530-ICD-STGT/STARLINK

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Interface Control Document (ICD) Between the STARLink Project and the Second TDRSS Ground Terminal (STGT)

Original

January 1995

National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

Interface Control Document (lCD)
Between **the**
STARLink Project
and the
Second **TDRSS** GroundTerminal **(STGT)**

Version 1.0

January 1995

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Preface

The purpose of this document is to provide a detailed definition of the interfaces between the STARLink Project equipment located at the Second TDRSS Ground Terminal (STGT), the STGT Data Interface System (DIS), and the NASA Communications (NASCOM) Network equipment located at STGT.

This document is under the configuration management of the Networks Division (ND) Configuration Control Board (CCB).

Configuration Change Requests (CCRs) to this document shall be submitted to the ND CCB, along with supportive material justifying the proposed change. Changes to this document shall be made by document change notice (DCN) or by complete revision.

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Abstract

This Interface Control Document (ICD) describes the detailed interfaces between the STARLink Project and the Second TDRSS Ground Terminal (STGT). Specifically, this ICD describes the voice and data communications interfaces between STARLink Unique Equipment (SLUE) located at STGT, the STGT Data Interface System (DIS) equipment, and the NASA Communications (NASCOM) Network equipment located at STGT.

Keywords: *ICD, interface, Nascom, STARLink, STGT.*

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Document History			
Document Number	**Status/Issue**	**Publication Date**	**CCR Number**
530-ICD-STGT/ STARLINK	Original	January 1995	
530-ICD-STGT/ STARLINK	DCN-01	October 1995	CCR-ICD*-01

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Section 1. Introduction

1.1 Purpose

This Interface Control Document (ICD) defines and controls the baseband voice and data communications interfaces between STARLink Unique Equipment (SLUE) located at the Second TDRSS Ground Terminal (STGT), the STGT Data Interface System (DIS) equipment, and the NASA Communications (NASCOM) Network equipment located at STGT.

1.2 Scope

This ICD identifies, defines, and controls the inputs and outputs to all voice/data channels between the SLUE, the STGT DIS, and the NASCOM 2000 equipment located at STGT. It defines the electrical and mechanical interface characteristics of those channels.

1.3 Time Frame

The ICD will be in effect during the existence of the described interface.

Section 2. Documents

2.1 Applicable Documents

2.1.1 Requirements Documents

The following documents, of the exact date of issue indicated, are part of this ICD to the extent cited herein. If there are conflicts between the listed documents and the requirements of this ICD, the requirements of this ICD shall be considered to be the superseding requirement. In the event of conflict between other listed documents, the order of precedence shall be as follows:

a. The requirements of NASA documents shall take precedence over the requirements of other listed documents.

b. The requirements of other Government documents shall take precedence over contractor documents and industrial standards.

Unless otherwise indicated, the entire document shall apply.

2.1.2 Specifications

a. *Phase II Requirements Specification for the Second TDRSS Ground Terminal (STGT)*, P-01, DCN 16, August 15, 1994.

b. *GSFC Specification: Electronic Equipment Racks*, STDN No. 270.5, July 1989.

c. *Requirements Specification for the Danzante Ground Terminal*, 530-RSD-DANZANTE, January 31, 1995.

d. *Interface Control Document (ICD) Between the Network Control Center (NCC)/Flight Dynamics Facility (FDF) and the White Sands Complex (WSC)*, 530-ICD-NCC-FDF/WSC, Rev. 3, May 1995.

2.1.3 Standards

a. *Electrical Characteristics of Balanced Voltage Digital Interface Circuits*, EIA STD RS-422A, December 1978. Section 4.1, 4.2.

b. *Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange*, EIA STD RS-232-C, June 1981.

2.2 Reference Documents

The following documents are for reference only:

a. *GSFC Specification: Installation Requirements for STDN Equipment*, STDN SPEC-6, May 1986.

b. *GSFC Specification: Grounding System Requirements*, STDN No. 270.7, July 1989.

Section 3. System Description

3.1 General

This section is provided as background information to describe the basic functions of, and interactions between the SLUE, STGT DIS, and NASCOM 2000 equipment located at STGT.

3.2 STARLink System Description

The STARLink Project will use the Tracking and Data Relay Satellite System (TDRSS) and NASCOM links to relay voice and data communications between the STARLink Airborne (SLA) ER-2 aircraft and the Project Operations Control Center (POCC) located at NASA Ames Research Center (ARC). STARLink will use TDRSS Ku-band Single Access (KSA) services. The overall architecture of the forward and return voice/data links is shown in Figure 3-1. TDRSS service and NASCOM resources are scheduled and controlled by the Network Control Center (NCC) located at the Goddard Space Flight Center (GSFC).

3.2.1 Forward Link

Analog POCC/SLA voice signals, 56 kbps SLA command data, and 9.6 kbps SLUE status request data generated at ARC are transported to the SLUE located at STGT via NASCOM. The equipment configuration and interfaces at STGT for the forward link are shown in Figure 3-2. The SLUE converts the analog voice to digital voice and multiplexes the voice, command, and other SLUE generated data into a single data stream. The data stream is encoded in the SLUE and transmitted to the SLA via the forward KSA link at an encoded bit rate of 400 kbps.

3.2.2 Return Link

The return KSA link is composed of multiplexed voice and data that is transmitted at a bit rate of 294.912 Mbps. Note that since the communications link between STGT and ARC is limited to the DIS STATMUX data throughput of 48 Mbps, the SLA limits its total effective return data throughput to $\leq$ 48 Mbps. The SLA performs bit stuffing to increase the rate of the bit stream to 274.176 Mbps and applies Reed-Solomon coding (254, 238) to produce a final encoded bit rate of 294.912 Mbps. The return bit stream is transmitted to STGT via the KSA return link with 147.456 Mbps on the I-channel and 147.456 Mbps on the Q-channel.

The equipment configuration and interfaces at STGT for the return link are shown in Figure 3-3. The SLUE at STGT performs forward error correction (FEC), removes the bit stuffing, and demultiplexes the SLA/POCC voice data from the return data stream. The SLUE converts the voice data into analog signals and routes these signals and the 9.6 kbps SLUE status data to ARC via NASCOM 2000 equipment. The separate I-channel and Q-channel SLA return data streams are combined by the SLUE into a single stream. The SLUE demultiplexes the SLA return data into a maximum of two bit streams with a combined rate less than or equal to 48 Mbps as determined by available bandwidth scheduled by the NCC.

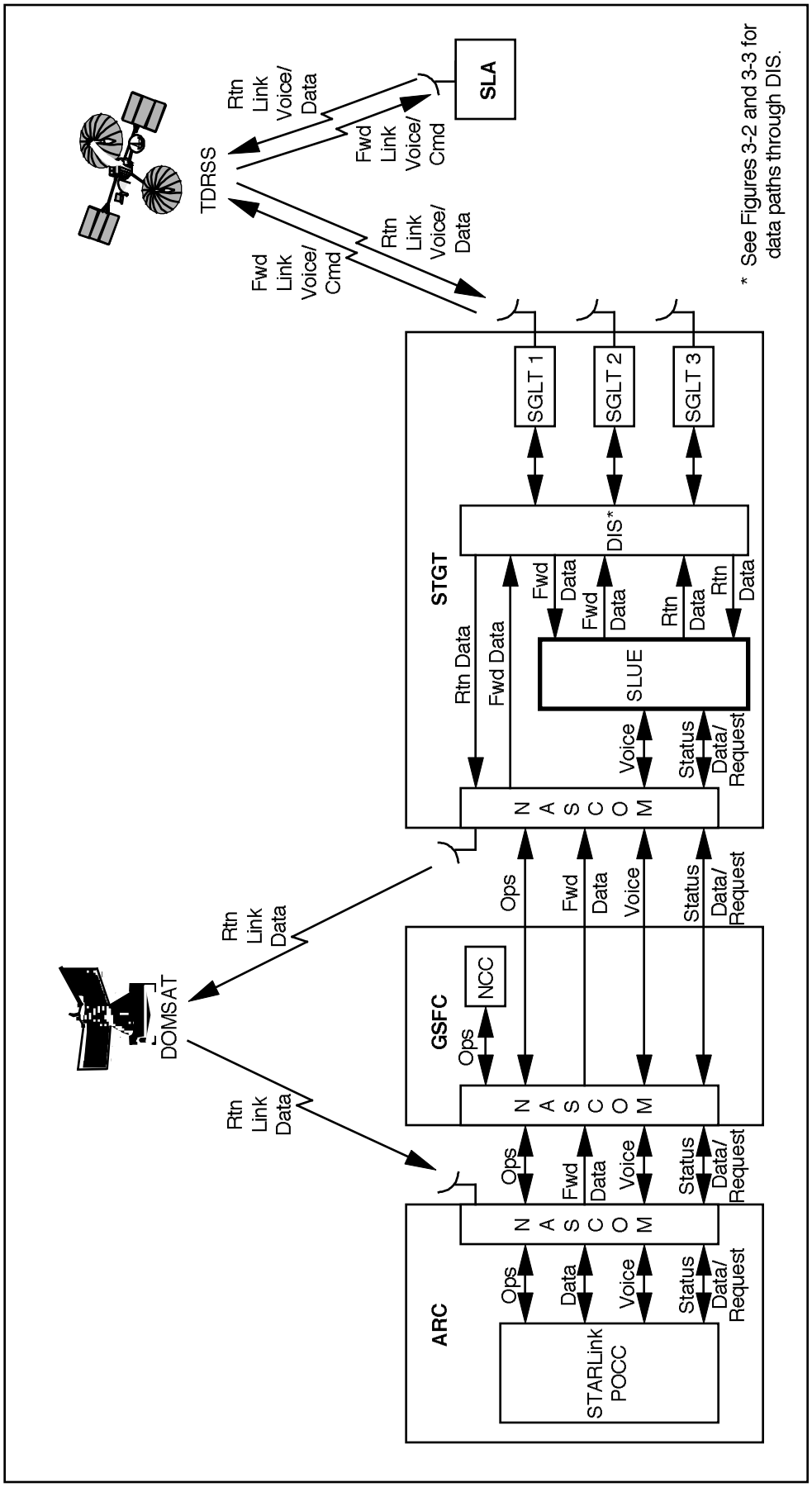

Figure 3-1. STARLink Forward and Return Link Architecture

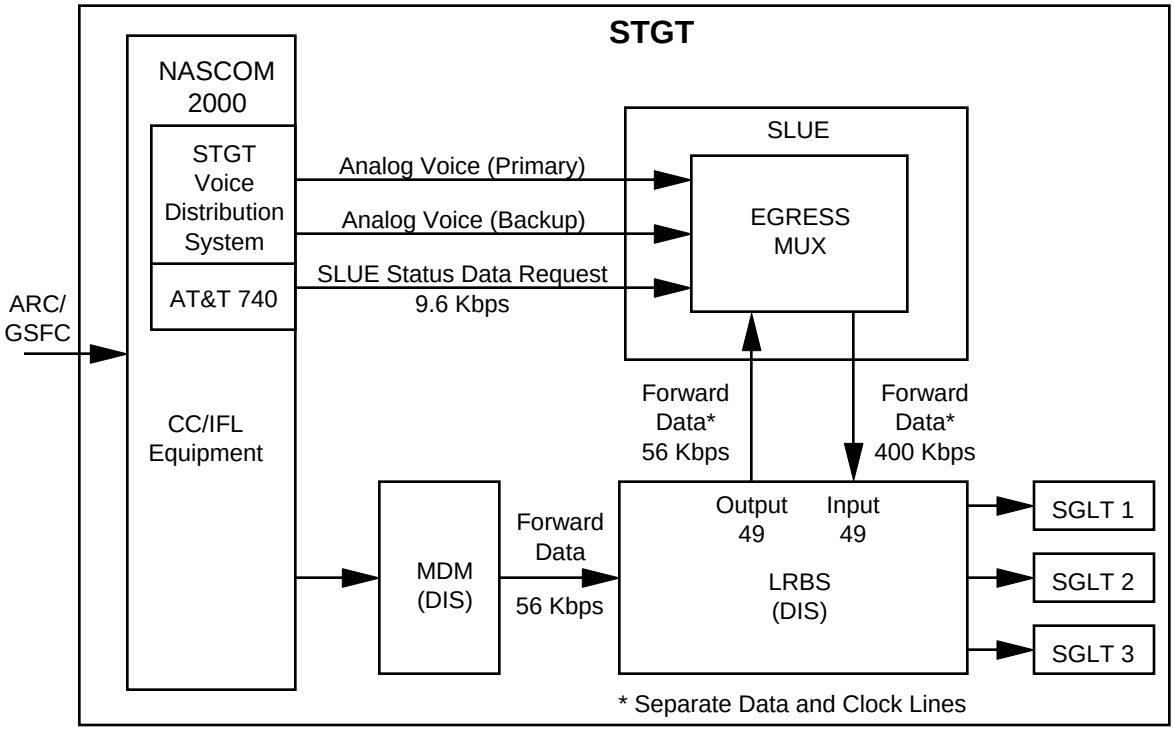

Figure 3-2. STARLink Forward Link Configuration at STGT

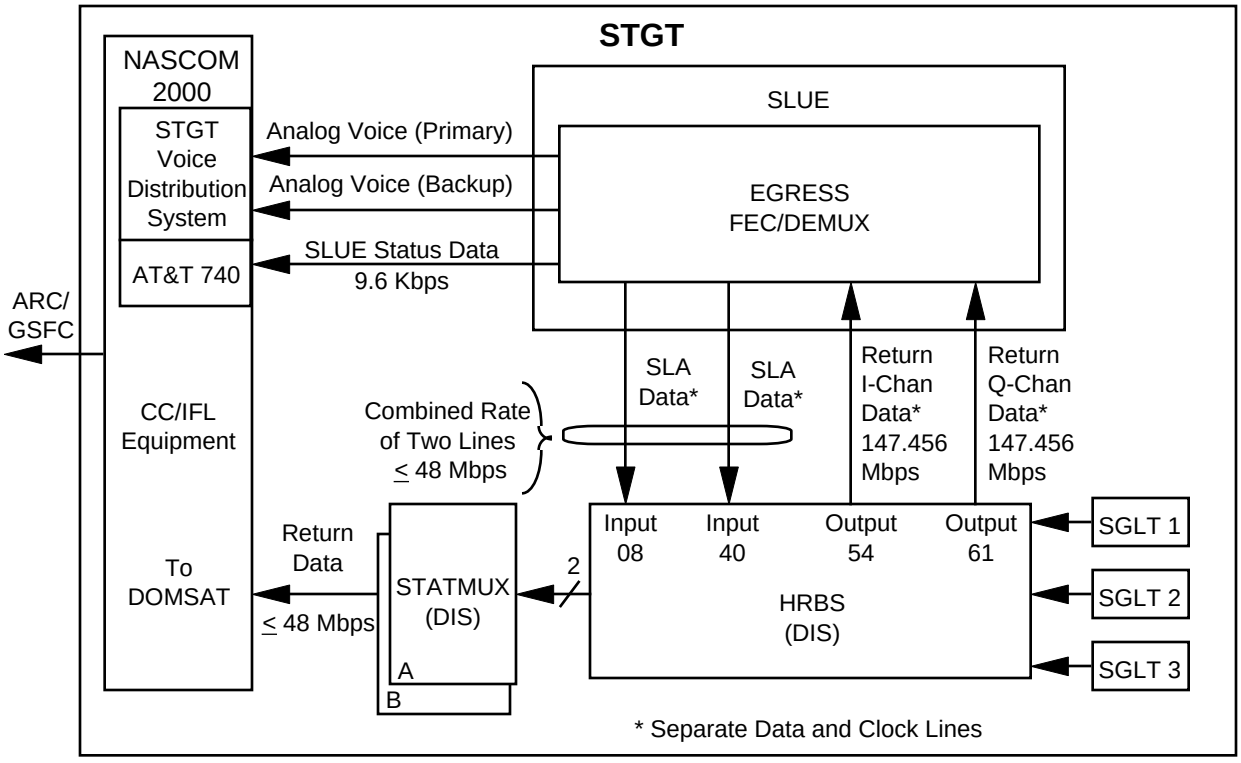

Figure 3-3. STARLink Return Link Configuration at STGT

The two SLUE output streams are routed through the High Rate Black Switch to the two input channels of the STATMUX. A single stream of up to 48 Mbps of SLA return data is output from the STATMUX and is transported to ARC via DOMSAT.

3.3 STGT System Description

The STGT has three Space-to-Ground-Link Terminals (SGLTs) capable of providing high data rate TDRSS service. Communications interfaces to and from elements of STGT are via the DIS. To support the STARLink Project, the SLUE will be installed at STGT and new interfaces provided between the SLUE, the STGT DIS, and NASCOM 2000 equipment as previously shown in Figures 3-2 and 3-3. Each digital interface between the SLUE and the Low Rate Black Switch (LRBS) and the High Rate Black Switch (HRBS) is a one-way baseband interface that consists of separate data and clock lines.

3.4 NASCOM System Description

NASCOM is the operational communications system network of NASA and is operated by the NASA Communications Division, Code 540, GSFC. The primary NASCOM switching and control center is located in GSFC Building 14; the TDRSS scheduling center is in the NCC located in GSFC Building 13. NASCOM serves as the hub for providing data transport to and from STGT. NASCOM is responsible for providing to STGT the data transport service to perform its required functions. This responsibility entails performing the following functions:

a. Data Delivery. Transmission of data for the STGT to the STGT/DIS interfaces.

b. Data Distribution. Acceptance of data from the STGT/DIS interfaces for routing and distribution.

c. Technical Control. Monitoring and problem control of NASCOM operational circuits in the network and at the NASCOM-DIS interface, including the NASCOM side of the NASCOM-DIS interface.

The NASCOM 2000 equipment applicable to SLUE interfaces at STGT includes the AT&T 740 T1 Mux/Demux and the STGT Voice Distribution System. The analog voice interfaces between the SLUE and NASCOM 2000 equipment are 4-wire, full-duplex phone circuits. The SLUE status data/request interface between the SLUE and the NASCOM 2000 equipment is an asynchronous serial RS-232 standard interface.

3.5 Communications Interface Requirements

Each digital interface between the SLUE and DIS equipment is a one-way baseband interface and shall comprise separate data and clock lines. Balanced voltage interfaces shall be used to support these digital interfaces.

3.5.1 STGT DIS/SLUE Low Rate Forward Link Interfaces

The characteristics of the low rate interfaces between the LRBS and the SLUE are listed in Table 3-1.

Table 3-1. LRBS/SLUE Low Rate Forward Link Interfaces

Port[1]	From	To	Description
LRBS Output 49	MDM	EGRESS MUX	56 kbps Command Data
LRBS Input 49	EGRESS MUX	SGLT 1,2, or 3	400 kbps Multiplexed Voice/Data

Note 1: All ports comprise separate data and clock lines.

3.5.2 STGT DIS/SLUE High Rate Return Link Interfaces

The characteristics of the high rate interfaces between the HRBS and the SLUE are listed in Table 3-2.

Table 3-2. HRBS/SLUE High Rate Return Link Interfaces

Port[1]	From	To	Description
HRBS Input 08	EGRESS FEC/DEMUX	STATMUX	SLA Data[2]
HRBS Input 40	EGRESS FEC/DEMUX	STATMUX	SLA Data[2]
HRBS Output 54	SGLT 1,2, or 3	EGRESS FEC/DEMUX	147.456 Mbps I-Channel Data
HRBS Output 61	SGLT 1,2, or 3	EGRESS FEC/DEMUX	147.456 Mbps Q-Channel Data

Note 1: All ports comprise separate differential data lines (+data and -data) and clock lines (+clock and -clock).

Note 2: The maximum combined data rate of both lines of SLA Data is 48 Mbps.

3.5.3 STGT NASCOM/SLUE Interfaces

The characteristics of the interfaces between the NASCOM 2000 equipment and the SLUE are listed in Table 3-3. The analog voice signals will be routed between the SLUE and the AT&T 740 T-1 equipment via the STGT Voice Distribution System. The RS-232 signals for SLUE status data and status data request will interface directly with the AT&T 740 equipment.

Table 3-3. NASCOM/SLUE Interfaces

Port	From/To	To/From	Description
STGT Voice Distribution System Node 232, Channel 15	EGRESS MUX	AT&T 740	Voice (Primary); 4-Wire Full-Duplex Phone Circuit
STGT Voice Distribution System Node 232, Channel 16	EGRESS MUX	AT&T 740	Voice (Backup); 4-Wire Full-Duplex Phone Circuit
AT&T 740 Node 231, Channel 43	EGRESS MUX	AT&T 740	9.6 kbps SLUE Status Data and Status Data Request; RS-232 Standard Interface

Section 4. Physical Control Level

4.1 Electrical Characteristics

4.1.1 Characteristics for Serial Digital DIS/SLUE Interfaces

The serial digital data and clock interfaces between the DIS and the SLUE have been designated Low Rate or High Rate interfaces. When the bit rate at the interface is 10 Mbps or less, the interface characteristics shall comply with Low Rate requirements. When the bit rate at the interface is higher than 10 Mbps, the interface characteristics shall comply with High Rate requirements. The data format shall be NRZ-L. The clock signal shall use a square wave format. The electrical characteristics of the Low Rate and High Rate interface equipment shall be in accordance with Sections 4.1 and 4.2 of EIA STD RS-422A, December 1978, except as otherwise specified herein. Definitions of the performance parameters in Tables 4-1 and 4-2 which describe the clock/data relationships are contained in Appendix A. For DIS-to-SLUE signals, the interface between each driver and the corresponding receiver shall be located at the output of the inter-connecting cable on the receiver end as shown in Figure 4-1. For SLUE-to-DIS signals, the interface between each driver and the corresponding receiver shall be located at the input to the inter-connecting cable as shown in Figure 4-2.

4.1.1.1 Low Rate Interface Requirements

Low Rate Drivers/Receivers shall be used for interfacing serial digital data and synchronous clock signals between the DIS LRBS and SLUE for data rates from 100 bps to 10 Mbps. The Low Rate Driver/Receiver configuration circuits are shown in Figures 4-1 and 4-2. These configurations shall consist of a balanced driver and receiver coupled by a shielded, balanced twin axial cable system for both the data and clock signals. The performance parameters for Low Rate interfaces are specified in Table 4-1.

Table 4-1. Performance Parameters for Low Rate Interfaces

Parameter	Requirement
Maximum Clock Asymmetry	5%
Maximum Time Skew (A) to (B) at Interface (Data or Clock)	8 ns
Maximum Clock to Data Skew (A) to (B)	25%
Minimum Differential (A) to (B) Voltage (Clock or Data) at Interface	2.4 V

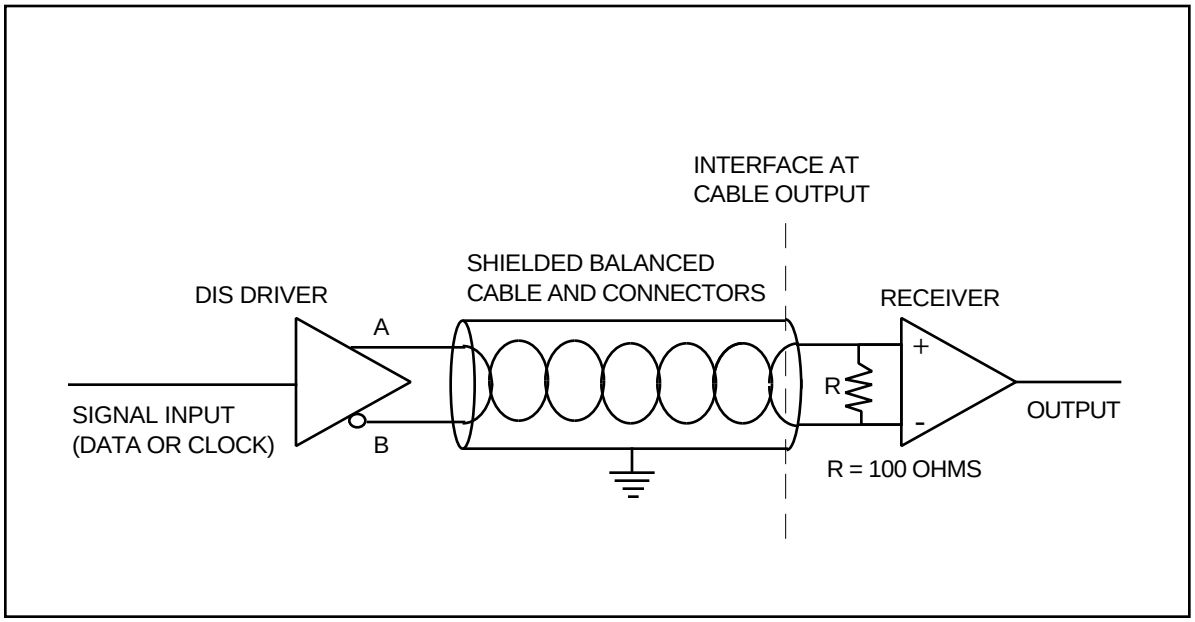

Figure 4-1. Low Rate Balanced Voltage DIS-to-SLUE Driver/Receiver Configuration

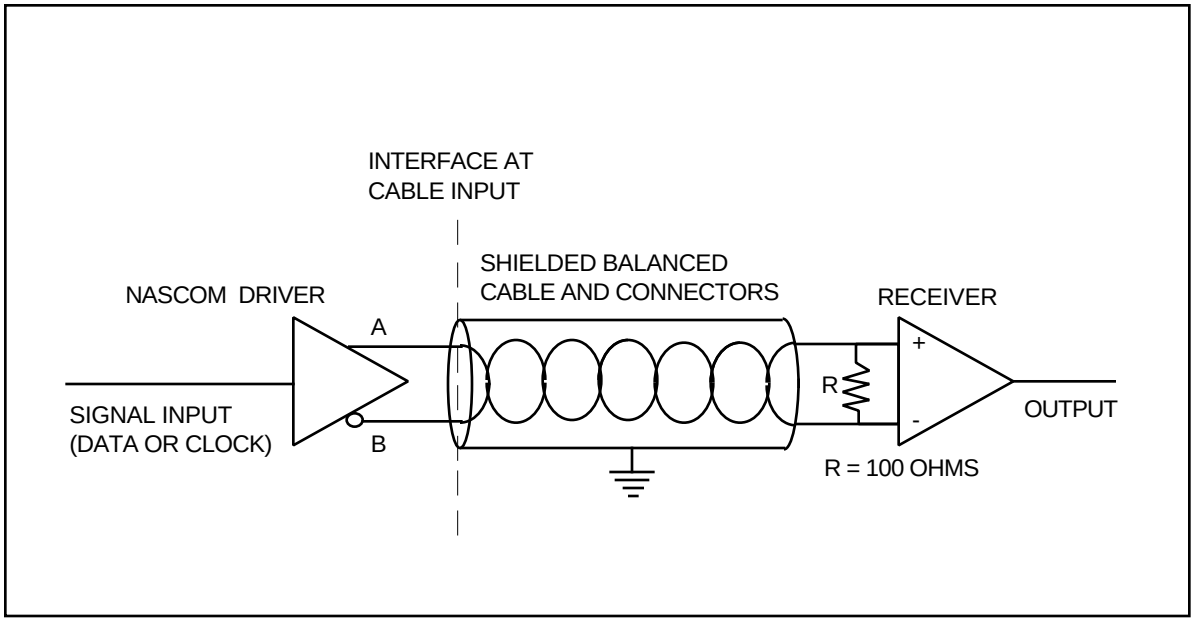

Figure 4-2. Low Rate Balanced Voltage SLUE-to-DIS Driver/Receiver Configuration

4.1.1.2 High Rate Interface Requirements

High Rate Drivers/Receivers shall be used for interfacing serial digital data and synchronous clock signals between the DIS HRBS and SLUE for data rates from 10 Mbps to 300 Mbps. The High Rate Driver/Receiver configuration circuits are shown in Figures 4-3 and 4-4. These configurations shall consist of balanced drivers and receivers coupled by a shielded, balanced dual coaxial cable system for both the data and clock signals. The performance parameters for High Rate interfaces are specified in Table 4-2.

Table 4-2. Performance Parameters for High Rate Interfaces

Parameter	Requirement
Maximum Clock Asymmetry	20%
Maximum Time Skew (A) to (B) at Interface (Data or Clock)	575 ps
Maximum Clock to Data Skew (A) to (B)	25%
Minimum Differential (A) to (B) Voltage (Clock or Data) at Interface	387 mV

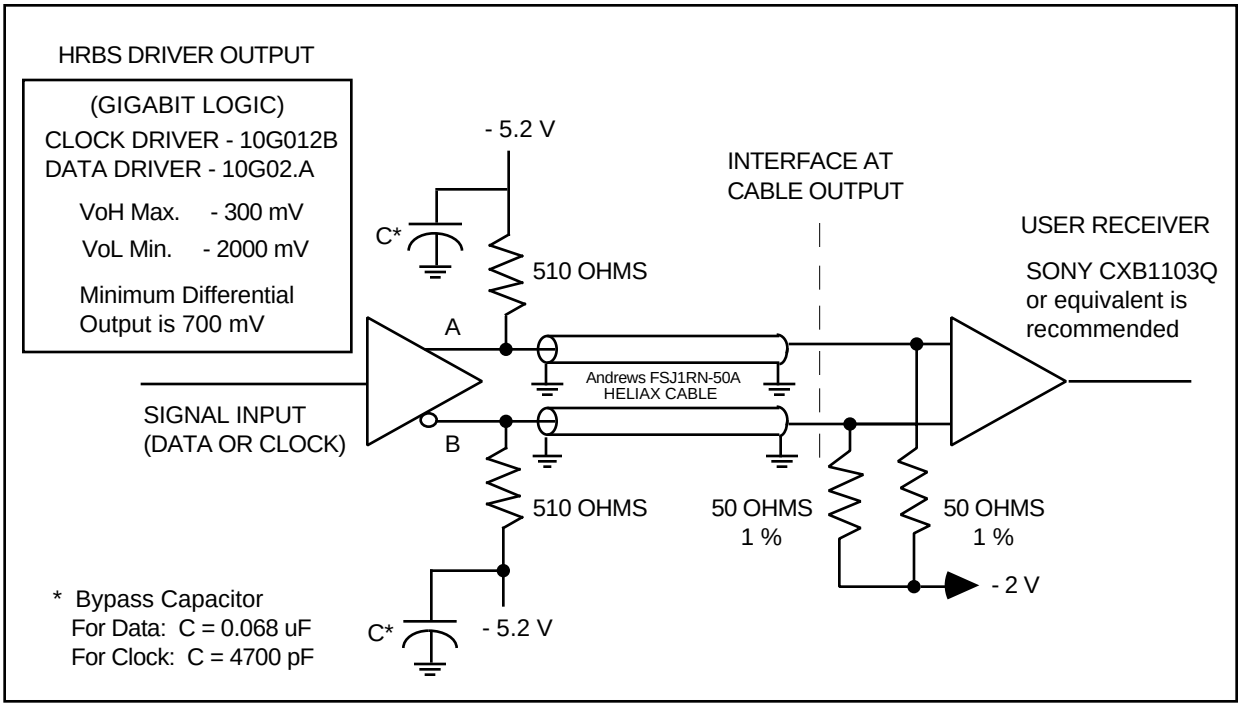

Figure 4-3. High Rate Balanced Voltage DIS-to-SLUE Driver/Receiver Configuration

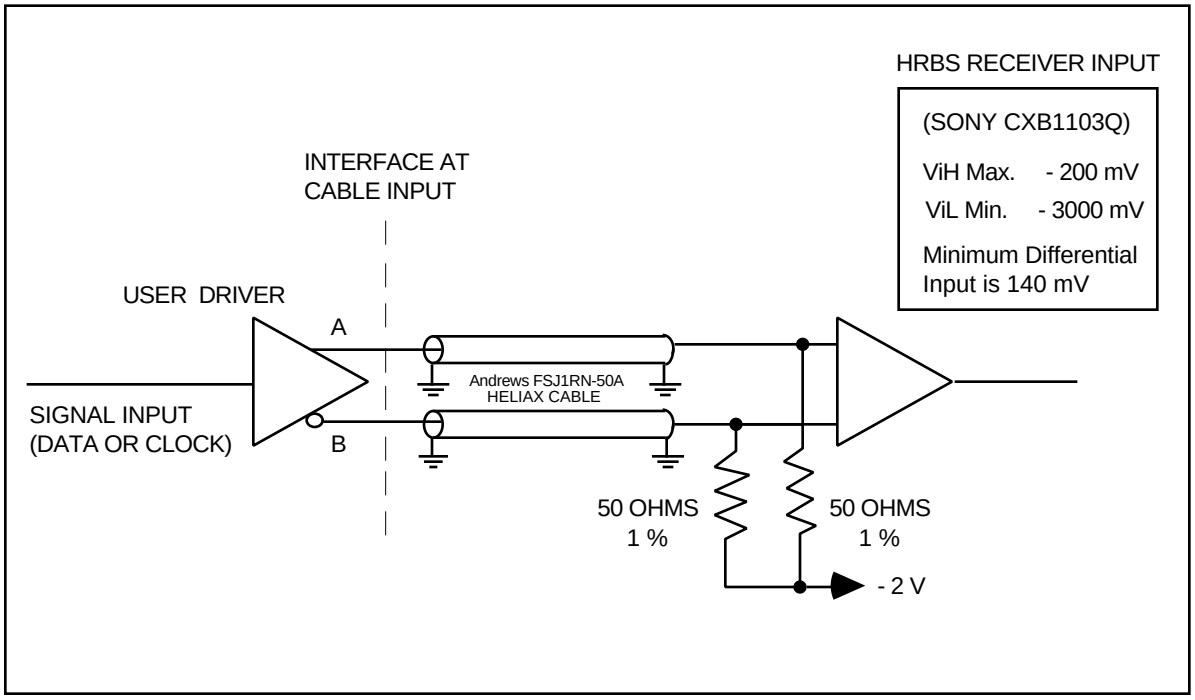

Figure 4-4. High Rate Balanced Voltage SLUE-to-DIS Driver/Receiver Configuration

4.1.2 Characteristics for NASCOM/SLUE Interfaces

The POCC/SLA voice interfaces (primary and backup) between the NASCOM 2000 equipment and the SLUE shall each consist of a dedicated, full-duplex, 4-wire phone circuit. The electrical characteristics of the RS-232 interface for the SLUE status data and status data request shall be in accordance with EIA STD RS-232C, June 1981.

4.1.3 Characteristics for STGT/SLUE Power Interfaces

The power interface for the SLUE rack shall consist of one 20 amp single phase service. The SLUE rack power connection shall be in accordance with GSFC STDN 270.5. STGT will provide the power connection hardware.

4.2 Installation Requirements

The SLUE at the STGT shall be physically located in the STGT Ground Communications Equipment (GCE) room. The SLUE rack shall be installed at STGT GCE grid N-83. The rack designation shall be 7643. All cables egressing the SLUE rack shall have STGT cable wire numbers. STGT personnel will assign cable numbers and label all cables based on a list of cables between the console and rack to be provided by the STARLink Project. Internal rack cable numbering will be assigned by the STARLink Project; however, all internal cables shall be marked with "mates to" information.

4.3 Mechanical Interface Characteristics

4.3.1 Low Rate Cables

For the low rate interfaces, the STGT cables shall be type AA7028, plenum shielded twin axial (Times). These cables will be provided by STGT.

4.3.2 High Rate Cables

For the high rate interfaces, the STGT cables shall be type FSJ1RN-50A 1/4 inch heliax (Andrews). These cables will be provided by STGT.

4.3.3 NASCOM 2000 Cables

Cables for the NASCOM 2000/SLUE analog voice and RS-232 interfaces will be provided by STGT.

4.3.4 Low Rate Connectors

For the low rate interfaces, the SLUE I/O panel shall provide Trompeter type TRB female bulkhead jacks BJ78, BJ79, or equivalent.

4.3.5 High Rate Connectors

For the high rate interfaces, the SLUE I/O panel shall provide N-type female bulkhead jacks.

4.3.6 Audio Connectors

For the analog voice interfaces, the SLUE rack shall provide a DB9 (socket) type ITT Cannon DEU110973 or equivalent. The pinout shall be as listed in Table 4-3.

Table 4-3. Pinout for SLUE Audio Connectors

Contact Number	Signal[1]
1	Shield (ground)
2	TX+ (From SLUE Rack to NASCOM 2000)
3	-
4	RX+ (From NASCOM 2000 to SLUE Rack)
5	-
6	-
7	TX-
8	-
9	RX-

Note 1: Transmit (TX) and Receive (RX) are identified from the NASCOM 2000 perspective.

4.3.7 RS-232 Connectors

For the RS-232 SLUE status data and status data request interface, the SLUE rack shall provide a subminiature D-type 25 (socket) connector ITT Cannon type DBMAM25S or equivalent. The pinout shall be as specified in EIA STD RS-232-C. The SLUE rack is considered Data Terminal Equipment (DTE).

4.3.8 SLUE Rack I/O Panel

The SLUE rack I/O panel shall be mounted horizontally to facilitate connection of heliax cables. The spacing for all connectors shall be 1.5 inches minimum, with 2 inches recommended.

Appendix A. Definition of Terms

A.1 Specified Parameters

Refer to Figure A-1 for an illustration of the parameters defined below.

a. Clock Asymmetry - This parameter specifies the allowable clock duty cycle range around 50 percent.

b. Differential (A) to (B) Voltage - This parameter specifies the allowable plus or minus differential voltage to ensure a voltage at the receiver input capable of producing a full receiver output swing.

c. Time Skew (A) to (B) - This parameter identifies the allowed time skew between the (A) cable and the (B) cable of any differentially transmitted signal. The total time skew given in Tables 4-1 and 4-2 varies linearly along the total cable length. The total time skew is the difference between the driver output skew and worst case receiver input skew.

d. Time Skew (A) Data to (A) Clock - This parameter identifies the allowed time skew between a clock signal (A cable) and its related data signal or signals (A cable). This parameter is evaluated on an instantaneous clock period to data period basis. It includes all combination effects of clock asymmetry and jitter conditions in their total affect on clock transition and data midpoint skew.

A.1 Logical Sense

The logical signal exchange between the driver and receiver shall be in accordance with the following convention for balanced differential interfaces:

a. The (A) terminal of the driver shall be negative with respect to the (B) terminal for a binary 1 exchange.

b. The (A) terminal of the driver shall be positive with respect to the (B) terminal for a binary 0 exchange.

c. The significant transition for the clock signal is the negative-going transition of the (A) line with respect to the (B) line. This transition shall occur within the specified tolerance of the mid-point of the data bit period.

d. All data crossings shall be coincident with the positive going clock transitions.

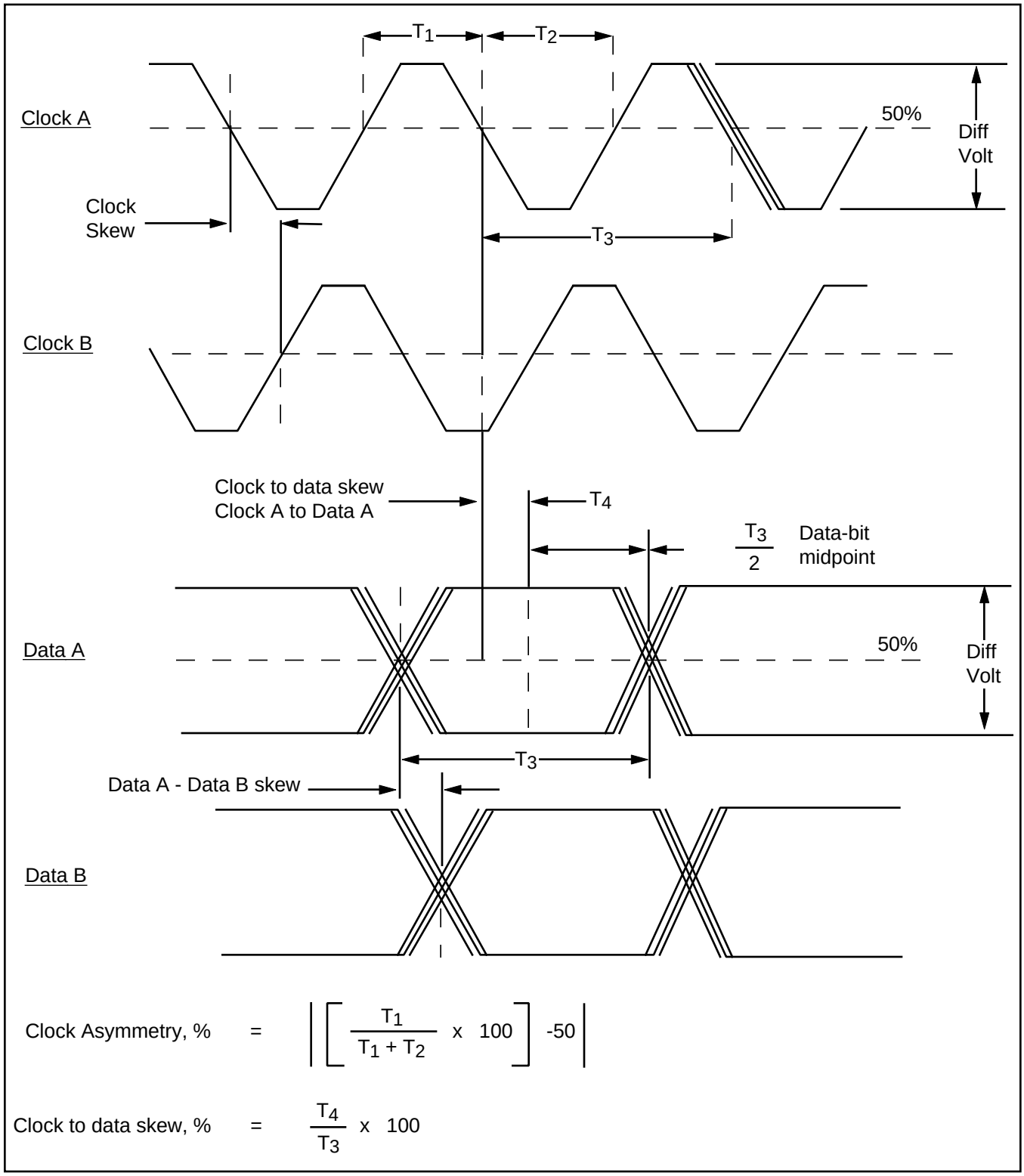

Figure A-1. Signal time Skew Definitions

Abbreviations and Acronyms

ARC	Ames Research Center
bps	bits per second
CC	Common Carrier
CCB	Configuration Control Board
CCR	Configuration Change Request
DCN	Document Change Notice
DEMUX	Demultiplexer
DIS	Data Interface System
DOMSAT	Domestic Satellite
DTE	Data Terminal Equipment
EIA	Electronic Industries Association
FEC	Forward Error Correction
Fwd	Forward
GCE	Ground Communications Equipment
GSFC	Goddard Space Flight Center
HRBS	High Rate Black Switch
ICD	Interface Control Document
IFL	Interfacility Link
kbps	kilobits per second
LRBS	Low Rate Black Switch
Mbps	Megabits per second
MDM	Multiplexer/Demultiplexer
MUX	Multiplexer
mV	millivolts
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications
NCC	Network Control Center

NRZ-L	Non Return to Zero-Level
ns	nanoseconds
POCC	Project Operations and Control Center
ps	picoseconds
RS	Recommended Standard
Rtn	Return
SGLT	Space-to-Ground Link Terminal
SLA	STARLink Airborne
SLUE	STARLink Unique Equipment
STATMUX	Statistical Multiplexer (a.k.a. High Data Rate Multiplexer)
STDN	Spaceflight Tracking and Data Network
STGT	Second TDRSS Ground Terminal
TBD	To be determined
TDRSS	Tracking and Data Relay Satellite System
V	Volts
ViH	Voltage in High
ViL	Voltage in Low
VoH	Voltage out High
VoL	Voltage out Low

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