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A signal recording and printing system for telemetering raingauges

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सार — संप्रेषण के निर्धारित समय से ठीक पहले केवल ग्राही और टेपरिकार्डर के स्विच को दबाकर दूरमापन वर्षामापी आंकड़ों का स्वचालित अभिग्रहण और प्रलेखन प्राप्त किया जाता है और बाद में स्विच को बंद कर दिया जाता है। दूर मुद्रक के कोडों में कुंजियों के सतत तरंग आंकड़े दीर्घ या लघु स्वरों के अनुसार उच्च एवं निम्नों में परिवर्तित हो जाते हैं और विचलित पूंजी (सिफ्ट रजिस्टर) में संग्रीहत हो जाते हैं दूरमुद्रण कार्यों को करने के लिए यौग्य बनानें के बाद मुद्रण नियंत्रण आंकड़ों का 50 बाड पर मुद्रण करने के लिए, रजिस्टर में स्थानांतरित कर देता है।

ABSTRACT. Automatic reception and recording of telemetering raingauge data is achieved by simply switching on the receiver and tape recorder just before the scheduled times of transmissions and switching them off later. The keyed continuous wave data in teleprinter code is converted to highs or lows corresponding to long or short notes and stored in a shift register. The printing control circuit, after enabling the teleprinter functions to be performed, shifts out the data in the register at 50 bauds to get a print out.

1. Introduction

The India Meteorological Department operates an automatic telemetering raingauge (ATRG) network during monsoon seasons to facilitate flood forecasting and warning by the Central Water Commission. Of late the network has been of eight transmitting stations with central receiving stations having communication facility with the flood forecasting centre.

The CW transmitter in the ATRG system turns on every three hours as determined by the crystal clock in the system. A 5 second tone, followed by station identification repeated four times and the thousands, hundreds, tens and units digits of rainfall in millimetre repeated four times in teleprinter code are transmitted in sequence and the transmitter goes off. The long notes are of 500 milliseconds duration and the short notes, 125 milliseconds. There is a gap of 500 milliseconds between each digit consisting of 5 bits in teleprinter code and 125 milliseconds between each bit. The transmitters and receivers are crystal tuned. The frequency used is 6.5 MHz during the day and 4 MHz at night. The scheduled times of transmission from different locations are staggered keeping an interval of 10 minutes between transmission so that even allowing for small clock shifts, the stations may not interfere with one another. Table 1 gives the details of stations operated during 1978 monsoon.

The data is being monitored and decoded manually. The work described here is an attempt to record and print the data which could eliminate the human element.

2. Principle of operation

An extremely simple method used to record the data, was to switch on the receiver and a tape recorder in recording mode two minutes before the scheduled time and switch them off two minutes later.

The recorder output is a keyed one KHz tone. Using an amplifier, time constant and Schmidt trigger circuits square waves of 500 milliseconds and 125 milliseconds duration corresponding to long and short notes are obtained. These are inverted and connected to reset terminals of a counter driven by 20 millisecond clock. Choosing a suitable output of the counter, the long notes alone are recognised as highs and the data is shifted serially into a register. As soon as the whole data is stored, the control circuit turns on, switching on the

TABLE 1

S. No.	Field end Tx. station	River catchment	Station code	Receiving station	*Schedule of data transmission (IST)	Period of "operation of" recording system (IST)
1	Betul	Narmada	. . . . – –	Bhushaval	1040	1038-1042
2	Harrai	Do.	– . – – –	Do.	1050	1048-1052
3	Chikalda	Tapi	. –	Do.	1100	1058-1102
4	Daryapur	Do.	. . . . – .	Do.	1110	1108-1112
5	Buldana	Do.	. . . – – –	Do.	1120	1118-1122
6	Amraoti	Do.	. . . – . .	Do.	1130	1128-1132
7	Sagbara	Do.	–	Ukai	1140	1138-1142
8	Mulher	Do.	. . – – .	Do.	1150	1148-1150

*Repeat every 3 hours

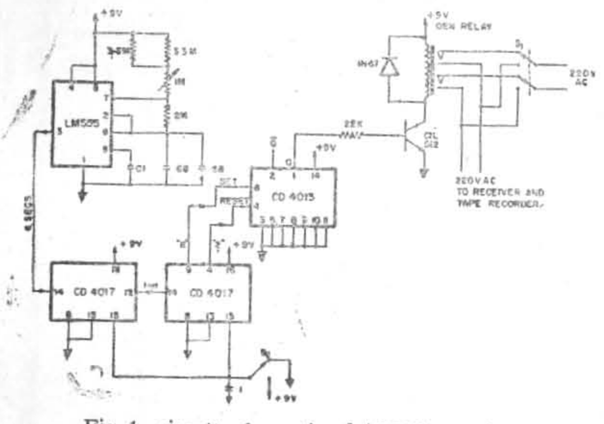

Fig. 1. circuit schematic of ATRG signal recording system

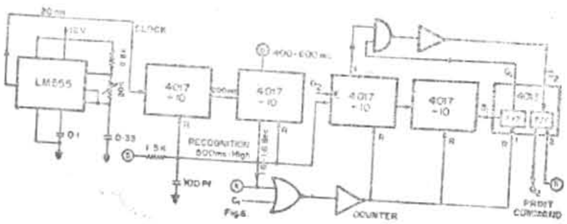

Fig. 3. Data reception technique

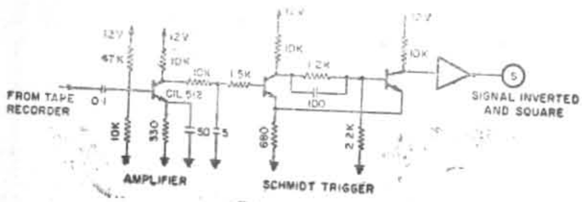

Fig. 2. Signal recovery

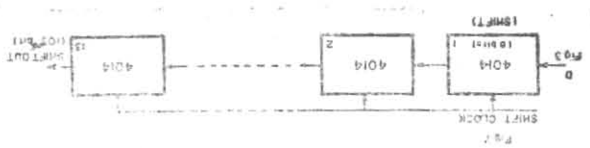

Fig. 4. The shift register data store

teleprinter. After the essential teleprinter functions are performed the data in the register is shifted out serially to get a printout in the teleprinter.

3. Signal recording

The circuit schematic used for turning on the receiver and tape recorder is shown in Fig. 1. The free running multivibrator using a linear IC LM 555 has a period of 6 seconds which is adjusted accurately by the trimmer. Precision resistances and polycarbonate capacitors with very low temperature coefficient have been used for high frequency stability. The 6 second pulses are divided by 10 by CD 4017 to get 1 minute pulses. At the '2' state of the following CD 4017, the flip-flop CD 4013 is reset. At the 8th count, it is set. The Q output which goes high switches on the relay through the driver. Through the relay contacts power is available to both the receiver and tape recorder for 4

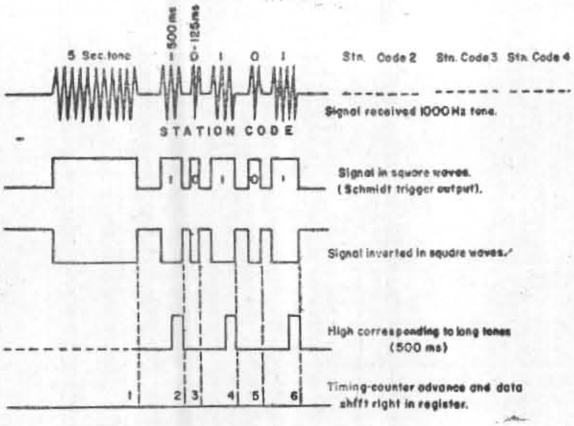

Fig. 5. Sequence of data reception

minutes till the counter is reset again. Switch S_1 allows manual operation.

After setting up the receiver and tape recorder, exactly 10 minutes prior to the scheduled time of first transmission swith S_2 is pressed momentarily. The equipment is on from 8-12, 18-22, 28-32, ... minutes after this event. The four minutes period is long when compared to the duration of roughly 1½ minutes for each transmission. But this allows for the warm-up time required by the tape-recorder as well as slight inaccuracy in timings.

4. Signal recovery

The output of the receiver or tape-recorder is a keyed one KHz tone. The amplifier, time delay circuit and the Schmidt trigger is as shown in Fig. 2. The output of the trigger is square waves of 500 milliseconds and 125 milliseconds duration.

5. Data reception technique

As seen in Fig. 3, the square wave output of the signal recovery circuit is connected to the reset terminals of counters 4017 after inversion and time delay. The input to this counter is 20 millisecond pulses from a free running multi-vibrator made of LM 555. The trimpot is for accurate adjustment of time. The counters are enabled only when the reset points are low. If the period is long enough, 200 millisecond pulses are available at the input of the second counter. Point D will be high, when the reset point goes high in case of a 500 millisecond signal. The sequence of transmission is already explained under 'Introduction'. The transmission starts with a 5 second tone. During this period the input of the counter described above, which remains high from 1.6 to 1.8 seconds is used to reset counters and flip flops in Fig. 3, and the counters in Fig. 5, as hown in the schematics. Q_2 in Fig. 3 is low. Enabled when Q_2 is low, the counter 4017 counts the number of positive transitions of S in Fig. 3. The wave form at S is depicted as 'Signal inverted square wave' in Fig. 5, sequence of data reception. The first positive transition occurs at the end of 5 sec tone. After this one digit — 5 bits in T/P code — station identification comes through. The sixth positive transition occurs after this. The station code is repeated four times at the end of which 21st positive transition takes place. Then the thousands, hundreds, tens and unit digits of rainfall data comes through making the 41st transition. This rainfall data also is repeated four times and the transmitter goes off. The counter in Fig. 3 will be registering 101 counts then. At count 100, Q_1 goes high and at count 101, Q_2 the print command.

6. Shift register

The circuit schematic of the shift registers made up of thirteen IC's 4014 is shown in Fig. 4. The register has a capacity of 104 bits. S of Fig. 2 through gates shown in Fig. 7 is the shift clock control while registering data and D of Fig. 3. is the input. The shift register recognises

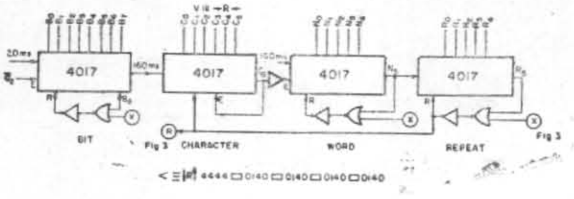

Fig. 6. Printing control counters

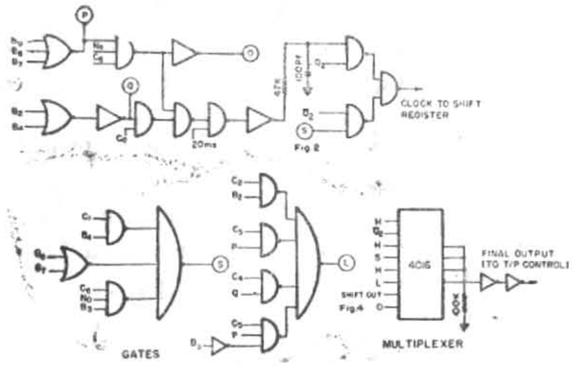

Fig. 7. Gates and multiplexer (Printing)

TABLE 2

The 5 bit teleprinter code (1 mark, 0 space)

		B_1	B_2	B_3	B_4	B_5
Carriage return	<	0	0	0	1	0
Line feed	≡	0	1	0	0	0
Letters	↓	1	1	1	1	1
Figures	↑	1	1	0	1	1
Space	□	0	0	1	0	0
	0	0	1	1	0	1
	1	1	1	1	0	1
	2	1	1	0	0	1
	3	1	0	0	0	0
	4	0	1	0	1	0
	5	0	0	0	0	1
	6	1	0	1	0	1
	7	1	1	1	0	0
	8	0	1	1	0	0
	9	0	0	0	1	1

the state of the input terminal during the positive transition of the clock. To ensure this the pulses S to the reset terminals of the counters in Fig. 3 are delayed. At positive transition number 101 of S, the first 100 positions of the shift register contain meaningful data, 'zero' corresponding to short notes and 'one' corresponding to long notes.

Fig. 5 : the sequence of data reception is intended to make clear the steps involved in storing the data starting from reception.

7. Printing

The printing circuits are enabled as soon as the print command, goes high. The format required is given in Fig. 6. First the teleprinter functions, carriage return, <; line feed, ≡; letter shift, ↓ ; R to denote rainfall ; figure shift, ↑ ; are performed. If '4' is the station code and 0140 is rainfall in millimetres and □ is space, the corresponding final print out will be

R 4444 0140 0140 0140 0140

The teleprinter data input line should generally be at + 80 volts which represents 'stop' so that the machine does not race. A 20 millisecond low, — 80V, pulse starts the machine. The five teleprinter code bits are of 20 millisecond duration each at 50 bauds. These enable either a teleprinter function or printing a character depending on the code. The teleprinter code used is given in Table 2. After the 5 code bits, a +80V provides a stop signal. As soon as the print enable signal goes high, the bit counter in Fig. 6 is enabled with 20 millisecond pulses at its input. As the counter is reset at B_8, 160 millisecond pulses are at the input of character counter. 160 milliseconds is the time for one teleprinter function or to print a character or figure. When print command is high through gates, the output of the multiplexer at Fig. 7 is a low when B_0 is high as all the controls of multiplexer $\bar{Q}_2$, S, L and O are low, and a high when B_6 or B_7 is high as control S goes high. These provide the start and stop commands to the teleprinter. When B_1 to B_5 are high, the 5 bit teleprinter codes are to be available in sequence at the multiplexer output.

The 160 mS pulses at the output of the bit counter drives the character counter. At C_0 B_2 and C_0 B_4 the data in the shift register is shifted two more places to right as the clock to the shift register goes high. At C_1 the function carriage return is performed as the output of the multiplexer goes high at C_1 B_4. At C_2 for line feed, C_2 B_2 should make the output high. At C_3, B_1 to B_5 all should be high for the letter shift, *i.e*, $C_3P=1$, where $P=\overline{(B_0+B_6+B_7)}$. At C_4 the letter 'R' is printed as C_4 B_2 and C_4 B_4 makes the output high. At C_5 the figure shift is performed using the relation $C_5.P.B_3=1$, when B_1, B_2, B_4 and B_5, are high. Thus the character counter is used to perform the teleprinter functions. At C_6 the character counter is disabled and the word counter is enabled.

During N_0 a space function is performed as $C_6N_0B_3$ make the output high. At N_1, the 20 millisecond pulses B_1, B_2, B_3, B_4, and B_5 each shift the data in the shift register one place to right and the first five data bits in teleprinter code have passed through at the output of the multiplexer as control 0 is high to get a print out of the first digit. The ceond, third and fourth digits are printed out during N_2, N_3 and N_4. Thus the station identification repeated 4 times is printed out and N_5 resets the counter and the repeat counter advances to its next state R_1.

When R_1 is high, at N_0 a space function is performed, at N_1, N_2, N_3 and N_4 the thousands, hundreds, tenths and units of rainfall data stored in the shift register are shifted out to get a print out. The next three repetitions of the data stored in the register is printed out at R_2 , R_3 and R_4.

At R_5 the printing control counter and print command flip flop are reset. The print command goes low and the printing control circuit is no more operative.

The teleprinter control unit consists of a relay driver which operates a relay to keep the teleprinter input line at + 80V corresponding to a high output of the multiplexer and at — 80V corresponding to low. A 12 volts regulated supply to power the circuits is also incorporated in this unit.

8. Performance

The tape recording part of the equipment was tested in the Instruments Division, Pune with the actual telemetering raingauge data during the 1978 monsoon. The system was being left on after setting the time at 10.30 A.M. till 12.00 noon regularly. The inaccuracy in timing never exceeded 15 seconds during these periods. This is considered remarkably good as the counter can be set to an accuracy of 6 seconds only and the timer accuracy is specified as 1.5 per cent.

The whole equipment has been tested in the laboratory regularly and was found to work quite satisfactorily. A basic requirement for printing is that the signal has to be recognised distinctly above noise. Though the duration of transmission is about one and a half minutes the printing out at 50 bauds is accomplished in just 5 seconds and the system is ready to accept the next data.

The receiver output can be accepted directly by the circuit for storage and print out. But the storage in tape provides the additional facility of playing it back several times. The tape recorder served as a continuous source of data which was absolutely essential for the development of this equipment.

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