A Fast, Automatic Printer
For Digital Type Data Devices

LAST year -hp- introduced a high-speed digital recorder* which automatically printed the measurements made by -hp- frequency counters. The recorder was arranged to print numbers of up to 11 columns (digits) on adding machine tape at rates up to 5 complete print-outs per second and thus considerably increased the speed and ease with which frequency measurements could be recorded.

Introduction of this recorder for frequency counters uncovered a need for a print-out instrument with the same high speed, simplicity and reliability of mechanism, and low required signal power but one which would be capable of operating with other types of digital data devices. A second version of the recorder has therefore been designed to permit fast print-outs from other devices that gather data in digital form. Where the first recorder was designed to operate from a staircase code, the second is designed to operate from 10-wire codes. It is thus especially valuable for use with digital voltmeters but can also be used with analog-digital converters, remote readout units, frequency counters with 10-wire outputs, shaft encoders, 10-lamp or 10-element systems, stepping switches, mechanical counters with commutators, relay and diode matrices, etc., to print digitized measurements of voltage, current, pressure, acceleration, flow, deflection and other quantities.

Although the new printer is arranged to operate with devices that provide their outputs in the form of 10-wire codes, this often includes devices that internally employ other codes, since such devices are generally usable with suitable output translators for readout pur-


Fig. 1. -hp- Model 561A printer provides fast print-outs for digital data devices such as digital voltmeters, analog-digital converters, etc., that provide an output in 10-wire code form. Print-outs can be made of 11 columns at rates up to 3 lines per second.

Fig. 2. Typical print-out obtainable when using printer with digital voltmeter. Left-hand column has been programmed to indicate source of reading, but if a mixture of + and readings were to be obtained, this or another column could be used to identify reading polarity. Special symbols can also be provided. Print-outs are made on 3-inch adding machine tape.
poses. The requirement for entering information into the printer is merely that in each column the particular wire corresponding to a number to be printed be impressed with a 10-volt or more negative dc voltage. The printer is a parallel-input device so that signals must be impressed simultaneously in all columns to be printed.

The mechanical arrangement of the new printer is indicated in Fig. 3. The actual printing is done by a series of 11 identical number-faced wheels which are mounted on and friction-coupled to a common shaft. Each wheel face is divided into 12 segments and each wheel is provided with a stationary 12-segment commutator corresponding to the wheel face segments. Connections to the individual segments are brought out to externally-available terminals, while the brush connection is brought to a sensing circuit. The impedance looking into the commutators has been made high (1 megohm) to permit the instrument to operate from low-power sources such as diode matrices.

Operation of the mechanism occurs in the following manner. When a command signal is applied to the "Command" terminal (Fig. 3), it is amplified and used to fire a thyatron. Anode current from the thyatron then closes a solenoid and activates a clutch that couples the print wheel shaft to a continuously-running motor. The wheel shaft then begins to rotate and, owing to the friction coupling between the number wheels and the wheel shaft, the number wheels also begin to rotate. As the wheels rotate, each wheel brush scans the individual commutator segments until the segment is reached that contains the code voltage. This voltage is applied through the brush to a sensing tube grid, cutting off the tube and releasing the solenoid in its plate circuit. This action releases a pawl which drops against the number wheel, locking the proper number in a pre-determined position for printing.

This same action has also been occurring with the other 10 wheels on the shaft in accordance with the information entered on their commutators, so that by the time the shaft has turned nearly one rotation all of the wheels are locked in whatever position the voltages on the wheel commutators have dictated. At the end of the shaft rotation a print bar automatically presses the print paper and an inked ribbon against the number wheels, transferring the eleven sets of 10-wire code signals to printed form. The wheel-positioning cycle occurs in 160 milliseconds, while the printing cycle occurs in 40 milliseconds. The total cycle thus occurs in 200 milliseconds so that 5 print-outs per second can be obtained.

**PRINT COMMAND**

The printer is designed so that its scan-print cycle becomes initiated on command, thus enabling the printer to be controlled by the external system. The command can be an external negative signal of 15 volts minimum amplitude or an external contact closure such as one of the contacts on a programmed stepping switch. Quite simple contact closures such as manually operated momentary-contact toggle switches can also be used. The contact closure should connect the "Print Command" terminal (Fig. 3) to the "Common" terminal.

**EXTERNAL DISABLING RELAY**

During the 160-millisecond period of the scan cycle, the information applied to the printer must remain fixed. Oftentimes, this requirement will be met naturally by the external equipment but in some cases a special relay included in the printer may be of convenience. The relay has a single-pole double-throw contact arrangement such that one contact opens and one closes when the print command signal is applied to the printer. This condition is maintained until completion of the scan cycle. External equipment can thus be prevented from changing information during this cycle by routing a suitable circuit through these contacts.

**WHEEL SYMBOLS**

Of the twelve positions on each type wheel, ten are occupied by numerals while the eleventh is provided with an asterisk (*) as a general-purpose symbol. The asterisk can be used for indicating polarity or for other coding. Other symbols such as +, -, Ω, letters of the alphabet, etc., can also be supplied.
The twelfth position on each wheel is blank so that the wheel will not print if not used. All wheels have this position internally programmed in such a way that only the blank position can be obtained unless the wheel commutator terminals have external connections made to them.

VOLTMETER USE

Digital voltmeters that operate on stepping switch principles usually provide their output in the form of contact closures which are equivalent to single-pole 10-position switches. A typical arrangement for operating the printer* with such a voltmeter is shown in Fig. 4. The contact closures corresponding to each digit of the voltmeter readout connect to the appropriate number wheel input connections on the printer. The printer provides a source of dc voltage from bus "A" which is connected to the switch rotors on the voltmeter. The voltmeter will then feed this dc back to the printer through the contact closures so that the printer receives a signal on the appropriate wire of the 10-line codes.

Each print-out is initiated either by a signal produced by the voltmeter or by a special contact closure provided in the voltmeter for the purpose. Where necessary to insure that the voltmeter holds its information for the duration of the 160-millisecond scan cycle, the contacts on the disabling relay in the printer can be used in an override circuit for the voltmeter.

The same general setup indicated in Fig. 4 can also be used to obtain printouts from such devices as shaft encoders, stepping switches, relay matrices, mechanical counters with commutators, etc.

PRINT-OUTS

Fig. 2 (first page) demonstrates the result of a typical method of program-
A PRINTED TAPE
adding machine tape which is available
tape as it is printed.
been found to be more often preferred
accordion-folded style. The latter has

Vumber wheels: 12 positions having numerals
print rote: 5 lines per second or 3300 characters

Accessories ovoilable: 1052-24 Folded Paper
Poper required: Standard
Print command: An externol contact closure,
lnpuf impedonce: 1 megohm.

Weighf: Cabinet Mount: Net 35 Ibs.; Rack
Mount: Net 30 Ibs.

Driving source: Stepping Switches, Relays,
Beam Switching Tubes, contact closure
or a negotive pulse 15 volts peak or more,
switch. Print commonds during scan and

Dimensions: Cabinet Mount:
20'' wide, 121/2'' high, 181/2'' deep. Rack Mount: 19'' wide,
161/2'' high, 181/2'' deep behind ponel. Re-

For transistor work the supply has been
designed so that its output current
cannot exceed any one of four select-
able values, even under shorted-terminal
conditions, thus giving considerable
protection against accidental overload
of valuable components under test. The
supply itself is also fully transistorized,
and this current-limiting feature fully
protects the internal circuits as well.
The supply provides voltages which are
adjustable from 0 to 30 vdc at rated
currents up to 150 ma. Either voltage
or current can be monitored by a di-
rect-reading panel meter which is ar-
ranged to have full-scale values of 10
and 30 volts and 10, 30, 100, and
300 ma. For circuit protection a panel
switch sets the maximum available cur-
rent at 25, 50, 100, or 225 ma.
The output terminals are floating and either
can be grounded as a convenience
in using various transistor configurations.
The output can also be con-

A new regulated power supply has
been designed for powering low-voltage
circuits such as those using transistors.
 output resistance shown in Fig. 2 as-
sumes that the meter is switched to the
voltage position, as do the regulation
figures cited earlier.

Physical size is worthy of mention
since the supply requires less bench
area (7'' wide x 5.2'' deep) than a
conventional textbook and is but 4.3''
high. Similarly, weight is only 4
pounds. Rubber feet are provided on
bottom and back sides to enable it to
be used with the panel either vertically
or horizontally positioned. Units can
also be stacked if desired.

DONALD F. SCHULZ
-HP- MODEL 721A
POWER SUPPLY
Regulated output voltage: 0 to 30 volts dc,
continuously variable.
Maximum load current: 150 ma for voltage
regulation; maximum available current, ap-
prox. 225 ma.
Load regulation: With the meter monitoring
voltage, the change in output voltage from
no load to full load is less than 0.3% or
36 ma whichever is greater.
Line regulation: Change in output voltage for
a change from nominal line voltage of
±10% is less than ±0.3% or ±15ma
whichever is greater.
Ripple and noise: Less than 150µv rms.
Output impedance: Less than 0.2 ohm in series
with less than 36Oh.
Meter ranges: Full scale indications of: 10ma,
30 ma, 100 ma, 300 ma, 10 v, and 30 v.
Overload protection: Maximum current selected
by switch in four steps, 25 ma, 50 ma, 100
ma, 225 ma.

Output terminals: Three banana jacks spaced
3/4'' apart. Positive and negative terminals
are isolated from chassis. A maximum of 400
volts may be connected between ground and
either output terminal.
Power: 115/230 volts ±10%, 50 to 60 cps,
16 watts.
Weight: Net 4 lbs., Shipping 7 lbs.
Dimensions: 7'' wide, 4 3/4'' high, 3 1/4'' deep.
Price: -HP- Model 721A Power Supply $145.00,
f.o.b. Palo Alto, California.

REPRINTED FROM PAGE 3

A CURRENT-LIMITING REGULATED POWER SUPPLY
FOR TRANSISTOR WORK

The printer uses standard 3-inch
adding machine tape which is available
in an accordion-folded style. The latter has
been found to be more often preferred
and a supply of this style is provided.
A drawer at the front of the instru-
ment can be extended to receive the
tape as it is printed.

-Ed A. Hilton

SPECIFICATIONS

-PH-
MODEL 561A
DIGITAL RECORDER

Column capacity: 11 columns (11 digits per
line).
Print rate: 5 lines per second or 3300 characters
per minute maximum.
Number wheels: 12 positions having numerals
0 through 9, an asterisk, and a blank. Other
symbols are available on special order.
Information entry: Through individual wires,
one for each position of each wheel, brought
to female connector.
Driving source: Stopping Switches, Relays,
Beam Switching Tubes, contact closure or
negotive pulse 15 volts peak or more,
switch. Print commands during scan and

Model 721A power supply

Fig. 2. Typical source impedance of
Model 721A power supply.

Fig. 1. -HP- Model 721A power supply
provides 0 to 30 vdc at currents up to 150
ma. Maximum current available can be
set by panel switch to minimize accidental
overloading of sensitive external circuits.