

Data Decoder Assembly Reliability Modifications

R. A. Mancini

DSN Data Systems Development Section

While the Data Decoder Assembly (DDA) has met the required goals of the decoding and processing of telemetry data in the DSN, it has exhibited a higher than desired failure rate. These failures were predominately of an intermittent nature and occurred more consistently in the controlling processor, the Interdata Model 4 (ID4) minicomputer. General lack of mechanical rigidity and the electromechanical construction used on the selector channels were determined to be the main contributors to these intermittent failures. These weaknesses in design initiated the bulk of the problems by causing connector contacts to become intermittent during operation. Mechanical redesign of the ID4 front panel hinges and a design for a cabinet strut stiffener were implemented in the DSN. Newer design, more reliable selector channels were purchased and installed in all ID4s in the DSN. These changes significantly reduced the failure rate; however, there still remains a much lower failure rate, the source of which is being investigated.

I. Introduction

The Data Decoder Assembly (DDA) is part of the Telemetry and Command Data Handling Subsystem of the Deep Space Network (DSN). In operation, the DDA is capable of performing three mutually exclusive functions: sequential decoding of convolutionally encoded data, block decoding of 32/6 or 16/5 biorthogonal block coded data, or high-rate data formatting of encoded or uncoded data for transmission on the wideband data line with simultaneous recording of the data on magnetic tape.

An Interdata Model 4 (ID4) minicomputer is one of nine assemblies mounted in a standard 205.74-cm (81-in.) equipment cabinet which makes up the DDA.

II. Background

Beginning with the first delivery of the JPL configuration of the ID4 computers (used in the Data Decoder Assembly), problems of an intermittent nature have been encountered. It should be pointed out at the beginning

of this report that the JPL configuration (mechanical mountings) of the ID4 was not an Interdata standard.

Interdata bolted their computer chassis into a standard 48.26-cm (19-in.) rack and made all interface cable connections from the front of the rack under the control panel, which was hung from the rack mounting frame on special hooks provided for this purpose.

JPL required that the computer be mounted on slide rails for ease of replacement (at that time sparing was to be done at the computer assembly level). Also, the control panel was hinged to the computer's main chassis to provide access to the motherboards (large component boards of the computer containing modularized computer functions, sometimes requiring several motherboards). Interfacing was required to be through (JPL selected) connectors mounted on the rear of the computer assembly. Also JPL required the use of vinyl sleaving for cables instead of the woven cloth used by Interdata.

Unfortunately, the mechanical design changes required of Interdata were not engineered properly; thus:

- (1) The original hinges were not operative until the computer was pulled out on its slides enough to provide clearance for the swing of the hinged front panel.
- (2) The chassis was expanded into a double bay configuration but fabricated of the same material as for the single bay and with no stiffening to provide rigidity normally given by the rack framework.
- (3) The vinyl sleaving used for cables exerted excessive torque on the daughterboard (component board and or cable plug-ins to motherboard) connectors causing intermittent connections under some conditions.

III. History of Problems

Interdata Model 4 computers were built and delivered to JPL and its Data Decoder Assembly contractor (in Phoenix) between November 1970 and May 1972. During that period, numerous field service visits and reports were made by Interdata to JPL, Phoenix, Goldstone, and Cape Kennedy. A study was made of 85 Interdata field service reports during the period November 10, 1970 to August 24, 1972. Of the 85 reports, there were 20 sepa-

rate items describing connector or contact problems. These 20 problems were reported on 17 reports.

During the installation periods, connector seating problems associated with the daughter/motherboard connectors were experienced in all Deep Space Stations.

As a result of the high rate of connector mating (seating) problems being reported and the general experience with the Interdata equipment at CTA 21, an investigation was initiated to define and document these problems for more thorough study.

All Deep Space Stations were asked to document specific failures in the ID4 (only) and forward the information in two groupings: specific failures (design faults, timing adjustments, noisy data lines, and components) and nonspecific failures (reseated motherboards and daughterboards, reloaded computer, etc.). Also the related downtime was requested. The responses from the DSN indicated a number of connector-related problems corrected by the reseating of motherboards and daughterboards.

The ID4 computer at that time contained 7776 contacts for all daughterboards, in addition to the motherboard backpanel and external interfacing connections.

Frame twisting of the computer causing intermittent failures was noted when pulling the ID4 out on its slide rails.

IV. Corrective Action Implemented

Based on the information accumulated in studying this intermittent failure problem, various corrective actions were taken.

A. New Hinges

The front panel hinges were redesigned to allow the panel to open for maintenance and troubleshooting with the computer bolted to the rack frame. This allows the rack stiffness to support the inadequate computer cabinet construction. These new hinges were installed in all ID4s in the DSN, and all new ID4s purchased for Mariner Venus/Mercury 1973 (MVM'73) and Viking requirements came with these new hinges installed.

B. Interdata Four Cabinet Strut

To preclude chassis distortion when the computer is pulled out on its slides, a stiffening strut was designed

and implemented in all ID4s in the DSN, and in all new ID4s purchased for MVM73 and Viking requirements. This strut fits across the front face of the computer chassis (or cabinet) and provides rigidity to what was effectively an open box face. With these struts installed, connector mating intermittent problems have been significantly reduced since the ID4 cabinet no longer distorts when the computer is pulled out on the slide rails.

C. New Selector Channels

A new selector channel design, which significantly reduced the number of contacts, was evaluated for replacement of the existing failure-prone selector channels. The new selector channels are of all integrated circuit (IC) construction mounted on two printed-circuit motherboards with wire-wrap interconnections, whereas the old selector channel was constructed of IC and discrete components mounted on 109 daughterboards, which were in turn mounted on three motherboards. The circuit interconnections were by means of wire-wrap also. By using these new selector channels, the number of electromechanical connections was reduced by 5232 in Configuration II DDAs and by 3488 in Configuration I DDAs. An additional feature of the new selector channel was the correction of a pulse timing condition in the address sequence which caused data to be stored and or retrieved from erroneous locations in ID4 memory. The new selector channel eliminated the timing problem through the exclusive use of integrated circuits reducing the propagation delay of discrete component construction. All ID4s in the DSN were retrofitted with the new selector channels.

V. Results

The implementation of these DDA reliability improvement modifications has significantly reduced the number of failures from marginal connections in the ID4.

VI. Remaining Problems

There are still a number of daughterboard cable connectors being used in the computer, and engineering has been looking into the possibility of replacing these daughterboard connectors with a more reliable type of connector, especially in the daisy chain high-speed memory bus associated with the selector channel operations.

Also, within the DDA, there are other points of sub-standard reliability. Several sets of coupler boards used in the DDA interface were fabricated with IC receptacles of questionable reliability (CTA 21 has one set of these and has experienced many instances of ICs loosening in their sockets). The DDA Interface Backplane Assembly is possibly over-flexible and appears to cause connector seating problems of the coupler chassis which mount on it.

The AMP, Inc., connectors used on the DDA Backplane Assembly and on the computer (ID4) interface connector panel have a tendency to be pushed or pulled out of their mounting holes if they are not assembled properly.

The ID4 low-voltage power supply fuse blows too frequently because of excessive heating in the area where it is mounted. An Engineering Change Order (ECO) is in preparation to remedy this problem.