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# DATACON, THE AGS COMPUTER CONTROL SYSTEM

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May 1980

Collider Accelerator Department  
**Brookhaven National Laboratory**

**U.S. Department of Energy**

USDOE Office of Science (SC)

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AGS DIVISION TECHNICAL NOTE

No. 164

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Datacon is the system by which AGS equipment may be interfaced to our computers, and which enables extension of data gathering and control capability by means of a single coaxial cable.

A videotape lecture introducing DATACON was made part of the AGS tape library. This Tech Note provides supporting "hard copy" for the instructional videotape.

Distr: Department Admin.  
AGS Division EE's  
J. Post and Group  
S. Wingard and Group

COMPUTER I/O  
SINGLE WIRE



DATACON  
DATACON2

# NUMBER SYSTEMS

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## SYMBOL & POSITION

---

DECIMAL  $10^n$

BINARY  $2^n$

OCTAL  $8^n$

HEXIDECIMAL  $16^n$

# DECIMAL

# BINARY

# OCTAL

DECIMAL	BINARY	OCTAL
0	0	0
1	1	1
2	10	2
3	11	3
4	100	4
5	101	5
6	110	6
7	111	7
8	1000	10
9	1001	11
10	1010	12
11	1011	13
12	1100	14
13	1101	15
14	1110	16
15	1111	17
16	10000	20
17	10001	21
18	10010	22

# NUMBER SYSTEMS

## SYMBOL AND POSITION

DECIMAL		BINARY				OCTAL	
0						0	
1						1	
2					1	2	
3					1	3	
4					1	4	
5					1	5	
6					1	6	
7					1	7	
8					1	0	
9					1	1	
10					1	2	
11					1	3	
12					1	4	
13					1	5	
14					1	6	
15					1	7	
16					1	0	
17					1	1	
18					1	2	
19					1	3	
20					1	4	
21					1	5	
25					1	3	7
26					1	4	0
27					1	4	1
28					1	4	2
29					1	4	3
30					1	4	4
31					1	4	5
32					1	4	6
33					1	4	7
34					1	5	0
<u>100 10 1 = 10<sup>n</sup></u>		<u>64 32 16 8 4 2 1 = 2<sup>n</sup></u>				<u>512 64 8 1 = 8<sup>n</sup></u>	

# A/D CONVERTERS

BINARY

OFFSET BINARY

2's COMPLEMENT

BINARY-CODED DEC.



	<u>BINARY</u>	<u>OFFSET BINARY</u>	<u>TWO'S COMPLEMENT</u>
FS	1 1 1	1 1 1	0 1 1
	1 1 0		
	1 0 1	1 1 0	0 1 0
	1 0 0		
	0 1 1		
	0 1 0	1 0 1	0 0 1
0 <sup>+</sup>	0 0 1		
0	0 0 0	1 0 0	0 0 0
0 <sup>-</sup>		0 1 1	1 1 1
		0 1 0	1 1 0
		0 0 1	1 0 1
-FS		0 0 0	1 0 0

n	2 <sup>n</sup>	2 <sup>-n</sup>	dB
0	1	1	0
1	2	.5	-6
2	4	.25	-12
3	8	.125	-18.1
4	16	.0625	-24.1
5	32	.03125	-30.1
6	64	.015625	-36.1
7	128	.0078125	-42.1
8	256	.00390625	-48.2
9	512	.001953125	-54.2
10	1 024	.0009765625	-60.2
11	2 048	.00048828125	-66.2
12	4 096	.000244140625	-72.2
13	8 192	.0001220703125	-78.3
14	16 384	.00006103515625	-84.3
15	32 768	.000030517578125	-90.3
16	65 536	.0000152587890625	-96.3

TABLE 1. Decimal Equivalents of 2<sup>n</sup> and 2<sup>-n</sup>

No. of Bits	10V Full Scale			
	A/D Transitions		To To	
n	LSB	All 1's (Volts)	LSB (1/2 LSB)	All 1's (Volts)
1	5V	5.0	2.5V	2.5
2	2.5V	7.5	1.25V	6.25
3	1.25V	8.75	625mV	8.13
4	625mV	9.38	312mV	9.07
5	312mV	9.69	156mV	9.53
6	156mV	9.84	78.1mV	9.76
7	78.1mV	9.92	39.1mV	9.88
8	39.1mV	9.961	19.5mV	9.941
9	19.5mV	9.980	9.77mV	9.970
10	9.77mV	9.990	4.88mV	9.985
11	4.88mV	9.9951	2.44mV	9.9927
12	2.44mV	9.9976	1.22mV	9.9964
13	1.22mV	9.9988	610μV	9.9982
14	610μV	9.9994	305μV	9.9991

CODING FOR ADC-L SERIES CONVERTERS

STRAIGHT BINARY (UNIPOLAR)	
+ FULL SCALE -1 LSB	111111111111
+ 3/4 FULL SCALE	110000000000
+ 1/2 FULL SCALE	100000000000
ZERO +1 LSB	000000000001
ZERO	000000000000

Analog Input Range (0 to +10V, FS)	Straight Binary
+9.9975	111111111111
+8.7500	111000000000
+7.5000	110000000000
+5.0000	100000000000
+2.5000	010000000000
+1.2500	001000000000
0.0000	000000000000

OFFSET BINARY (BIPOLAR)	
+ FULL SCALE -1 LSB	111111111111
+ 3/4 FULL SCALE	111000000000
+ 1/2 FULL SCALE	110000000000
ZERO	100000000000
- 1/2 FULL SCALE	010000000000
- 3/4 FULL SCALE	001000000000
- FULL SCALE +1 LSB	000000000001
- FULL SCALE	000000000000

Analog Input Range (± 10V, FS)	Offset Binary	2's Complement
+ 9.995	111111111111	011111111111
+ 8.750	111100000000	011100000000
+ 7.500	111000000000	011000000000
+ 5.000	110000000000	010000000000
0.000	100000000000	000000000000
- 5.000	010000000000	110000000000
- 7.500	001000000000	101000000000
- 8.750	000100000000	100100000000
- 9.995	000000000001	100000000001
-10.000	000000000000	100000000000

CODING FOR ADC-D AND K SERIES

TWO'S COMPLEMENT (BIPOLAR)	
+ FULL SCALE -1 LSB	011111111111
+ 3/4 FULL SCALE	011000000000
+ 1/2 FULL SCALE	010000000000
ZERO	000000000000
- 1/2 FULL SCALE	110000000000
- 3/4 FULL SCALE	101000000000
- FULL SCALE +1 LSB	100000000001
- FULL SCALE	100000000000

Analog Input Range ±5V, FS	Offset Binary	2's Complement
+4.9975	111111111111	011111111111
+4.3750	111100000000	011100000000
+3.7500	111000000000	011000000000
+2.5000	110000000000	010000000000
0.0000	100000000000	000000000000
-2.5000	010000000000	110000000000
-3.7500	001000000000	101000000000
-4.3750	000100000000	100100000000
-4.9975	000000000001	100000000001
-5.0000	000000000000	100000000000

## DATCON MAGNITUDE READOUT

VOLTAGE	0 to +5V	0 to +10V	±10V
+10		4095	2047
+5	4095	2047	
0+	0001	0001	0001
0	0000	0000	0000
0-			4095
-5			
-10			2048

w/ ±10 VOLTS, 2047 "COUNTS" per 10 VOLTS = 204.7 "COUNTS" per VOLT

CALIBRATION AS REPORTED TO MCR:

DEVICE POSITION	BENCH/FIELD DATA	CALCULATIONS	FORWARDED TO MCR
RETRACT	9.233 VOLTS	$(9.233)(204.7) = 1889.995$	RETRACT 1890
⌀ +1 INCH	3.992 VOLTS	$(3.992 - 2.863)(204.7) = 231.106$	
⌀	2.863 VOLTS	$(2.863)(204.7) = 586.056$	⌀ 586
INSERT	1.007 VOLTS	$(1.007)(204.7) = 206.133$	INSERT 206
			"COUNTS/INCH" 231

# POSITION CALIBRATION

DEVICE POSITION	BENCH DATA (V)	RECORDED IN MCR
RETRACT ⊕ + 1"	9.233	RETRACT 1890
⊕	3.992	⊕ 586
INSERT	2.863	INSERT 206
	1.007	
		"COUNTS/IN" = 231

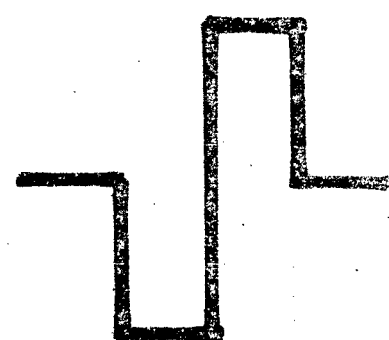
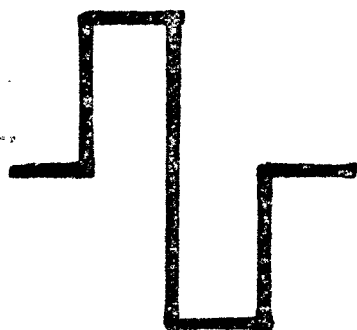
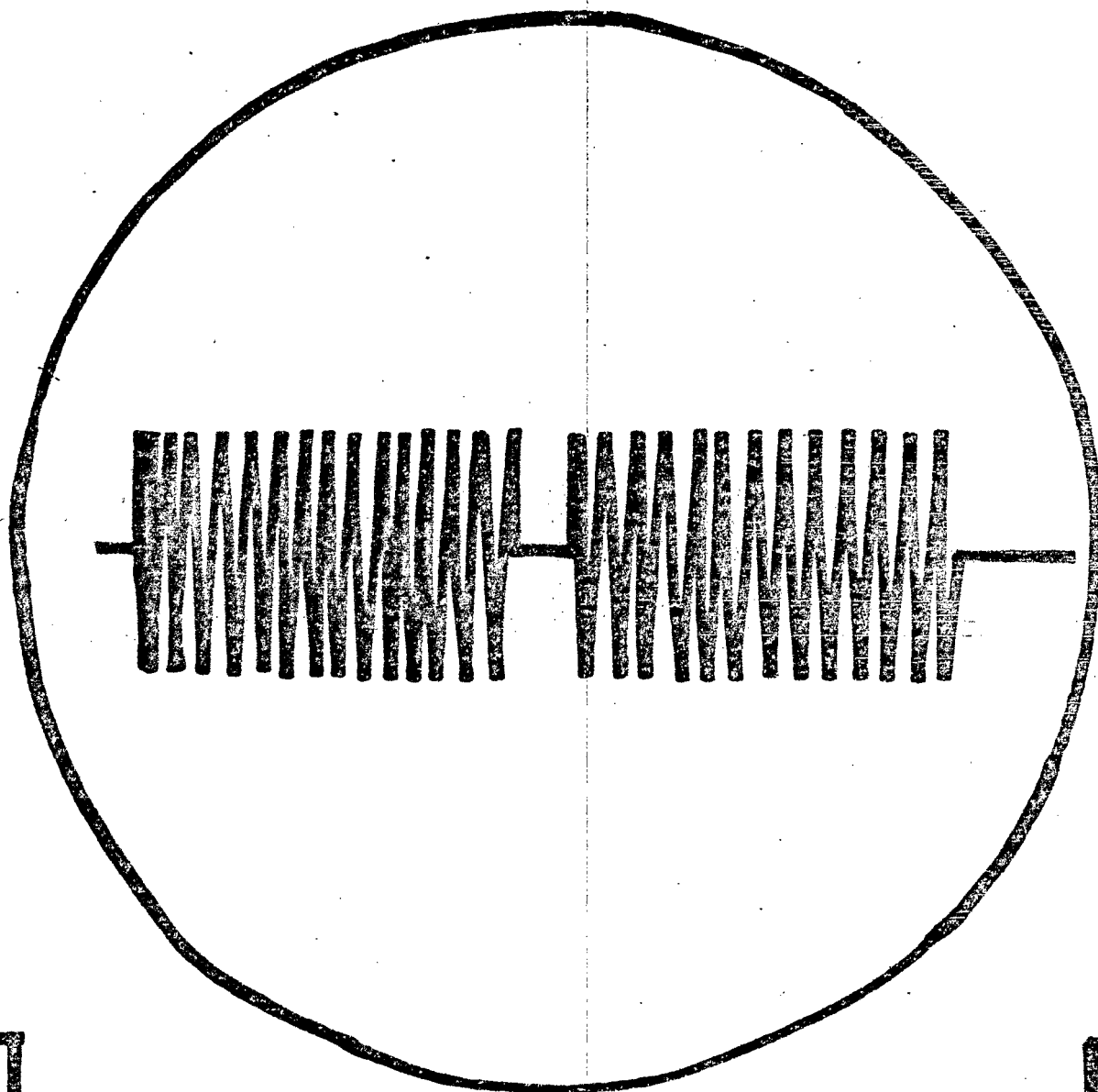
$$(9.233)(204.7) = 1889.9$$

# DATACON

## MAGNITUDE READOUT

VOLTAGE	+5 0	+10 0	+10 -10
+ 10		4095	2047
+ 5	4095	2047	
0 <sup>+</sup>	0001	0001	0001
0	0000	0000	0000
0 <sup>-</sup>			4095
- 5			
- 10			2048

# DATA CON SIGNAL

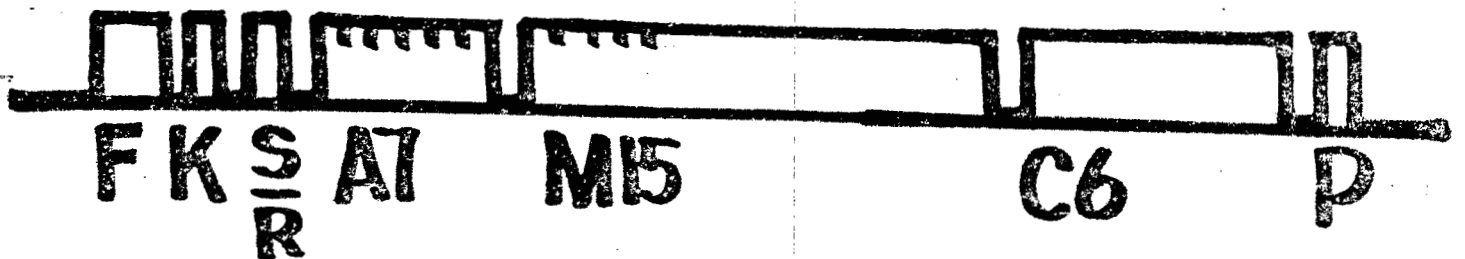


# TRANSMISSION

FRAME  
KEY

SET / READ  
ADDRESS

MAGNITUDE  
COMMAND  
PARITY



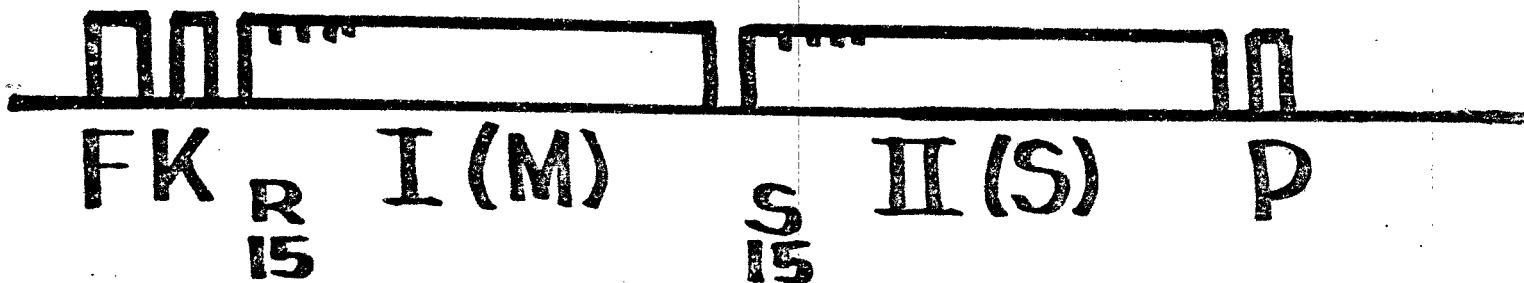
REPLY (6  $\mu$ sec)

FRAME  
KEY

DATA GROUP I  
(MAGNITUDE)

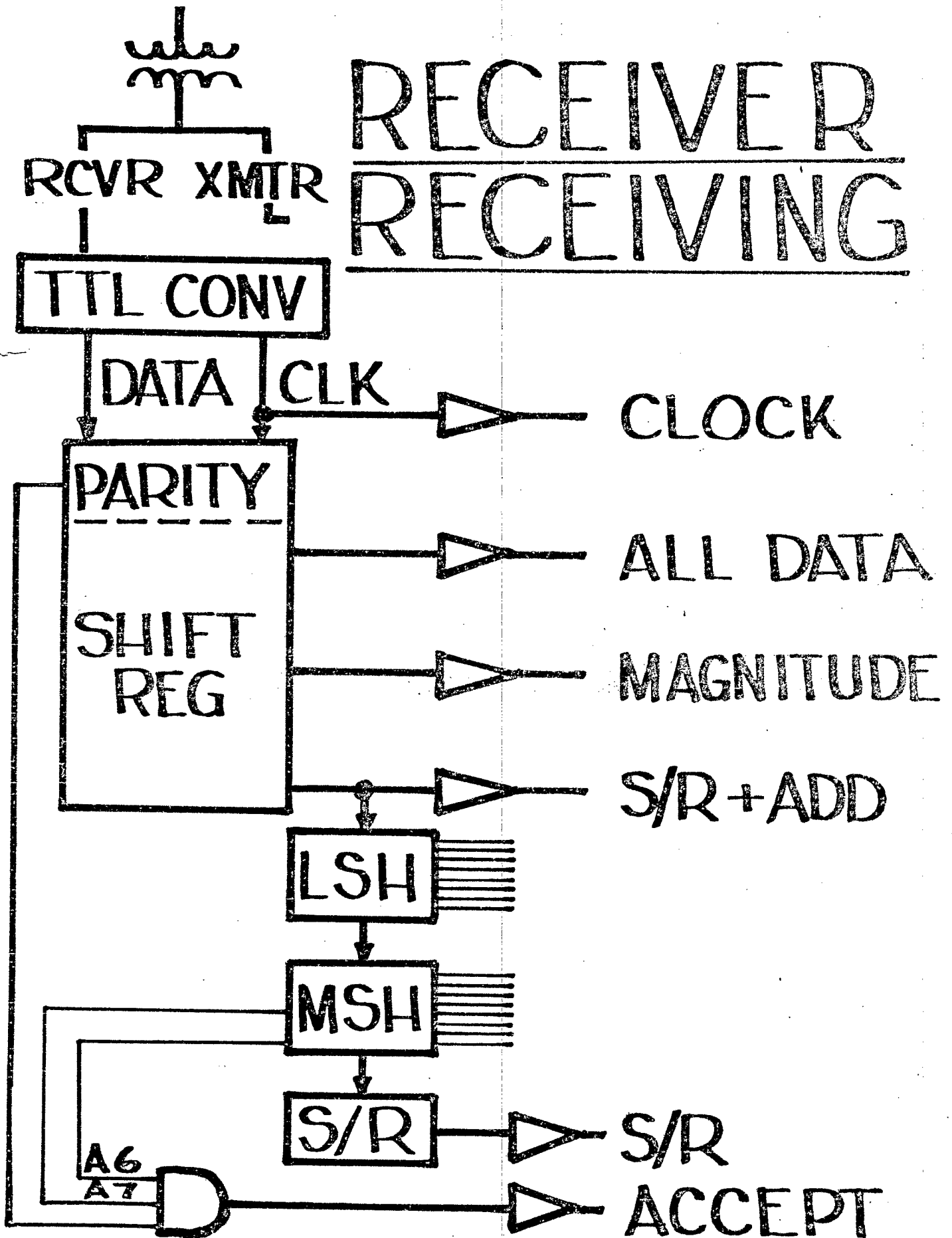
DATA GROUP II  
(STATUS)

PARITY



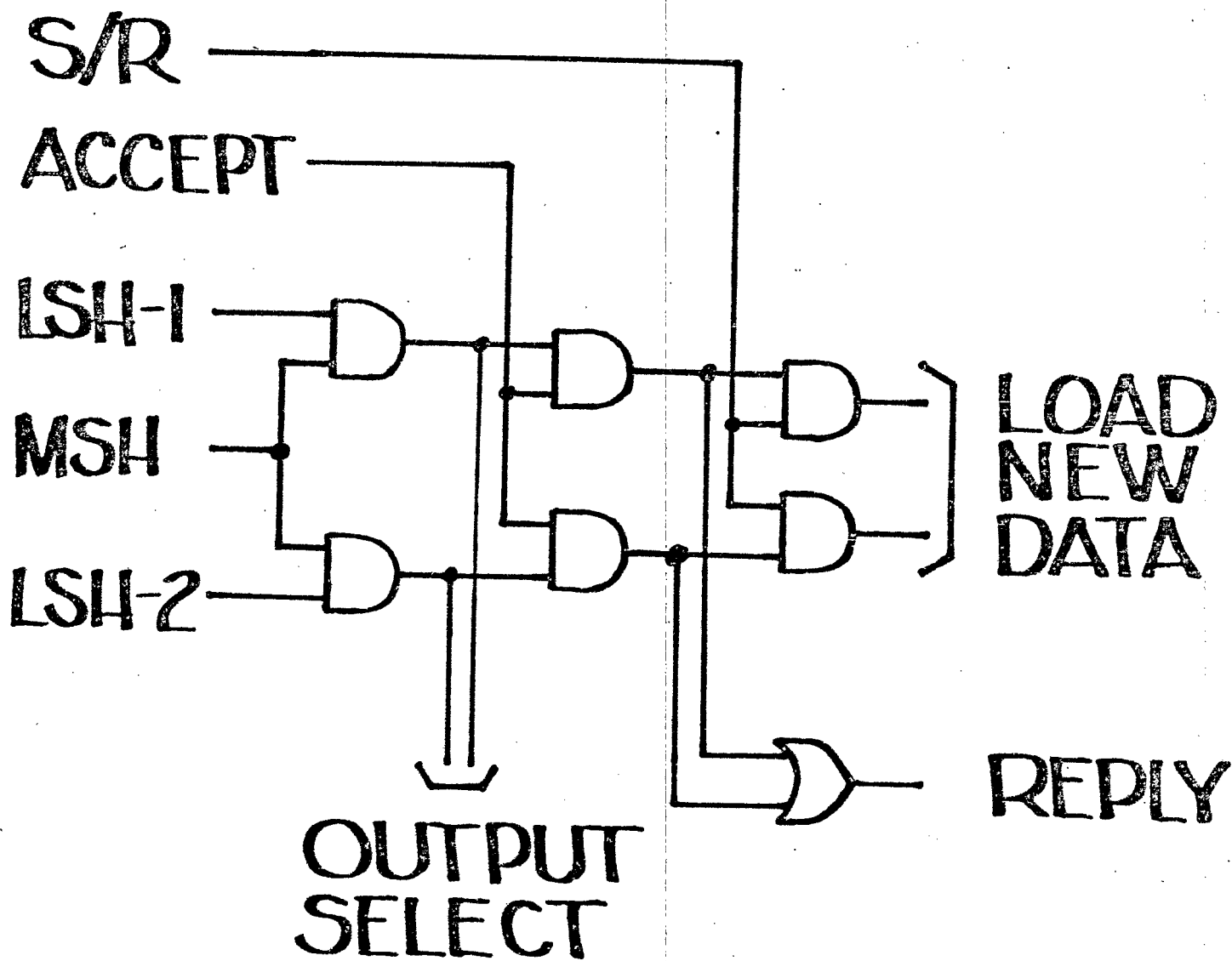


# RECEIVER RECEIVING



# TWO-CHANNEL

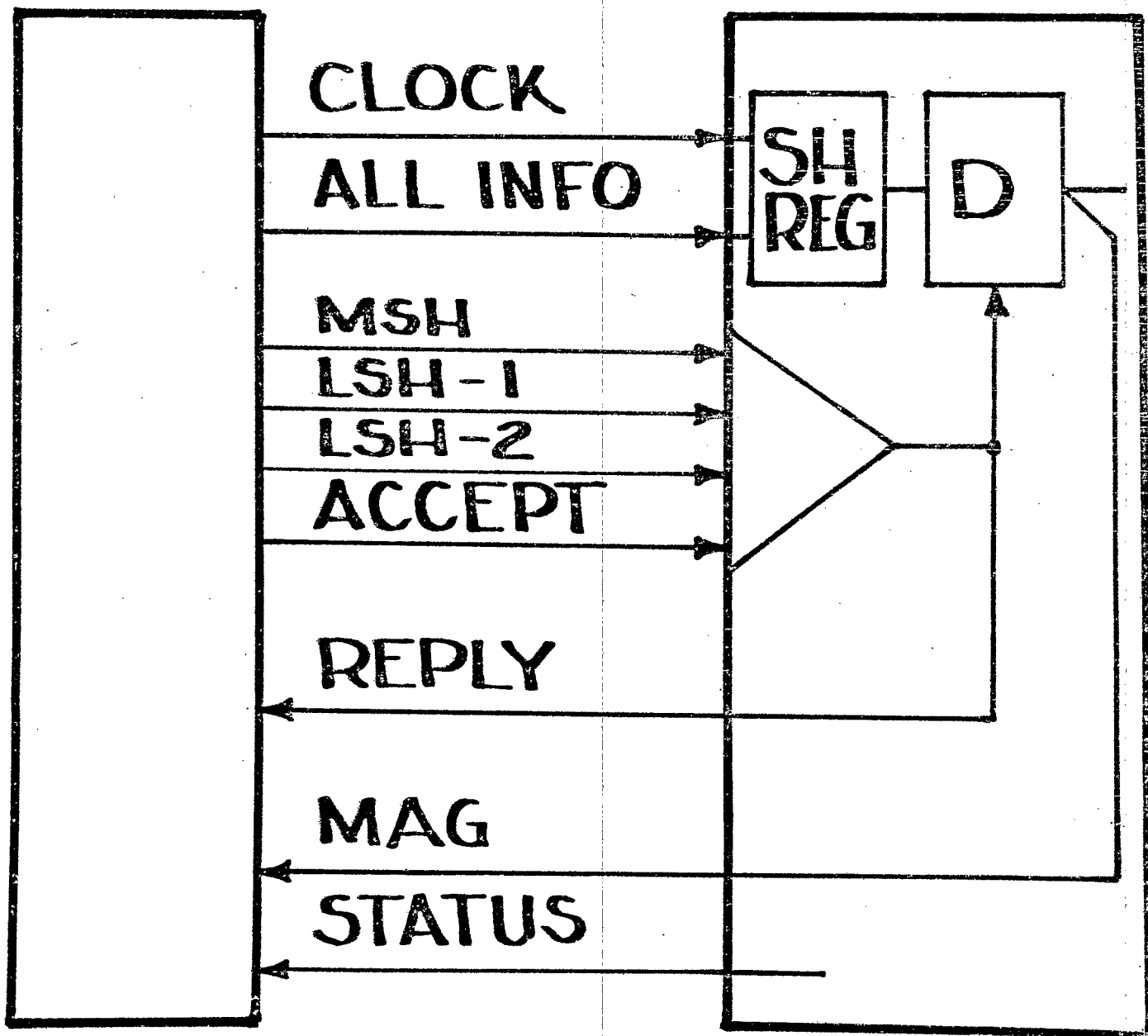
# INPUT CIRCUIT



DUAL AUTODET  
A/D CONVERTER  
ANALOG MULTIPLEX  
P.S. CONTROLLER  
STEPPING MOTOR " "  
DUAL SCALER  
I/O REGISTER  
FUNCTION GENERATOR

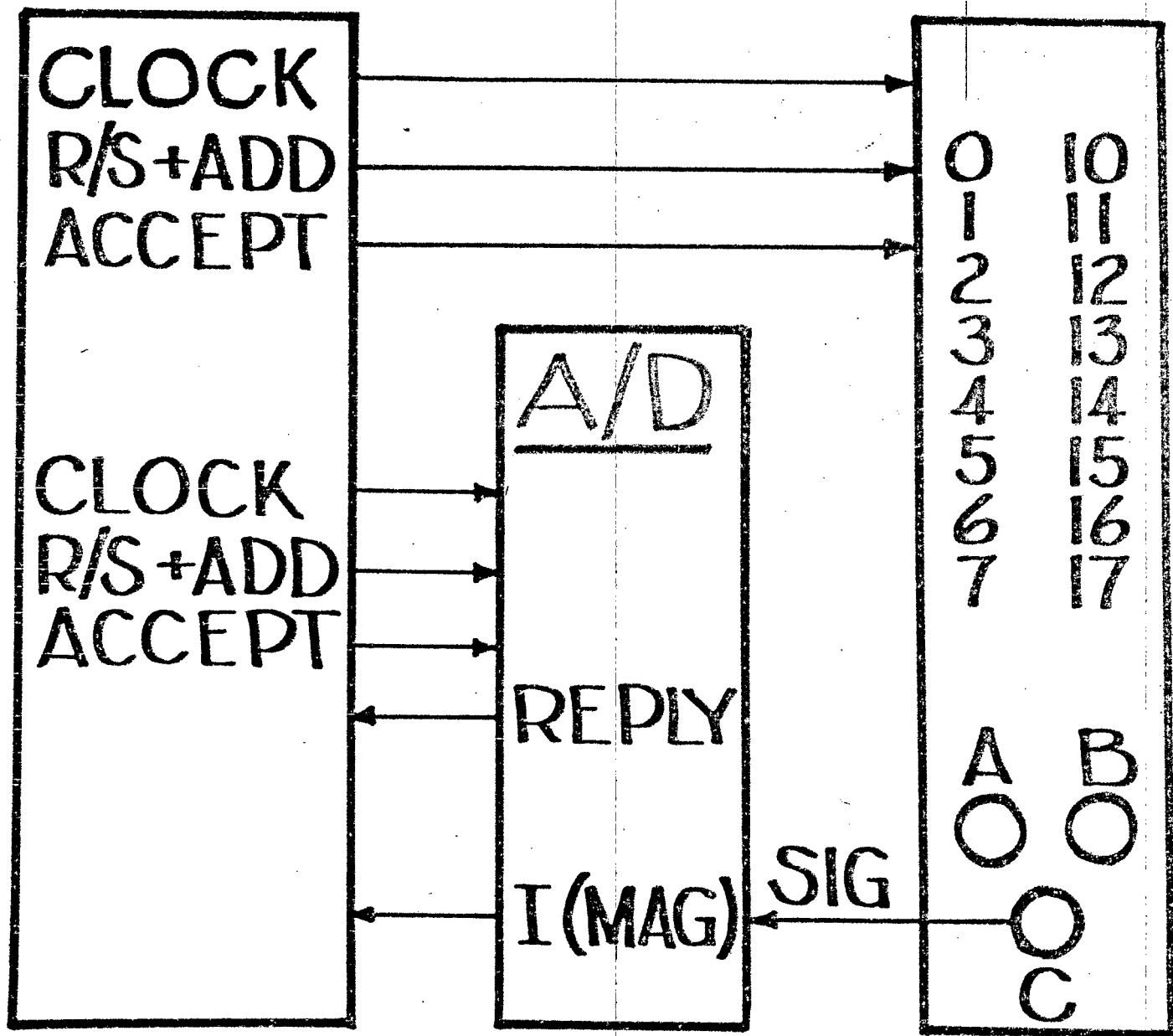
# REMOTE RECEIVER

# DUAL AUTODET

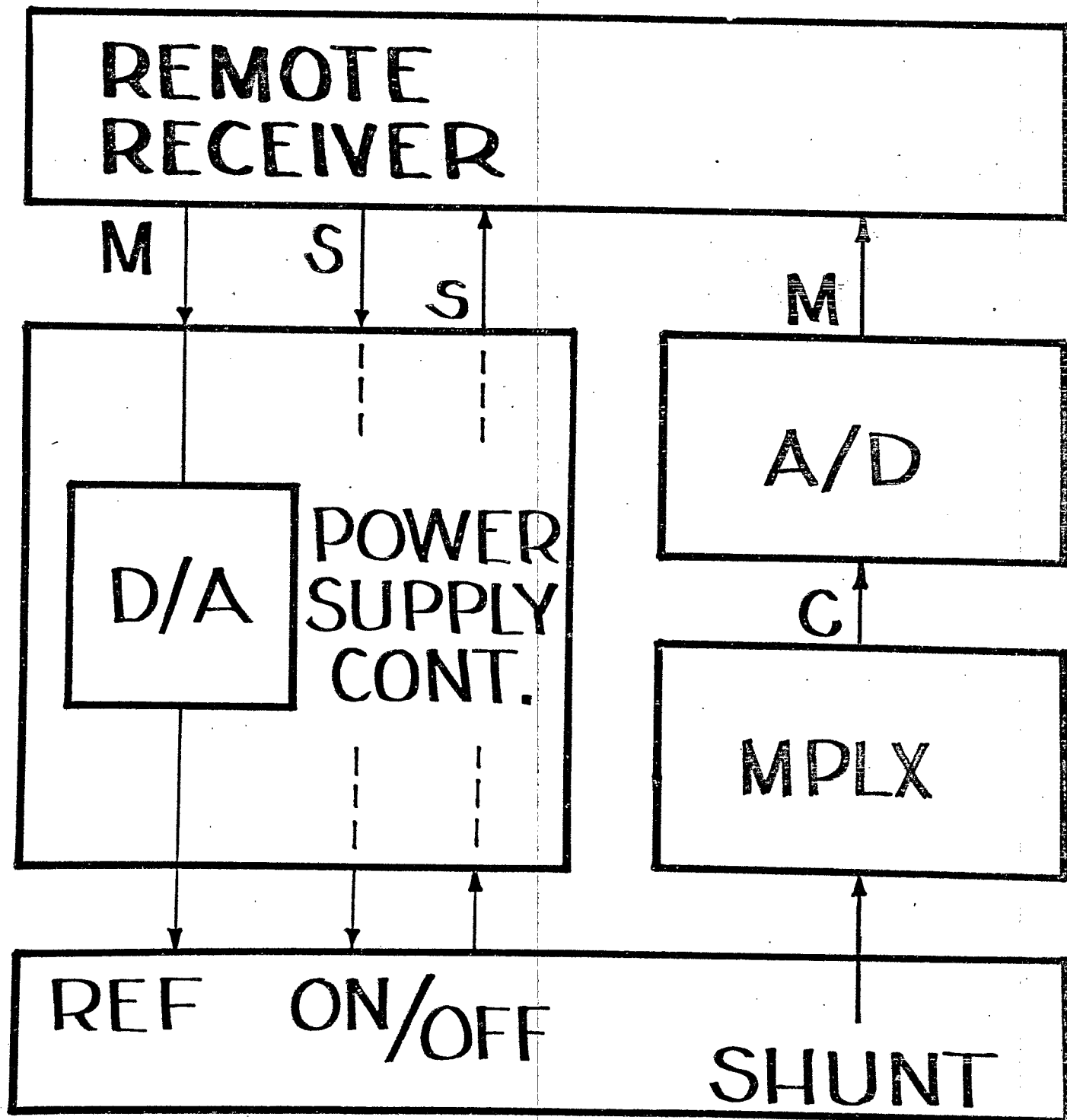


# REMOTE RECEIVER

# ANALOG MPLX



# P. S. CONTROLLER



# ENTERING DATCON

LOG XXX,XXX ↘

JOB 41 507A91 TTY35

PASSWORD: YYY ↘

1330 25-JAN-79 FRI

AAAAA -----

BBBBB -----

CCCCC -----

• R DATCON ↘

\*  
[REDACTED]

\* D PPA )

\* A 344 )

\* R )

CHAN	MAG	SM	STAT	ER---
0344	2026	00	024000	
PPA	-----			ERRORS: 0

\*



# DATA TABLES

## ADDRESS

200

200, 201, 202, 205

200 - 202, 205

## MAGNITUDE

0, 250, 500, 750

0, 250, 250, 250

0, 250!

$10 (4095)$

## COMMAND

7 BITS

$8 (177)$

# PROGRAM CONTROL

---

ADDRESS  
MAGNITUDE  
COMMAND

READ  
WRITE  
BOTH

OUTPUT (OFF/ON)  
X<sub>10</sub>

# POWER SUPPLY CONTROL

## COMMAND

DC ON	STBY	RST	FREQ	-	I/P	POLARITY
C6	C5	C4	C3	C2	C1	C0

## READBACK

STBY	ON	REG FLT	POL	-	-	-	-	I/P	SEC	LO	MAG FLT
M15				0	0	0	0	0			M0

C 140 }      M 1000 }      B }

CHAN    MAG    SM    STAT  
 126    1001    00    140000

# STEPPING MOTORS

## COMMAND

O=IN I=RET	ENABLE	HOME	-	-	-	-
C6	C5	C4	C3	C2	C1	C0
			0	0	0	0

## READBACK

I/P	ENBL	HOME	HI LM	LO LM	LAST CW	-	-	-	-
M15									M0
						0	0	0	0

C 40 } M 500 } B }

CHAN MAG SM STAT  
0344 2010 00 164000