SDH Anomalies, Defects, Failures, and Alarms

The SDH frame structure has been designed to contain a large amount of overhead information. The overhead information provides for a variety of management and other functions such as:

- Alarm Indication Signals (AIS)
- Error Performance Monitoring using BIP-N
- Pointer Adjustment Information
- Path Status
- Path Trace
- Section Trace
- Remote Defect, Error, and Failure Indications
- Signal Labels
- New Data Flag Indications
- Data Communications Channels (DCC)
- Automatic Protection Switching (APS) Control
- Orderwire
- Synchronisation Status Message

Much of this overhead information is involved with alarm and in-service monitoring of the particular SDH sections. Table 8 and Figure 9, that follow the definitions, list the criteria for errors and the performance monitoring for errors.

Definitions

Alarm – The maintenance signal used in the digital network to alert downstream equipment that a defect or equipment failure has been detected.

Anomaly – The smallest discrepancy which can be observed between the actual and desired characteristics of an item. The occurrence of a single anomaly does not constitute an interruption in the ability to perform a required function. Examples of SDH anomalies are:

- B1 BIP
- B2 BIP
- Path B3 BIP
- REI
- Pattern Bit (OOS test)

Defect – The density of anomalies has reached a level where the ability to perform a required function has been interrupted. Defects are used as input for performance monitoring, the control of consequent actions, and the determination of fault cause. Examples of SDH Defects are:

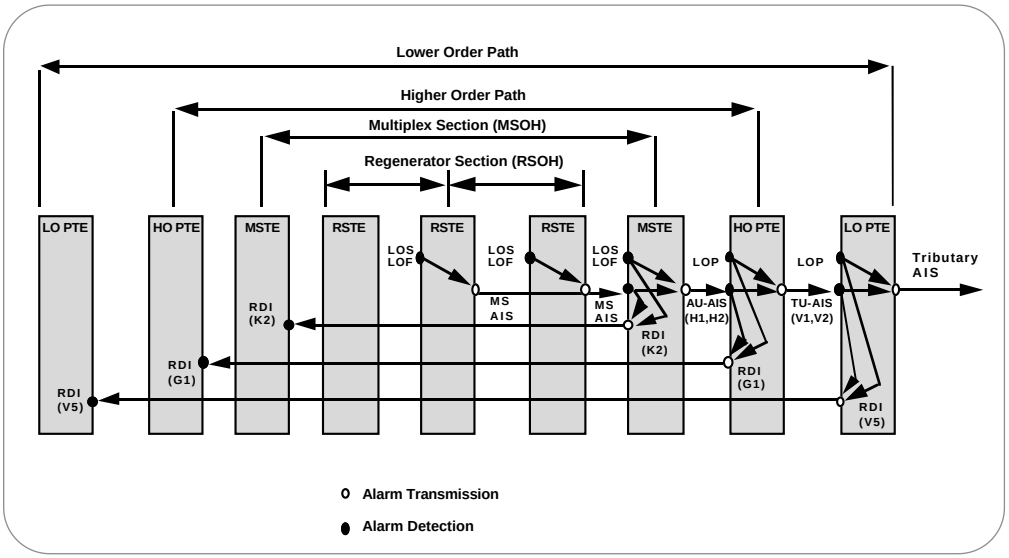
- OOF
- AIS
- RDI
- LOF
- LOP
- LOM

Failure – The inability of a function to perform a required action which has persisted beyond a maximum time allocated.

SDH Error Performance Monitoring

Error performance monitoring in the SDH is based on Bit-Interleaved-Parity (BIP) checks calculated on a frame-by-frame basis. These BIP checks are inserted in the Regenerator Section Overhead, Multiplex Section Overhead, and Path Overheads.

In addition, Higher-Order Path Terminating Equipment (HO PTE) and Lower-Order Path Terminating Equipment (LO PTE) produce Remote Error Indications (REI) based on errors detected in the HO Path and LO Path BIP respectively. The REI signals are sent back to the equipment at the originating end of a path. All defects listed in Figure 8 are described in Table 8.



► ***Figure 8.*** *Interaction between defects in forward and backward directions, according to the different SDH levels.*

Table 8. Anomalies, Defects, Failures, Alarms

Abbreviation	Description	Criteria
LOS	Loss of Signal	LOS is raised when the synchronous signal (STM-N) level drops below the threshold at which a BER of 1 in 10^3 is predicted. It could be due to a cut cable, excessive attenuation of the signal, or equipment fault. The LOS state will clear when two consecutive framing patterns are received and no new LOS condition is detected.
OOF	Out of Frame Alignment	OOF state occurs when several consecutive SDH frames are received with invalid (errored) framing patterns (A1 and A2 bytes). The maximum time to detect OOF is 625 microseconds. OOF state clears within 250 microseconds when two consecutive SDH frames are received with valid framing patterns.
LOF	Loss of Frame Alignment	LOF state occurs when the OOF state exists for a specified time in microseconds. The LOF state clears when an in-frame condition exists continuously for a specified time in microseconds. The time for detection and clearance is normally 3 milliseconds.
LOP	Loss of Pointer	LOP state occurs when N consecutive invalid pointers are received or N consecutive New Data Flags (NDF) are received (other than in a concatenation indicator), where N = 8, 9, or 10. LOP state is cleared when three equal valid pointers or three consecutive AIS indications are received. LOP can be identified as: • AU-LOP (Administrative Unit Loss of Pointer) • TU-LOP (Tributary Unit Loss of Pointer)
AIS	Alarm Indication Signal	AIS is an all-ONES characteristic or adapted information signal. It's generated to replace the normal traffic signal when it contains a defect condition in order to prevent consequential downstream failures being declared or alarms being raised. AIS can be identified as: • MS-AIS (Multiplex Section Alarm Indication Signal) • AU-AIS (Administrative Unit Alarm Indication Signal) • TU-AIS (Tributary Unit Alarm Indication Signal)
REI	Remote Error Indication	An indication returned to a transmitting node (source) that an errored block has been detected at the receiving node (sink). This indication was previously known as FEBE (Far End Block Error). REI can be identified as: • MS-REI (Multiplex Section Remote Error Indication) • HP-REI (Higher-order Path Remote Error Indication) • LP-REI (Lower-order Path Remote Error Indication)
RDI	Remote Defect Indication	A signal returned to the transmitting Terminating Equipment upon detecting a Loss of Signal, Loss of Frame, or AIS defect. RDI was previously known as FERF (Far End Receiver Failure). RDI can be identified as: • MS-RDI (Multiplex Section Remote Defect Indication) • HP-RDI (Higher-order Path Remote Defect Indication) • LP-RDI (Lower-order Path Remote Defect Indication)
RFI	Remote Failure Indication	A failure is a defect that persists beyond the maximum time allocated to the transmission system protection mechanisms. When this situation occurs, an RFI is sent to the far end and will initiate a path protection switch if this function has been provisioned. RFI can be identified as: • LP-RFI (Lower-order Path Remote Failure Indication)
B1 error	B1 error	Parity errors evaluated by byte B1 (BIP-8) of an STM-N shall be monitored. If any of the eight parity checks fail, the corresponding block is assumed to be in error.
B2 error	B2 error	Parity errors evaluated by byte B2 (BIP-24 x N) of an STM-N shall be monitored. If any of the N x 24 parity checks fail, the corresponding block is assumed to be in error.
B3 error	B3 error	Parity errors evaluated by byte B3 (BIP-8) of a VC-N (N = 3,4) shall be monitored. If any of the eight parity checks fail, the corresponding block is assumed to be in error.
BIP-2 error	BIP-2 error	Parity errors contained in bits 1 and 2 (BIP-2) of byte V5 of a VC-m (m=11,12,2) shall be monitored. If any of the two parity checks fail, the corresponding block is assumed to be in error.
LSS	Loss of Sequence Synchronisation	Out-of-service bit error measurements using pseudo-random sequences can only be performed if the reference sequence produced on the receiving side of the test set-up is correctly synchronised to the sequence coming from the object under test. In order to achieve compatible measurement results, it's necessary that the sequence synchronisation characteristics are specified. The following requirement is applicable to all ITU-T O.150 Recommendations dealing with error performance measurements using pseudo-random sequences. Sequence synchronisation shall be considered to be lost and re-synchronisation shall be started if: • The bit error ratio is ≥ 0.20 during an integration interval of 1 second; or • It can be unambiguously identified that the test sequence and the reference sequence are out of phase.