Determination and analysis of a standard interface model derived from a medium speed line printer

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INTRODUCTION

The need for the development of a standard interface for computer associated equipment is a subject that requires investigation based on analytical facts rather than emotion. To establish a baseline for the definition of an interface model, a medium speed line printer utilizing 22 interfaces for a given printer model provides adequate interfaces for investigation. Such a model has many similarities relative to any interface consideration. All data presented is factual and represents an actual functioning interface to a controller. Most interfaces are associated with terminals, minicomputer or medium scale computers.

ANALYSIS OF INTERFACE DIFFERENCES FOR A MEDIUM SPEED LINE PRINTER

A consideration of the differences between all interfaces makes it possible to analytically investigate the many parameters present. Such a parameter study gives insight to the significance of a standard interface.

Hardware requirements and limits

The connectors and cable requirements for the interface circuitry vary greatly between controller manufacturers. Changes in connector configurations cause cabinet modifications, extra paper work and manufacturing configuration control. Such necessary complications add cost to the product to satisfy the varied customer requirements.

One variation associated with the connector is pin assignments. Out of the 22 interfaces being considered, 16 different pin configurations exist. The number of pins contained in the various connectors is a low of 22 with three coax, and a high of 50 pins. Of the actual pins used, a low of 20 and a high of 32 was present.

Three physical size differences of connectors occurred. A further complication was the use of both alpha and numeric pin designations. Connector variability causes extra definition and paper work requirements.

Functional definitions and variations

The interchange of data between the printer and controller may be basically defined to consist of a minimum number of control functions. Table I lists general printer control functions and the occurrence data. It can be seen that only the data strobe and basic data line signals are present in all interfaces. Such signal variations cause configuration differences and extra paper work requirements.

Table II lists the total functions utilized. No one interface utilizes all of the functions listed in Table II. The various functions defined for each given interface require design changes from minor modifications to entire printed circuit board design.

Options

Certain of the functions included in Table II are considered to be optional requirements. Such requirements add speed advantages or economic impact and should be considered as a variable even in standard interface definitions.

The VFU (Vertical Format Unit) variation between teletype and IBM type paper tape is not an optional requirement. However, the difference between a two channel unit and a 12 channel unit requires considerable circuit design differences. Extra cost is associated with the 12 channel unit and the interface requirement for 12 channel is the most complex. The Vertical Format Unit is used for programmed control of paper movement.

Different character fonts allow speed advantages for given data format requirements. This difference in function is significant enough to be included in option definition.

Interface signal title variations

Table III lists the total interface signal titles utilized. Variations in signal titles with respect to controller requirements causes cable wire run list differences and schematic

TABLE I—General Printer Control Functions

FUNCTION	*STANDARD/VARIES*
Alarm Condition	Varies
Character Ready	Varies
Data Lines 1–6	Varies
Data Lines 1–7	Varies
Data Strobe	Standard
Line Ready	Varies
On Line	Varies

changes. Table IV lists the signal titles that are associated with the interface defined to be standard by the printer manufacturer. The standard interface has been utilized with over 75 unique customer's controllers. The 21 other interfaces considered include various combinations of connector differences, functional differences, and signal title differences. The various levels of change cause paper work differences. Table V lists the interface model parameters with respect to the interfaces considered. It is evident that a standard interface definition would reduce costs by elimination of much of the workload as defined by Table II and Table V. A standard interface utilizing signals definition similar to Table IV and a definition of cable and functions would greatly reduce the need for the many configuration differences required.

ANALYSIS OF REASONS FOR INTERFACE DIFFERENCES

The reason for the many different ways of doing a similar function is directly related to the many different printers available. Each printer manufacturer selects unique functions and cable requirements. Other peripheral manufacturers respond likewise. A system manufacturer is

TABLE II—Total Functions Utilized

Automatic Print	
Automatic Print and Paper Advance	
Differential Interface—Line Driver/Receiver	*
Feed After Print	
Feed Before Print	
Motor Off Delay	
Negative Logic	
Paper Jam Detection	
Paper Runaway	
Paper Tear Detection	
Positive Logic	
Print on Command	
Serial/Parallel Interface	
Special Termination Resistors	
Special Test Character	
2 Channel VFU (IBM/TELETYPE)	*
12 Channel VFU (IBM/TELETYPE)	*
48 Character Set	*
64 Character Set	*
96 Character Set	*

* OPTIONAL

TABLE III—Total Interface Signal Titles

$\overline{\text{ACK}}$
$\overline{\text{Alarm}}$
Alarm
$\overline{\text{Alarm Serial}}$
$\overline{\text{Belt Mtr in Speed}}$
Buffer Rdy
Buffer Ready
$\overline{\text{Buffer Ready Serial}}$
Char Rdy
Character Ready
Data Bit 1–6
$\overline{\text{Data Bit 1–7}}$
Data Bit 1–7
$\overline{\text{Data Strobe}}$
$\overline{\text{Data Strobe}}$
DSTB
EOPL
VFU Channel 1
VFU Channel 2
VFU Channel 8
Gnd
$\overline{\text{Master Reset}}$
$\overline{\text{MA-STAT}}$
$\overline{\text{On Line}}$
On Line
Paper Out
PE
Print
$\overline{\text{Ready}}$
$\overline{\text{Select}}$
Serial Data
+5V

then faced with connecting a number of peripheral units to a controller. Once the selections are made, a cable and connection requirement emerges. As competition grows, the system manufacturer becomes interested in attempting to mutilize other peripherals, mostly due to either economic or reliability considerations. Figure 1 shows four printers connected to four controllers illustrating the requirements that may be imposed on a printer manufacturer to be competitive. Referring to Figure 1, the following relationships are determined.

Printer A has three interfaces with interface A1 considered to be a standard interface of the printer manufacturer. The standard interface for Printer A is compatible with controller 1 and controller 2. Interfaces A2 and A3 are compatible with controllers 3 and 4 respectively.

TABLE IV—Standard Interface Signal Definition

$\overline{\text{Alarm}}$
$\overline{\text{Belt Motor in Speed}}$
Buffer Ready
Data Bit 1–7
Data Strobe
$\overline{\text{Line Ready}}$
$\overline{\text{Master Reset}}$
On Line
Paper Out
Ground
+5V

Printer B utilizes four unique interfaces to be compatible with the four controllers.

Printer C1 standard interface is compatible with controller 3 and controller 4. Interfaces C2 and C3 are compatible with controllers 1 and 2 respectively.

Printer D1 standard interface is compatible with controller 1 and controller 2. Interfaces D2 and D3 are compatible with controller 4 and controller 3 respectively.

Figure 1 shows that a printer standard interface as defined by the printer manufacturer is not compatible with other printer standard interfaces, and therefore not compatible with all controllers.

It is also shown in Figure 1 that each controller accepts four different printers identically or demands a standard interface. In order for all printers to be compatible to all controllers, a total of 13 interfaces is required. A standard interface theoretically could reduce the number to 1 interface. Typically, many independent printer manufacturers are required to design many different interfaces to be competitive. It is not uncommon for controller manufacturers to also design many different interfaces to be compatible with printers and other devices. In order that controllers second source devices without change to the system, many interface circuit designs are required.

Printer standard interfaces

Most independent printer manufacturers establish a standard interface. The standard interface is compatible with a certain number of controllers. In all cases where the standard interface is incompatible, unique interfaces occur. Considering a sample of customers that included the 22 unique interfaces, 75 customers utilized the standard interface described in Table IV. This would mean that competitive printer manufacturers would have to modify their interface to become a second source. Of all printer manufacturers, it is unlikely that any standard printer interface of one manufacturer would be compatible with any other manufacturer's standard printer interface. This fact insures that a lot of design will be necessary to insure compatibility to a number of controllers.

TABLE V—Interface Model Parameters

DRAWING	NO. OF VARIATIONS
Schematics	14
WRL	12
50 Pin Connector	1
37 Pin Connector	1
22 Pin—3 Coax Connector	1
Alpha Pin Designation	1
Numeric Pin Designation	1
Physical Configuration—Connector	3
PWA Assembly Drawings	15
Interface Cable	12
PWA—Artwork	11
Mini-Computer Additional Interfaces	5

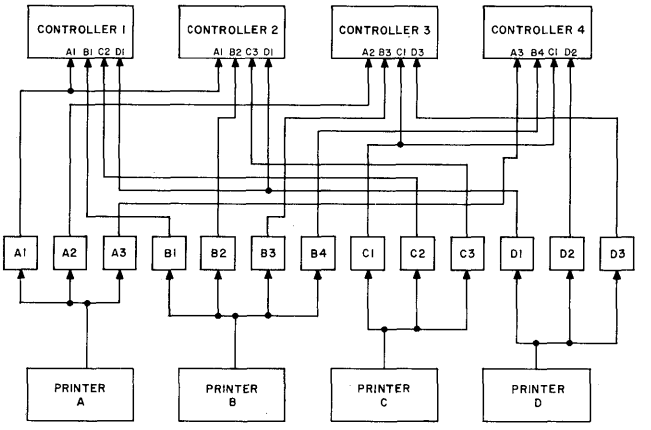

Figure 1—Controller to printer interface

Printer mini-computer interfaces

Many times two different interfaces are required to be compatible with mini-computer interfaces. In such cases, the printer standard interface is fed into a number of unique interfaces to be compatible with the many mini-computer types now available. Due to the lack of a standard mini-computer interface specification, at least five different external interfaces (for a given medium speed line printer) are required to be compatible with all mini-computer types.

SUMMARY

By analyzing the compatibility requirements for a single line printer, it can be seen that a great many varieties of interfaces exist. Most interfaces are unique to certain customers and are a second source to other printer manufacturers. In order to have a practical interface definition, operational definitions must be considered. Once the software programs for a controller are established, the printer must be designed to be compatible. Therefore, functional operations must be standardized along with connector definition and printer functions. In order for a printer standard to be established, a standard for controllers must also be established. In fact, a controller standard should be established prior to a printer standard consideration. Since each printer manufacturer has established a standard interface, not compatible for all controllers, it is evident that if a controller standard interface existed, the standard printer interface would be compatible. At the very least, a specification for standard interfaces would allow efficient design due to the evaluation of all parameters. At present, new conditions occur with such frequency, that total stabilization of interface designs is highly unlikely. As long as a manufacturer is a first source, the interest in a standard interface would be low. However, if the same manufacturer had interest in becoming a second source, the interest now may be high.

Second sourcing of components met with initial resistance from component manufacturers. However, due to economic pressures from users, second sourcing of components is now very common. In order to second source components, a standard specification for the component was generated. The same basic situation applies to computer systems. It is true that the definition of the standard is more complex, but a definition can be accomplished. As long as the user and the manufacturer are willing to change design and configuration, the pressure to define a standard interface will be lacking. The most important fact associated with the standard interface question is that extra cost is required if a standard is not generated. The cost of the extra design is, in most cases, totally unnecessary if a standard is established. When the user and manufacturer understand the unnecessary waste and cost, pressure will be applied to establish a standard interface. A standard interface specification would be as practical to a printer manufacturer as a component specification would be to a component manufacturer.