# Magnetic-Tape Module Copy and Verification System

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*The Magnetic-Tape Module Copy and Verification System consists of three programs, DOI-5431-SP, DOI-5378-SP, and DOI-5428-SP. These three programs are used to copy module type software on magnetic tape for distribution and to verify these copies for accuracy.*

## I. Introduction

The problem of copying and verifying module-type programs on magnetic tape by the DSN Program Library for distribution to Deep Space Stations was solved in a three-stage sequence involving three progressively complex computer programs. The first of the three, a simple checksum verifier, was written to satisfy an immediate need for verifying that a modular tape is copied correctly. Modular tapes are copied initially with Telemetry and Command Subsystem (TCD) Multimission Software Update Program DOI-5414-SP in lower core. Module Checksum Verifier DOI-5431-SP, in upper core, is then operated to obtain a checksum for both the master tape and the copy. In use, the checksum for the master tape is computed first; the checksum for each copy is then computed and compared visually with the checksum of the master.

In the next stage, a more sophisticated program, Magnetic-Tape Module Verifier DOI-5378-SP, was written to perform a bit-by-bit comparison between the master

and copy tapes, thus assuring 100% accuracy. The program also computes a checksum and total word count. Again, the tapes are copied with TCD Multimission Software Update Program DOI-5414-SP, and Magnetic-Tape Module Verifier DOI-5378-SP is operated in upper core to verify in a second pass that the copy is accurate. In addition to the bit-by-bit comparison between the two tapes, the checksums and word counts are compared by the program not only to provide additional assurance of accuracy but also to establish checksum and word-count figures against which a tape can be measured at any subsequent time to determine its usefulness.

It was thereupon established that copying a modular tape with TCD Multimission Software Update Program DOI-5414-SP and verifying the copies with Magnetic-Tape Module Verifier DOI-5378-SP was a sound, accurate procedure. However, the update program required many type-ins by the operator, and switching between the two programs required continual operator intervention. Therefore, to speed the process, a third program was written

which copies all records from a master tape up to a double end-of-file mark (or two meters of blank tape) onto the copy tape on the first pass, and then performs a bit-by-bit comparison, word count, and checksum computation on the second pass. In this program, Magnetic-Tape Module Copy/Verify Program DOI-5428-SP, both passes are completely under program control. The operator has only to observe type-outs and to clear halts between tapes. Operation is sufficiently fast so that 20 copies of a modular tape can be made in less than 2 hours. The typewriter type-outs provide a log showing how many tapes were copied without error.

## II. Description of Programs

The purpose of the simplest of the three programs, Module Checksum Verifier DOI-5431-SP, is to compute an exclusive-or checksum of the data file on a magnetic tape. It operates in upper core, with the copying routine DOI-5414-SP in lower core, so that the operator may switch between programs as he copies and verifies magnetic tapes.

Magnetic-Tape Module Verifier DOI-5378-SP also computes a checksum, but in addition it tallies the words on both tapes and performs a bit-by-bit comparison of the data on the tapes. It differs operationally from DOI-5431-SP in that it works with two tapes. A functional flow chart is shown in Fig. 1. The program is seen to test for a buffer error when it reads and stores a record from Tape 1 and to test for a comparison error when it reads Tape 2. If either type of error is encountered, the tape is backspaced over one record and another attempt is made. After three attempts, an error message is typed out. If the tapes reach the end of data without an error, the checksums and word counts are compared. If these values agree, the program branches back to the copy routine DOI-5414-SP after typing out the checksums and word counts.

The significant difference between Magnetic-Tape Module Copy/Verify Program DOI-5428-SP and its forebears is that DOI-5428-SP adds a copy routine to its functions. In the copy routine, the master tape is read under interrupt control and the copy tape is written with interlace. On the second pass, both tapes are read under interrupt control, their contents are compared bit-by-bit, and checksums and word counts are computed for both tapes. As with DOI-5378-SP, agreement must be reached in all three areas in order to obtain a "Verification OK" typeout. In any case of error, the program branches back to the start of the copy routine to make another attempt at writing an accurate copy of the master.

The flowchart in Fig. 2 shows the main functional elements of the program. With the master modular tape on tape unit 1 and a blank tape on unit 2, the program begins by reading and storing a record from the master tape. This record is then written on the blank tape on unit 2. This process continues until an end-of-file mark or one or two meters of blank tape is encountered, at which time both tapes are rewound to loadpoint.

The program next checks the accuracy of the copied tape by reading and storing records from both tapes, comparing the records bit-by-bit, and computing a checksum and word count for each. If a comparison error is found, an error message is typed out and the program branches back to the copy routine for another attempt. Otherwise, the procedure repeats until an end-of-file mark or blank tape is found. The checksums and word counts of the two tapes are then compared and appropriate error messages are typed out if they differ.

If no errors are found, the program types out a success message, listing the checksum and word-count values of both tapes. Finally, it branches back to the start of the program to make and verify another copy of the master modular tape.

With this program, the task of copying modular magnetic tapes is reduced to a fairly simple operation which can be handled by an operator with little training. Operation requires only that the operator ascertain that a "Verification OK" message is obtained before removing and labeling each copy. The typewriter messages comprise a log which indicates exactly how many accurate copies of the master were made. This program has been in use for almost a year with no indications of difficulty or deficiency in its operation of copying and verifying modular magnetic tapes.

## III. Procedure

With new modular tapes, the following procedure is used: The first copy is made with TCD Multimission Software Update Program DOI-5414-SP and verified with Magnetic-Tape Module Verifier DOI-5378-SP. Another copy is then made using Magnetic-Tape Module Copy/Verify Program DOI-5428-SP. If the checksums and word counts of the two copies agree, subsequent copies are made with DOI-5428-SP to take advantage of that program's facility. If checksums or word counts do not agree, copies are made with DOI-5414-SP and verified with DOI-5378-SP until the reason for the discrepancy is found and reconciled. This procedure obviates errors in

copying which may be beyond the capability of DOI-5428-SP.

The computation of checksums and word counts with these programs provides an extra dimension of reliability in that if a program tape is suspected of possible damage, it may be verified at the Deep Space Stations using Magnetic-Tape Checksum Verifier DOI-5344-SP. The checksum value and word count obtained with DOI-5344-SP must agree with those values on the tape label, which were established when the tape was copied.

## IV. Conclusion

The problem of copying and verifying modular magnetic tapes was resolved in a time-effective manner by preparing programs in three steps, progressing from a simple checksum verifier to a program which copies tape from the master and performs a bit-by-bit verification between the master and the copy. The checksum verifier sufficed at the outset, but it was replaced as soon as possible by a program which compared the two tapes bit-by-bit to insure 100% accuracy. This latter program was then updated to perform the entire task of copying and verifying modular magnetic tapes.
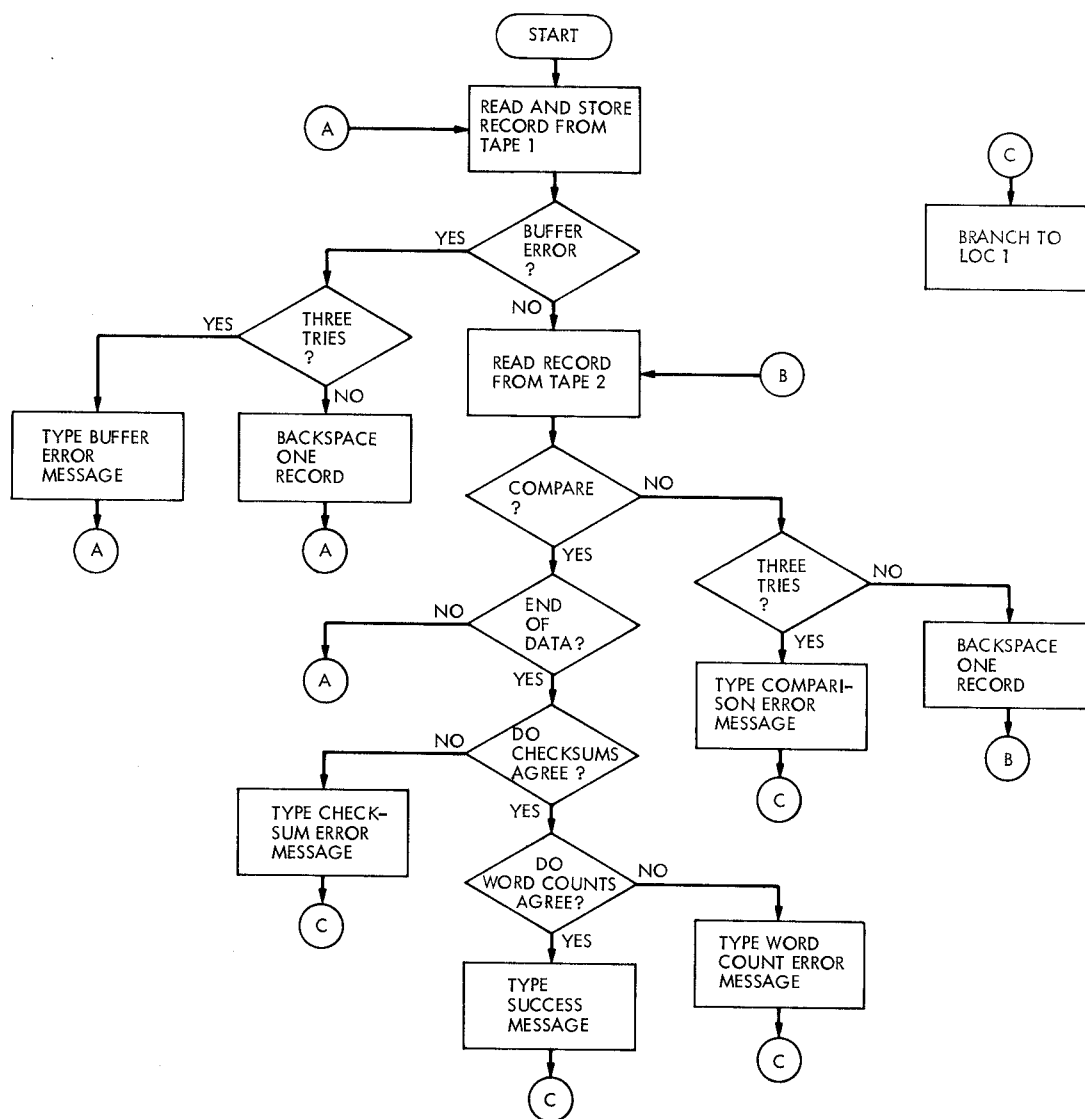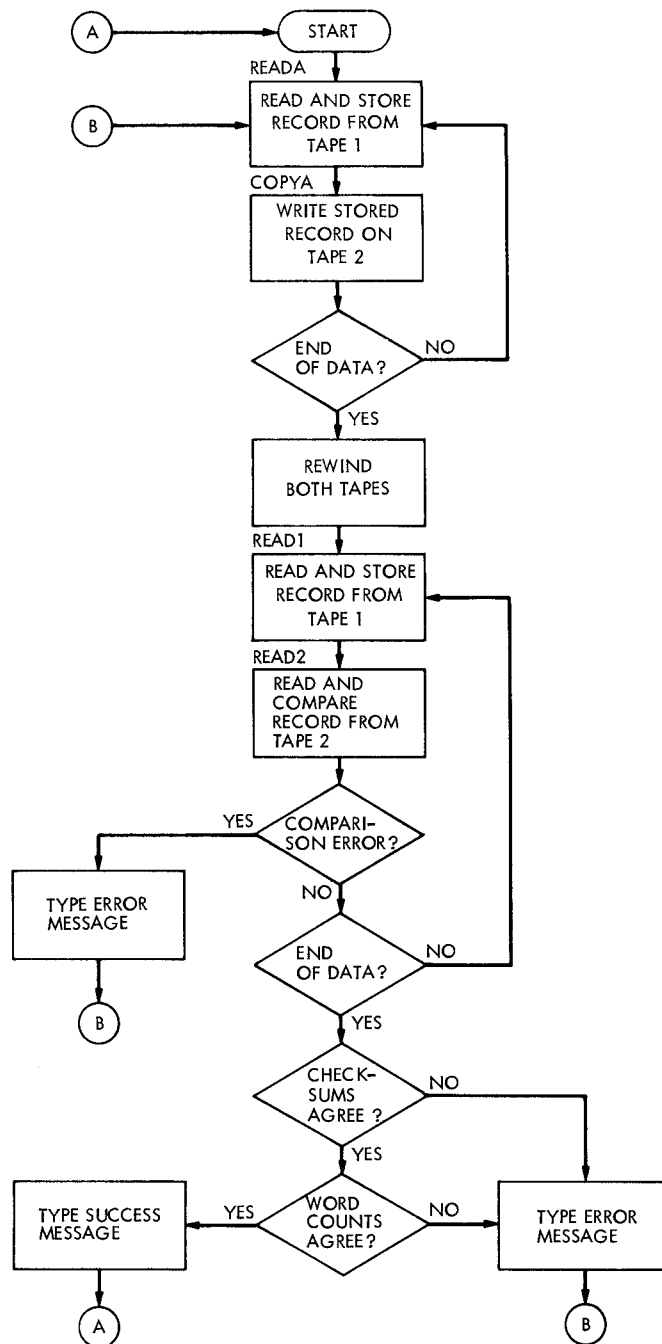
**Fig. 1. Magnetic-tape module verifier program DOI-5378-SP**

**Fig. 2. Magnetic-tape module copy/verify program DOI-5428-SP**