APPLICATION NOTE 32

FOREWORD

The purpose of Application Note 32 is to provide a guide for selecting Hewlett-Packard and Dymec* digitizing instruments when a specific application or combination of measurement functions is in mind. It serves as a guide in choosing those output-indicating instruments, such as digital recorders and remote indicators whose input requirements are compatible with hp and Dymec* digitizing equipment.

Application Note 32 demonstrates the simplicity with which Hewlett-Packard and Dymec* equipment may be used, individually as well as conveniently interconnected, to form a great many basic instrumentation systems.

Moreover, versatility and compatibility of different instrument types, an essential element in any instrument system, is also shown by Hewlett-Packard and Dymec* in several ways:

1. Plug-in units allow a wide variety of applications from one basic instrument.
2. Standard catalog equipment is easily interconnected in "building-block" form for instrumentation systems, without special furnishings or custom engineering charges: Electronic counters or digital voltmeters, adequate for initial purposes, can be supplemented at any time with more specialized equipment, such as remote readouts, punched card or tape recording, multiple digital comparison, go-no-go testing, electric typewriter recording, or other measuring devices.
3. Operational obsolescence is reduced between instrument models by carry-over design advances, based on human engineering precepts.
4. Constant attention to quality and exhaustive development testing extends the reliable scope of equipment beyond the lab--to van, production, and field applications--without special precautions or degradation in performance.

INTRODUCTION

GENERAL:

Application Note 32 is made up of six related divisions: three charts and a table, a capsulated discussion on printer control design, and a section about digital recorder print-wheels.

(1) Chart "1" lists different possible measurement functions (e.g. FREQUENCY, PERIOD, PHASE ANGLE) along the side of the chart, and lists such things as possible accuracies, instruments, and display at the top.

(2) Chart "2" lists different output-indicating instrument (i.e. digital recorders and remote indicators) along the side along with compatible digitizing instruments; and at the top are listed the particular requisites of operation.

(3) Chart "3" lists specific digitizing instruments along the side, with the compatible output equipment listed at the top.

(4) The Speed Measurement Table is simply a tabulation of different tachometers for use in reciprocation or rotational speed measurements, having a short introduction of measurement prerequisites.

(5) Section I is a brief enumeration of design considerations when building transistor control circuitry for 565A Printers, essentially the same type mechanism used in hp digital recorders.

(6) Section II discusses the variety of characters and symbols available that may be ordered on special print-wheels for the digital recorders; a classification of stocked, special print-wheels is at the end.

DEFINING THE MEASUREMENT NEED:

Before selecting equipment for any particular measurements, the quantitative problem should first be defined and isolated as best as available information will allow. This not only precludes shortcomings in the

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final results, but prevents wasted dollar value; that is, it prevents acquiring equipment whose full potential will never be used. On the other hand, additional quantities may be discovered, necessitating more equipment later on, which could then be included in the final analysis for choosing perhaps one instrument suitable for all applications. Some measurement considerations are these:

1. Particular measurement required (phase, period, voltage, etc.)
2. Frequency range covered
3. Accuracy required
4. Recording needs
5. Monitor or control action
6. Alternate applications

SELECTING EQUIPMENT:

As a rule of thumb, first considerations in selecting digitizing measurement equipment center about the electronic counter or digital voltmeter that can make the desired measurement with the required accuracy. After that, factors like indication, remote readout, recording, and alternate applications can be evaluated in their order of relative importance.

By referring to Chart "1", Chart "2", and Chart "3" it will be possible to determine and evaluate this type of information for both digitizing and output recording equipment. Chart "1" is arranged by measurement function in order of increasing frequency on one axis and increasing accuracy on the other axis along with related information. Chart "2" is arranged so that the most suitable digital recorder can be chosen for use with the digitizing instrument selected. And Chart "3" is essentially the reverse of this procedure, the digitizing instruments being listed first for compatibility with output-indicating equipment, which are listed at the top of the chart.

All charts are similarly constructed in that information is contained along separate axes, being cross-correlated by a system of dots in a columnar arrangement: to determine the requirements for a particular measurement, or to see the combination possibilities of instruments, first, read along the selected column while observing the position of all the dots; second, change axis direction and trace along each column which intersects that where a dot is positioned for the associated heading in the column. By using this criss-cross method, fixed quantities can be selected for reference with different measurement variables.

FREQUENCY (Note 1)

	ACCURACY	RANGE	PLUG-INS	RECORDER OUTPUT	INSTRUMENT	MEASUREMENT FUNCTION	DISPLAY
3 cps to 100 kc	TIME BASE ±0.1% ±0.01%	DC 50 cps to 50 kc 50 kc to 100 kc 50 cps to 10 kc 10 kc to 100 kc 50 kc to 500 kc	Option 02 Option 03 Option 04 Ⓜ 525A Plug-In Ⓜ 525B Plug-In Ⓜ 525C Plug-In Ⓜ 525D Plug-In Ⓜ 5253A Plug-In Ⓜ 526B Plug-In Ⓜ 526C Plug-In Ⓜ 526D Plug-In Ⓜ 5262A Plug-In Ⓜ P932	Ⓜ 560A (Note 4) Ⓜ 561B (Note 3) Ⓜ 562A (Note 3) Analog output Digital out on counter used	Ⓜ 405BR Ⓜ 405CR Ⓜ 457A Ⓜ 500B Ⓜ 521A Ⓜ 521C Ⓜ 521D Ⓜ 521E Ⓜ 521G Ⓜ 5211A Ⓜ 5211B Ⓜ 5212A Ⓜ 522B Ⓜ 523C Ⓜ 523D Ⓜ 5232A Ⓜ 5233L Ⓜ 524C Ⓜ 524D Ⓜ 5243L Ⓜ 5245L Ⓜ 5275A Ⓜ 5403 Ⓜ 5512A Ⓜ 5532A dy 2210 + counter dy 2211A + counter dy 2211B + counter dy 2401A dy 2410A dy 5207-1+counter	Time interval Period 10 Period av 10 to 10⁵ Period av 10 to 10⁷ Period av Ratio Ratio X1 & X10 Ratio X1 to X10,000 Multiple Ratio Frequency 1 to 10⁴ Periods av 1 to 10⁵ Periods av 1 to 10⁶ Periods av 1 to 10⁷ Periods av 1 to 10⁸ Multiplier 1 to 10⁹ Multiplier 1 to 10¹⁰ Multiplier Multiplier 1 or 10	Meter Columnar Range and function annunciator NIXIE
1 cps to 120 kc	Accuracy = ±1/2% digit calibration Obtain up to 1 part/10 accuracy See Ⓜ Application Note 2 and 27 for above 18 gc						
10 cps to 120 kc	± 10 parts/10⁶ per wk ± 2 parts/10⁶ per wk						
1 cps to 220 kc	± 2 parts/10⁶ per mo ± 3 parts/10⁶ per day						
10 cps to 220 kc	± 5 parts/10⁶ per wk						
2 cps to 300 kc	±0.3% Reading ±1 count ±0.75% Reading ±1 count						
1 cps to 1.2 mc	±0.02% Typical for converter						
10 cps to 1.2 mc	±0.03% Typical for converter						
2 cps to 1.2 mc	±0.05% Typical for converter						
0 to 2.0 mc	±0.06% Typical for converter						
10 cps to 10.1 mc	±0.75% Typical for converter						
0 to 20 mc	±0.1° ±360° Accuracy (fp/fc)						
0 to 50 mc	External source Ⓜ 101A with ±5 parts/10⁷ per wk						
10 cps to 100 mc ic	±0.01% of full scale per day stability on 1 volt range and above						
100 mc to 220 mc	±0.02% full scale ±0.15% reading for converter @ 50 cps - 10 kc						
100 mc to 510 mc	0.03% full scale ±0.3% reading for converter						
100 mc to 512 mc	0.08% full scale ±5% reading for converter						
to 12.4 gc							
to 18 gc and above							

PHASE ANGLE MEASUREMENT (Note 2)

1 cps to 20 kc DC
50 cps to 20 kc AC
1 cps to 20 kc AC or DC
0 to 2.0 mc

VOLTAGE MEASUREMENT (Note 5)

1 mv
100 uv
10 uv
1 uv (100 mv range) 10 uv (1 volt range)
100 uv DC
100 uv AC

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NOTES

1. Accuracy:
   ±1 count ±time base accuracy (one count is $\frac{1}{ft}$ where f is frequency counted, t is gate time)

2. Phase Angle:
   Accuracy assumes noise of at least 65 db below signal, and negligible error of counted frequency: frequency of phase measured signal = f_p, and counted frequency = f_c. Internal counted frequency of the 523C and "D" = 1 mc (max), with provision for external counting from 10 cps to 1.2 mc; internal counted frequency of the 524C or "D" is 10.0 mc (max), with provision for external counting of 100 kc or 1.0 mc.

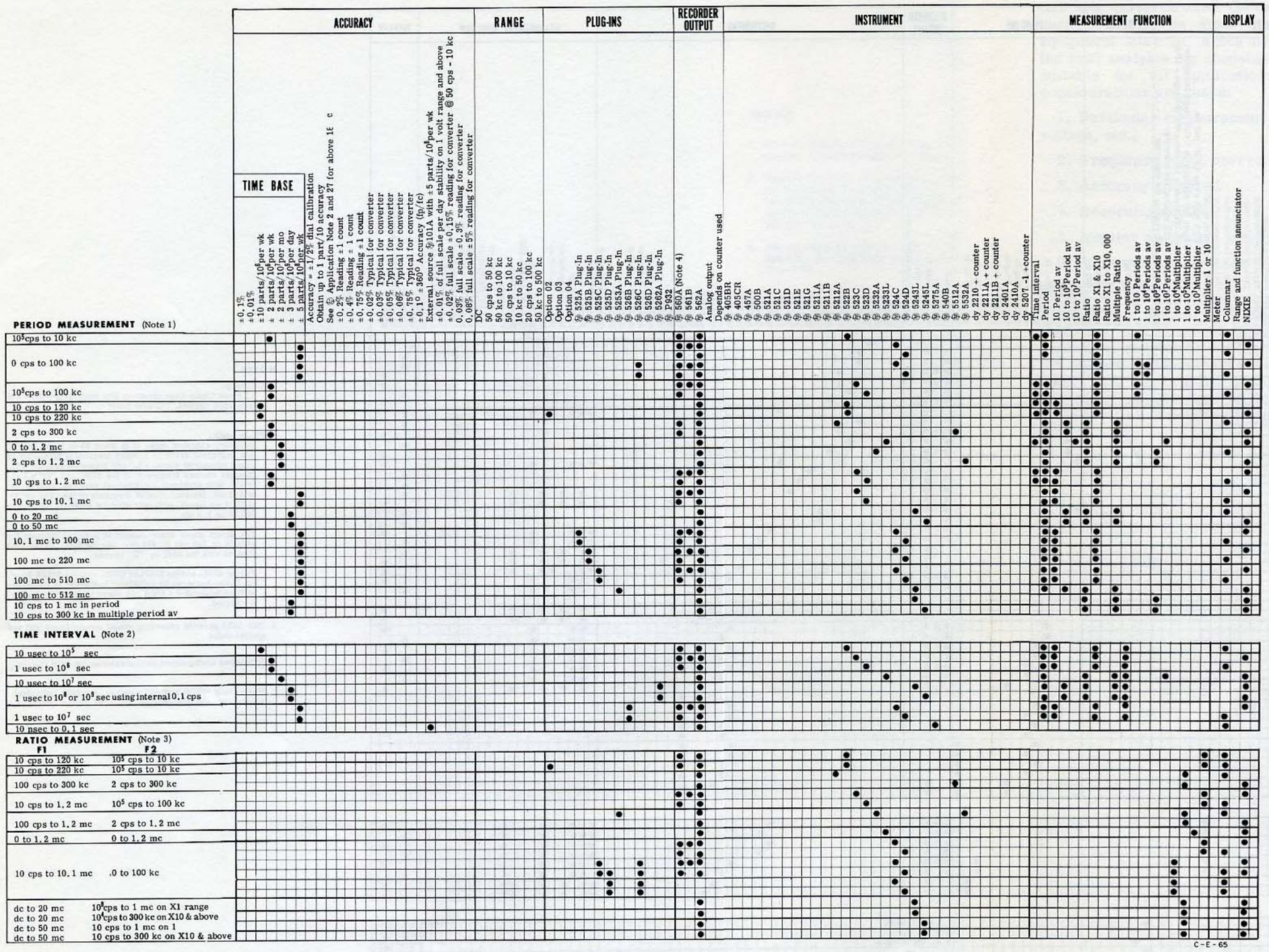
   For direct phase angle readout in tenths of degrees for signals of 396 cps to 404 cps, use the 526D Phase Unit Plug-In with the 524C or "D" counter.

   For the 5233L and the 5243L or 5245L with the 5262A Plug-in, Phase Angle can be calculated in degrees as a function of Time Interval: $\theta = t/p \times 360$ where t = time interval and p = period.

3. H25-562A permits recording actual measurement unit and special codes

4. Ⓜ 560A has analog output incorporated as standard feature.

5. When using 405CR and 457 together, combine individual accuracies and frequencies for total range coverage.



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NOTES

1. Accuracy:
   ±1 count ±time base accuracy ±trigger error /periods averaged (one count is $\frac{1}{nf_cT}$ where: n is number of periods averaged, f_c is frequency counted, T is period of signal being measured)

2. Accuracy:
   ±1 count ±time base accuracy ±trigger error

3. Accuracy:
   ±1 count of f_1 ±trigger error* of f_2 divided by number of periods averaged. One count of f_1 is $\frac{f_2}{nf_1}$ where n is number of periods averaged, f_1 is frequency applied to counting binaries (enters Time Base Ext. jack), f_2 is frequency applied to decade dividers (enters Signal Input jack)

   * Trigger error for sinewave input is ±0.3% for signals with 40 db signal-to-noise ratio.

4. ⓟ560A has analog output incorporated as standard feature.

	Digitizing Model	Number of 562A BCD or 560A Comparator Boards Required	Digitizing Model Option Number: 01 (See Note 4)	Digitizing Model Option Number: 02	Option 13 (See Note 5): One Option 30 BCD Input Connector Assembly (9 column)	Option 13 (See Note 5): One Option 31 BCD Input Connector Assembly (6 column)	Option 13 (See Note 5): Two Option 32's Input Cables (9 column) BCD or 3 10-line	Option 13 (See Note 5): Eleven Option 21's BCD Boards (+1-2-2-4 "1" State Positive)	Cable Furnished: 562A-16C	Cable Furnished: 561B-16A	Cable Furnished: 560A-16H	Additional Cable Required: 561B-16A	Additional Cable Required: 560A-16H	Analog Output 0-100 mv dc 0-1 ma dc (See Note 9)	Dual Input Couplers (See Note 6): K07-560A	Dual Input Couplers (See Note 6): K08-560A (Rack Mount)	1-6 Column Output (See Note 7)	1-11 Column Output (For 12 Column See Note 8)
562A (BCD) Operation With Companion Equipment: (Note 2)	H80-521A	4				●	1		●					●			●	
	H80-521C	5				●	1		●					●			●	
	H80-521D	4				●	1		●					●			●	
	H80-521E	5				●	1		●					●			●	
	H80-521G	5				●	1		●					●			●	
	H80-522B	5				●	1		●					●			●	
	H80-523C	6				●	1		●					●			●	
	H80-523D	6				●	1		●					●			●	
	H80-524C	8			●		1		●					●				●
	H80-524D	8			●		1		●					●				●
	5212A	5				●	1		●					●			●	
	5512A	5				●	1		●					●			●	
	5232A	6				●	1		●					●			●	
	5532A	6				●	1		●					●			●	
	5233L	6				●	1		●					●			●	
	5243L (Note 1)	10			●		1		●					●				●
	5245L (Note 1)	10			●		1		●					●				●
	5275A	7			●		1		●					●				●
	H80-405BR	5				●	1		●					●			●	
	DY 2401	8			●		1		●					●			●	
	DY 2500 (Note 2)	5												●			●	
	DY 2503 (Note 2)	5												●			●	
562A (BCD) Operation From 2 Sources		1-11			●	●	●	●						●				●
561B (10 Line) Operation With Companion Equipment:	521D			●						●							●	
	521E			●						●							●	
	523C			●						●							●	
	524C			●						●								●[A]
	405CR									●							●[B]	
561B (10 Line) Operation From 2 Sources				●						●		●						●[A,B]
560A (Staircase) Operation With Companion Equipment: (Note 3)	521A	4	●								●			●			●	
	521C	5	●								●			●			●	
	521D	4	●								●			●			●	
	521E	5	●								●			●			●	
	521G	5	●								●			●			●	
	522B	5	●								●			●			●	
	523C	6	●								●			●			●	
	523D	6	●								●			●			●	
	524C	8	●								●			●				●[A]
	524D	8	●								●			●				●[A]
	405CR	5	●								●			●			●[B]	
	DY 2500										●			●			●	
	DY 2503										●			●			●	
560A (Staircase) Operation From 2 Sources	(with Option 05)										●		2	●	●	●	●	●[A,B]

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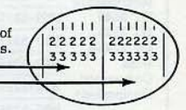
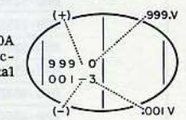
NOTES

1. 562A with Option 14 will accept 10-column information from 5243L and 5245L (8 digits, decimal and actual measurement unit). The 9-column operation omits the decimal and uses standard print wheel for measurement unit information. For 562A 12-column capacity, order H24-562A. For 561B 12-column capacity, order H12-561B.
2. (For DY2500 and DY2503) Requires Dymec option M21 and special cable furnished by Dymec.
3. ℗ Model 560A has 11 print wheels and is supplied with 6 plug-in comparators for 6-column operation unless otherwise specified. Additional comparators (℗ 560A-58) may be plugged in at any other time (℗ 560A-58A, $25.00 each).
4. To adapt ℗ Model 521A and 521C having serial numbers 3631 and below, with option 01, specify 521A-95A adapter kit.
5. Option 13 includes, in itself, four distinct options for 562A 11-column operation; and though 1-2-2-4 column boards are indicated, other coded boards may be substituted, each print wheel having its own board. Input from two unsynchronized sources is possible.
6. Dymec counters DY2500 and DY2503 must first be modified to operate into the Dual Input Couplers.
7. The 560A and 561B Digital Recorders are adapted initially for 6-column print-out. The 562A Digital Recorder print-out is dependent upon the number of plug-in BCD boards or option number specified.
8. Eleven column print-out capability is standard for all digital recorder models, but the ability of the different recorders to accept information is requisite on the number of BCD boards installed for the 562A; the number of input cables used for the 561B; the number of comparator boards installed for the 560A. (cf. Note 7)
9. Analog output is standard from the 560A and 580A or 581A; however, the 562A requires option 41 (1-2-2-4) or option 42 (1-2-4-8).

A. Eleven column print-out capability of the 561B when using 2 input cables.
J102 prints up to 5 columns
J101 prints up to 6 columns



B. Print-out format from 561B or 560A indicating voltage, polarity, and decimal positions of the 405CR Digital Voltmeter.



	Digitizing Model	Cable Furnished (562A-16C)	Additional Cable Required DYMEC Optional Accessory	Digitizing Model Option 02	Analog Output 0-100 mv dc 0-1 ma dc (See Note 3)	Romote Indicator, K05- (521D, 521E, 523C, 524C, 405) & Remote Cable K07- (Note 2) (521D, 521E, 523C, 524C, 405)
580A/581A Operation With Companion Equipment:	H80-521A	●			●	
	H80-521C	●			●	
	H80-521D	●			●	
	H80-521E	●			●	
	H80-521G	●			●	
	H80-522B	●			●	
	H80-523C	●			●	
	H80-523D	●			●	
	H80-524C	●			●	
	H80-524D	●			●	
	5212A	●			●	
	5512A	●			●	
	5232A	●			●	
	5532A	●			●	
	5233L	●			●	
	5243L	●			●	
	5245L	●			●	
	5275A	●			●	
	H80-405CR	●			●	
	DY 2401	●			●	
	DY 2500 (Note 1)		●			
	DY 2503 (Note 1)		●			
Remote Indicator Operation With Companion Equipment:	521D			●		●
	521E			●		●
	523C			●		●
	524C			●		●
	405CR					●
Operation of DYMEC Instruments DY 2540 DY 2530 DY 2545A With Companion Equipment:	H60-521A		●			
	H60-521C		●			
	H60-521D		●			
	H60-521E		●			
	H60-521G		●			
	H60-522B		●			
	H60-523C		●			
	H60-523D		●			
	H60-524C		●			
	H60-524D		●			
	H60-405BR		●			
	H60-405CR		●			
	DY 2500		●			
	DY 2503 (Special)		●			
DY 2545 DY 2540 (Special) With Companion Equipment: (See Note 4)	5212A		●			
	5512A		●			
	5232A		●			
	5532A		●			
	5233L		●			
	5243L		●			
	5245L		●			
	5275A		●			
	DY 2401		●			

NOTES

1. (For DY2500 and DY2503) Requires Dymec option M21 and special cable furnished by Dymec.
2. Remote Cable K07-524C ($135.00 + $2.25/ft) may be ordered in lieu of cable 561B-16A which otherwise is furnished with option 02. All other remote indicator cables are separately ordered: Cable 561B-16A, $100.00 (6 ft); K07 Cables are $90.00 + $2.25/ft.
3. Analog output is standard from the 560A and 580A or 581A; however, the 562A requires option 41 (1-2-2-4) or option 42 (1-2-4-8).
4. Further information about DYMEC Equipment can be obtained by writing for "Digital Systems Brochure" -Dymec, 395 Page Mill Road, Palo Alto, California.

Digitizing Model	I 560A Output (Staircase)	II 561B or Remote Readout (ten line code) See Notes 1 and 2	III 562A, 580A/581A (+1 - 2 - 2 - 4 BCD and reference voltages)	IV DY Output BCD (1 - 2 - 2 - 4) See Note 4	Multiple Outputs Installed In One Instrument			
					Combination I and II See Note 8	Combination I and III or I and IV See Note 8	Combination II and III or II and IV See Note 8	Combination of three I, II and III or I, II and IV See Note 8
521A	●		●	●		●		
521C	●		●	●		●		
521D	●	●	●	●	●	●	●	●
521E	●	●	●	●	●	●	●	●
521G	●		●	●		●		
522B	●		●	●		●		
523C	●	●	●	●	●	●	●	●
523D	●		●	●		●		
524C	●	●	●	●	●	●	●	●
524D	●		●	●		●		
5212A			●[5]	●[3]				
5512A			●[5]	●[3]				
5232A			●[5]	●[3]				
5532A			●[5]	●[3]				
5275A			●[5]	●[3]				
5233L			●[5]	●[3]				
5243L			●[5]	●[3]				
405BR			●[6]	●				
405CR	●	●[5]	●[7]	●	●	●	●	
DY2401			●[5]	●[3]				
DY2500	●[5]		●	●[5]		●		
DY2503	●[5]		●	●				

Notes: 1. One remote readout may be used at a time: limited by power supply.

2. Simultaneous use of 561B and Remote Readout is not recommended: limited by power supply.

3. Standard 562A output operates from modified DY equipment.

4. For installing both III and IV in one instrument contact Dymec: solution depends upon particular system.

5. Standard.

6. Including polarity and decimal.

7. No polarity or decimal.

8. Cost of combining options is sum of option costs, except for 523C. For the 523C combination of three outputs, add $25 to sum of option prices. Note: combination of two or more printer outputs does not necessarily permit simultaneous printing to more than one printer. More than one printer heavily loads print command signal in some cases, and it may require amplification.

Speed Measurement Table

Speed measurements may be made with great accuracy by the use of digital tachometers and electronic counters. Accuracy depends upon the resolution obtained and the counter's time base stability. Resolution, generally the most important factor, is mainly a function of the tachometer characteristics and the driving system used.

Once a suitable tachometer is selected from the table below, the output frequency range may be used to determine the counter required. Remember that the frequency ranges listed below are based on tachometer shaft speed, not the sources'. If a step-up or step-down system is involved in driving the tachometer, the speed ratio must be considered.

Range	℗ Model	Description
600-300,000 rpm	506A	Photoelectric type; requires no mechanical connection. One pulse out for each light-dark section on shaft; virtually error free.
40-40,000 rpm	508A	Magnetic type; moderate torque require. Mechanical connection necessary; essentially error free; 60 pulses per revolution; counter with 1 second gate time reads directly in rpm.
30-30,000 rpm	508B	Same as 508A except 100 pulses per revolution
40-25,000 rpm	508C	Same as 508A except 120 pulses per revolution
50-5,000 rpm	508D	Same as 508A except 360 pulses per revolution

SECTION I

DESIGN CONSIDERATIONS FOR 565A TRANSISTORIZED CONTROL CIRCUITS

Many circuit configurations may be used to control the Ⓗ Model 565A Digital Printer; however, a number of circuit considerations should be recognized when transistors are used (see figure 1):

A. 1) Although maximum brush current is one milliampere, lower current is better for more reliable, positive action; a level of 100 μa is frequently used.

2) Commutator and brush contact should have at least 6 volts between them when open.

3) Operating parameters for solenoids should not exceed 24 volts for high dependability. Ten volt solenoids are preferred. Since it is possible to damage transistors by an inductive kick when the circuit is opened, a diode clamping circuit is recommended for limiting any voltage surge to about four times the solenoid voltage. Lower surge voltages than this delay the pawl from locking the print wheel, because decay time of the magnetic field is increased. Driving transistors, therefore, should have a collector voltage rating in excess of four times solenoid voltage.

4) Biasing circuits for driving transistors should reduce solenoid current as close to zero as possible since residual currents also will retard pawl lock-in.

5) Many transistor types may be used as amplifiers or for driving solenoids, but one that is used successfully for driving 10 volt solenoids is the 2N1183B.

B. 1) A clamping diode returned to a minus four times coil voltage can be used to protect the driving transistor from high voltage spikes without increasing drop-out time above the required 3 to 4 milliseconds; for a 10 volt pawl magnet, the diode is returned to a -35 volt supply. This allows a reverse voltage amplitude swing of about 45 volts when the +10 volt energizing voltage is removed.

2) The solenoid should not be loaded with additional circuitry in an attempt to reduce the inductive kick since this increases the time required to dissipate the stored energy, and, consequently, the wheel's lock-in time.

C. 1) Paliney brushes are recommended for reducing brush noise that is contributed to the circuit when low voltages are used, as in transistor circuits, since noise will sometimes cause spurious pawl action: All Ⓗ Model 565A Printer Mechanism are supplied with Paliney brushes.

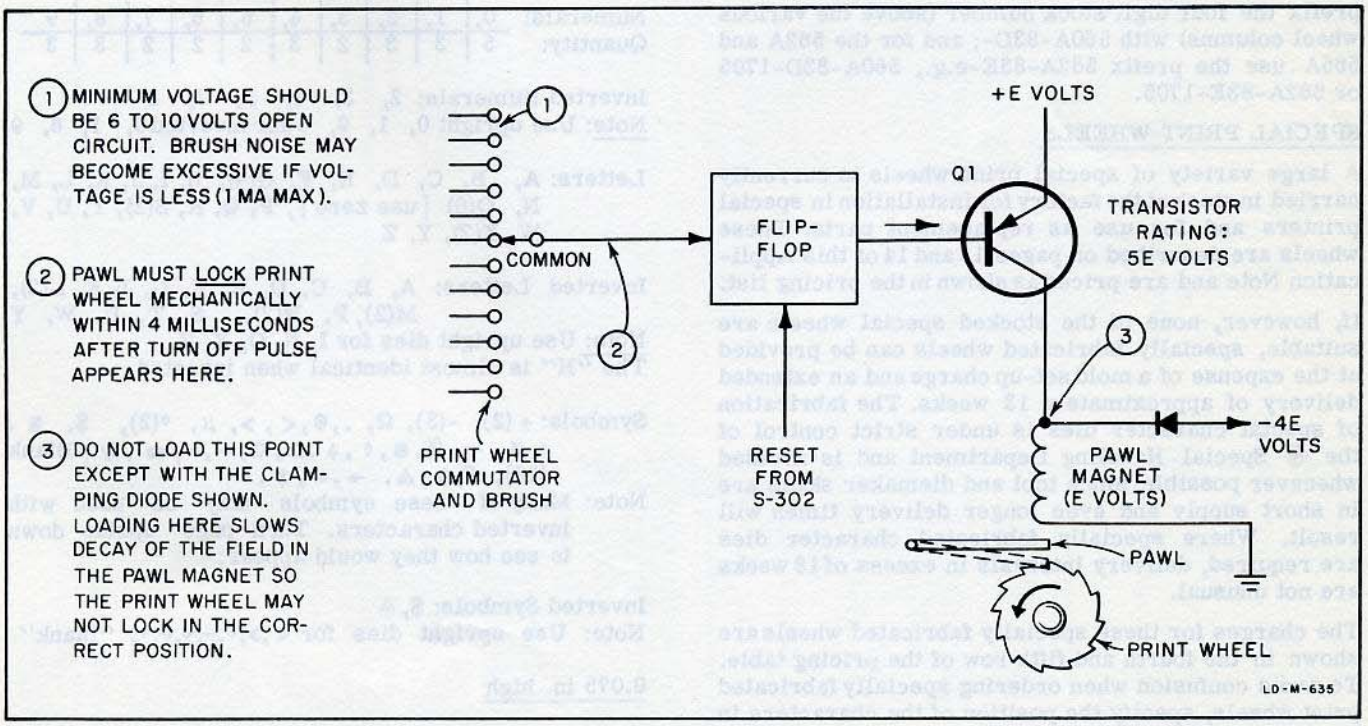


Figure 1. Representative Ⓗ 565A Printer Circuitry

SECTION II

PRINT WHEELS

STANDARD PRINT WHEELS

Each standard printer mechanism comes equipped with 11 STANDARD print wheels, which are also available as replacement parts. Every wheel has the capacity for 12 characters (positions), and in the case of the STANDARD wheel is as follows, with an alternate format in the second column:

1	stock no. — For 560A or 561B: 560A-95T For 562A or 565A: 562A-95B	1	stock no. — For 560A or 561B: 560A-95P For 562A or 565A: 562A-95P
3		3	
5		5	
7		7	
9		9	
-		*	
8		8	
6		6	
4		4	
2		2	
0		0	

ORDERING PRINT WHEELS

Two separate stock numbers are assigned to all print-wheel formats. Physically the wheels are the same, but those ordered for the 562A Digital Recorder and 565A Printer Mechanism have low noise brushes for working with solid-state circuits (see Section I, C-1); and though the low noise assemblies may be used in the 560A and 561B Digital Recorders, the converse is not true. Consequently, all the SPECIAL print-wheel stock numbers on page 12 will have two prefixes: For 560A and 561B SPECIAL print-wheels, prefix the four digit stock number (above the various wheel columns) with 560A-83D-; and for the 562A and 565A use the prefix 562A-83E-e.g., 560A-83D-1705 or 562A-83E-1705.

SPECIAL PRINT WHEELS

A large variety of special print wheels is currently carried in stock at the factory for installation in special printers and for use as replacement parts. These wheels are described on pages 13 and 14 of this Application Note and are priced as shown in the pricing list.

If, however, none of the stocked special wheels are suitable, specially fabricated wheels can be provided at the expense of a mold set-up charge and an extended delivery of approximately 13 weeks. The fabrication of special character dies is under strict control of the hp Special Handling Department and is avoided whenever possible, since tool and diemaker skills are in short supply and even longer delivery times will result. Where specially fabricated character dies are required, delivery intervals in excess of 18 weeks are not unusual.

The charges for these specially fabricated wheels are shown in the fourth and fifth row of the pricing table. To avoid confusion when ordering specially fabricated print wheels, specify the position of the characters in relation to the position of the characters in the standard 560A-95T print wheel (as shown above).

CHARACTER DIES

One character die is required for each of the twelve positions on a print wheel. Hence, if a print wheel repeats a character, more than one die for that character is required, and if additional dies must be made, the standard die charges apply.

Another general consideration to keep in mind is that a die cannot be inverted; a die intended to print upright characters (right reading viewed from the front of the printer) cannot be inverted (turned upside down). There are, however, some dies which can be used for printing either upright or inverted characters. For instance, the letter "0" can be used to print either way because it is the same whether printed with upright or inverted characters. Other dies can also be used for printing either upright or inverted characters even though their meaning changes. For instance, the upright character ">" (greater than) becomes "<" (less than) when used with inverted characters.

AVAILABLE CHARACTER DIES

Numerals in parentheses indicate the number of dies for a character, if there is more than one die.

SINGLE CHARACTERS

3/32 in. high

Numerals:	0,	1,	2,	3,	4,	5,	6,	7,	8,	9
Quantity:	5	3	3	2	3	2	2	2	3	3

Inverted Numerals: 2, 3, 4, 5, 7, 8
Note: Use upright 0, 1, 9, 6 for inverted 0, 1, 6, 9

Letters: A, B, C, D, E, F, G(4), H, I, J, K, L, M, N, O(6) [use zero], P, Q, R, S(2), T, U, V, W, X(2), Y, Z

Inverted Letters: A, B, C, D, E, F, G, J, K, L(2), M(2), P, R(2), S, T, U, W, Y
Note: Use upright dies for I, N, O, X, Z
The "H" is almost identical when inverted.

Symbols: + (2), -(3), Ω, ., ∅, <, >, μ, *(2), $, ▣, :, ∅, =, %, ■, ↑, ↓, Δ, ∇, ~, ↶, ■, ✓, Blank (14), ?, ∅, ⏃, →, ←, ↕.
Note: Many of these symbols may be used with inverted characters. Turn page upside down to see how they would appear.

Inverted Symbols: $, Δ
Note: Use upright dies for <, >, +, -, ~, ↶, *, "blank".

0.075 in. high

Numerals: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, -(2)
Letters: G, M, O(4), a, f(2), h, i, m, n, p, r, t, u

DOUBLE CHARACTERS

3/32 in. high: NN, ΔN, +N, ~N, -N, 1/, 2/, "blank" 1, "blank-blank," Mc, Kc, ms, sec, μs, ns

0.075 in. high: ΔG, GG, LI, ~G, +G, -G

Note: Double letters on a print wheel use up the entire width of a wheel including the portion of the wheel which is normally used to control the wheel's position. Hence, a double-letter print wheel can be controlled only by pinning it to an adjacent single-character wheel (see illustration). Thus, when you use a double-letter print wheel, you can obtain up to three characters in a two-column space, but must give up one independently controlled column.

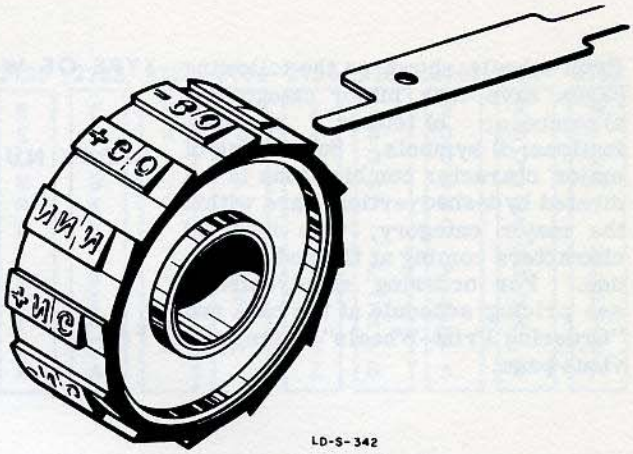


Figure 2. Double-Character Print Wheel (on left) Pinned to Single-Character Wheel

Print-wheels shown on the following pages have four major categories: a) numbers; b) letters; c) combinations; d) symbols. Sub-listing of major character combinations is indicated by dashed vertical bars within the major category, with inverted characters coming at the end of each one. For ordering requirements, see pricing schedule at the back and "Ordering Print-Wheels" on the previous page.

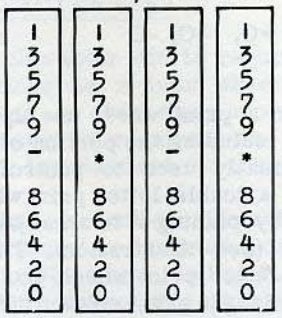
TYPE OF WHEEL

STOCK NUMBER

FACE

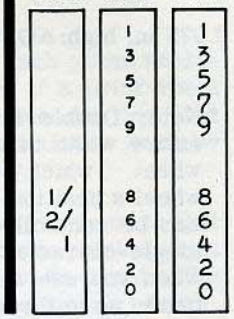
STANDARD WHEELS

560 & 561		562 & 565	
560A -95T	560A -95P	562A -95B	562A -95P



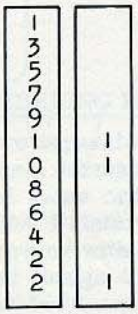
SECTION A NUMERICAL

2718 2730 2749

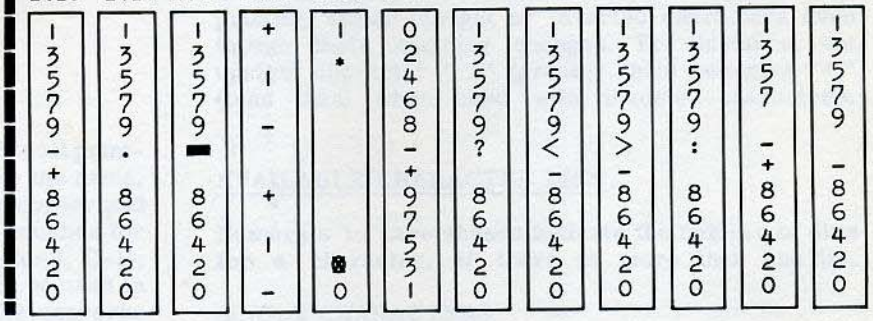


NUMBERS PLUS SYMBOLS

2753 2754

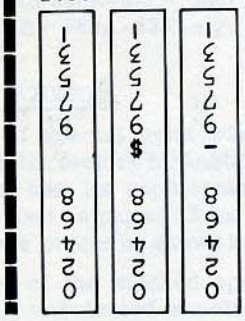


1713 1714 1746 1756 1787 1788 1792 2759 2760 2761 2776 2782



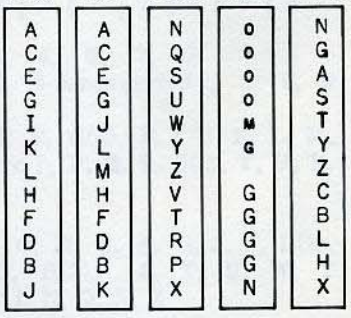
INVERTED

1708 1773 1791

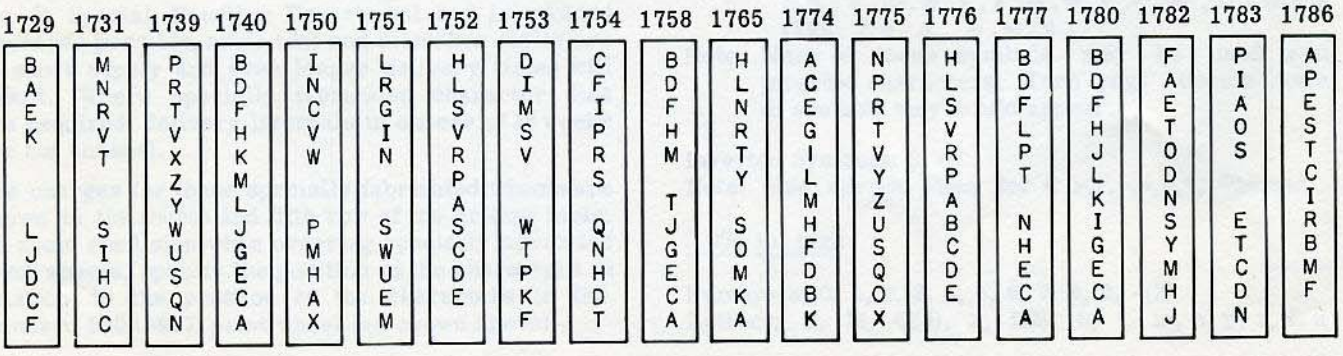


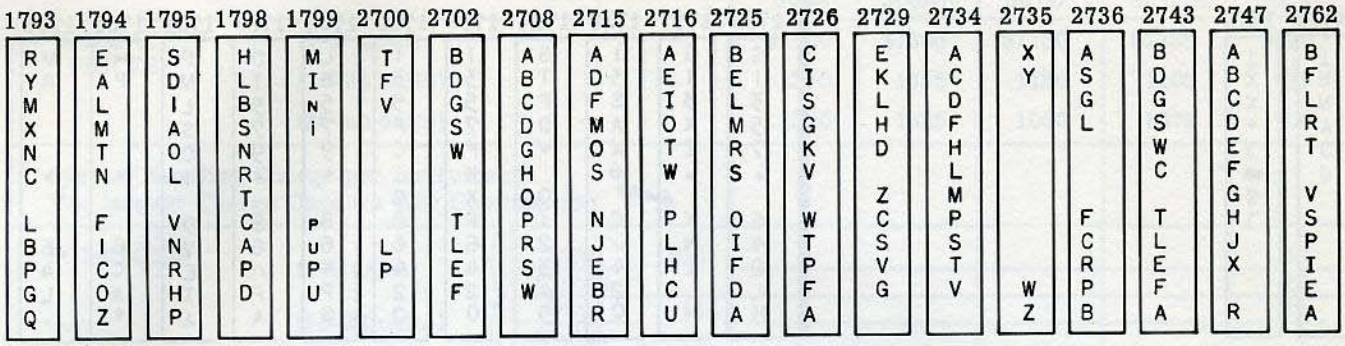
SECTION B LETTERS

1707 1718 1719 1722 1726

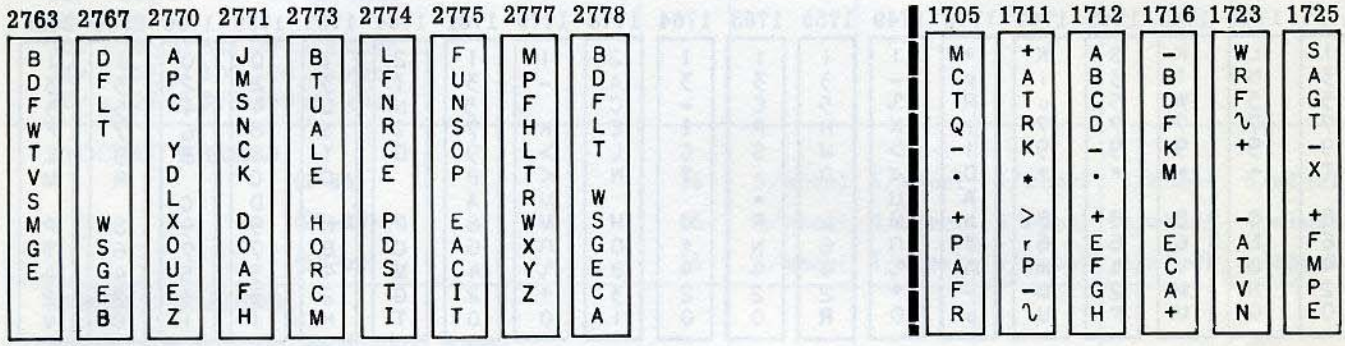


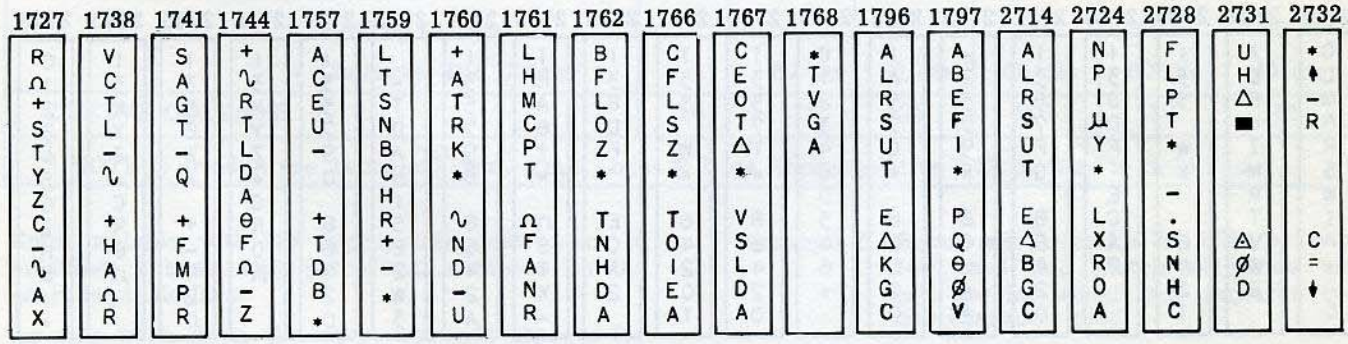
1729 1731 1739 1740 1750 1751 1752 1753 1754 1758 1765 1774 1775 1776 1777 1780 1782 1783 1786



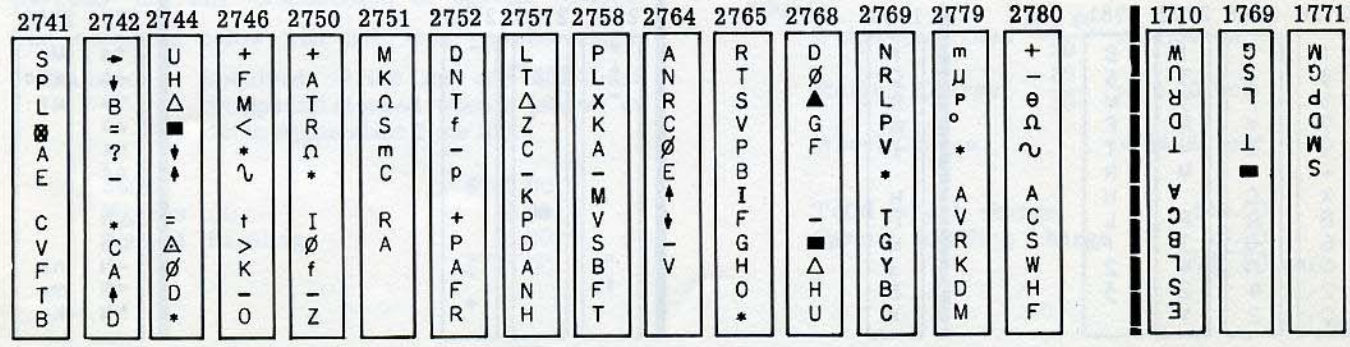


LETTERS PLUS SYMBOLS





INVERTED



SECTION C COMBINATIONS

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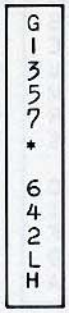

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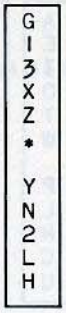

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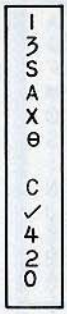

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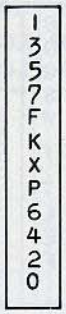

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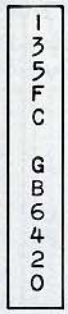

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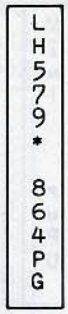

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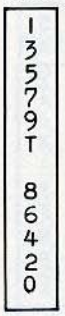

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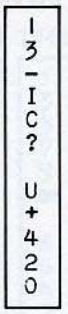

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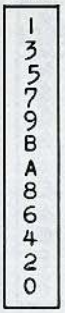

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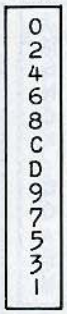

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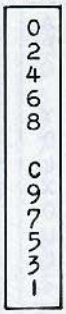

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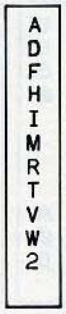

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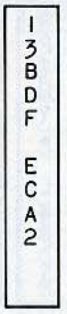

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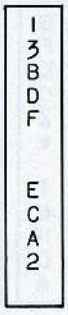

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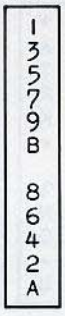

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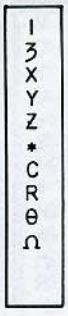

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INVERTED

1709

SECTION D SYMBOLS

2701

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DOUBLE WHEELS

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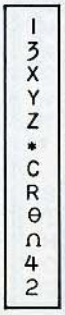

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PRICING SCHEDULE

				560A	560AR	561B	561BR	565A
BASIC UNIT PRICES*	(1-9 units)			$1400	$1385	$1150	$1135	$750
	(10-24 units)			1370	1355	1120	1105	725
	(25-up units)			1340	1325	1090	1075	700
Special Handling Charge per Instrument Use largest Charge Once for Any Combination								
SOLENOIDS	(1-9 units)	Pawl	$15					20
		Clutch						12
	(10-24 units)	Pawl	15					15
		Clutch						9
	(25-up)	Pawl	15					10
		Clutch						6
Pawls: 10v ±10% at 100-110 ma each; 24v ±10% at 50- 65 ma each; 30v ±10% at 45- 55 ma each. Clutches: 10v ±10% at 695-850 ma each; 24v ±10% at 300-370 ma each; 30v ±10% at 375-460 ma each								
STOCKED WHEELS	(1-24)		15	5/wheel	5/wheel	5/wheel	5/wheel	5/wheel
	(25-49)		15	4/wheel	4/wheel	4/wheel	4/wheel	4/wheel
	(50-up)		15	3/wheel	3/wheel	3/wheel	3/wheel	3/wheel
SPECIAL MOLDING Characters in Stock Use Stocked Wheel Price Above + Molding Charge				60	60	60	60	60
SPECIAL MOLDING AND DIES Use Stocked Wheel Price Above								
	+ Molding Charge			60	60	60	60	60
	+ Character Die Charge			60/die	60/die	60/die	60/die	60/die
TWELVE COLUMNS			10	175	175	130	130	105

* NOTE: For 562A see Technical Data. Your Local hp Sales Representative Will be Glad to Help You.

Enter a table with the appropriate instrument to establish a basic unit price. All numbers on the chart imply dollars.

As you work down the chart you add charges for various special options to this basic price, including a special handling charge.

You should add in only one special handling charge (largest) for any combination of special options.

The examples below will help you use the chart:

Example I. Required: Price for one 565A and two special stocked wheels (shown on list in Application Note 32).

565A	$750.00
Wheels (2)	10.00
Special handling	15.00
	$775.00

Example II. Required: Price for 30 565A's with 24v pawl and clutch solenoids and one special wheel that requires two new character dies.

565A (Quantity of 30)	$700.00 each
24V Pawl Solenoids	10.00 each
24V Clutch Solenoids	6.00 each

Wheels:

2 character Dies $\frac{2 \times 60}{30}$ = $4.00/unit

Molding Charge $\frac{60}{30}$ = $2.00/unit

Wheel Charge = $4.00/unit

Total wheel charge	$10.00
Special handling charge	15.00
	$741.00 each