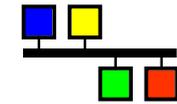


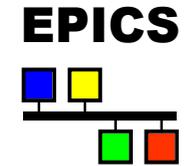
EPICS



Creating EPICS Databases with Capfast

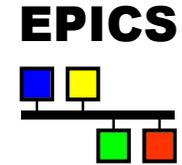
Nick Rees

Introduction



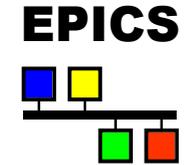
- ◆ What is Capfast and why?
- ◆ How does it map to the EPICS database?
- ◆ Capfast tutorial

What is Capfast and why?



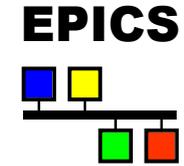
- ◆ Schematic capture tool typically used for circuit design.
- ◆ Not the leading schematic capture tool today
 - ◆ I think it was stronger in the early days.
 - ◆ Started as a UNIX tool and other Windows tools passed it by
- ◆ ... however it is very easily configurable
 - ◆ All schematics, symbols and configurations & menus are text files
 - ◆ Outputs a standard net-list format.
- ◆ ... and has some powerful features:
 - ◆ Provides hierarchical drawings to structure a database
 - ◆ Provides bus-mechanisms for bundling links

How does Capfast map to EPICS?



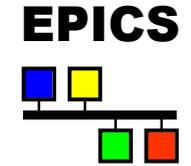
Electronic parts	EPICS Records
Part type (e.g. Resistor)	Record Type (e.g. Analog in)
Property (e.g. Resistance)	Field value (e.g. PREC=3)
Pins	Links or Field inputs
Connections	Link connections
Fabrication	make

Differences



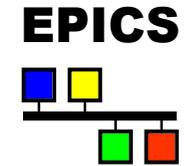
- ◆ EPICS records typically have more fields than electronics parts have configurable properties, so this area is handled poorly.
- ◆ EPICS data links push or pull data from fields (which are passive), so connection diagrams are a bit confusing at first:
 - ◆ Fundamentally, there can only be one field in a single, multiply connected, wire.
 - ◆ Any output link will push into this field.
 - ◆ Any input link will pull data from this field.
 - ◆ Links also imply processing depending on the properties of the link.
 - ◆ Processing links pass no data and can only be connected to

Capfast tutorial



- ◆ Capfast has two editors:
 - ◆ `xschedit` for schematics
 - ◆ `xsymed` for symbols.
- ◆ You create new symbols to encapsulate other drawings and build a drawing hierarchy.

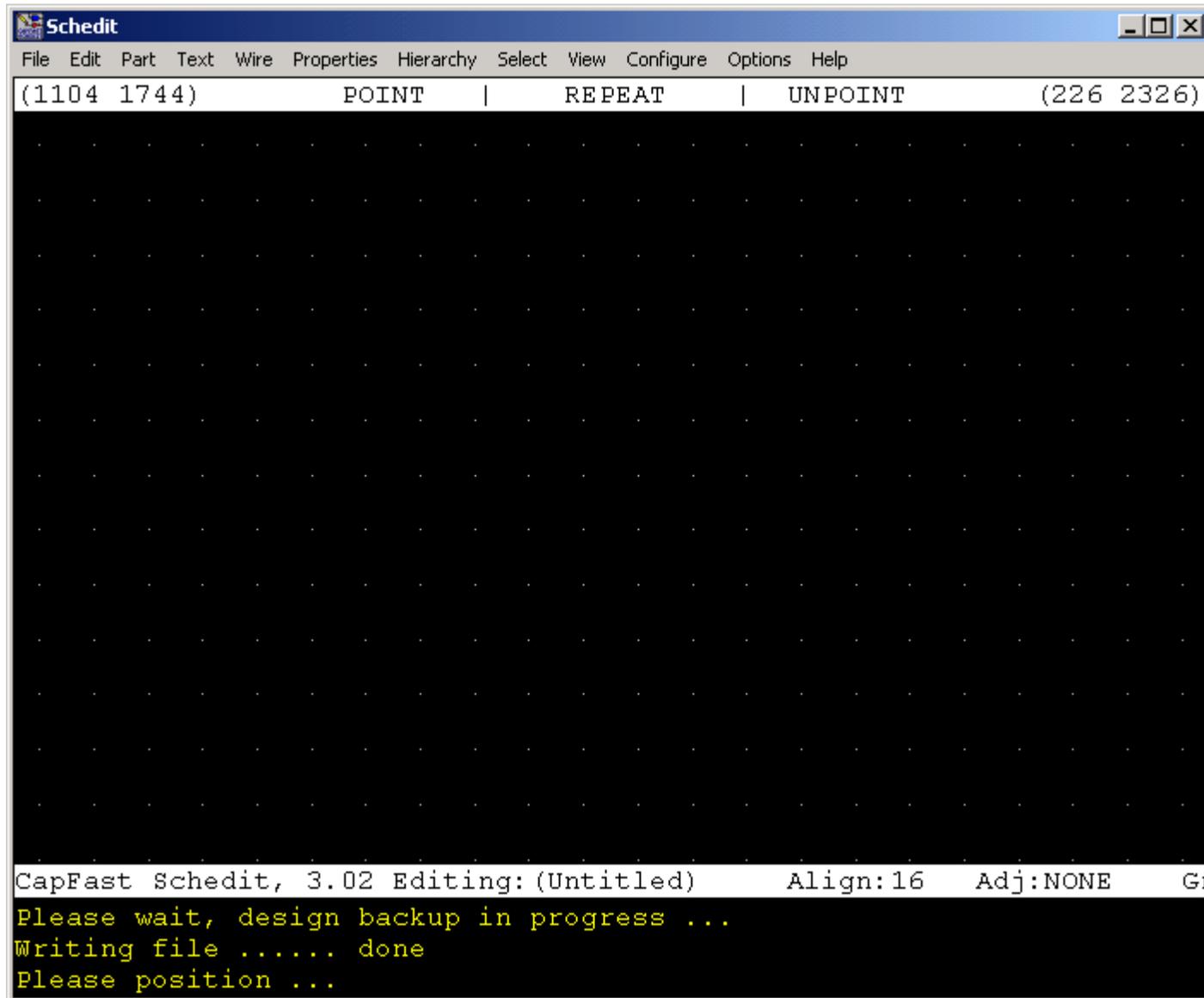
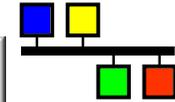
The basics



- ◆ `<Esc>` key aborts current operation.
- ◆ Mouse buttons are context sensitive and their meanings are given at the top of the screen.
- ◆ Menu shortcuts available by using the underlined letter (no `<Alt>` required on Unix).
- ◆ Number keys or arrow keys can be used for scrolling (5 centers the schematic on the screen).
- ◆ `V R` shortcut (View Redraw) will force a redraw.
- ◆ Menu's are PC or Motif like.
- ◆ Clicking in the drawing area sets up markers for the next command (e.g. define a wire route).

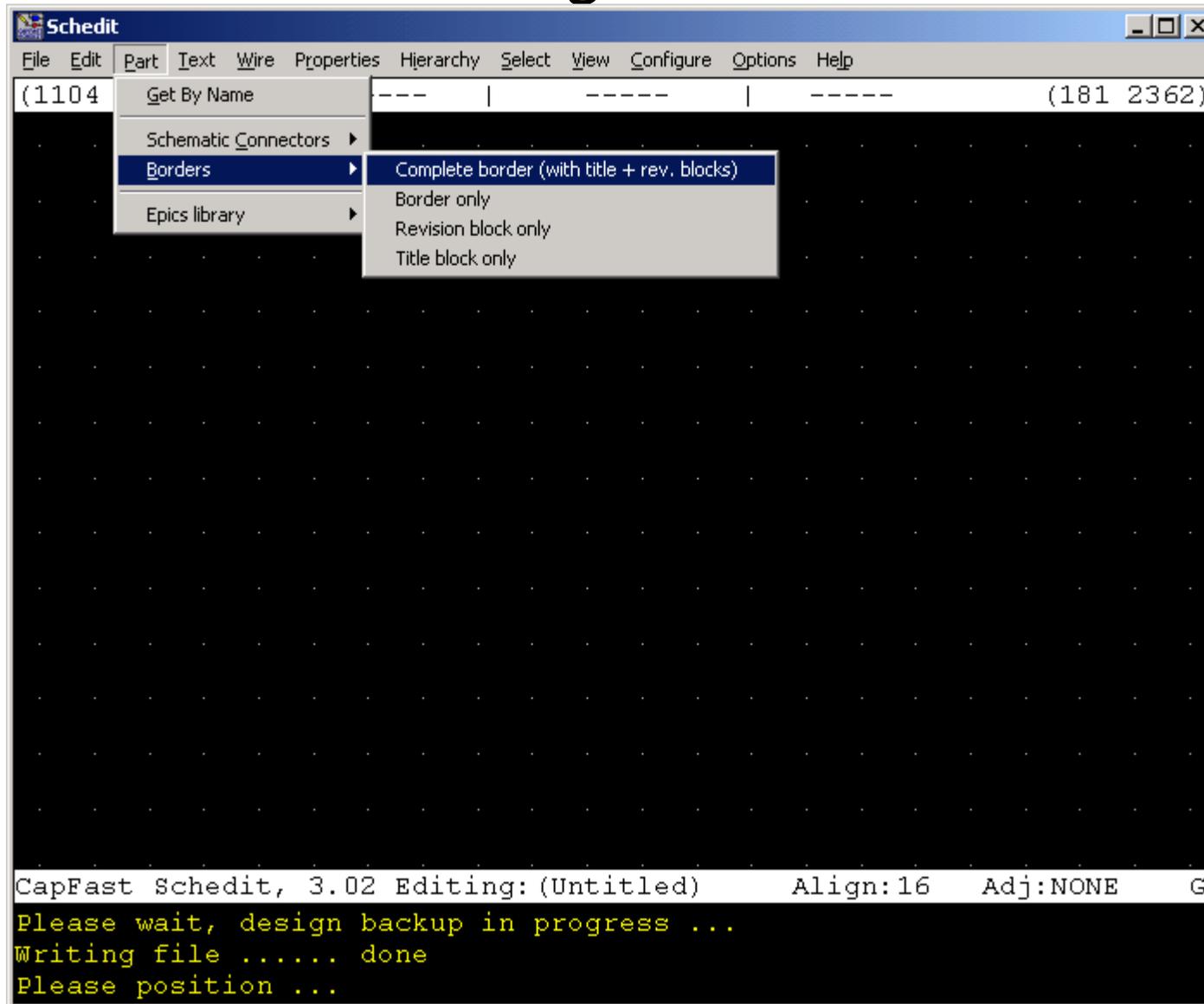
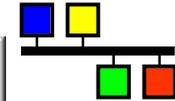
Schedit screen

EPICS



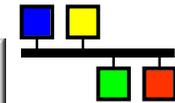
Getting a border

EPICS



Got a border, now add a record

EPICS

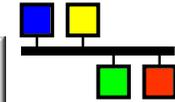


The screenshot shows the Schedit software interface. The menu is open, showing the 'Epics library' with a list of records. A red arrow points from the 'Epics library' menu item to the 'analog in (small)' record. Another red arrow points from the 'analog in (small)' record to the 'PART' field in the 'PART SHEET OF' dialog box. The dialog box is open, showing the 'PART' field with the value 'R'. The status bar at the bottom of the window displays the following text:

```
CapFast Schedit, 3.02 Editing: (Untitled) Align:16 Adj:NONE G  
Searching for file...done  
Reading file....done  
Please position ...
```

Place it and give it a name

EPICS



Schedit

File Edit Part Text Wire Properties Hierarchy Select View Configure Options Help

(1168 5472) POINT | REPEAT | UNPOINT (1175 5467)

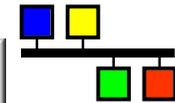
WPMW:INP
SLMK
WPMW:SDIS
at
FLNK
VFL
input

CapFast Schedit, 3.02 Editing: (Untitled) Align:16 Adj:NONE G

Reading file....done
Please position ...
Instance name? input

Get a calculation record

EPICS

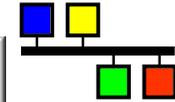


The screenshot shows the Schedit software interface. The menu bar includes File, Edit, Part, Text, Wire, Properties, Hierarchy, Select, View, Configure, Options, and Help. The main workspace is a grid with a yellow wire and a yellow arrow pointing to the 'Epics library' menu. The 'Epics library' menu is open, showing a list of components. The 'calculation (small)' component is highlighted. The status bar at the bottom displays the following text:

```
CapFast Schedit, 3.02 Editing: (Untitled) Align:16 Adj:NONE G
Reading file....done
Please position ...
Instance name? input
```

Place it and give it a name

EPICS



Schedit

File Edit Part Text Wire Properties Hierarchy Select View Configure Options Help

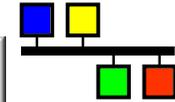
(1154 5278) POINT | REPEAT | UNPOINT (959 5878)

CapFast Schedit, 3.02 Editing: (Untitled) Align:16 Adj:NONE G

Instance name? calc
Please position ...
Please position ...

Add an output record

EPICS



Schedit

File Edit Part Text Wire Properties Hierarchy Select View Configure Options Help

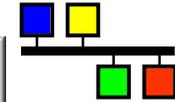
(1600 5488) POINT | REPEAT | UNPOINT (773 6097)

CapFast Schedit, 3.02 Editing: (Untitled) Align:16 Adj:NONE G

Please position ...
Instance name? output
1 items selected

Click twice and connect them up

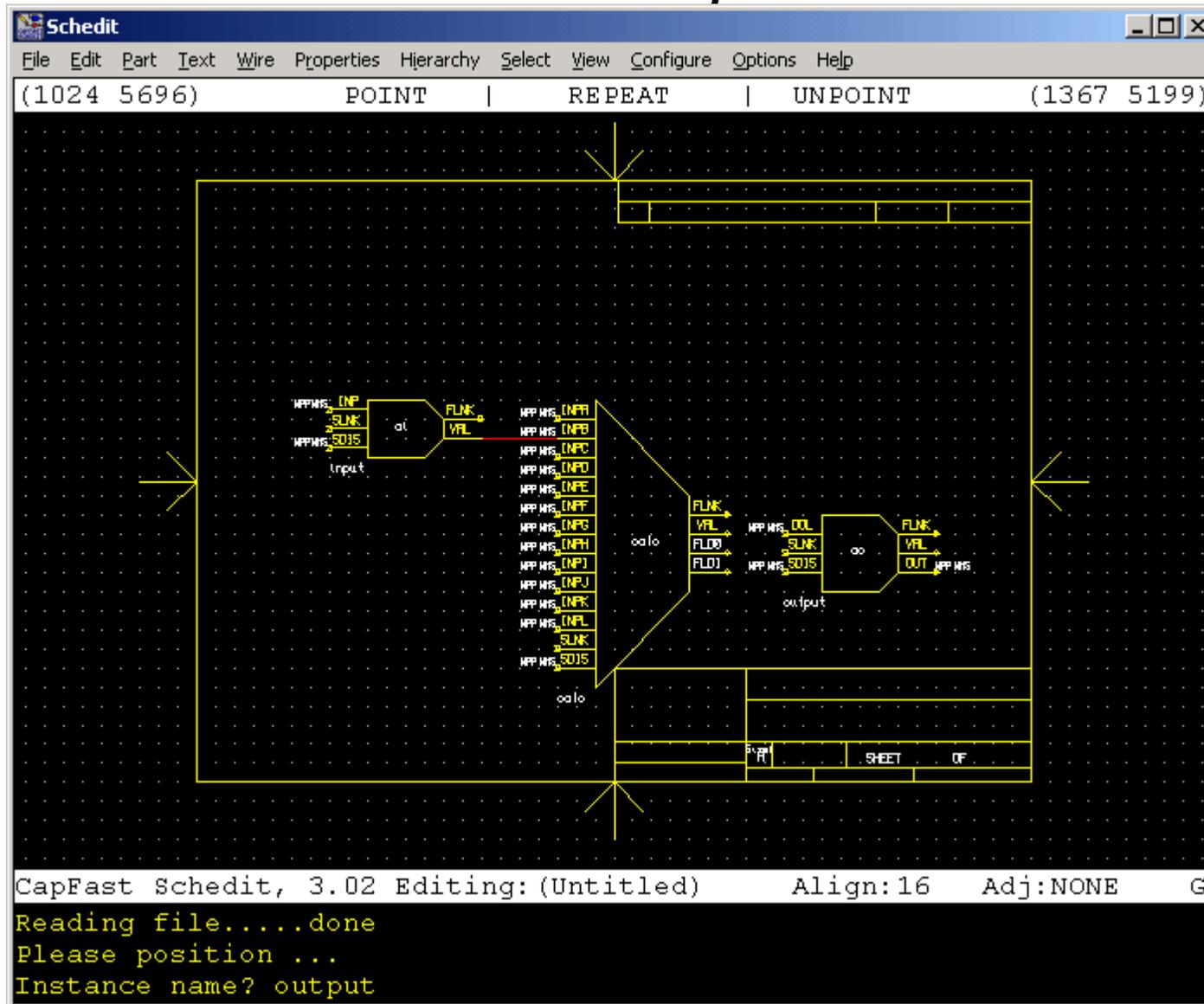
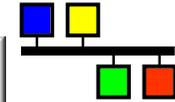
EPICS



The screenshot shows the Schedit software interface. The menu bar includes File, Edit, Part, Text, Wire, Properties, Hierarchy, Select, View, Configure, Options, and Help. The main window displays a wiring diagram on a black background with a white grid. A context menu is open over a yellow wire, listing options: Draw Wire, Extend Wire, Draw Bus, Extend Bus, Re-Route, Alias Symbol, and Bustap Symbol. The diagram features several components: an 'Input' block with 'SUNK' and 'SOLIS' inputs; a central vertical list of 'MPP MRS' components (INP through SOLIS); a 'FLNK' block with 'VAL' and 'VAL+' outputs; and an 'output' block with 'SUNK' and 'SOLIS' inputs and 'OUT' output. A status bar at the bottom shows 'CapFast Schedit, 3.02 Editing: (Untitled) Align:16 Adj:NONE G'. A console window at the bottom displays the text: 'Reading file.....done', 'Please position ...', and 'Instance name? output'.

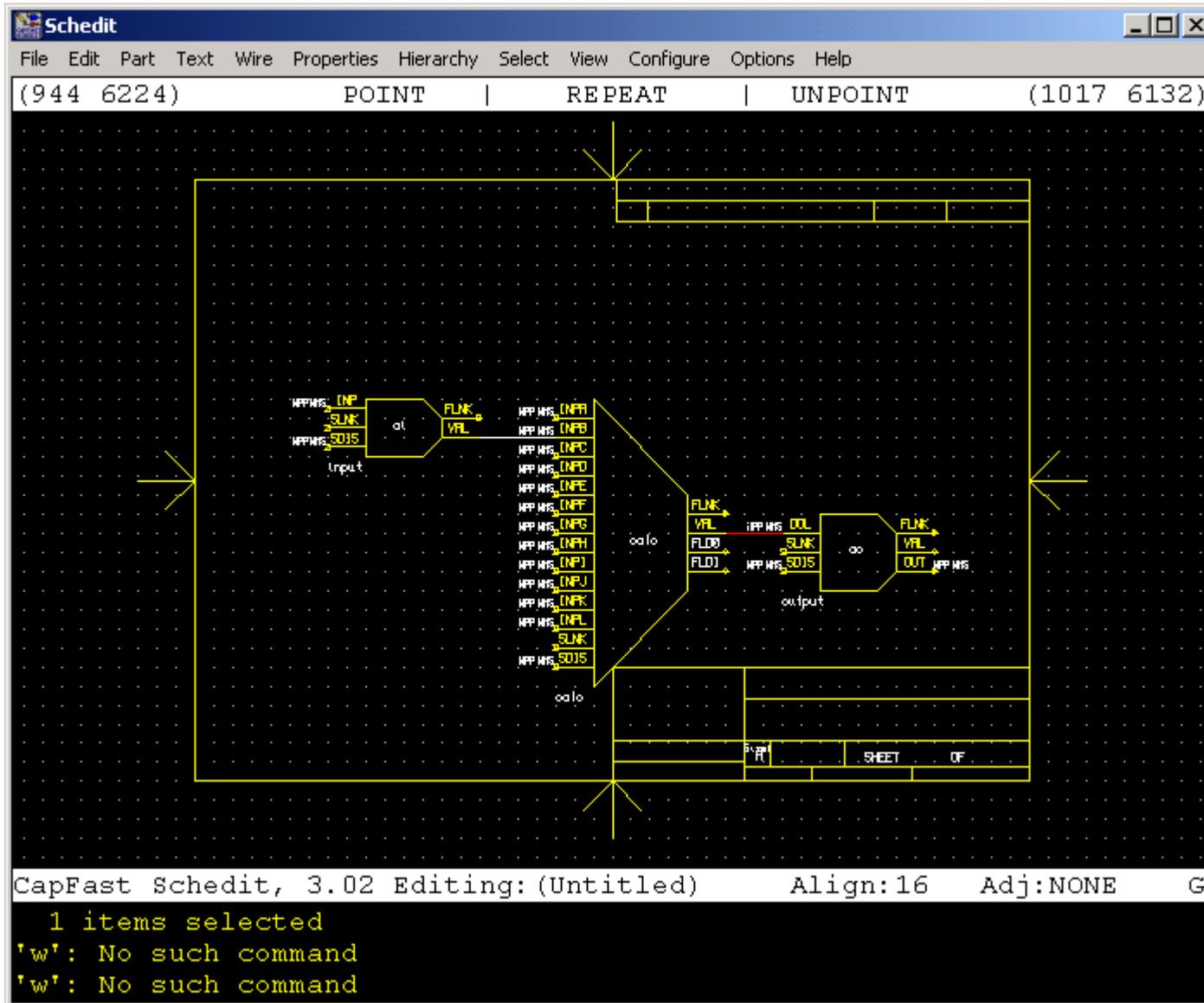
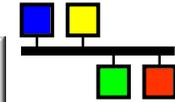
Wired up...

EPICS



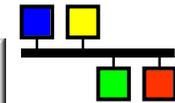
Next wire

EPICS



Add hardware inputs and

EPICS



Schedit

File Edit Part Text Wire Properties Hierarchy Select View Configure Options Help

(9 4 4 6

Get By Name

Schematic Connectors

Borders

Epics library

analog in (large)	event (small)	permissive (large)	stringout (s
analog in (small)	fanout (large)	permissive (small)	subroutine i
analog in (sim)	fanout (small)	pid (large)	subroutine i
analog out (large)	histogram (large)	pid (small)	timer (large
analog out (small)	histogram (small)	pulsetrain (large)	timer (small
analog out (sim)	longin (large)	pulsetrain (small)	waveform (
binary in (large)	longin (small)	select (large)	waveform (
binary in (small)	longout (large)	select (small)	waveout (la
binary out (large)	longout (small)	sequence (large)	waveout (si
binary out (small)	multibit binary in (L)	sequence (small)	hardware in
calculation (large)	multibit binary in (S)	state (large)	hardware o
calcout (small)	multibit binary out (L)	state (small)	ramp (large
calcout (large)	multibit binary out (S)	steppermotor (large)	ramp (small
calculation (small)	pulsecounter (large)	steppermotor (small)	data fanout
compression (large)	pulsecounter (small)	stringin (large)	data fanout
compression (small)	pulsedelay (large)	stringin (small)	
event (large)	pulsedelay (small)	stringout (large)	

CapFast Schedit, 3.02 Editing: (Untitled) Align:16 Adj:NONE G

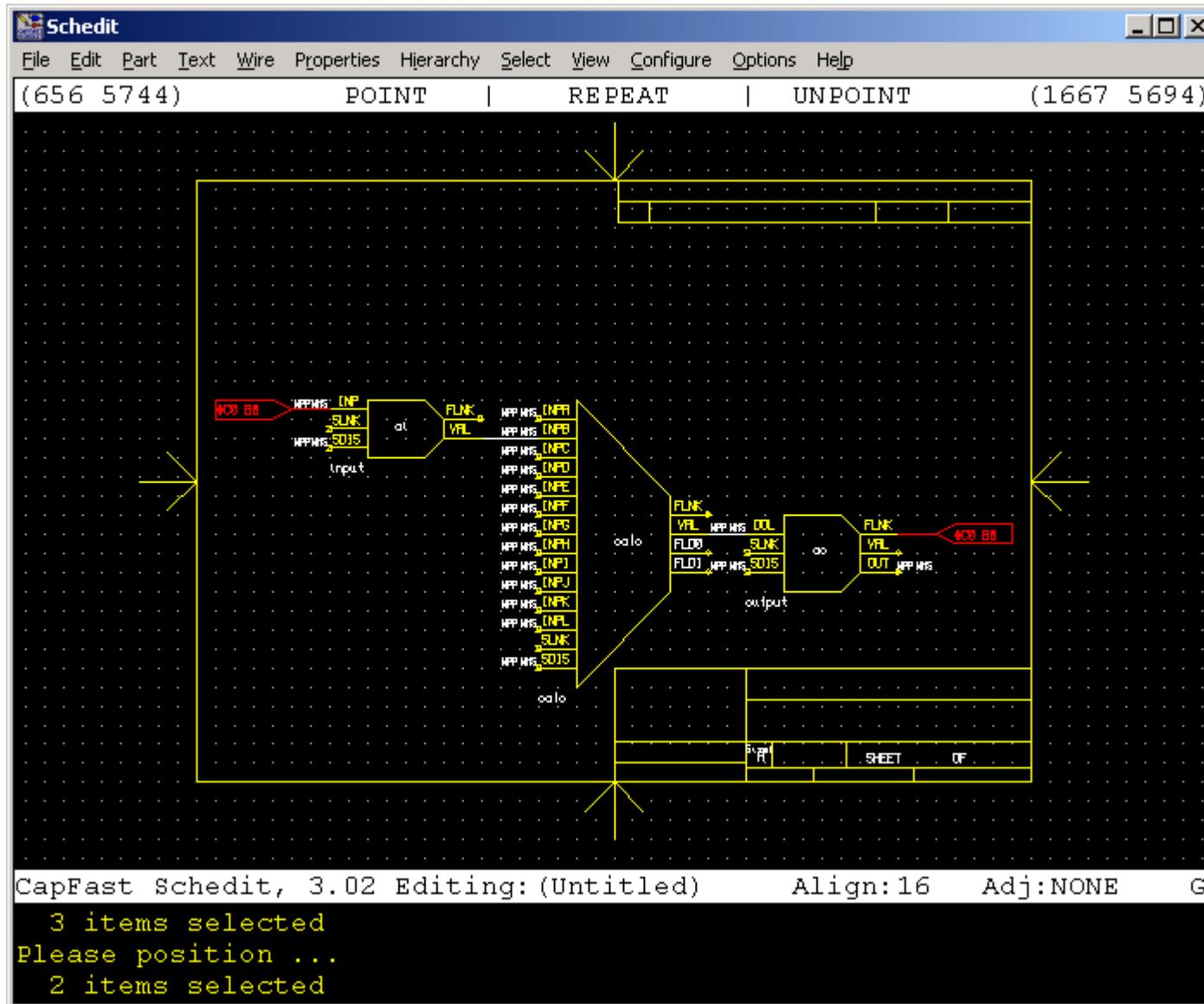
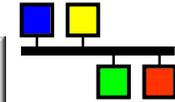
'w': No such command

'w': No such command

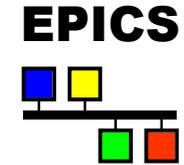
'!': No such command

Done

EPICS



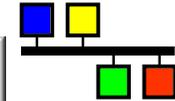
Hardware inputs and outputs



- ◆ These are a method of putting constant values into link fields.
 - ◆ The val(outp) and vap(in) properties contain the string value that the link field will be set to.
 - ◆ Normally used for hardware, but also can be used to link to a record of a know name, which doesn't appear in the current drawing hierarchy.

Edit these properties

EPICS



Schedit

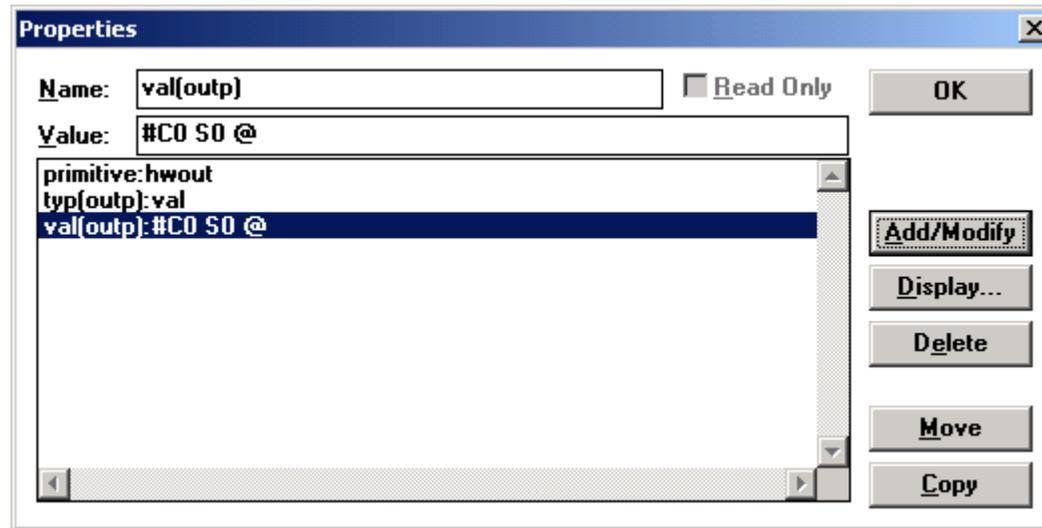
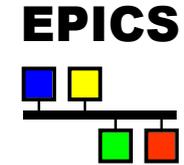
File Edit Part Text Wire Properties Hierarchy Select View Configure Options Help

(816 6096) Edit... (866 6137)

CapFast Schedit, 3.02 Editing: (Untitled) Align:16 Adj:NONE G

'r': No such command
Please wait, design backup in progress ...
Writing file done

Property (field) editing



- ◆ Click on the property line and edit in the Value box.
- ◆ **Add/Modify** saves the change.
- ◆ **Display...** allows you to set the display attributes.
- ◆ **Delete** deletes the field - or returns it to the default value.
- ◆ **Move** moves the highlighted properties (fields).
- ◆ **Copy** allows you to copy properties to other records.

*A more
typical
record
(UNIX)*

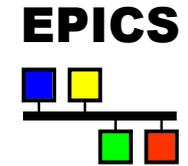
Properties of input

Name: DTYP Read Only

Value: Xycom XY566

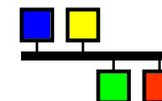
Buttons: Close, Cancel, Add/Modify, Display..., Delete, Move, Copy

```
ADEL:0.0000000000000000e+00
AOFF:0.00000000e+00
ASLO:1.00000000e+00
DESC:analog input record
DISS:NO_ALARM
DISV:1
DTYP:Xycom XY566
EGU:volts
EGUF:0.00000000e+00
EGUL:0.00000000e+00
EVNT:0
HHSV:NO_ALARM
HIGH:0.00000000e+00
HIHI:0.00000000e+00
HOPR:0.00000000e+00
HSV:NO_ALARM
HYST:0.0000000000000000e+00
LINR:LINEAR
LLSV:NO_ALARM
LOLO:0.00000000e+00
LOPR:0.00000000e+00
LOW:0.00000000e+00
LSV:NO_ALARM
MDEL:0.0000000000000000e+00
PHAS:0
PINI:NO
PREC:0
PRIO:LOW
SCAN:Passive
SIML:0.0000000000000000e+00
SIMS:NO_ALARM
SIOL:0.0000000000000000e+00
SMOO:0.00000000e+00
Type:ai
def(FLNK):0.0000000000000000e+00
def(INP):0.0000000000000000e+00
```



Edit more properties etc...

EPICS



Schedit

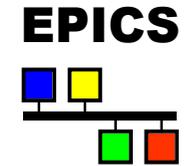
File Edit Part Text Wire Properties Hierarchy Select View Configure Options Help

(0 0) POINT | REPEAT | UNPOINT (2042 6085)

CapFast Schedit, 3.02 Editing:test Align:16 Adj:NONE

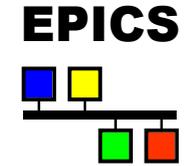
Can't set variable 'cpyinst' because 'YES' doesn't seem to be a number
Command aborted

Commonly used items



- ◆ **File->Hierarchy->Descend (or Ascend)**
- ◆ **File->Hierarchy->Create Symbol from Schematic**
- ◆ **Edit-> anything!**
- ◆ **View->Redraw**
- ◆ **View->Zoom Area**
- ◆ **Part->Schematic Connectors->Hierarchical Input**
- ◆ **Part->Borders**
- ◆ **Part->Epics Library->**
- ◆ **Text-> anything!**
- ◆ **Wire->Draw Wire**
- ◆ **Wire->Reroute**

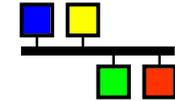
Commonly used items (ctd)



- ◆ **Properties->Edit**
- ◆ **Select->Items**
- ◆ **Select->More Items**
- ◆ **Select->Area**
- ◆ **Select->Symbol to Replace**
- ◆ **Select->Clear**

Different Symbol Styles

EPICS



Schedit

File Edit Part Text Wire Properties Hierarchy Select View Configure Options Help

(-432 80)

al
Soft Channel

DESC:analog input record

SCAN:Positive	HIHI:0.0000000e+00	FLNK
PHAS:0	LOLO:0.0000000e+00	VAL
EVNT:0	HIGH:0.0000000e+00	FLD0
PINI:NO	LOW:0.0000000e+00	FLD1
LINR:LINEAR	HHSV:NO_ALARM	FLD2
PREC:0	HSV:NO_ALARM	FLD3
EGUF:0.0000000e+00	LSV:NO_ALARM	
EGUL:0.0000000e+00	LLSV:NO_ALARM	
EGU:volt	DISS:NO_ALARM	
HOPR:0.0000000e+00	PRIO:LOW	
LOPR:0.0000000e+00	AOFF:0.0000000e+00	
ASLO:1.0000000e+00	SMOO:0.0000000e+00	
DISV:i		
HYST:0.0000000000000000e+00		
ADEL:0.0000000000000000e+00		
MDEL:0.0000000000000000e+00		
SIOL:0.0000000000000000e+00		
SIML:0.0000000000000000e+00		
SIMS:NO_ALARM		

small

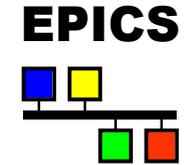
slm

large

CapFast Schedit, 3.02 Editing: (Untitled) Align:16 Adj:NONE Grid:32

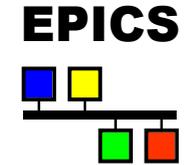
Reading file.....done
Please position ...
Instance name? small

User defined ports



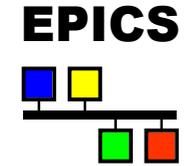
- ◆ Note that the larger symbols have ports with names like `FLD0`, `FLD1` etc.
- ◆ These are ports with user defined names.
 - ◆ Names are defined by editing a property called `username(u0)` (or `u1`, `u2` etc).
 - ◆ Replace the default value of that property (`FLD0`) with the name of the field you want the connecting link to refer to (e.g. `SCAN`).

Hierarchical Schematics



- ◆ Use `xschedit` to design the lower levels of the hierarchy.
 - ◆ Use hierarchical connectors for off page connections.
- ◆ Use `xsymed` to create a symbol of the same name which encapsulates the lower level schematic,
 - ◆ The pin-out should have pins with the same name as the hierarchical connectors.
 - ◆ This can be simplified slightly using:
File->Hierarchy->Create Symbol from Schematic
 - ◆ EPICS symbols typically have flying leads that are two grid boxes long, with the field name written above the flying lead.
- ◆ Use `xschedit` to create another schematic which incorporates the new symbol.

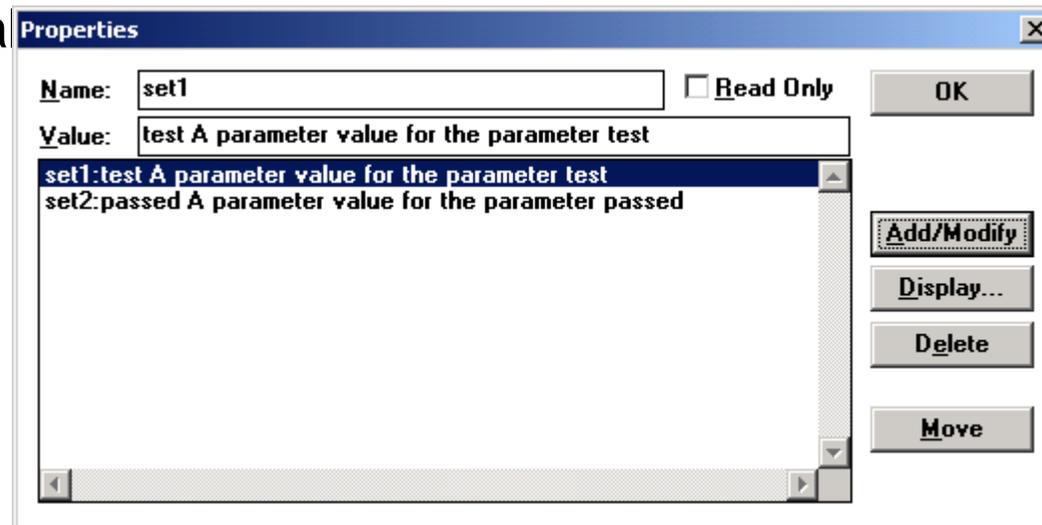
Hierarchies (ctd)



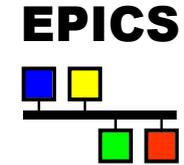
- ◆ Parameters can be passed into a hierarchical symbol by:
 - ◆ Using the form $\$(parameter)$ where ever the parameter is used in the included schematics.
 - ◆ Defining a property of the symbol (in `xsymed`) with a name beginning with 'set' and a value of the parameter name, space and then the value.
 - ◆ Example: the parameter test will be set to the value:

'A parameter va

The last character of the set name is unimportant. It just makes the property name unique.

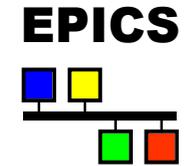


Hierarchical record names



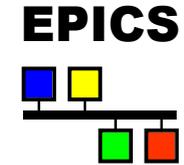
- ◆ By default, record names have the form:
 - ◆ `<schematic name>:<symbol name>`
- ◆ Symbols in hierarchically included diagrams have the form:
 - ◆ `<schematic name>:<symbol name level 1>:...:<symbol name>`
- ◆ There is a maximum length to record names of 28 characters - so if the hierarchy is deep, keep names short.
- ◆ PV and name properties can over-ride the default naming conventions, but I have never had to use them.

Printing



- ◆ Aliases `schprint` and `symprint` to print a schematic as on letter sized paper on the default printer.
 - ◆ Look at their definition for more details.

Starting up



- ◆ `xschedit` and `xsymed` take three command line options:

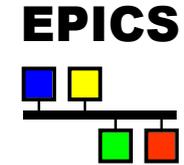
- ◆ `-k` : specifies or adds to the menu search path
- ◆ `-p` : specifies or adds to the symbol search path
- ◆ `-w` : specifies the number of lines in the text region.

- ◆ Example:

```
xschedit -p+${EPICS_BASE}/templates/capfast/sym \  
-k${EPICS_BASE}/templates/capfast+
```

- ◆ The `+` is significant since it says whether to pre-pend or append to the path.
- ◆ The file `cad.rc` contains the default options
 - ◆ Searched for first in your local directory, then in your home directory and finally in the the capfast directories.

Starting up (ctd)

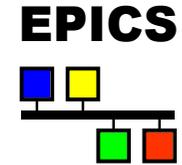


- ◆ Startup commands can be put into `schedit.rc` or `symed.rc` in your home directory.
- ◆ You can copy `schedit.rc` from `~npr`:

```
:constrainprops epics.rules
:set libchoice epics
:mload schedit2
:set asksnames YES
:set askwnames NO
:set askpnames YES
:set cellnames YES
:set wirenames NO
:set cpyinst YES
```

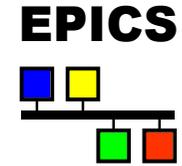
- ⇒ Constrains property values
- ⇒ Selects epics parts library
- ⇒ Reloads the menus

Turning Schematics into Databases



- ◆ Done using `make`
- ◆ Specify the database name (extension of `.db`) using the `DATA` make variable in `Makefile.Host`.
- ◆ There must be a schematic of the same name, but with extension `.sch`.
- ◆ Dependencies are currently broken, so hierarchies are not handled well - you have to `touch` the top schematic.

Exercise



- ◆ Create an example application with a `capfast`, `dl` and `startup` directories using `applSetup.pl`
- ◆ Create a schematic similar to the one shown in this talk. However, use your imagination if you like!
 - ◆ Use the simulation fields and add some simulated plant feedback.
- ◆ Edit the example `startup.vws` to include your database.
- ◆ Load onto the VME crate.
- ◆ Create a display to change the set-point, and graph the results.