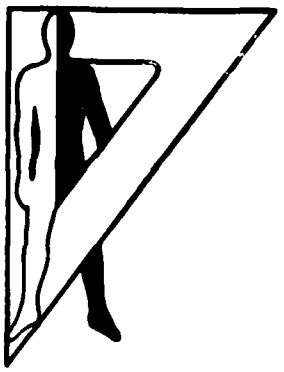

Technical Note 5-81

MINI-TANK HIT DETECTION SYSTEM

Bruce E. Amrein

April 1981
AMCMS Code 612716.H700011

U. S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland

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

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.

Use of trade names in this report does not constitute an official endorsement or approval of the use of such commercial products.

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Note 5-81	2. GOVT ACCESSION NO. AD-A101484	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* MINI-TANK HIT DETECTION SYSTEM		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Bruce E. Amrein		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Human Engineering Laboratory Aberdeen Proving Ground, MD 21005		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS Code 612716.H700011
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE April 1981 13. NUMBER OF PAGES 8
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)*

Accelerometer
Telemetry
Hit Detector
Armored Vehicle

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

The US Army Human Engineering Laboratory is developing a scaled configuration of a tank. Designated as the HEL Fire Control Research Target (FCRT), the vehicle is designed to accept caliber .50 spotter rifle fire. Accelerometers, located on the interior of the vehicle, detect hits and transmit the data via the vehicle radio/intercom system to the crew and the control station.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

AMCMS Code 612716.H700011

Technical Note 5-81

MINI-TANK HIT DETECTION SYSTEM

Bruce E. Amrein

April 1981

APPROVED:
JOHN D. WEISZ
Director
U.S. Army Human Engineering Laboratory

U. S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland 21005

CONTENTS

MINI-TANK HIT DETECTION SYSTEM

INTRODUCTION

The US Army Human Engineering Laboratory (HEL) is developing a scaled configuration of a standard tank based upon an M114 hull. It is scaled to approximately 0.6 in silhouette and 0.7 in width. Designated as the HEL Fire Control Research Target (FCRT), the vehicle is designated to accept caliber .50 spotter rifle fire.

The Mini-Tank Hit Detection System was designed as a reliable, maintenance-free system which transmits a tone to the occupants of the vehicle and to the control station crew, via the vehicle radio/intercom system, that a hit upon the skin of the vehicle has been detected. This signal may be processed and correlated with other data by other control station equipment as data collection requirements become more sophisticated. Initially, however, the fact that a hit has occurred meets the data collection requirements.

DISCUSSION

The HEL Mini-Tank Hit Detection System consists of an eight-channel signal conditioning and telemetry system which accepts raw data from accelerometers and transmits an audible tone via VHF radio to a receiving station located outside the vehicle.

Using piezoelectric accelerometers located throughout the vehicle, the impact of direct hits by caliber .50 tracer ammunition is detected. The sensing element is the Endevco Model 2217E High Sensitivity Low-G Accelerometer which is self-generating and requires no external power for operation. Voltage sensitivity is 90mV/g, nominal. The frequency response is 2 to 5000 Hertz. These accelerometers are mounted on insulated 10-32 UNF studs that are mounted to tapping plates which have been welded to the inner surface of the armor-plated vehicle. Figure 1 shows the location of the five accelerometers presently in place on the vehicle. Provision has been made in the signal conditioning equipment to accommodate eight accelerometers if necessary.

The signal conditioning equipment consists of a shock-mounted aluminum case containing necessary input and output connectors and a wire-wrapped circuit card containing all electronic circuitry. This case is shown in Figure 2.

The electronic circuitry of the system can be broken down into three distinct functional categories.

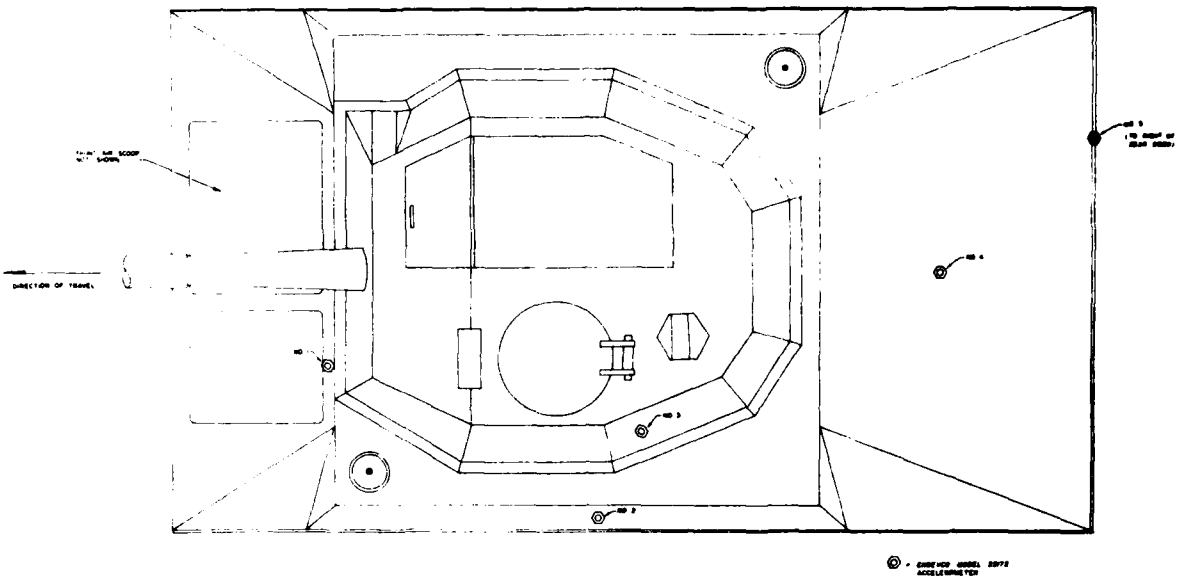

Figure 1. Location of accelerometers.

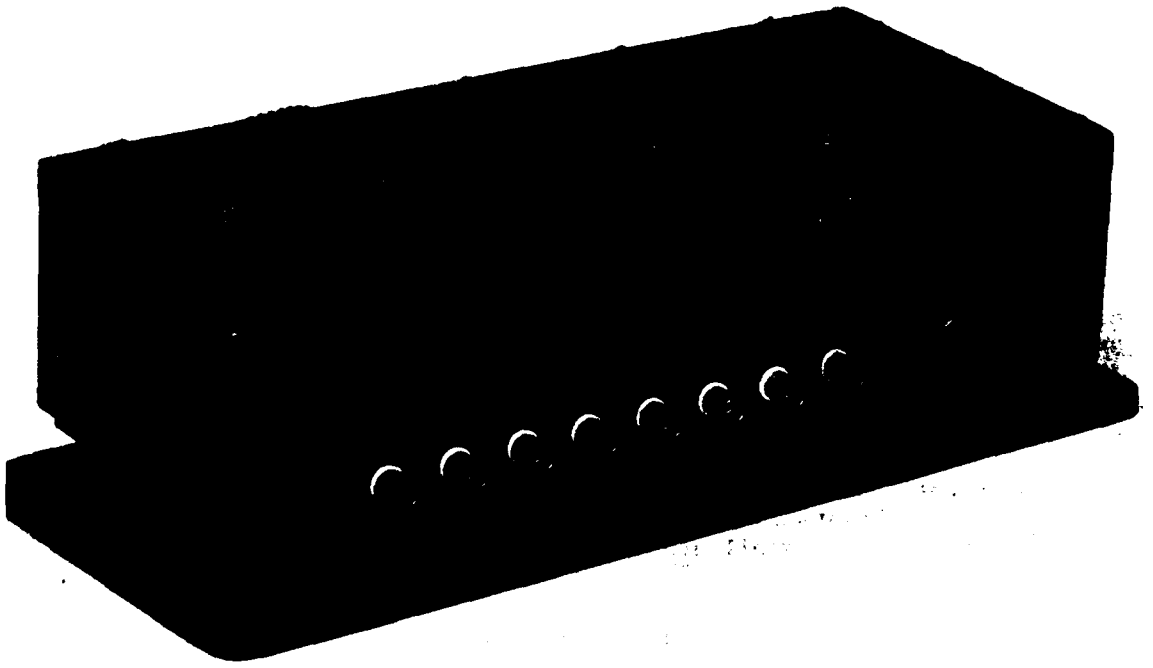

Figure 2. Mini-Tank Hit Detection System.

Power Supply

Regulated supply voltages (+12 VDC, +5 VDC) are obtained from solid-state voltage regulators located on the circuit card. Raw direct current voltage is obtained from the vehicle electrical system via the VHF radio system. The entire system is protected against overcurrent faults by a circuit breaker.

Signal Conditioning

Signal conditioning for the eight piezoelectric accelerometers is provided by eight identical input circuits. Each circuit consists of an isolated BNC chassis connector, which accepts a low-level signal from the accelerometer. This signal is passed through a 0.1 microfarad capacitor that removes any residual DC component from the signal which may be caused by vehicle motion or the earth's gravitational field. Each low-level AC signal is amplified by a National Semiconductor LM 224 low-power operational amplifier. The LM 224 was selected because of its superior operating temperature range (-25°C to +85°C). The voltage gain for this stage is approximately 10. At this gain, the frequency response of the amplifier is 100 kHz.

The next stage of the signal conditioning involves a National Semiconductor LM 339 low-power, low-offset voltage comparator. This precision device is used to detect the presence of a waveform peak which exceeds a predetermined threshold point. This peak corresponds to the impact of a projectile on the vehicle surface. The threshold point of the comparator is adjusted with a 20-turn potentiometer for any required in-the-field sensitivity adjustments. This adjustment ultimately determines the sensitivity of each individual accelerometer. Accelerometers located near sources of vehicle vibration may be desensitized, as necessary, in order to eliminate false hit signals.

The output of the LM 339 voltage comparator (TTL compatible) is normally at logic zero. Whenever a hit is detected, the output of the comparator switches to logic one. The hit may be detected by one or more accelerometers, thus numerous comparators may switch to logic one to signify a hit.

The output of each comparator is inverted. This inverted output drives a Light-Emitting-Diode that indicates which accelerometer detected the hit. Also, the inverted output of each of the eight comparators is fed to the inputs of an eight-input NAND gate which combines the individual hit signals into one composite hit signal. This signal drives the telemetry/signalling portion of the system.

Figure 3 shows a block diagram of the signal conditioning equipment.

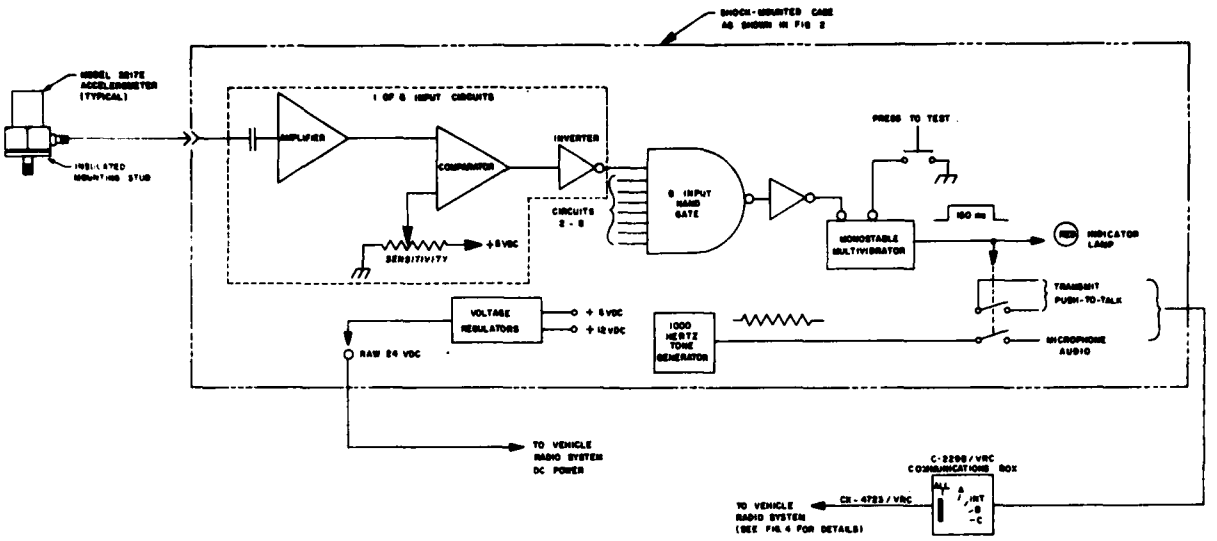

Figure 3. Hit detector signal conditioning equipment.

Telemetry/Signalling

A detected hit causes a monostable multivibrator to turn on for approximately 150 milliseconds. During this time period, the standard military receiver/transmitter is keyed and a 1000-Hertz tone is transmitted via the vehicle intercom/radio system. Each crewmember hears the tone in his CVC helmet and any receiver turned to the transmit frequency also monitors the tone.

A red indicator lamp also illuminates on the control panel of the Hit Detection System to indicate that a hit has been detected. When depressed, this indicator/switch simulates a hit in order to verify proper operation of the signalling system.

Figure 4 shows the vehicle intercom/radio system and the interface to the Hit Detection System.

SUMMARY

The Mini-Tank Hit Detection System provides the HEL with a rugged, reliable, and maintenance-free data collection system which detects projectile hits upon the surface of the HEL Fire Control Research Target (FCRT). The system alerts the crewmembers and the test supervisors at the control point that a hit has been detected. This system utilizes standard military radio hardware for the telemetry/signalling portion of the system.

In the future, additional hardware could be added to the ground station to upgrade the data system. Capabilities to record time of shot, time of hit, etc., could be added to the basic telemetry system.

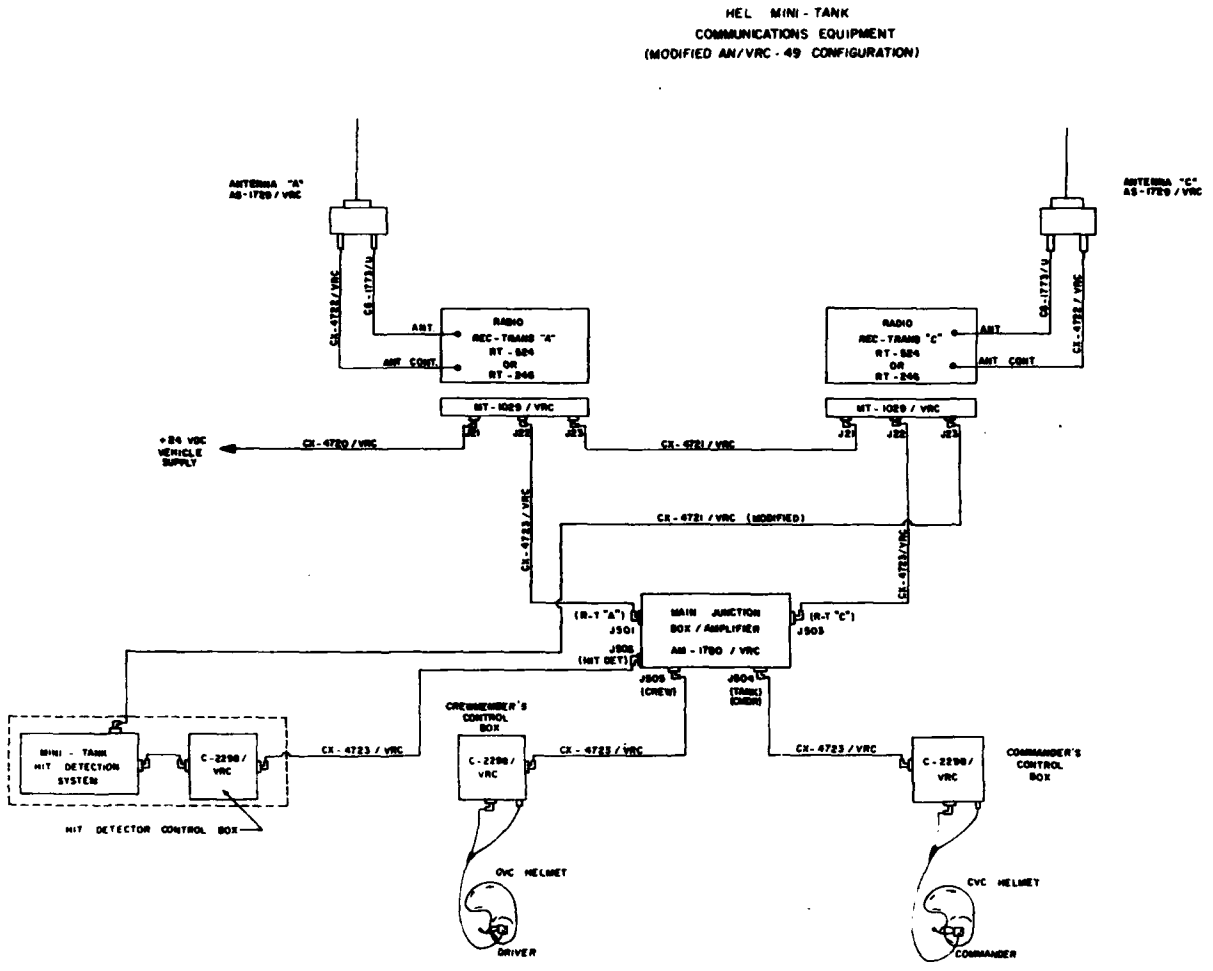

Figure 4. Vehicle intercom/radio system.