

AD-A058 094 ARMY COMMUNICATIONS RESEARCH AND DEVELOPMENT COMMAND --ETC F/G 17/2  
ATACS EQUIPMENTS. INTEROPERATION, BLOCK DIAGRAMS AND ABBREVIATE--ETC(U)  
MAY 78 G G BAIANO, C Q MURPHY  
UNCLASSIFIED CORADCOM-7A-2 NL

1 OF 1  
AD  
A058 094



END  
DATE  
FILMED  
10-78  
DDC



**LEVEL II**

12  
FB

ADA 058094

RESEARCH AND DEVELOPMENT TECHNICAL REPORT  
CORADCOM- 78-2

ATACS EQUIPMENTS  
Interoperation, Block Diagrams and Abbreviated Descriptions

AD No. \_\_\_\_\_  
JDC FILE COPY

Giustino G. Baiano  
Curtis Q. Murphy  
Center for Communications Systems

DDC  
AUG 28 1978  
E

May 1978

DISTRIBUTION STATEMENT  
Approved for public release;  
distribution unlimited.

**CORADCOM**  
US ARMY COMMUNICATION RESEARCH & DEVELOPMENT COMMAND  
FORT MONMOUTH, NEW JERSEY 07703

78 08 23 032

## NOTICES

### Disclaimers

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

The citation of trade names and names of manufacturers in this report is not to be construed as official Government indorsement or approval of commercial products or services referenced herein.

### Disposition

Destroy this report when it is no longer needed. Do not return it to the originator.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 17 CORADCOM-78-2	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
6 TITLE (and Subtitle) ATACS EQUIPMENTS, Interoperation, Block Diagrams and Abbreviated Descriptions,	5. TYPE OF REPORT & PERIOD COVERED	
	6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s) 10 Glustino G./Baiano Curtis Q./Murphy	8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Communications R&D Command ATTN: DRDCO-COM-RO Fort Monmouth, New Jersey 07703	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS  694357212803901	
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Communications R&D Command ATTN: DRDCO-COM-RO Fort Monmouth, New Jersey 07703	12. REPORT DATE 11 May 78	
	13. NUMBER OF PAGES 28 (12) 33 p.	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 9 Research and development Technical rept.,	15. SECURITY CLASS. (of this report)  UNCLASSIFIED	
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report)  (A) Approved for Public Release; Distribution Unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)  ATACS Equipments, Block Diagrams, Equipment Configurations, TD-1065, TD-1069, KG-27, AN/GRC-103, TD-976		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  This report summarizes and presents the primary system interface parameters of ATACS equipments, and shows the required interconnections among them. Included are annotated block diagrams, bit rates, frequencies, number of channels, power levels, antenna sizes, and details of the cable system. The present PCM voice system is discussed, and its expansion to the high data rate (32 kb/s) system by use of the TD-1069 and TD-1065 explained.		

H10 489 B



## CONTENTS

	<u>PAGE</u>
PURPOSE .....	1
SUMMARY .....	1
DISCUSSION .....	2
ATACS Analog System .....	2
ATACS Cable System .....	2
Low Capacity System .....	6
Medium Capacity System .....	9
Multichannel Troposcatter PCM Communication .....	14
Interim System .....	15
High Capacity System .....	15
Extension of ATACS to Data Transmission .....	22
Non-ATACS Configurations .....	25
CONCLUSION .....	28

## FIGURES

1. ATACS 24 Channel Cable System .....	3
2. AN/TRC-145 - Low Capacity System .....	7
3. AN/TRC-113 and AN/TCC-65 - Low Capacity with Cable Conversion .....	8
4. Medium Capacity System .....	10
5. Biternary Detection Process .....	12
6. Medium Capacity System .....	13
7. 12 Channel PCM Multichannel Tropospheric Scatter Terminal .....	16
8. 24 Channel PCM Multichannel Tropospheric Scatter Terminal .....	17

CONTENTS

	<u>PAGE</u>
FIGURES (cont'd)	
9. Present High Capacity System - Interim Use .....	18
10. Future High Capacity System .....	20
11. ½ Baud, Bipolar Modulation .....	21
12. Data Transmission through ATACS .....	24
13. Data Transmission Over Cable .....	24
14. Non-ATACS 48 Channel System .....	26
15. Non-Standard Cable Configuration .....	27

ACCESSION BY		
DWS	White Surface	<input checked="" type="checkbox"/>
DGS	Buff Surface	<input type="checkbox"/>
UNANNOUNCED <input type="checkbox"/>		
JUSTIFICATION .....		
BY .....		
DISTRIBUTION/AVAILABILITY CODES		
Dist.	AVAIL. and/or SPECIAL	
A		

## ATACS EQUIPMENTS

### Interoperation, Block Diagrams and Abbreviated Descriptions

#### PURPOSE

This report has been prepared to summarize and present the primary system interface parameters of the army tactical multi-channel communication system (ATACS).

#### SUMMARY

The present ATACS system is mainly PCM voice, with some low-speed data transmission (TTY). It is being expanded to include "high-speed" data (up to 32 kb/s), by use of the TD-1065 (in production) and TD-1069 multiplexers. (They will be fielded in 1979-80, and will insert the data into a TD-660 576 kb/s data stream). This report discusses both the present systems and the future system.

This report shows the required interconnections among basic equipments normally employed in the ATACS systems. These equipments may be located in several different shelters, miles apart, interconnected by the cable system and in the form of many different physical configurations. In addition, these systems are multichannel in capability and will transmit voice, teletype, facsimile and torn tape data. (One voice channel of the TD-660 is used for each type of service).

The major functional characteristics and interface relationships are described by means of annotated block diagrams giving such information as bit rates, frequencies, number of channels, power levels, antenna size, etc.

These systems, once they have been properly configured, are designed for distribution throughout the field army. They are to be found in brigade, division and corps areas and provide command and control communications throughout all levels of command in the theater.

These assemblages are, for ease of transportability, housed in shelters or trailers and transported by trucks (or aircraft). They are energized by field electrical generator sets or by commercial power if available.

Additional information and guidance on deployment, configurations and interoperability relating to these ATACS systems may be obtained by referring to the ATACS document called "Description of Army Tactical Communications Assemblages and Equipments". This document had been prepared by the office of the ATACS Project Manager and was published 1 January 1974.



## DISCUSSION

### a. ATACS Analog System

#### (1) ATACS Cable System (Figure 1)

The cable system provides for transmission of 6, 12, or 24 voice channels between terminals separated by up to 40 miles (the 6 channel mode is seldom used). The TD-660's perform analog to digital (A/D) conversion and 6 bit pulse code modulation (PCM) encoding of the 12 channels into a single 576 kilobits per second (kb/s) stream. (For 6 channel use, adjacent channel time slots are doubled, and the data rate halved to 288 kilobits per second). This stream is then sent, along with appropriate timing signals, to the TD-754 (or TD-204) Cable Combiner. The 6th PCM bit of channel 12 is a series of alternate ones and zeros (10101010...) called "framing" pulses, and constitute the timing signal for the Master TD-660. The 6th bit of channel 12 of the Slave is a series of 1100110011... pulses. These allow identification of Master and Slave at the receive end. The Slave PCM pulse train is synchronized to the Master PCM pulse train by the synchronization signal shown in the figure. The pulse shape is unipolar NRZ (non-return to zero), since there was no standard digital interface when the equipment was designed. (The TD-754 is a newer version of the TD-204, with the same electrical characteristics).

The cable combiner modulates the input baseband signal (576 kb/s) onto a suitable carrier, and transmits dipulse signals over the CX-11230 cable to the receiving TD-754 at a 2,304 kb/s rate. The signals propagated over the CX-11230 cable are dipulse, and are used to minimize cable losses. (These dipulse signals occur at a 2304 kb/s rate, whether 12 or 24 channels of voice are transmitted. When used for 24 channels, two TD-660's are used, the Master providing timing to the Slave).

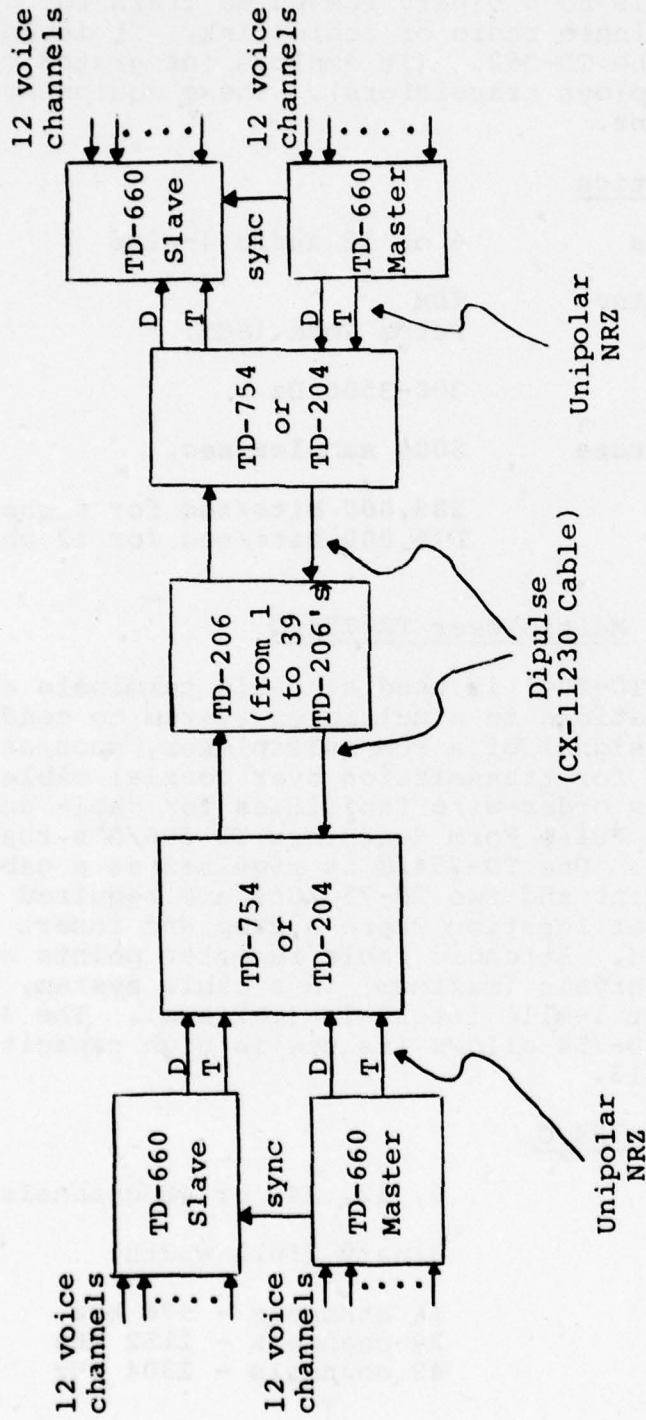
The TD-206 pulse restorer is used to extend path length by re-shaping the pulse, and is spaced at 1 mile intervals.

The receiving TD-660 demultiplexes the serial stream into 12 parallel channels, does the D/A conversion, and delivers the 12 voice channels.

This cable system is often used with a radio terminal to distribute voice channels from the radio site to remote sites. This distribution is shown in later sections of this report.

Characteristics of components of the cable system are given below.





Pulse Rates

Unipolar NRZ - 576 or 1152 kb/sec  
 Dipulse - 2304 kb/sec

Legend

D - Data  
 T - Timing

FIGURE 1. ATACS 24 Channel Cable System

### Multiplexer TD-660/G

The Multiplexer TD-660 provides the capability of converting up to 12 voice channels to a binary PCM pulse train for duplex transmission over a single radio or cable link. It is an improved version of the TD-352. (It employs integrated circuits, whereas the TD-352 employs transistors). These equipments are electrically equivalent.

#### Technical Characteristics

Number of channels	6 or 12 audio 4-wire
Type of multiplexing or modulation	TDM Pulse Code (PCM)
channel bandwidth	300-3500 Hz
channel sampling rate	8000 samples/sec.
output bit rate	288,000 bits/sec for 6 channels 576,000 bits/sec for 12 channels

### Multiplexer TD-754/G

The TD-754/G (or TD-204) is used at cable terminals and attended repeater locations in a multiplex system to condition the input and output signal of a PCM multiplexer, such as Multiplexer TD-660/G, for transmission over coaxial cable. The TD-754/G also provides order-wire facilities for cable and radio systems and power for Pulse Form Restorers TD-206/G's that are used in cable systems. One TD-754/G is required at a cable to GRC-103 conversion point and two TD-754/G's are required at an attended cable repeater location where a drop and insert capability is required. Attended cable repeater points are placed at 40 mile intervals (maximum) in a cable system, with TD-206/G's required at 1-mile intervals (maximum). The 48 channel mode of the TD-754 allows its use in high capacity systems, such as Figure 13.

#### Characteristics of TD-754/G

Channel capacity	6, 12, 24, or 48 channels
Pulse type	Binary (full width)
Pulse rate	12 channels - 576 kHz 24 channels - 1152 kHz 48 channels - 2304 kHz

### Cable Input and Output Signal

Impedance	62 ohms
Amplitude to cable	0 to peak, 2 volts
Amplitude from cable	30 mv. p-p nominal
Type	Dipulse
Bit Rate	2.304 MHz
Order Wire Facility	Baseband independent of PCM traffic
Frequency response	300 to 1700 Hz
Signaling Frequency	1600 Hz
Power requirements	109-121 V, 47 to 63 Hz 62 watts

The TD-754 is an improved cable combiner over the TD-204 (smaller, lighter in weight, using integrated circuits).

### Pulse Form Restorer TD-206/G

The Pulse Form Restorer TD-206 is a two-way, regenerative repeater used in a cable system to re-time and regenerate the original pulse train in both directions of transmission. The TD-206 eliminates distortions caused by noise and band width limitations. The distribution of TD-206's in a cable system is 1 mile intervals, and 39 restorers can be used before an attended repeater is required. Power for the TD-206 is provided by the TD-204 or its replacement, the TD-754. The TD-206/G has connectors that mate directly with CX-4245 cable. The newer TD-206B/G has connectors that mate directly with CX-11230 coaxial cable.

### Characteristics

#### Input and Output

Impedance	62 ohms
Input Signal Amplitude	30 mv pp max; 10 mv pp min.
Output Signal Amplitude	Leading edge of pulse 2V from 0 to peak



Pulse type	Dipulse
Pulse rate	2.304 MHz
Power requirement	38 ma constant current (supplied by TD-204 and TD-754)

(2) Low Capacity System

The low capacity (12 channel) ATACS system is shown in Figure 2, for the direct radio connection.

The TD-660 sends its serial data 576 kb/s digital stream to the AN/GRC-103, which transmits the data as an FM modulated RF carrier. The radio operates over the frequency range 220 to 1850 MHz, by use of one of four RF heads designated Band I, Band II, Band III, or Band IV. The receiving AN/GRC-103 detects the RF signal and extracts timing from the detected bit stream. It then delivers the data and timing to the TD-660, where the voice channels are demultiplexed and detected. Wave-shapes between the TD-660 and AN/GRC-103 are unipolar NRZ.

If the transmitter site is separated from the subscriber site, by up to 40 miles, a cable system (as in Figure 3) is inserted between the AN/GRC-103 and the TD-660. The pulse restorers (TD-206) are located at 1 mile intervals. This is called a low capacity system with Cable Conversion, and is shown in Figure 3. (A TSEC/KG-27 may be located between the TD-660 and TD-754 to provide security, as shown in Figure 3).

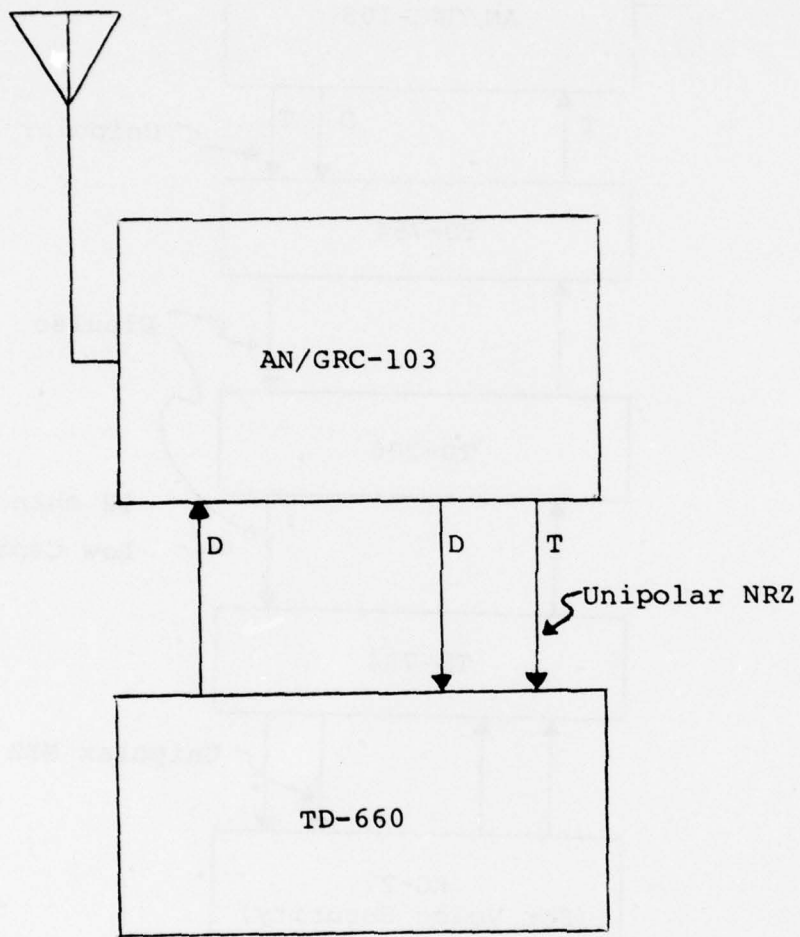
Security Device TSEC/KG-27

The TSEC/KG-27 encryption device is used to provide security whenever the TD-660 is used. It was designed especially for this purpose. Its operation is explained in reference to Figure 3.

Functionally, it is in series with the output 576 kb/s bit stream out of the TD-660, and before the TD-754. (If the cable system were not used, it would be between the TD-660 and the radio). On transmission, it accepts a clear data stream and outputs an encrypted data stream, at the 576 kb/s rate. It provides the inverse function during reception. It requires timing, data and framing pulses over separate lines during transmission and provides data out, during transmission. On reception, it requires data and timing from the radio and provides data, timing and framing to the local TDM equipment. All input and output lines carry NRZ unipolar signals.

All the equipment configurations of this report could be secured in this fashion.

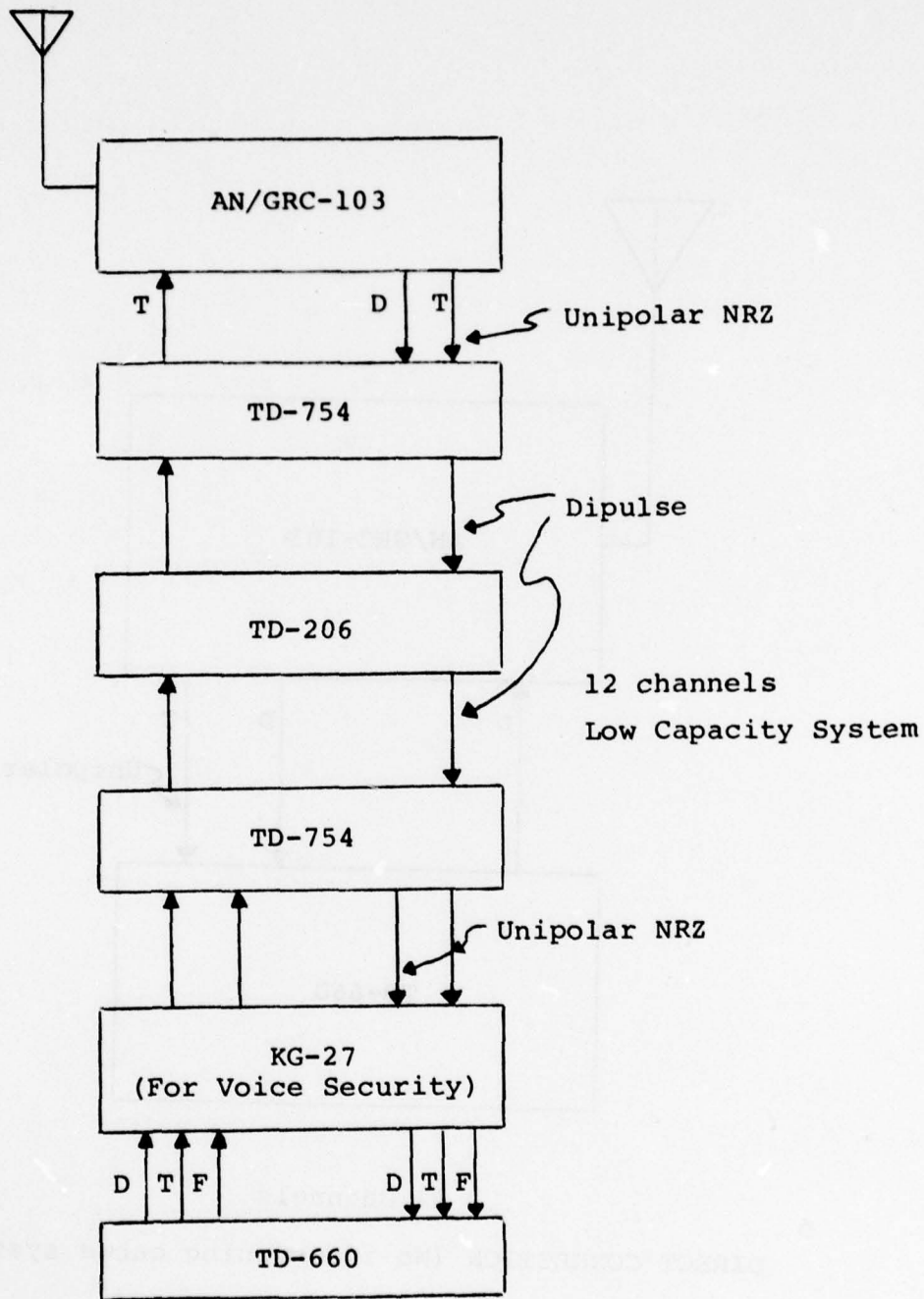




12 Channels

DIRECT CONNECTION (No intervening cable system)

FIGURE 2. AN/TRC-145 - Low Capacity System



TD-206 repeater used only at one mile intervals.

Cable-Radio Conversion (Sometimes referred to as split terminals)

The TSEC/KG-27 is used with the TD-660 when security is required.

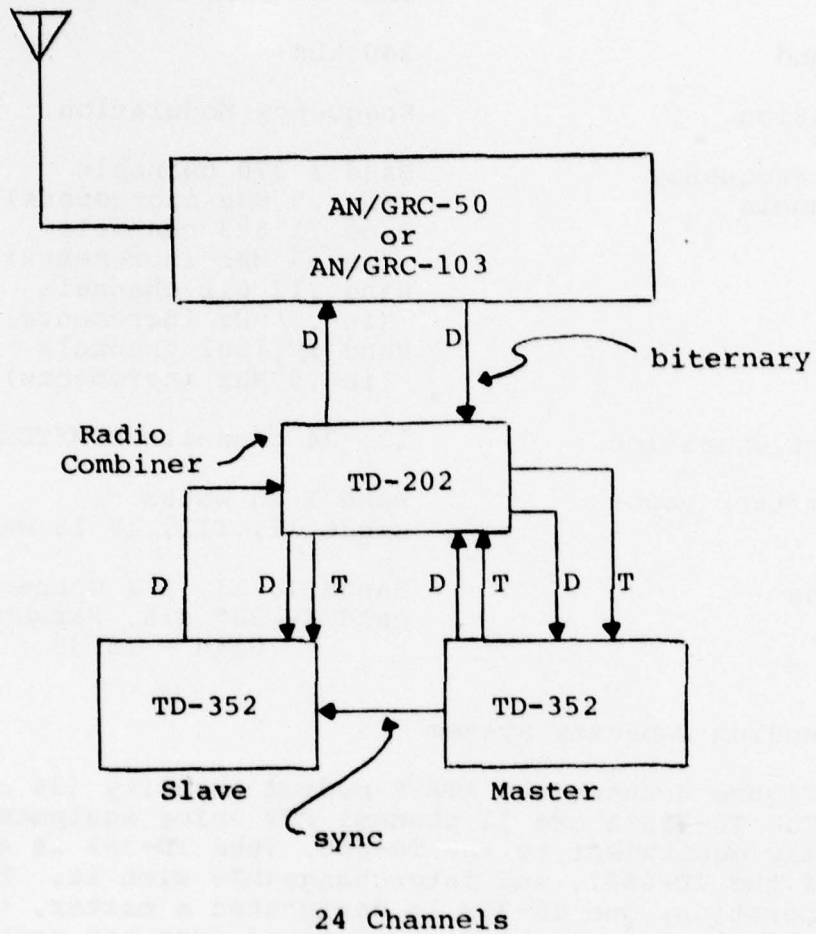
FIGURE 3. AN/TRC-113 and AN/TCC-65 -  
Low Capacity with Cable Conversion

### Characteristics for the AN/GRC-103

Frequency range	Band I 220-404.5 MHz Band II 394.5-705 MHz Band III 695-1000 MHz Band IV 1350-1850 MHz
Baseband	240 kHz
Modulation	Frequency Modulation
Radio Frequency Channels	Band I 370 channels (in .5 MHz increments) Band II 623 channels (in .5 MHz increments) Band III 612 channels (in .5 MHz increments) Band IV 1002 channels (in .5 MHz increments)
Type of Operation	12, 24 channels PCM/TDM
Transmitter Power	Band I 25 watts Bands II, III, IV 15 watts
Antenna	Bands I, II, III Corner Reflector Band IV 38" dia. Parabolic Dish Gain - 18 dB

### (3) Medium Capacity System

Figure 4 shows the ATACS medium capacity (24 channels) system. The TD-352's are 12 channel PCM voice equipments, electrically equivalent to the TD-660, (the TD-352 is an earlier version of the TD-660), and interchangeable with it. For 24 channel operation, one TD-352 is designated a master, the other a slave. Timing for the slave is derived from the master unit, which also transmits timing to the TD-202. The transmitted data signal from the master TD-352 consists of a series of "framing" pulses (10101010...) which are the PCM pulses in the 6th pulse position of channel 12, of the master unit. (The slave transmits 0011001100... as its framing pulse). The pulse shape is unipolar NRZ, the same as data pulse shapes. Both data and timing pulses are sent to the radio combiner TD-202. The TD-202 accepts 24 input channels (or 12) and combines them, by interleaving, into a 1152 kb/s stream of binary pulses, which passed through a Gaussian filter before being used to FM modulate the AN/GRC-50 radio. This signal is called biternary, and is an analog signal. A three level detection technique is used inside the TD-202 to supply the two detected 576 kb/s PCM pulse trains. The biternary detection process is described below, with reference to Figure 5.



Direct Connection (No cable system involved)

FIGURE 4. Medium Capacity System  
(In Common Use)



Channel S (slave) and channel M (master) input data to the TD-202 at 576 kb/s, as shown in the figure. Inside the TD-202, a timing signal at twice this rate (1052 pulses/sec) samples both channels, and interleaves the data, as shown in "d" of Figure 5. This data stream is passed through a Gaussian filter (within the TD-202) and the output analog waveform is shown in "e". This is the biternary signal which modulates the radio. It is also the signal output from the radio to the TD-202 on the receive end of the link.

The radio combiner then performs a three level detection process, as shown in the shaded portion of diagram "e". A signal whose amplitude is in the region "B" is a 1 for both Channel "S" and "M". A signal whose amplitude is in region "C" is a "0" on each channel. The framing signal for each channel (101010... for Master, and 11001100... for Slave) provides a synchronizing signal in the receiver which identifies the S and M timing signals within the TD-202. This allows the assignment of all detected pulses, including those whose amplitude is in the "A" shaded region of diagram "e" of Figure 5, into the proper S or M channel.

By this three level detection technique, the biternary data input stream is separated into its output data stream.

The purpose of the biternary modulation is to send 24 channels over a radio whose bandwidth was designed for a 12 channel binary transmission, corresponding to a 576 kb/s bit rate. By sending a 3 level 576 kb/s signal, a certain amount of performance is sacrificed. (The maximum range of transmission is less for biternary than it could be for binary transmission at the same bit rate). However, this is an acceptable trade-off. Therefore, by use of the biternary signal, 24 channel PCM voice is transmitted over the AN/GRC-50 or AN/GRC-103 which otherwise could transmit only 12 channels.

The medium capacity system using the cable extension system is shown in Figure 6. The multiplexer TD-202 is described in more detail below.

#### Multiplexer TD-202

The multiplexer TD-202 is a 12 or 24 channel PCM radio transmission interface unit. The transmit section of the TD-202 accepts the output either from one or two TD-352's, or a TD-204, or from another TD-202 and processes it for radio transmission. The receive section accepts the PCM output from a radio receiver, processes and re-times it, and extracts the order-wire signal. The TD-202 is used at a radio terminal, radio repeater, or a radio-to-cable conversion point. The TD-202 also accepts the output from either one or two TD-660's, or a TD-754. The TD-202 is used as the radio transmission interface for 24 channel operation except where the radio set has its own built-in combiner.

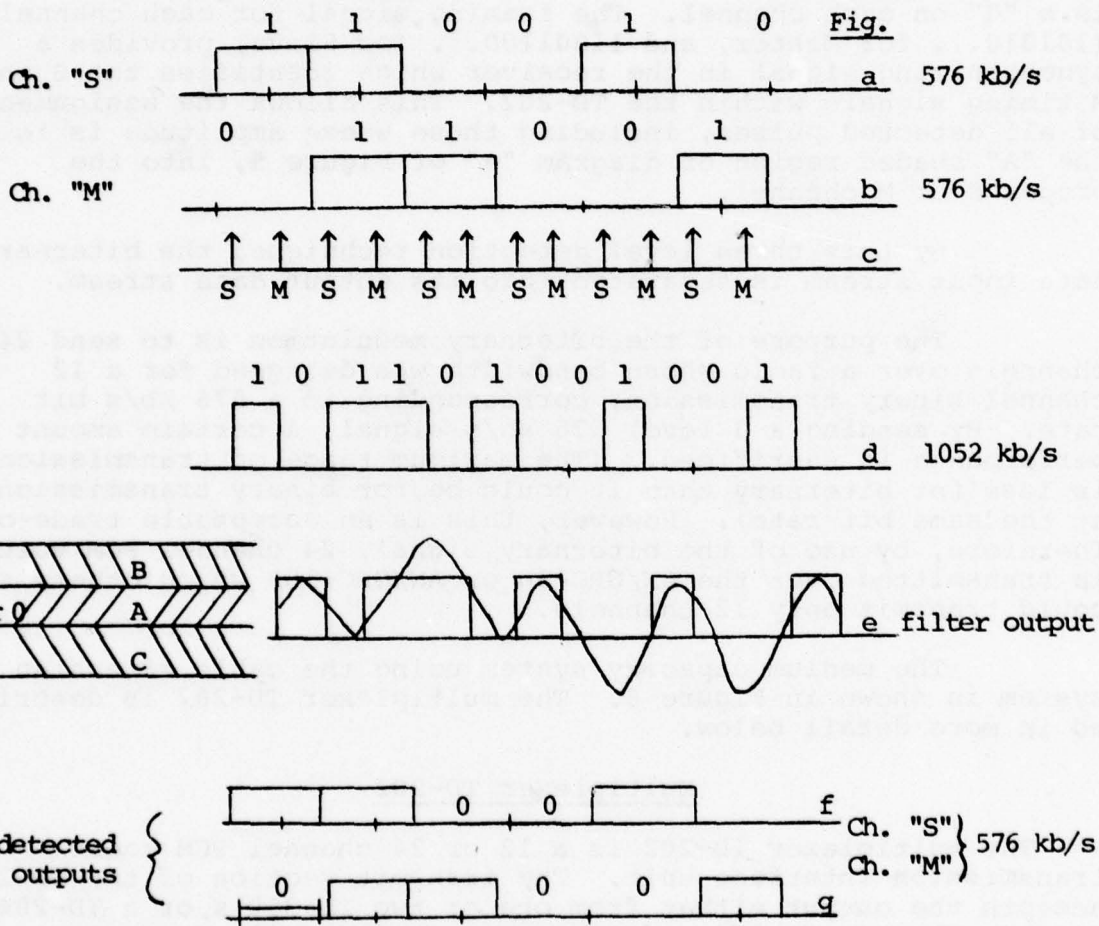
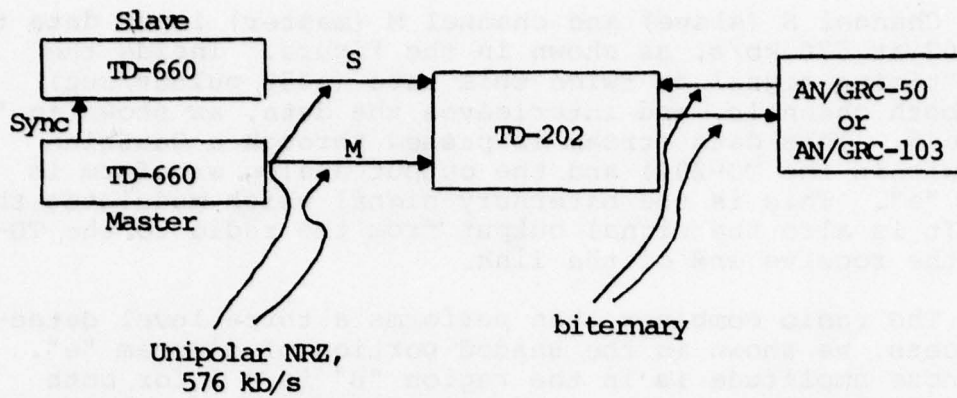
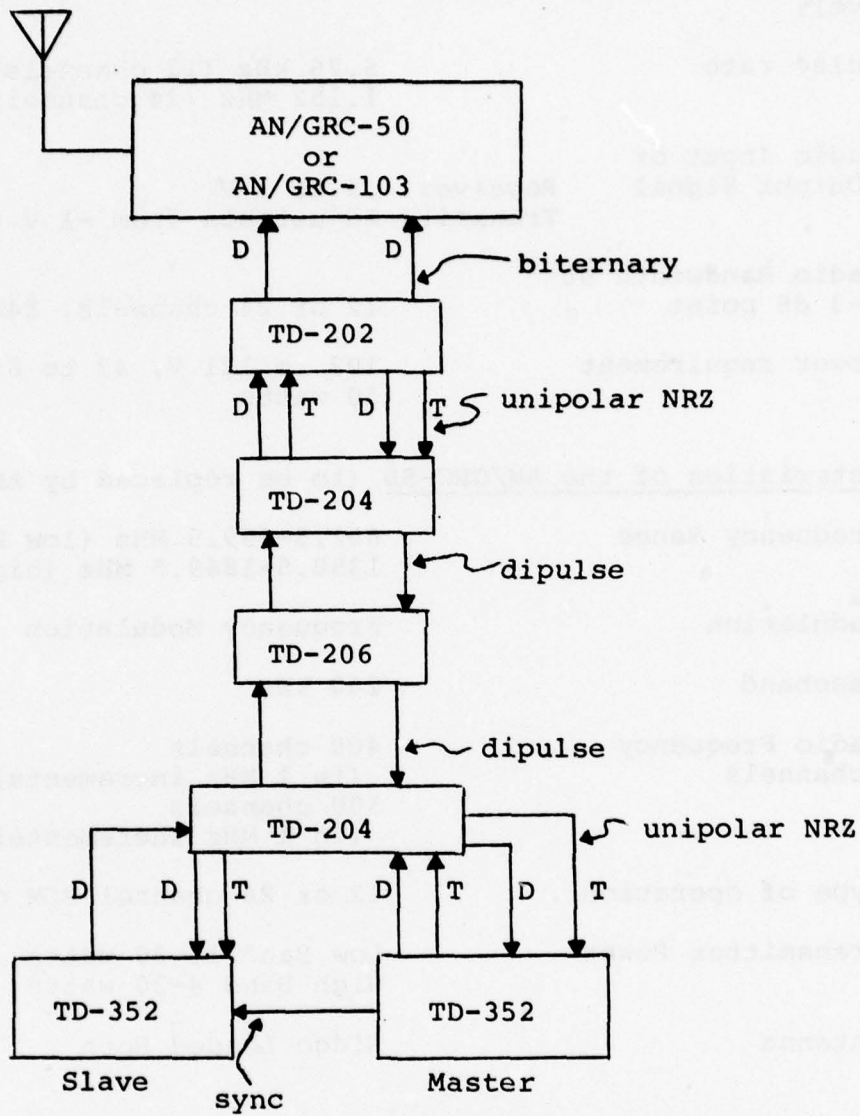


FIGURE 5. Biternary Detection Process



24 Channels

Cable System

FIGURE 6. Medium Capacity System  
(In Common Use)



### Characteristics of the TD-202

Binary (full width for 12 channel transmit and receive and 24 channel transmit), biternary (full width for 24 channel receive).

Pulse rate	5.76 kHz (12 channels) 1.152 MHz (24 channels)
Radio Input or Output Signal	Receive: .5 to 3 V Transmit: Adjustable from -1 V to -2 V
Radio Bandwidth at -3 dB point	12 or 24 channels, 240 kHz
Power requirement	109 to 121 V, 47 to 63 Hz 30 watts

### Characteristics of the AN/GRC-50 (to be replaced by AN/GRC-103)

Frequency Range	601.5-999.5 MHz (low band) 1350.5-1849.5 MHz (high band)
Modulation	Frequency Modulation
Baseband	240 kHz
Radio Frequency channels	400 channels (in 1 MHz increments) 500 channels (in 1 MHz increments)
Type of operation	12 or 24 channel PCM or FDM
Transmitter Power	Low Band 15-30 watts High Band 8-20 watts
Antenna	Ridge Loaded Horn

#### (4) Multichannel Troposcatter PCM Communication

The 12 channel PCM troposcatter communication configuration is shown in Figure 7. The TD-352 provides analog to digital conversion of up to 12 voice channels. The PCM signals are unipolar NRZ, and are transmitted over the CX-11230 cable system as previously discussed.

The AN/GRC-143 is an FM transmitter operating in the 4400 to 5000 MHz band, and can provide 12 or 24 channel transmission, as required. The input pulses to the radio are dipulse



and are input to the 1A12 modem, which is an integral part of the radio set. This modem performs the same function as the TD-754 (of Figure 1) and the TD-204.

The radio can be used for diffractive and tropospheric scatter modes of operation at ranges up to 100 miles. It employs a power amplifier (AM-6090/GRC-143) to provide 1 kw output. For 12 channel operation, the carrier is deviated 250 kHz.

The same equipment is used in a 24 channel mode by use of an additional TD-660, in a slave master relationship, as shown in Figure 8. For this use, the carrier is deviated 500 kHz.

#### Characteristics of the AN/GRC-143

Frequency Range	4400 to 5000 MHz
Modulation	Frequency Modulation
Radio Frequency Channels	6001
Types of Operation	12 or 24 channels PCM, TDM with order wire for each group
Transmitter Power	Adjustable from 100 watts to 1 kw
Antenna	two 10 foot segmented parabolic reflectors

#### (5) Interim System

The present (interim) ATACS system is shown in Figure 9. "Interim system" refers to the present use of the AN/GRC-144 on 12 or 24 channels, as determined by the use of 1 or 2 TD-660's. (This interim period will end when the TD-976 is fielded). This uses the AN/GRC-144 transmitter, with an integral 1A12 model, and nomenclatured AN/GRC-144(V)1. As previously explained, the 1A12 modem performs the same function as the TD-754 and allows direct connection of the radio to either the cable system, or the TD-660. The use of the 1A12 is called the "standard cable configuration". (Sometimes the 1A12 is not used, as in Figure 15.)

#### (6) High Capacity System

When the TD-976 Asynchronous Digital Combiner (ADC) is fielded (1980), it will provide ATACS with the capability of transmitting up to 96 PCM voice channels. (As explained later in this report, high-speed digital data, with channel data rates up to 32 kb/s, will be added by use of the TD-1069 and TD-1065).

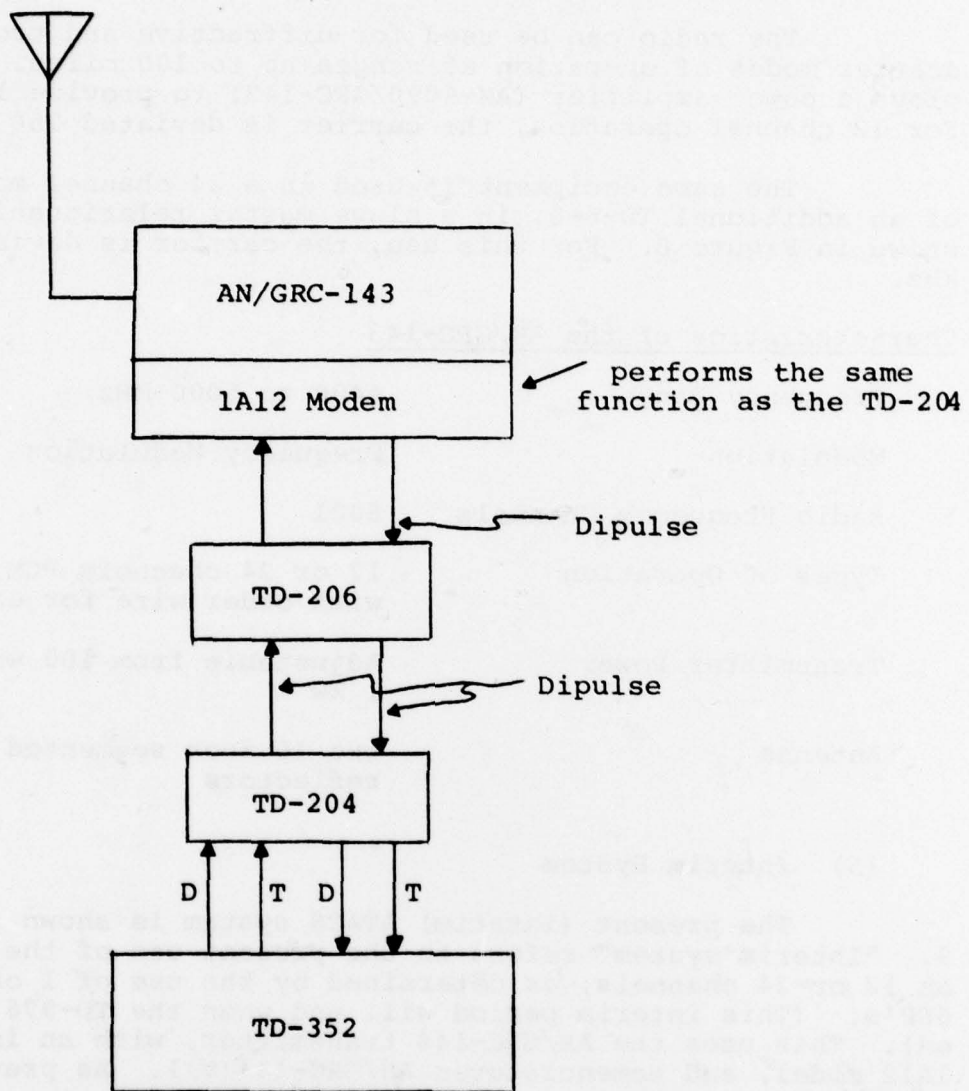


FIGURE 7. 12 Channel PCM Multichannel Tropospheric Scatter Terminal

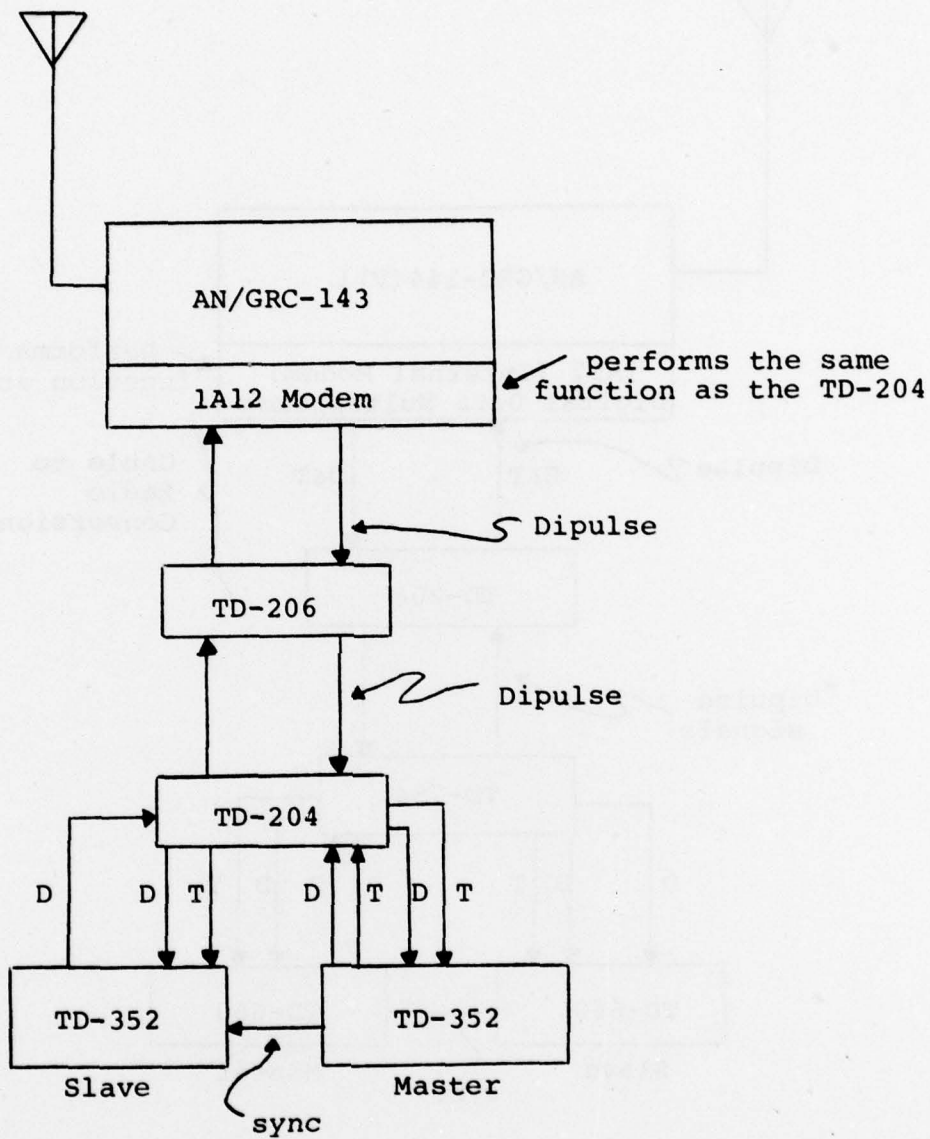
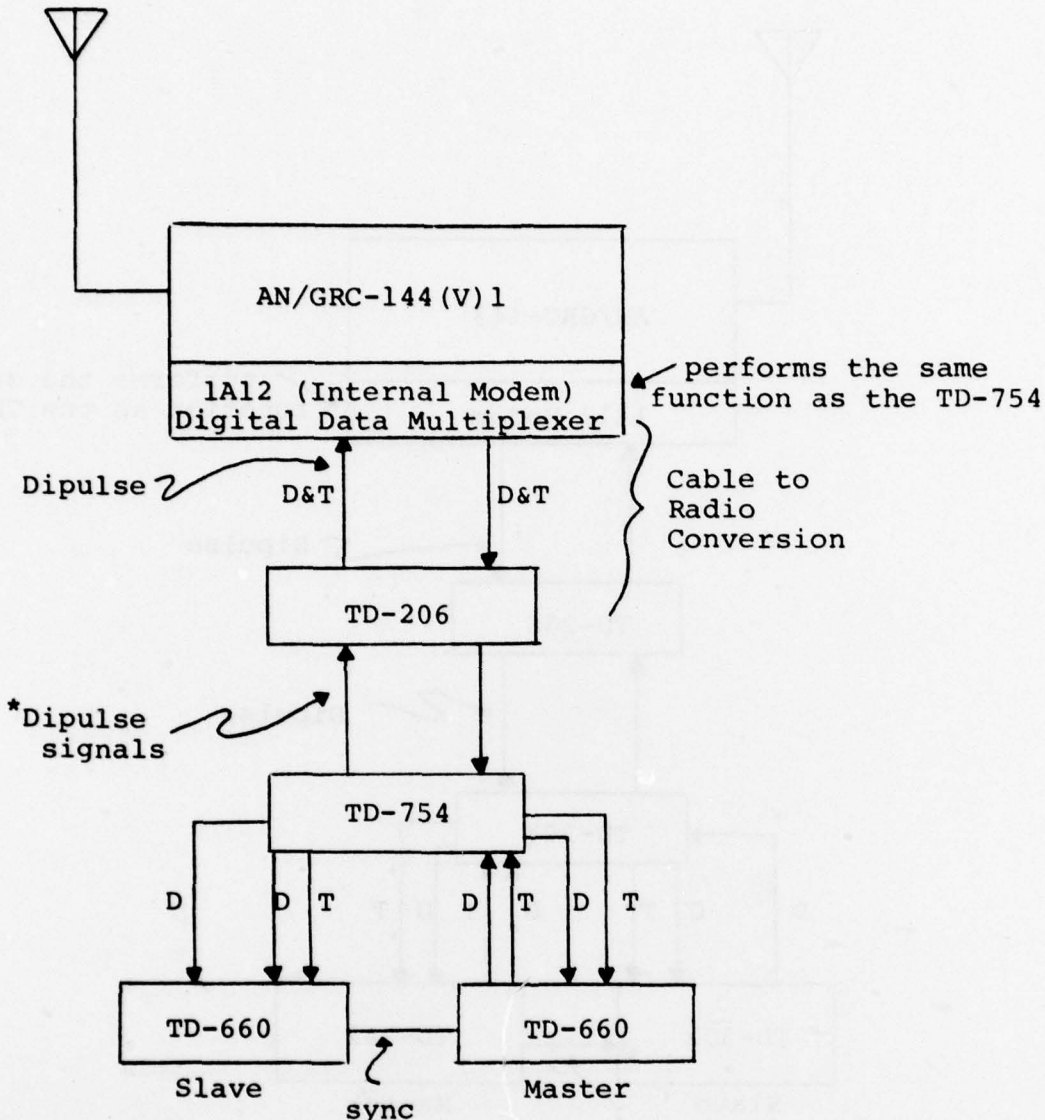


FIGURE 8. 24 Channel PCM Multichannel Tropospheric Scatter Terminal



24 Channels

\*CX-11230 cable

FIGURE 9. Present High Capacity System - Interim Use (Until TD-976 is fielded)



It should be noted that the TD-976's operate synchronously with each other. The transmit and receive sections of the end equipments (TD-660's in Figure 10) operate asynchronously with each other. As shown in Figure 10, the system will accommodate up to 8 TD-660's. One will be designated Master, as usual.

The cable system shown uses the CX-11230 cable, with the TD-976 and the 1A12 "Modified" modem (an integral part of the AN/GRC-144 radio, designated AN/GRC-144(V)2 acting as cable terminals. The signals transmitted over the cable are  $\frac{1}{2}$  baud, bipolar pulses, and the 1A12 has been modified to accept them. In this modulation technique, all "ones" alternate in polarity, and their time duration is maintained at one half the value of the zeros. This is shown in Figure 11. Cable attenuation characteristics for these pulses, with pulse form restorers TD-982 spaced at  $\frac{1}{2}$  mile intervals, are satisfactory. The 1A12 modem is designed to accept either dipulse or  $\frac{1}{2}$  baud bipolar signals, and to provide appropriate modulation signals to the AN/GRC-144(V) 2. This is an FM radio operating in the band 4400-5000 MHz. Its transmitted bit rate is 4.9152 megabits/sec, and its bandwidth is 2 MHz.

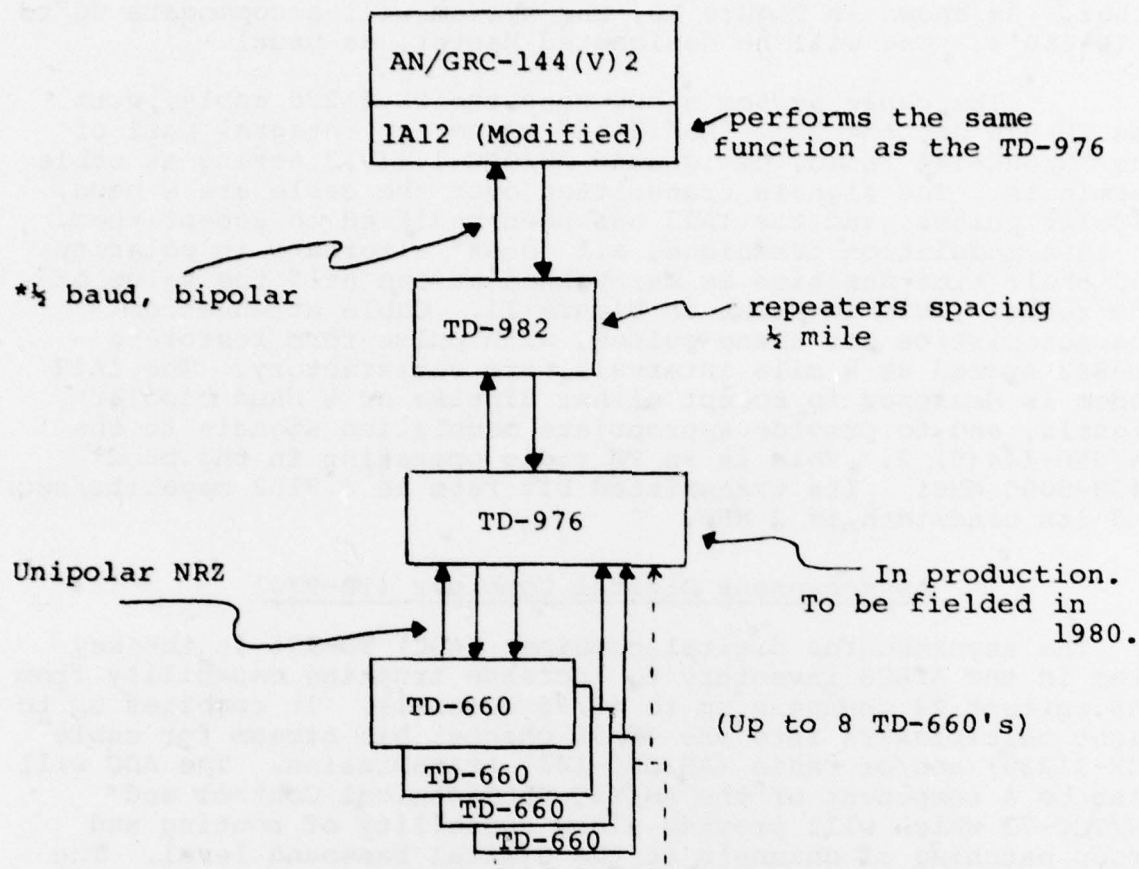
#### Asynchronous Digital Combiner (TD-976)

The asynchronous digital combiner (ADC) TD-976 is the key item in the ATACS inventory to increase trunking capability from the current 24 channels up to 48/96 channels. It combines up to eight multiplexers into one 48/96 channel bit stream for cable (CX-11230) and/or radio (AN/GRC-144) transmission. The ADC will also be a component of the AN/TSQ-85 Technical Control and AN/TCC-73 which will provide a new capability of routing and group patching of channels at the digital baseband level. The purpose of this combiner is to multiplex and demultiplex on a time division basis up to eight separate PCM 12 channel groups.

#### Characteristics

Bit rate input	288/576
Output	4.9152 Mbps
Cable Transmission	Up to 8 km over CX-11230 with restorers TD-982
Power requirements	115 VAC 50 to 400 hertz
Order wire	Voice or digital data/TTY

The asynchronous digital combiner is a new item which, when used with the TD-660, will replace the TD-353 (a 48 channel PCM Multiplexer used in Army Communication Command Units) and TD-203; 48 channel PCM multiplexer and 48/96 channel PCM Radio Combiner, respectively. The TD-976 ADC is in production and will be fielded in 1980.

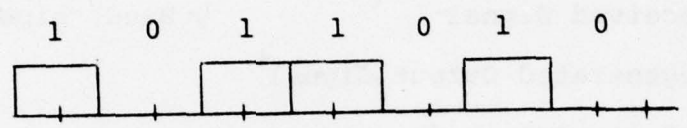


To be used for 48 or 96 channels, Asynchronous  
 In ATACS, all AN/GRC-144's will be used with the TD-976, eventually, and be bipolar, and be designated AN/GRC-144(V)2.  
 Present use of AN/GRC-144 on 24 channels is an interim use. The active army will use the TD-976, but the reserves will continue to use the interim system.

\* 1/2 baud, bipolar stream - In a 1/2 baud bipolar stream ones are represented, alternately, by +v or -v for half the bit period and by 0 voltage for the remainder of the bit period. Zeros are represented by 0 voltage.

FIGURE 10. Future High Capacity System

Baseband



$\frac{1}{2}$  baud, bipolar

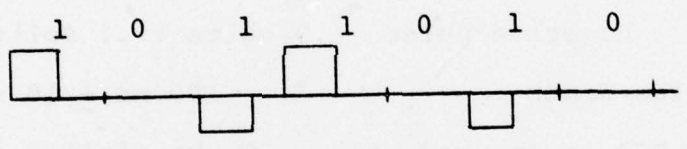


FIGURE 11.  $\frac{1}{2}$  Baud, Bipolar Modulation



### Pulse Form Restorer TD-982( )/G

The Pulse Form Restorer TD-982 is an unattended full duplex pulse form restorer designed to detect and regenerate  $\frac{1}{2}$  baud bipolar signals to the Asynchronous Digital Combiner (ADC) TD-976. It includes independent orderwire circuitry, fault detection provisions, and internal power supply operated from the constant current supplied by the TD-976. The purpose of the TD-982 is to restore the  $\frac{1}{2}$  baud bipolar signals of the TD-976 over a CX-11230 cable transmission system. The TD-982 will be inserted in the cable system at one-half mile intervals. Up to nine TD-982's may be used to form a five mile CX-11230 cable system.

#### Characteristics

Received Signal  $\frac{1}{2}$  Baud, bipolar

Regenerated Output Signal

Pulse Amplitude

positive pulse + .9 volts  $\pm$  .1 volts

negative pulse - .9 volts  $\pm$  .1 volts

Pulse Width 100 ns  $\pm$  10 ns

The TD-982 is in production. To be fielded in 1980 with the TD-976.

#### b. Extension of ATACS to Data Transmission

Time Division Digital Multiplexer (TDDM) TD-1069.

The TD-1069 (TDDM) will provide the ATACS Trunking System with the capability of combining up to 12 channels of digital data into one 32 kilobit per second (kb/s) data stream. This stream may be inserted into any (one) channel of the TD-660, via the TD-1065. (See Figure 12). It accepts data rates of 600, 1200, 2400, 4800, and 9600 bits per second, and TTY rates of 45.50, 75.0, and 150 bits per second on any of the 12 input channels, but the combined rates may not exceed 32 kbs. (If it is less, the TD-1069 provides pseudo-random dummy bits to increase the output bit rate to 32 kbs). It then time division multiplexes all the inputs into a single data stream of 32 kb/s.

As shown in Figure 12, it is normally operated with the TD-1065 Data Buffer. The 32 kbs data stream is provided to any of the 12 available channels of the TD-660, on a switch-selectable basis with the TD-1065. The three cables shown between TD-1069 and the TD-1065 carry the digital signals, which meet MIL-STD-188 low level digital interface characteristics.



The TD-1069 may also be operated in the field as a back-to-back digital communication system, for links of 3 miles or less over WF-16 field wire. This is shown in Figure 13. It will be fielded in 1981. It's electrical characteristics are given below.

#### TD-1069 Characteristics

Voltage	115 VAC $\pm$ 10%
Frequency	50, 60 400 Hz $\pm$ 5%
Power consumption	125 watts
Channel rates	600, 1200, 2400, 4800, 9600 bits per sec 45.5, 75, 150 bits per second
Channel Drive Capability	3 miles over WF-16 and up to 1000 feet WM-130
Output Rate	32 kilobits per second

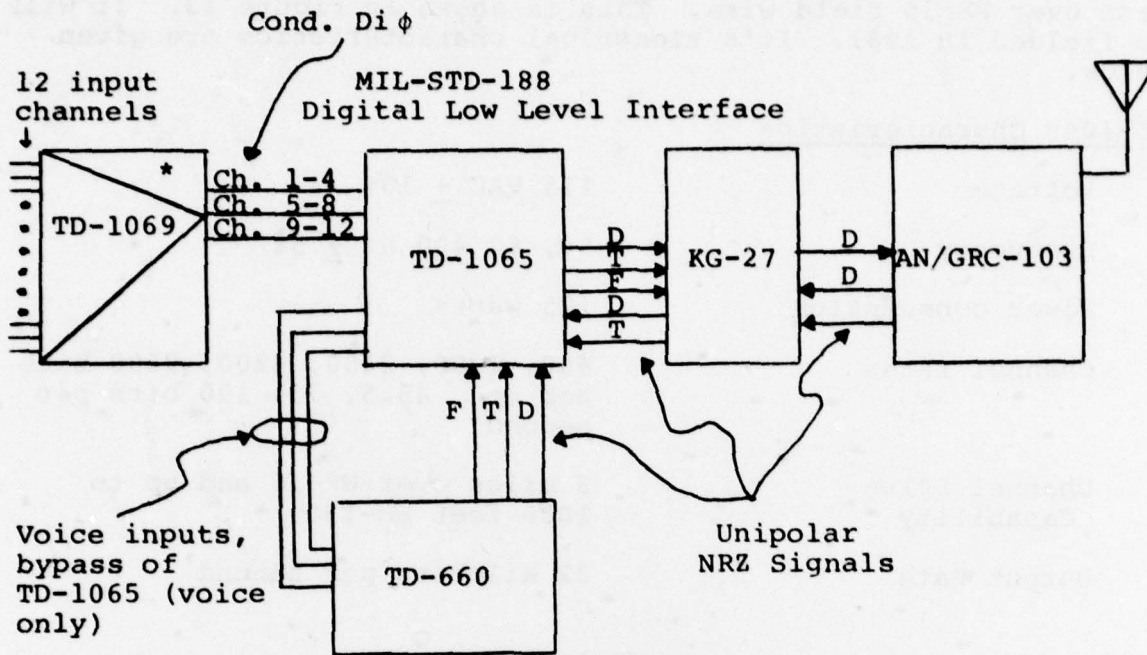
#### TD-1065

The Data Buffer (DB) TD-1065 is a new item that is now in production. It will provide for the digital access of high-speed data and/or wideband secure voice traffic at rates of 16,000 and 32,000 bits per second into the ATACS trunking system. It will provide a 12 channel digital transmission capability when used in conjunction with either Multiplexer TD-660 ( )/G or TD-352 ( )/G. This equipment will be fielded in less than two years. Its operation is explained with reference to Figure 12.

The TD-1065 accepts a serial bit stream of either 16 or 32 kbs into any of its 12 input channels. It also monitors the serial output bit stream (576 kbs) of the associated TD-660 or TD-352 which passes through it, and inserts the 16 or 32 kbs input data into the appropriate time slots, as selected at the input panel.

The TD-1065 also accepts voice inputs, but they are passed to the associated TD-660, where the appropriate A/D conversion and PCM encoding functions are performed.

The TD-1065 can be remotely located up to 3 miles (over WF-16 field wire) from the TD-660 or TD-352. (It can be remoted up to 1000 feet by use of WM-130). The digital interface at the input is the MIL-STD-188 low-level, digital interface. The signals from the TD-660 (into the TD-1065) and the output signals from the TD-1065 are unipolar NRZ pulses.



\*Three cables, carrying four channels each, connect the TD-1065 and TD-1069. The 32 kb/s serial stream is inserted into the TD-1065 over one of these channels, as determined by the front panel selector.

FIGURE 12. Data Transmission through ATACS

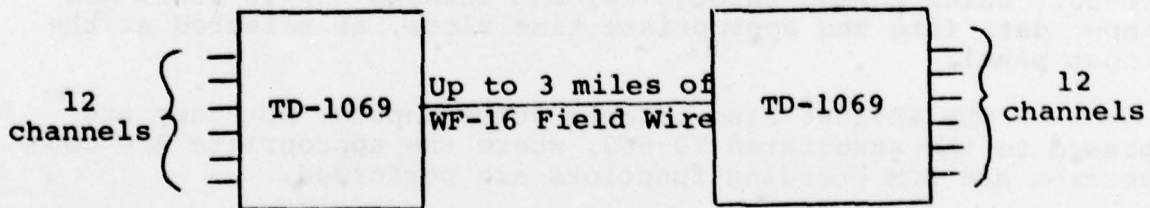


FIGURE 13. Data Transmission Over Cable

### TD-1065 Data Buffer Electrical Characteristics

Voltage	115 VAC $\pm$ 10%
Frequency	50, 60, 400 Hz $\pm$ 5%
Power Consumption	80 watts
Channels	12
Digital Input Rate	16 and 32 kilobits per sec
Channel Synchronization Time	25 milliseconds

#### c. Non-ATACS Configurations

The remaining configurations of equipments are not used in ATACS. They are included in this report for the sake of completeness.

The configuration of Figure 14 is used in Army Communications Command Units. It is either a 48 or 96 channel system, depending on the number of TD-353 PCM multiplexers employed. This is a 48 channel PCM multiplexer with the same general characteristics as the TD-660 (6 bit PCM). Obviously, the bit rate is four times that of the TD-660 (2.304 Mb/s). The output signal waveform is unipolar NRZ to the TD-204 cable combiner.

The TD-203 radio combiner accepts the 48 channel unipolar NRZ signals from each of two TD-204's, and outputs binary NRZ input signals which FM modulate the AN/GRC-147 transmitter. It should be noted that only 200 each TD-203's and TD-353's were manufactured.

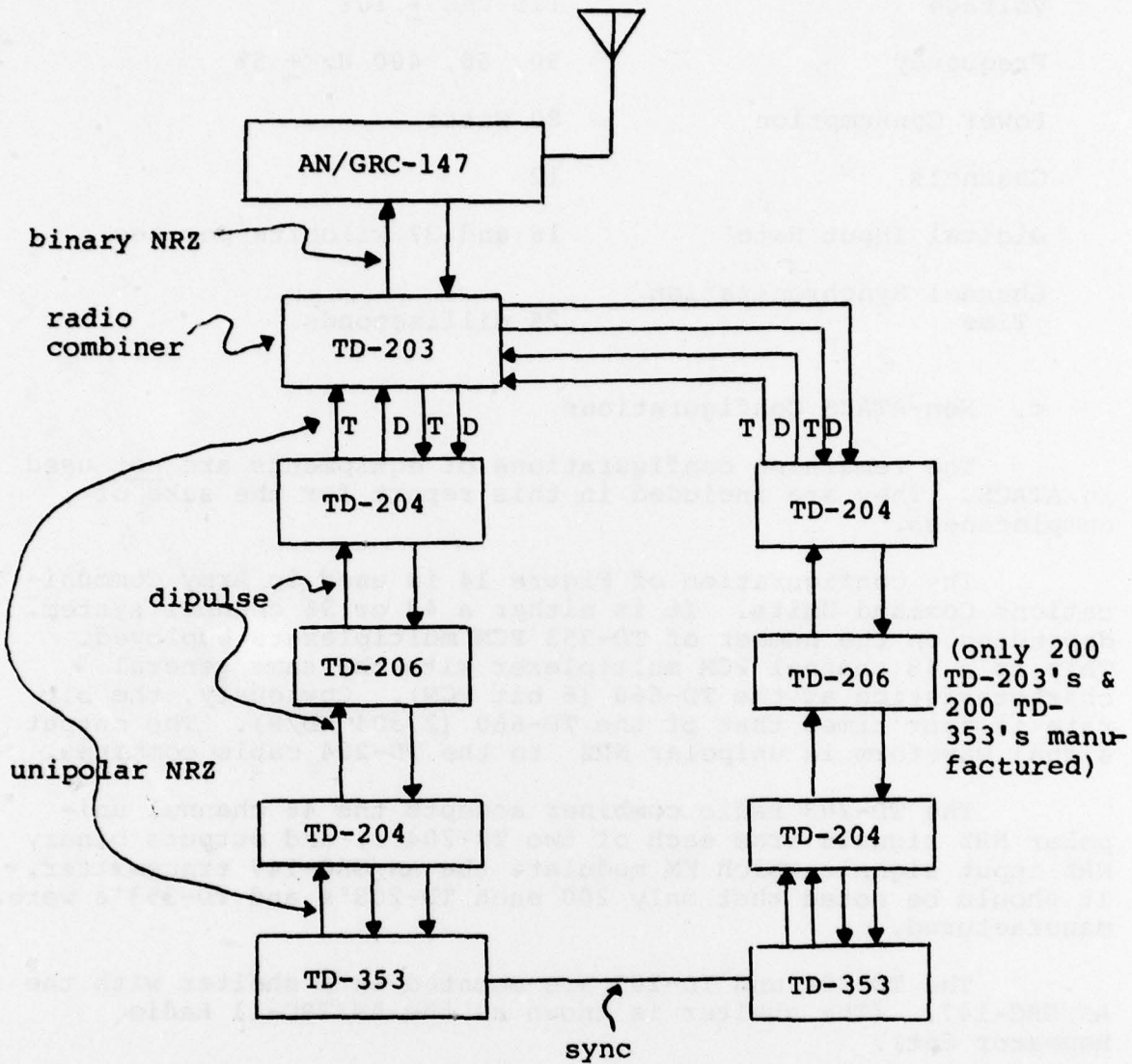
The TD-204 and TD-203 are mounted in a shelter with the AN/GRC-147. (The shelter is known as the AN/TRC-11 Radio Repeater Set).

The TD-353 and TD-204 are housed in the telephone terminal AN/TCC-62.

The AN/GRC-147 is an FM transistorized radio set, operating in the frequency range 4,400 to 5,000 MHz with output power of 1.0 watts. (This radio is an interim set, and will eventually be replaced by the AN/GRC-144).

The configuration of Figure 15 also is not used in ATACS, but may be used in Army Communications Command Units. This diagram shows both 48 and 96 channel transmission without the intervening cable system.

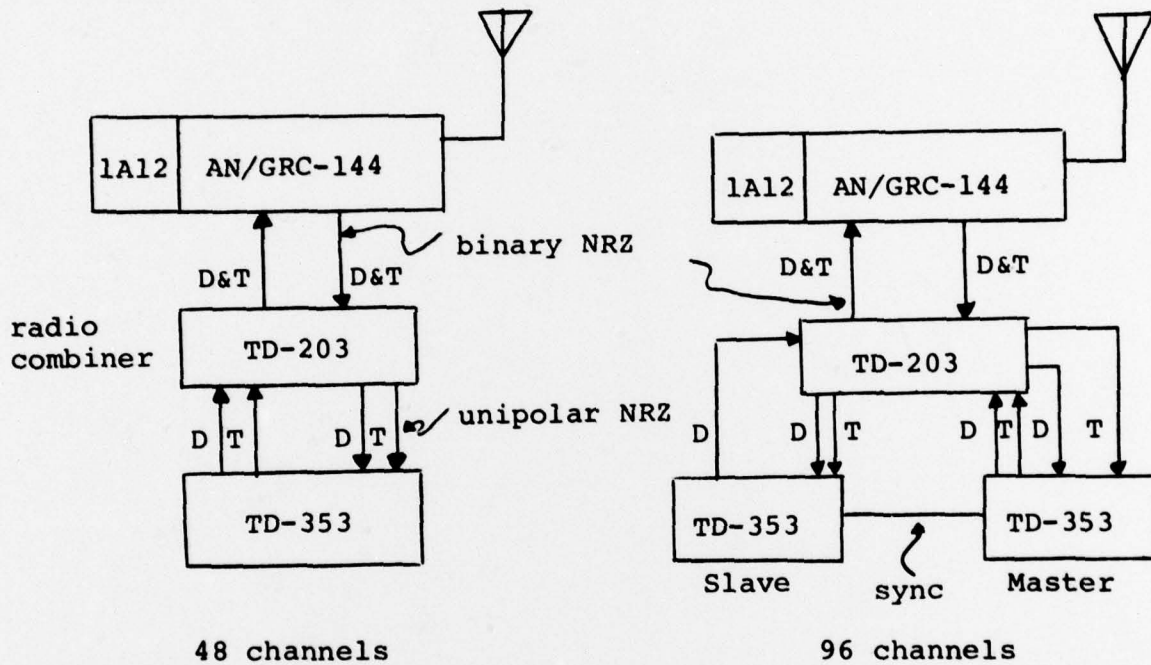




Note: Present use: TD-204 and TD-203 are mounted in a shelter with AN/GRC-147 (Shelter called S-299/TRC-11)  
 The AN/TCC-62 houses the TD-353 and the TD-204

FIGURE 14. Non-ATACS 48 Channel System  
 (Used in Army Communications Command Units)





(Not used in ATACS; may be used in Army Communications Command)

FIGURE 15. Non-Standard Cable Configuration

It should be noted that this configuration uses the "non-standard" cable configuration mode of the AN/GRC-144. In this mode, the 1A12 modem is bypassed, and the radio accepts the binary NRZ signals directly.

#### CONCLUSION

The addition of the TD-1065, TD-1069, and TD-976 in the early 1980's will provide a high speed digital capability to the ATACS system, and will help the Army meet its future digital communications requirements.

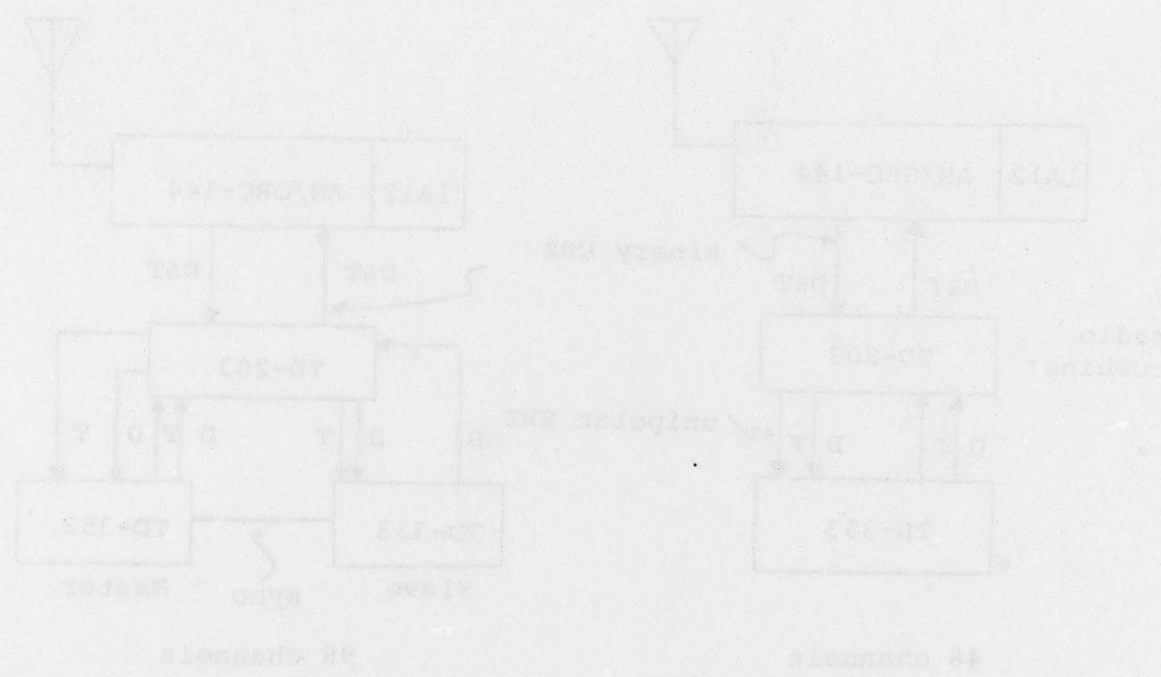


FIGURE 13. Non-Standard Cable Configuration  
(Not used in ATACS; may be used in Army Communications Command)