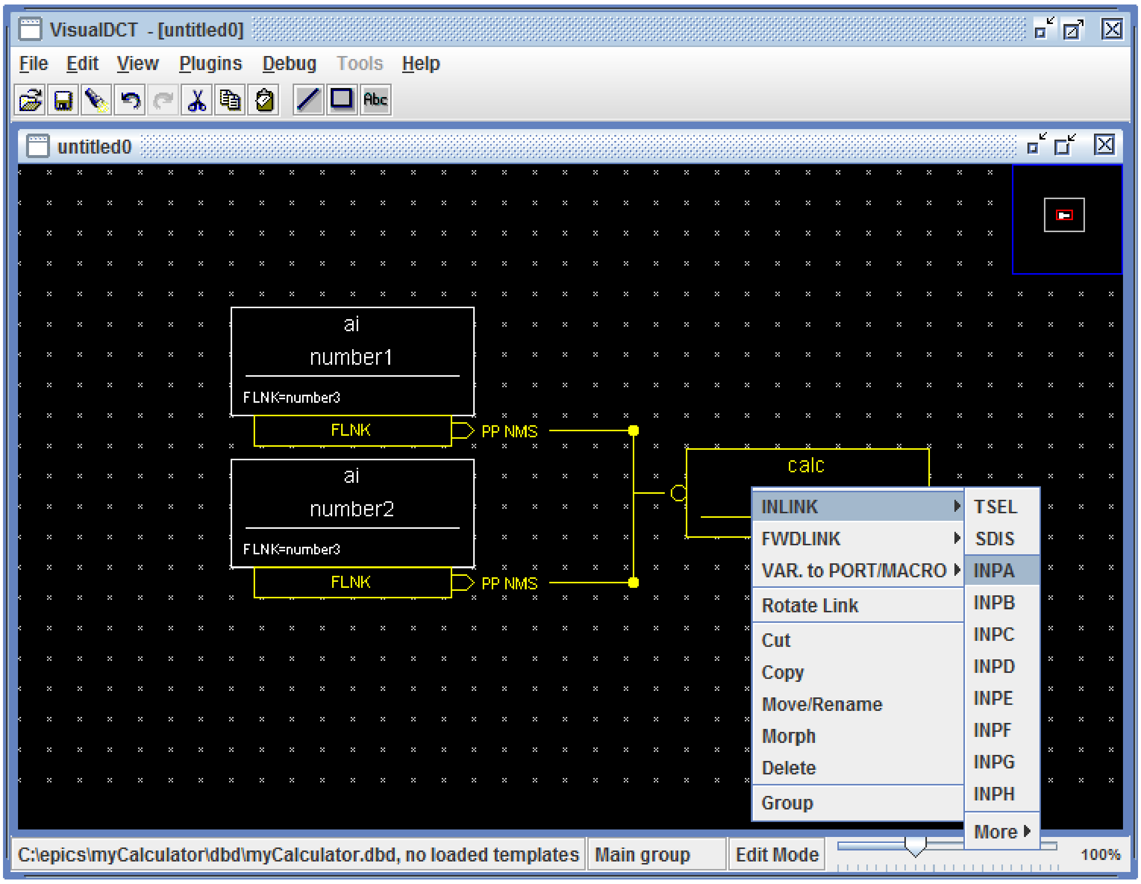
Do the same with number2. Use right click over number 3 and rotate link if you need to rotate the link around number3.



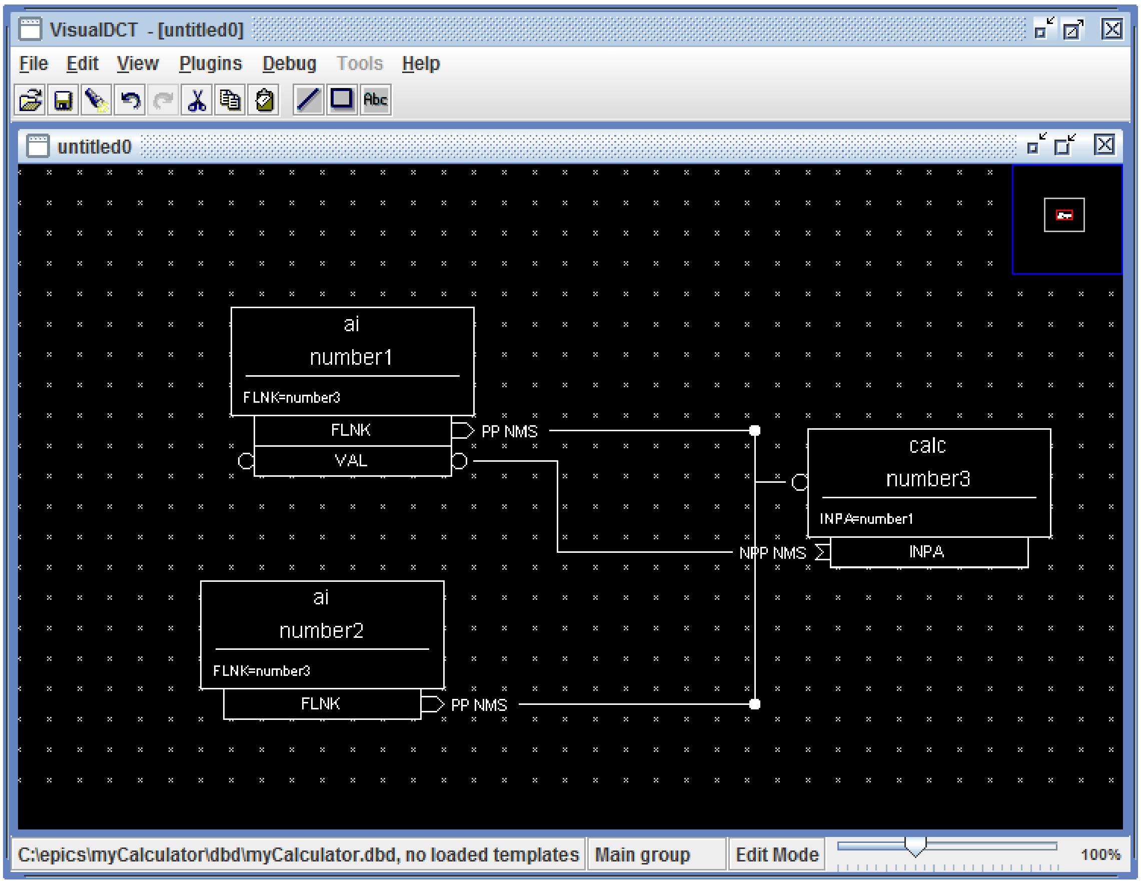
Forward links does not exchange values between records, it just defines the order of execution, it first executes number1 and number2 records, then number3. But what is a record execution? Well, analogic inputs (ai) just store the value entered, calculation records (CALC) when executed, evaluate the equation and gives a value. Each type of record has a different execution process.

Here goes another important concept, records have fields, and we are going to edit then now.

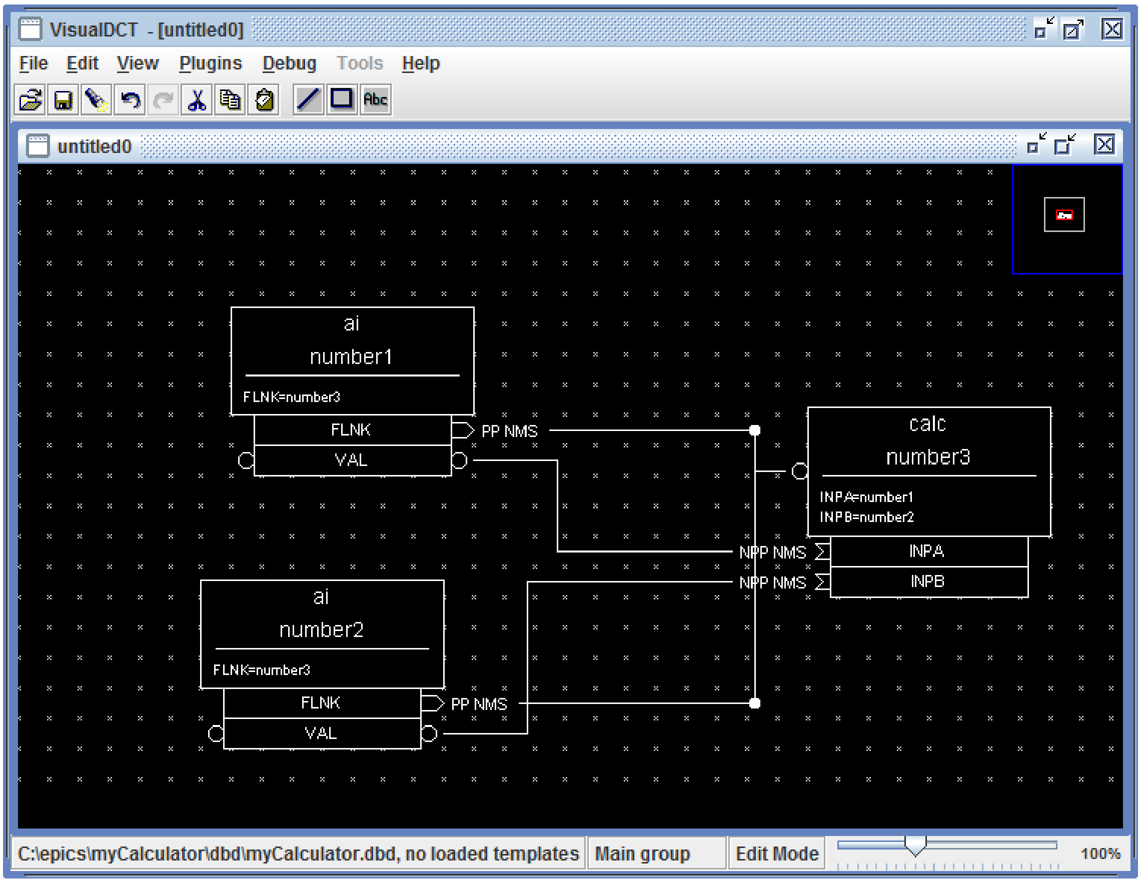
We want them to exchange values. Right click on number 3 >> INLINK >> INPA (input A)



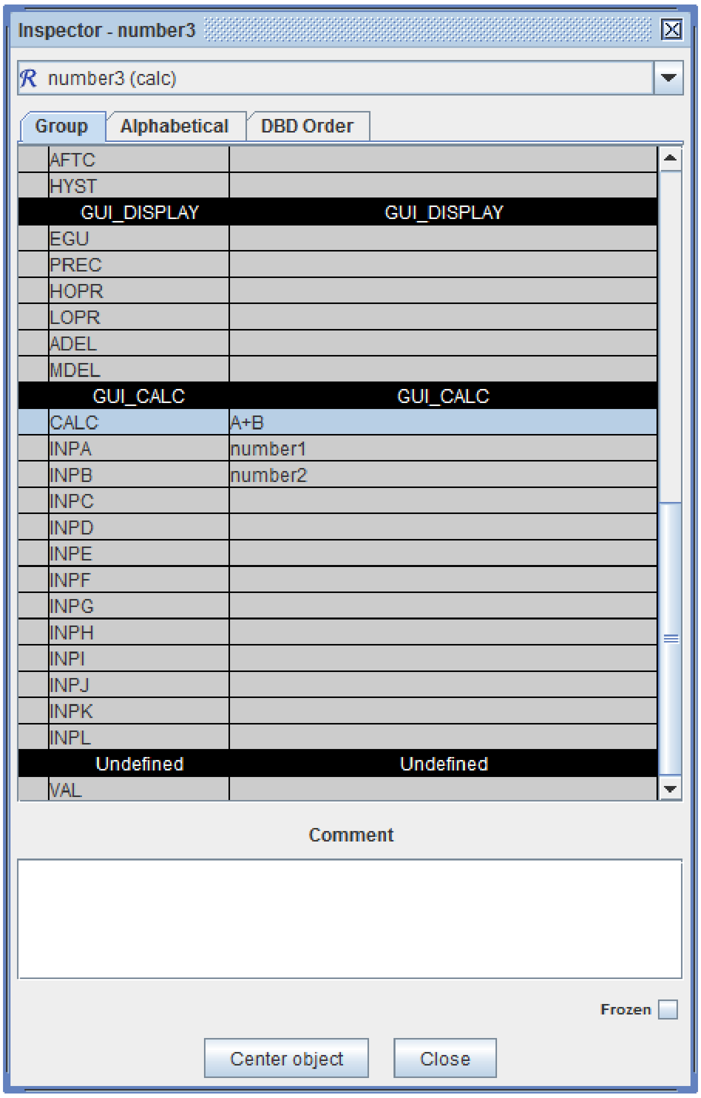
Then click on number1.



Do the same for number2, but instead select INPB (input B).

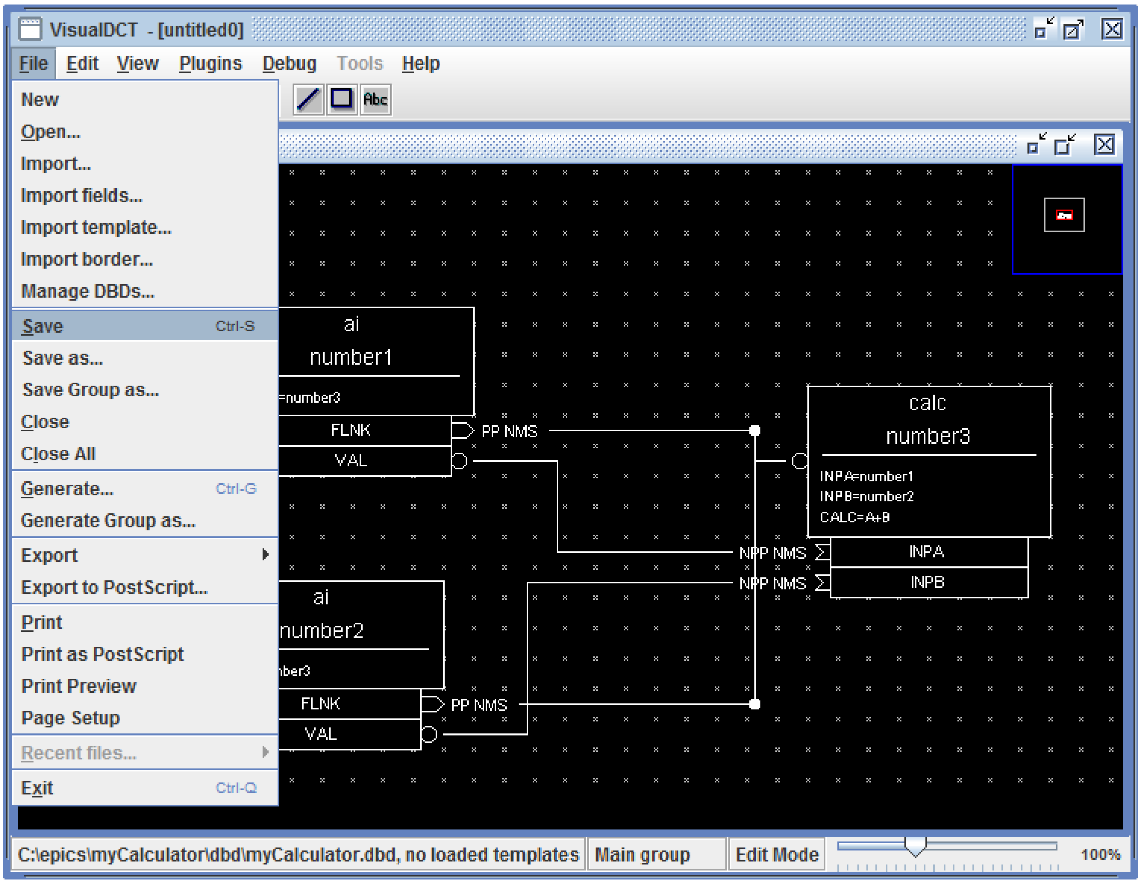


We need to edit the field CALC in number 3. Double click over number3 to open the inspector. Search for the field CALC and set it as A+B.



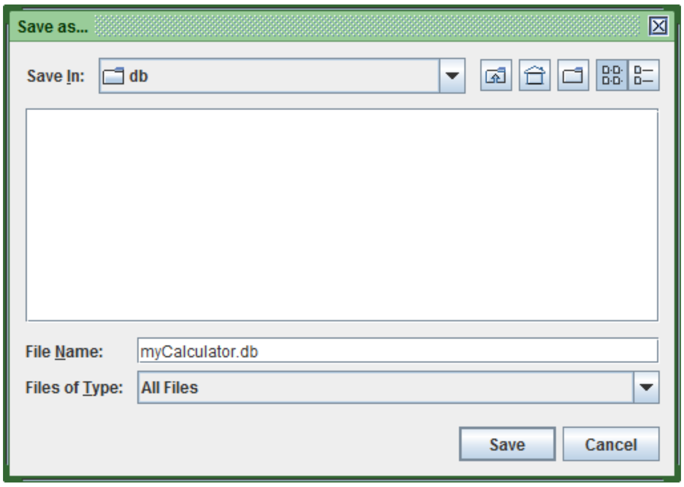
AFTC	
HYST	
GUI_DISPLAY	GUI_DISPLAY
EGU	
PREC	
HOPR	
LOPR	
ADEL	
MDEL	
GUI_CALC	GUI_CALC
CALC	A+B
INPA	number1
INPB	number2
INPC	
INPD	
INPE	
INPF	
INPG	
INPH	
INPI	
INPJ	
INPK	
INPL	
Undefined	Undefined
VAL	

Now, we just have to save it.



C:\epics\myCalculator\dbd\myCalculator.dbd, no loaded templates

Save it in the db folder we created earlier.



Save In: db

File Name: myCalculator.db

Files of Type: All Files

Open myCalculator.bd file and have a look at it:

```
record(ai, number1) {
  field(FLNK, "number3")
}

record(ai, number2) {
  field(FLNK, "number3")
}

record(calc, number3) {
  field(CALC, "A+B")
  field(INPA, "number1")
  field(INPB, "number2")
}
```

All the other stuff are just parameters used by the visualDCT.

Note that you could have written this file using a simple text editor. As I said before, we can create records using a text editor or the viusalDCT. The file structure is kind of self explanatory.

Get things ready

We have to tell our IOC that we have created a new database.

Open the st.cmd file - `$EPICS_BASE/$WORKINGNAME/iocBoot/iocmyCalculadora/st.cmd`

Change these lines:

```
## Load record instances
#dbLoadRecords("db/xxx.db","user=CarlosGaldino")
```

To this:

```
## Load record instances
dbLoadRecords("db/myCalculator.db","user=CarlosGaldino")
```

Save the file.

Executing the IOC

On windows, Just type the command in the cygwin terminal:

```
cd /cygdrive/c/epics/myCalculator/iocBoot/iocmyCalculator
../../bin/cygwin-x86_64/myCalculator st.cmd
```

On linux, go to the boot folder and execute st.cmd

```
cd $EPICS_BASE/$WORKINGNAME/iocBoot/iocmyCalculadora
./st.cmd
```

Testing the IOC

Now we will use some commands to check the PV's and change their values. Remember that depending on the epics version you are using the syntax might change a little bit

See all the records (dataBase List)

```
dbl
```

See fields in a Record (dataBase Print)

`dbpr number1`	show most commom fields

`dbpr number1.VAL`	show specifc field VAL
`dbpr number1.NAME`	another specific field
`dbpr number1 1`	show just a few fields
`dbpr number1 2`	more fields
`dbpr number1 3`	and more
`dbpr number1 4`	show all the fields

Change the fields value (dataBase Put Field)

`dbpf number1.VAL 10`	change specific field
`dbpf number1 10`	when no field is specified the defalt is the VAL field

Now, change number1 to 10 and number2 to 23.4

```
dbpf number1 10
dbpf number2 23.4
```

Check number3 value (field VAL).

```
dbpr number3
```

or

```
dbpr number3.VAL
```

Notice that number3 has evaluated the sum of number1 and number2.