

# BERT

Bit-Error Rate Testing (BERT) is used for analyzing quality and for problem resolution of digital transmission equipment. BERT tests the quality of an interface by directly comparing a pseudorandom or repetitive test pattern with an identical locally generated test pattern.

The BERT operation is data-intensive. Regular data cannot flow on the path while the test is in progress. The path is reported to be in alarm state when BERT is in progress and restored to a normal state after BERT has been terminated.

BERT is supported in the following two directions:

- Line - Supports BERT in TDM direction.
- System - Supports BERT in PSN direction.


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# BERT Restrictions

- BERT is not supported on the following modes:
  - T3—Framing M-13, non-channelized
  - E3—Framing G832, channelized
- When the BERT is initiated with pattern 0s and 1s from the local end and the loopback local is applied from the far end, then the BERT syncing does not happen. Since the BERT process is asserted as LOS alarms for all 0s and AIS alarms for all 1s BERT patterns. Whereas the BERT syncing behaves properly when the BERT is initiated from both the local and the far end.

  For all 1s on T3 or E3, the BERT behaviour is not asserted as AIS and the BERT syncing happens as usual.
- In the unframed mode, BERT sync is not stable and may generate alarms until Cisco IOS XE Fuji 16.9.4.

**Note** Framing type should be similar in all routers end to end.

- System BERT is not supported for any pattern in framed SATOP for releases earlier to Cisco IOS XE 17.13.1.

  Starting with Cisco IOS XE 17.13.1, system BERT is supported for any pattern in the framed SAToP on T1/E1 interface module.

- System BERT is not configurable, without cem-group configuration.
- Path modes, unframed modes, and concatenation modes are not supported.
- The default BERT pattern supported is PRBS. The QRSS pattern is supported only on T1 or E1 level and the STS-1E path level for pattern 2^20-O151.

**BERT Restrictions for Cisco IOS XE Bengaluru 17.4.1 release**

- When the BERT is initiated from the local end and the loopback local is applied from the far end, then BERT syncing does not happen. Since the BERT process is asserted as LOS alarms for all 0s and AIS alarms for all 1s BERT patterns. Whereas the BERT syncing behaves properly when the BERT is initiated from both the local and the far end.

# BERT Patterns

The following topics explain BERT patterns supported:

## BERT Patterns on T1 or E1 Interface Module

Bit error rate testing (BERT) is supported on T1 or E1 interfaces. You can run BERT tests on 16 controllers out of 48T1 or E1 controllers at a time.

***Table 1: Feature History***

| Feature Name | Release Information | Description |
|---|---|---|
| Support for all 0s and 1s BERT Patterns | Cisco IOS XE Bengaluru 17.4.1 | Support for all 0s and 1s BERT patterns on T1 or E1 interfaces. |
| Support for 3-in-24 BERT Patterns | Cisco IOS XE Dublin 17.11.1 | Support for 3-in-24 BERT patterns on T1 or E1 interfaces. |

The BERT patterns on the 48-port T1 or E1 interface module are :

*Table 2: BERT Pattern Descriptions*

| Keyword | Description |
|---|---|
| **All 1s** [1] | Pseudo-random binary test pattern consisting of all 1's that is used to test alternating line volt and repeaters. |
| **All 0s** | Pseudo-random binary test pattern consisting of all 0's that is used for test line coding. |
| **2^15-1 O.151** | Pseudo-random O.151 test pattern consisting of a maximum of 14 consecutive zeros and 15 consecutive ones. The length of this pattern is 32,768 bits. |
| **2^20-O.151** | Pseudo-random O.151 test pattern consisting of a maximum of 19 consecutive zeros and 20 consecutive ones. The length of this pattern is 1,048,575 bits. |
| **2^20-O.153** | Pseudo-random O.153 test pattern consisting of a maximum of 19 consecutive zeros and 20 consecutive ones. The length of this pattern is 1,048,575 bits. |
| **2^23-1 O.151** | Pseudo-random 0.151 test pattern consisting of a maximum of 22 consecutive zeros and 23 consecutive ones. The length of this pattern is 8,388,607 bits. |
| **2^9** [2] | Pseudo-random binary test pattern consisting of a maximum of eight consecutive zeros and nine consecutive ones. The length of this pattern is 511 bits. |
| **2^11** [3] | Pseudo-random binary test pattern consisting of a maximum of ten consecutive zeros and eleven consecutive ones. The length of this pattern is 2048 bits. |
| **3-in-24** [4] | Pseudo-random binary test pattern consisting of repeating 24-bit sequence that contains three ones, fifteen consecutive zeros, and 12.5 percent average one's density. |

[1] Starting with Cisco IOS XE Bengaluru 17.4.1, All Is are supported.
[2] Starting with Cisco IOS XE Gibraltar 16.12.1, 2^9 is supported on the T1 mode.
[3] Starting with Cisco IOS XE Fuji 16.9.5, 2^11 is supported on the T1 mode.
[4] Starting with Cisco IOS XE Dublin 17.11.1, 3-in-24 pattern is supported on the T1 mode.

**Note** If All 1's BERT pattern is tested on the system side, then ensure that you need to start all 1's pattern from both sides of the end points.

Configuring BERT on one side and loopback on other side of the end points is not supported. The router treats all 1's pattern as AIS alarm and BERT will not come in sync with the other side configuration of the end point.

# BERT Patterns on T3/E3 Interface Module

Bit error rate testing (BERT) is supported on T3/E3 interfaces.

- You can run 16 BERTs at a time.
- The test can be either of the T1/E1 or the T3/E3 interface.

***Table 3: Feature History***

| Feature Name | Release Information | Description |
|---|---|---|
| Support for all 0s and 1s BERT Patterns | Cisco IOS XE Bengaluru 17.4.1 | Support for all 0s and 1s BERT patterns on T3 or E3 interfaces. |
| Support for 3-in-24 BERT Patterns | Cisco IOS XE Dublin 17.11.1 | Support for 3-in-24 BERT patterns on T3 or E3 interfaces. |

The BERT patterns on the 48-port T3/E3 interface module are:

***Table 4: BERT Pattern Descriptions***

| Keyword | Description |
|---|---|
| **All 1s** [5] | Pseudo-random binary test pattern consisting of all 1's that is used to test alternating line volt and repeaters. |
| **All 0s** | Pseudo-random binary test pattern consisting of all 0's that is used for test line coding. |
| **2^15-1 O.151** | Pseudo-random O.151 test pattern consisting of a maximum of 14 consecutive zeros and 15 consecutive ones. The length of this pattern is 32,768 bits. |
| **2^20-O.151** | Pseudo-random O.151 test pattern consisting of a maximum of 19 consecutive zeros and 20 consecutive ones. The length of this pattern is 1,048,575 bits. |
| **2^20-O.153** | Pseudo-random O.153 test pattern consisting of a maximum of 19 consecutive zeros and 20 consecutive ones. The length of this pattern is 1,048,575 bits. |
| **2^23-1 O.151** | Pseudo-random 0.151 test pattern consisting of a maximum of 22 consecutive zeros and 23 consecutive ones. The length of this pattern is 8,388,607 bits. |
| **2^9** [6] | Pseudo-random binary test pattern consisting of a maximum of eight consecutive zeros and nine consecutive ones. The length of this pattern is 511 bits. |

| Keyword | Description |
|---|---|
| **2^11** [7] | Pseudo-random binary test pattern consisting of a maximum of ten consecutive zeros and eleven consecutive ones. The length of this pattern is 2048 bits. |
| **3-in-24** [8] | Pseudo-random binary test pattern consisting of repeating 24-bit sequence that contains three ones, fifteen consecutive zeros, and 12.5 percent average one's density. |

[5] Starting with Cisco IOS XE Bengaluru 17.4.1, All Is are supported on all modes.
[6] Starting with Cisco IOS XE Gibraltar 16.12.1, 2^9 is supported on both T3 and T1 modes.
[7] Starting with Cisco IOS XE Fuji 16.9.5, 2^11 is supported on both T3 and T1 modes.
[8] Starting with Cisco IOS XE Dublin 17.11.1, 3-in-24 pattern is supported on the T1, T3, E1, and E3 modes.

**Note** If All 1's BERT pattern is tested on the system side, then ensure that you need to start all 1's pattern from both sides of the end points.

Configuring BERT on one side and loopback on other side of the end points is not supported. The router treats all 1's pattern as AIS alarm and BERT will not come in sync with the other side configuration of the end point.

# BERT Patterns on 1-Port OC-48 or 4-Port OC-12/OC-3 CEM Interface Module

*Table 5: Feature History*

| Feature Name | Release Information | Description |
|---|---|---|
| Support for all 0s and 1s BERT Patterns | Cisco IOS XE Bengaluru 17.4.1 | Support for all 0s and 1s BERT patterns for SONET and SDH. |
| Support for 3-in-24 BERT Patterns | Cisco IOS XE Dublin 17.11.1 | Support for 3-in-24 BERT patterns for SONET and SDH. |

The BERT patterns on the 1-Port OC-48 or 4-Port OC-12/OC-3 interface module are:

*Table 6: BERT Pattern Descriptions*

| Keyword | Description |
|---|---|
| **All 1s** [9] | Pseudo-random binary test pattern consisting of all 1's that is used to test alternating line volt and repeaters. |
| **All 0s** | Pseudo-random binary test pattern consisting of all 0's that is used for test line coding. |

| Keyword | Description |
|---|---|
| **2^15-1 O.151** | Pseudo-random O.151 test pattern consisting of a maximum of 14 consecutive zeros and 15 consecutive ones. The length of this pattern is 32,768 bits. |
| **2^20-O.151** | Pseudo-random O.151 test pattern consisting of a maximum of 19 consecutive zeros and 20 consecutive ones. The length of this pattern is 1,048,575 bits. |
| **2^20-O.153** | Pseudo-random O.153 test pattern consisting of a maximum of 19 consecutive zeros and 20 consecutive ones. The length of this pattern is 1,048,575 bits. |
| **2^23-1 O.151** | Pseudo-random 0.151 test pattern consisting of a maximum of 22 consecutive zeros and 23 consecutive ones. The length of this pattern is 8,388,607 bits. |
| **2^9** [10] | Pseudo-random binary test pattern consisting of a maximum of eight consecutive zeros and nine consecutive ones. The length of this pattern is 511 bits. |
| **2^11** [11] | Pseudo-random binary test pattern consisting of a maximum of ten consecutive zeros and eleven consecutive ones. The length of this pattern is 2048 bits. |
| **3-in-24** [12] | Pseudo-random binary test pattern consisting of repeating 24-bit sequence that contains three ones, fifteen consecutive zeros, and 12.5 percent average one's density. |

[9] All 1s are supported only on SONET CT3, SDH AU-3 - CT3/CE3 - T1/E1, and SDH AU-3 - VC3. Starting with Cisco IOS XE Bengaluru 17.4.1, All Is are supported on all modes.

[10] Starting with Cisco IOS XE Bengaluru 17.4.1, 2^9 mode is supported.

2^9 is not supported on the following modes:

- SONET—Unframed, STS-3c, STS-12c, and STS-48c.
- SDH AU-4—VC4, TUG-3-VC3, TUG-3-E3, TUG-3-T3, and TUG-3 - VC1x.
- SDH AU-3—VC3, VC4-4c, VC4-16c, and VC1x.

[11] Starting with Cisco IOS XE Bengaluru 17.4.1, 2^11 mode is supported.

2^11 is not supported on the following modes:

- SONET—Unframed, STS-3c, STS-12c, and STS-48c.
- SDH AU-4—VC4 and TUG-3-VC3.
- SDH AU-3—VC3, VC4-4c, and VC4-16c.

[12] Starting with Cisco IOS XE Dublin 17.11.1, 3-in-24 pattern is supported on the T3, E3, T1, E1, and VT or VC modes.

**Note** If All 1's BERT pattern is tested on the system side, then ensure that you need to start all 1's pattern from both sides of the end points.

Configuring BERT on one side and loopback on other side of the end points is not supported. The router treats all 1's pattern as AIS alarm and BERT will not come in sync with the other side configuration of the end point.

# BERT Patterns on 1-Port OC-192 or 8-Port Low Rate CEM Interface Module

*Table 7: Feature History*

| Feature Name | Release Information | Description |
|---|---|---|
| Support for all 0s and 1s BERT Patterns | Cisco IOS XE Bengaluru 17.4.1 | Support for all 0s and 1s BERT patterns for SONET and SDH. |

The BERT patterns on the 1-Port OC-192 or 8-Port Low Rate CEM interface module are:

*Table 8: BERT Pattern Descriptions*

| Keyword | Description |
|---|---|
| **All 0s** | Pseudo-random binary test pattern consisting of all 0's that is used for test line coding. |
| **All 1s** [13] | Pseudo-random binary test pattern consisting of all 1's that is used to test alternating line volt and repeaters. |
| **2^15-1 O.151** | Pseudo-random O.151 test pattern consisting of a maximum of 14 consecutive zeros and 15 consecutive ones. The length of this pattern is 32,768 bits. |
| **2^20-O.151** | Pseudo-random O.151 test pattern consisting of a maximum of 19 consecutive zeros and 20 consecutive ones. The length of this pattern is 1,048,575 bits. |
| **2^20-O.153** | Pseudo-random O.153 test pattern consisting of a maximum of 19 consecutive zeros and 20 consecutive ones. The length of this pattern is 1,048,575 bits. |
| **2^23-1 O.151** | Pseudo-random 0.151 test pattern consisting of a maximum of 22 consecutive zeros and 23 consecutive ones. The length of this pattern is 8,388,607 bits. |
| **2^9-1** [14] | Pseudo-random binary test pattern consisting of a maximum of eight consecutive zeros and nine consecutive ones. The length of this pattern is 511 bits. |

| Keyword | Description |
|---|---|
| **2^11-1**<br>15 | Pseudo-random binary test pattern consisting of a maximum of ten consecutive zeros and eleven consecutive ones. The length of this pattern is 2048 bits. |

[13] All 1s are supported only on SONET CT3, SDH AU-3 - CT3/CE3 - T1/E1, and SDH AU-3 - VC3. Starting with Cisco IOS XE Bengaluru 17.4.1, All Is are supported on all modes.

[14] Starting with Cisco IOS XE Bengaluru 17.4.1, 2^9 mode is supported.

2^9 is not supported on the following modes:

- SONET—Unframed, STS-3c, STS-12c, and STS-48c.
- SDH AU-4—VC4, TUG-3-VC3, TUG-3-E3, TUG-3-T3, and TUG-3 - VC1x.
- SDH AU-3—VC3, VC4-4c, VC4-16c, and VC1x.

[15] Starting with Cisco IOS XE Bengaluru 17.4.1, 2^11 mode is supported.

2^11 is not supported on the following modes:

- SONET—Unframed, STS-3c, STS-12c, and STS-48c.
- SDH AU-4—VC4 and TUG-3-VC3.
- SDH AU-3—VC3, VC4-4c, and VC4-16c.

**Note** If All 1's BERT pattern is tested on the system side, then ensure that you need to start all 1's pattern from both sides of the end points.

Configuring BERT on one side and loopback on other side of the end points is not supported. The router treats all 1's pattern as AIS alarm and BERT will not come in sync with the other side configuration of the end point.

# BERT Patterns on STS-1 Mode

***Table 9: Feature History***

| Feature Name | Release Information | Description |
|---|---|---|
| Support for 3-in-24 BERT Patterns | Cisco IOS XE Dublin 17.11.1 | Support for 3-in-24 BERT patterns on the STS-1 mode. |

The BERT patterns on the STS-1 mode are:

*Table 10: BERT Pattern Descriptions*

| Keyword | Description |
|---|---|
| **All 1s** [16] | Pseudo-random binary test pattern consisting of all 1's that is used to test alternating line volt and repeaters. |
| **All 0s** [17] | Pseudo-random binary test pattern consisting of all 0's that is used for test line coding. |
| **2^15-1 O.151** | Pseudo-random O.151 test pattern consisting of a maximum of 14 consecutive zeros and 15 consecutive ones. The length of this pattern is 32,768 bits. |
| **2^20-O.151** | Pseudo-random O.151 test pattern consisting of a maximum of 19 consecutive zeros and 20 consecutive ones. The length of this pattern is 1,048,575 bits. |
| **2^20-O.153** | Pseudo-random O.153 test pattern consisting of a maximum of 19 consecutive zeros and 20 consecutive ones. The length of this pattern is 1,048,575 bits. |
| **2^23-1 O.151** | Pseudo-random 0.151 test pattern consisting of a maximum of 22 consecutive zeros and 23 consecutive ones. The length of this pattern is 8,388,607 bits. |
| **2^9** [18] | Pseudo-random binary test pattern consisting of a maximum of eight consecutive zeros and nine consecutive ones. The length of this pattern is 511 bits. |
| **2^11** [19] | Pseudo-random binary test pattern consisting of a maximum of ten consecutive zeros and eleven consecutive ones. The length of this pattern is 2048 bits. |
| **3-in-24** [20] | Pseudo-random binary test pattern consisting of repeating 24-bit sequence that contains three ones, fifteen consecutive zeros, and 12.5 percent average one's density. |

16 All 1s are supported only on STS-1 CT3. Starting with Cisco IOS XE Bengaluru 17.4.1, All Is are supported on all modes.
17 Starting with Cisco IOS XE Bengaluru 17.4.1, All 0s are supported on all modes.
18 2^9 is not supported on STS-1 mode unframed, STS-1 CT3 and STS-1 VT-15.
19 2^11 not supported on STS-1 mode unframed.
20 Starting with Cisco IOS XE Dublin 17.11.1, 3-in-24 pattern is supported on the T3, E3, T1, E1, and VT modes.

**Note** If All 1's BERT pattern is tested on the system side, then ensure that you need to start all 1's pattern from both sides of the end points.

Configuring BERT on one side and loopback on other side of the end points is not supported. The router treats all 1's pattern as AIS alarm and BERT will not come in sync with the other side configuration of the end point.

# How to Configure BERT

## Configuring BERT in Modes VC-4 and VC Nc

To configure BERT in modes VC-4 and VC Nc:

```
configure terminal
controller sdh 0/0/16
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
mode vc4
clock source internal
bert pattern 2^15 internal 10 direction [line | system]
```

### Verifying BERT Configuration in Modes VC-4 and VC Nc

Use **show controllers** command to verify BERT Configuration in Modes VC-4 and VC Nc:

```
#show controller sdh 0/0/16 | sec BERT
BERT test result (running)Test Pattern : 2^15,
Status : Sync, Sync Detected : 0Interval : 10 minute(s),
Time Remain : 00:09:47
Bit Errors (since BERT started): 0 Mbits,Bits Received (since BERT started): 0 Mbits
Bit Errors (since last sync): 1943 bits
Bits Received (since last sync): 1943 Kbits
Direction : LineRouter#
```

## Configuring E1 Bert

To configure E1 Bert:

```
enable
configure terminal
controller MediaType 0/0/16
mode sdh
controller sdh 0/0/16
rate stm4
au-3 1
mode vc1x
tug-2 1 payload vc12
e1 1 bert pattern 2^11 interval 10
end
```

# Configuring T1 Bert

To configure T1 Bert:

```
enable
configure terminal
controller sdh 0/0/16
rate stm4
au-3 1
mode vc1x
tug-2 1 payload vc11
t1 1 bert pattern 2^11 interval 10
end
```

# Configuring BERT in Mode T3/E3

To configure BERT in Mode T3/E3 for both AUG mapping AU-3 and AU-4:

```
configure terminal
controller sdh 0/0/16
rate STM1
no ais-shut
alarm-report all
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
mode tug-3
clock source internal
tug-3 1
mode t3
threshold b3-tca 0
overhead c2 0
t3 clock source internal
t3 bert pattern 2^15 internal 10 direction [line | system]
```

## Verifying BERT Configuration in Mode T3 or E3

Use **show controllers** command to verify BERT configuration in mode T3 or E3:

```
show controller sdh 0/0/16 | sec BERT
BERT test result (running)Test Pattern : 2^15,
Status : Sync, Sync Detected : 0Interval : 10 minute(s),
Time Remain : 00:09:47
Bit Errors (since BERT started): 0 Mbits,
Bits Received (since BERT started): 0 Mbits
Bit Errors (since last sync): 1943 bits
Bits Received (since last sync): 1943 Kbits
Direction : Line
```

# Configuring BERT in Mode VC-1x

To configure BERT in mode VC-1x for both AUG mapping AU-3 and AU-4:

```
configure terminal
controller sdh 0/0/16
rate STM1
no ais-shut
alarm-report all
```

```
clock source internal
overhead s1s0 0
aug mapping au-4
au-4 1
mode tug-3
clock source internal
tug-3 1
mode vc-1x
tug-2 1 payload VC11
vc 1 bert pattern 2^15 internal 10 direction [line | system]
```

## Verifying BERT Configuration in Mode VC-1x

Use **show controllers** command to verify BERT configuration in mode VC-1x:

```
#show controller sdh 0/0/16 | sec BERT
BERT test result (running)Test Pattern : 2^15,
Status : Sync, Sync Detected : 0Interval : 10 minute(s),
Time Remain : 00:09:47Bit Errors (since BERT started): 0 Mbits,Bits Received (since BERT
started): 0 Mbits
Bit Errors (since last sync): 1943 bits
Bits Received (since last sync): 1943 Kbits
Direction : Line
```

# System CESoP NxDS0 BERT

*Table 11: Feature History*

| Feature Name | Release Information | Description |
|---|---|---|
| System CESoP NxDS0 BERT | Cisco IOS XE Dublin 17.11.1 | You can configure BERT patterns at the DS0 level on the following interface modules for both the system and line directions.<br>• 48-Port T1 or E1 CEM interface module<br>• 48-Port T3 or E3 CEM interface module<br>• 1-port OC-48/STM-16 or 4-port OC-12/OC-3 / STM-1/STM-4 + 12-port T1/E1 + 4-port T3/E3 CEM interface module<br>• ASR 900 Combo 8-port SFP GE and 1-port 10 GE 20G interface module<br>You can configure speed with bandwidth of 56 kbps or 64 kbps along with the BERT pattern.<br>With DS0 level BERT configuration, you can verify the end-to-end connectivity. |

CESoP NxDS0 BERT enables you to configure BERT patterns at the DS0 level under CEM circuits and verify if the traffic is stable along with the configured BERT pattern.

Ensure that both sides should have the same mode configured along with the same BERT pattern with the same speed. For example, in a network where CE is connected to PE through an OCx line or PE1 is connected PE2, ensure that both CE and PE or PE1 and PE2 should have the same mode configured along with the same BERT pattern and same speed. Ensure that when you configure the DS0 BERT pattern, you should configure the speed with the bandwidth of 56 kbps or 64 kbps.

You can configure BERT in the system and line direction with speed on the following controller modes:

- T1 or E1
- T3 or E3 (channelized T1 or E1)
- SONET—CT3, CT3-E1, or VT-15
- SDH—On AU-3 or AU-4, VC-1x (VC-11 or VC-12), CT3-E1 mode

The following example shows that the line BERT is configured with a speed of 64kbps on the SONET controller:

**vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction line speed 64kbps**

# Restrictions for System CESoP NxDS0 BERT

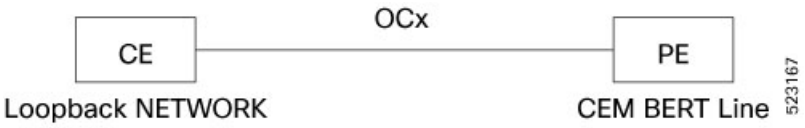
- You should configure CESoP BERT at the DS0 level with timeslots and speed.
- Channel Associated Signaling (CAS) is not supported.
- You can configure a total of 16 BERTs at a time for an interface module.

# Configuring System CESoP NxDS0 BERT

### Scenario 1 - Configuring System CESoP NxDS0 BERT on PE Side

Consider a scenario, where CE is connected to PE through an OCx line. Network loopback is configured on CE and system CESoP NxDS0 BERT in line direction and speed of 64 kbps is configured on PE. Verify the BERT pattern and speed configured on PE. The BERT should be in sync.

***Figure 1: Configuring System CESoP NxDS0 BERT on PE***




**Configuring SONET Controller on CE**

```
controller SONET 0/10/1
 no snmp trap link-status
 rate OC3
 no ais-shut
 alarm-report all
 clock source internal
 !
 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 cem-group 0 timeslots 1
 !
 sts-1 2
  clock source internal
  !
 sts-1 3
  clock source internal

interface CEM0/10/1
no ip address
cem 0
end
```

**Configuring Network Loopback on CE**

```
enable
configure terminal
controller sonet 0/10/1
loopback network
end
```

### Configuring SONET Controller on PE

```
controller SONET 0/5/1
 no snmp trap link-status
 rate OC3
 no ais-shut
 alarm-report all
 clock source internal
 !
 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 cem-group 0 timeslots 1
 !
 sts-1 2
  clock source internal
  !
 sts-1 3
  clock source internal

interface CEM0/5/1
 no ip address
 cem 0
```

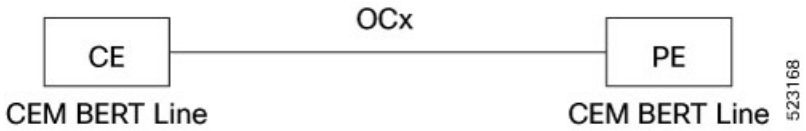
### Configuring BERT Pattern with line direction and speed as 64kbps on PE

```
PE(config)#controller sonet 0/5/1
PE(config)#sts-1 1
PE(config-ctrlr-sts1)# vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction line
 speed 64kbps
PE(config-ctrlr-sts1)#end
```

## Scenario 2 - Configuring Line BERT on CE and PE

Consider a scenario, where CE is connected to PE through an OCx line. BERT with line direction and speed of 64 kbps is configured on both CE and PE. Verify the BERT pattern and speed configured on both CE and PE. The BERT should be in sync.

***Figure 2: Configuring Line BERT on CE and PE***




### Configuring SONET Controller on CE

```
controller SONET 0/10/1
 no snmp trap link-status
 rate OC3
 no ais-shut
 alarm-report all
 clock source internal
```

```
 !
 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 cem-group 0 timeslots 1
 !
 sts-1 2
  clock source internal
  !
 sts-1 3
  clock source internal

interface CEM0/10/1
no ip address
cem 0
end
```

### Configuring BERT Pattern with line direction and speed as 64 kbps on CE

```
PE(config)#controller sonet 0/5/1
PE(config)#sts-1 1
PE(config-ctrlr-sts1)#vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction line
 speed 64kbps
PE(config-ctrlr-sts1)#end
```

### Configuring SONET Controller on PE

```
controller SONET 0/5/1
 no snmp trap link-status
 rate OC3
 no ais-shut
 alarm-report all
 clock source internal
 !
 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 cem-group 0 timeslots 1
 !
 sts-1 2
  clock source internal
  !
 sts-1 3
  clock source internal

interface CEM0/5/1
 no ip address
 cem 0
```

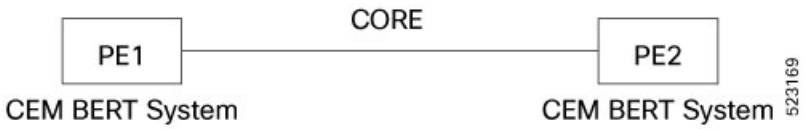
### Configuring BERT Pattern with Line Direction and Speed of 64 kbps on PE

```
PE(config)#controller sonet 0/5/1
PE(config)#sts-1 1
PE(config-ctrlr-sts1)#vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction line
 speed 64kbps
PE(config-ctrlr-sts1)#end
```

### Scenario 3 - Configuring System CESoP NxDS0 BERT with System Direction on PE1 and PE2

Consider a scenario, where PE1 is connected to PE2 through a CORE Gigabit Ethernet line. System CESoP NxDS0 BERT with system direction and speed of 56 kbps is configured on both PE1 and PE2. Verify the BERT pattern and speed configured on both PE1 and PE2. The BERT should be in sync.

*Figure 3: Configuring System CESoP NxDS0 BERT with System Direction on PE1 and PE2*




Ensure that you perform the following steps:

1. The core should be UP between PEs and the cross connection should be UP.
2. Configure SONET modes on PEs.
3. Configure BERT on PEs.

### Configuring SONET Controller on PE1

```
controller SONET 0/10/1
 no snmp trap link-status
 rate OC3
 no ais-shut
 alarm-report all
 clock source internal
 !
 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 cem-group 0 timeslots 1
 !
 sts-1 2
  clock source internal
  !
 sts-1 3
  clock source internal

interface CEM0/10/1
no ip address
cem 0
end
```

### Configuring BERT Pattern with Line Direction and Speed as 56 kbps on PE1

```
PE(config)#controller sonet 0/5/1
PE(config)#sts-1 1
PE(config-ctrlr-sts1)# vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction
system speed 56kbps
PE(config-ctrlr-sts1)#end
```

### Configuring SONET Controller on PE2

```
controller SONET 0/5/1
 no snmp trap link-status
 rate OC3
 no ais-shut
```

```
 alarm-report all
 clock source internal
 !
 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 cem-group 0 timeslots 1
 !
 sts-1 2
  clock source internal
  !
 sts-1 3
  clock source internal

interface CEM0/5/1
 no ip address
 cem 0
```

### Configuring BERT Pattern with Line Direction and Speed of 56 kbps on PE2

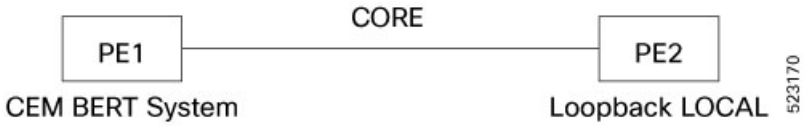
```
PE(config)#controller sonet 0/5/1
PE(config)#sts-1 1
PE(config-ctrlr-sts1)# vtg 1 t1 1 bert timeslots 1 pattern 2^15 interval 100 direction
system speed 56kbps
PE(config-ctrlr-sts1)#end
```

## Sample Scenarios

Similarly, the following are sample scenarios where you can configure system CESoP NxDS0 BERT.

### Sample Scenario - 1

***Figure 4: Configuring System CESoP NxDS0 BERT with System Direction on PE1 and Loopback as Local on PE2***




1. The core should be UP between PEs and the cross connection should be UP.
2. Configure SONET modes on PE1 and PE2s.
3. Configure system CESoP NxDS0 BERT with system direction and speed on PE1 and loopback as local on PE2.

Verify the BERT pattern and speed configured on both the PE1 and PE2. The BERT should be in sync.

### Sample Scenario - 2

***Figure 5: Configuring System CESoP NxDS0 BERT with System Direction and Speed on PE1 and Loopback as Network on CE2***




1. The core should be UP between PEs and the cross connection should be UP between PE2 and CE2.
2. Configure SONET modes on PE1 and CE2.

3. Configure system CESoP NxDS0 BERT with system direction and speed on PE1.
4. Configure loopback as network on CE2.

Verify the BERT pattern and speed configured on both the PE1 and CE2. The BERT should be in sync.

**Sample Scenario - 3**

***Figure 6: Configuring System CESoP NxDS0 BERT with System Direction on PE1 and Line BERT CE2***




1. The core should be UP between PEs and the cross connection should be UP between PE2 and CE2.
2. Configure SONET modes on PE1 and CE2.
3. Configure system CESoP NxDS0 BERT with system direction and speed on PE1.
4. Configure line BERT on CE2.

Verify the BERT pattern and speed configured on both the PE1 and CE2. The BERT should be in sync.

# Verifying System CESoP NxDS0 BERT

The following **show** commands enable you to verify the system CESoP NxDS0 BERT configuration:

- **show controllers t1 bay/slot/port**
- **show controller <controller-type> bay/slot/port | section BERT**

```
PE1#show controller sonet 0/10/1 | sec BERT
  BERT running on timeslots 1,
  BERT test result (running)
     Test Pattern : 2^15, Status : Sync, Sync Detected : 0
     Interval : 100 minute(s), Time Remain : 01:30:52
     Bit Errors (since BERT started): 35 Mbits,
     Bits Received (since BERT started): 2047290 Mbits
     Bit Errors (since last sync): 35 Mbits
     Bits Received (since last sync): 2047290 Kbits
     Direction   : Line
     Speed   : 64kbps
```

```
CE#show controller sonet 0/5/1 | sec BERT
  BERT running on timeslots 1,
  BERT test result (running)
     Test Pattern : 2^15, Status : Sync, Sync Detected : 0
     Interval : 100 minute(s), Time Remain : 01:30:52
     Bit Errors (since BERT started): 35 Mbits,
     Bits Received (since BERT started): 2047290 Mbits
     Bit Errors (since last sync): 35 Mbits
     Bits Received (since last sync): 2047290 Kbits
     Direction   : system
     Speed   : 64kbps
```

# BERT Error Injection

*Table 12: Feature History*

| Feature Name | Release Information | Description |
|---|---|---|
| BERT Error Injection | Cisco IOS XE Bengaluru 17.4.1 | BERT Error injection enables you to inject errors into the BERT stream on SONET and SDH controllers. You can introduce BERT errors in a range of 1 to 255. |

This feature enables you to inject a fixed number of BERT errors when a BERT pattern is running and check the same number of BERT errors to be received at the remote end. Starting with Cisco IOS XE Bengaluru 17.4.1 release, you can configure BERT error injection using the **bert errors** *count of errors* command and before configuring the errors, you must use the **bert pattern** command.

BERT Error Injection is supported on T1 and T3 for SONET and SDH controllers.

BERT Error Injection is supported in the following modes:

*Table 13: Supported Modes for BERT Error Injection*

| Controller | Mode |
|---|---|
| SONET | • STS-1 T3<br>• STS-1 CT3<br>• VT-15 – T1<br>• VT-15 – VT |
| SDH | • AU-3 - CE3<br>• AU3 - CT3<br>• AU3 - E3<br>• AU3 - T3<br>• AU3 - VC1X<br>• AU4 - VC3<br>• AU4 -Tug-3 E3<br>• AU4 -Tug-3 VC1x<br>• AU4 -Tug-3 T3 |

# Prerequisites of BERT Error Injection

- Ensure that you have set up BERT engine before injecting BERT Errors.

# Restrictions of BERT Error Injection

- The BERT Error Injection once configured cannot be removed.
- BERT Error Injection is not supported on the SONET unframed mode.
- A maximum of 16 BERT engines are supported per LOTR card.
- You can configure a maximum of 255 BERT Error counts on the IM.
- BERT Error Injection is **not** supported on the following modes:
  - SONET: Unframed, STS-3C, STS-12C, STS-48C
  - SDH: VC4-4C, VC4-16C, AU3-V3, AU4-VC4

# Configuring BERT Error Injection for SONET

### Configuring BERT Error Injection - STS-1 T3 Mode

Ensure that you configure the STS-1 and T3 mode followed by BERT Pattern on the SONET STS-1 T3 interface.

To configure BERT Error Injection for the STS-1 mode on the T3 interface, enter the following commands:

```
config terminal
Enter configuration commands, one per line. End with CNTL/Z.
PE1(config)#controller sonet 0/4/0
PE1(config-controller)#sts-1 1
PE1(config-ctrlr-sts1)#t3 bert errors 255
Router#(config-ctrlr-sts1)#end
```

### Configuring BERT Error Injection - STS-1 CT3 Mode

Ensure that you configure the STS-1 and CT3 mode followed by BERT Pattern on the SONET STS-1 CT3 interface

To configure BERT Error Injection for the STS-1 CT3 mode, enter the following commands:

```
Router#(config)#controller sonet 0/4/0
Router#(config-controller)#sts-1 1
Router#(config-ctrlr-sts1)#t1 1 bert errors 255
Router#(config-ctrlr-sts1)#end
```

### Configuring BERT Error Injection - VT-15 – T1 Mode

Ensure that you configure the STS-1 VT-15 and T1 modes followed by BERT Pattern on the SONET VT-15 T1 interface.

To configure BERT Error Injection for the STS-1 VT-15 and T1 modes, enter the following commands:

```
Enter configuration commands, one per line. End with CNTL/Z.
Router# (config)#controller sonet 0/4/0
Router# (config-controller)#sts-1 1
Router# (config-ctrlr-sts1)#vtg 1 t1 1 bert errors 255
Router# (config-ctrlr-sts1)#end
```

### Configuring BERT Error Injection - VT-15 – VT Mode

: Ensure that you configure the STS-1 VT-15 and VT modes followed by BERT Pattern on the SONET VT-15 VT modes.

To configure BERT Error Injection for the STS-1 VT-15 and VT modes, enter the following commands

```
config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router#(config)#controller sonet 0/4/0
Router#(config-controller)#sts-1 1
Router#(config-ctrlr-sts1)#vtg 1 vt 1 bert errors 255
Router#(config-ctrlr-sts1)#end
```

## Verifying BERT Error Injection for SONET

### Verifying BERT Error Injection – STS-1 T3 Mode

To verify BERT Error Injection for the STS-1 mode on the T3 interface, use the **show-controller SONET | sec BERT** command;

```
Router# show controller sonet 0/4/0 | sec BERT
BERT test result (running)
Test Pattern : All 0's, Status : Sync, Sync Detected : 1
DSX3 BERT direction : Line
Interval : 60 minute(s), Time Remain : 00:59:00
Bit Errors (since BERT started): 255 bits,
Bits Received (since BERT started): 2697 Mbits
Bit Errors (since last sync): 255 bits
Bits Received (since last sync): 2697 Mbits
Direction    : Line
```

### Verifying BERT Error Injection – STS-1 CT3 Mode

To verify BERT Error Injection for the STS-1 mode and CT3 mode, use the **show-controller SONET | sec BERT** command:

```
Router#
show controller sonet 0/4/0 | sec BERT
BERT test result (running)
Test Pattern : All 0's, Status : Sync, Sync Detected : 1
Interval : 60 minute(s), Time Remain : 00:59:01
Bit Errors (since BERT started): 255 bits,
Bits Received (since BERT started): 89 Mbits
Bit Errors (since last sync): 255 bits
Bits Received (since last sync): 89 Mbits
Direction : Line
```

### Verifying BERT Error Injection – STS-1 VT-15 and T1 Modes

To verify BERT Error Injection for the STS-1 VT-15 and T1 modes, use the **show-controller SONET | sec BERT** command:

```
Router#
show controller sonet 0/4/0 | sec BERT
```

```
BERT running on timeslots 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,
BERT test result (running)
Test Pattern : All 0's, Status : Sync, Sync Detected : 1
Interval : 60 minute(s), Time Remain : 00:58:59
Bit Errors (since BERT started): 255 bits,
Bits Received (since BERT started): 92 Mbits
Bit Errors (since last sync): 255 bits
Bits Received (since last sync): 92 Mbits
Direction : Line
```

### Verifying BERT Error Injection – STS-1 VT-15 and VT Modes

To verify BERT Error Injection for the STS-1 VT-15 and VT modes, use the **show-controller SONET | sec BERT** command:

```
Router#
show controller sonet 0/4/0 | sec BERT
BERT test result (running)
Test Pattern : All 0's, Status : Sync, Sync Detected : 1
Interval : 60 minute(s), Time Remain : 00:59:00
Bit Errors (since BERT started): 255 bits,
Bits Received (since BERT started): 94 Mbits
Bit Errors (since last sync): 255 bits
Bits Received (since last sync): 94 Mbits
Direction : Line
```

# Configuring BERT Error Injection for SDH

### Configuring BERT Error Injection – CT3-T1-AU3 Mode

Ensure that you configure the CT3-T1-AU-3 mode followed by BERT Pattern on the SDH AU-3-T1 interface.

To configure BERT Error Injection for the CT3-T1-AU3 Mode, enter the following commands:

```
config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router#(config)#controller sdh 0/4/0
Router#(config-controller)#au-3 1
Router#(config-ctrlr-au3)#t1 1 bert errors 255
Router#(config-ctrlr-au3)#end
```

### Configuring BERT Error Injection – E3-AU-3 Mode

Ensure that you configure the E3-AU-3 mode followed by BERT Pattern on the SDH E3-AU-3 interface

To configure BERT Error Injection for the E3-AU-3 Mode, enter the following commands:

```
config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router#(config)#controller sdh 0/4/0
Router#(config-controller)#au-3 1
Router#(config-ctrlr-au3)#e3 bert errors 255
Router#(config-ctrlr-au3)#end
```

### Configuring BERT Error Injection – T3-AU-3 Mode

Ensure that you configure the T3-AU3 mode followed by BERT Pattern on the SDH T3-AU-3 interface.

To configure BERT Error Injection for the T3-AU-3 Mode, enter the following commands:

```
Router# config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router#(config)#controller sdh 0/4/0
Router#(config-controller)#au-3 1
Router#(config-ctrlr-au3)#t3 bert errors 255
Router#(config-ctrlr-au3)#end
```

# Verifying BERT Error Injection for SDH

### Verifying BERT Error Injection – CT3-T1-AU3 Mode

To verify BERT Error Injection for the CT3-T1-AU3 Mode, use the **show-controller SDH | sec BERT** command

```
Router#
show controller sdh 0/4/0 | sec BERT
BERT test result (running)
Test Pattern : All 0's, Status : Sync, Sync Detected : 1
Interval : 60 minute(s), Time Remain : 00:59:00
Bit Errors (since BERT started): 255 bits,
Bits Received (since BERT started): 90 Mbits
Bit Errors (since last sync): 255 bits
Bits Received (since last sync): 90 Mbits
Direction : Line
```

### Verifying BERT Error Injection – E3-AU-3 Mode

To verify BERT Error Injection for the E3-AU-3 Mode, use the **show-controller SDH | sec BERT** command:

```
Router# show controller sdh 0/4/0 | sec BERT
BERT test result (running)
Test Pattern : All 0's, Status : Sync, Sync Detected : 1
DSX3 BERT direction : Line
Interval : 60 minute(s), Time Remain : 00:59:00
Bit Errors (since BERT started): 255 bits,
Bits Received (since BERT started): 2046 Mbits
Bit Errors (since last sync): 255 bits
Bits Received (since last sync): 2046 Mbits
```

### Verifying BERT Error Injection – T3-AU-3 Mode

To verify BERT Error Injection for the T3-AU-3 Mode, use the **show-controller SDH | sec BERT** command:

```
Router# Show controller sdh 0/4/0 | sec BERT
BERT test result (running)
Test Pattern : All 0's, Status : Sync, Sync Detected : 1
DSX3 BERT direction : Line
Interval : 60 minute(s), Time Remain : 00:59:30
Bit Errors (since BERT started): 255 bits,
Bits Received (since BERT started): 1282 Mbits
Bit Errors (since last sync): 255 bits
Bits Received (since last sync): 1282 Mbits
```