

Eine elektronische Schaltung von der Idee bis zum Einbau am Experiment

H. Leich:

Einführung

Schaltungsentwicklung

Layout-Bearbeitung

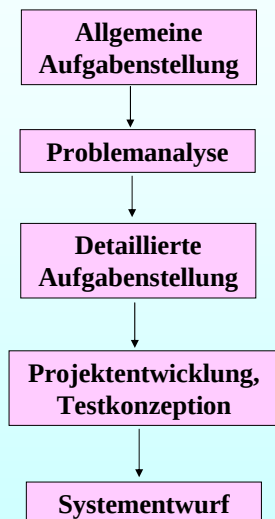
W. Philipp

Technologische Umsetzung

6/14/2005

Technical seminar June 2005

1



6/14/2005

Technical seminar June 2005

2

Ein Projekt

„Interlock für die XFEL-RF-Station“

- 1. Generation: erfüllt die Grundfunktionen
- 2. Generation: Funktionserweiterung, komfortable Anbindung an DOOCS über Metaserver
- 3. Generation (im Bau): für den Einsatz bei XFEL ausgerichtet; modular; flexibel; Softwareanbindung über Standardprotokoll

Export der Zeuthener Lösung nach HH

6/14/2005

Technical seminar June 2005

3

“The TTF2 / XFEL RF Station Interlock: Requirements and Implementation”

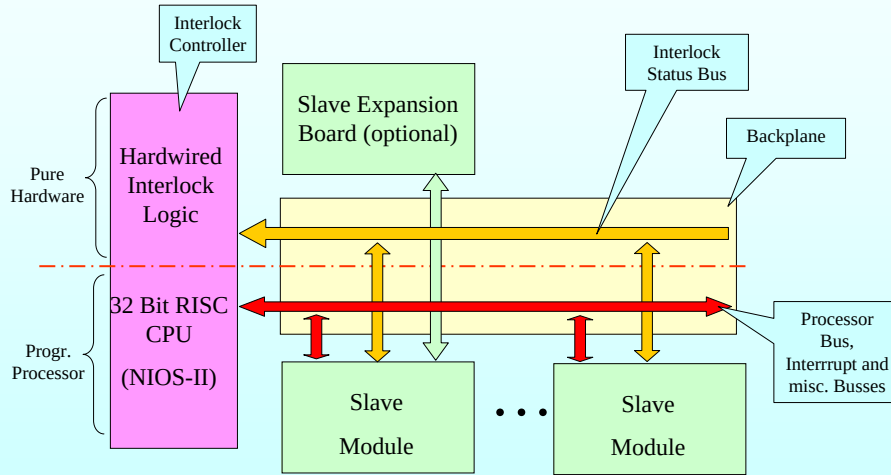
- 1. Requirements**
- 2. Implementation Details**
- 3. System Modules**
 - Crate, Power supply, Slow control
 - Controller
 - Digital Input/Output
 - Analog Input/Output
 - Digital IO for Light Links
 - Analog Input Module with Window Comparator Functionality
- 4. Control Functions**
- 5. Interface to a higher level Control System (DOOCS)**
- 6. Design documents**

6/14/2005

Technical seminar June 2005

4

Architecture Overview

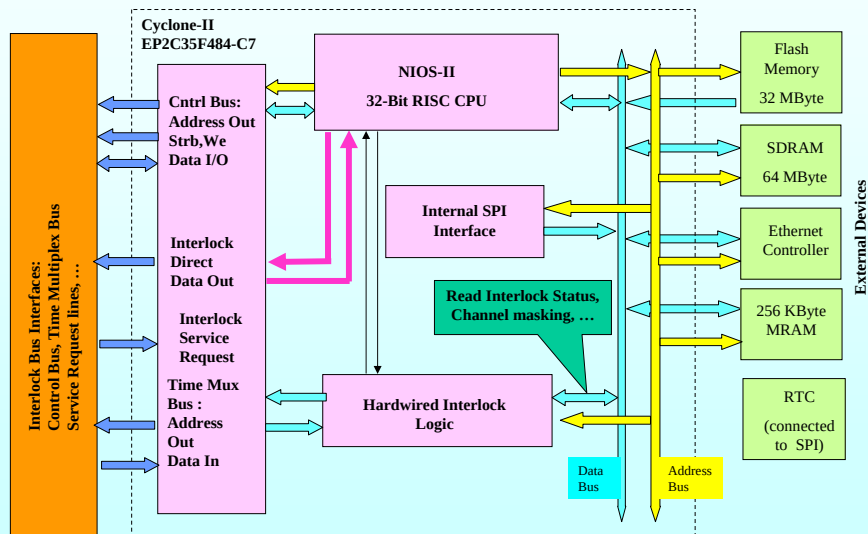


6/14/2005

Technical seminar June 2005

5

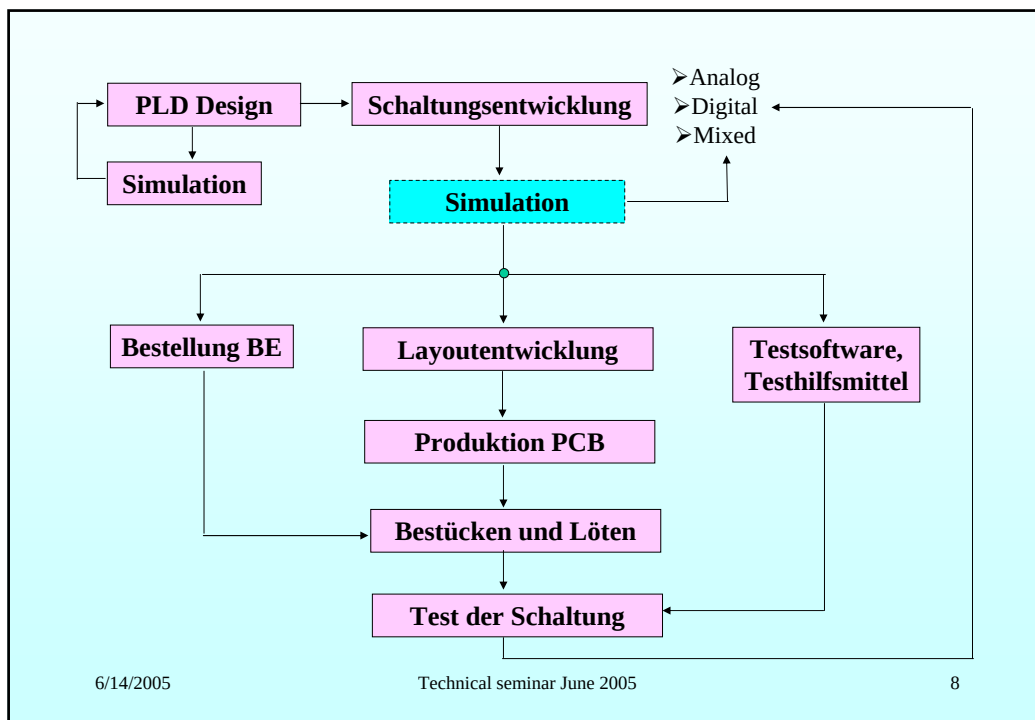
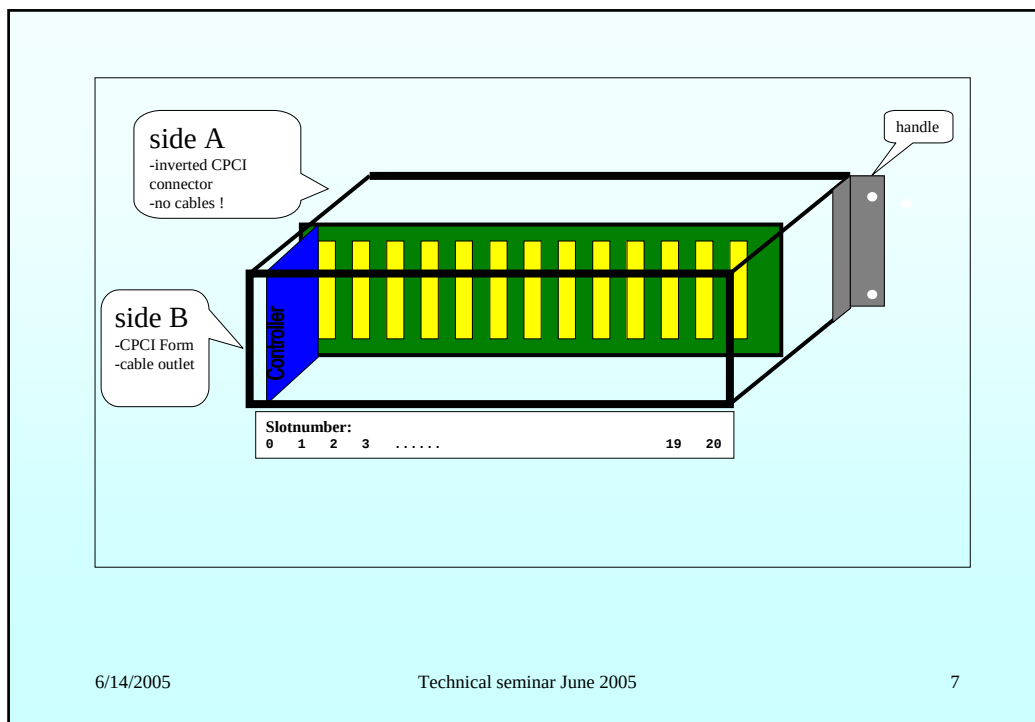
Controller Architecture



6/14/2005

Technical seminar June 2005

6



Hilfsmittel für den Entwurfsprozeß (I)

Schaltungsentwurf:

- Handzeichnung
- Grafische Eingabe mittels CAD-Software
- Beschreibungssprache (VHDL, Verilog)
- Zustandsdiagramm

Verifizierung:

- meist nur für Teile (Zustandsdiagramm, PLD)
 - Problem: Modelle!
- Simulatoren: VHDL, Verilog
 - funktionelle Simulation
 - Zeitsimulation

6/14/2005

Technical seminar June 2005

9

Hilfsmittel für den Entwurfsprozeß (II)

PLD Design:

- Design tools der PLD-Hersteller (XILINX, ALTERA, LATTICE)
- Design tools der CAD-Firmen (Mentor Graphics, Cadence, ...)
- Simulation ist ein muß!

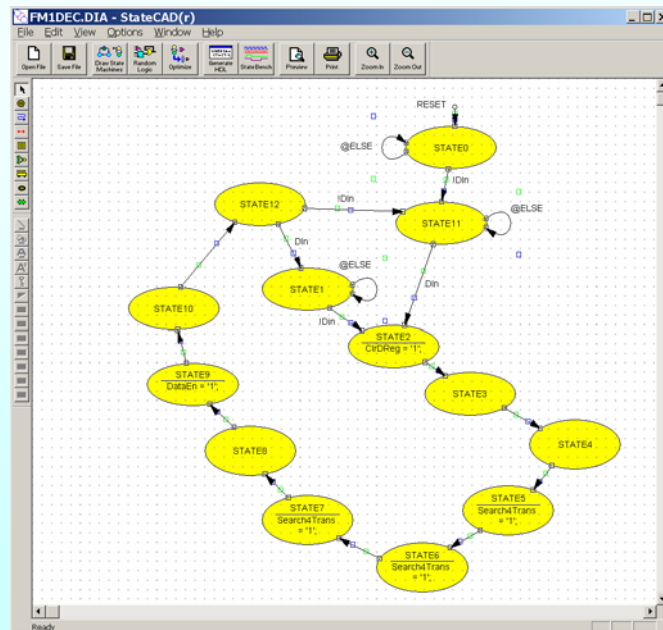
Layoutentwicklung:

- Handzeichnung
- Integrierte design tools von CAD-Firmen (Mentor Graphics, Cadence, Altium, ...)
 - im DESY: ORCAD, Expedition, Protel, Eagle

6/14/2005

Technical seminar June 2005

10



6/14/2005

Technical seminar June 2005

11

```
-- C:\XFEL\TIMEDEC\FM1DEC.vhd
-- VHDL code created by Xilinx's StateCAD 6.1i
-- Mon Feb 28 17:27:43 2005

LIBRARY ieee;
USE ieee.std_logic_1164.all;

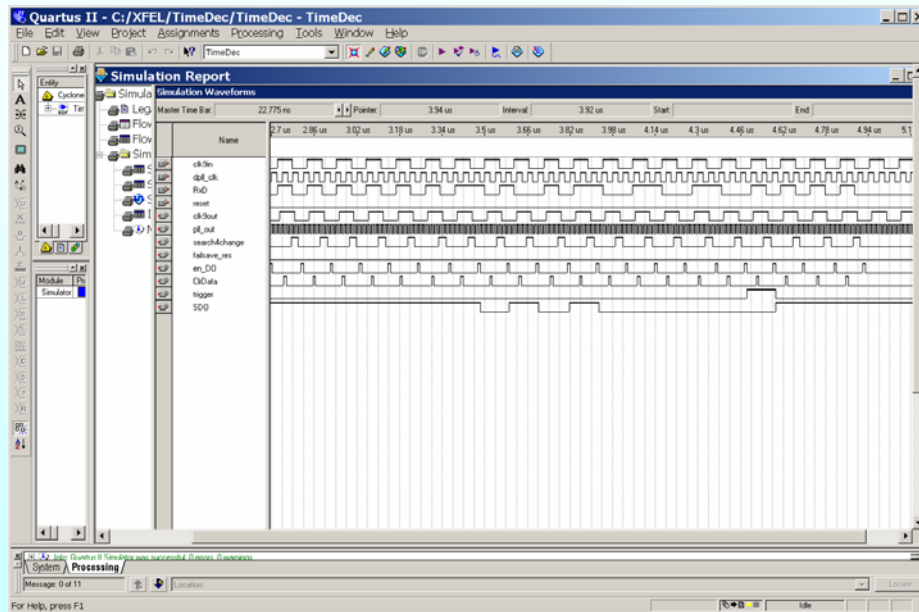
ENTITY FM1DEC IS
    PORT (CLK,DIn,RESET: IN std_logic;
          ClrDReg,DataEn,Search4Trans : OUT std_logic);
END;

ARCHITECTURE BEHAVIOR OF FM1DEC IS
    -- State variables for machine sreg
    SIGNAL STATE0, next_STATE0, STATE1, next_STATE1, STATE2, next_STATE2, STATE3
        , next_STATE3, STATE4, next_STATE4, STATE5, next_STATE5, STATE6, next_STATE6,
        STATE7, next_STATE7, STATE8, next_STATE8, STATE9, next_STATE9, STATE10,
        next_STATE10, STATE11, next_STATE11, STATE12, next_STATE12 : std_logic;
    SIGNAL next_Search4Trans : std_logic;
BEGIN
    PROCESS (CLK, RESET, next_STATE0, next_STATE1, next_STATE2, next_STATE3,
            next_STATE4, next_STATE5, next_STATE6, next_STATE7, next_STATE8, next_STATE9,
            next_STATE10, next_STATE11, next_STATE12, next_Search4Trans)
    BEGIN
        IF ( RESET='1' ) THEN
            STATE0 <= '1';
            STATE1 <= '0';
            ...
            Search4Trans <= '0';
        ELSIF CLK='1' AND CLK'event THEN
            STATE0 <= next_STATE0;
            ...
        END IF;
    END PROCESS;
END;
```

6/14/2005

Technical seminar June 2005

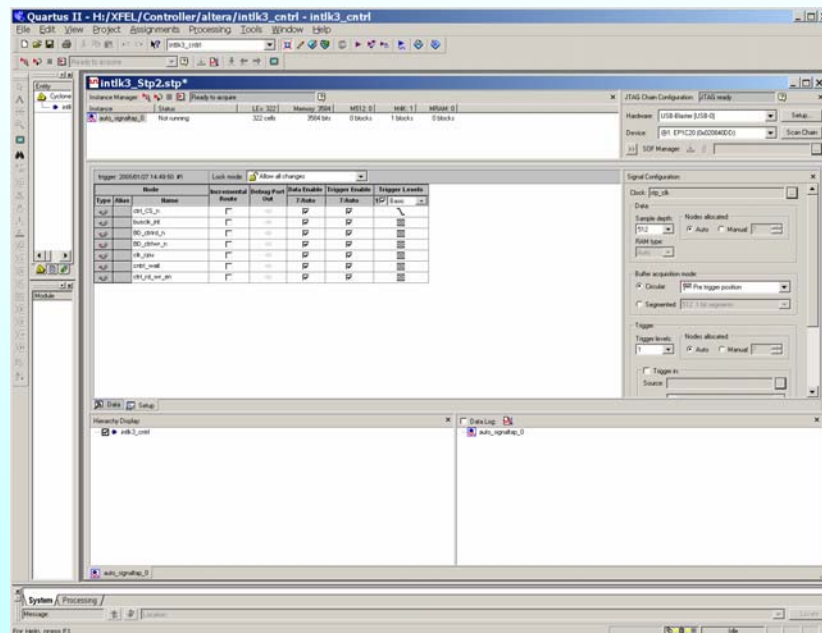
12



6/14/2005

Technical seminar June 2005

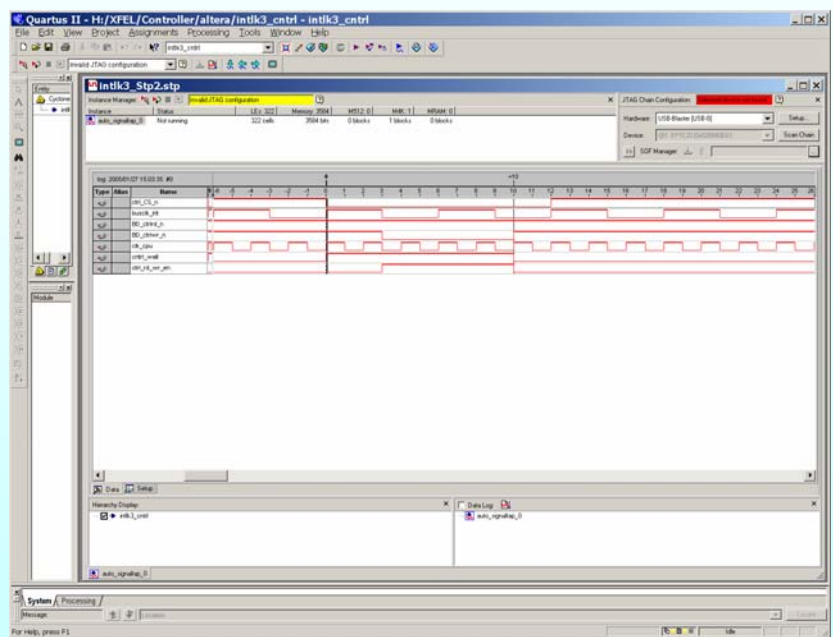
13



6/14/2005

Technical seminar June 2005

14

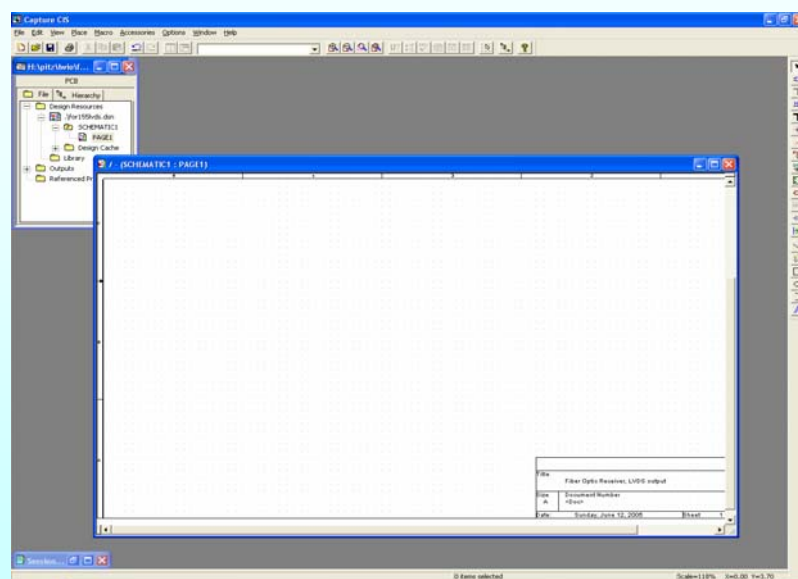


6/14/2005

Technical seminar June 2005

15

Open New Project in OrCAD Capture

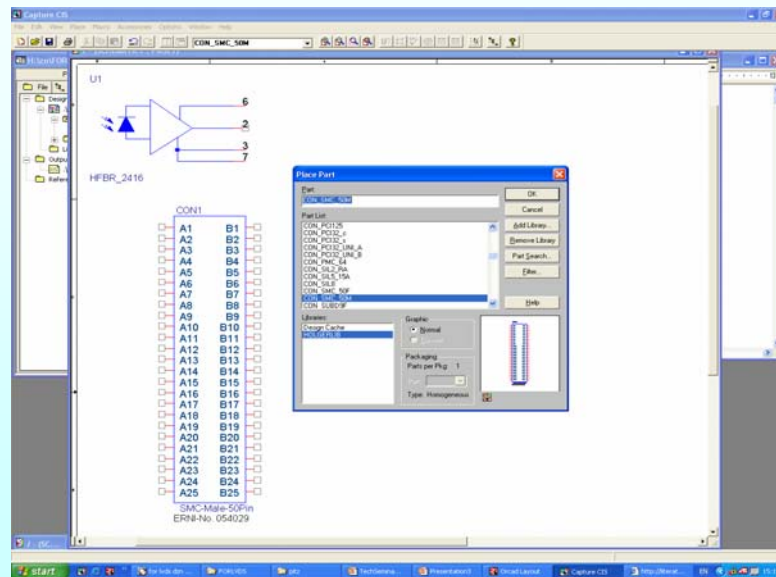


6/14/2005

Technical seminar June 2005

16

Place Component from Local Library

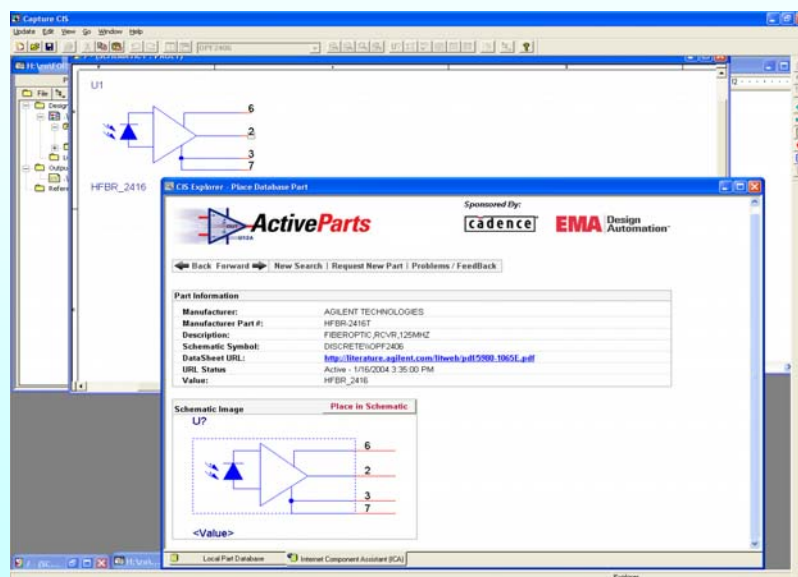


6/14/2005

Technical seminar June 2005

17

Place component with Internet Component Assistant (ICA)

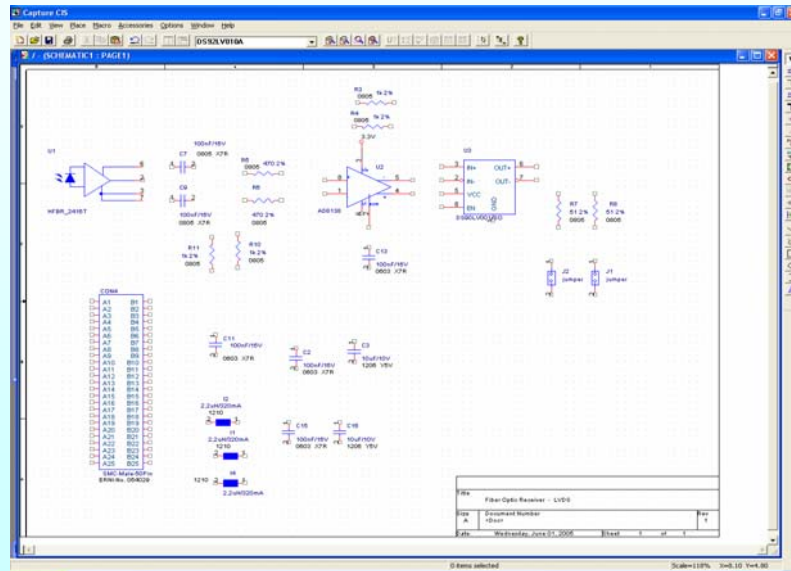


6/14/2005

Technical seminar June 2005

18

Place all Schematic Components

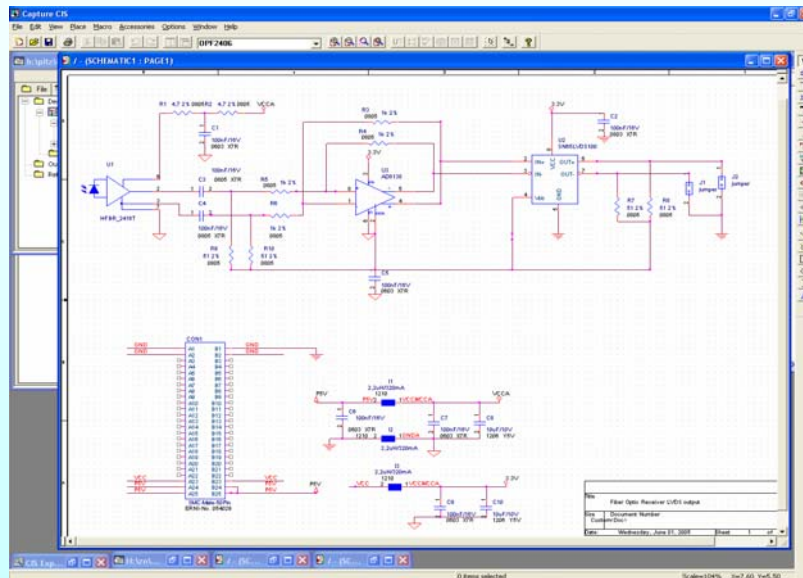


6/14/2005

Technical seminar June 2005

19

Draw all Net Connections

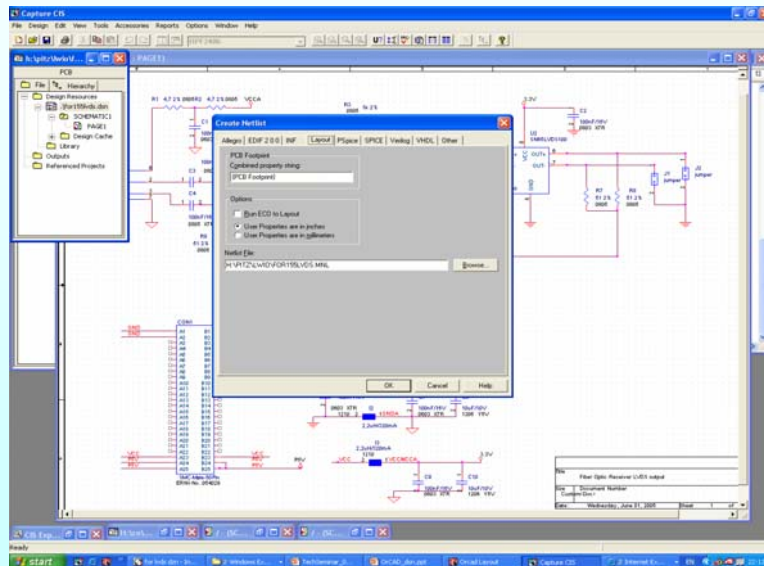


6/14/2005

Technical seminar June 2005

20

Create Netlist

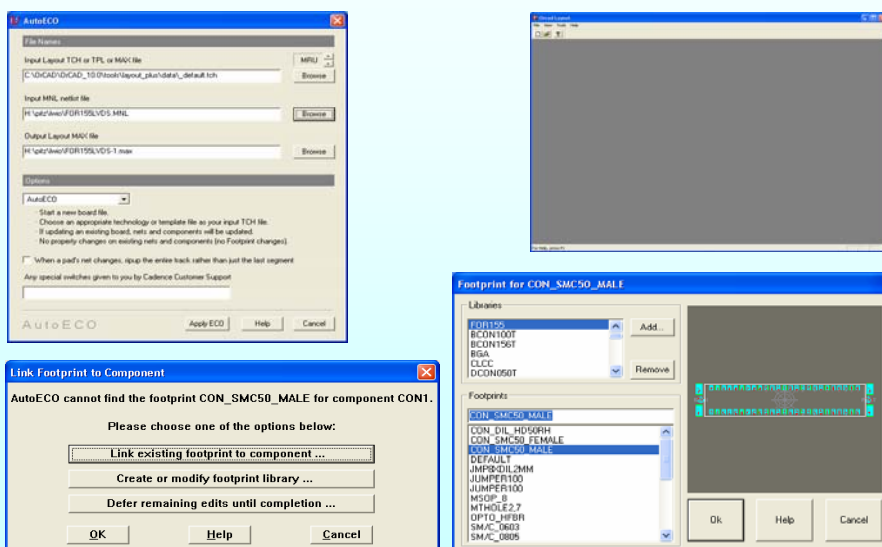


6/14/2005

Technical seminar June 2005

21

Open New Layout and link Footprints to Components



6/14/2005

Technical seminar June 2005

22

Design Board Layout

The image displays three screenshots of PCB design software. The top-left screenshot shows a 'Layout Plan' window with a top-down view of a circuit board layout, featuring various components and their interconnections. The top-right screenshot shows a 'Design Component Test (ERC: GFI)' window, which is a component test or error report window. The bottom screenshot shows a 'Schematic' window, which is a detailed circuit diagram showing the electrical connections between components, including a microcontroller, memory, and various passive components.

6/14/2005

Technical seminar June 2005

23

Routed Board

The screenshot displays a PCB layout software interface. The title bar reads "Layout Plot - J:\PST\A.XM\0155F\0155F-1.ADX". The menu bar includes File, Edit, View, Tools, Options, Window, and Help. The toolbar contains icons for various functions. The status bar shows "Design Component Tool (RUC ON)". The main workspace shows a red PCB layout with yellow traces. Components are labeled with part numbers and names, including R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R31, R32, R33, R34, R35, R36, R37, R38, R39, R40, R41, R42, R43, R44, R45, R46, R47, R48, R49, R50, R51, R52, R53, R54, R55, R56, R57, R58, R59, R60, R61, R62, R63, R64, R65, R66, R67, R68, R69, R70, R71, R72, R73, R74, R75, R76, R77, R78, R79, R80, R81, R82, R83, R84, R85, R86, R87, R88, R89, R90, R91, R92, R93, R94, R95, R96, R97, R98, R99, R100, R101, R102, R103, R104, R105, R106, R107, R108, R109, R110, R111, R112, R113, R114, R115, R116, R117, R118, R119, R120, R121, R122, R123, R124, R125, R126, R127, R128, R129, R130, R131, R132, R133, R134, R135, R136, R137, R138, R139, R140, R141, R142, R143, R144, R145, R146, R147, R148, R149, R150, R151, R152, R153, R154, R155, R156, R157, R158, R159, R160, R161, R162, R163, R164, R165, R166, R167, R168, R169, R170, R171, R172, R173, R174, R175, R176, R177, R178, R179, R180, R181, R182, R183, R184, R185, R186, R187, R188, R189, R190, R191, R192, R193, R194, R195, R196, R197, R198, R199, R200, R201, R202, R203, R204, R205, R206, R207, R208, R209, R210, R211, R212, R213, R214, R215, R216, R217, R218, R219, R220, R221, R222, R223, R224, R225, R226, R227, R228, R229, R230, R231, R232, R233, R234, R235, R236, R237, R238, R239, R240, R241, R242, R243, R244, R245, R246, R247, R248, R249, R250, R251, R252, R253, R254, R255, R256, R257, R258, R259, R260, R261, R262, R263, R264, R265, R266, R267, R268, R269, R270, R271, R272, R273, R274, R275, R276, R277, R278, R279, R280, R281, R282, R283, R284, R285, R286, R287, R288, R289, R290, R291, R292, R293, R294, R295, R296, R297, R298, R299, R300, R301, R302, R303, R304, R305, R306, R307, R308, R309, R310, R311, R312, R313, R314, R315, R316, R317, R318, R319, R320, R321, R322, R323, R324, R325, R326, R327, R328, R329, R330, R331, R332, R333, R334, R335, R336, R337, R338, R339, R340, R341, R342, R343, R344, R345, R346, R347, R348, R349, R350, R351, R352, R353, R354, R355, R356, R357, R358, R359, R360, R361, R362, R363, R364, R365, R366, R367, R368, R369, R370, R371, R372, R373, R374, R375, R376, R377, R378, R379, R380, R381, R382, R383, R384, R385, R386, R387, R388, R389, R390, R391, R392, R393, R394, R395, R396, R397, R398, R399, R400, R401, R402, R403, R404, R405, R406, R407, R408, R409, R410, R411, R412, R413, R414, R415, R416, R417, R418, R419, R420, R421, R422, R423, R424, R425, R426, R427, R428, R429, R430, R431, R432, R433, R434, R435, R436, R437, R438, R439, R440, R441, R442, R443, R444, R445, R446, R447, R448, R449, R450, R451, R452, R453, R454, R455, R456, R457, R458, R459, R460, R461, R462, R463, R464, R465, R466, R467, R468, R469, R470, R471, R472, R473, R474, R475, R476, R477, R478, R479, R480, R481, R482, R483, R484, R485, R486, R487, R488, R489, R490, R491, R492, R493, R494, R495, R496, R497, R498, R499, R500, R501, R502, R503, R504, R505, R506, R507, R508, R509, R510, R511, R512, R513, R514, R515, R516, R517, R518, R519, R520, R521, R522, R523, R524, R525, R526, R527, R528, R529, R530, R531, R532, R533, R534, R535, R536, R537, R538, R539, R540, R541, R542, R543, R544, R545, R546, R547, R548, R549, R550, R551, R552, R553, R554, R555, R556, R557, R558, R559, R560, R561, R562, R563, R564, R565, R566, R567, R568, R569, R570, R571, R572, R573, R574, R575, R576, R577, R578, R579, R580, R581, R582, R583, R584, R585, R586, R587, R588, R589, R590, R591, R592, R593, R594, R595, R596, R597, R598, R599, R600, R601, R602, R603, R604, R605, R606, R607, R608, R609, R610, R611, R612, R613, R614, R615, R616, R617, R618, R619, R620, R621, R622, R623, R624, R625, R626, R627, R628, R629, R630, R631, R632, R633, R634, R635, R636, R637, R638, R639, R640, R641, R642, R643, R644, R645, R646, R647, R648, R649, R650, R651, R652, R653, R654, R655, R656, R657, R658, R659, R660, R661, R662, R663, R664, R665, R666, R667, R668, R669, R670, R671, R672, R673, R674, R675, R676, R677, R678, R679, R680, R681, R682, R683, R684, R685, R686, R687, R688, R689, R690, R691, R692, R693, R694, R695, R696, R697, R698, R699, R700, R701, R702, R703, R704, R705, R706, R707, R708, R709, R710, R711, R712, R713, R714, R715, R716, R717, R718, R719, R720, R721, R722, R723, R724, R725, R726, R727, R728, R729, R730, R731, R732, R733, R734, R735, R736, R737, R738, R739, R740, R741, R742, R743, R744, R745, R746, R747, R748, R749, R750, R751, R752, R753, R754, R755, R756, R757, R758, R759, R760, R761, R762, R763, R764, R765, R766, R767, R768, R769, R770, R771, R772, R773, R774, R775, R776, R777, R778, R779, R780, R781, R782, R783, R784, R785, R786, R787, R788, R789, R790, R791, R792, R793, R794, R795, R796, R797, R798, R799, R800, R801, R802, R803, R804, R805, R806, R807, R808, R809, R810

PLD Design

- ALTERA: **Quartus**
- XILINX: ISE
- andere

6/14/2005

Technical seminar June 2005

25

Interlock Controller Board



6/14/2005

Technical seminar June 2005

26

Interlock Crate with Backplane



6/14/2005

Technical seminar June 2005

27

Interlock WebServer – Screenshot 1

INTERLOCK 3 - Mozilla Firefox

File Edit View Go Help

http://141.34.30.68/

XFEL Interlock 

[Login](#)

Display

- [System Info](#)
- [Interlock Status](#)
- [Window Comperators](#)
- [Slow Control](#)
- [Logbooks](#)
- [Measurements](#)

Welcome to the Nios® Webserver.

Please select a function.
Hallo Torsten! Habe ch. 3 maskiert! Geht also auch mit FireFox

INTLK3 Controller

Firmware	Revision: Interlock3 Webserver Ver 1.0 Description: INTLK3 Webserver with DEFAULT config Date:
Network	Filename: text_flash.flash MAC: 14:13:12:11:16:19 IP Addr: 141.34.30.68 IP Mask: 255.255.255.0 Gateway: 131.169.209.16

Connected Stations

Current Configuration					Stored Configuration		
Station	Name	Version	Prog.File	Prog.Date	Name	Version	Prog.Date
5	Intlk3_Digi40IO	1.0	intlk3_digi40io	22.07.04			No changes
9	INTLK3_ANAIO	1.0	intlk3_analo.pof	18.08.04			No changes
19	INTLK3_LightIO	1.0	INTLK3_LightIO.pof	05.02.04			No changes

Fertig

6/14/2005

Technical seminar June 2005

28

Interlock WebServer – Screenshot 2

XFEL Interlock

[Login](#)

Display

- [System Info](#)
- [Interlock Status](#)
- [Window Compensators](#)
- [Slow Control](#)
- [Logbook](#)
- [Measurements](#)

INTLK3 Status

Views: [Standard View](#) [Alternate View](#) [View All](#) [Refresh](#)

FlowBox

Sig#	Mask	Signal Name	Threshold
1	☐	Flow Transformer Tank	F < Fmin
2	☐	Flow Klystron Collector	F < Fmin
3	☐	Flow Klystron Body	F < Fmin
4	☐	Flow Solenoid 1.3	F < Fmin
5	☐	Flow Modulator	F < Fmin
6	☐	Flow Circulator 1.2	F < Fmin
7	☐	Flow Dummy Load 1.2	F < Fmin
8	☐	Flow PreAmp	F < Fmin

TempBox

Sig#	Mask	Signal Name	Threshold
9	☐	Temp Transformer Tank Oil	T > Tmax
10	☐	Temp Transformer Tank Water Out	T > Tmax
11	☐	Temp Klystron Tank Oil	T > Tmax
12	☐	Temp Solenoid 1.3 Motor Out	T > Tmax

Fertig

6/14/2005

Technical seminar June 2005

29

Eine elektronische Schaltung von der Idee bis zum Einbau am Experiment

Fertigung einer Flachbaugruppe
(Leiterplattenbestückung)

Der allgemeine Fertigungsablauf

1. Arbeitsvorbereitung
2. SMD- Bestückung
3. Bestückung der bedrahteten Bauelemente
4. mechanische Montage

6/14/2005

Technical seminar June 2005

31

Arbeitsvorbereitung

- von Entwicklern beigestellte Unterlagen (Bestückungsplan, Stückliste usw.) sowie Material sichten
- Bauelemente (meist passive wie Widerstände und Kondensatoren) aus dem Handlager ergänzen
- Fertigungshilfsmittel, Lötpastenschablone, Handmanipulator oder Bestückungsautomat sowie sonstige erforderliche Werkzeuge bzw. Vorrichtungen einrichten bzw. programmieren

6/14/2005

Technical seminar June 2005

32

SMD- Bestückung

- Lotpastenauftrag
- Bauelemente platzieren
- Lötprozess
- visuelle Inspektion

6/14/2005

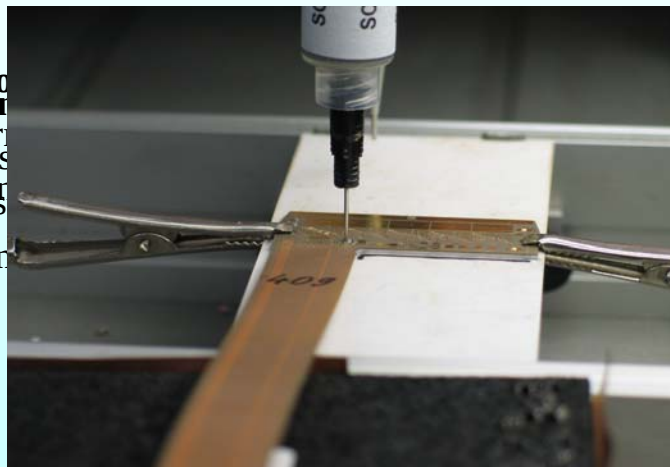
Technical seminar June 2005

33

Lotpastenauftrag

Schabl
Disper
mit Vor
▪ Bes
Maschin
aus

- von



tnis

6/14/2005

Technical seminar June 2005

34

Bauelemente platzieren

- Handmanipulator



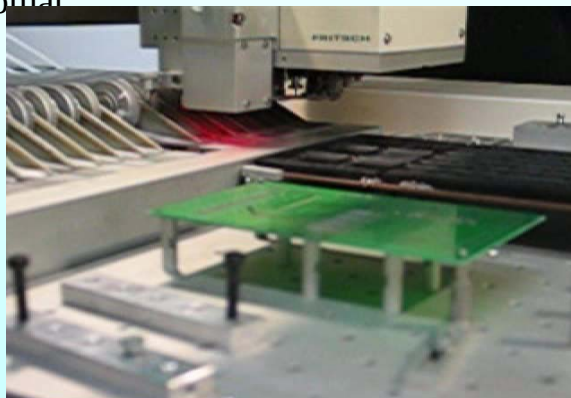
6/14/2005

Technical seminar June 2005

35

Bauelemente platzieren

- Bestückungsautomat



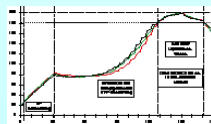
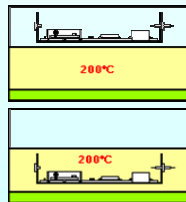
6/14/2005

Technical seminar June 2005

36

Lötprozess

- Reflowlöten in der Demofab



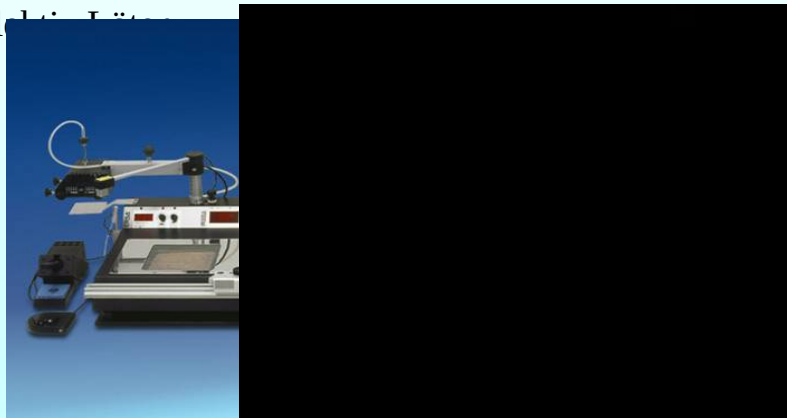
6/14/2005

Technical seminar June 2005

37

Lötprozess

- selective löten

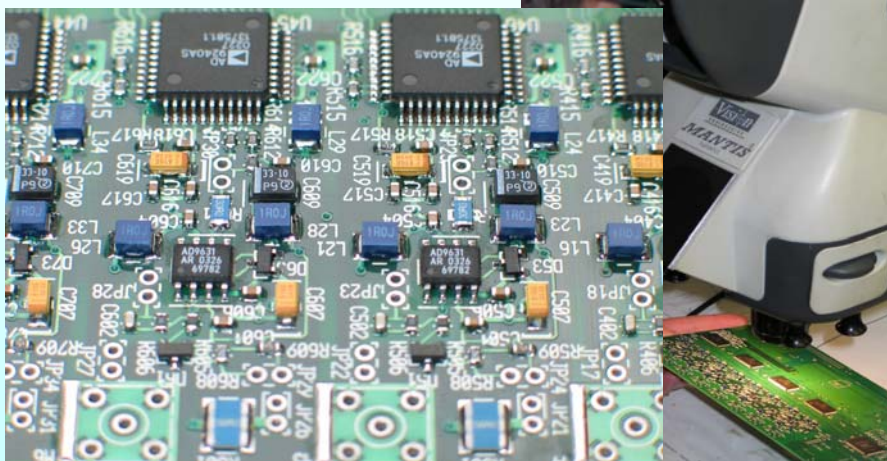


6/14/2005

Technical seminar June 2005

38

visuelle Inspektion



6/14/2005

Technical seminar June 2005

39

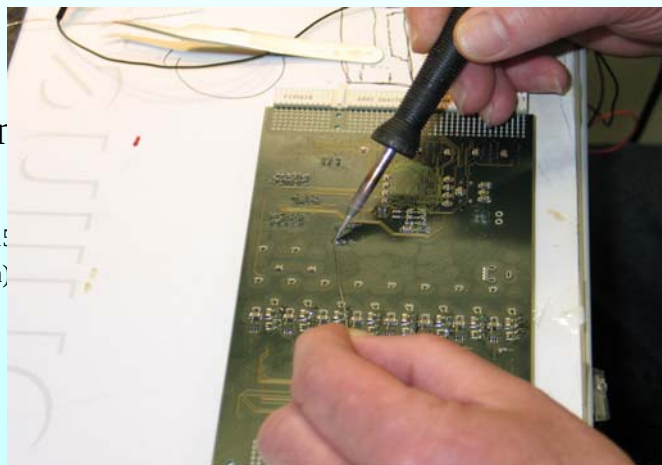
Bestückung der bedrahteten Bauelemente

Handlöten

Steckverbind

einpressen

Einpresskraft bis 15
(entsp. 1,5 Tonnen)



6/14/2005

Technical seminar June 2005

40

mechanische Montage



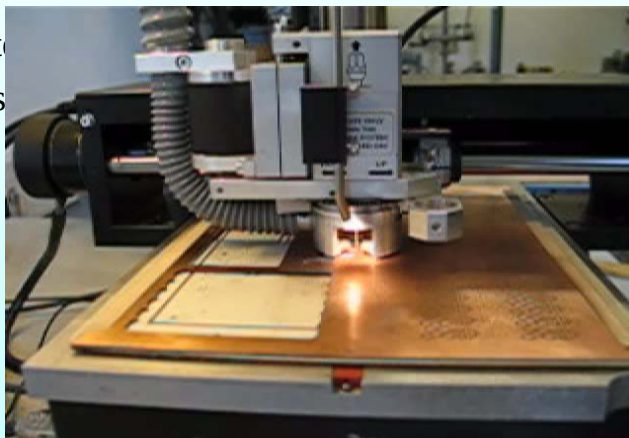
6/14/2005

Technical seminar June 2005

41

Prototypenherstellung

Leit
Fräs



6/14/2005

Technical seminar June 2005

42

vielen Dank für das gezeigte
Interesse

6/14/2005

Technical seminar June 2005

43