

## The Big Letters Program (Part 1)

Copies a message on an EDSAC tape into memory a line at a time and then prints each line in big letters on the teleprinter. All lines are terminated by a line-feed except for the final line which is terminated by a blank tape character. The big letters are 5 rows high and vary in width. All characters on the teleprinter may be used (including letter shift and figure shift) except for carriage returns which are ignored. The output of the message “#G\*!HELLO!THERE!#G&” is given below.

### *Example Output:*

```
+-----+
:   BIG LETTERS   :
:       BY       :
: MARTIN J. SLUCUTT :
+-----+
```

YOUR MESSAGE WILL FOLLOW SHORTLY...  
LOADING, PLEASE WAIT...

```
# #      H H EEEEE L L      OOO      TTTT H H EEEEE RRRR EEEEE      # #
##### H H E L L      O O      T H H E R R E      #####
# #      HHHH EEE L L      O O      T HHHH EEE RRRR EEE      # #
##### H H E L L      O O      T H H E R R E      #####
# #      H H EEEEE LLLL LLLL OOO      T H H EEEEE R R EEEEE      # #
```

### *Make-up of the Program Tape:*

space P K

T56K

M3

```
@&#!!!!!!!!ZAAAAAAAAAAAAAAAAAAAAAZ*
@&#!!!!!!!!C*!!!!BIG!LETTERS!!!!#C*
@&#!!!!!!!!C*!!!!!!!!BY!!!!!!!!#C*
@&#!!!!!!!!C*!MARTIN!J#M*!SLUCUTT!#C*
@&#!!!!!!!!ZAAAAAAAAAAAAAAAAAAAAAZ*
@&
@&*YOUR!MESSAGE!WILL!FOLLOW!SHORTLY#MMM*
@&*LOADING#N*!PLEASE!WAIT#MMM*
@&
@&
```

space P Z

T56K

Master

E137K P F

The master routine is made-up of the following parts:

Section of Master Routine	Location
Subroutine MS1 prints a single row of a big letter. The location of the letter in memory is given as a parameter in location 4F	0
Subroutine MS2 reads characters on an EDSAC tape into the memory location specified by the C parameter upwards, stopping when a line-feed or blank tape character is read	490
Main routine	810
Variables	M
Constants	$\Delta$
Big letter widths and bit patterns	V

Notes:

- The program needs to test for the equality of two memory locations and this could not be avoided. The following routine was developed to test the equality of 2M and 6M, for example:

63	.	..	.	
64	.	..	.	
65	T		F	Clear accumulator (if required)
66	A	2	M	] Calculate difference between two values
67	S	6	M	
68	G	80	0	Branch if negative (not equal)
69	S		$\Delta$	Subtract 1 (stored in location $\Delta$ )
70	E	80	0	Branch if positive (not equal)
71	T		F	Two values are equal (Acc. was 0 at 68 and -1 at 70)
72	.	..	.	] Routine if equal
..	.	..	.	
..	.	..	.	
80	.	..	.	] Routine if not equal
81	.	..	.	

- With the output of the teleprinter as shown below for the message "HELLO&", the variables would be as follows:

```

H      H      EEEEE  L          L          OOO
H      H      E          L          L          O  O
HHH ← Teleprinter position

```

M = -3	Row count: initially = -5, finally = 0.
1M = HF	Output character (H).
2M = $\phi$ F	Space character.
3M = -4	Width count: initially = -7, finally = 0. (Initially = negative width of big letter including gap afterwards).
4M = &89F (1100...)	Remaining bit pattern: initially = 01111100....
5M = 5	Input character count (number of characters in the current line).
6M = 24	Last input character (value of line-feed in this example).
7M = 1	Output character count (The first character is being printed on the row).
8M = 0	= 0 for letter shift, = 1 for figure shift.

The Big Letters Program (Part 2)

*The Master Tape:*

	G	K		
	T	47 K	]	Set M parameter
	P	138 0	]	
	P	147 0		Set Δ parameter
	T	54 K	]	Set C parameter
	P	460 0	]	
	P	160 0		Set V parameter
	T	Z		
98 → 0	A	3 F	]	Plant link
1	T	48 0	]	
2	A	4 F	]	(Get parameter, p from 4F)
3	A	2 Δ	]	Form A p F to get output character
4	T	5 0	]	
5	(A	C)		Becomes A p F/D
6	U	1 M	]	Form S w F to get character width, where
7	L	2 F		$w = ((\text{character value} * 8) + V + \text{status})$
8	A	8 M		(Adjust if figure shift)
9	L	D		(Shift left for address)
10	A	55 F		
11	A	3 Δ		
12	T	13 0	]	
13	(S	V)		Becomes S w F
14	E	48 0		Jump to 48 - Character width is 0
15	T	3 M		Set width counter
16	A	1 M	]	
17	L	2 F		Form A b F/D to get bit pattern, where
18	A	M		$b = ((\text{character value} * 8) + \text{row count} + 7)$
19	A	7 Δ		
20	L	D		(Shift left for address)
21	A	55 F		
22	A	2 Δ		
23	T	24 0	]	
24	(A	V)		Becomes A b F/D
25	T	4 M		Set bit pattern
26	S	8 M		Get status
27	E	32 0		Jump to 32 - In letter shift mode
28	T	F	]	
29	A	4 M		In figure shift mode so shift bit pattern 8 bits
30	L	64 F		
31	T	4 M	]	
27 → 32	A	1 M	]	Shift output character for printing
33	L	1024 F	]	
34	T	1 M	]	
47 → 35	T	F	]	
36	A	4 M		Left shift line code by 1 bit
37	L	D		
38	U	4 M	]	
39	G	42 0		Jump to 42 - Bit pattern is 1...
40	O	2 M		Space (Bit pattern is 0...) (d)
41	E	43 0		Jump to 43
39 → 42	O	1 M		Output character
41 → 43	T	F	]	
44	A	3 M	]	Increment width counter

	45	A	Δ					
	46	U	3 M					
	47	G	35 θ	Repeat to output remaining character row				(d)
14 →	48	(E	F)					
<hr/>								
86 →	49	A	3 F	Plant link				
	50	T	80 θ					
	51	T	5 M	Set input character count to zero				
79 →	52	A	5 M					
	53	L	D	(Left shift for address)				
	54	A	54 F	Form T i F/D to transfer input character,				
	55	A	1 Δ	where i = (C + input character count)				
	56	T	75 θ					
	57	I	6 M	Read character from tape				
	58	A	6 M	Check if input character is a blank tape				
	59	S	4 Δ	character				
	60	G	65 θ	(Jump to 65 - No blank tape)				
	61	S	Δ					
	62	E	65 θ	(Jump to 65 - No blank tape)				
	63	T	F	(Input character is a blank tape character)				
	64	E	80 θ	Jump to 80				
<hr/>								
60,62 →	65	T	F					(e)
	66	A	6 M	Check if input character is a line-feed				
	67	S	5 Δ					
	68	G	73 θ	(Jump to 73 - No line-feed)				
	69	S	Δ					
	70	E	73 θ	(Jump to 73 - No line-feed)				
	71	T	F	(Input character is a line-feed)				
	72	E	80 θ					
<hr/>								
68,70 →	73	T	F	Set (C + input character count) to input				
	74	A	6 M	character				
	75	(T	C)	(Becomes T i F/D)				
	76	A	5 M					
	77	A	Δ	Increment input character count				
	78	T	5 M					
	79	E	52 θ	Repeat to read next character on tape				
<hr/>								
64,72 →	80	(E	F)					
<hr/>								
Enter →	81	X	F	No order <sup>1</sup>				
134,								
136 →	82	T	F					
	83	S	6 Δ	Set row count to -5				
	84	T	M					
	85	A	85 θ	Read line from tape				
	86	G	49 θ	using subroutine MS2				
<hr/>								
MS2,								
129 →	87	T	F	Set output character count to 0				
	88	T	7 M					
123 →	89	A	7 M	Calculate number bit patterns				(c)
	90	S	5 M	remaining to output on current row				
	91	E	124 θ	Jump to 124 - None remaining				(b)
	92	T	F	Calculate location of next				
	93	A	7 M	output character				(a)
	94	L	D	(Shift left for address)				
	95	A	54 F					
	96	T	4 F	Set 4F as parameter for MS1				

	97	A	97	θ	] Print row of character using subroutine MS1			
	98	G		θ				
MS1 →	99	T		F	] Check if output character is a figure shift (Jump to 110 - No figure shift) (Jump to 110 - No figure shift) (Output character is a figure shift) Set status to 1 Figure shift Jump to 119			
	100	A	1	M				
	101	S	9	Δ				
	102	G	110	θ				
	103	S		Δ				
	104	E	110	θ				
	105	T		F				
	106	A		Δ				
	107	T	8	M				
	108	O	11	Δ				
	109	E	119	θ		(a)		
102,								
104 →	110	T		F	] Check if output character is a letter shift (Jump to 119 - No letter shift) (Jump to 119 - No letter shift) (Output character is a letter shift) Set status to 0 Letter shift			
	111	A	1	M				
	112	S	J	Δ				
	113	G	119	θ				
	114	S		Δ				
	115	E	119	θ				
	116	T		F				
	117	T	8	M				
	118	O	12	Δ			(c)	
109,113								
115 →	119	T		F	] Increment output character count Repeat output bit pattern cycle			
	120	A	7	M				
	121	A		Δ				
	122	T	7	M				
	123	E	89	θ				
91 →	124	O	8	Δ	Line-feed			
	125	T		F	] Increment row counter			
	126	A		M				
	127	A		Δ				
	128	U		M				
	129	G	87	θ	Repeat output row cycle			
	130	O	8	Δ	Line-feed			
	131	X		F	No order <sup>2</sup>			
	132	A	6	M	] Check if last input character is a blank tape character (Repeat main routine - no blank tape) (Repeat main routine - no blank tape)			
	133	S	4	Δ				
	134	G	82	θ				
	135	S		Δ				
	136	E	82	θ				
	137	Z		F	Stop			
M 0		P		F	Row count			
	1	P		F	Output character			
	2	φ		F	Space			
	3	P		F	Width count			
	4	P		F	Bit pattern			
	5	P		F	Input character count			
	6	P		F	Last input character			
	7	P		F	Output character count			
	8	P		F	= 0 (= 0 for letter shift, = 1 for figure shift)			
Δ 0		P		D	= 1			
	1	T		F	Transfer order			
	2	A		F	Add order			

3	S	F	Subtract order
4	P	8 F	= 16 (Value of blank tape)
5	P	12 F	= 24 (Value of line-feed)
6	P	2 D	= 5
7	P	3 D	= 7
8	Δ	F	Line-feed
9	P	5 D	= 11 (Value of figure shift)
10	P	7 D	= 15 (Value of letter shift)
11	π	F	Figure shift
12	*	F	Letter shift
V 0	P	3 D	= 7 (Width of P)
1	P	3 D	= 7 (Width of 0)
2	*	56 F	( 1111 111 )
3	I	1100 F	( 1 1 1 11 )
4	*	84 F	( 1111 1 1 1 )
5	I	100 F	( 1 11 1 )
6	I	56 F	( 1 111 )
7	P	F	
8	P	3 D	= 7 (Width of Q)
9	P	2 F	= 4 (Width of 1)
10	U	32 F	( 111 1 )
11	I	1120 F	( 1 1 11 )
12	J	1056 F	( 1 1 1 1 )
13	O	32 F	( 1 1 1 )
14	Y	1056 F	( 11 1 1 )
15	P	F	
16	P	3 D	= 7 (Width of W)
17	P	3 D	= 7 (Width of 2)
18	I	1080 F	( 1 1 111 )
19	I	1092 F	( 1 1 1 1 )
20	J	1048 F	( 1 1 1 11 )
21	J	1056 F	( 1 1 1 1 )
22	T	124 F	( 1 1 11111 )
23	P	F	
24	P	3 D	= 7 (Width of E)
25	P	3 D	= 7 (Width of 3)
26	*	1080 F	( 11111 111 )
27	I	68 F	( 1 1 1 )
28	K	24 F	( 111 11 )
29	I	68 F	( 1 1 1 )
30	*	1080 F	( 11111 111 )
31	P	F	
32	P	3 D	= 7 (Width of R)
33	P	3 D	= 7 (Width of 4)
34	*	24 F	( 1111 11 )
35	I	1064 F	( 1 1 1 1 )
36	*	124 F	( 1111 11111 )
37	O	8 F	( 1 1 1 )
38	I	1032 F	( 1 1 1 )
39	P	F	
40	P	3 D	= 7 (Width of T)
41	P	3 D	= 7 (Width of 5)
42	*	1148 F	( 11111 11111 )
43	W	64 F	( 1 1 )
44	W	120 F	( 1 1111 )
45	W	4 F	( 1 1 )
46	W	120 F	( 1 1111 )
47	P	F	

48	P	3 D	= 7 (Width of Y)
49	P	3 D	= 7 (Width of 6)
50	I	1084 F	( 1 1 1111 )
51	T	64 F	( 1 1 1 )
52	W	120 F	( 1 1111 )
53	W	68 F	( 1 1 1 )
54	W	56 F	( 1 111 )
55	P	F	
56	P	3 D	= 7 (Width of U)
57	P	3 D	= 7 (Width of 7)
58	I	1148 F	( 1 1 11111 )
59	I	1028 F	( 1 1 1 )
60	I	1032 F	( 1 1 1 )
61	I	1040 F	( 1 1 1 )
62	U	32 F	( 111 1 )
63	P	F	
64	P	1 D	= 3 (Width of I)
65	P	3 D	= 7 (Width of 8)
66	I	56 F	( 1 111 )
67	I	68 F	( 1 1 1 )
68	I	56 F	( 1 111 )
69	I	68 F	( 1 1 1 )
70	I	56 F	( 1 111 )
71	P	F	
72	P	3 D	= 7 (Width of O)
73	P	3 D	= 7 (Width of 9)
74	U	56 F	( 111 111 )
75	I	1092 F	( 1 1 1 1 )
76	I	1084 F	( 1 1 1111 )
77	I	1028 F	( 1 1 1 )
78	U	120 F	( 111 1111 )
79	P	F	
80	P	3 D	= 7 (Width of J)
81	P	F	= 0 (No character)
82	*	1024 F	( 11111 )
83	W	F	( 1 )
84	W	F	( 1 )
85	J	F	( 1 1 )
86	R	F	( 1 )
87	P	F	
88	P	F	= 0 (Figure shift)
89	P	F	= 0 (Figure shift)
90	P	F	( )
91	P	F	( )
92	P	F	( )
93	P	F	( )
94	P	F	( )
95	P	F	
96	P	3 D	= 7 (Width of S)
97	P	2 D	= 5 (Width of ")
98	U	1104 F	( 1111 1 1 )
99	I	80 F	( 1 1 1 )
100	U	F	( 111 )
101	P	1024 F	( 1 )
102	*	F	( 1111 )
103	P	F	

104	P	3 D	= 7 (Width of Z)
105	P	3 D	= 7 (Width of +)
106	*	1024 F	( 11111 )
107	Q	16 F	( 1 1 )
108	W	124 F	( 1 1111 )
109	R	16 F	( 1 1 )
110	*	1024 F	( 11111 )
111	P	F	
112	P	3 D	= 7 (Width of K)
113	P	2 F	= 4 (Width of '(')
114	I	1056 F	( 1 1 1 )
115	$\pi$	64 F	( 1 11 1 )
116	S	64 F	( 11 1 )
117	$\pi$	64 F	( 1 11 1 )
118	I	1056 F	( 1 1 1 )
119	P	F	
120	P	F	= 0 (Letter shift)
121	P	F	= 0 (Letter shift)
122	P	F	( )
123	P	F	( )
124	P	F	( )
125	P	F	( )
126	P	F	( )
127	P	F	
128	P	F	= 0 (Blank tape)
129	P	F	= 0 (Blank tape)
130	P	F	( )
131	P	F	( )
132	P	F	( )
133	P	F	( )
134	P	F	( )
135	P	F	
136	P	3 D	= 7 (Width of F)
137	P	3 D	= 7 (Width of \$)
138	*	1084 F	( 11111 1111 )
139	I	80 F	( 1 1 1 )
140	K	56 F	( 111 111 )
141	I	20 F	( 1 1 1 )
142	I	120 F	( 1 111 )
143	P	F	
144	P	F	= 0 (Carriage return)
145	P	F	= 0 (Carriage return)
146	P	F	( )
147	P	F	( )
148	P	F	( )
149	P	F	( )
150	P	F	( )
151	P	F	
152	P	3 D	= 7 (Width of D)
153	P	2 D	= 5 (Width of ;)
154	*	F	( 1111 )
155	I	1072 F	( 1 1 11 )
156	I	1024 F	( 1 1 )
157	I	1072 F	( 1 1 11 )
158	*	96 F	( 1111 11 )
159	P	F	
160	P	2 F	= 5 (Width of space)



161	P	2	F	= 5 (Width of space)
162	P		F	( )
163	P		F	( )
164	P		F	( )
165	P		F	( )
166	P		F	( )
167	P		F	( )
168	P	3	D	= 7 (Width of H)
169	P	3	D	= 7 (Width of £)
170	I	1052	F	( 1 1 111 )
171	I	1056	F	( 1 1 1 )
172	*	1144	F	( 11111 1111 )
173	I	1056	F	( 1 1 1 )
174	I	1148	F	( 1 1 11111 )
175	P		F	( )
176	P	3	D	= 7 (Width of N)
177	P	2	D	= 5 (Width of ,)
178	I	1024	F	( 1 1 )
179	S	1024	F	( 11 1 )
180	J	1024	F	( 1 1 1 )
181	O	1072	F	( 1 11 11 )
182	I	1120	F	( 1 1 11 )
183	P		F	( )
184	P	3	D	= 7 (Width of M)
185	P	2	F	= 4 (Width of .)
186	I	1024	F	( 1 1 )
187	Z	1024	F	( 11 11 )
188	J	1024	F	( 1 1 1 )
189	I	1120	F	( 1 1 11 )
190	I	1120	F	( 1 1 11 )
191	P		F	( )
192	P		F	= 0 (Line-feed)
193	P		F	= 0 (Line-feed)
194	P		F	( )
195	P		F	( )
196	P		F	( )
197	P		F	( )
198	P		F	( )
199	P		F	( )
200	P	3	D	= 7 (Width of L)
201	P	2	F	= 4 (Width of ``'')
202	I	64	F	( 1 1 )
203	I	32	F	( 1 1 )
204	I	32	F	( 1 1 )
205	I	32	F	( 1 1 )
206	*	1088	F	( 11111 1 )
207	P		F	( )
208	P	3	D	= 7 (Width of X)
209	P	3	D	= 7 (Width of /)
210	I	1028	F	( 1 1 1 )
211	T	8	F	( 1 1 1 )
212	W	16	F	( 1 1 )
213	T	32	F	( 1 1 1 )
214	I	1088	F	( 1 1 1 )
215	P		F	( )
216	P	4	F	= 8 (Width of G)
217	P	4	F	= 8 (Width of #)

```

218  U 1060 F ( 1111 1 1 )
219  I 126 F ( 1 111111 )
220  I 1572 F ( 1 11 1 1 )
221  I 638 F ( 1 1 111111 )
222  U 1060 F ( 1111 1 1 )
223  P F

224  P 3 D = 7 (Width of A)
225  P 3 D = 7 (Width of -)
226  U F ( 111 )
227  I 1024 F ( 1 1 )
228  * 1148 F ( 11111 11111 )
229  I 1024 F ( 1 1 )
230  I 1024 F ( 1 1 )
231  P F

232  P 3 D = 7 (Width of B)
233  P 3 D = 7 (Width of ?)
234  * 56 F ( 1111 111 )
235  I 1092 F ( 1 1 1 1 )
236  * 8 F ( 1111 1 )
237  I 1024 F ( 1 1 )
238  * 16 F ( 1111 1 )
239  P F

240  P 3 F = 6 (Width of C)
241  P 2 F = 4 (Width of :)
242  U F ( 111 )
243  I 96 F ( 1 11 )
244  I F ( 1 )
245  I 96 F ( 1 11 )
246  U F ( 111 )
247  P F

248  P 3 D = 7 (Width of V)
249  P 3 D = 7 (Width of =)
250  I 1024 F ( 1 1 )
251  I 1148 F ( 1 1 11111 )
252  I 1024 F ( 1 1 )
253  T 124 F ( 1 1 11111 )
254  W F ( 1 )
255  P F

256  E 137 K ] Enter at location 810
257  P F

```

- a) Cycle to print a row of a character.
- b) Cycle to print an entire row.
- c) Cycle to print a line of the message.
- d) Cycle to output each individual letter/space of a row of character.
- e) Cycle to input a line of the message.

*Notes:*

- 1) Change to Z F to stop at beginning of the program and step through to check program.
- 2) Used for inserting Z F to check program during development.