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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		0
1					1		1
2					1	0	2
3					1	1	3
4					1	0	4
5					1	0	5
6					1	1	6
7					1	1	7
8					1	0	0
9					1	0	1
10					1	0	2
11					1	0	3
12					1	1	4
13					1	1	5
14					1	0	6
15					1	1	7
16					1	0	0
17					1	0	1
18					1	0	2
19					1	0	3
20					1	0	4
21					1	0	5
25					1	1	1
26					1	1	0
27					1	0	1
28					1	0	2
29					1	0	3
30					1	0	4
31					1	0	5
35					1	0	1
36					1	0	2
37					1	0	3
38					1	0	4
39					1	0	5
40					1	0	6
41					1	0	7
42					1	0	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			
	LSB	All 1's (Volts)	To LSB (1/2 LSB) (Volts)	To 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

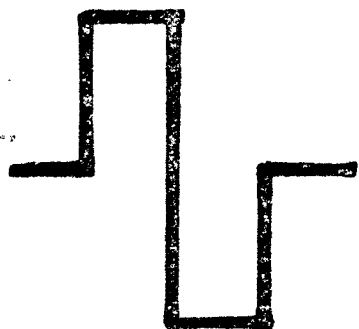
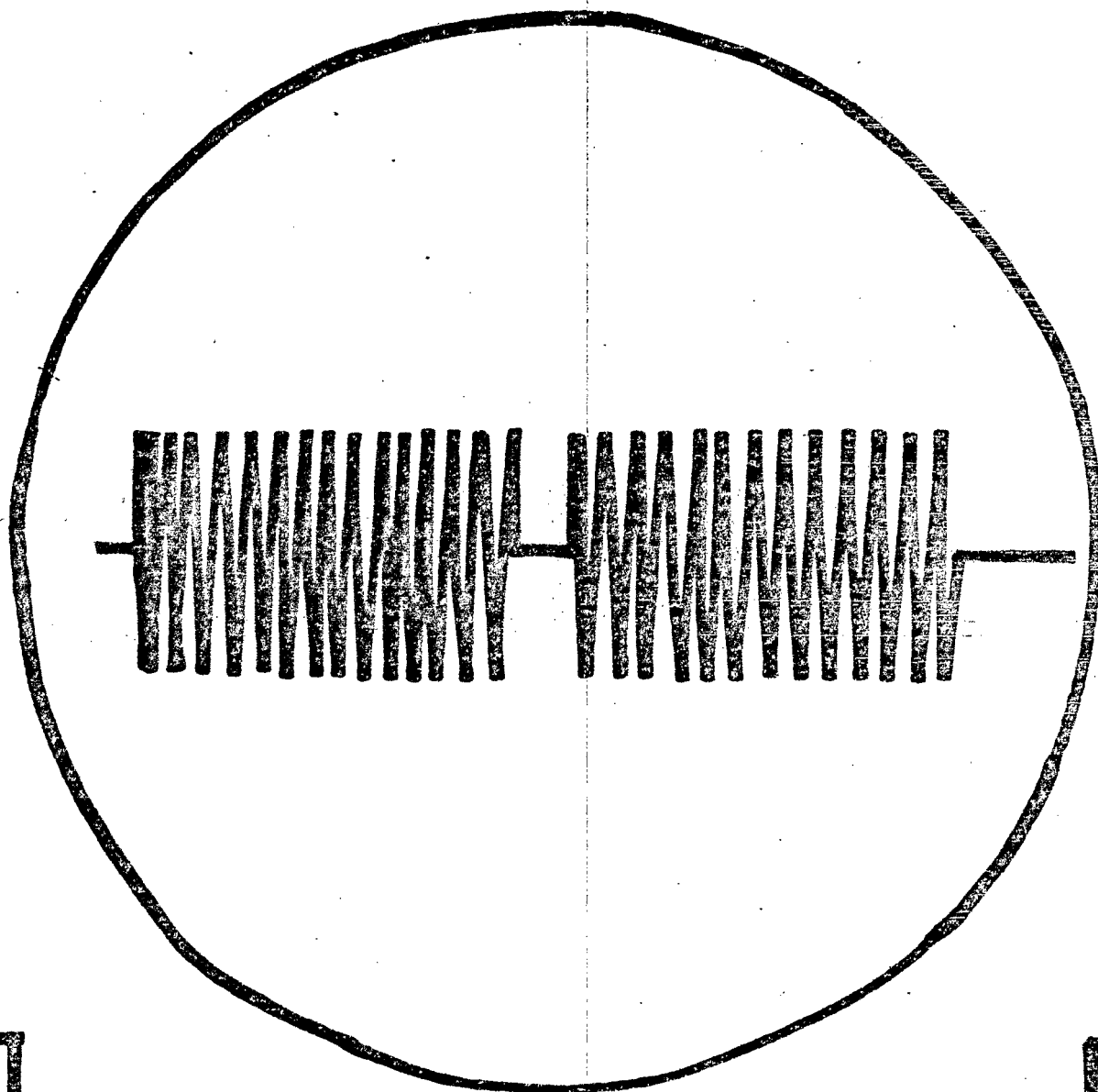
$$(9.233)(204.7) = 1889.9$$

# 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

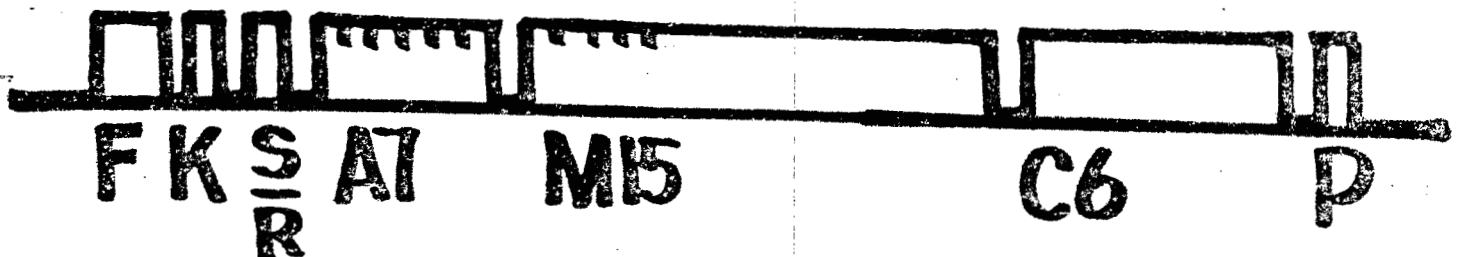


# TRANSMISSION

FRAME  
KEY

SET / READ  
ADDRESS

MAGNITUDE  
COMMAND  
PARITY



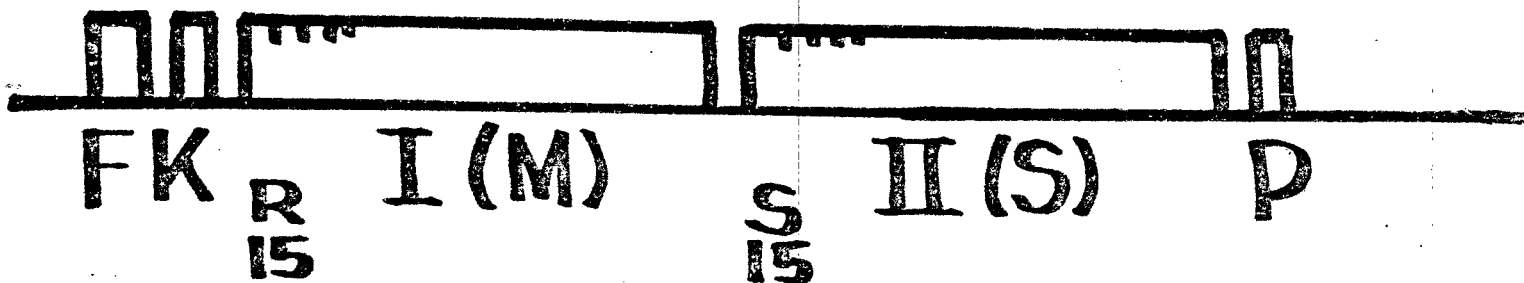
REPLY (6  $\mu$ sec)

FRAME  
KEY

DATA GROUP I  
(MAGNITUDE)

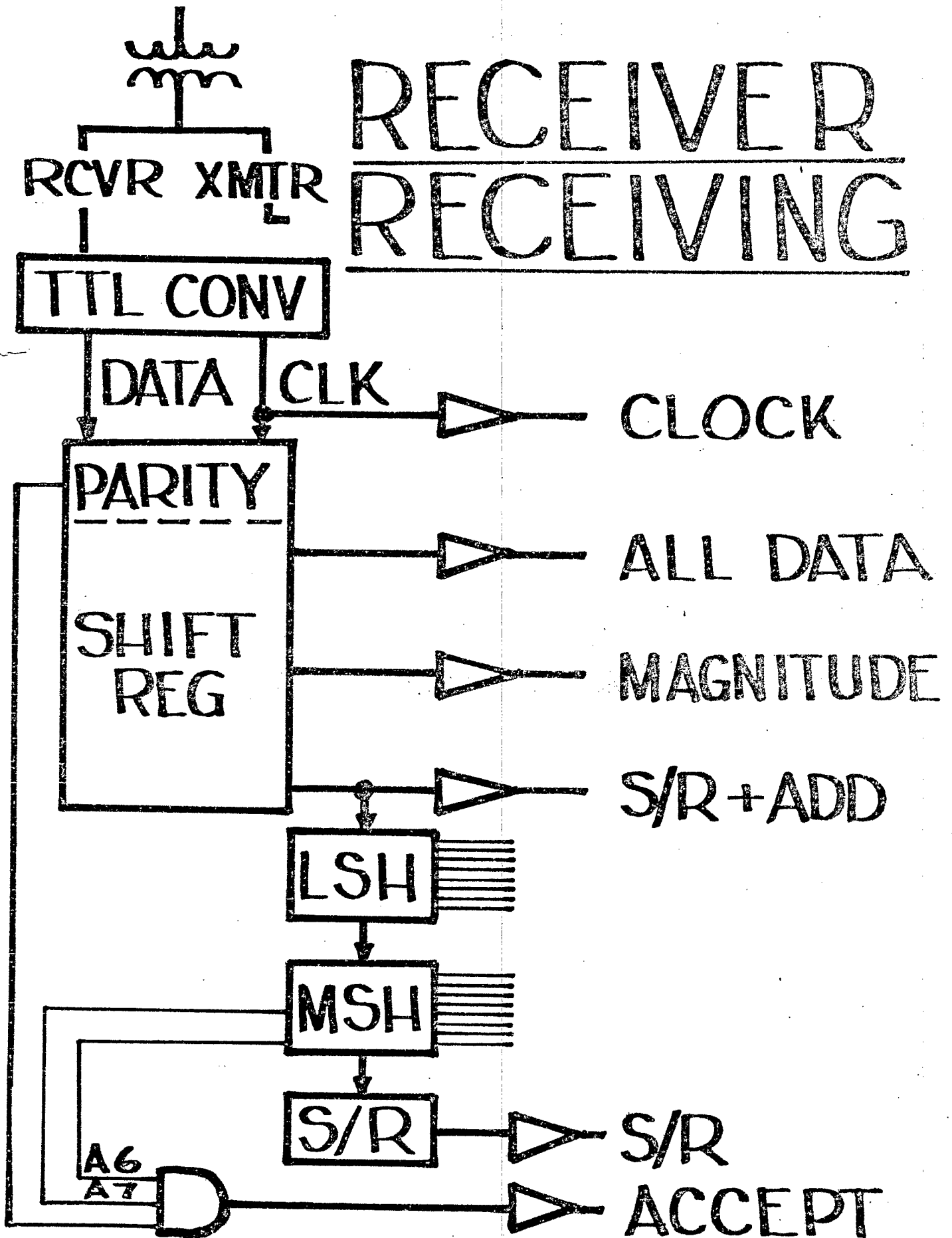
DATA GROUP II  
(STATUS)

PARITY



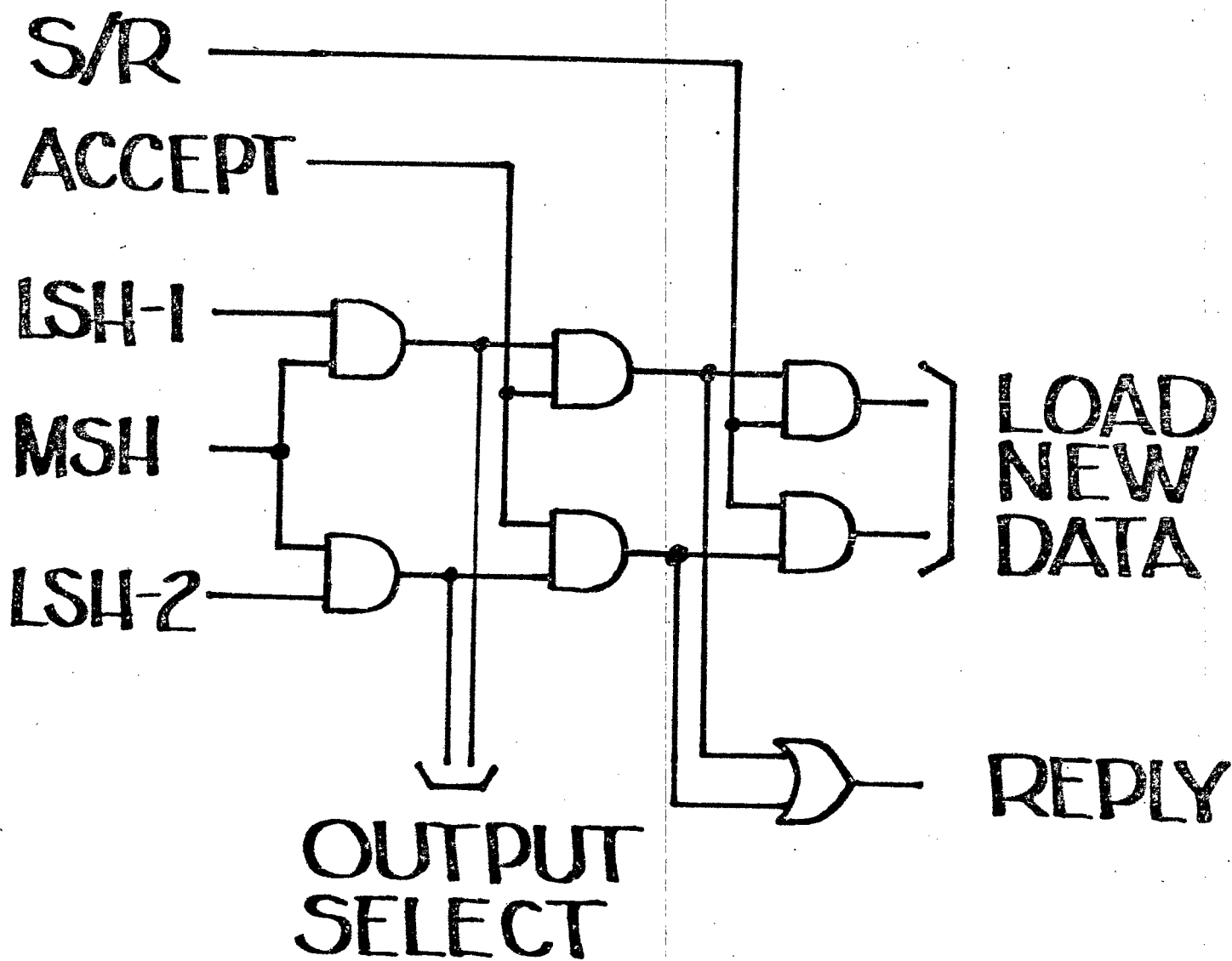


# RECEIVER RECEIVING



# TWO-CHANNEL

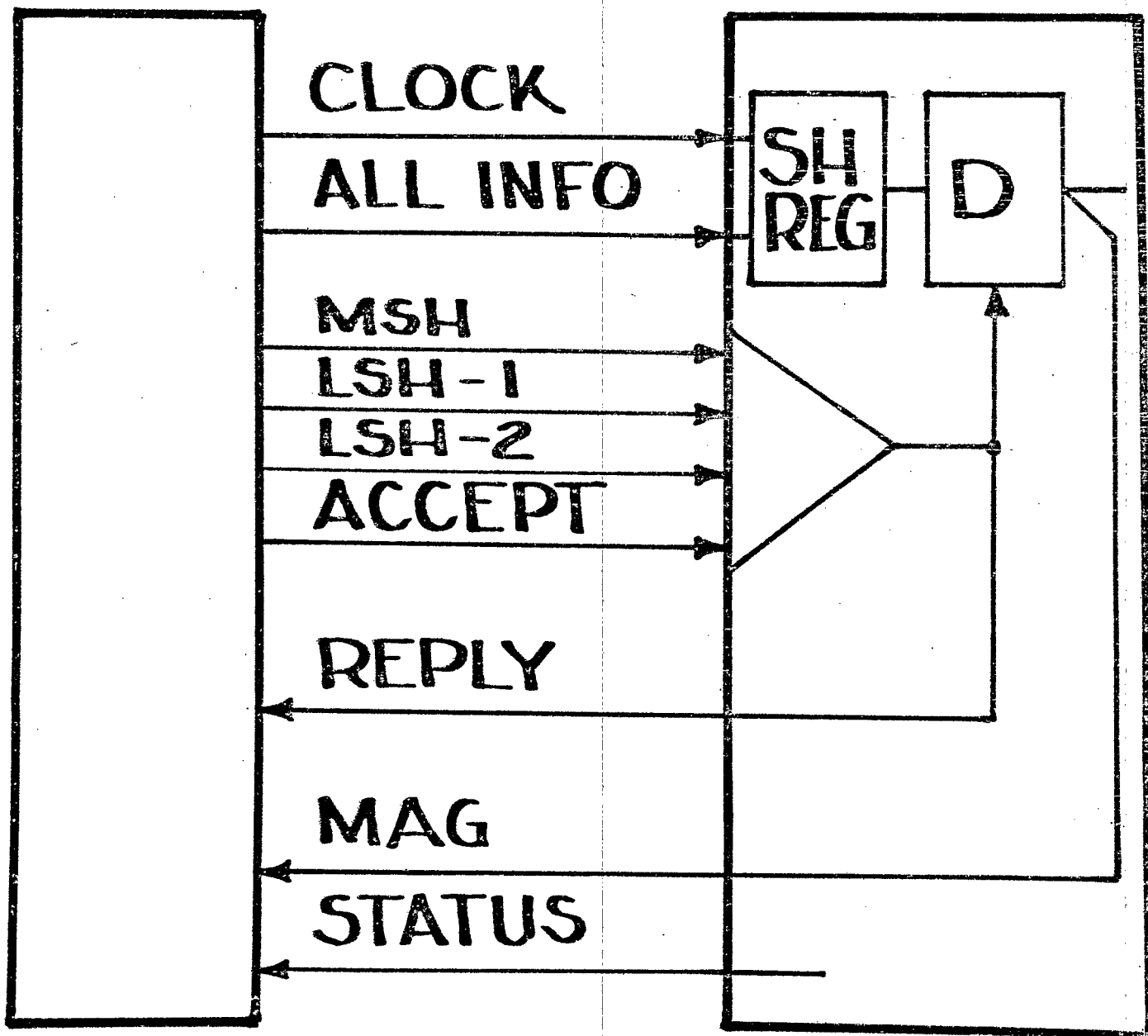
# INPUT CIRCUIT



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

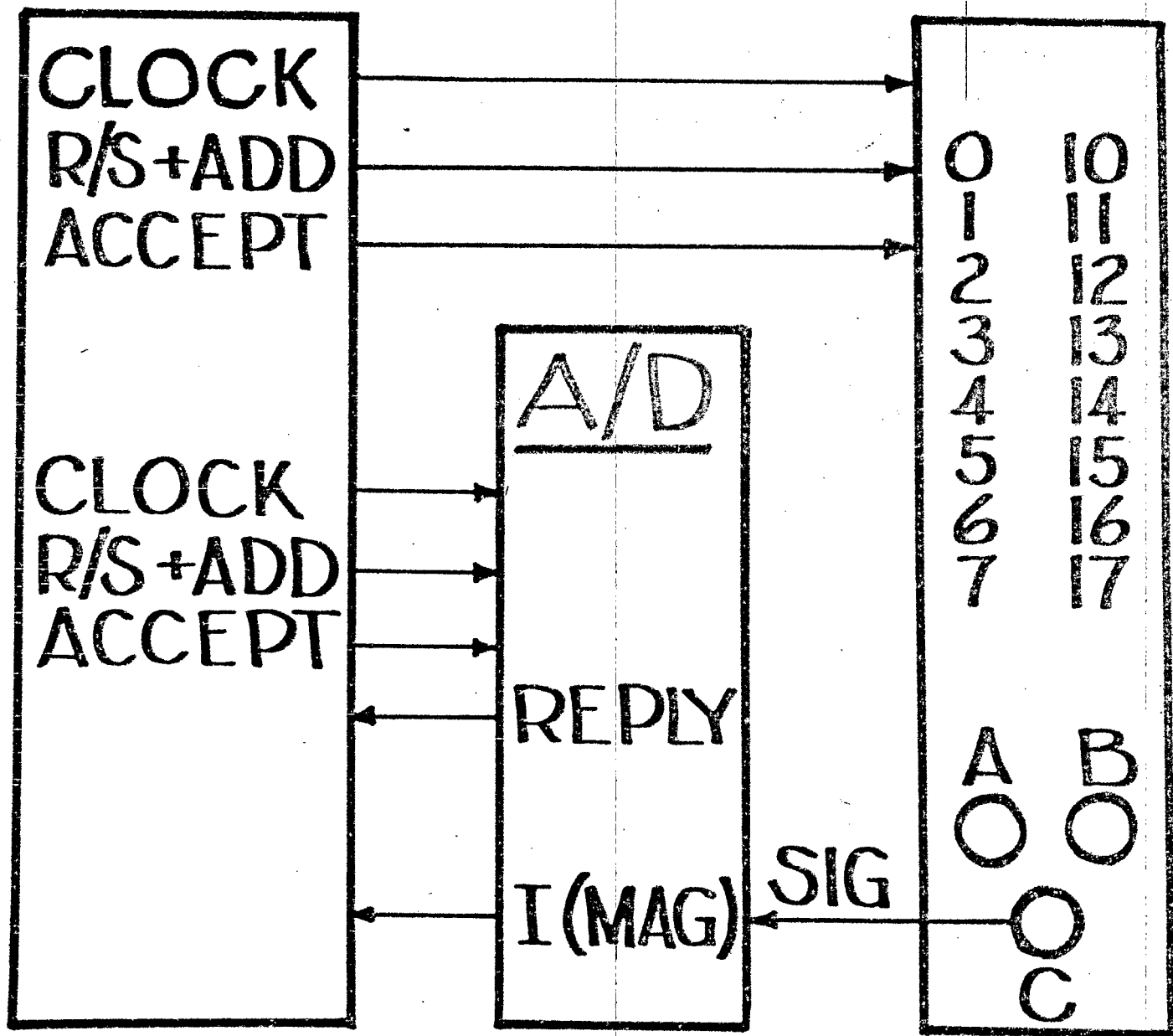
# REMOTE RECEIVER

# DUAL AUTODET

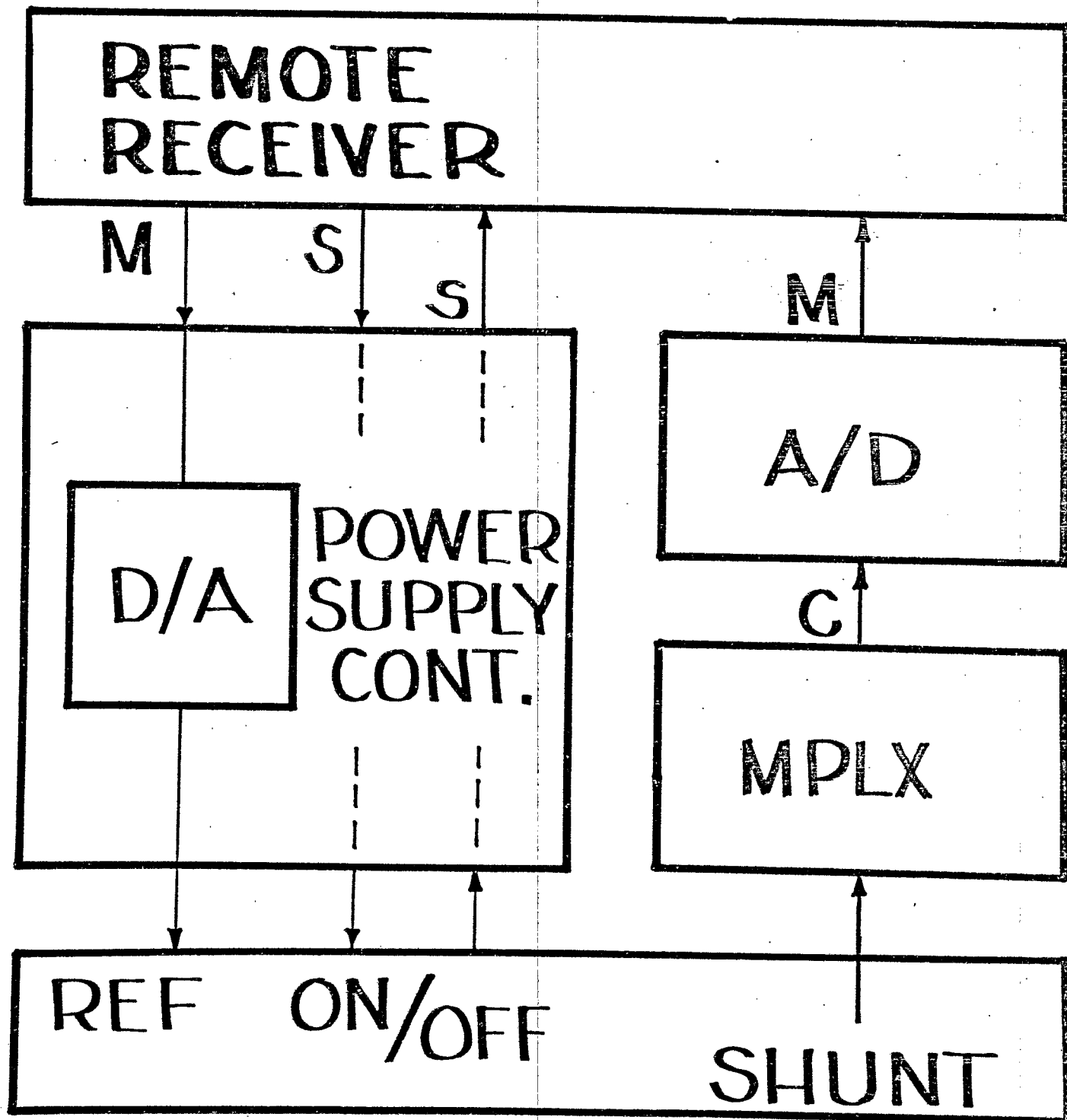


# REMOTE RECEIVER

# 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