TOCOM SYSTEM

BI-DIRECTIONAL CABLE TELEVISION

INFORMATION AND CONTROL TRANSMISSION SYSTEM

Presented by

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ABOUT THE AUTHOR

Bill Osborn graduated from Texas A&M University in 1957 with a BSEE after serving for several years as an Army Officer. He is a Professional Registered Engineer and a member of Tou Beta Pu, Eta Kappa Nu, Texas Society of Professional Engineers and Rotary International.

After graduation, Mr. Osborn worked for Sandia Corporation and was responsible for establishing a secondary standards laboratory for the AEC. He then joined National Data Processing Corporation in Dallas and was involved in the design of one of the initial automatic banking and check sorting systems. In 1962, Mr. Osborn joined Arps Corporation as Vice President of Engineering. During his tenure with Arps he was responsible for the development of logging tools for the oil industry.

Mr. Osborn has been involved in numerous projects, including automation and control systems, instrumentation systems, computer systems, and communication and broadcast systems. Mr. Osborn is the inventor of several patents relating to instrumentation and the oil industry.

INTRODUCTION

TOCOM is the NOW TOTAL CATV COMMUNICATIONS SYSTEM developed by CAS Manufacturing Company. Bi-Directional Flow of information on a single cable, particularly the ability to transmit information from the subscriber to a central receiving point and to transmit control information to each subscriber location, is the end product of the TOCOM System.

TOCOM is a broad band, single cable, bi-directional CATV Communications System providing conventional 26 channel forward transmission, a 26 channel converter receiver, a crystal controlled subscriber identified digital transmitter, built into the converter, a hub located computer interface interrogator and master computer memory bank.

TOCOM is the vehicle to provide home protection systems, pay television, surveys for television rating service, controlled television channels, meter reading, amplifier level monitoring, and instant "subscriber response" polls, via automatic computer read-out and billing. Remote use of computers from the home and narrow band picture phone are possible future uses. Providing any one service would not economically justify a total communications system. Providing all services is an open door to profitably increasing subscriber revenues.

TOCOM SYSTEM - BI-DIRECTIONAL CABLE TELEVISION INFORMATION AND CONTROL TRANSMISSION SYSTEM

The TOCOM system consists of three primary elements - a Central Data Terminal, a Bi-directional coax amplifier system, and a large number of Remote Transmitter Receiver units. In general, the TOCOM system has the capability of transmitting from the Central Data Terminal, interrogation information to one or more selected Remote Transmitter Receivers. This causes the Remote Transmitter Receiving unit or units that have been interrogated by the interrogation signals to sample certain data and to transmit this information back to the Central Data Terminal, with all signals being transmitted on a single coax cable.

The system as it is presently designed, though expandable, has the capability at any Remote Transmitter Receiver location of interrogating seven words of information, each word containing 16 bits. In the present system, the seven words of 16 bits are so coded to return certain specific information; however, the seven words of 16 bits could be coded to return any information so desired. In addition to being able to obtain the interrogated information, the system also has certain other capabilities which will be discussed later in this paper.

The system as it is presently designed and presently coded at each Remote Transmitter Receiver location, will interrogate the following information. Referring to Figure 1, the system can determine if there is a fire, ambulance or police alarm activated at the location; it can determine to what channel the set is tuned; it can determine if the selected Pay TV channels have been authorized by the User; it can determine what opinion

the user has (in conjunction with video signal the user is asked a question, he then will make his selection by pushing one of three buttons on the Remote Transmitter Receiver, thus indicating that his opinion is NO - YES - or NO OPINION). Also the system can determine if the TV set is on or off. In addition the Remote Transmitter Receiver unit, when connected to kilowatt hour meter, gas meter, water meter, or any other such type of device, can automatically read the meter or meters. In addition to being able to determine the specific information mentioned above, the system in conjunction with a digital computer that is located at the Central Data Terminal, can disable or enable select remote units, can determine where faults occur in the line, and determine if any specific Remote Transmitter Receiver unit has failed.

For the future of the system, with very little modification, we see the capability of not only interrogating information from the remote locations, but also the control of devices at remote locations. For example, to turn on or off heating system or air conditioning systems at a given time, we can feed the cat, wake up a person, turn on the coffee pot, or any number of things that would be desirable to have control of from a Central location on an automatic basis. In general, the system has the capability of control and interrogation of remote units be they located in a CATV system or an industrial complex. It is possible with very little modification for the system to interrogate more information if desired. For example, we can include parity bits for reliability purposes, we can measure analog signals, we can increase the number of words and bits, and if necessary, we can increase the sample rate considerably over and above the rate the system is now presently operating.

The system, as it is now operated, has the capability of controlling one thousand Remote Transmitter Receivers per group with the capability of 30 groups, that is 30,000 Remote Transmitter Receivers on each trunk line and further the capability of handling in effect any number of trunk lines. So in general we may say that the system, as designed, has the capability of handling roughly 120,000 – 180,000 Remote Transmitter Receivers. This is a round number; we can control considerably less or considerably more, if necessary, but we feel from a practical standpoint this large number is really in excess of what will be necessary on any one particular system. The speed of the system is such that to sample 1,000 Remote Transmitter Receivers, or up to 180,000 Remote Transmitter Receivers, will only require 30 seconds. What this really amounts to, is that we will sample on a simultaneous basis, more than one Remote Transmitter Receiver. It requires approximately 30 milliseconds to sample one Remote Transmitter Receiver, obtaining from that Remote Transmitter Receiver, one 16 bit word. We can readily see that if we sample more than one Remote Transmitter Receiver at any one time then, in effect, our sample rate goes up such that we still require 30 milliseconds per word sample but sampling more than one Remote Transmitter Receiver at any one time enables us to go up to the sample rate of 180,000 Remote Transmitter Receivers in 30 seconds. This can be seen by referring to Fig. 2, whereby a Central Data Terminal is controlling N number of trunk lines with up to 30 groups of Remote Transmitters on each trunk line and each group on each trunk line containing up to one thousand Remote Transmitter Receiver units. You will notice in the Fig. 2, that from the Central Data Terminal, we are indicating that we have information flow to police, fire, ambulance, power company, etc. In general, what this indicates is that from the computer located in the Central Data Terminal, on command from the

computer based upon information received from the Remote Transmitter Receivers, we can automatically alert the police dept., fire dept., ambulance company; also, we can send data to the power company, water company, etc., such as to meter readings, etc.

In order to understand how this system operates, referring to Fig. 3, there is an indication of the format of the transmission of the system. The Central Data Terminal transmits interrogation information to the remote transmitter receivers with selected frequency coding in the 50 megacycle range. This information is received at each Remote Transmitter Receiver, operated on accordingly, and then transmits information back to the Central Data Terminal in the 6 to 30 megacycle region. The transmission back to the Central Data Terminal is as follows: Each group of Remote Transmitter Receivers on each trunk line is assigned a specific frequency; for example, 10 megacycles or 10.8 megacycles, 12 megacycles, 13.2 mgc., 14.7 mgc. (I might add that these frequencies have been selected such that harmonics fall in between the upper channels such that we don't end up with birdies in the video system.) Referring to Fig. 3, the operation or interrogation of any one Remote Transmitter Receiver unit is as follows: The Central Data Terminal transmits a master reset signal. This causes the remote transmitter receivers throughout the system to come to what we refer to as the initial state or reset state. We then transmit an ID Enable signal. This enables all the remote transmitters in the entire system to receive an ID code, which is 10 bits long, which is then transmitted to all of the Remote Transmitter Receivers. Each Remote Transmitter Receiver decodes these signals and, depending upon how it is decoded, in each Remote Transmitter Receiver, reacts to a particular ID code. For example, Remote Transmitter Receiver No. 1

in Group 1, and No. 1 in Group 2, and No. 1 in Group 3, etc., would all have the same ID code. When a Remote Transmitter Receiver receives it's code, it then, in effect, enables itself to say "OK I am the particular remote unit you are talking to, please send additional information." At this point, the Central Data Terminal transmits an additional signal which identifies the particular word that we would like to have interrogated from the Remote Transmitter Receivers which have received and identified themselves from the previous ID code. At this point, the particular switches, turned-on transistors, or whatever device we are interrogating, are enabled, or in effect, the information from these units, is transferred into the Remote Transmitter Receiver and at this point we then transmit 16 data shift bits from the Central Data Terminal. This causes the 16 bits of information which have been, in effect, brought into the Remote Transmitter Receiver from the combination ID code and word code and are caused to be shifted out, or in effect to be transmitted to the Central Data Terminal. The actual transmission is caused by the 16 bits turning on or off the appropriate 6 mghz oscillator, to 30 mghz oscillator, that is contained in the Remote Transmitter Receiver. This information is received at the Central Data Terminal and operated on accordingly.

In order to better understand the operation of the system, referring to Fig. 4, is a block diagram of a Remote Transmitter Receiving unit. At the remote unit, the information in the 52 mgc region and up is in effect bypassed through a by-pass filter and transmitted on to a conventional 26 channel converter which converts a particular channel, that is Ch. 2, 4, 6, 8, whatever it may be, to Ch. 12 and is transmitted to the users TV set. The 50 mgc interrogation information is brought to an RF section which is a portion of

the Remote Transmitter Receiver unit. Here the interrogation information is decoded in such a manner as to cause the appropriate information to be sent either the ID register, the word code register, or the data register. As previously explained, the ID register, when it recognizes its particular code enables the output remote transmitter. In addition, the word code enables a particular set of switches or devices to which we are interested in interrogating, i.e., the alarm, channel numbers, etc. This information is transferred into the data register and then, in conjunction with the 16 shift pulses, operates on a transmitter such that the 6 to 30 mghz, whatever the transmitter frequency happens to be, is returned back down the co-ax to the Central Data Terminal.

At this point I would like to add a few comments regarding the features of the system which we feel are unique. One is in reference to the opinion polls. Located on the front panel of the remote transmitter receiver are 3 push buttons labelled No - Yes - or No Opinion. The sequence of events of operation of these switches is as follows: From the video portion of the program a viewer is asked a particular question - what is his opinion about this or that - at this time the Central Data Terminal transmits a particular code to each Remote Transmitter Receiver which, in effect causes the opinion circuits in all Remote Transmitter Receivers to be reset. The purpose of this is such that as each Remote Transmitter Receiver is interrogated, it will be necessary for someone to have pushed the opinion button, just prior to the time that the opinion poll is taken. The purpose behind this is to not obtain an opinion from every set but only those that are properly activated by one of the users. Following this sequence of events a little further, the time has just occurred where we have sent the reset information to each opinion

circuit in each Remote Transmitter Receiver; the viewer has been asked the question, and at this time let's say for example he pushes the Yes Opinion button. Assuming a moment later, he decides No, I really meant No, then at that time he pushes the No button, this will cause the internal circuitry to, in effect, reset his Yes Opinion and to set his No Opinion, hence the person who has given his opinion has a short period of time to change his mind if he so desires. Also I would like to emphasize the condition that resetting this opinion circuit enables us only to obtain the opinion from people who actually activated the opinion circuits and not obtain an opinion that was, in effect, set by a child two hours before the program occurred. Referring again to Fig. 4, there is a certain portion of the remote transmitter receiver which is marked test. The purpose of this portion of the system is to enable the Central Data Terminal to send out certain selected information to each remote transmitter whereby we may in one condition disable every remote transmitter receiver throughout the system; we can, secondly, enable every Remote Transmitter Receiver on the system, or we can, by transmitting an identification code, along with a separate code, selectively enable or disable each respective remote transmitter unit. I will not get into the details of this but, from a maintenance point of view, this can be extremely helpful in operating on the system, if and when failures occur.

The Remote Transmitter Receiver units are so designed that the maintenance personnel, if a remote transmitter receiver fails, can in a matter of a very few moments change out a Remote Transmitter Receiver and have a new one in operation. To accomplish this simply required one to disconnect the coax coming into the unit from the CATV system,

to disconnect the cable running to the antenna input on the TV set, and the connectors going to the remote alarm units, water meter, etc. The maintenance personnel simply reverses this process and has to do one other item, that is to place three wires that are in the remote transmitter receiver digital section to certain pins which, in effect, identifies that particular remote transmitter receiver with a particular identification code. Now, in most systems where it is necessary to, in effect, have an identification code, requires the soldering or connecting of as high as 48 to 64 wires in the proper location. We have devised a system here whereby only three wires need to be soldered in place. Further, the system is simple enough that anybody that can subtract can accomplish this very readily. I will not get into the details of this at the moment but I would like to emphasize that the system is designed to accommodate not only the user but to facilitate maintenance, of the system. In regard to the maintenance and repair of the systems, in reference to the Remote Transmitter Receiver unit, the console at the Central Data Terminal is so designed that a Remote Transmitter Receiver unit that has failed can be brought into the console, plugged in and it can be immediately determined if the RF section or the digital section of the remote transmitter receiver has failed. Depending upon which area of the unit has failed, there is a cook-book routine which can immediately isolate which portion of the system has failed and the repair technician can take the appropriate action at that time.

Referring to Fig. 5, which is a block diagram of the Central Data Terminal, the Central Data Terminal consists of really three major elements. 1. The Central Data Processor, 2. a Hard Wire Controller/Display system and the RF system, and of course, the normal

TV head-end system. There has been extreme care put forth into the design of the Central Data Terminal in order to obtain maximum use of equipment, ease of maintenance, ease of operation, etc.

The system, under normal operation, would be controlled from the Central Data Processing unit as follows:
The Central Data Processer tells the Hard Wire Controller, I would like to have the information from certain remote transmitter units whose ID code is such and such and I would like to receive words 1, 2, 3, 4 or whatever it may be. The Hard Wire Controller at this point takes over, and with this information, actuates the 50 mghz RF transmitter which sends out the interrogation information to the remote transmitter receiver. The information is returned then from the appropriate Remote Transmitter Receiver units and is brought into the display portion of the system. At this time the Hard Wire Controller tells the computer, I have the information - come get it. At this point then the Central Data Processor will bring in the 16 bit words from each remote transmitter receiver which was interrogated and then operate on this particular information as it so programmed.

Now, I would like to emphasize that the system was designed to operate normally on this basis, such that the Central Data Processor then has the maximum amount of free time to do other functions, such as bookkeeping, statistical analysis, etc.

However, it is possible to operate under two other modes of operation. The second is what we call the direct mode. In this type of operation, the Central Data Processor

bypasses the Hard Wire Controller and directly controls the 50 mghz RF transmitter system, and can control the head-end system and the display system directly. Under these conditions, the Central Data Processor will then cause the 50 mgc RF transmitter to send out the interrogation pulses, the information will be received back and the Central Data Processor then obtains the information from the Display portion of the system. This design is to enable operation of the system if for some reason the Hard Wire Controller were to fail.

The third mode of operation of the system is a semi-manual mode. In this mode of operation an operator can take entire control of the system by going to the consŏle, operating certain switches, which will indicate to the system that he desires to interrogate a particular Remote Transmitter Receiver and he desires certain information to be returned from that Remote Transmitter Receiver. This semi-automatic mode was designed into the system such that, in effect, the system could go off-line from the computer; monitor, for example, the alarm conditions on a continuous basis and leave the Central Data Processor free for other purposes so desired. In addition it gives a back-up if the Central Data Processor were to fail.

By using a Central Data Processor, i.e., a digital computer in the system, it is possible to do any number of things with the data received. In effect, we open up a pandora's box as far as capabilities. For example, the Central Data Processor can;

1. detect when an alarm condition occurs, and via an automatic system call the fire dept., police dept., or ambulance company and alert them to the fact that there is a fire, burglary, or whatever it may be at a specific location. In addition,

in the case of a fire, some additional information may be transmitted to the fire department. For example, we may alert the fire department that the fire is at a Paint Factory, an Old Age Home, or a Hospital and is a particularly critical situation. Or, for example, it may alert the police dept. that there is a burglary occurring at a jewelry store which would require a little more haste than if it were a warehouse containing newspaper.

Further, with the use of the Central Data Processor, we can determine any number of different types of statistical information. For example, in reference to opinion polls, we can determine by area who had what opinion. For example, does the south side of town have a different opinion than that of the east, north, west, etc. Since we are able to determine on a real time basis to what channel each set is tuned and whether the set is on or off it is easy to determine a TV rating type poll. For example, how many people are watching program A, how many are watching program B. I might add at this point, though we can't guarantee that certain people are watching the TV set but we can determine the TV set is turned on and tuned to a specific channel. It is quite feasible that by knowing this, and by use of the opinion poll portion of the system, we could determine more definite information. We could transmit an opinion poll asking people to respond by asking people to push the yes button if two or more adults are watching the program or push the no button if children under 12 are watching the program, etc. In reference to Pay TV, since we can determine who is turned to what channel on a real time basis, and that the Pay TV authorization switch is turned on we can automatically control Pay TV as far as billing. If customer 741 in Group 1

turns on his switch and turns to Ch 13, which is a Pay TV channel at 10:30 in the morning, then we will know within 30 seconds of when he turns his set on and we will know within 30 seconds of when he authorized and tuned to the Pay TV channel, and likewise we will know within 30 seconds of when he changed to a different channel and can, via the computer, automatically bill him for that particular Pay TV portion of the program.

In addition, with the ability to read the kilowatt-hour meter, water meters, etc., and in conjunction with the digital computer, it is possible for us to read the meters, simply store the raw date, transmit this data to the power company, water company, etc. or to calculate the bills, punch these out on punch cards, similar to what all of us receive in the mail every month. In effect, handle this portion of the reading of the meters and automatic billing in any way that the power company, water company, etc. so desires.

In general, and briefly speaking, it is possible, using the Central Data Processor, to operate on information in most any way we so desire. To bring this information out on telephone lines to remote locations, to another computer, or we can bring information out on punch tape, type it out on a teletype, we can put it out on disc memory, or mag tape, or punch cards. In effect, almost any manner or method that is so desired by the customer or by the operator, whichever the case may be.

I might further add that by programming the computer, it will act as a very powerful maintenance tool. If we interrogate certain Remote Transmitter Receivers, and we do not get any information back from a selected group, by proper programming we can readily determine that the probability is we have a line failure at a given point.

Likewise, it is true that if we interrogate a certain Remote Transmitter Receiver and have been unsuccessful in receiving any return signals from that unit, it is fairly obvious that that Remote Transmitter Receiver is malfunctioning. We can pinpoint this, and print out on a teletype and say to a repair man that the Remote Transmitter Receiver at 1701 Main Street has failed, or whatever the case may be. Further down the line we see the possibility and probability of placing Remote Transmitter Receivers along the coax system and monitoring such things as the AGC, the amplifier's gain, etc. Monitoring these measurements to determine if they fall within certain limits or detect changes such that if we see any type of failure we can alert the repair people, have them change out the failing amplifier, etc., before it actually fails.

Regarding the economics of the system, it is our opinion that with the extensive capability of this system, we feel that the economics are such that a good profit can be received by the operator in using the TOCOM system. For example, that the public is very ready for an effective, automatic, burglar alarm - fire alarm type system, because, in effect, we can monitor everybodys house that is on the system every 30 seconds and determine if they have a fire, burglary, etc. The TOCOM system is designed to readily accept the appropriate output signals from most fire alarms, burglar alarms, etc., or we can provide the system.

We feel that the ability to obtain opinions is an excellent revenue source from two points of view. 1. There are large quantities of money spent daily obtaining opinions from people - what kind of soap do you use, etc. Our system can easily be expanded - or used as it is to obtain such information. We can obtain this information, operate on

it, and bring it out in a useable form in a matter of minutes where by in most systems the information is days, weeks and in some cases months old before it is ever reduced to a useable form. In regard to the opinion poll, we feel that this can be used effectively in the psychology of people in the effort to put the Remote Transmitter Receivers in every home. For example, if housewife A watches an opinion program every day at 10:30 and she is giving her opinions, you can bet that housewife B next door is also going to have to have a Remote Transmitter Receiver unit in order for her to give her opinion as is housewife A.

From the point of view of Pay TV, we feel that this is the first system that is not only economical but useable in regards to an effective pay TV system. Keeping in mind that we know on a real time basis, who is watching what and when. Further knowing who is watching what and when, it gives us for the first time an effective TV rating service. This portion of the system alone should, properly used, bring in considerable revenue to the operator of a TOCOM system.

I believe that it is essential that it be kept in mind that the TOCOM system, although it is presently designed and built to monitor specific functions, does have the capability of interrogating literally any information at remote points and transmitting this information back to a Central Data Terminal. We have given considerable thought to the various uses of this system, as applied to the CATV business, however, I feel sure that as time goes on, other uses will be brought to our attention and I am sure, as the system is designed, it can be easily modified to accommodate these needs.

I would like to further add that the TOCOM system, in addition to use in the CATV industry has a large potential in other areas, such as automation of oil fields, pipe lines, utilities, power plants, water plants, factories; any place where it requires the control of elements at a remote point from a control console. The TOCOM system has the advantage over presently used systems, if for no other reason than the ability to run one coax cable in lieu of running literally hundreds of twisted pair of telephone cables as is now the common situation.

In reference to the cost of the system, we have not at this point determined hard-set costs for the Remote Transmitter Receiver or Central Data Terminal, etc. However, we feel that the Remote Transmitter Receivers, which do include the converters, will cost in the neighborhood of $100.00 each (approximately) and will vary from that value up or down, depending on quantities. In reference to the cost of the Central Data Terminal, this cost can range anywhere from probably $80,000 and up, depending on the requirements, and in general will be dictated a great deal by the number of people to be controlled or interrogated and to the amount of programming necessary to program the processor in order to accomplish the functions desired by the operator.

SYSTEM CAPABILITY

GENERAL: INTERROGATE SEVEN SIXTEEN BIT WORDS FROM EVERY REMOTE UNIT.

PRESENT SYSTEM DETERMINES:

1. FIRE
2. AMBULANCE
3. POLICE
4. CHANNEL NUMBER
5. PAY TV AUTHORIZED
6. OPINION CONTROL WITH RESET CONDITION
7. SET ON/OFF
8. KW-HOUR METER READING
9. GAS METER READING
10. WATER METER READING
11. DISABLE OR ENABLE SELECTED REMOTE UNITS
12. FAULT ISOLATION

FUTURE:

1. CONTROL OF DEVICES AT EACH REMOTE LOCATION
2. MONITORING OF LINE CONDITION
3. IN GENERAL - CONTROL OR INTERROGATION OF REMOTE LOCATIONS

SYSTEM CAN EASILY BE MODIFIED TO:

1. INTERROGATE MORE INFORMATION
2. INCLUDE PARITY
3. MEASURE ANALOG SIGNALS
4. INCREASE SAMPLE RATE

FIGURE 1

TOCOM

SYSTEM BLOCK DIAGRAM

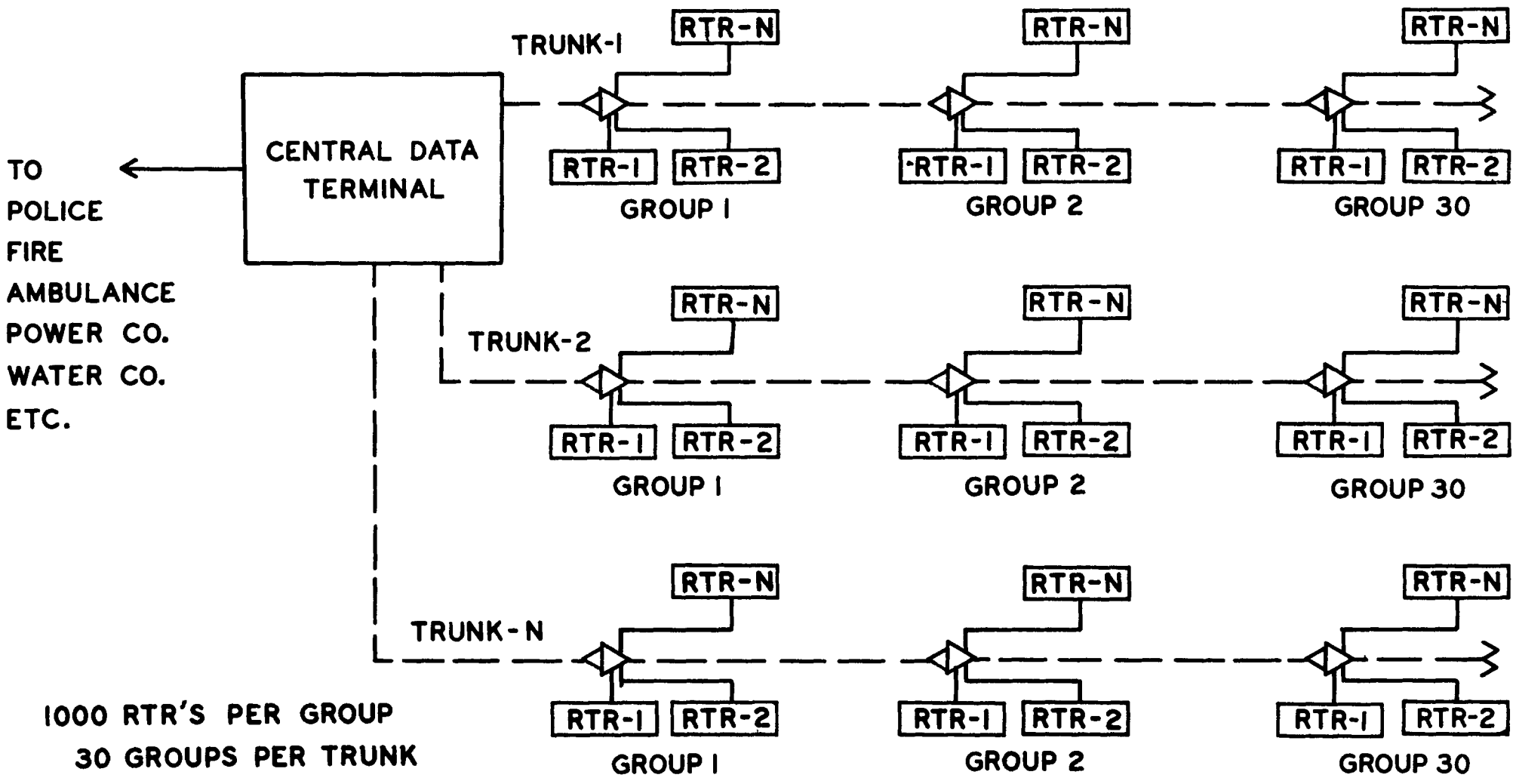

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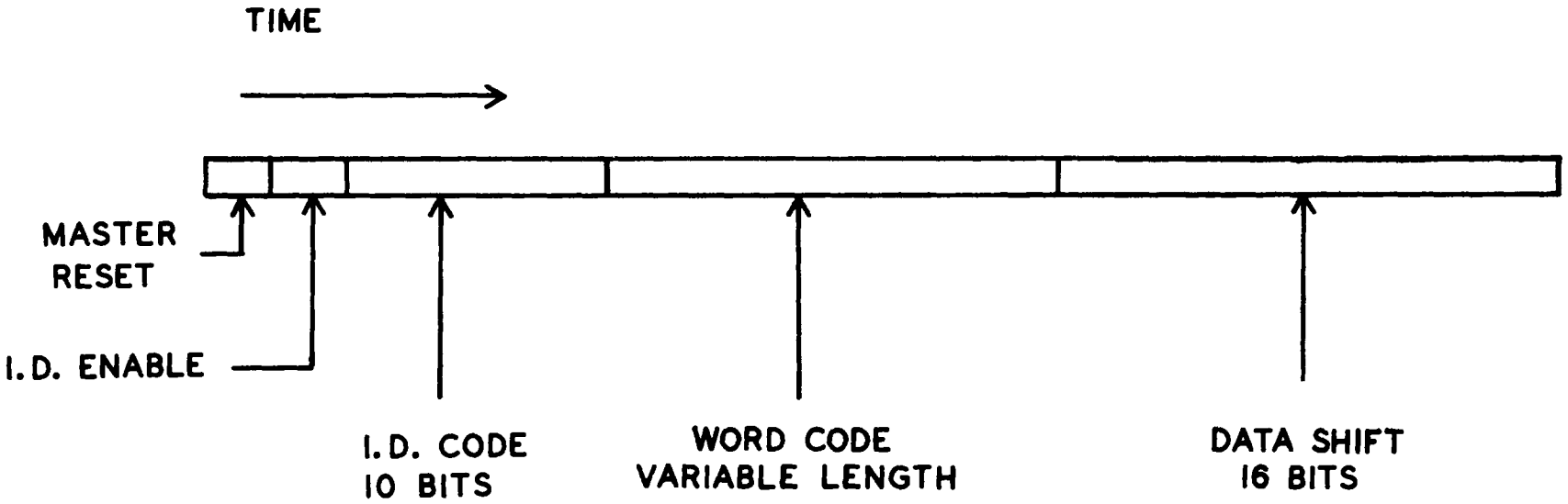
FIGURE 2

TOCOM



SIGNAL FORMAT

FIGURE 3

TOCOM

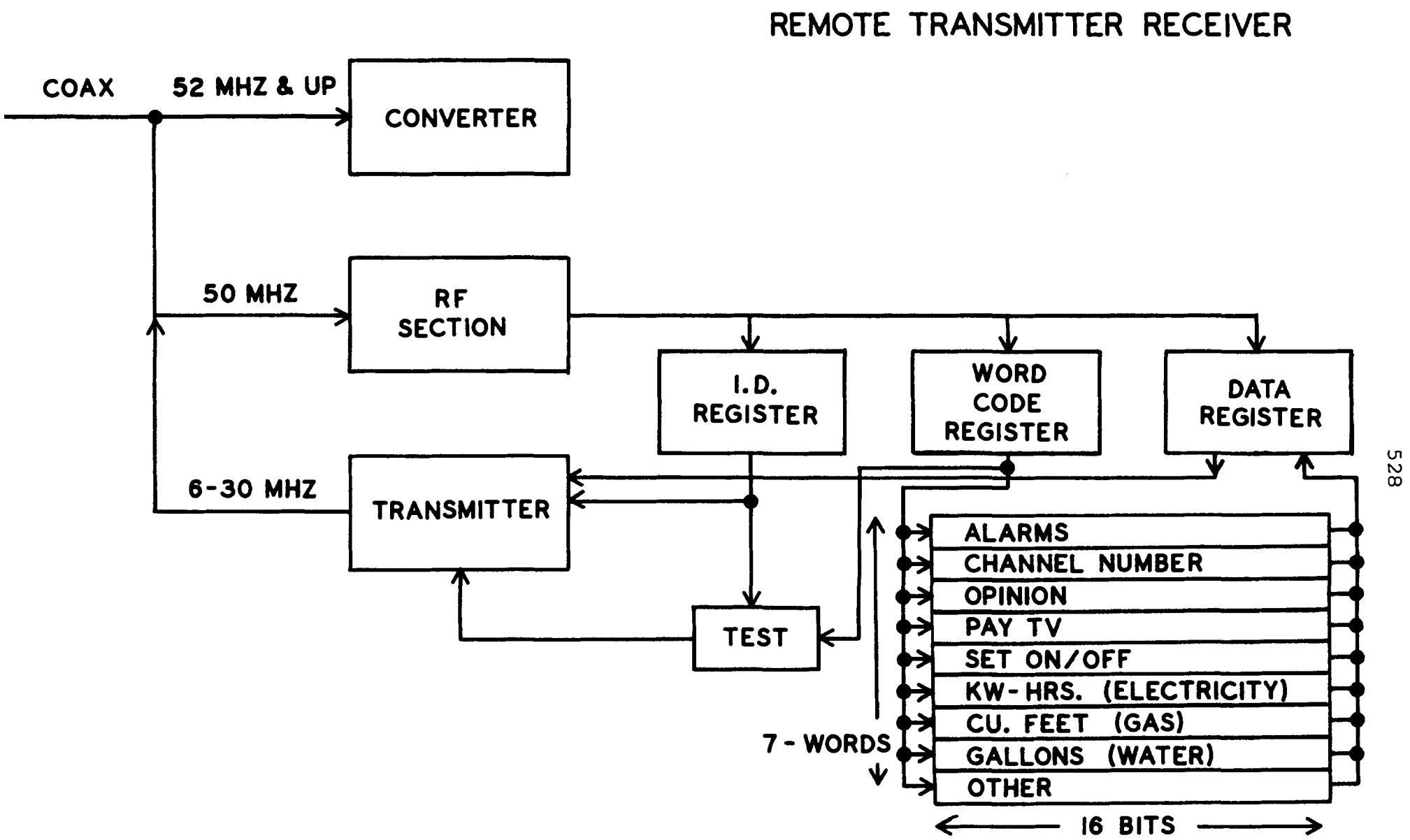


FIGURE 4

TOCOM

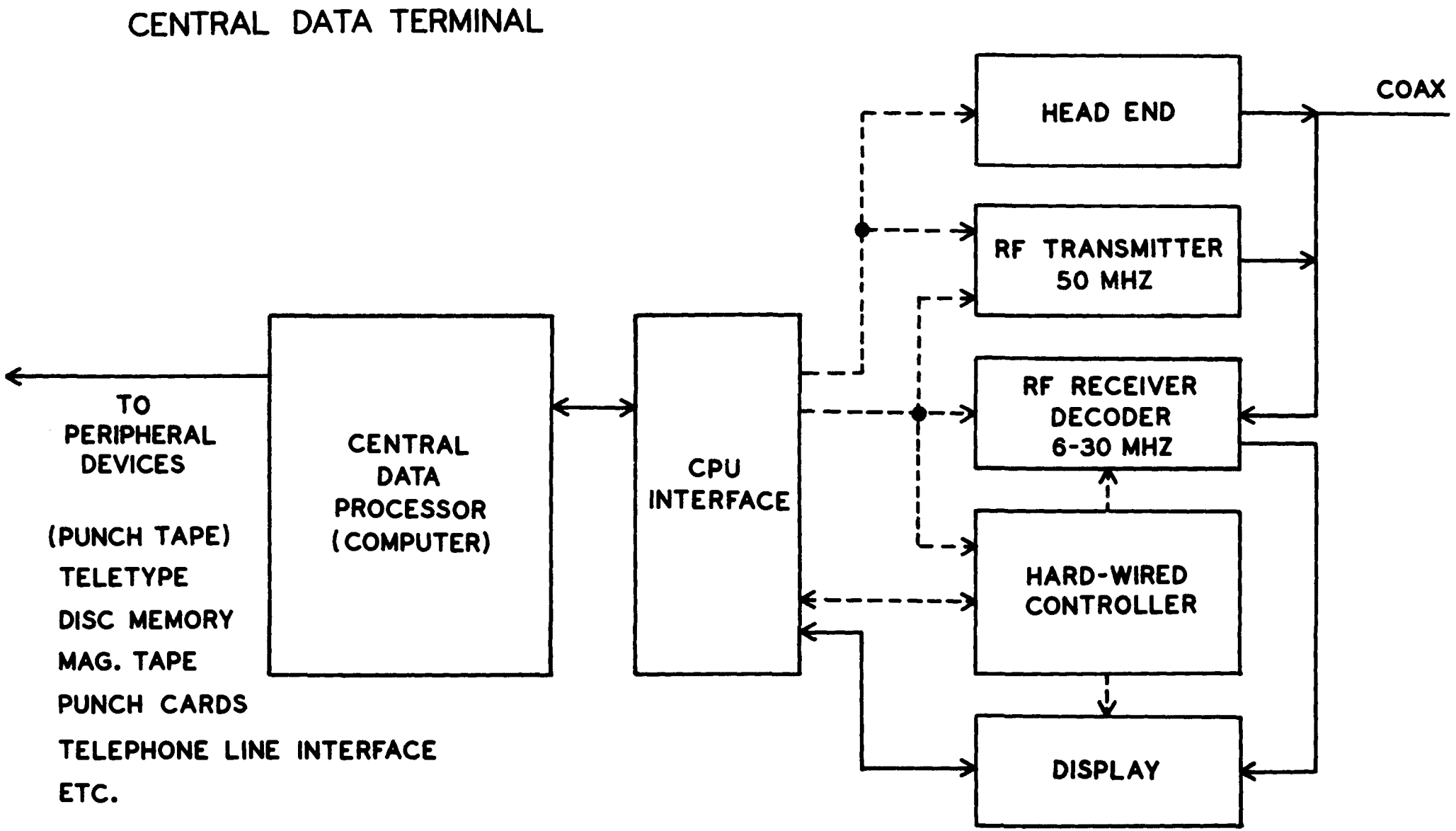


FIGURE 5

TOCOM