Center for Technology & Innovation
IBM 1403-N1 Printer Controller
2014 Progress Report

12/20/2014

Figure 8. IBM 1403 Printer Model N1

IBM 1403 – N1 Printer Controller
Project Context

- Center for Technology and Innovation commissioned a new Printer Controller to drive the 1960s IBM 1403-N1 high speed printer in its collection. Retired IBMers are refurbishing the vintage hardware.
- Binghamton University Watson School Capstone Project team is developing the Printer Controller software, while Triple Cities Makerspace is developing the Printer Controller hardware.
- Watson School participation in 2013/4 (Proof of Concept) and 2014/15 (Implementation phase) funded by the Institute of Electrical and Electronics Engineers (IEEE) Binghamton Section.

IBM 1403-N1 – Printer Controller
2014-5 Project Organization

- Center for Technology & Innovation (CT&I)
  - Printer refurbishment; Project Coordination
  - Art Law, Coordinator; Bob Arnold, Bill Green, Bob Lusch, Don Manning, Fred Petras, Tom Schappe, Jack Westermann
- Triple Cities Makerspace (TCMS):
  - Printer Controller hardware redesign, expansion, and build
  - Eric Adler, Jim Ulrich, Erik Leonard, Stephen Musok and other TCMS members
- Watson School Senior Capstone Project (WCP):
  - Printer Controller Timing Control Subsystem; Hardware safety interlock
  - Nick Hekman, EE; John Wiseman, COE; Alena Yampolskaya, COE; Jack Maynard, Faculty Advisor

2014-12-20 3

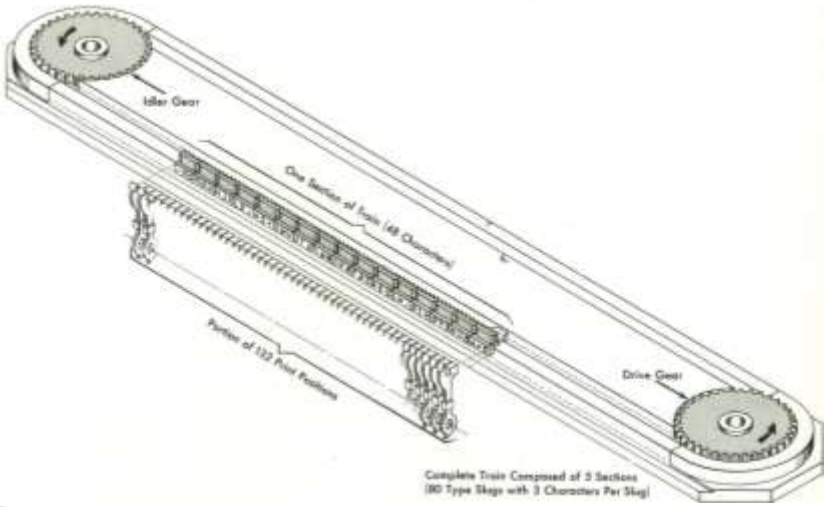
IBM 1403-N1 Printer Controller
Challenges

- No timing or driving hardware available for the printer
- Using modern microprocessor to replace vintage hardware
- Maintaining synchronization with the printer
- Hammers may need to be fired as often as every 5µs

2014-12-20 4

IBM 1403-N1 Printer Controller

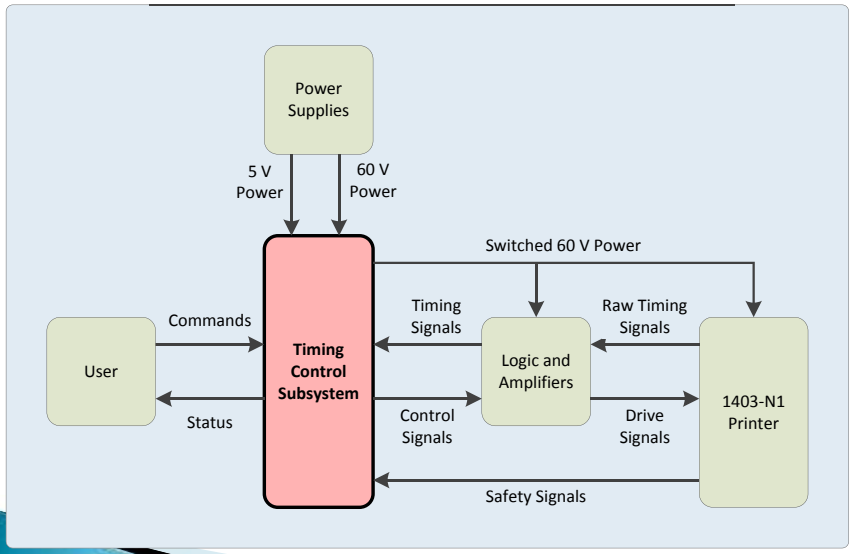
Print Train Assembly



2014-12-20 5

IBM1403-N1 Print Controller

Context Diagram



2014-12-20 6

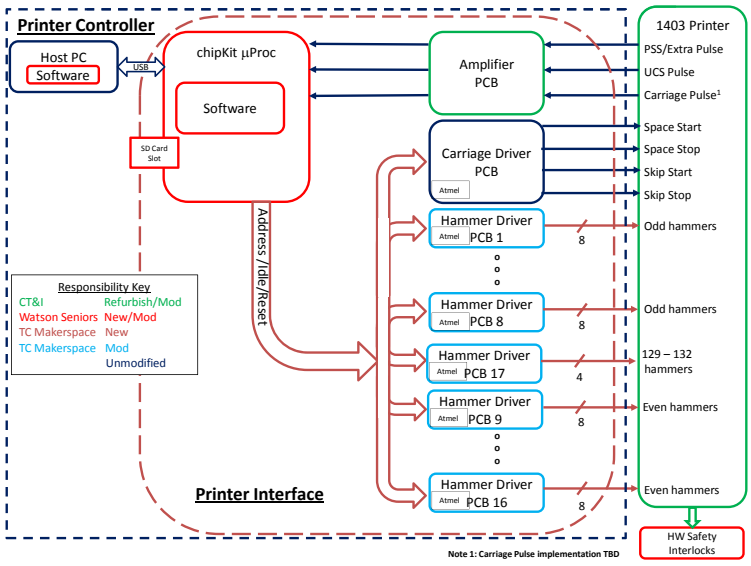
Context Diagram
Description

Timing Control Subsystem
- Accept user input strings for printing.
- Maintain synch with the print train. PSS pulses arrive every 243 µs.
- Send signal to the energize printer hammer every 5µs +/- 0.5µs.
- Display status, fault, and performance information to the user.
- Operate the printer at 1100 lines per minute.

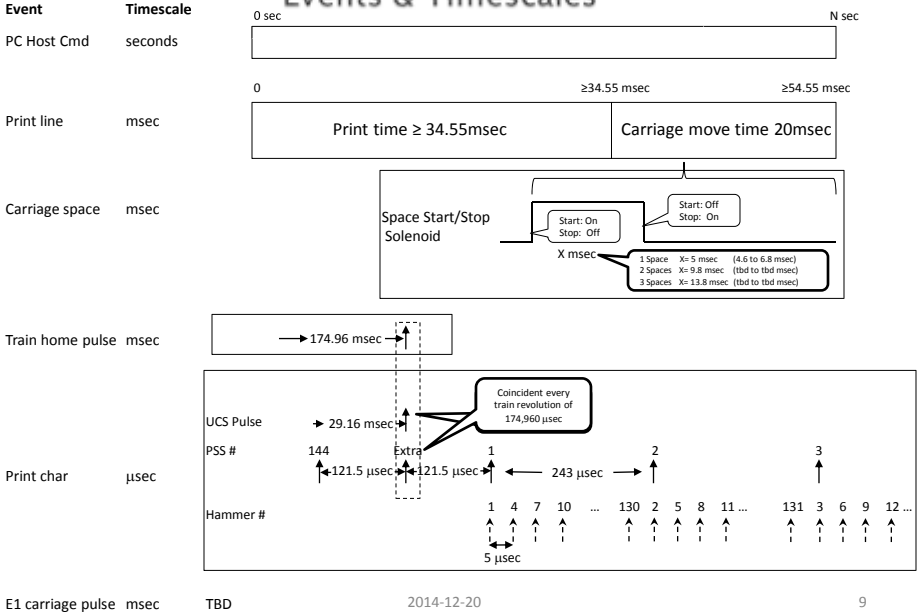
Logic and Amplifiers
- Commanded by Timing Control Subsystem to energize hammers
- Coordinates timing of multiple hammers
- Commanded by Timing Control Subsystem to advance carriage
- Translates signals between Timing Control Subsystem and printer

Hardware Safety Interlock
- Remove 60V power when hardware error conditions detected

1403-N1 Printer Controller
Hardware & Software Components



1403 – Printer Controller
Events & Timescales



Center for Technology & Innovation
Printer Controller Accomplishments & Tasks

- Accomplishments
  - Project Management
    - System requirements document developed
    - Organized project and assigned responsibilities
    - Host weekly meetings to obtain and distribute status, forum for technical and project discussions, identify issues and problems, work solutions
  - Technical
    - Modified design of amplifier card and validated changes
    - Worked with Watson Team to validate processing of PSS timing signals from Drive Gear, through Amplifier Card, generating interrupt signal to chipKit micro-processor, and processing of interrupt signal by chipKit micro-processor software
    - Redesign of electrical design and physical layout of Hammer Driver Card (with Triple Cities Makerspace)

Center for Technology & Innovation
Printer Controller Accomplishments & Tasks

- 2015 Tasks
  - Project Management
    - Maintain progress to complete project by May, 2015
  - Technical
    - Release updated Hammer Driver Printed Circuit Board design for fabrication
    - Populate and assemble Hammer Driver Cards
    - Modify Amplifier card with updated design
    - Coordinate and participate in system integration and acceptance testing of Printer Controller hardware, software, and printer

Center for Technology & Innovation
Printer Refurbishment Accomplishments & Tasks

- Accomplishments
  - AC power applied to all major units and appear to be functional
    - Drive motors for train, carriage, ribbon, stacker, and cover lift
  - Remade and installed missing drive gear
  - Tested timing signals from drive and idler gear look good
  - Evaluated electrical wiring and made minor modifications
  - Forms handling – carriage & tractors – appear to function properly.

- 2015 Tasks
  - Hammer unit– Complete inspection/cleaning/testing required
  - Paper path guides – rusted, to be stripped and replated
  - Stacker mechanism – cleaning and lubrication required
  - Ribbon unit – test, confirm functionality.
  - Cartridge oiler – test, confirm functionality
  - Edge connectors identified, extensions added, insulated and mounted
  - Large signal cables – route to rack

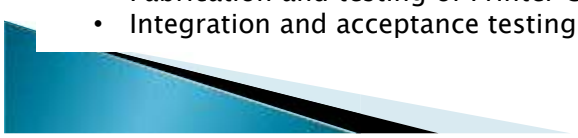
Watson Senior Undergraduate Team
Printer Controller Accomplishments & Tasks

- Accomplishments
  - Successfully developed prototype software to verify:
    - Ability to handle PSS timing interrupts
    - Processing power to process at 5 micro-second rate
  - Started development of production software
  - Met all coursework requirements
    - Series of project and design documents
  - Presented Interim (end of semester) presentation attended by CT&I and IEEE representatives
    - Presentation was very successful

- 2015 Tasks
  - Complete production software development
  - Complete development and testing of Hardware Interlock
  - Integration and acceptance testing

Triple Cities Makerspace
Printer Controller Accomplishments & Tasks

- Accomplishments
  - Design of overall Printer Controller hardware
    - Card mounting and internal cabling
    - External connectors
    - Case and chassis design and procurement
    - Power
  - Re-design of Hammer Driver Card (with CT&I)
    - Enable simultaneous multiple hammer control
    - Reduce card count by increasing number of hammers handled per card
  - Work with Watson Team to establish interface between Timing Control Subsystem and Logic and Amplifiers hardware
- 2015 Tasks
  - Fabrication and testing of Printer Controller hardware
  - Integration and acceptance testing



IBM 1403-N1 Printer Controller Schedule

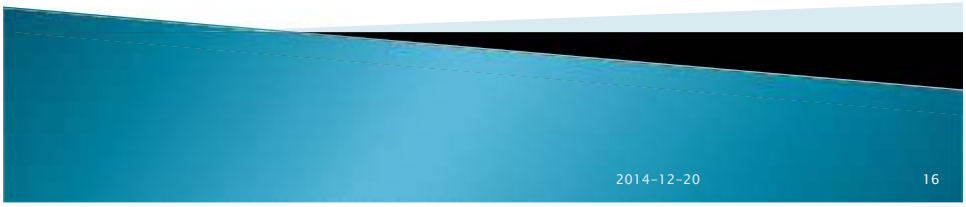
	Oct				Nov				Dec				Jan				Feb				Mar				Apr				May
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1
Watson Capstone																													
Architecture doc final						X																							
Interim Presentation										X																			
System Acceptance Rvw																										X			
Sys Requirements Doc	X	X	X	X	X																								
Prototype build																													
Hardware build		X	X	X													X	X											
Software build				X	X	X	X	X																					
Testing							X	X	X	X							X	X											
Printer Refurb			X	X	X	X	X	X	X	X	X			X	X	X	X	X	X										
Production HW design/build					X	X	X	X	X	X	X	X	X	X	X	X	X	X											
Production SW design/build							X	X	X	X	X	X	X	X	X	X	X	X	X	X									
Sys Integration/Test																	X	X	X	X	X	X	X	X	X				

Winter school break

Timing Controller Software Hardware Interlock

Watson School of Engineering Binghamton University Capstone Senior Project (WCP 07)

Fall 2014 Semester Progress Report
Detailed Design Excerpts
12/12/2014

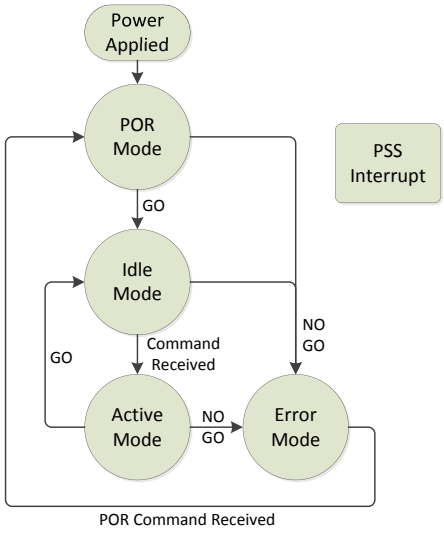


Timing Controller Interface to Hammer & Carriage Driver Cards

The Timing Control Board will interface with Hammer & Carriage Driver Cards using parallel communications, in which eight address lines will set the command and a sync line will signal the hardware that a command is available.

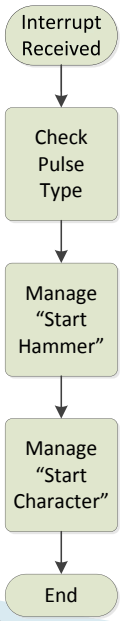
Command Table	
Command Value	Command
0x00	Idle (perform no action)
0x01 - 0x84	Fire the indicated hammer
0xA0	Toggle carriage command active
0xA1	Toggle carriage command idle
0xFF	Reset all drivers

WCP07 IBM Printer Driver Required Modes



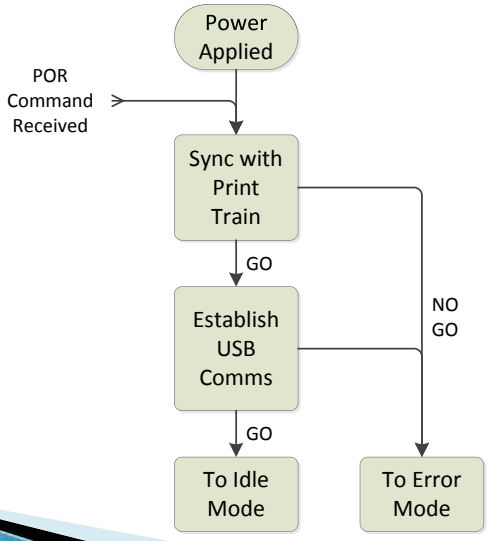
2014-12-20 18

WCP07 IBM Printer Driver PSS Interrupt



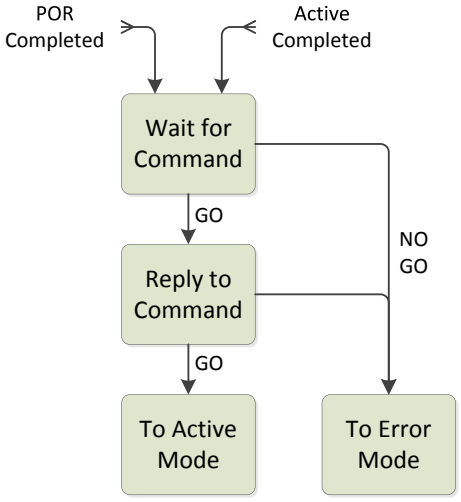
2014-12-20 19

WCP07 IBM Printer Driver POR Mode



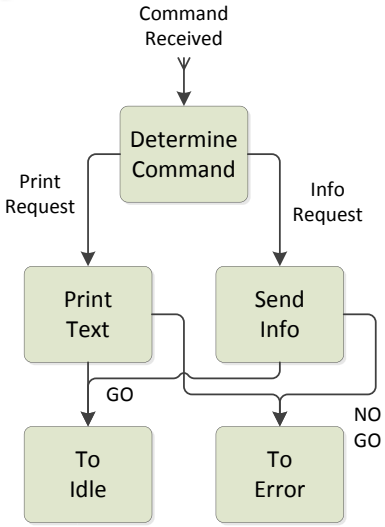
2014-12-20 20

WCP07 IBM Printer Driver Idle Mode



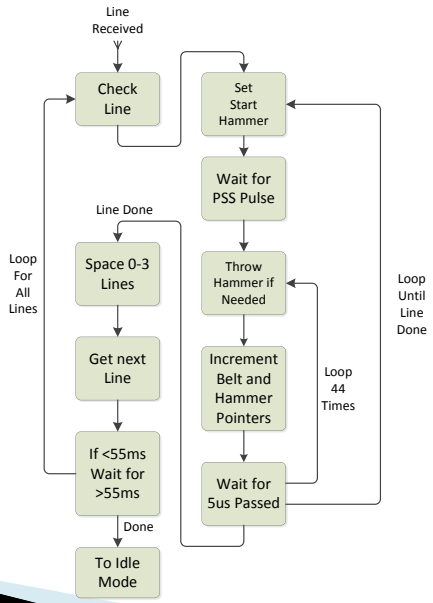
2014-12-20 21

WCP07 IBM Printer Driver Active Mode



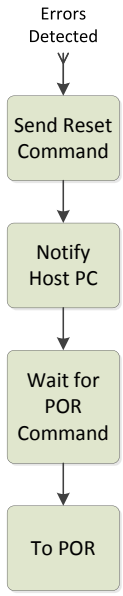
2014-12-20 22

WCP07 IBM Printer Driver Print Text



2014-12-20 23

WCP07 IBM Printer Driver Error Mode



WCP07 IBM Printer Driver Interlock PCB