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Linear Token Passing Multiplex Data Bus

NONCURRENT NOTICE

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1. SCOPE:

This standard specifies the characteristics of the SAE Linear Token Passing Bus (LTPB) Interface Unit.

The LTPB provides a high reliability, high bandwidth, low latency serial interconnection network suitable for utilization in real time military and commercial applications. Multiple redundant data paths can be implemented to enhance reliability and survivability in those applications which require these attributes. The token passing and data exchange protocols are optimized to provide low latency and fast failure detection and correction. Physical configurations with bus lengths up to 1000 m can be accommodated.

This specification defines the following:

- a. General Description (3.1): An overview of the LTPB protocol.
- b. Physical Media Interface (3.2): This portion of the standard defines the physical interface to both optical and electrical bus media.
- c. Access Protocol Definition (3.3): This portion of the standard defines the symbols, frame formats, timing functions and traffic recording requirements of the Token Passing Interface Unit (TPIU).
- d. Network Protocol Definition (3.4): This portion of the standard defines the network control and station management functions.
- e. Test and Verification (Section 4): This paragraph defines the responsibilities and methods for test and verification of the LTPB.
- f. TPIU State Machine (Section 5): This section defines the TPIU States and state transition rules.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of all SAE Technical Reports shall apply.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AIR4288 Linear Token Passing Multiplex Data Bus User's Handbook

AS4290 DRAFT Validation Test Plan for AS4074 linear Token Passing Multiplex Data Bus

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2.1.2 Military Publications: Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

ISO/DIS 7498	International Systems Organization Open Systems
22 April 1982	Interconnection - Basic Reference Model, Draft International Standard
N1406	Working Draft for an Addendum to ISO 7498 Covering
March 1983	Connectionless Data Transmission

2.2 Acronyms and Abbreviations:

A_{max}	Maximum end-to-end attenuation
A_{min}	Minimum end-to-end attenuation
A_r	Attenuation of reflected signals
bps	Bits per second
BAT	Bus Activity Timer
BIT	Built-In-Test
BIU	Bus Interface Unit
BTO	BAT Timeout
BW	Spectral Bandwidth
CRC	Cyclic Redundancy Check
C/B	Center of Bit
CTLIC	Claim Token Limit Counter
dB	Decibel
dBm	Decibel referenced to 1 milliwatt
D_{clad}	Fiber Optic cladding diameter
D_{cm}	Maximum total dispersion
D_{core}	Fiber Optic core diameter
D_{gp}	Group propagation delay difference
D_j	Jitter
DA	Destination Address field (may contain physical or logical address depending on frame type)
exp	Exponential value (raised to the power)
ED	End Delimiter
ELRX	Electrical Receiver
ELTX	Electrical Transmitter
ERA	Bus A Error
ERB	Bus B Error
E/T	End of Transmission
F	Frequency
FC	Frame Control
FORX	Fiber Optic Receiver
FOTX	Fiber Optic Transmitter
FT	Frame Type
FW	Filter Word
GCD	Global Clock Differential

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2.2 (Continued):

HEX	Hexadecimal
INFO	Information Field
JIAWG	Joint Integrated Avionic Working Group
KHz	Kilohertz
LC	Load Configuration
LLC	Logical Link Control
LTPB	Linear Token Passing Bus
m	Bit position in FW field
M	Optical Margin
MAC	Media Access Control
Mbaud	Megabaud
Mbps	Megabits per Second
MER	Message Error
MFCS	Message Frame Check Sequence
MHz	Megahertz
MIU	Media Interface Unit
MPDU	Message Protocol Data Unit
MSA	Maximum Station Address in logical ring
N_{ct}	Number of words in Claim Token Frame
NA	Numerical Aperture
NSA	Next Station Address in logical ring
P	Preamble
P_r	Receiver Minimum Valid Preamble Length
P_t	Transmitter Preamble Length
Px	Priority
PDU	TPIU Protocol Data Unit
PSA	Physical Station Address
R_{ber}	Receiver Bit Error Rate
R_{cmr}	Receiver Common Mode Rejection Ratio
R_d	Data Rate (Mbps)
R_f	Receiver Maximum Fall Time (90% to 10%)
R_{idr}	Receiver Intertransmission Dynamic Range
R_{iz}	Receiver Input Impedance
R_{nv}	Receiver Noise Voltage Input
R_{or}	Receiver Operating Range
R_{ous}	Receiver Combined Over/Undershoot
R_p	Receiver Optical Power Input
R_{pwd}	Receiver Input Maximum Pulse Width Distortion
R_{pm}	Receiver Minimum Optical Power Input
R_{po}	Receiver Maximum Optical Power Input
R_r	Receiver Maximum Rise Time (10% to 90%)
R_s	Signaling Rate

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2.2 (Continued):

R _{tm}	Start-of-Bit to Center-of-Bit
R _{to}	Start-of-Bit to Start-of-Bit
R _{vm}	Receiver Minimum Input Voltage
R _{vo}	Receiver Maximum Input Voltage
R _x	Receiver
RAT	Ring Admittance Timer
RC	Report Configuration
RQF	Receive Queue Full
RS	Report Status
RT	Report Time
RMT	Redundant Media Timeout
RMS	Redundant Media Skew Error
RMS	Root Mean Square
RPB	Receiver Primary Bus
RPE	Receiver Parity Error
RXE	Receiver Enable
RXM	Receive Message Available
S _d	Surge Voltage Duration
Sitg	System Minimum Intertransmission Gap
S _v	Surge Voltage
S ₀	Idle State
S ₁	Claim Token State
S ₂	Check Token Address State
S ₃	Send Message State
S ₄	Pass Token State
S ₅	Check Token Pass State
S ₆	Check Message Address State
S ₇	Receive Message State
S _A	Source Address
S _D	Start Delimiter
S/B	Start-of-Bit
S/T	Start-of-Transmission
SMC	Station Management Code
T _{ba}	Bus Activity Indication Time
T _d	Clock Maximum Uncompensated Drift Rate
T _{pwd}	Transmitter Maximum Pulse Width Distortion
T _{ds}	Data Streaming Timer
T _f	Transmitter Maximum Fall Time (90% to 10%)
T _{iz}	Transmitter Drive Impedance
T _m	Minimum Duration between Transitions
T _{ms}	Master and Most Distant Slave Station (Global Timer)
T _o	Nominal Bit Time
T _{ous}	Transmitter Combined Over/Undershoot
T _{pd}	Propagation Delay Time
T _{pl}	Transmitter Optical Leakage Power
T _{po}	Transmitter Optical Power
T _{pr}	Transmitter Residue Power
T _r	Transmitter Maximum Rise Time (10% to 90%)

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2.2 (Continued):

T _{sk}	Transmitter Redundant Media Skew Time
T _{sr}	Maximum Station Response Time
T _{tm}	Transmitter Minimum Signaling Duration
T _{to}	Transmitter Nominal Bit Time
T _{tp}	Token Passing Time Value
T _u	Time Master Update Rate (milliseconds)
T _{vo}	Transmitter Output Voltage Level
T _{vr}	Transmitter Peak Output Voltage
Tx	Transmitter
TBD	To Be Determined
TFCS	Token Frame Check Sequence
THT	Token Holding Timer
TIME	Global Clock Value (48 bits)
TPIU	Token Passing Interface Unit
TMA	Transmit Message Aborted
TMD	Time Master Disable
TME	Time Master Enable
TPE	Transmitter Parity Error
TPT	Token Passing Timer
TRT	Token Rotation Timer
TRTx	Token Rotation Timer (for priority level "x")
TS	This Station
TSM	Time Synchronization Message
TTA	Bus A Transmission Monitor Timeout
TTB	Bus B Transmission Monitor Timeout
TTO	TPT Timeout
TXE	Transmitter Enable
TXM	Transmit Message
W1	Optical Wavelength Lower
W2	Optical Wavelength Upper
WC	Word Count
WCE	Message Word Count Error

3. GENERAL REQUIREMENTS:

3.1 General Description:

The LTPB shall consist of a set of stations connected by a broadcast transmission medium - that is, each station which transmits shall be heard by all of the other stations. Stations shall accept a transmission based upon either physical or logical addressing mechanisms.

The functional block diagram for the LTPB is shown in Figure 3.1-1 along with its relationship to the ISO OSI Basic Reference Model. It shall consist of the following elements:

- a. Physical Media: The Physical Media shall be composed of 1 or 2 physical bus paths. Each bus path shall be characterized as a broadcast medium.

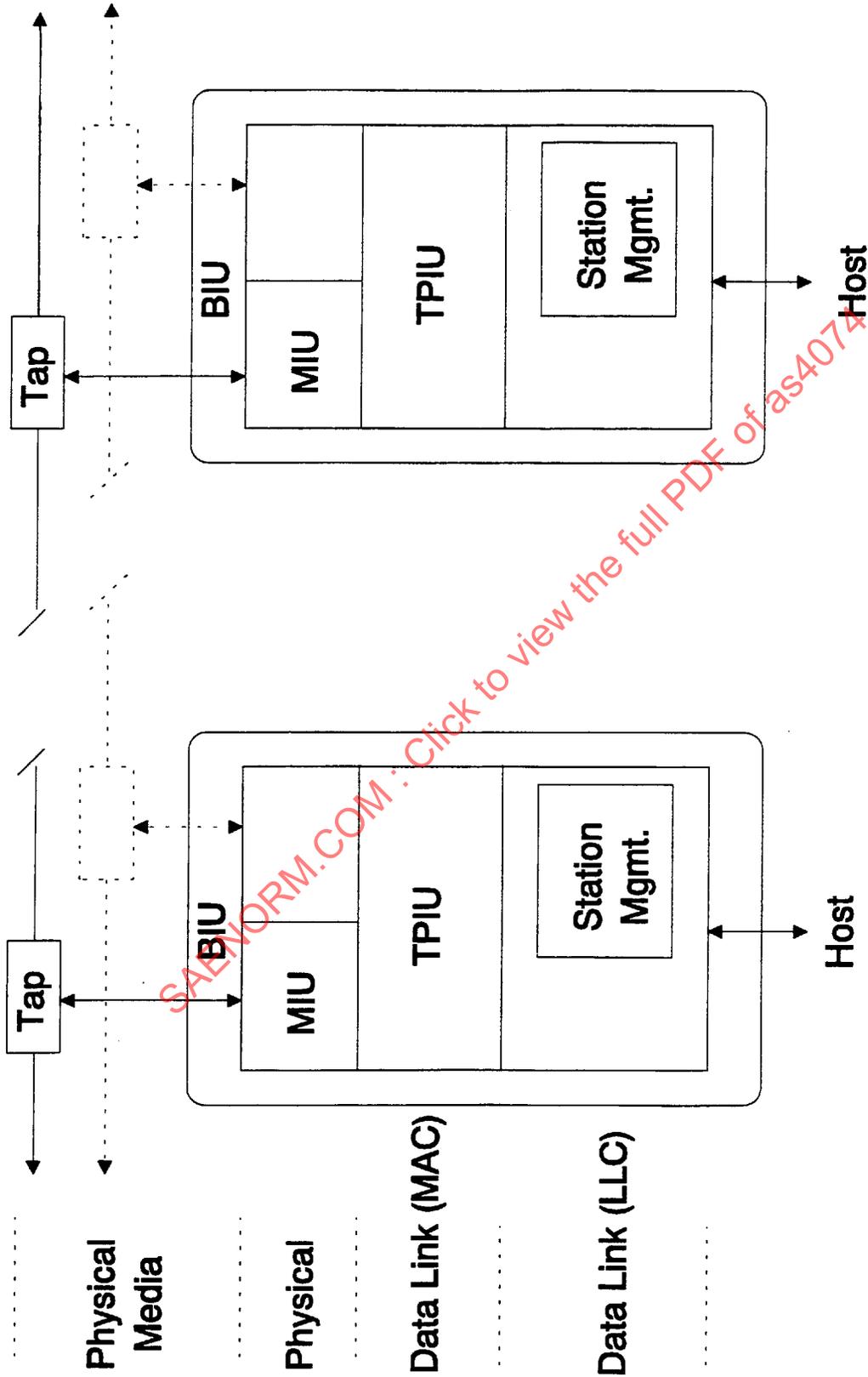


FIGURE 3.1-1 - Linear Token Passing Bus Block Diagram

3.1 (Continued):

- b. Bus Interface Unit (BIU): The BIU interfaces to the bus media and the Host. Each bus path shall be an independent entity requiring a Media Interface Unit (MIU). One TPIU shall serve all implemented MIUs. The remainder of the BIU shall perform station management, network management, and Host interface functions.

3.1.1 Media Access: Access to the media shall be controlled by the Token. The Token is continually passed around a logical ring (see Figure 3.1-2) superimposed on the linear bus. A station receiving the Token gains the right to make a transmission on the medium for a certain amount of time. This amount of time depends upon the following quantities:

- a. Value of the Token Holding Timer (THT), used for all messages of priority 0, as well as;
- b. The residual value of the Token Rotation Timers (TRTs), one for each priority from 1 to 3.

This amount of time shall always be less than or equal to a predetermined maximum value. When this amount of time has expired, or the station has sent all of its messages, then the station shall forward the Token to the next member of the logical ring.

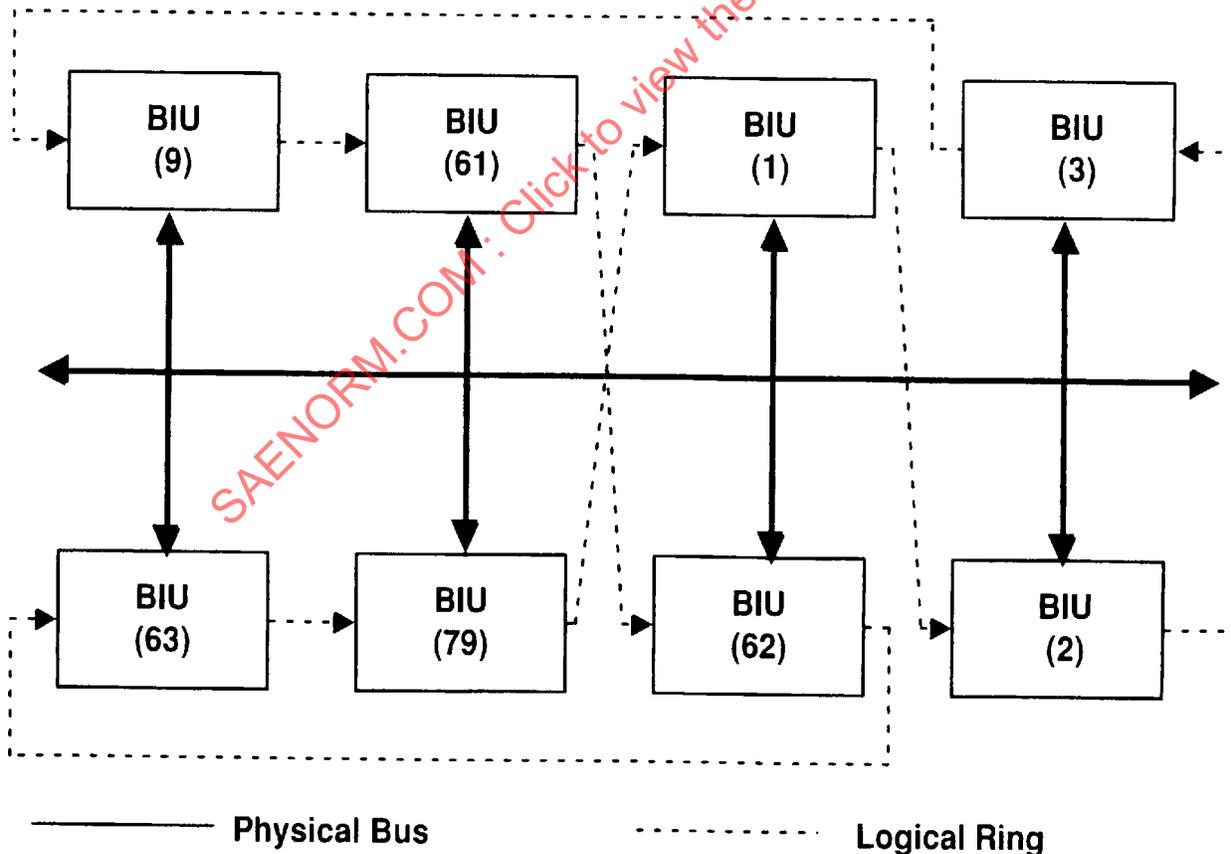


FIGURE 3.1-2 - Logical Ring Superimposed on a Linear Bus

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- 3.1.2 Low Latency for High Priority Messages: Low latency for high priority messages shall be assured by the use of message priority TRTs. A station which has a message at the highest priority (Priority 0) shall always send that message when it receives the Token. Priority 0 messages continue to be sent until there are no Priority 0 messages or the THT expires. If that station has lower priority messages to send, it will send those messages as long as the TRT associated with that priority level has not expired. Otherwise, the station must forward the Token to its successor. In this way the token passing bus users shall defer to higher priority traffic when the traffic load becomes heavy.
- 3.1.3 Station Failures: Station failures shall be handled by the station immediately preceding the failed station in the logical ring sequence. The station passing the Token shall verify that there is Bus Activity. After two consecutive attempts at passing the Token the station shall automatically increment the destination address in the Token and try again. This incremental bridging shall continue until the station finds a successor or the destination address wraps around and matches the local station address, at which time the station shall cease its attempts to find a successor.
- 3.1.4 Logical Ring Admittance: Stations shall be allowed admittance to the logical ring on a periodic basis. Each station shall contain a Ring Admittance Timer (RAT). When this timer expires and there is a gap between the local station's address and that of its successor then the Token shall be passed to the sequential address following that of the local station. The normal Token passing rules shall then be applied. Therefore, if any of the stations in the gap desire admittance they shall be granted an opportunity during this time period.
- 3.1.5 Logical Ring Initialization: Initialization of the logical ring shall occur after the Token is lost or upon power up. Each station which powers up and completes its own internal diagnostic and startup procedures shall activate a Bus Activity Timer (BAT). If the station hears any bus activity it shall reset this timer. This indicates that some portion of the logical ring is active and the station shall defer to this activity. The station may receive a valid Token, addressed to it, because the RAT of a station numerically preceding it in the logical ring has expired. In this case, the station shall begin to hunt for a successor using the normal Token passing rules. If the BAT expires, the station shall attempt to gain control of the Token. It shall transmit a frame whose length is determined by the station address. After completing its transmission and waiting for a suitable period (based upon bus length) it shall listen. If the station hears any other transmission, it has lost the claiming process and shall wait for the Token. If the station hears nothing it shall assume that it has won the Token and begin to hunt for a successor. In this case the normal Token passing rules shall apply.

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3.1.6 System Monitor: System Monitoring shall be provided by monitoring of the passage of the Token throughout the logical ring and Station Management status messages. The Host shall be notified whenever a change has occurred or when commanded to do so. Station Management status messages shall be utilized by a station to report specific, non-fatal, failures such as a receiver failure, transmitter failure, etc.

3.2 Media Interface Unit (MIU):

The MIU shall provide connection between the TPIU and the bus medium. One MIU shall be required for each bus path. This section defines the following characteristics of the MIU:

- a. Symbol Set
- b. Transmitter, Receiver, and Media Characteristics
- c. Media Redundancy Requirements
- d. Transition Monitoring

This standard shall encompass both fiber optic and electrical transmission media, as well as redundant data paths, if necessary.

The general characteristics of the MIU shall be as defined in this section. Specific parameter values for each characteristic of the interface are summarized in tabular form as slash sheets referenced in Appendix A.

3.2.1 Symbol Set: The peer TPIU entities exchange Protocol Data Units via the MIU. The MIU provides the direct interface to the media through the following:

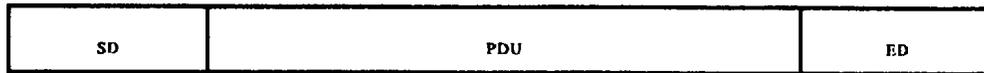
- a. Line States
- b. Control Symbols
- c. Data Symbols
- d. Violation Symbols

3.2.1.1 Line States: Two line states (mutually exclusive) are defined for the physical medium:

- a. Quiet/Idle: Indicates the state of the medium when no Bus Activity is present.
- b. Active: Indicates that a signal is being transmitted on the physical medium. This is defined by the presence of at least three signal transitions in a period of 4 bit times.

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3.2.1.2 Control Symbols: Control symbols serve to synchronize the receiver to the signal and to delimit the boundaries of the TPIU Protocol Data Unit (PDU). The overall format of every frame which is transmitted on the media shall be as illustrated in Figure 3.2.1.2-1.



SD - START DELIMITER
PDU - TPIU PROTOCOL DATA UNIT
ED - END DELIMITER

FIGURE 3.2.1.2-1 - Overall Frame Structure

Three control symbols are defined (see slash sheets referenced in Appendix A for the specific format and length of these symbols):

- a. Preamble (P): The MIU shall append a preamble to the beginning of every transmission which is placed on the medium. Only one preamble shall be sent per transmission, which consists of zero, one, or more Message Frames followed by a Token Frame, or a Claim Token Frame of the structure shown in Figures 1.2-1 and 3.3.1-1. The receiving MIU shall use the preamble to stabilize its receiver to the amplitude and frequency of the incoming signal, but shall not pass any of it to the TPIU. Because part of the preamble may be lost in the media, both the transmitted length and the minimum length for the receiver to stabilize are specified. The transmitted preamble length shall be equal to PT data bits with a format as specified in the appropriate slash sheet referenced in Appendix A. The receiver shall work properly with any preamble which is at least PR consecutive bits immediately prior to the Start Delimiter (SD) conforming to the waveform limits of 3.2.2.1.3.4 and 3.2.2.2.3.1.
- b. Start Delimiter (SD): The SD shall uniquely define the beginning of the TPIU PDU. It shall be appended to the front of the PDU by the sending MIU prior to transmission. The receiving MIU shall align itself to the PDU by detecting the SD. The SD shall be removed from the frame by the receiving MIU prior to passing the PDU to the TPIU.
- c. End Delimiter (ED): The ED shall uniquely define the end of the TPIU PDU. It shall be appended to the end of the frame by the sending MIU after transmission of the PDU. The receiving MIU shall terminate the reception of the PDU by detecting the ED. The ED shall be removed from the frame by the receiving MIU prior to passing the PDU to the TPIU.

3.2.1.3 Data Symbols: Each Data Symbol shall convey 1 or more binary digits. The specific encoding method shall be as defined in the slash sheets referenced in Appendix A.

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3.2.1.4 Invalid Symbols: An Invalid Symbol shall be defined as any activity detected on the physical medium which does not conform to any of the defined symbols.

3.2.2 Transmitter, Receiver, and Media Characteristics: Two types of bus media interfaces may be defined as follows:

- a. Fiber Optic Bus Media Interface Characteristics
- b. Electrical Bus Media Interface Characteristics

3.2.2.1 Fiber Optic Bus Media Interface Characteristics: The fiber optic bus media interface characteristics shall be specified in four groups as follows:

- a. Common Characteristics
- b. Transmitter Characteristics
- c. Receiver Characteristics
- d. Transmission Media Characteristics

The general requirements for these characteristics are defined in 3.2.2.1.1 through 3.2.2.1.4. Specific numerical values for all quantities shall be as given in slash sheets referenced in Appendix A.

3.2.2.1.1 Fiber Optic Media Common Characteristics: The characteristics common to the transmitter, receiver, and medium, and independent of the specific implementation shall be as given in this paragraph. They shall include:

- a. MIU Input/Output Ports
- b. Data Rate
- c. Signaling Rate
- d. System Minimum Intertransmission Gap
- f. Wavelength and Spectral Bandwidth

3.2.2.1.1.1 Fiber Optic Media Station Input/Output Ports: Each MIU shall have a receiver input port and transmitter output port. Other signals, such as control or power, if required, shall be provided as specified in the slash sheet. A short circuit on any electrical signal shall not result in damage to the BIU.

3.2.2.1.1.2 Fiber Optic Media Data Rate: The data rate for continuous transmission shall be R_d Mbps. The nominal bit time shall be T_o nanoseconds ($T_o = 1000/R_d$)

3.2.2.1.1.3 Fiber Optic Media Signaling Rate: The signaling rate for continuous transmission on the fiber optic medium shall be R_s Mbaud. The minimum duration between transitions shall be T_m nanoseconds ($T_m=1000/R_s$).

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- 3.2.2.1.1.4 Fiber Optic Media System Minimum Intertransmission Gap: Under control of the TPIU, an optical transmitter shall remain in the off state between successive transmissions such that a system minimum intertransmission gap is guaranteed at the receiver. The optical receiver shall operate as specified in Section 3.2.2.1.3 with an intertransmission gap of S_{itg} nanoseconds under the worst case condition where the full intertransmission dynamic range R_{idr} exists between the end bit of the previous message and the start bit of the next message.
- 3.2.2.1.1.5 Fiber Optic Media Wavelength and Spectral Bandwidth: The nominal wavelength of the emitted optical radiation shall be in the range $W1$ to $W2$ nanometers. The spectral bandwidth shall be less than BW nanometers as measured between the 3 dB power points. Therefore, the extreme (3 dB) power points must both lie within $W1 - BW/2$ and $W2 + BW/2$.
- 3.2.2.1.2 Fiber Optic Transmitter (FOTX) Characteristics: This section defines the general characteristics which are applicable to the FOTX of the MIU. These characteristics shall be measured at the output port of the MIU.
- 3.2.2.1.2.1 FOTX Output Power: The optical output power shall be T_{po} dBm in the spectral range $W1 - BW/2$ to $W2 + BW/2$. This parameter shall be measured for a continuous transmission at R_s Mbaud and shall constitute the peak optical power.
- 3.2.2.1.2.2 FOTX Maximum Residual Power: During any signaling event time slot corresponding to the off time of the optical source, the peak optical power shall reach a value of less than T_{pr} dBm peak in the spectral range $W1 - BW/2$ to $W2 + BW/2$.
- 3.2.2.1.2.3 FOTX Maximum Leakage Power: When any transmitting station completes its transmission, or is commanded not to transmit, its leakage power shall be less than T_{pl} dBm peak in the spectral range $W1 - BW/2$ to $W2 + BW/2$. This requirement shall also be satisfied during power up and power down conditions.
- 3.2.2.1.2.4 FOTX Output Waveform: The transmitter shall produce a waveform within the limits shown in Figure 3.2.2.1.2.4-1 after application of the appropriate parameter values from the slash sheets referenced in Appendix A. There shall be no reversal of the signal during the 10% to 90% and 90% to 10% transition periods. Mid- and End-Bit mid-amplitude crossings shall deviate less than T_{pwd} from the ideal crossing point as measured from the previous crossing point. The rise times and fall times shall be less than T_r and T_f nanoseconds, respectively, as measured between the 10% and 90% points. Waveform distortion due to the cumulative effects of undershoot, overshoot, and ringing shall be less than T_{ous} .

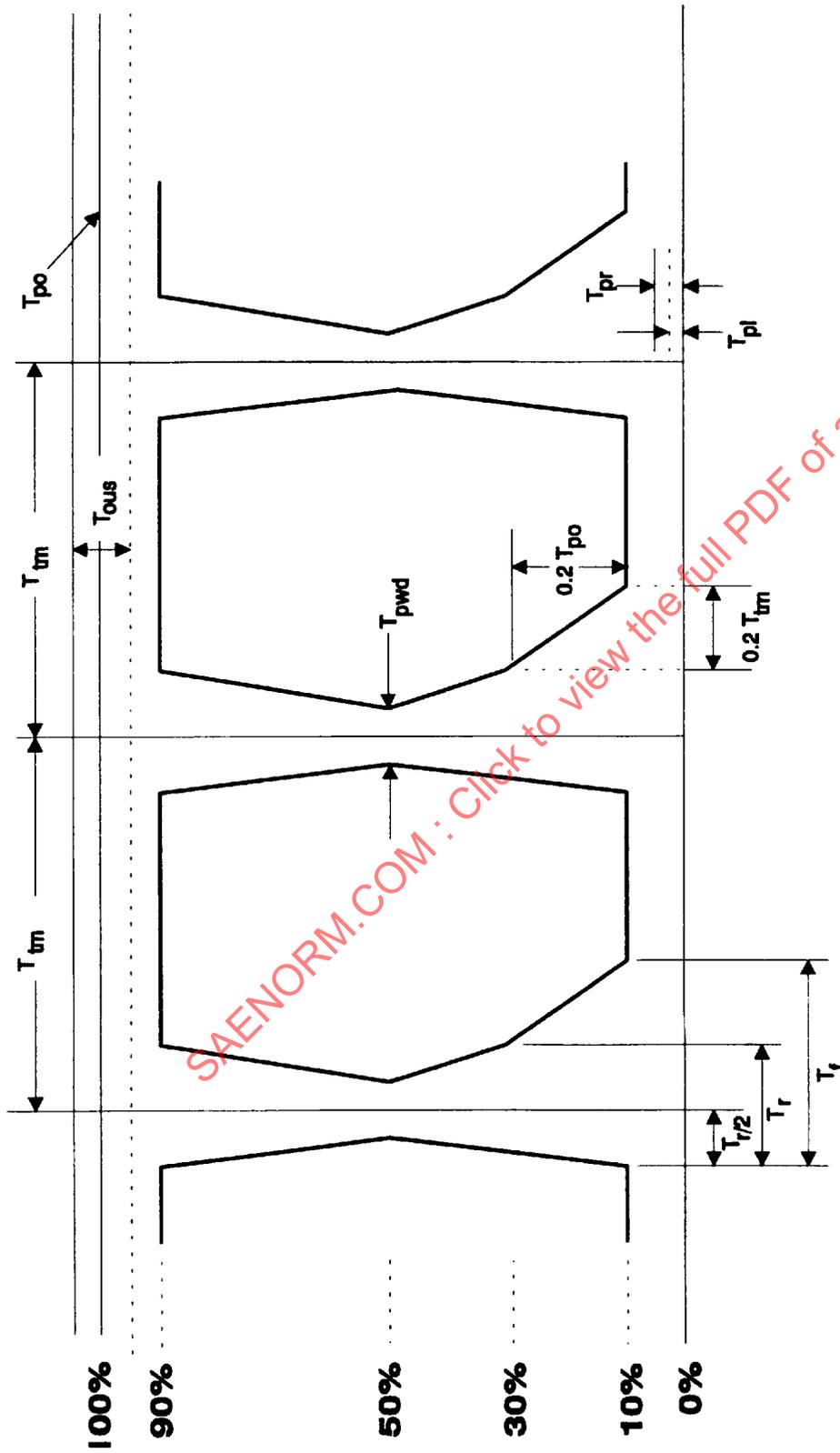


FIGURE 3.2.2.1.2.4-1 – Fiber Optic Transmitter Output Waveform

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3.2.2.1.2.5 FOTX Data Streaming Timeout: The transmitted signal shall be monitored. If the transmission does not cease within T_{ds} after its start, the transmitter shall shut down and indicate a fault condition to the TPIU. No further transmission from that faulty MIU shall occur until a positive clear signal has been received from the TPIU.

3.2.2.1.3 Fiber Optic Receiver (FORX) Characteristics: This section specifies the general characteristics of the FORX of the MIU. These characteristics shall be measured at the input port to the MIU.

3.2.2.1.3.1 FORX Sensitivity: The optical receiver shall operate at no greater than the maximum bit error rate R_{ber} with a received optical power of R_{pm} dBm. The received power shall be the minimum steady state peak power level, during the optical signal high state, required for the receiver to correctly signal an output logic level high state.

3.2.2.1.3.2 FORX Operating Range and Margin: The optical receiver shall operate as specified in 3.2.2.1.3.3 with any input signal ranging from R_{pm} dBm to $R_{pm} + R_{or}$ dBm. R_{or} shall be the Operating Range, in dB, of the receiver. The Operating Range shall not be confused with the Receiver Intertransmission Dynamic Range, R_{idr} , or interpreted as the optical margin between the transmitter and receiver. The optical margin (M) shall be defined as the difference between the mean Transmitter Peak Optical Power (Signal High) and the Receiver Minimum Optical Power Input (see Equation 1):

$$M = T_{po} - R_{pm} \text{ dB} \quad (\text{Eq.1})$$

Optical margin shall be utilized for determining the required loss characteristics of the bus transmission system. Refer to Figure 3.2.2.1.3.2-1 for clarification.

In no case shall the receiver be impaired, or otherwise damaged, by an optical input up to R_{po} dBm, a condition which may occur during Token Claim.

3.2.2.1.3.3 FORX Bit Error Rate: The overall bit error rate shall be less than R_{ber} . This error rate shall be sustained for the worst case waveforms and over the entire operating range of the receiver which includes signal variations up to the intertransmission dynamic range.

3.2.2.1.3.4 FORX Input Waveform: The receiver shall correctly process the optical input waveform shown in Figure 3.2.2.1.3.4-1 after application of the appropriate parameter values as specified in the slash sheets referenced in Appendix A.

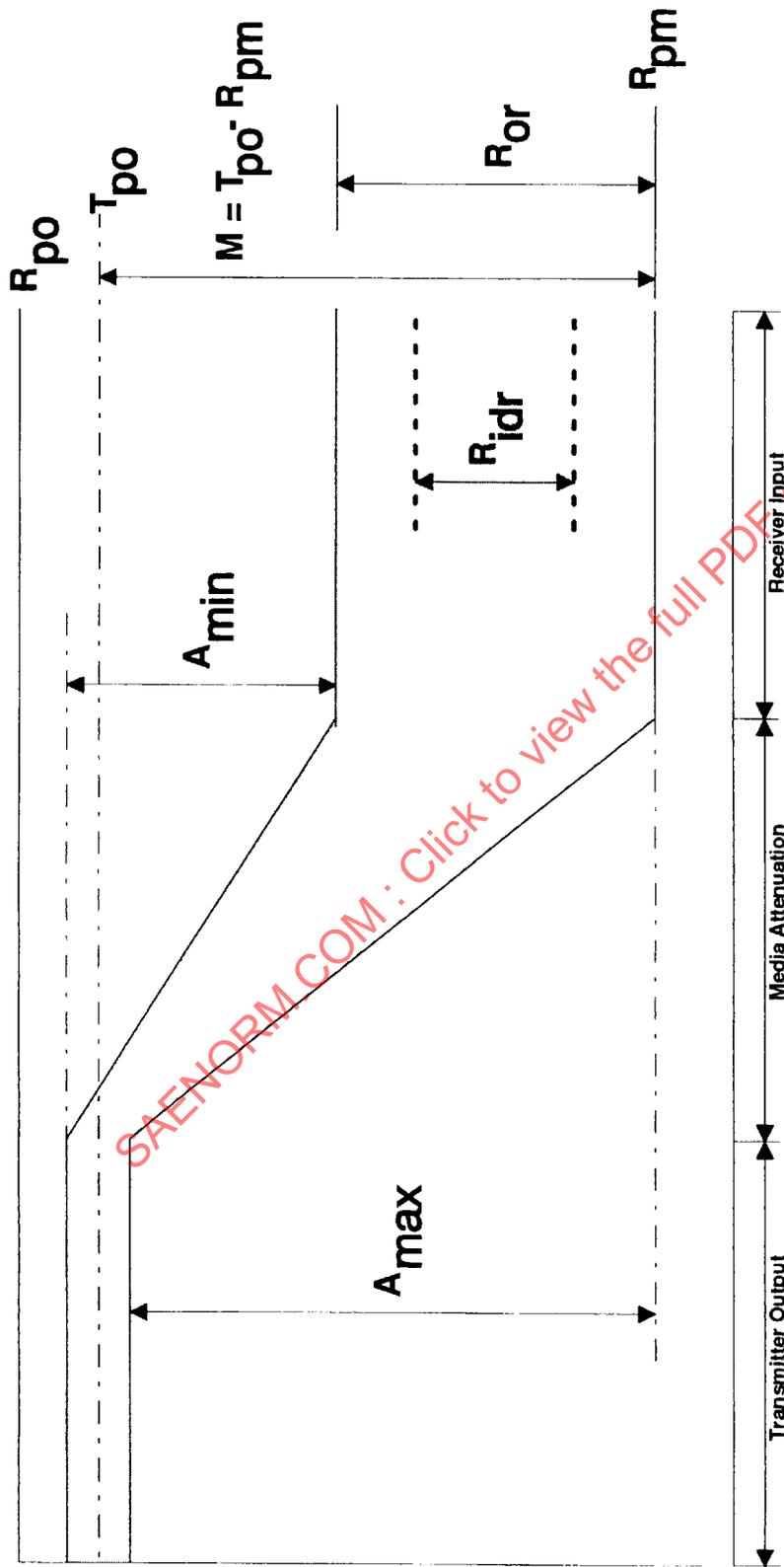


FIGURE 3.2.2.1.3.2-1 - Transmitter/Receiver/Receiver Optical Power Levels

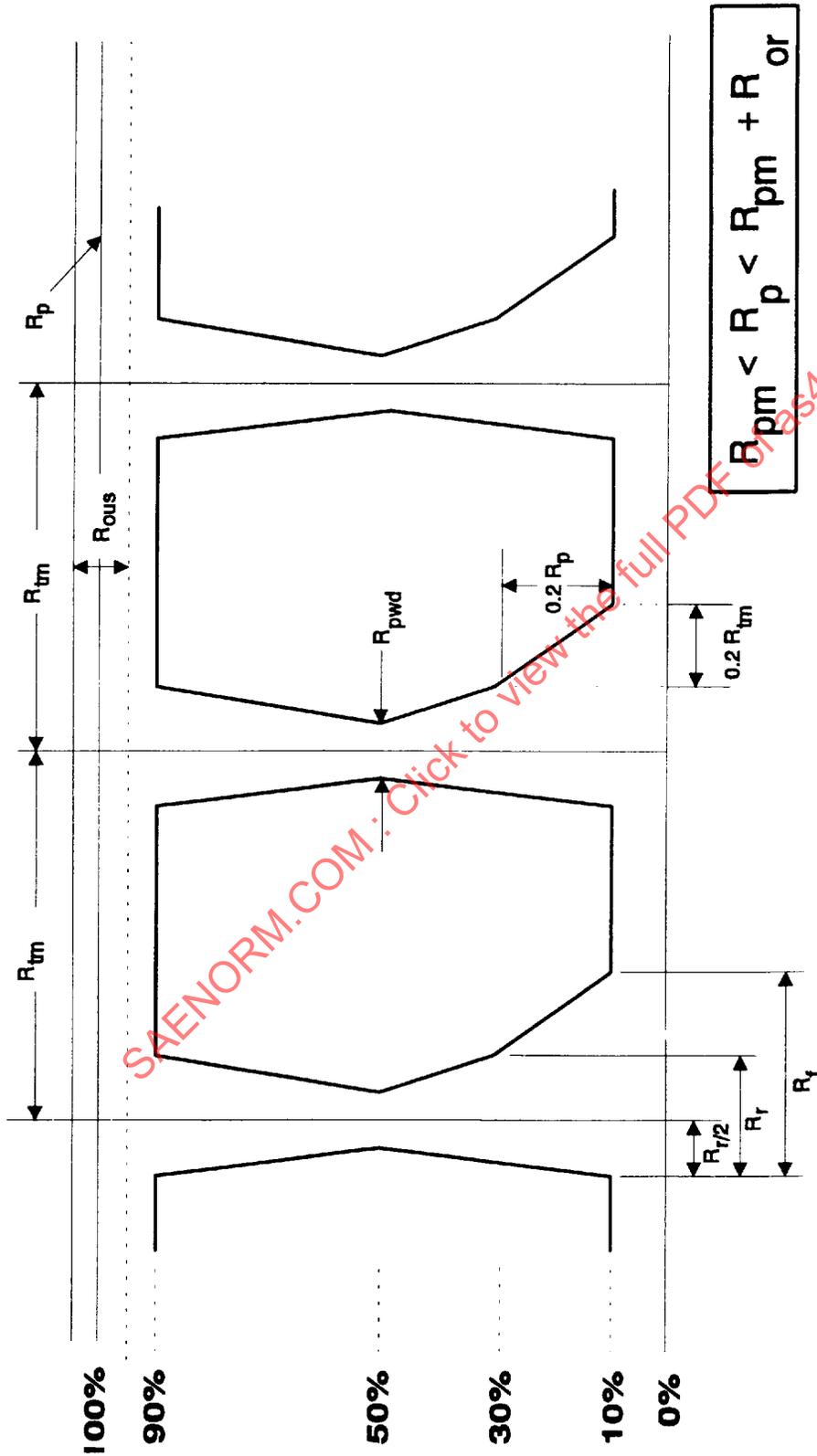


FIGURE 3.2.2.1.3.4-1 - Fiber Optic Receiver Input Waveform

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3.2.2.1.4 Fiber Optic Media Characteristics: A minimum set of fiber optic transmission medium characteristics shall be specified in order to insure interoperability between stations in the same system:

- a. Physical Characteristics
- b. Numerical Aperture
- c. Chromatic and Modal Dispersion
- d. Attenuation

3.2.2.1.4.1 Fiber Optic Media Physical Characteristics: The optical fiber utilized shall have a core diameter of D_{core} micrometers and a cladding diameter of D_{clad} micrometers.

3.2.2.1.4.2 Fiber Optic Media Numerical Aperture: The minimum numerical aperture of the fiber, measured in accordance with the applicable standard, shall be at least NA.

3.2.2.1.4.3 Fiber Optic Media Chromatic and Modal Dispersion: The total dispersion (chromatic and multimode) due to the fiber optic transmission medium components between any transmitter and receiver shall not exceed D_{cm} (nanoseconds). D_{cm} shall be interpreted as the 10% to 90% rise time of the received optical pulse when the medium is excited by an optical step waveform meeting the characteristics in 3.2.2.1.2.4.

3.2.2.1.4.4 Fiber Optic Media Attenuation: The optical transmission system (including all connectors, fiber optic cable, and access couplers, and other transmission components) shall have a minimum end-to-end attenuation of A_{min} dB and a maximum attenuation of A_{max} dB, as measured between any two ports to the transmission system.

3.2.2.2 Electrical Bus Media Interface Definition: The Electrical Bus Media Interface shall be specified in four groups as follows:

- a. Common Characteristics
- b. Transmitter Characteristics
- c. Receiver Characteristics
- d. Transmission Characteristics

The electrical characteristics are specified generically with specific numerical requirements being defined in slash sheets referenced in Appendix A.

3.2.2.2.1 Electrical Bus Media Interface Characteristics: The characteristics common to the transmitter, receiver, and medium, and independent of the specific implementation shall be given in this paragraph. They shall include:

- a. Station Input/Output Ports
- b. Data Rate
- c. Signaling Rate
- d. System Minimum Intertransmission Gap
- e. Surge Voltage

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- 3.2.2.2.1.1 Electrical Media Station Input/Output Ports: Each MIU shall have a receiver input port and transmitter output port. Other signals, such as control or power, if required, shall be provided as specified in the slash sheet. A short circuit on any electrical signal shall not result in damage to the BIU.
- 3.2.2.2.1.2 Electrical Media Data Rate: The data rate for continuous transmission on the electrical media shall be R_d Mbps. The bit symbol period shall be T_o nanoseconds ($T_o=1/R_d$).
- 3.2.2.2.1.3 Electrical Media Signaling Rate: The signaling rate for continuous transmission on the electrical medium shall be R_s Mbaud. The minimum duration between transitions shall be T_m nanoseconds ($T_m = 1000/R_s$).
- 3.2.2.2.1.4 Electrical Media System Minimum Intertransmission Gap: Under control of the TPIU, the electrical transmitter shall remain in the off state between successive transmissions such that a system minimum intertransmission gap is guaranteed at the receiver. The electrical receiver shall operate correctly with an intertransmission gap of S_{itg} nanoseconds under the worst case condition where the full intertransmission dynamic range R_{idr} exists between the end of the previous message and the start of the next message.
- 3.2.2.2.1.5 Electrical Media Surge Voltage: The transmitter and receiver shall survive a surge voltage level of S_v volts for a duration of S_d milliseconds without damage. Normal operation shall return within S_d milliseconds after the surge voltage condition has terminated.
- 3.2.2.2.2 Electrical Transmitter (ELTX) Characteristics: This section defines the general characteristics which are applicable to the ELTX of the MIU. These characteristics shall be measured at the output port of the MIU. They are as follows:
- Output Voltage level
 - Peak Residual Output Voltage Level
 - Output Waveform
 - Data Streaming Timeout
- 3.2.2.2.2.1 ELTX Output Voltage Level: The transmitter shall generate a peak to peak output voltage level of $2*T_{vo}$ as measured from line-to-line at the MIU port for a continuous wave signal in the frequency range of W1 to W2 MHz. The transmitter shall maintain an output impedance level of T_{iz} ohms in the powered or unpowered state over the frequency range of W1 to W2 MHz.
- 3.2.2.2.2.2 ELTX Peak Residual Output Voltage Level: The peak output voltage level of the transmitter in the off state shall be less than $|2*T_{vr}|$ volts as measured from line-to-line at the MIU port. This level shall be maintained during power-up, power-down, master clear, and all other situations where the transmitter is in the off condition. This voltage level shall also be achieved within $5.5*T_o$ after the last mid-bit transition of the last symbol of a frame.

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- 3.2.2.2.2.3 ELTX Output Waveform: The transmitter shall produce a waveform within the limits shown in Figure 3.2.2.2.3-1 after application of the appropriate parameter values from the slash sheet referenced in Appendix A. There shall be no reversal of signal during the 10% to 90% and 90% to 10% transition periods.
- 3.2.2.2.2.4 ELTX Data Streaming Timeout: The transmitted signal shall be monitored. If the transmission does not cease within T_{ds} after its start, the transmitter shall shut down and indicate a fault condition to the TPIU. No further transmission from that faulty MIU shall occur until a positive clear signal has been received from the TPIU.
- 3.2.2.2.3 Electrical Receiver (ELRX) Characteristics: This section defines the general characteristics of the ELRX of the MIU. These characteristics shall be measured at the input port of the MIU. They are as follows:
- Sensitivity and Waveform Compatibility
 - Dynamic Range
 - Common Mode Rejection Ratio
 - Input Impedance
 - Bit Error Rate
- 3.2.2.2.3.1 ELRX Sensitivity and Waveform Compatibility: The electrical receiver shall operate correctly with an input voltage level at any point between $|R_{vo}|$ and $|R_{vm}|$. Saturation shall not occur below $|R_{vo}|$ volts and the signal shall be interpreted as on for any level above $|R_{vm}|$ volts. The receiver shall not respond to any signal which is less than $0.2 * |R_{vm}|$ volts.
- The receiver shall correctly process the electrical input waveform shown in Figure 3.2.2.2.3.1-1 after application of the appropriate parameter values as specified in the slash sheet referenced in Appendix A.
- 3.2.2.2.3.2 ELRX Dynamic Range: The electrical receiver shall operate correctly with an input signal ranging from $|R_{vm}|$ to $|R_{vo}|$ volts. The dynamic range shall be defined as $20 * \text{LOG}(R_{vo}/R_{vm})$.
- 3.2.2.2.3.3 ELRX Common Mode Rejection Ratio: The electrical receiver shall operate correctly with a common mode voltage level of $|R_{cmr} * R_{vo}|$ volts. This level shall be measured from each signal line to signal ground. The ELRX shall operate correctly in the presence of a white gaussian noise signal of R_{nv} millivolt (RMS) evenly distributed over the bandwidth of W1 MHz to W2 MHz.
- 3.2.2.2.3.4 ELRX Input Impedance: The electrical receiver shall present an input impedance of R_{iz} in the frequency range of W1 MHz to W2 MHz. This impedance shall be maintained in both the powered and unpowered states.

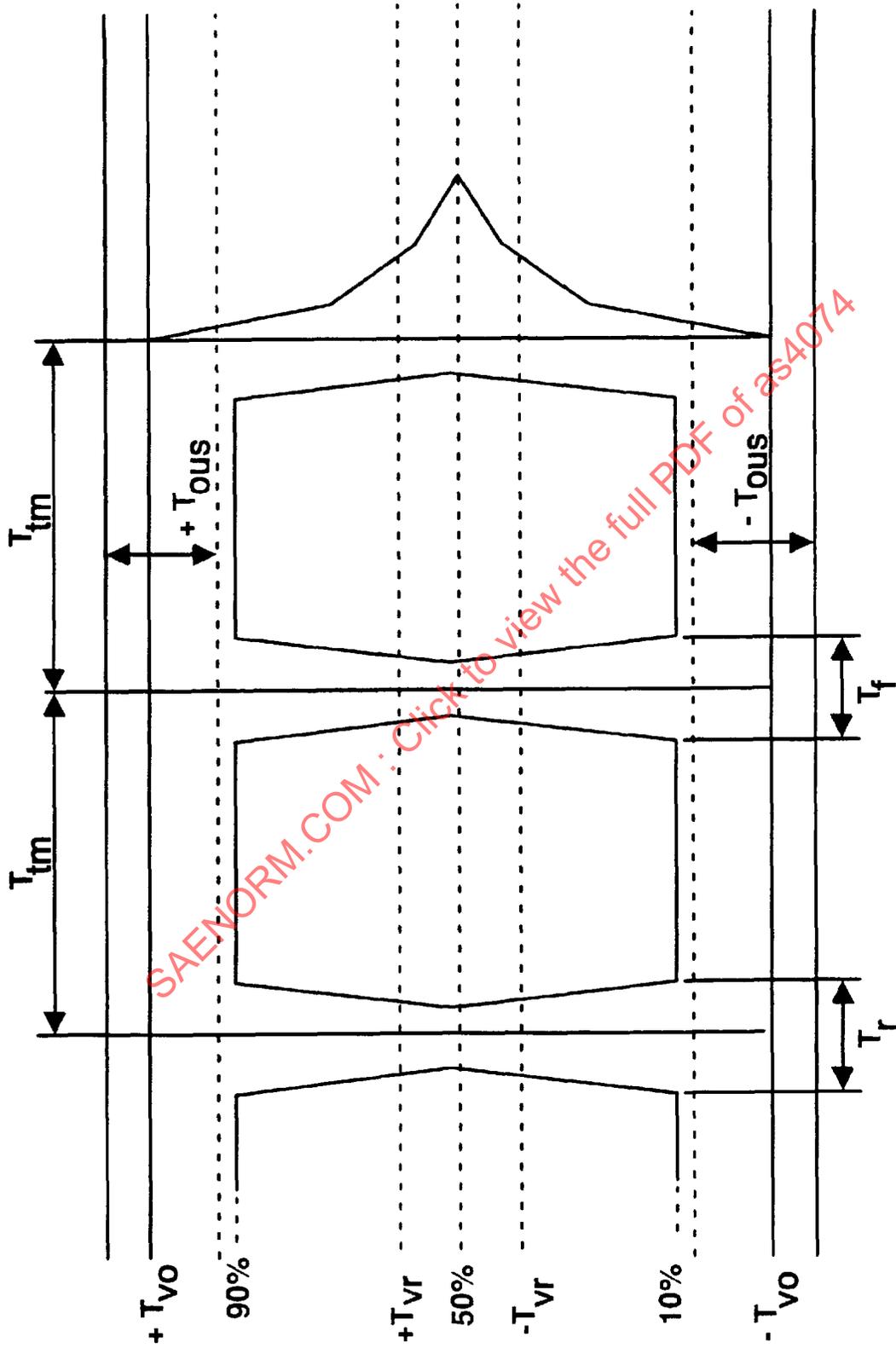


FIGURE 3.2.2.2.3-1 - Electrical Transmitter Output Waveform

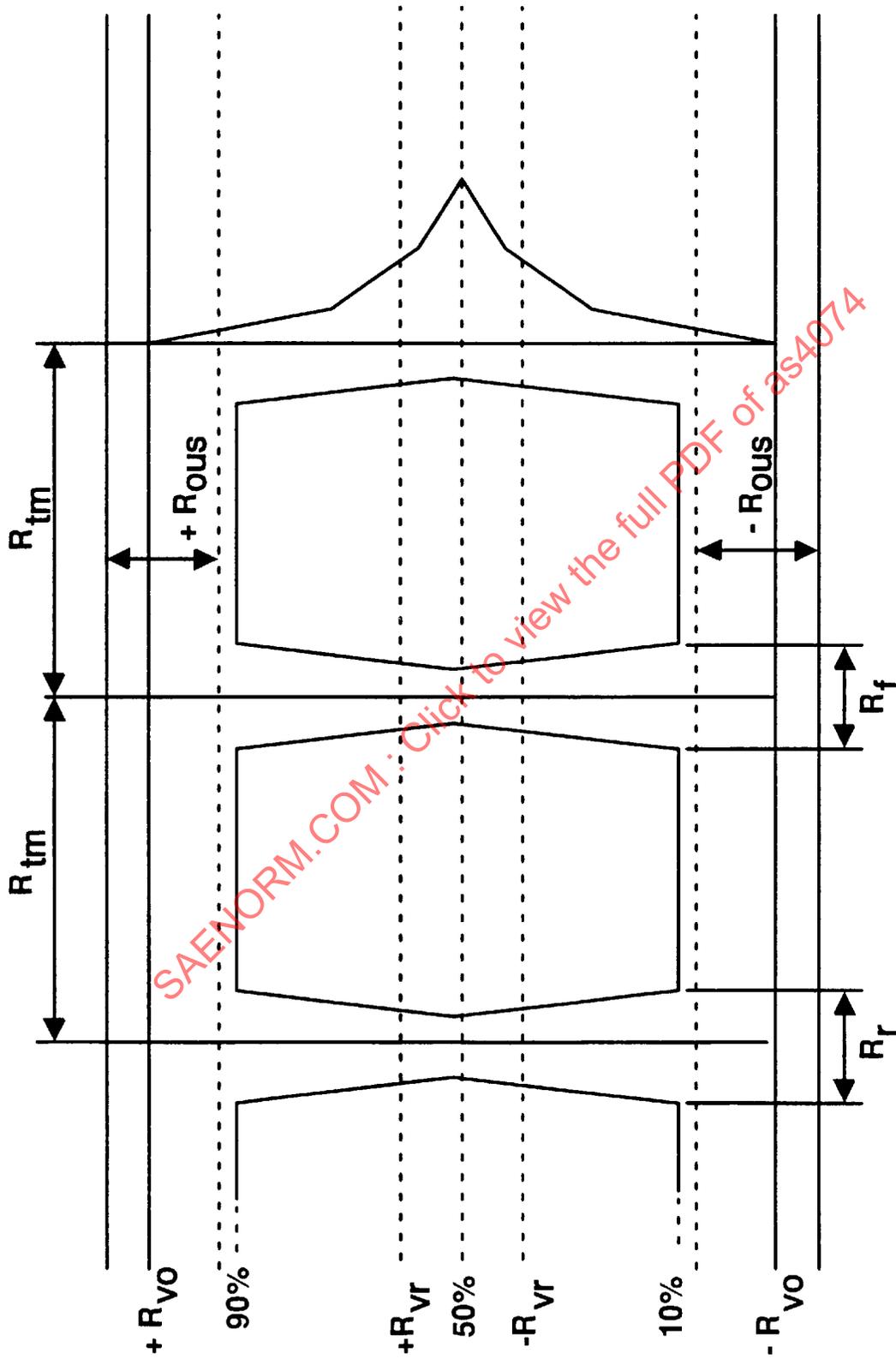


FIGURE 3.2.2.3.1-1 - Electrical Receiver Input Waveform

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- 3.2.2.2.3.5 ELRX Bit Error Rate: The overall bit error rate shall be less than R_{ber} . This error rate shall be sustained for the worst case waveforms and over the entire dynamic range of the receiver. This specification shall be met in the presence of both:
- Signal variations up to the intertransmission dynamic range (R_{idr}) from the end of one frame to the start of the next frame
 - Gaussian white noise of R_{nv} millivolts distributed evenly between $W1$ and $W2$ MHz.
- 3.2.2.2.4 Electrical Media Transmission Characteristics: A minimum set of electrical media characteristics shall be specified in order to insure interoperability between systems:
- Return loss
 - Frequency Response
 - Attenuation
 - Group Propagation Delay
 - Jitter
- 3.2.2.2.4.1 Electrical Media Return Loss: The reflected energy shall be attenuated by at least A_r from the transmitted signal level when measured at any receiver input port.
- 3.2.2.2.4.2 Electrical Media Frequency Response: The bus media frequency response, as measured through any two ports, shall have lower and upper bandpass points of $W1$ and $W2$, respectively.
- 3.2.2.2.4.3 Electrical Media Attenuation: The total attenuation of the bus media shall be at least A_{min} dB and shall not exceed A_{max} dB. This parameter shall be measured between the two worst case ports on the media at the data rate of R_d Mbps.
- 3.2.2.2.4.4 Electrical Media Group Propagation Delay: The total group propagation delay difference of any two frequencies in the range of $W1$ MHz to $W2$ MHz shall be less than D_{gp} along the worst case path.
- 3.2.2.2.4.5 Electrical Media Jitter: The maximum jitter component introduced between any two BIUs shall be less than D_j nanoseconds.
- 3.2.3 Media Redundancy Requirements: The LTPB shall, in the case where additional reliability is required, provide for the optional use of redundant physical media. The redundant media shall be implemented in such a way as to be transparent to the operation of the token passing protocol using a "synchronous redundancy" scheme. The maximum number of redundant physical media shall be two. The methodology for implementing physical media redundancy shall not prohibit the replication of the entire BIU in cases where a higher system level reliability is required.

3.2.3 (Continued):

"Synchronous redundancy" refers to hardware methods of implementing redundant physical paths where the MIU is replicated with no further effect on any higher level protocol operations (see Figure 3.1-1). Transmissions shall occur on both media simultaneously and shall be received by either, or both, receivers with the first valid data stream available being accepted. The receiver shall be capable of selecting the frames on each physical media path such that an error on one bus does not cause the loss of the complete message, when there is a redundant media skew time of up to T_{sk} between the redundant inputs. If no frame was received on one redundant path, or the later message skew was greater than T_{sk} , the BIU shall notify the Host of the fault on that physical path and shall continue normal operation.

- 3.2.4 Transmission Monitoring: The MIU receiver shall monitor the bus whenever the station is transmitting. Failure to detect bus activity (see 3.2.1.1) within two propagation delay times ($2 \cdot T_{pd}$ microseconds) indicates a problem exists between the transmitter and receiver. The MIU shall cease transmission, shall generate a fault condition to the TPIU, and shall disable itself (except when the BIU is in the Claim Token State, in which case this condition indicates a collision, and the station shall take the action specified in 5.2).

During transmission of Token, message, and claim token frames, the MIU shall check the validity of each frame it transmits as received by its receiver. In the event of a validity check failure (as defined below for each specific frame type), the MIU shall take the action specified:

- a. Claim Token Frame: Validity check failure indicates a collision. The station shall take the action specified in 5.2.
- b. Token Frame: A single occurrence of a validity check failure (failure of transmitted token frame to meet requirements defined for received token frame validity in 5.3) shall not alter protocol operation. Two consecutive token transmit validity errors on the same token hold shall cause the MIU to generate a fault condition to the TPIU and disable itself.
- c. Message Frame: A validity check failure (failure of a transmitted message frame to meet requirements defined for received message frame validity in 5.8) shall not alter protocol operation. Under no circumstances shall the MIU forward the received copy of the message to the host.

3.3 Media Access Protocol Facilities:

This section of the standard defines the facilities of the Media Access layer. These facilities are processed by the TPIU and include:

- a. Frame Formats
- b. Timers
- c. Traffic Summary

3.3.1 Frame Formats: The TPIU shall utilize three distinct frame formats as shown in Figure 3.3.1-1.

- a. Token Frame: Token Frames shall consist of SD, a one bit FC set to zero, DA, Token Frame Check Sequence (TFCS), and ED fields. The Token Frame shall always be 24 bits long.
- b. Claim Token Frame: Claim Token Frames shall consist of SD, FC, Source Address (SA), Filler, and ED fields. The length of the Claim Token Frame shall be determined by the Physical Station Address of the Source. The Filler words in the Claim Token Frame shall all be coded 4884 (HEX).
- c. Message Frame: Single Message Frames shall consist of SD, FC, SA, DA, Word Count (WC), Information, MFCS, and ED fields. The length of a Message Frame shall be defined within the message. When multiple message frames are transmitted during a token holding period, successive message frames shall consist of the SD, FC, SA, DA, WC, Information, MFCS, and ED Fields.

There shall be no interframe gap between multiple frames generated by the same station for a given token hold. When multiple frames are generated in the same token hold, only the first frame shall be preceded by a preamble.

The SD and ED are shown in Figure 3.3.1-1 only to clarify the relationship of the frame formats in the overall frame structure. The specific format and length of these fields are described as part of the MIU (see 3.2) which appends, receives, processes, and deletes them. The TPIU PDU shall consist of all fields between the Start and End Delimiters.

3.3.1.1 Frame Control (FC): The FC field (see Figure 3.3.1-2) shall define the type of frame and provides other data which affects the processing of the frame by the receiver. The following subfields are defined:

- a. Frame Type
- b. Priority
- c. Station Management Code

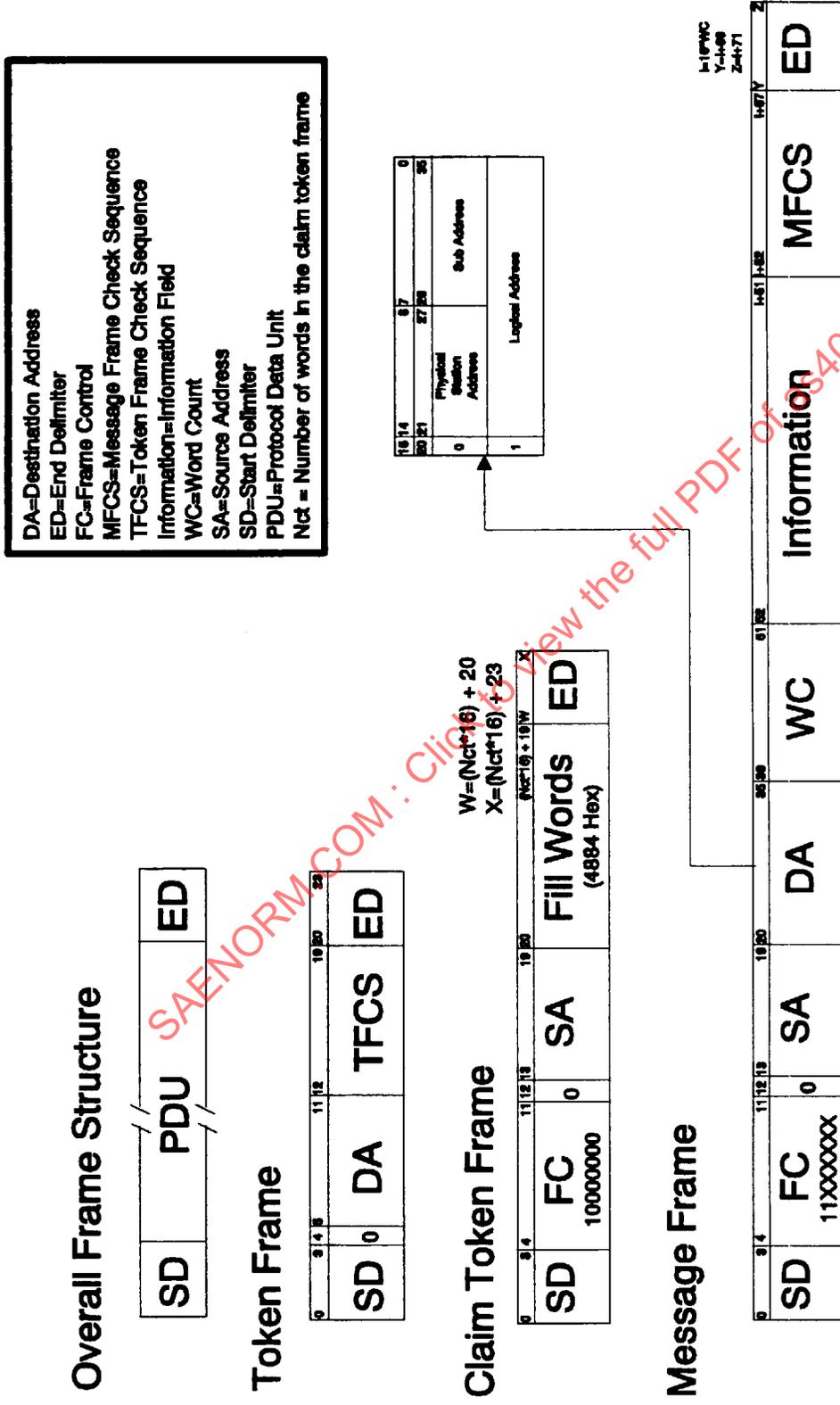


FIGURE 3.3.1-1 - Token Passing Protocol Frame Formats

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15	14	13	12	11	10	9	8	
FT (0)	(Part of next field)							Token
FT (100)			(00000)					Claim Token
FT (110)			Px		SMC			Station Management Message
FT (111)			Px		SMC			Data Message

FT - FRAME TYPE
SMC - STATION MANAGEMENT CODE
Px - PRIORITY

FIGURE 3.3.1-2 - Frame Control Field Definitions

3.3.1.1.1 Frame Type (FT): The FT subfield is present in every transmitted frame and defines the format of the transmitted frame as follows:

FT	DEFINITION
000	Token Frame
100	Claim Token Frame
101	Illegal
110	Station Management Frame
111	Data Message Frame

3.3.1.1.2 Priority (Px): The Px subfield shall be present only in the FC field of Station Management and Data Message Frames. It shall stipulate the priority of the frame processing with respect to latency control as follows:

P ₁ P ₀	PRIORITY
00	0 (Highest)
01	1
10	2
11	3 (Lowest)

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3.3.1.1.3 Station Management Code (SMC): The SMC subfield shall be defined only for Station Management and Data Message Frames. The following rules shall apply:

- a. Station Management Messages shall be used to provide control of the LTPB and BIUs. The SMC subfield shall provide for a set of control command/responses as defined in 3.4.
- b. Data Messages shall be exchanged among host processes. The definition of the SMC subfield in the FC Field of a Data Message is left to these processes. The BIU shall not alter the contents of the SMC subfield in these messages.

3.3.1.2 Source Address (SA): The SA field shall contain the Physical Station Address (PSA). These addresses shall be constrained to the following limits in Equation 2:

$$0 \leq PSA \leq 127 \quad (\text{Eq.2})$$

3.3.1.3 Destination Address (DA): The DA field shall specify either a logical or physical DA. The most significant bit of the field shall indicate the mode of addressing used in the remaining 15 bits (Point-to-Point: 0, Broadcast/Multicast: 1). The (Point-to-Point) DA field shall be further subdivided into a PSA (Bits 8-14) and a subaddress (Bits 0-7). The logical (Broadcast/Multicast) addresses shall be assigned by the host. Each station shall accept messages addressed to its particular Physical Address. Each station shall also have the capability to receive any subset of the total logical address space of 2^{15} . The TPIU shall determine if the message is for it by checking the location in the Host programmable message filter that is pointed to by the logical Address field in the message. The address FFFF (HEX) shall be defined as the broadcast address to all active stations, and shall always be accepted by an active station. Thus, location 7FFF (HEX) shall be permanently enabled in the Host programmable message filter.

3.3.1.4 Word Count (WC): The WC field shall specify the total number of 16 bit words in the Information (INFO) field. The allowable INFO field size shall be $1 \leq WC \leq 4096$.

3.3.1.5 Information (INFO): The INFO field shall contain the data being transmitted. This field shall always contain the number of 16 bit words specified by the WC field.

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3.3.1.6 Message Frame Check Sequence (MFCS): The MFCS shall provide a check for errors in the Message. Each station which transmits a Message Frame shall generate and insert the MFCS in the Message Protocol Data Unit (MPDU). Each station receiving a Message Frame shall verify that the MFCS is correct. This shall constitute a "valid Message." The MFCS shall cover the FC, DA, SA, WC, and INFO fields. The MFCS shall be preloaded with all 0's before the start of each message frame. The MFCS is a Cyclic Redundancy Check (CRC) and shall use the following generator polynomial in Equation 3:

$$G(x) = X^{16} + X^{12} + X^5 + 1 \quad (\text{Eq.3})$$

3.3.1.7 Token Frame Check Sequence (TFCS): The TFCS shall provide a check for errors in the Token. Each station shall generate and insert the TFCS in the TPDU when it transmits a Token. Each station receiving the Token shall verify that the TFCS is correct. This constitutes a "Valid Token". The TFCS shall cover the one bit FC (=0) and the DA field of the Token frame. The TFCS shall be preloaded with all 0's before the start of each token frame. The TFCS is a CRC and shall use the following generator polynomial in Equation 4:

$$G(x) = X^8 + X^4 + X^2 + X + 1 \quad (\text{Eq.4})$$

3.3.2 Timers: The TPIU shall implement the following timer functions:

- a. Token Holding Timer (THT)
- b. Token Rotation Timers (TRT)
- c. Ring Admittance Timer (RAT)
- d. Token Passing Timer (TPT)
- e. Bus Activity Timer (BAT)

All TPIU Timers shall be derived from the local BIU data clock. The control parameters shall default to the values specified in the applicable paragraph but shall be settable during initialization of the TPIU.

The operation of the THT, TRTs, and RAT, (see Section 5) shall adhere to the flow chart shown in Figure 3.3.2-1. Whenever a station receives the Token:

- a. It shall set the THT to its maximum value. The THT bounds the transmission time for the messages at Priority 0 level (Priority 0 is the highest priority, x=0).
- b. The Station shall transmit all Priority x messages until one of the following occurs:
 - (1) THT expires: All lower Priority TRTs are reloaded and the token is passed.

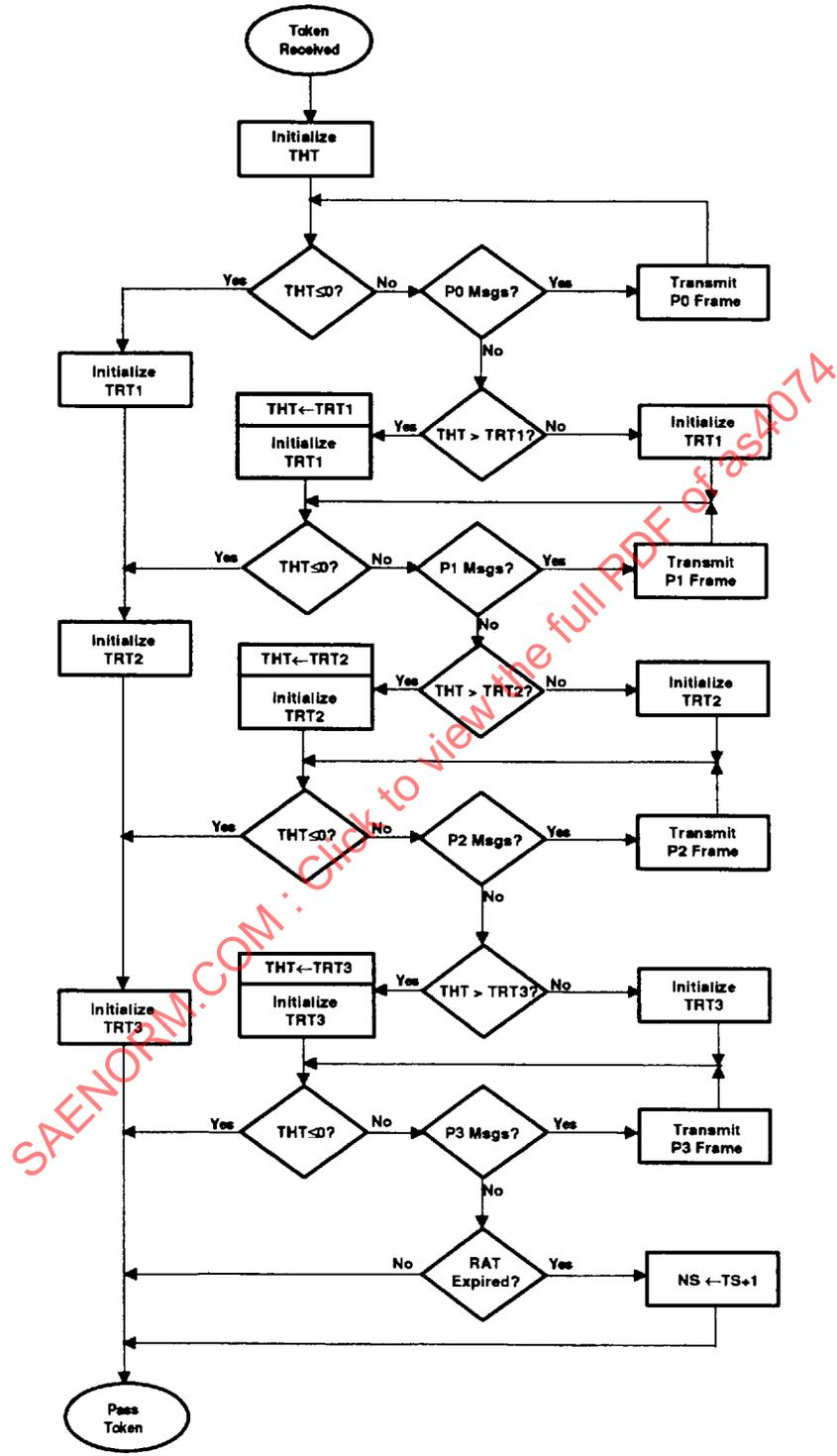


FIGURE 3.3.2-1 - Send Message State Flowchart

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3.3.2 (Continued):

(2) The station has no more Priority x messages: The station shall internally permit message transmission at the next priority level ($x = x + 1$). THT shall be set to the lesser of the remaining value in TRT_x or the remaining value in THT, and then TRT_x shall be set to the specified maximum value.

c. If the current priority is $x < 3$ and the token has not been passed, then return to (step b).

d. If the current priority is $x=3$, the RAT has expired, and the Token has not been passed (that is, all messages of all priorities have been sent and there is still time on TRT_3), then the station shall begin the Ring Admittance process, described in 5.5, until the Token is successfully passed. The RAT shall be set once the Ring Admittance process terminates.

3.3.2.1 Token Holding Timer (THT): The THT shall limit the amount of time which a station may transmit after it has received the Token. This timer shall be programmable with a 16 bit quantity representing a variable value from 0 to 65 535 μ s. The THT shall be loaded during initialization with the default value specified in the appropriate slash sheet referenced in Appendix A.

The Token holder may transmit a Message as long as there is time left on the THT. If the THT expires during the Message transmission, the station shall finish the Message transmission and then shall pass the Token to its successor.

3.3.2.2 Token Rotation Timer (TRT): The TRT shall measure the rotation period of the Token about the logical ring. Each station shall implement a TRT for each priority level of Message traffic (except priority 0 - highest). The TRTs shall be programmable with a 16 bit quantity representing a variable value from 0 to 65 535 μ s. The TRTs shall be loaded during initialization with the default values specified in the appropriate slash sheet referenced in Appendix A. During operation, the TRTs shall be set such that the following relationship between the TRT maximum values is maintained as shown in Equation 5:

$$TRT1 \geq TRT2 \geq TRT3 \quad (\text{Eq.5})$$

3.3.2.3 Ring Admittance Timer (RAT): The RAT shall control when stations may be allowed to enter the logical ring. This timer shall be programmable with a 16 bit quantity representing a variable value from 0 to 6553.5 ms. The RAT shall be loaded during initialization with the default value specified in the appropriate slash sheet referenced in Appendix A. The Ring Admittance process is described in 5.5.

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3.3.2.4 Token Passing Timer (TPT): Each station shall monitor the bus media after passing the Token. If a period of T_{tp} microseconds passes without receiving a bus activity indication (see 3.2.1.1), then the station shall consider a Token Pass failure to have occurred.

The TPT shall be programmable with an 8 bit quantity representing a variable value from 0 to 10.20 μ s. The TPT shall be loaded during initialization with a value defined by the worst case round trip propagation delay to, and from, the station to which the Token was passed plus an allowance for the station to respond and for that response to be detected (see Equation 6).

$$T_{tp} = 2 * T_{pd} + T_{sr} + T_{ba} \text{ microseconds} \quad (\text{Eq.6})$$

where:

- T_{pd} = Maximum Bus Propagation Delay for the particular system in microseconds
- T_{sr} = Maximum Station Response Time
- T_{ba} = Bus Activity indication time
 - = 20 bit times - worst case
 - = $20/R_d$ microseconds
- R_d = Bus data rate in MPBS

3.3.2.5 Bus Activity Timer (BAT): The TPIU shall continuously monitor the bus for activity. The BAT shall be programmable with an 11 bit quantity representing a variable value from 0 to 2047 μ s. Each station's BAT shall be loaded during initialization with a value based on that station's PSA, and the values shall be defined so that the minimum BAT value is longer than the longest "normal" idle time on the bus (which is a TPT plus an allowance for Maximum Station Response, bus propagation delay, and Bus Activity Indication time on the following token pass) (see Equation 7):

$$\begin{aligned} \text{BAT} &= (\text{PSA} + 1) * (T_{tp} + T_{sr} + T_{pd} + T_{ba}) \text{ microseconds} \\ &= (\text{PSA} + 1) * (2T_{sr} + 3T_{pd} + 2T_{ba}) \text{ microseconds} \end{aligned} \quad (\text{Eq.7})$$

where:

T_{tp} , T_{sr} , T_{pd} , and T_{ba} are as defined in 3.3.2.4

When the Bus Activity Timeout occurs the TPIU shall inform the BIU that a Bus Activity Timeout has occurred. The BAT shall then be reset and restarted. The BIU shall initiate the Claim Token procedure on the first instance of a Bus Activity Timeout. Successive instances shall not invoke a Claim Token unless the BIU has either:

- a. Successfully entered the Logical Ring at least once since the most recent Bus Activity Timeout
- b. Recognized a collision while it was in the Claim Token state

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3.3.3 Traffic Summary: Each TPIU shall be required to keep a cumulative summary of the following information:

- a. Valid Messages Transmitted: This count shall increment once for each message transmitted without error.
- b. Claim Tokens Transmitted: This count shall increment once for each Claim Token transmitted.
- c. Transmissions Aborted: This count shall increment once for each transmission that was aborted due to error.
- d. Frame Validity Errors: This count shall increment once for each transmitted frame that was received with a validity error. A separate count shall be maintained for each media path.
- e. Frame Received Errors: This count shall increment once for each frame not transmitted by this BIU that was received with a validity error. A separate count shall be maintained for each media path.
- f. Valid Messages Received: This count shall increment once for each message received without error that was addressed to the station.
- g. Receive Queue Overflow Errors: This count shall increment once for each message that could not be forwarded to the Host due to a receive queue overflow condition.

Each parameter shall increment continuously in a circular fashion up to a value of $2^{\text{exp}[16]} - 1$. A traffic summary shall be cleared only on Host command.

3.4 Station Management:

The Station Management function of the BIU shall process the following Station Management messages and functions:

- a. Mode Control Command (000)
- b. Status Report (001)
- c. Load/Report Configuration Command (010)
- d. Configuration Report (011)
- e. Loopback Test Message Echo (100)
- f. Loopback Test Message (101)
- g. Time Synchronization Message (110)
- h. Time Report (111)

These functions shall be performed when commanded from either the active bus or the Host. The Host shall have the capability to disable response to any Station Management command from the active bus.

All messages are presented in a word (16 bit) oriented manner.

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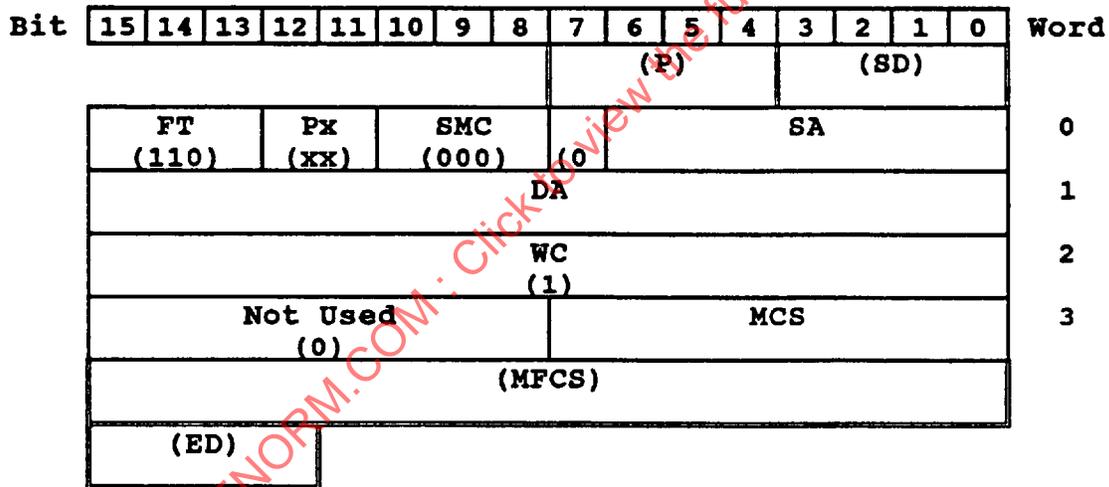
3.4 (Continued):

Order of transmission is from most significant bit to least significant bit.

NOTE: For completeness the SD, MFCS, and ED are illustrated even though they would not normally be visible at this level of the BIU. Field values, where known, are shown in parenthesis below the field mnemonic in the format.

3.4.1 Mode Control Command: The Mode Control Command (000) shall be used to direct changes in the BIU. This command shall be issued as a Station Management Frame as formatted in Figure 3.4.1-1. The Mode Control Command shall set the BIU Command Register to the specified value.

The Mode Control Command shall be sent to the physical address of the intended destination station. A Mode Control Command with a logical address shall be ignored. The subaddress field may be defined by the Host, and a destination station shall only accept Mode Control Command messages with a subaddress field the destination Host has designated for reception (the Host may enable or disable recognition of this command through the subaddress field).

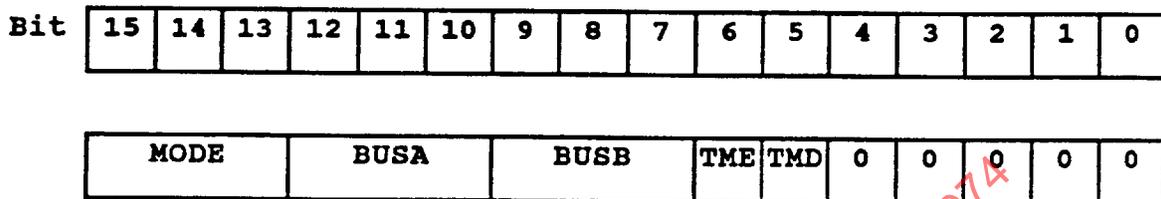


Field	Description
FT	Frame Type (110) - Station Management Message.
Px	Priority (00) - Message Priority.
SMC	Station Management Code (000) - Mode Control Command Code.
DA	Destination Address - Physical address of destination station.
SA	Source Address - Physical address of the source station.
WC	Word Count (1) - The number of data words following this word.

FIGURE 3.4.1-1 - Mode Control Command Format

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3.4.1.1 BIU Command Register: The BIU Command Register is used to control the current state of the BIU. Commands are invoked by writing to this register with the appropriate bit set to 1. The result of the command is echoed in the BIU Status Register (3.4.2.2.1). The format of the BIU Command Register is shown in Figure 3.4.1.1-1.



Field	Description																
MODE	<p>These bits control the current BIU mode:</p> <table style="width: 100%; border: none;"> <tr><td style="width: 50px;">000</td><td>NO_OPERATION (remain in current state)</td></tr> <tr><td>001</td><td>ENTER_LOOPBACK_MODE</td></tr> <tr><td>010</td><td>DISABLE</td></tr> <tr><td>011</td><td>ENABLE</td></tr> <tr><td>100</td><td>ENTER QUIESCENT_MODE</td></tr> <tr><td>101</td><td>reserved (remain in current state)</td></tr> <tr><td>110</td><td>reserved (remain in current state)</td></tr> <tr><td>111</td><td>RESET/PERFORM_SELF_TEST</td></tr> </table>	000	NO_OPERATION (remain in current state)	001	ENTER_LOOPBACK_MODE	010	DISABLE	011	ENABLE	100	ENTER QUIESCENT_MODE	101	reserved (remain in current state)	110	reserved (remain in current state)	111	RESET/PERFORM_SELF_TEST
000	NO_OPERATION (remain in current state)																
001	ENTER_LOOPBACK_MODE																
010	DISABLE																
011	ENABLE																
100	ENTER QUIESCENT_MODE																
101	reserved (remain in current state)																
110	reserved (remain in current state)																
111	RESET/PERFORM_SELF_TEST																
BUSA	<p>These bits control the Bus A media state:</p> <table style="width: 100%; border: none;"> <tr><td style="width: 50px;">000</td><td>(reserved)</td></tr> <tr><td>001</td><td>BUS_ENABLE</td></tr> <tr><td>010</td><td>BUS_TEST_MODE_ENABLED</td></tr> <tr><td>011</td><td>RECEIVER_ONLY_ENABLED</td></tr> <tr><td>100</td><td>TPO_TEST_ENABLED</td></tr> <tr><td>101</td><td>DATA_STREAMING_TIMER_DISABLED</td></tr> <tr><td>110</td><td>(reserved)</td></tr> <tr><td>111</td><td>BUS_DISABLED</td></tr> </table>	000	(reserved)	001	BUS_ENABLE	010	BUS_TEST_MODE_ENABLED	011	RECEIVER_ONLY_ENABLED	100	TPO_TEST_ENABLED	101	DATA_STREAMING_TIMER_DISABLED	110	(reserved)	111	BUS_DISABLED
000	(reserved)																
001	BUS_ENABLE																
010	BUS_TEST_MODE_ENABLED																
011	RECEIVER_ONLY_ENABLED																
100	TPO_TEST_ENABLED																
101	DATA_STREAMING_TIMER_DISABLED																
110	(reserved)																
111	BUS_DISABLED																
BUSB	<p>These bits control the Bus B media state. These are the same as for Bus A.</p>																
TME	<p>Time Master Mode Enable: If set to 1, the BIU Time Master Mode is enabled (becomes time master). Note: if TMD is set also, TME shall be ignored.</p>																
TMD	<p>Time Master Mode Disable: If set to 1, the BIU Time Master Mode is disabled.</p>																

FIGURE 3.4.1.1-1 - BIU Command Register Format

3.4.1.2 BIU Modes: The BIU modes are commanded through the BIU Command Register. The BIU commanded mode state diagram is shown in Figure 3.4.1.2-1. Upon writing to the BIU Command Register, the BIU shall enter the appropriate mode as follows:

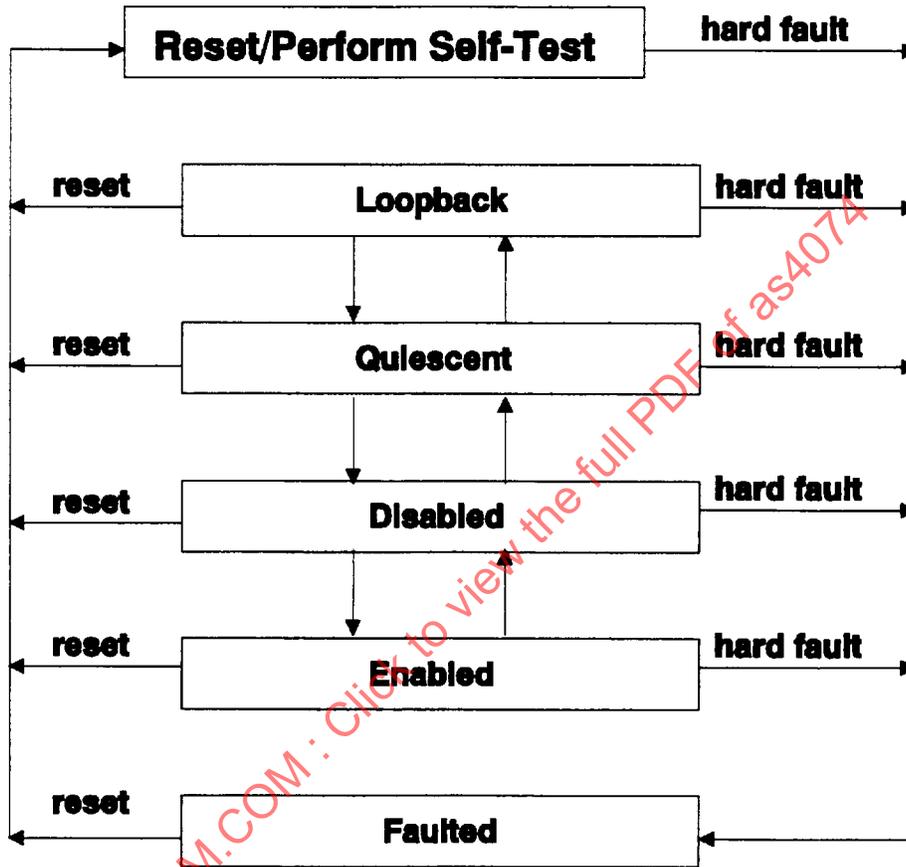


FIGURE 3.4.1.2-1 - BIU Commanded Modes

The BIU shall be in RESET mode on power-up, after a Master Clear/Reset, or after receiving a Reset/Perform Selftest command, and shall proceed immediately into its initialization and selftest procedures. The BIU shall enter the QUIESCENT mode after successful completion of initialization and selftest.

3.4.1.2 (Continued):

A DISABLE command shall bring the BIU to its DISABLED mode after initializing BIU control parameters and enabling LTPB operation.

An ENABLE command shall bring the BIU to its ENABLED mode where it is enabled to transmit and receive messages.

The BIU shall be in FAULTED mode after a hard fault is detected and shall only exit this mode upon a RESET/PERFORM_SELFTEST command. A hard fault is defined as a failure that precludes error-free operation on at least one path.

The BIU shall enter the LOOPBACK mode when commanded from the QUIESCENT mode only.

The DISABLE, ENTER QUIESCENT MODE, and RESET/PERFORM_SELFTEST commands shall cause the BIU to return to the appropriate state as shown in Figure 3.4.1.2-1. The BIU shall only transition one state at a time, with the exception of the RESET/PERFORM_SELFTEST command, which shall cause the BIU to transition through RESET to QUIESCENT mode.

3.4.1.2.1 BIU Reset/Perform Selftest: The RESET/PERFORM_SELFTEST command shall cause the BIU to return to RESET mode and perform a complete selftest and reinitialization. Specific selftest operations are defined in 3.4.5. This command shall be recognized in any mode. The BIU shall be in QUIESCENT mode upon completion of this command.

3.4.1.2.2 BIU Quiescent Mode: The ENTER QUIESCENT MODE command shall be recognized when the BIU is in the DISABLED or LOOPBACK modes. The transition from DISABLED or LOOPBACK mode into QUIESCENT mode shall cause the following:

- a. The transmitter and protocol operation shall be disabled (BIU placed off-line).
- b. All transmit message queues shall be cleared.

The BIU shall not disable protocol operation until the token has been successfully passed and accepted by a successor, if this command is received during a token hold. The BIU shall be in QUIESCENT mode upon completion of this command and shall indicate this in the BIU Status Register. When in the QUIESCENT mode, the BIU shall not be able to transmit and receive tokens, and shall only be able to receive Station Management Frames. All message transmit and data message receive operations shall be disabled.

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3.4.1.2.3 BIU Loopback Mode: The ENTER_LOOPBACK_MODE command shall only be recognized when the BIU is in QUIESCENT mode. When in LOOPBACK mode, the BIU shall disable its transmitters and receivers and form a connection between local transmitter and receiver circuits for test purposes. The BIU shall transmit any messages written to a transmit queue as if it were in ENABLED mode. The received copy of the transmitted message (messages transmitted will be immediately received, since the transmitter output is connected to the receiver input) shall be put into the receive queue and forwarded if normal message reception map and filter criteria are met.

The BIU shall indicate LOOPBACK mode in the BIU Status Register.

3.4.1.2.4 BIU Disabled: The DISABLE command shall only be recognized when the BIU is in the QUIESCENT or ENABLED mode. The transition from QUIESCENT to DISABLED mode upon this command shall cause the following:

- a. All timers and counters shall be loaded to default or Host supplied values
- b. The Next Station Address (NSA) shall be set to Physical Station Address (PSA)+1 (modulo Maximum Station Address (MSA))
- c. The BIU shall attempt to begin token passing either through the Claim Token process or Ring Admittance

The BIU shall be in DISABLED mode upon completion of this command and shall indicate this in the BIU Status Register. When DISABLED, the BIU shall be able to transmit and receive tokens, shall be able to receive all Station Management Frames and shall be able to transmit the following Station Management Frames: Configuration Report, Status Report, Time Report, and Loopback Test Message Echo. Data Message Frame transmit and receive and all other Station Management Frame transmit operations shall be disabled. Time Master mode shall not be enabled.

NOTE: At least one LTPB transmitter and receiver must be enabled or an BIU hard fault condition will occur.

The transition from the ENABLED to the DISABLED mode shall cause the following:

- a. Further data message writes into the transmit queues shall be disabled but Station Management Frame transmission shall be allowed for those messages defined above. Any previously enqueued messages shall be transmitted on the LTPB.
- b. Reception of all LTPB messages except for Station Management shall be disabled. Any previously enqueued messages shall be forwarded to the host.
- c. Time Master mode shall be disabled.

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3.4.1.2.4 (Continued):

- d. The BIU shall continue to participate in LTPB protocol functions (shall remain on-line).

The BIU shall be in DISABLED mode upon completion of this command and shall indicate this in the BIU Status Register.

3.4.1.2.5 BIU Enabled: The ENABLE command shall only be recognized when the BIU is in the DISABLED mode. The transition from DISABLED to ENABLED mode upon this command shall cause the following:

- a. LTPB data message transmission shall be enabled
- b. LTPB message reception shall be enabled for all messages

The BIU shall be in ENABLED mode upon completion of this command and shall indicate this in the BIU Status Register. In ENABLED mode, all LTPB message transmission/reception functions are enabled.

3.4.1.2.6 BIU Faulted: The BIU shall be in FAULTED mode after a hard fault is detected. A hard fault is defined as a failure that precludes operation on at least one path. Upon entering FAULTED mode, the BIU shall immediately cease all operations and disable its transmitters and receivers on both paths. The BIU shall only exit the FAULTED mode upon a RESET/PERFORM SELFTEST command.

3.4.1.3 BIU Media Interface Operational Modes. The BIU media interface operational modes may also be commanded through the BIU Command Register BUSA and BUSB fields. These commands shall only be recognized when the BIU is in the QUIESCENT mode. Upon writing a new command word, the Bus A or Bus B media interface shall enter the appropriate mode defined as follows:

BUSA or BUSB	STATE
000	NO_OPERATION (remain in current state)
001	ENABLE_BUS
010	ENABLE_BUS_TEST_MODE
011	ENABLE_RECEIVER_ONLY
100	ENABLE_TPO_TEST
101	DISABLE_DATA_STREAMING_TIMER
110	RESET_DATA_STREAMING_TIMER
111	DISABLE_BUS

The ENABLE_BUS command shall enable the appropriate receiver and transmitter to full power mode.

The ENABLE_BUS_TEST_MODE command shall enable the receiver and appropriate transmitter to half (3 dB down) power mode, which shall cause the appropriate BUS A or B transmitter power output to be reduced by one half (-3 dB) to allow system margin testing. This command will only affect a fiber-optic media implementation.

3.4.1.3 (Continued):

The ENABLE_RECEIVER_ONLY command shall enable the appropriate receiver but disable the transmitter for receive only operation. The BIU shall default to this state after a reset/self_test operation.

The ENABLE_TPO_TEST and DISABLE_DATA_STREAMING_TIMER commands shall be used in conjunction to allow LTPB average transmitter output power measurement. The DISABLE_DATA_STREAMING_TIMER command shall override data streaming timer expiration to allow continuous transmission on the LTPB. The ENABLE_TPO_TEST command shall cause the transmitter to output a continuous signal at the signalling rate (R_s). The corresponding receiver shall be enabled. The ENABLE_TPO_TEST command shall not be recognized unless the data streaming timer has been previously disabled.

The RESET_DATA_STREAMING_TIMER command shall reset the designated data streaming timer and return the path to its normal state. The DISABLE_BUS command shall disable the appropriate receiver and transmitter.

The BIU shall indicate the appropriate transmitter or receiver mode by setting or clearing the appropriate bits in the BIU Status Register.

- 3.4.1.4 BIU Time Master Mode: TME = 1 in the BIU Command Register shall cause the BIU to become the LTPB time master. This command shall be recognized when the BIU is in any mode. The LTPB shall transmit LTPB time synchronization messages as specified in 3.4.6.1 at a rate defined by the TSM update rate. The time synchronization message transmission shall only occur when the BIU is in the ENABLED mode. TMD = 1 of the BIU Command Register shall cause the BIU to cease operation as the LTPB time master.

The BIU shall indicate time master status by setting or clearing the appropriate bit in the BIU Status Register.

- 3.4.2 Load/Report Configuration: The Load/Report Configuration Command (010) shall provide the means to set up control parameters in a remote BIU, and to verify they are correct by requesting a report of local configuration or status from the remote BIU. The Load/Report Configuration Command shall be formatted as shown in Figure 3.4.2-1.

The Load/Report Configuration Command shall be sent to the physical address of the destination station. A Load/Report Configuration Command with a logical address shall be ignored. The subaddress field may be defined by the Host, and a destination station shall only accept Load/Report Configuration Command messages with a subaddress field the destination Host has designated for reception.

If a report bit is set in the command the BIU shall immediately format a report and either pass it to the Host, or enqueue it for return to the source of the command on a subsequent token hold, if applicable.

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Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Word
													(SD)				
	FT (110)			Px (00)		SMC (010)		(0)	SA								0
	DA																1
	WC (1,28+(N*17))																2
	LC	RC	RS	RT	(0000000000000)												3
	(00000000)							TPT									4
	(00000)				BAT												5
	RAT																6
	THT																7
	TRT1																8
	TRT2																9
	TRT3																10
	CTLC=4 (Reserved For JIAWG Interoperability)																11
	(00000000)							MSA									12
	(0000000000000)							TSM Update Rate->									13
	MFP																14
	FW #0																15
	:																
	:																
	:																
	FW #15																
	(MFCS)																
	(ED)																

FIGURE 3.4.2-1 - Load/Report Configuration Command Format

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Field	Description
FT	Frame Type (110) - Station Management Message
Px	Priority (00) - Message Priority (level 0)
SMC	Station Management Code (010) - Load/Report Configuration Command
DA	Destination Address - Physical address of destination station.
SA	Source Address - Physical address of the source station.
WC	Word Count (1 or 28+(N*17)) - The number of words following this field. This may be 1 for a Report Configuration (RC=1), Report Status (RS=1), or Report Time (RT=1) Command without loading a new configuration, or 28+(N*17) when a Load Configuration (LC=1) is specified alone or with report commands.
LC	Load Configuration- When set the BIU will load the parameters from the following words into its internal parameter storage areas.
RC	Report Configuration - When set the BIU will formulate a Configuration Report and return it to the requester.
RS	Report Status - When set the BIU will formulate a Status Report and return it to the requester.
RT	Report Time - When set the BIU will formulate a Time Report and return it to the requester.
TPT	Token Pass Timer initialization value.
BAT	Bus Activity Timer initialization value.
RAT	Ring Admittance Timer initialization value.
THT	Token Holding Timer initialization value.
TRT1	Token Rotation Timer initialization value - Priority Level 1.
TRT2	Token Rotation Timer initialization value - Priority Level 2.
TRT3	Token Rotation Timer initialization value - Priority Level 3.
CTLTC	Claim Token Limit Counter (reserved for JIAWG interoperability) - for use in JIAWG systems to load the CTLTC value.
MSA	Maximum Station Address in the Logical Ring - This parameter shall define the highest physical station address in the system. The station shall not search higher than this when performing Token management activities.
TSM UP- DATE RATE	The update rate to be used for sending Time Synchronization Messages if the station is Time Master.
MFP	Message Filter Page - The BIU message filter shall be organized as 128 pages of 256 bits each (32,768 bits). This field shall specify the page number. The logical address covered by this page shall be 256*MFP+255.

FIGURE 3.4.2-1 (Continued)

Field	Description
Fwn	<p>Filter Page Word # n - Each page shall consist of 256 bits. Each Filter Page Word shall specify 16 of those bits. The bits in the FW field shall correspond to logical addresses as follows: Logical Address = $256 * MFP + 16 * n + m$</p> <p>where:</p> <p>m = the bit position in the FW fields (LSB = 0)</p> <p>A one in the position shall enable receipt of the Message with that logical address. Correspondingly a 0 in the position shall disable receipt of the message with that logical address.</p>
MFCs	Message Frame Check Sequence.

FIGURE 3.4.2-1 (Continued)

3.4.2.1 Configuration Report. The Configuration Report (011) message shall be sent to the physical DA of the requesting station (obtained from the SA field of the Load/Report Configuration message) and shall contain the BIU control parameter values. The message subaddress shall be equivalent to that sent by the requesting station (obtained from the subaddress field of the Load/Report Configuration message). The Configuration Report message shall be formatted as shown in Figure 3.4.2.1-1.

If the BIU receives a Configuration Report it shall pass it to the Host.

3.4.2.2 Status Report. The Status Report (001) message shall be sent to the physical DA of the requesting station (obtained from the SA field of the Load/Report Configuration message) and shall contain BIU status. The message subaddress shall be equivalent to that sent by the requesting station (obtained from the subaddress field of the Load/Report Configuration message). The Status Report message shall be formatted as shown in Figure 3.4.2.2-1.

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Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Word
														(SD)			
	FT (110)		Px (11)		SMC (011)		(0)		SA								0
	DA																1
	WC = 11																2
	(00000000)							TPT									3
	(00000)				BAT												4
	RAT																5
	THT																6
	TRT1																7
	TRT2																8
	TRT3																9
	CTLC=4 (Reserved For JIAWG Interoperability)																10
	(00000000)							MSA									11
	(00000000)							NSA									12
	(00000000000000)										TSM Update Rate->						13
	MFP																14
	FW #0																15
	:																
	:																
	:																
	FW #15																
	(MFCS)																
	(ED)																

FIGURE 3.4.2.1-1 - Configuration Report Format

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Field	Description
FT	Frame Type (110) - Station Management Message
Px	Priority (11) - Message Priority (level 3)
SMC	Station Management Code (011) - Configuration Report
DA	Destination Address - Physical address of destination station.
SA	Source Address - Physical address of the source station.
WC	Word Count (1 or 28+(N*17)) - The number of words following this field. This may be 1 for a Report Configuration (RC=1), Report Status (RS=1), or Report Time (RT=1) Command without loading a new configuration, or 28+(N*17) when a Load Configuration (LC=1) is specified alone or with report commands.
TPT	Token Pass Timer initialization value.
BAT	Bus Activity Timer initialization value.
RAT	Ring Admittance Timer initialization value.
THT	Token Holding Timer initialization value.
TRT1	Token Rotation Timer initialization value - Priority Level 1.
TRT2	Token Rotation Timer initialization value - Priority Level 2.
TRT3	Token Rotation Timer initialization value - Priority Level 3.
CTLG	Claim Token Limit Counter (reserved for JIAWG interoperability) - shall return the value of 4.
MSA	Maximum Station Address in the Logical Ring.
NSA	Next Station Address - The address of the successor station in the Logical Ring to which the station is currently sending tokens.
TSM UPDATE RATE	The update rate used for sending Time Synchronization Messages if the station is Time Master.
MFP	Message Filter Page - The BIU message filter shall be organized as 128 pages of 256 bits each (32,768 bits). This field shall specify the page number. The logical address covered by this page shall be 256*MFP+255.

FIGURE 3.4.2.1-1 (Continued)

FWn Filter Page Word # n - Each page shall consist of 256 bits. Each Filter Page Word shall specify 16 of those bits. The bits in the FW field shall correspond to logical addresses as follows:
Logical Address = $256 * MFP + 16 * n + m$

where:

m = the bit position in the FW fields (LSB = 0)

A one in the position shall enable receipt of the Message with that logical address. Correspondingly a 0 in the position shall disable receipt of the message with that logical address.

MFCS Message Frame Check Sequence.

FIGURE 3.4.2.1-1 (Continued)

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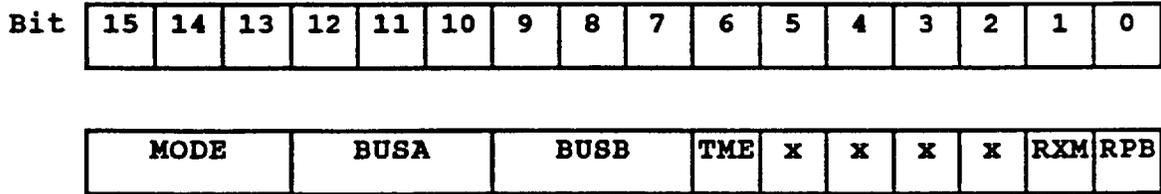
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Word
														(SD)			
	FT (110)	Px (11)	SMC (001)	(0)	SA												0
	DA																1
	WC = 11																2
	BIU STATUS REGISTER																3
	BIU ERROR REGISTER																4
	VALID MESSAGES TRANSMITTED COUNT VALUE																5
	CLAIM TOKENS TRANSMITTED COUNT VALUE																6
	VALID MESSAGES RECEIVED COUNT VALUE																7
	FRAME ECHO ERROR COUNT VALUE - BUSA																8
	FRAME ECHO ERROR COUNT VALUE - BUSB																9
	ABORTED TRANSMISSION COUNT VALUE																10
	RECEIVE QUEUE OVERFLOW ERROR COUNT VALUE																11
	FRAME RECEIVED ERROR COUNT VALUE - BUSA																12
	FRAME RECEIVED ERROR COUNT VALUE - BUSB																13
	(MFCS)																
	(ED)																

Field	Description
FT	Frame Type (110) - Station Management Message
Px	Priority (11) - Message Priority (level 3)
SMC	Station Management Code (001) - Status Report
DA	Destination Address - Physical address of destination station.
SA	Source Address - Physical address of the source station.
WC	Word Count (11) - The number of words following this field.
MFCS	Message Frame Check Sequence.

FIGURE 3.4.2.2-1 - Status Report Format

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3.4.2.2.1 BIU Status Register: The BIU Status Register is used by the BIU to report its current state. The format of the BIU Status Register is shown in Figure 3.4.2.2.1-1.



Field	Description																
MODE	<p>These bits control the current BIU mode:</p> <table style="width: 100%; border: none;"> <tr><td style="width: 50px;">000</td><td>NO_OPERATION (remain in current state)</td></tr> <tr><td>001</td><td>ENTER_LOOPBACK_MODE</td></tr> <tr><td>010</td><td>DISABLE</td></tr> <tr><td>011</td><td>ENABLE</td></tr> <tr><td>100</td><td>ENTER QUIESCENT_MODE</td></tr> <tr><td>101</td><td>reserved (remain in current state)</td></tr> <tr><td>110</td><td>reserved (remain in current state)</td></tr> <tr><td>111</td><td>RESET/PERFORM_SELF_TEST</td></tr> </table>	000	NO_OPERATION (remain in current state)	001	ENTER_LOOPBACK_MODE	010	DISABLE	011	ENABLE	100	ENTER QUIESCENT_MODE	101	reserved (remain in current state)	110	reserved (remain in current state)	111	RESET/PERFORM_SELF_TEST
000	NO_OPERATION (remain in current state)																
001	ENTER_LOOPBACK_MODE																
010	DISABLE																
011	ENABLE																
100	ENTER QUIESCENT_MODE																
101	reserved (remain in current state)																
110	reserved (remain in current state)																
111	RESET/PERFORM_SELF_TEST																
BUSA	<p>These bits control the Bus A media state:</p> <table style="width: 100%; border: none;"> <tr><td style="width: 50px;">000</td><td>(reserved)</td></tr> <tr><td>001</td><td>BUS_ENABLE</td></tr> <tr><td>010</td><td>BUS_TEST_MODE_ENABLED</td></tr> <tr><td>011</td><td>RECEIVER_ONLY_ENABLED</td></tr> <tr><td>100</td><td>TPO_TEST_ENABLED</td></tr> <tr><td>101</td><td>DATA_STREAMING_TIMER_DISABLED</td></tr> <tr><td>110</td><td>(reserved)</td></tr> <tr><td>111</td><td>BUS_DISABLED</td></tr> </table>	000	(reserved)	001	BUS_ENABLE	010	BUS_TEST_MODE_ENABLED	011	RECEIVER_ONLY_ENABLED	100	TPO_TEST_ENABLED	101	DATA_STREAMING_TIMER_DISABLED	110	(reserved)	111	BUS_DISABLED
000	(reserved)																
001	BUS_ENABLE																
010	BUS_TEST_MODE_ENABLED																
011	RECEIVER_ONLY_ENABLED																
100	TPO_TEST_ENABLED																
101	DATA_STREAMING_TIMER_DISABLED																
110	(reserved)																
111	BUS_DISABLED																
BUSB	These bits control the Bus B media state. These are the same as for Bus A.																
TME	TIME_MASTER_MODE_ENABLED: If set to 1, the LTPB interface Time Master Mode is enabled.																
RXM	RECEIVE_MESSAGE_AVAILABLE: If set to 1, an LTPB message has been received without error and is available to the Host.																
RPB	RECEIVER_PRIMARY_BUS: If set to 1, the message was received on BUSA. If set to 0, the message was received on BUSB. (This bit is valid only if the RXM bit is set).																
x	reserved (ignore)																

FIGURE 3.4.2.2.1-1 - BIU Status Register Format

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3.4.2.2.2 BIU Error Register: The BIU Error Register is used by the BIU to report any errors encountered in a message transmit or receive operation. The format of the BIU Error Register is shown in Figure 3.4.2.2.2-1.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
x	MER	RPE	WCE	RMT	RMS	ERA	ERB	RQF	TXM	TMA	TPE	TTA	TTB	BTO	TTO	

Field	Description
MER	MESSAGE_ERROR: If set, the last message was received in error and should be discarded. This bit will be set if the RECEIVER_PARITY_ERROR bit is set, the WORD_COUNT_ERROR bit is set, or if both the BUSA_ERROR and BUSB_ERROR bits are set.
RPE	RECEIVER_PARITY_ERROR: If set to 1, a parity error was detected in the path between the receiver and the receive queue.
WCE	MESSAGE_WORD_COUNT_ERROR: If set, the received message word count is not equal to the number of words stored in the receive queue.
RMT	REDUNDANT_MEDIA_TIMEOUT: If set, a redundant media timeout occurred on the bus opposite that indicated by the RPB bit. A redundant media timeout indicates that the redundant copy of the message was not received on the secondary bus within the skew limits defined by section 3.2.3.
RMS	REDUNDANT_MEDIA_SKEW_ERROR: If set, a redundant media skew error occurred on the bus opposite that indicated by the RPB bit. A redundant media skew error indicates that the redundant copy of the message on the secondary bus was lost because the skew limits defined by section 3.2.3 were exceeded sometime during the message reception.
ERA	BUSA_ERROR: If set, a bus error was detected on BUSA. A bus error may be an INVALID SYMBOL, a frame check failure, or the last word was less than 16 bits.
ERB	BUSB_ERROR: If set, a bus error was detected on BUSB.
RQF	RECEIVE_QUEUE_FULL: If set to 1, the LTPB receive queue is full.
TXM	TRANSMIT_MESSAGE: If set to 1, the errors currently reported were associated with a transmitted message (echo).
TMA	TRANSMIT_MESSAGE_ABORTED: If set to 1, the last LTPB message transmitted was aborted.

FIGURE 3.4.2.2.2-1 - BIU Error Register Format

Field	Description
TPE	TRANSMITTER_PARITY_ERROR: If set to 1, a parity error was detected in the path between a transmit queue and the transmitter.
TTA	BUSA_TRANSMISSION_MONITOR_TIMEOUT: If set to 1, the last LTPB frame transmitted on BUSA caused a Transmission Monitor timeout error (no echo was detected), indicating a media failure.
TTB	BUSB_TRANSMISSION_MONITOR_TIMEOUT: If set to 1, the last LTPB frame transmitted on BUSB caused a Transmission Monitor timeout error (no echo was detected), indicating a media failure.
BTO	BAT_TIMEOUT: If set to 1, an LTPB Bus Activity timeout has occurred indicating this BIU performed a bus reinitialization.
TTO	TPT_TIMEOUT: If set to 1, an LTPB Token Passing timeout has occurred indicating this BIU is hunting for a new successor.
x	reserved (ignore)

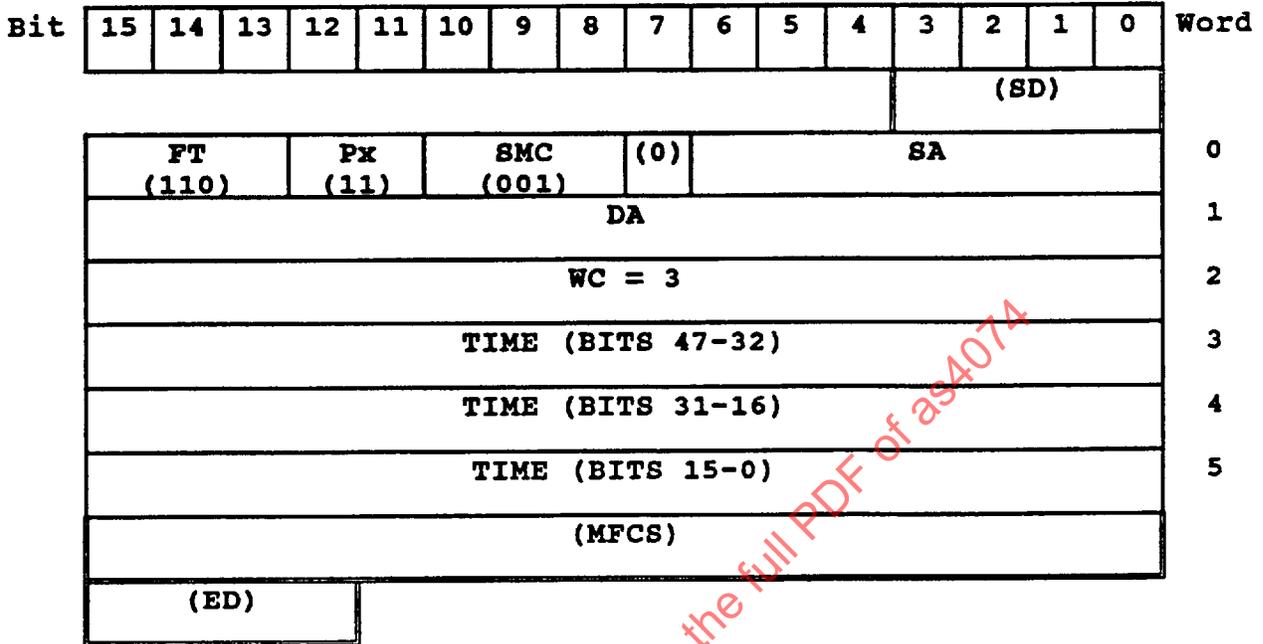
FIGURE 3.4.2.2.2-1 (Continued)

3.4.2.3 Time Report: The Time Report (111) message shall be sent to the physical DA of the requesting station (obtained from the SA field of the Load/Report Configuration message) and shall contain the current value of the reference timer. The reference timer value transmitted shall not differ by more than 3 μ s from the actual reference timer value at the time the message frame check sequence/ED boundary appears at the MIU transmitter port. The message subaddress shall be equivalent to that sent by the requesting station (obtained from the subaddress field of the Load/Report Configuration message). The Time Report message shall be formatted as shown in Figure 3.4.2.3-1.

3.4.3 Test Messages: Test Messages shall provide a method of verifying data paths throughout the system. The BIU actions with regard to test messages shall depend on the type of test message.

The overall format of the Test Message shall be as shown in Figure 3.4.3-1. Any priority level may be used as well as any data pattern in the INFO Field following the WC field. Two specific test messages are defined. The overall format of each shall be the same except for the SMC field. If the SMC field is 101 the test message shall be interpreted as a Loopback Test Message. It shall be sent on the bus by the source BIU. The destination BIU(s) shall accept this test message and return it to the source in the form of a Loopback Test Message Echo with SMC set to 100 (see 3.4.5.3).

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Field	Description
FT	Frame Type (110) - Station Management Message
Px	Priority (11) - Message Priority (level 3)
SMC	Station Management Code (111) - Status Report
SA	Source Address - Physical address of the source station.
DA	Destination Address - Physical address of destination station.
WC	Word Count (3) - The number of words following this field.
TIME	The 48-bit Global Clock value.
MFCS	Message Frame Check Sequence.

FIGURE 3.4.2.3-1 - Time Report Format