USAARL REPORT NO. 84-9

AUTOMATIC GAIN CONTROL CIRCUIT FOR VIDEO SIGNALS OF SCENES OF VARYING ILLUMINATION LEVELS

By
John H. Hapgood
and
Clarence E. Rash

RESEARCH SYSTEMS DIVISION

July 1984

U.S. ARMY AEROMEDICAL RESEARCH LABORATORY
FORT RUCKER, ALABAMA 36362

USAARL

NOTICE

Qualified Requesters

Qualified requesters may obtain copies from the Defense Technical Information Center, Cameron Station, Alexandria, Virginia. Orders will be expedited if placed through the librarian or other person designated to request documents from the Defense Technical Information Center.

Change of Address

Organizations receiving reports from the US Army Aeromedical Research Laboratory on automatic mailing lists should confirm correct address when corresponding about laboratory reports.

Disposition

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

Disclaimer

The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

Reviewed:

BRUCE C. LEIBRECHT, Ph.D.
MAJ(P), MSC
Director, Sensory Research Division

Released for Publication:

J. D. LaMOTHE, Ph.D.
LTC, MS
Chairman, Scientific Review Committee

DUDLEY R. PRICE
COL, MC, SFS
Commanding

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: USAARL Report No. 84-9	2. GOVT ACCESSION NO. A144198 / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): AUTOMATIC GAIN CONTROL CIRCUIT FOR VIDEO SIGNALS OF SCENES OF VARYING ILLUMINATION LEVELS	5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): John H. Hapgood Clarence E. Rash	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US Army Aeromedical Research Laboratory Fort Rucker, AL 36362	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62777.A3E162777A 879, BG, 164
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Medical Research & Development Command Fort Detrick Frederick, MD 21701	12. REPORT DATE: July 1984 13. NUMBER OF PAGES: 11
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

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)

low-light-level television (LLLTV)
automatic gain control (AGC)
video amplifier

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A type of automatic gain control circuit useful for enhancement of video signals of scenes of varying light illumination levels is described. A DC voltage developed from the peak-to-peak input signal controls the effective gain of a video amplifier in a nonstandard method using a step-function control voltage.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

Increased emphasis on night operations by the US Army, especially within the aviation community, has resulted in numerous low-light-level (LLL) video systems and thermal imaging systems. Such systems are used to acquire, identify, and track targets, as well as to fly aircraft under various LLL conditions such as inclement weather and darkness.

LLL video systems utilize an image intensifier which, when actuated by a light image, can produce a similar image of increased contrast. With thermal imaging systems, a thermal detector transforms incident thermal energy into an electrical signal which produces a video image of the scene on a display. Typically, in both systems, a composite video signal is produced which is fed to one or more display monitors for observer interpretation. With LLL systems, as well as with standard video cameras, as the light level changes, continuous adjustment of the display's contrast and brightness is necessary to maintain an optimum image. The circuit described here was developed to provide a better signal-to-noise ratio under extreme LLL conditions and to reduce the need for display adjustments under varying scene-illumination conditions.

CIRCUIT DESCRIPTION

The circuit diagrammed in Figure 1 acts as an automatic gain control (AGC) for an input video signal, but its operation differs from the AGC operation in a standard video receiver. It has two modes of operation. Under normal or above normal ambient illumination, the AGC circuitry attenuates the amplifier circuit input. For signal levels associated with low ambient illumination, the AGC effectively is removed from the circuit operation, allowing amplification of the full input signal.

The input composite signal is applied to the inputs of IC1, a wideband video amplifier, and IC2, a 741 operational amplifier. The output of IC1 is controlled by IC2, IC3, and Q1. The composite video signal applied to IC2 is amplified and then rectified and filtered by diode D1 and capacitor C8, respectively. Resistor R9 determines the gain of IC2.

The resulting DC voltage, which is proportional to the input signal level, is applied to pins 4 and 13 of IC3, a quad bilateral switch, and to the base of transistor Q1. The gain of IC2 and the values of R12 and R13 are selected so that when an input video signal of 0.5 volts peak-to-peak is present, the voltage at the base of Q1 is +0.5 vdc or slightly less. If the peak-to-peak input signal exceeds 0.5 v, then the DC base voltage on Q1 will increase, turning on Q1 hard. This causes the Q1 collector voltage to go to ground. This action also grounds pin 5 on IC3, opening the switch between pins 3 and 4 on IC3. Therefore, the DC voltage resulting from the input signal is fully applied to control pin 13 of the switch between pins 1 and 2 of IC3. This closes this switch, setting up a voltage divider consisting of resistor R6 and op-amp IC1. This reduces the signal applied directly to the input of IC1.

When the input signal level drops below 0.5 volts peak-to-peak, the AGC action is disabled, increasing the effective circuit gain. For this lower signal level, the DC voltage applied on the base of Q1 is not sufficient to turn on Q1. Therefore, the collector voltage, and hence the voltage on pin 5 of IC3, is equal to +Vcc. As a result, the switch between pins 3 and 4 (on IC3) is closed, shorting the DC level voltage to ground. This action also grounds control pin 13 of the switch between pins 1 and 2. This opens this switch, which causes the full input signal to be fed to IC1 for amplification.

DISCUSSION

The described circuit can be incorporated between the composite video source, such as a camera, and the display without modification of the circuitry of either. The response time of the circuit (less than 2 seconds) makes it capable of handling changes in scene illumination that might occur during the normal panning motion of a camera.

Actual circuit performance is illustrated in Figure 2. Figures 2a and 2c show the display imagery resulting from a standard video camera recording a high illumination and low illumination scene, respectively. The illumination levels for the high and low illumination scenes were 80.8 footcandles and 0.95 footcandles, respectively, measured parallel to the target surface. Figures 2b and 2d show the same scenes with the AGC circuit inserted. For high illumination, some contrast enhancement can be noted resulting in a slightly more detailed display picture. In the low illumination case, a marked improvement is attained with the AGC.

This circuit can enhance effectively the imagery produced by LLL, standard, and thermal imaging sources of video signals under varying levels of illumination. In contrast, at low illumination levels this enhancement lowers the threshold for target detection and recognition. For the user this means faster and more accurate identification of targets.

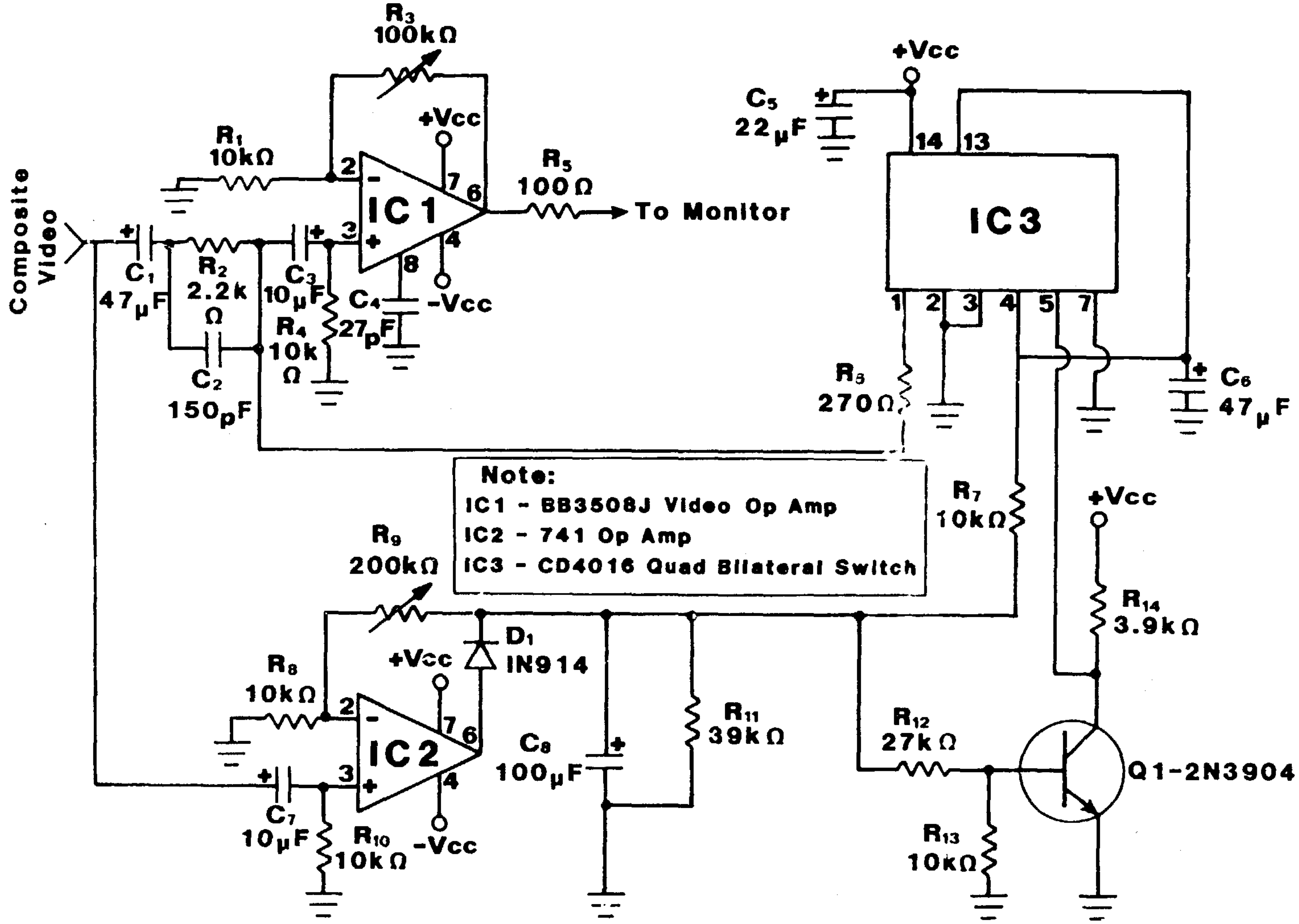
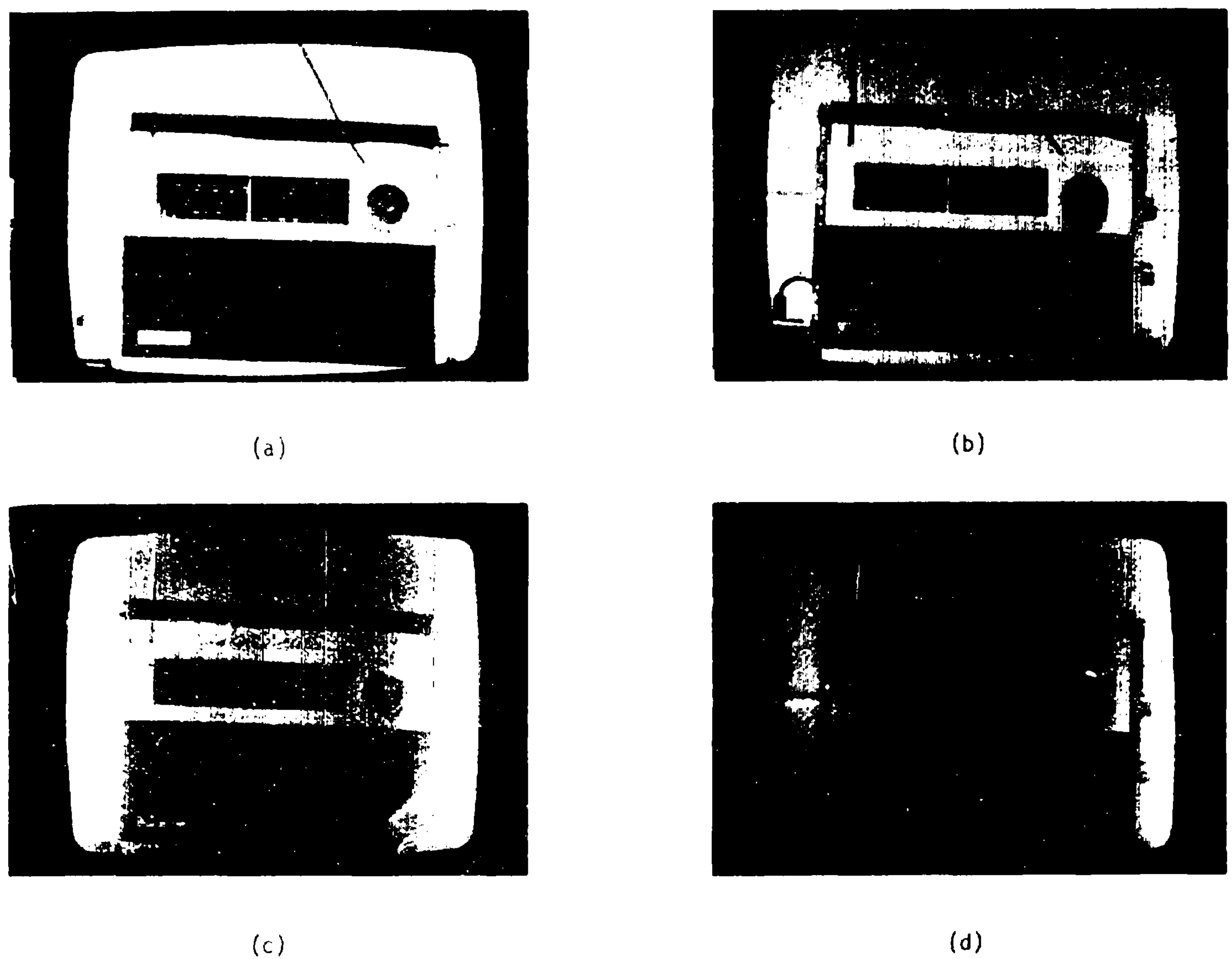


FIGURE 1. Scnematic for AGC circuit.



(a) (b) (c) (d)

FIGURE 2. Photographs of display: High illumination scene (a) without new AGC circuit and (b) with new AGC circuit; low illumination scene (c) without new AGC circuit and (d) with new AGC circuit.

INITIAL DISTRIBUTION

Commander
US Army Natick R&D Laboratories
ATTN: Technical Librarian
Natick, MA 01760

Commander
US Army Research Institute of
Environmental Medicine
Natick, MA 01760

US Navy
Naval Submarine Med Rsch Lab
Medical Library, Naval Submarine Base
Box 900
Groton, CT 06340

US Army Avionics R&D Laboratory
ATTN: DAVAA-O
Fort Monmouth, NJ 07703

Cdr/Dir
US Army Combat Surveillance &
Target Acquisition Laboratory
ATTN: DELCS-D
Fort Monmouth, NJ 07703-5304

US Army R&D Technical
Support Activity
Fort Monmouth, NJ 07703

Commander
10th Medical Laboratory
ATTN· DEHE (Audiologist)
APO New York 09180

Chief
Benet Weapons Laboratory
LCWSL, USA ARRADCOM
ATTN: DRDAR-LCB-TL
Watervliet Arsenal
Watervliet, NY 12189

Commander
Naval Air Development Center
Biophysics Lab (ATTN: George Kydd)
Code 60B1
Warminster, PA 18974

Human Factors Engineering Division
Acft & Crew Systems Tech Dir
Naval Air Development Center
Warminster, PA 18974

Naval Air Development Center
Technical Information Division
Technical Support Department
Warminster, PA 18974

Commander
Naval Air Development Center
ATTN: Code 6022 (Mr. Brindle)
Warminster, PA 18974

Dr. E. Hendler
Human Factors Applications, Inc.
295 West Street Road
Warminster, PA 18974

Director
Army Audiology & Speech Center
Walter Reed Army Medical Center
Washington, DC 20307-5001

Director
Walter Reed Army Institute
of Research
Washington, DC 20012

Commander
US Army Institute of
Dental Research
Walter Reed Army Medical Center
Washington, DC 20012

Uniformed Services University
of the Health Sciences
4301 Jones Bridge Road
Bethesda, MD 20014

Commanding Officer
Naval Medical R&D Center
National Naval Medical Center
Bethesda, MD 20014

Under Secretary of Defense for
Research and Engineering
ATTN: Military Assistant for
Med & Life Sciences
Washington, DC 20301

Director of Professional Services
Office of the Surgeon General
Department of the Air Force
Washington, DC 20314

Naval Air Systems Command
Technical Library Air 950D
Room 278, Jefferson Plaza II
Department of the Navy
Washington, DC 20361

US Navy
Naval Research Laboratory Library
Code 1433
Washington, DC 20375

US Navy
Naval Research Laboratory Library
Shock & Vibration Information Center
Code 8404
Washington, DC 20375

Harry Diamond Laboratories
ATTN: Technical Information Branch
2800 Powder Mill Road
Adelphi, MD 20783-1197

Director
US Army Human Engineering Laboratory
ATTN: Technical Library
Aberdeen Proving Ground, MD
21005-5001

US Army Materiel Systems
Analysis Agency
ATTN: Reports Processing
Aberdeen Proving Ground, MD
21005-5017

US Army Ordnance Center
and School Library
Aberdeen Proving Ground, MD
21005-5201

Director
US Army Ballistic Rsch Laboratory
ATTN: DRXBR-OD-ST (Tech Rpts)
Aberdeen Proving Ground, MD
21005-5066

US Army Environmental Hygiene
Agency Library, Bldg E2100
Aberdeen Proving Ground, MD
21010

Commander
US Army Medical Research
Institute of Chemical Defense
Aberdeen Proving Ground, MD
21010

Technical Library
Chemical Systems Laboratory
Aberdeen Proving Ground, MD
21010

Commander
US Army Medical R&D Command
ATTN: SGRD-RMS (Mrs. Madigan)
Fort Detrick
Frederick, MD 21701

Commander
US Army Medical Research Institute
of Infectious Diseases
Fort Detrick
Frederick, MD 21701

Commander
US Army Medical Bioengineering
R&D Laboratory
Fort Detrick
Frederick, MD 21701

Director of Biological and
Medical Sciences Division
800 North Quinch Street
Arlington, VA 22217

Defense Technical
Information Center
Cameron Station, VA 22314

US Army Materiel Development and
  Readiness Command
ATTN: DRCSG
5001 Eisenhower Avenue
Alexandria, VA 22333

US Army Foreign Science and
  Technology Center
ATTN: DRXST-IS1
220 7th Street, NE
Charlottesville, VA 22901

Commander
US Army Transportation School
ATTN: ATSP-TD-ST
Fort Eustis, VA 23604

Director
Applied Technology Lab, USARTL-AVSCOM
ATTN: Library, Bldg 401
Fort Eustis, VA 23604

US Army Training & Doctrine Command
ATTN: ATCD
Fort Monroe, VA 23651

Commander
US Army Training & Doctrine Command
ATTN: Surgeon
Fort Monroe, VA 23651

Structures Laboratory Library
USARTL-AVSCOM
NASA Langley Research Center
Mail Stop 266
Hampton, VA 23665

US Navy
Naval Aerospace Medical
  Institute Library
Bldg 1953, Code 102
Pensacola, FL 32508

US Air Force
Armament Development and
  Test Center
Eglin AFB, FL 32542

Colonel Stanley C. Knapp
US Central Command
CCSG MacDill AFB, FL 33608

Redstone Scientific Information
  Center
DRDMI-TBD
US Army Missile R&D Command
Redstone Arsenal, AL 35809

Air University Library
(AUL/LSE)
Maxwell AFB, AL 36112

Commander
US Army Aeromedical Center
Fort Rucker, AL 36362

Commander
USAAVNC & Fort Rucker
ATTN: ATZQ-CDR
Fort Rucker, AL 36362

Director
Directorate of Combat Developments
Building 507
Fort Rucker, AL 36362

Director
Directorate of Training Development
Building 502
Fort Rucker, AL 36362

Chief
Army Research Institute
  Field Unit
Fort Rucker, AL 36362

Commander
US Army Safety Center
Fort Rucker, AL 36362

Commander
USAAVNC & Fort Rucker
ATTN: ATZQ-T-ATL
Fort Rucker, AL 36362

Commander
US Army Aircraft Development
  Test Activity
ATTN: STEBG-MP-QA
Cairns Army Air Field
Fort Rucker, AL 36362

President
US Army Aviation Board
Cairns Army Air Field
Fort Rucker, AL 36362

US Army Research and
  Technology Laboratories
Propulsion Laboratory MS 77-5
NASA Lewis Research Center
Cleveland, OH 44135

Human Engineering Division
Air Force Aerospace Medical
  Research Laboratory
ATTN: Technical Librarian
Wright-Patterson AFB, OH 45433

US Air Force Institute of
  Technology (AFIT/LDE)
Building 640, Area B
Wright-Patterson AFB, OH 45433

John A. Dellinger, MS, ATP
Univ of Illinois - Willard Airport
Savoy, IL 61874

Henry L. Taylor
Director
Institute of Aviation
Univ of Illinois - Willard Airport
Savoy, IL 61874

Commander
US Army Troop Support and Aviation
  Materiel Readiness Command
ATTN: DRSTS-W
St. Louis, MO 63102

Commander
US Army Aviation Systems Command
  (Provisional)
ATTN: SGRD-UAX-AL (MAJ Lacy)
4300 Goodfellow Boulevard
St. Louis, MO 63166

Commander
US Army Aviation Systems Command
  (Provisional)
ATTN: DDRAV-E
4300 Goodfellow Boulevard
St. Louis, MO 63166

Commander
US Army Aviation Systems Command
  (Provisional)
ATTN: Library
4300 Goodfellow Boulevard
St. Louis, MO 63166

Commanding Officer
Naval Biodynamics Laboratory
PO Box 24907
Michoud Station
New Orleans, LA 70129

Federal Aviation Administration
Civil Aeromedical Institute
ATTN: Library
Box 25082
Oklahoma City, OK 73125

US Army Field Artillery School
ATTN: Library
Snow Hall, Room 14
Fort Sill, OK 73503

Commander
US Army Academy of Health Sciences
ATTN: Library
Fort Sam Houston, TX 78234

Commander
US Army Health Services Command
ATTN: Library
Fort Sam Houston, TX 78234

Commander
US Army Institute of
  Surgical Research
ATTN: SGRD-USM (Jan Duke)
Fort Sam Houston, TX 78234-6200

US Air Force
Aerospace Medical Division
School of Aerospace Medicine
Aeromedical Library/TSK-4
Brooks AFB, TX 78235

US Army
Dugway Proving Ground
Technical Library
Building 5330
Dugway, UT 84022

Dr. Diane Damos
Psychology Department
Arizona State University
Tempe, AZ 85287

US Army Yuma Proving Ground
Technical Library
Yuma, AZ 85364

US Army White Sands Missile Range
Technical Library Division
White Sands Missile Range
New Mexico 88002

US Air Force
Flight Test Center
Technical Library, Stop 238
Edwards AFB, CA 93523

US Army Aviation Engineering
  Flight Activity
ATTN: DAVTE-M (Technical Library)
Edwards AFB, CA 93523

US Navy
Naval Weapons Center
Technical Library Division
Code 2333
China Lake, CA 93555

US Army Combat Developments
  Experimental Command
Technical Library
HQ, USACDEC
Box 22
Fort Ord, CA 93941

Aeromechanics Laboratory
US Army Research and
  Technical Laboratories
Ames Research Center, M/S 215-1
Moffett Field, CA 94035

Commander
Letterman Army Institute of Research
ATTN: Medical Research Library
Presidio of San Francisco, CA
  94129

Six United States Army
ATTN: SMA
Presidio of San Francisco, CA
  94129

Director
Naval Biosciences Laboratory
Naval Supply Center, Bldg 844
Oakland, CA 94625