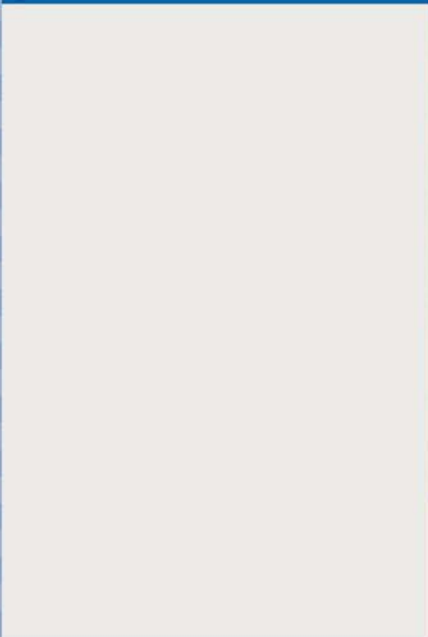


Experience the power of one  
Ubigate iBG3026™



# System Description



The purposes of Safety Concerns are to ensure user's safety and to prevent property losses.  
Please read this document carefully for proper use.

## **COPYRIGHT**

This manual is proprietary to SAMSUNG Electronics Co., Ltd., and is protected by copyright.

No information contained herein may be copied, translated, transcribed, or duplicated for any commercial purposes or disclosed to third parties in any form without the prior written consent of SAMSUNG Electronics Co., Ltd.

## **TRADEMARKS**

Ubigate iBG3026 is a registered trademark of SAMSUNG Electronics.

All other company and product names may be trademarks of their respective owners.

**This manual should be read before the installation and operation, and the operator should correctly install and operate the product by using this manual.**

This description may be changed for the system improvement, standardization and other technical reasons without prior notice.

For further information on the updated manual or have a question for the content of manual, contact the homepage below.

**Homepage: <http://www.samsungdocs.com>**



# GENERAL USER INFORMATION

---

## Radio Frequency Interference

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to FCC Part 15 Rules.

These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his/her own risk.

## FCC Requirements

This equipment complies with FCC Part 68 Rules and requirements adopted by Administrative Council for Terminal Attachment (ACTA).

### FCC Part 68

The FCC Part 68 label is located on the bottom of the chassis.

The label contains:

- Product Identifier Number
- FCC Registration Number
- Ringer Equivalence Number (REN)



NOTE

#### NOTE

If requested, this information must be provided to your telephone company.

## Unauthorized Modifications

Any change or modifications performed on this equipment that are not expressly approved in writing by SAMSUNG ELECTRONICS, CO., LTD. could cause non-compliance with the FCC rules and void the user's authority to operate the equipment.

## Telephone Connection Requirement

A plug and jack is used to connect this equipment to the premises wiring and telephone network must comply with the FCC Part 68 rules and requirements adopted by the ACTA.

A compliant telephone cord and modular plug is provided with this product which is designed to connect to a compatible Standard Modular jack.

Connection to the telephone network should be made by using standard modular telephone jacks, type RJ-11C. The RJ-11C plug and/or jacks used must comply with the FCC Part 68 rules.

CIRCUIT TYPE	MODULE TYPE	FACILITY INTERFACE CODE	NETWORK JACK
LOOP START LINE	FXO-4M	02LS2	RJ11C
	T1E1-2M	04DU9.DN	RJ48C
	T1E1-4	04DU9.1KN	RJ48C
		04DU9.1SN	
		04DU9.1SN (PRI)	
		04DU9.DN	
		04DU9.1KN	
04DU9.1SN			
04DU9.1SN (PRI)			
DID LINE	FXS-4M, FXS-24	02RV2.T	RJ11C
	T1E1-2M	04DU9.BN	RJ48C
	T1E1-4	04DU9.BN	RJ48C
E & M TIE LINE	E & M-2M	TL11M	RJ45S
	T1E1-2M	04DU9.BN	RJ48C
	T1E1-4	04DU9-BN	RJ48C

## Ringer Equivalence Number

The REN is used to determine the number of devices to be connected to a telephone line. If the total allowable REN load is exceeded, the phone circuit may fail to ring. In most cases, the total REN for a telephone line should not exceed Five (5).

Contact Local Telephone Company, to be certain about the number of devices connected to a line, which is determined by the total REN.

For earlier products, the REN is separately shown on the label.

## Incidence of Harm

The telephone company will notify you in advance about the temporary discontinuation of service, if this equipment is causing harm to the telephone network.

In case advance notification is not feasible, the telephone company will notify the customer as soon as possible and you will also be advised about your right to file a complaint with the FCC, if it is necessary.

## Changes to Telephone Company Equipment or Facilities

The telephone company may make changes in its facilities, equipment, operations or procedures that could affect the operation of the equipment. If this happens, the telephone company will provide advance notice in order for you to make necessary modifications to maintain uninterrupted service.

## Service Center

If you need assistance during troubleshooting, please contact our local office SAMSUNG ELECTRONICS, CO., LTD. for repair or warranty information. If the trouble is causing harm to the telephone network, the telephone company may request you to remove the equipment from the network until the problem is resolved.

## Field Repairs

Only technicians certified on the Ubigate iBG3026 are authorized by SAMSUNG ELECTRONICS, CO., LTD. to perform system repairs. Certified technicians may replace modular parts of a system to repair or diagnose trouble. Defective modular parts can be returned to SAMSUNG ELECTRONICS, CO., LTD. for repair.

## General

Connection to party line service is subject to state tariffs. Contact the State Public Utility Commission, Public Service Commission or Corporation Commission for information.

## Direct Inward Dialing (DID)

If the equipment is not operating as per the **Proper Answer Supervision** mentioned in FCC Part 68 rules, then it is a violation.

Rules of PROPER ANSWER SUPERVISION:

1. Always On the following DID calls, the Equipment returns Answer Supervision to the Public Switched Telephone Network (PSTN)
  - Answered by the called station.
  - Answered by the attendant.
  - Routed to a recorded announcement that can be administered by the Customer Premises Equipment (CPE) user.
  - Routed to a dial prompt.
  
2. Always This equipment returns answer supervision on all DID calls forwarded to the PSTN.  
Permissible exceptions are:
  - A call is unanswered.
  - A busy tone is received.
  - A reorder tone is received.

## Equal Access Requirements

Through the use of access codes, this equipment is capable of providing user's access to interstate providers of operator services. Modification of this equipment by call aggregators to block access dialing codes is a violation of the Telephone Operator Consumers Act of 1990.

## Electrical Safety Advisory

Parties responsible for equipment requiring AC power should consider including an advisory notice in their customer information suggesting them to use a surge arrestor. Telephone companies report that electrical surges, typically lightning transients, are very destructive to customer terminal equipment connected to AC power sources. This has been identified as a major nationwide problem.

## Music on Hold Warning



In accordance with US copyright laws, a license may be required from the American Society of Composers, Authors and Publishers (ASCAP) or other similar organizations if copyright music is transmitted through the **Music on Hold** feature. SAMSUNG ELECTRONICS, CO., LTD. hereby disclaims any liability arising out of failure to obtain such a license.

## Direct Inward System Access (DISA) Warning

The lines used for the DISA feature must have the disconnected Supervision option provided by the telephone company.



As it is impossible to control who may access your DISA line it is suggested that you do not turn this feature on unless you intend to use it. If you do use this feature, it is good practice to frequently change pass codes and periodically review your telephone records for unauthorized use.

## Safety Warnings



High touch current earth connection is essential before making telecommunication network connection.



Energy Hazard-careful treatment is needed.



Every wire for communication should be larger than 26 AWG.



Double pole/neutral fusing.

## Underwriters Laboratories

The Ubigate iBG3026 system has been tested to comply with Safety Standards in the United States and Canada. This system is listed with Underwriters Laboratories. The cUL Mark is separately shown on the label.

## Installation Safety Guidelines and Warnings

### Safety Recommendations

The Safety Warnings that appear in this document (such as the one below) indicate a procedure that can harm you if not done correctly.



Electric hazard exists. Verify the power is turned off. Do not work on energized equipment. Working on energized equipment can result in serious electrical shock.



To avoid electric shock, do not connect Safety Extra-Low Voltage (SELV) circuits (found in LAN ports) to Telephone-Network Voltage (TNV) circuits (found in WAN ports).



This equipment must be installed and maintained by properly trained service personnel. Make sure the proper electrical service is available before plugging the unit and turning it on. Disconnect the telecommunication lines before unplugging the main power connector.

### Class 1 Laser Product

The Ubigate iBG3026 is equipped with Small Form Pluggable (SFP) laser transceiver on some ports.



Invisible laser radiation may be emitted from disconnected fibers or connectors.  
Do not stare into beams or view directly with optical instruments.

## Cover Panels

Do not operate the Ubigate iBG3026 with missing blank faceplates and cover panels. These covers prevent exposure to hazardous voltages and currents inside the chassis. They are important to maintaining proper air flow through the chassis. They also prevent electromagnetic interference (EMI) that might disrupt other equipment.



Laser radiation and EMI are present when the router cover panel is open.

## Electrostatic Discharge (ESD) Warning

Observe the following guidelines to minimize the potential for Electrostatic Discharge (ESD) damage, which can cause intermittent or complete component failures.



When handling Ubigate iBG3026 or its components, wear grounding wrist straps to avoid ESD damage to the equipment. Do not directly touch the backplane with your hand or any metal tool, or you could shock yourself.

- 1.** Always use an ESD wrist strap or ankle strap, and verify that it is in direct contact with your skin. Avoid contact between the component and your clothing as it causes ESD damage.
- 2.** When handling any component that is removed from the chassis, verify that the equipment end of your ESD strap is attached to one of the ESD points on the chassis.
- 3.** Use care when installing or uninstalling modules or interface cards. Tighten the captive installation screws to ensure a proper connection when inserting modules or interface cards.

4. When removing or installing a component, always place it component-side up on an antistatic surface, in an antistatic card rack. If you are returning a component, place it in an electrostatic bag before packing it.



# INTRODUCTION

---

## Purpose

Ubigate iBG3026 System Description describes the general information for the iBG3026 hardware description, software description, and additional modules etc.

## Document Content and Organization

This manual is composed of four Chapters, two Annex, the Abbreviation, and the Index.

### CHAPTER 1. Introducing the iBG3026

- iBG3026 Overview
- Product Specifications
- iBG3026 Software Features and Licenses

### CHAPTER 2. Hardware Overview

- iBG3026 Chassis
- iBG3026 Boot Sequence
- iBG3026 Front Panel
- iBG3026 Rear Panel
- Modules and Internal Option Cards Types
- Port Numbering

- Modules and Option Cards
- iBG3026 Power System
- iBG3026 Cooling System

### **CHAPTER 3. Software Overview**

- Routing Engine and Packet Forwarding Engine
- Kernel
- Processes
- User Interfaces

### **CHAPTER 4. Voice Features**

- Introduction to Voice Feature
- Key Features
- Voice Deployment Scenario
- Performance and Capacity

### **ANNEX A. Cable Specifications**

### **ANNEX B. Open Source Announcement**

### **ABBREVIATION**

Describes the acronyms used in this manual.

### **INDEX**

Index provides main searching keywords to be found.

## Conventions

The following types of paragraphs contain special information that must be carefully read and thoroughly understood. Such information may or may not be enclosed in a rectangular box, separating it from the main text, but is always preceded by an icon and/or a bold title.

**WARNING**

Provides information or instructions that the reader should follow in order to avoid personal injury or fatality.

**CAUTION**

Provides information or instructions that the reader should follow in order to avoid a service failure or damage to the system.

**NOTE**

Indicates additional information as a reference.

## Information for Product and Technical Support

For questions regarding the product and technical supports:

<http://www.samsungnetwork.com>

## Revision History

EDITION	DATE OF ISSUE	REMARKS
00	10. 2007.	First Edition.
01	08. 2008.	Added hot swap and VPN-SSL descriptions. Delete MPLS function and etc.
02	12. 2009.	Added IVM-U2.
03	03. 2010.	Modified Open Source Announcement.
04	07. 2010.	Added FXO-2M, FXS-2M, ATOP-1, ATOI-1 Modified Open Source Announcement.



# SAFETY CONCERNS

The purpose of the Safety Concerns section is to ensure the safety of users and prevent property damage. Please read this document carefully for proper use.

## Symbols



**Caution**

Indication of a general caution.



**Restriction**

Indication for prohibiting an action for a product.



**Instruction**

Indication for commanding a specifically required action.



## **CAUTION**



SFPs include a laser transceiver on the fiber-optic uplink port. Use of controls or adjustments of performance or procedures other than those specified in this manual may result in hazardous radiation exposure.



To comply with the Telcordia GR-1089 NEBS standard for electromagnetic compatibility and safety, connect only to intra-building or non-exposed wiring or cabling.



# TABLE OF CONTENTS

<b>GENERAL USER INFORMATION</b>	<b>III</b>
Radio Frequency Interference .....	III
FCC Requirements .....	IV
Unauthorized Modifications .....	IV
Telephone Connection Requirement.....	V
Ringer Equivalence Number.....	V
Incidence of Harm .....	VI
Changes to Telephone Company Equipment or Facilities .....	VI
Service Center .....	VI
Field Repairs .....	VI
General.....	VII
Direct Inward Dialing (DID) .....	VII
Equal Access Requirements.....	VII
Electrical Safety Advisory .....	VIII
Music on Hold Warning.....	VIII
Direct Inward System Access (DISA) Warning .....	VIII
Safety Warnings .....	IX
Underwriters Laboratories .....	IX
Installation Safety Guidelines and Warnings.....	X
<b>INTRODUCTION</b>	<b>XIII</b>
Purpose .....	XIII
Document Content and Organization.....	XIII
Conventions.....	XV
Information for Product and Technical Support.....	XV
Revision History.....	XVI
<b>SAFETY CONCERNS</b>	<b>XVII</b>
Symbols.....	XVII
Caution .....	XVIII

<b>CHAPTER 1. Introducing the iBG3026</b>	<b>1-1</b>
<b>iBG3026 Overview .....</b>	<b>1-1</b>
Main Features, Functions and Benefits.....	1-1
Branch Office Configuration Example .....	1-3
Deployment Scenario.....	1-4
New Service Offering Example .....	1-6
Product Architecture.....	1-8
<b>Product Specifications.....</b>	<b>1-10</b>
iBG3026 Product Specification .....	1-10
Interface.....	1-11
Modules and Internal Option Cards .....	1-12
Memory.....	1-13
Power.....	1-14
Ventilation .....	1-14
Real-Time Clock and NVRAM.....	1-14
<b>iBG3026 Software Features and Licenses.....</b>	<b>1-15</b>
Switch/Router Features .....	1-15
Security Features.....	1-17
<b>CHAPTER 2. Hardware Overview</b>	<b>2-1</b>
<b>iBG3026 Chassis .....</b>	<b>2-2</b>
<b>iBG3026 Boot Sequence.....</b>	<b>2-4</b>
<b>iBG3026 Front Panel .....</b>	<b>2-5</b>
<b>iBG3026 Rear Panel.....</b>	<b>2-7</b>
<b>Modules and Internal Option Cards Types .....</b>	<b>2-11</b>
<b>Port Numbering .....</b>	<b>2-13</b>
LAN Ports.....	2-13
WAN Ports .....	2-15
Mini Modules.....	2-17
Port Numbering Examples .....	2-18
<b>Modules and Option Cards.....</b>	<b>2-19</b>
Internal Option Cards.....	2-19
WAN Interface Module .....	2-21
LAN Interface Modules .....	2-30
Voice Modules.....	2-37

<b>iBG3026 Power System .....</b>	<b>2-42</b>
AC Power Supply .....	2-42
AC Power Supply with PoE .....	2-43
DC Power Supply with PoE .....	2-43
Power Supply Redundancy .....	2-44
<b>iBG3026 Cooling System.....</b>	<b>2-44</b>

**CHAPTER 3. Software Overview 3-1**

<b>Routing Engine and Packet Forwarding Engine .....</b>	<b>3-1</b>
<b>Kernel.....</b>	<b>3-2</b>
<b>Processes .....</b>	<b>3-2</b>
Management Process.....	3-2
Chassis Process.....	3-4
Hot Swap.....	3-5
Routing Protocol Process .....	3-6
Interface Process.....	3-13
Forwarding Process.....	3-13
<b>User Interfaces .....</b>	<b>3-14</b>
Command Line Interface .....	3-14
Web GUI (HTTP Server).....	3-15

**CHAPTER 4. Voice Features 4-1**

<b>Introduction to Voice Feature.....</b>	<b>4-1</b>
Network Architecture.....	4-2
Interface between Network Entities .....	4-4
Operation Mode.....	4-5
<b>Key Features.....</b>	<b>4-8</b>
VoIP Gateway.....	4-8
Security.....	4-11
Call Routing and Digit Manipulation.....	4-12
Call Admission Control (CAC).....	4-14
Voice Services .....	4-16
E911 Support.....	4-20
High Availability of Voice Feature.....	4-21

TABLE OF CONTENTS

---

**Voice Deployment Scenario.....4-23**  
    PSTN Toll Bypass .....4-23  
    IP Phones .....4-24  
    Management System .....4-25  
**Performance and Capacity .....4-26**

**ANNEX A. Cable Specifications A-1**

**Console Port Cable ..... A-1**  
**Auxiliary Port Cable ..... A-2**  
**BRI-2U Mini Module Cable ..... A-3**  
**BRI-2ST Mini Module Cable ..... A-4**  
**ESG-8, LMG-20, LMF-20, LMP-20, LMG-44, LMGP-44 Module Cable..... A-5**  
**T1E1-4, T1E1-2M Module Cable..... A-6**  
**HSSI-1 Module Cable..... A-7**  
**HSSI-1 Module Cable (Null Modem Case) ..... A-8**  
**FXS-24 Module Cable ..... A-9**  
**E & M-2M Module Cable ..... A-11**  
**FXO-2M, FXO-4M, FXS-2M, FXS-4M Module Cable ..... A-12**  
**ATOP-1, ATOI-1 Module Cable ..... A-13**  
**WTE-4S Module Cable (X.21 DCE) ..... A-14**  
**WTE-4S Module Cable (X.21 DTE)..... A-15**  
**WTE-4S Module Cable (RS232 DCE)..... A-16**  
**WTE-4S Module Cable (RS232 DTE) ..... A-18**  
**WTE-4S Module Cable (RS449 DCE)..... A-20**  
**WTE-4S Module Cable (RS449 DTE) ..... A-22**  
**WTE-4S Module Cable (V.35 DCE)..... A-24**  
**WTE-4S Module Cable (V.35 DTE) ..... A-26**  
**WTE-4S Module Cable (RS530A DTE)..... A-28**  
**WTE-4S Module Cable (RS530 DTE) ..... A-30**

**ANNEX B. Open Source Announcement B-1**

**ABBREVIATION** **I**

3 ~ C.....	I
D ~ H.....	II
I ~ O.....	III
P ~ S.....	IV
T ~ W.....	V

**INDEX** **I**

A ~ D.....	I
E ~ I.....	II
K ~ P.....	III
Q ~ V.....	IV
W.....	V

**LIST OF FIGURES**

Figure 1.1 Branch Office Configuration Example ..... 1-3

Figure 1.2 iBG3026 Office Network Deployment Scenario Example..... 1-4

Figure 1.3 iBG3026 Enterprise Network Deployment Scenario Example..... 1-5

Figure 1.4 New Service Offering Example..... 1-7

Figure 2.1 Isometric View ..... 2-2

Figure 2.2 Fan Tray ..... 2-3

Figure 2.3 iBG3026 Front View ..... 2-5

Figure 2.4 iBG3026 Main Board View ..... 2-7

Figure 2.5 iBG3026 Rear View ..... 2-8

Figure 2.6 Modules and Internal Option Card..... 2-12

Figure 2.7 Main Board LAN Port Numbering..... 2-13

Figure 2.8 Ethernet Switch Gigabit Module Port Numbering ..... 2-14

Figure 2.9 20-Port Network Module Port Numbering..... 2-14

Figure 2.10 44-Port Network Module Port Numbering..... 2-15

Figure 2.11 2-Port Mini Module Port Numbering ..... 2-15

Figure 2.12 4-Port Mini Module Port Numbering ..... 2-15

Figure 2.13 1-Port WAN Module Port Numbering..... 2-16

Figure 2.14 4-Port WAN Module Port Numbering..... 2-16

Figure 2.15 Main Board Mini Module Ports Numbering..... 2-17

Figure 2.16 Voice Carrier and Mini Module Ports Numbering..... 2-17

Figure 2.17 VPN-A, VPN-SSL Internal Option Card..... 2-19

Figure 2.18 VoP-32, 64, 128 Internal Option Cards..... 2-19

Figure 2.19 IVM Internal Option Card..... 2-20

Figure 2.20 BRI-2ST Mini Module ..... 2-21

Figure 2.21 BRI-2U Mini Module ..... 2-22

Figure 2.22 T1E1-2M Mini Module ..... 2-23

Figure 2.23 T1E1-4 Network Module..... 2-24

Figure 2.24 WTE-4S Network Module ..... 2-25

Figure 2.25 HSSI-1 Network Module..... 2-26

Figure 2.26 WT3-1C Module ..... 2-27

Figure 2.27 ATOP-1 Mini Module ..... 2-28

Figure 2.28 ATOI-1 Mini Module..... 2-29

Figure 2.29 ESG-8 Network Module..... 2-31

Figure 2.30 ESF-10 Network Module ..... 2-32

Figure 2.31 LMG-20 Network Module ..... 2-33

Figure 2.32	LMF-20 Network Module.....	2-34
Figure 2.33	LMP-20 Network Module.....	2-34
Figure 2.34	LMG-44 Network Module .....	2-35
Figure 2.35	LMGP-44 Network Module.....	2-36
Figure 2.36	VCU-A Network Module .....	2-37
Figure 2.37	FXO-2M Mini Module .....	2-37
Figure 2.38	FXO-4M Mini Module .....	2-38
Figure 2.39	FXS-2M Mini Module .....	2-38
Figure 2.40	FXS-4M Mini Module .....	2-39
Figure 2.41	E & M-2M Mini Module.....	2-40
Figure 2.42	FXS-24 Network Module .....	2-41
Figure 2.43	FXS-24 Extension Box.....	2-41
Figure 2.44	AC Power Supply.....	2-42
Figure 2.45	AC Power Supply with POE .....	2-43
Figure 2.46	DC Power Supply with POE.....	2-43
Figure 2.47	Air flow of the iBG3026 .....	2-44
Figure 3.1	iBG-DM Management Network Diagram.....	3-15
Figure 4.1	iBG3026 Network Diagram .....	4-2
Figure 4.2	Example of iPX Interworking Mode Network Configuration.....	4-6
Figure 4.3	Example of Stand-alone mode network configuration .....	4-7
Figure 4.4	Toll Bypass for Voice and Fax services .....	4-23
Figure 4.5	Connection to IP Phone, Analog Phone, and FAX .....	4-24
Figure 4.6	Management using CLI/GUI/NMS.....	4-25
Figure A.1	Console Port Cable.....	A-1
Figure A.2	Auxiliary Port Cable .....	A-2
Figure A.3	BRI-2U Mini Module Cable .....	A-3
Figure A.4	BRI-2ST Module Cable .....	A-4
Figure A.5	ESG-8, LMG-20, LMF-20, LMP-20, LMG-44 Module Cable .....	A-5
Figure A.6	T1E1-4, T1E1-2M Module Cable .....	A-6
Figure A.7	HSSI-1 Module Cable .....	A-7
Figure A.8	HSSI-1 Module Cable (Null Modem Case) .....	A-8
Figure A.9	FXS-24 Module Cable .....	A-9
Figure A.10	E & M-2M Module Cable.....	A-11
Figure A.11	FXO-2M, FXO-4M, FXS-2M, FXS-4M Module Cable.....	A-12
Figure A.12	ATOP-1, ATOI-1 Module Cable .....	A-13
Figure A.13	WTE-4S Module Cable (X.21 DCE).....	A-14

## TABLE OF CONTENTS

---

Figure A.14	WTE-4S Module Cable (X.21 DCE) .....	A-15
Figure A.15	WTE-4S Module Cable (RS232 DCE).....	A-16
Figure A.16	WTE-4S Module Cable (RS232 DTE) .....	A-18
Figure A.17	WTE-4S Module Cable (RS449 DCE).....	A-20
Figure A.18	WTE-4S Module Cable (RS449 DTE) .....	A-22
Figure A.19	WTE-4S Module Cable (V.35 DCE) .....	A-24
Figure A.20	WTE-4S Module Cable (V.35 DTE).....	A-26
Figure A.21	WTE-4S Module Cable (RS530A DTE).....	A-28
Figure A.22	WTE-4S Module Cable (RS530 DTE) .....	A-30



# CHAPTER 1. Introducing the iBG3026

Chapter 1 describes the iBG3026 overview and specifications.

## iBG3026 Overview

### Main Features, Functions and Benefits

The iBG3026 is a modular Wide Area Network (WAN) router.

It is a 2U rack-mount unit with redundant power supplies and slots for interchangeable interface modules.

The core of the router is a LAN/WAN and router. A Virtual Private Network (VPN)/Internet Protocol Security (IPSec) and VPN/Secure Socket Layer (SSL) option cards provide high performance encryption and decryption services for the router.

The iBG3026 also supports optional Ethernet switch/route subsystem and a voice subsystem cards and interface modules. iBG3026 also supports multi-Gigabit Ethernet Level-2 switching, Level-3 IP routing and VoIP processing.

### Samsung's Integrated Switch Router

iBG3026 integrates all the essential communication services-routing, switching, security and VoIP-into a single platform that can replace many separate network devices. In addition, versatility of many integrated features and a wide range of network modules provides simplicity of management and investment protection while giving SMBs room to grow with business expansions. For example, if an SMB wants to reduce the voice communications cost, it can use the voice gateway available on the iBG3026. Together with VoIP, variety of Quality of Service (QoS) features and Ethernet module with Power-over-Ethernet ports will provide necessary infrastructure for Internet Protocol (IP) telephony.

Furthermore, iBG3026 includes many ease-of-use management features to help SMBs to configure, monitor and troubleshoot without difficulty. Only iBG3026 cost-effectively brings real benefits of network connectivity and convergence as well as network security to SMBs.

## Performance and Scalability

- 530 Kpps Routing
- Maximum 2xDS3, 58x10/100/1000 Mbps ports
- 60 Gbps Switching Capacity (Full Duplex)
- 42 Gbps Switching Throughput (Full Duplex)

## Seamless Integration

Full routing, switching, voice and security in a single platform

## Simple, yet Powerful Management

- Customers can manage all aspects of routing, switching, security and voice from a single web-Graphic User Interface (GUI), as well using the powerful Command Line Interface (CLI).
- Read-only remote management enables service providers a quick view of the router for easy troubleshooting of Customer Premises Equipment (CPE).

## Versatility

- WAN: Clear-Channel/Channelized T1/E1 and T3, Integrated Service Digital Network (ISDN), Serial, High Speed Serial Interface (HSSI), Metro Ethernet and, Frame Relay, Point to Point Protocol (PPP), Multi Level Precedence and Preemption (MLPP)
- LAN: 100 Mbps or GbE Metro Ethernet, 10/100/1000 Mbps, Packet over Ethernet (PoE), Virtual Local Area Network (VLAN), 802.1q
- QoS: DiffServ, Auto QoS, Hierarchical QoS, LF & I, Service-Level Agreement (SLA), Low-Latency Queuing (LLQ), Frame Relay (FR) PVC Queuing
- Voice: Session Initiation Protocol (SIP), H.323, Call Manger, Public Switched Telephone Network (PSTN) Fallback, Foreign Exchange Subscriber/Direct Inward Dialing (FXS/DID), Foreign Exchange Office/Centralized Automated Message Accounting (FXO/CAMA), Receive and Transmit (E & M), ISDN, T1/E1

## Rock-Solid, yet Flexible Security

IPSec, Generic Routing Encapsulation (GRE), Layer 2 Tunneling Protocol (L2TP), Triple Data Encryption Standard (3DES)/Advanced Encryption Standard (AES), Intrusion-Detection Systems (IDS), Intrusion-Prevention Systems (IPS), Anti Virus, Content Filtering

## Branch Office Configuration Example

Employing full routing capabilities and enterprise-class switching capacity plus integrated security and Voice over Internet Protocol (VoIP), iBG3026 eliminates the need for many separate network devices at the customer sites. Because iBG3026 offers wide range of features and network interfaces, you will be able to introduce new value-added services such as hosted Internet Protocol Private Branch Exchange (IP PBX) and/or VPN without requiring additional devices at customer sites that need to be managed separately. In addition, remote management features of iBG3026 allow you to graphically configure, monitor or troubleshoot iBG3026 as a managed CPE device with ease. With iBG3026 on your side, you will boost your revenue while providing the right solution to your customers. Customer name increase productivity for its mobile executives, improved contact center operations, and facilitated expansion and acquisitions

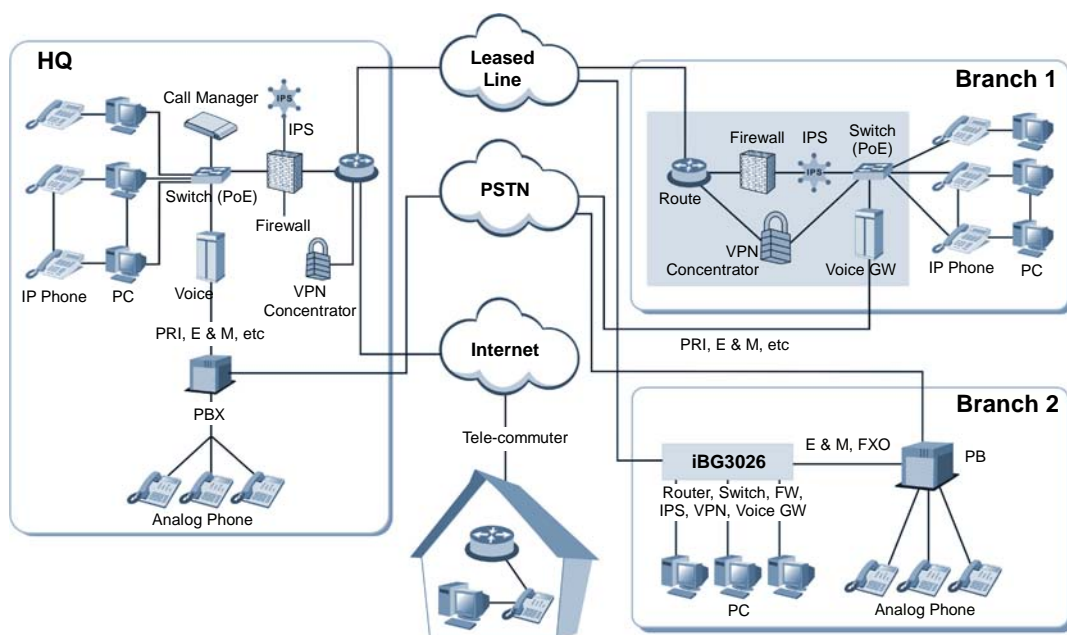


Figure 1.1 Branch Office Configuration Example

## Deployment Scenario

The iBG3026 is designed to provide WAN-connectivity to a small to medium sized office. The iBG3026 provides VPN/firewall functionality for WAN interfaces, so users can build secure communication channels through the public Internet.

In addition to access router functionality, iBG3026 provides Layer 2/3 Ethernet switching capability for internal traffic. Figure 1.2 shows a typical deployment scenario for the iBG3026. As shown, iBG3026 provides WAN interfaces such as T1, E1, T3, and metro Ethernet in order to support WAN connectivity. In addition, it is possible to equip an iBG3026 with up to 58 10/100/1000 Ethernet ports that will provide Layer-2 and Layer-3 Ethernet switching functionality. iBG3026 also offers Voice over Internet Protocol (VoIP) gateway and IP PBX capabilities.

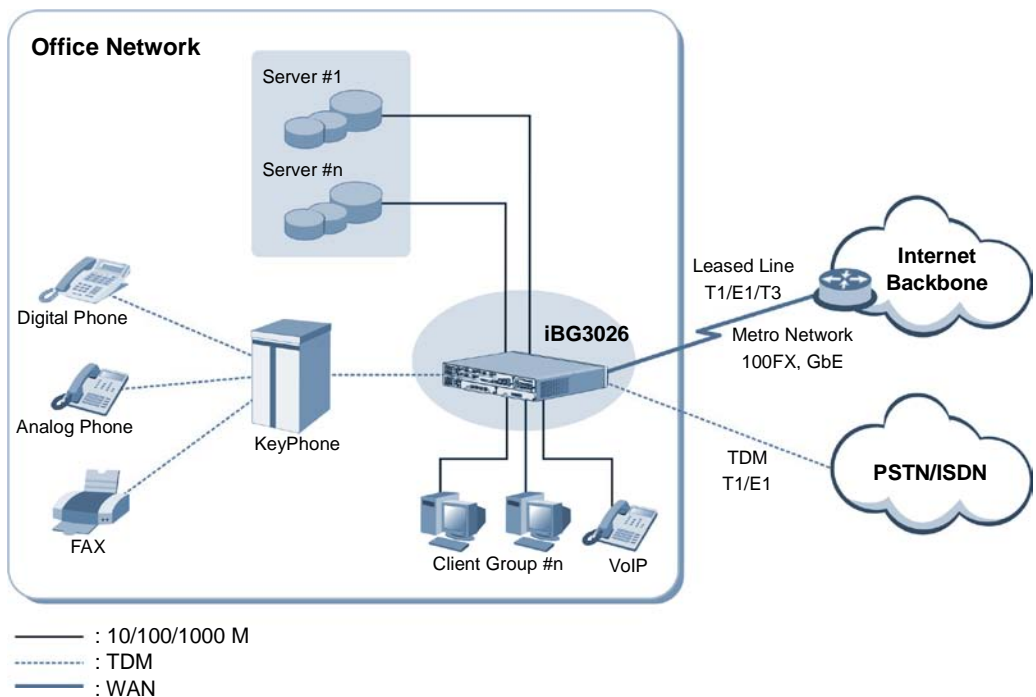


Figure 1.2 iBG3026 Office Network Deployment Scenario Example

This allows the iBG3026 to support IP Phones in addition to traditional analog and digital PBX telephone systems, enabling a single platform to provide converged voice, data, and video communications over IP networks, as well as over PSTN and other data network infrastructures.

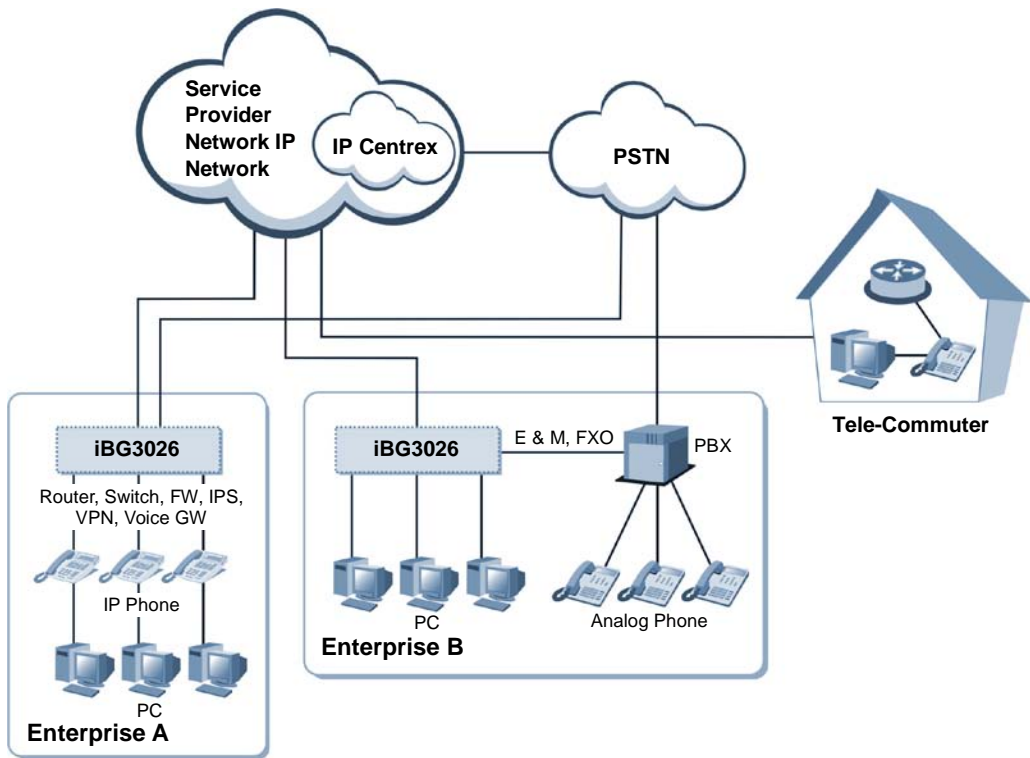


Figure 1.3 iBG3026 Enterprise Network Deployment Scenario Example

## **New Service Offering Example**

### **Basic Connectivity**

If simple and reliable Internet connectivity is the only requirement, your enterprise can accomplish it with one of many WAN interface cards. Plus, the high-port density switching module eliminates the need for an additional, separate Ethernet switch. Furthermore, enterprise customers will have peace of mind knowing that one of the various modules will satisfy whatever need might arise in the future.

### **Secure Connectivity**

The need to protect Enterprise networks has become an absolute requirement and connecting to the network without protection is unthinkable. iBG3026 includes Firewall/IPS and VPN acceleration modules for complete protection of both voice and data. Whatever the size of an enterprise and whatever the need is, an enterprise customer can safely connect branch offices to headquarters, protect both audio and video traffic and prevent malicious attacks.

### **Toll Bypassing**

The ability to utilize your current data link to carry quality voice provides tremendous savings on voice communications.

With the voice gateway module in iBG3026, you can easily and rapidly deploy a VoIP solution.

### **IP Telephony**

In addition to toll savings, the real value of VoIP comes from value-added applications running on top of the communications infrastructure, which in turn helps you raise productivity significantly. The IP phones with a number of useful features and internal or external IP PBX that can be clustered and will provide you with the scalability to sustain your growth. Moreover, iBG3026 will be compatible with most widely accepted media servers, giving you the power to pick and choose the best media server for your needs.

## Complete Solution

With all these features implemented—routing, switching, security and voice—nothing comes close to iBG3026 in terms of richness of features and meeting customer needs. Furthermore, iBG3026 can perform at full wire-speed even when all features are enabled. Wherever and however it is deployed, iBG3026 will satisfy any enterprise customer.

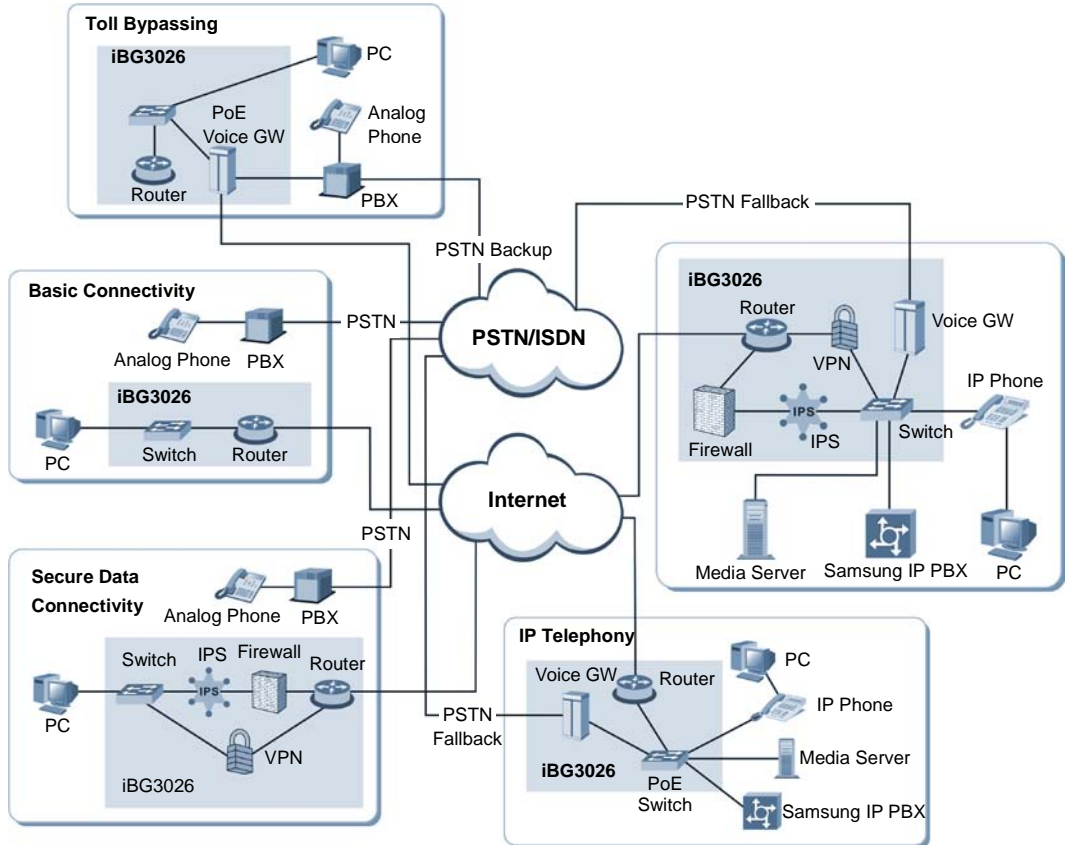


Figure 1.4 New Service Offering Example

## Product Architecture

A description of the functional architecture of the iBG3026 can be divided into two major categories: The iBG3026 control plane and the data plane.

The control plane provides router management functions that configure, manage, and control the various modules within the router and the individual devices on those modules. The data plane provides the data paths to switch and route data packets through the router and to transform those packets as required for protocol conversion and security functions.

### Control Plane Architecture

Management and control of the iBG3026 is provided by the core processor on the main board. In addition to directly managing the devices on the main board, such as Double Data Rate Synchronous Dynamic Random Access Memory (DDR SDRAM), Flash, Real Time Clocks, etc., the processor communicates with all of the other modules in the iBG3026 to manage their functions. For the modules that mount directly on the main board (the mini modules, the VPN/IPSec option card, the VPN/SSL option card and the VoIP option card) the processor communicates directly through the connector used for the slave module. The processor communicates with the other modules in the router (the power supplies, the fan tray unit, and the network modules) across the router backplane.

For bandwidth and reliability purposes the iBG3026 uses independent bus segments to each of the module slots.

### Data Plane Architecture

The iBG3026 uses a memory-based architecture in which the High-level Data Link Control (HDLC) Controllers, Ethernet Media Access Controls (MACs), and other packet processors use Direct Memory Access (DMA) to move packet data to and from a central buffer memory on the main board.

The routing processor examines packet headers in memory, determines what to do with each packet, and links it to the appropriate output queue.

If the VPN/IPSec or VPN/SSL option card is installed, packets may be linked to the security processor on the option card for encryption or decryption.

As with the other controllers, the security processor uses DMA to move packet data into and out of the buffer memory for processing.

Network modules and mini modules that are part of the iBG3026 provide T1/E1, Serial, Digital Signal level-3 (DS3), HSSI, ISDN Basic Rate Interface (BRI), Fast Ethernet, and Gigabit Ethernet external interfaces to this subsystem.

The voice subsystem is optional, only being implemented if the VoIP option card is installed on the main board and appropriate analog or digital voice network modules and mini modules are installed. The VoIP option card includes a Digital Signal Processor (DSP) that is capable of processing up to 128 voice calls.

Network modules and mini modules that are part of the voice subsystem provide analog voice (both FXS/DID and FXO), E & M, T1 (D4, ESF, and ISDN PRI), E1 (CAS and ISDN PRI), DS3, and ISDN BRI external interfaces to this subsystem.

The Ethernet subsystem may be expanded through the addition of the Ethernet switch Gigabit card and Ethernet network modules. These modules include Ethernet packet processors that support both Level 2 switching and Level 3 IP routing of Ethernet packets. Network modules may also include Ethernet switches to expand the number of available ports. In addition, each of the modules includes two high speed stacking links interfaces that are connected to the other network module/option board positions in the chassis.

The high speed stacking links provide very high bandwidth bidirectional connectivity between the modules, such that they all form a single logical Ethernet switch. Due to the Time Division Multiplexer (TDM) switch in the voice subsystem and the packet processors and switches in the Ethernet subsystem, not all traffic has to pass through the router subsystem.

Local voice calls can be connected between voice ports without going through the VoIP processor. Likewise, Ethernet packets whose (switched or routed) destination port is a local port are handled entirely within the Ethernet subsystem.

# Product Specifications

## iBG3026 Product Specification

ITEM	Specification
Memory	- Typical: 512 MB - Maximum: 1 GB
Compact Flash Memory	- Typical: 128 MB - Maximum: 256 MB
Boot ROM	2 MB
AC Power Supply	- Input Voltage: 100~240 V - Frequency: 50~60 Hz - Power Consumption: 275 W
AC Power Supply with PoE	- Input Voltage: 100~240 V - Frequency: 50~60 Hz - Power Consumption: 635 W
DC Power Supply with PoE	- Input Voltage: -48 V - Power Consumption: 635 W
High Temperature (Operating)	104°F (+ 40°C)
Low Temperature (Operating)	32°F (0°C)
High Temperature (Non-Operating)	167°F (+ 75°C)
Low Temperature (Non-Operating)	- 13°F (- 25°C)
Humidity (Operating)	5 to 95%, non-condensing
Dimension (H x W x D)	- Height: 3.5 inch (88.9 mm) - Width: 17.38 inch (441.5 mm) (Including rack-mounting brackets: 17.53 inch, 445.5 mm) - Depth: 16.5 inch (419.2 mm)
Weight	11.5 kg
Altitude	0 to 13,123 ft (0 to 4, 018 m)
Regulatory & Safety Compliance	- FCC Part 15 Class A - FCC Part 68 - IEC/EN 60950-1 - UL60950 - EN55022/EN55021

## Interface

The following tables provide specifications for T1 WAN, Serial WAN, and Ethernet LAN interfaces.

### E1 WAN Interface

Specifications	Descriptions
Receive line rate	2.048 Mbps $\pm$ 50 ppm (payload = 1.984 Mbps)
Line code	HDB3
Framing CRC	non-CRC (ITU G.704), and unframed
Input signal	DSX-1, 0 to -24 dB
Output signal build out	long-haul or short-haul
Impedance	75 or 120 ohm
Connectors	RJ-48C
Timing	Internal or network
Pulse density	ITU G.703

### T1 WAN Interface

Specifications	Descriptions
Receive line rate	1.544 Mbps $\pm$ 32 ppm
Line code	B8ZS or AMI
Framing	D4 or ESF
Interface ESF FDL	- AT & T TR-54016-1986 - AT & T TR-54016-1989 - ANSI T1.403-1989
Input signal	DSX-1, 0 to -24 dB
Output signal build out	0, -7.5 dB, -5 dB
Equalization	0 to 655 ft. (DSX-1)
Impedance	100 ohm
Connectors	RJ-48C
Timing	Internal or network
Pulse density	AT & T TR-62411; HDLC Inversion, forced

## Ethernet LAN Interface

Specifications	Descriptions
Data flow	Full-duplex or half-duplex
Connectors	RJ-45
Data speed	10/100/1000 Mbps, auto negotiating

## Modules and Internal Option Cards

iBG3026 supports several kinds of modules and internal option cards.

- Mini module
- Network module
- Double-wide network module
- Ethernet option module
- Internal option card

The following table lists the iBG3026 modules and internal option cards.

Name		Detailed Description
Internal Option Cards	VPN-A	IPSec VPN option card
	VPN-SSL	SSL VPN option card
	VoP-32	VoIP 32ch gateway card
	VoP-64	VoIP 64ch gateway card
	VoP-128	VoIP 128ch gateway card
	IVM-U2	Integrated Voice Mail option card
WAN Interface Modules	BRI-2ST	2-port ISDN BRI-S/T interface mini module
	BRI-2U	2-port ISDN BRI-U interface mini module
	T1E1-2M	2-port channelized T1/E1 mini module
	T1E1-4	4-port T1/E1 network module
	WTE-4S	4-port serial network module
	HSSI-1	1-port HSSI network module
	WT3-1C	1-port channelized network module
	ATOP-1	1-port ADSL over POTS mini module
	ATOI-1	1-port ADSL over ISDN mini module

(Continued)

Name		Detailed Description
LAN Interface Modules	ESG-8	10-port GbE option module
	ESF-10	10-port GbE SFP option module
	LMG-20	20-port GbE (UTP) network module
	LMF-20	20-port 10/100 FE (UTP) network module
	LMP-20	20-port 10/100 FE (UTP) PoE network module
	LMG-44	44-port GbE (UTP) network module (Double-wide)
	LMGP-44	44-port GbE (UTP) PoE network module (Double-wide)
Voice Modules	VCU-A	2 Voice Carrier network module
	FXO-2M	2-port Analog FXO mini module
	FXO-4M	4-port Analog FXO mini module
	FXS-2M	2-port Analog FXS/DID mini module
	FXS-4M	4-port Analog FXS/DID mini module
	E & M-2M	2-port E & M module mini module
	FXS-24	24-port Analog FXS/DID network module
	FXS-24 Extension Box	24-port analog voice channel connector module

## Memory

The iBG3026 supports the following types of memory:

- Double-Data-Rate Synchronous Dynamic Random Access Memory (DDR SDRAM): This type of memory stores the running configuration and routing tables. It also buffers packets at the network interfaces. The base configuration shipped from the factory is 512 MB of main memory.
- The Small Outline Dual In-line Memory Module (SODIMM) slot can be upgraded to maximum of 1GB.
- Compact Flash memory card: The base configuration shipped from the factory is a 128-MB Compact Flash memory card, which can be upgraded to a maximum of 256-MB. The iBG3026 supports one Compact Flash card slot. Compact Flash is used to store application code images and the system configurations.
- Internal Flash Memory: iBG3026 includes 2 MB of internal flash memory which is used to boot the router.

## Power

Two power supplies may be installed in the iBG3026 in a redundant configuration. The supplies provide load sharing such that, if one of the supplies fails, is turned off, or is removed, the other supply will take over the entire load without affecting router operation. A failed power supply provides a status signal to the processor on the main board, so that the alarm condition can be reported. The failed supply can then be removed and replaced without affecting router operation.

- AC Power Supply supplies +12 VDC at 275 W (23 A at nominal voltage) with an AC input between 90 and 264 VAC.
- AC Power Supply with PoE supplies +12 VDC at 275 W (23 A at nominal voltage) and -48 VDC at 360 W (7.5 A at 48 VDC) with an AC input between 90 and 264 VAC. The 48 VDC supply is isolated from the +12 VDC supply.
- DC Power Supply with PoE supplies +12 VDC at 275 W (23 A at nominal voltage) and -48 VDC at 360 W (7.5 A at 48 VDC) with a DC input between 36 and 72 VDC. The -48 VDC supply is isolated from the +12 VDC supply.

## Ventilation

The fan tray assembly mounts internal to the chassis between the backplane and the front panel of the unit. The LED card is a logic PCB that interfaces between the processor on the main board and the fans and front panel LED indicators.

## Real-Time Clock and NVRAM

The iBG3026 real time clock and Non-Volatile RAM (NVRAM) provide two basic functions to the router:

- It provides a real-time clock so that the iBG3026 can maintain the correct date and time.
- It provides a small block (32 KB) of battery backed up static RAM (SRAM) storage.

# iBG3026 Software Features and Licenses

## Switch/Router Features

Category	Features and Licenses	
L2/L3 LAN Switching	<ul style="list-style-type: none"> <li>- L2/L3 Switching</li> <li>- IPv4/IPv6 Switching</li> <li>- Line-Rate at GbE</li> </ul>	
Layer 2 Protocols	<ul style="list-style-type: none"> <li>- VLAN (802.1q, Port, Protocol, Subnet, Policy Based)</li> <li>- GARP/GVRP</li> <li>- STP, Rapid STP, Multiple STP</li> <li>- Port Mirroring</li> <li>- Link Aggregation</li> <li>- 802.1x Authentication</li> <li>- IGMP Snooping</li> </ul>	
WAN Protocols	<ul style="list-style-type: none"> <li>- ISDN BRI/PRI, HDLC</li> <li>- FR/MLFR, PPP/MLPPP</li> <li>- PPP/MLPPP over ISDN</li> <li>- FR Congestion Management and Traffic Policing</li> </ul>	
Routing Protocols	<ul style="list-style-type: none"> <li>- Static Routing</li> <li>- OSPF v1/v2, RIP v1/v2, BGP4</li> <li>- IGMP v1/v2</li> <li>- PIM-SM/DM, DVMRP</li> <li>- VRRP</li> <li>- Policy-Based Forwarding/Routing</li> </ul>	
Quality of Service	DiffServ	<ul style="list-style-type: none"> <li>- Classification (MF, Flow Label)</li> <li>- Marker (SrTCM/TrTCM)</li> <li>- Policing/Shaping</li> <li>- Queuing (CBQ, PQ)</li> <li>- Scheduling (Deficit RR)</li> <li>- Congestion Avoidance (WRED)</li> </ul>
		<ul style="list-style-type: none"> <li>- Bandwidth Guarantee, SLA</li> <li>- Hierarchical QoS</li> <li>- LF &amp; I</li> <li>- Mapping of IP-QoS to Frame Relay</li> <li>- QoS for FR PVC</li> <li>- LLQ for IPSec Encryption Engine</li> <li>- Tunnel Encapsulation</li> </ul>
Load Balancing	<ul style="list-style-type: none"> <li>- Per Flow (ECMP, LACP)</li> <li>- Per Packet</li> </ul>	

(Continued)

Category	Features and Licenses	
Performance	Routing	<ul style="list-style-type: none"> <li>- IPv4 Forwarding: 530 Kpps</li> <li>- IPv6 Forwarding: 265 Kpps</li> <li>- Max. Route Table Size: 64 K</li> <li>- Max. MAC Table Size: 16 K</li> </ul>
	Switching: 21 Gbps	
Management	<ul style="list-style-type: none"> <li>- Multilevel Administration Access (MLA)</li> <li>- SNMP v1/v2/v3, RMON (1, 2, 3, 9)</li> <li>- CLI, Telnet, NTP, tftp, Bootp, DHCP, SSHv2, SCP</li> <li>- Web based GUI, MIBs</li> <li>- Logging &amp; Reporting, Diagnostic</li> <li>- True Flash File System</li> <li>- System Image rollback</li> <li>- Hot-Swap Handling</li> </ul>	
AAA Client	<ul style="list-style-type: none"> <li>- 802.1x</li> <li>- RADIUS</li> <li>- TACACS+</li> </ul>	

## Security Features

Category	Features and Licenses
Secure Connectivity	<ul style="list-style-type: none"> <li>- IPSec for Site to Site</li> <li>- IPSec for Remote Access</li> <li>- hub-and-spoke support</li> <li>- Encryption (DES, 3DES, AES)</li> <li>- L2TP, GRE</li> <li>- Data Integrity (MD5, SHA-1)</li> <li>- Authentication (XAUTH)</li> <li>- Key Management (Manual, IKE v1, PKI, Preshared, Auto Key Exchange)</li> <li>- NAT Traversal</li> </ul>
Internal Security	<ul style="list-style-type: none"> <li>- AAA, 802.1x</li> <li>- ACL</li> <li>- Policy based VLAN</li> <li>- MAC Address Filtering</li> </ul>
Attack Defense	<ul style="list-style-type: none"> <li>- Route mode</li> <li>- Packet Filtering</li> <li>- Stateful Packet Inspection</li> <li>- NAT (1:1, N:1, Reverse, Dynamic)</li> <li>- ALG (FTP, ICMP, DNS, SIP, H.323, SQL, Net, Messenger, IPSec ESP, IKE, L2TP)</li> <li>- Application Content filtering (Java, ActiveX)</li> <li>- Dos/DDoS Protection</li> <li>- IP/TCP fragment attack protection</li> <li>- IP Spoofing Protection</li> <li>- URL Filtering</li> <li>- Virtual Firewall</li> <li>- DMZ</li> <li>- Behavior-based Detection</li> <li>- Layer 2 Detection</li> <li>- Stateful Signature Detection</li> <li>- Traffic/Protocol Anomaly Detection</li> <li>- Active Response (Drop Packet, Drop Connection)</li> </ul>
Management	<ul style="list-style-type: none"> <li>- Reporting</li> <li>- Logging</li> <li>- Online Signature Update (Weekly, Emergency)</li> </ul>
Certification	<ul style="list-style-type: none"> <li>- Firewall: ICSA</li> <li>- VPN: ICSA, FIPS 140-2</li> </ul>

(Continued)

Category	Features and Licenses	
Performance	Firewall	- Performance: 1.9 Gbps - Concurrent Session: 150 K - New sessions setup rate: 1000 session/Sec
	IPS	- Signature & Behavior based attack detection & Prevention: 1,000 - Performance: 200 Mbps
	VPN/IPSec	- Performance: 313 Mbps - Tunnel: 1,500 - Tunnel Setup rate: 10/sec
	VPN/SSL	- Performance <ul style="list-style-type: none"> <li>• Clientless Mode 38 Mbps</li> <li>• Port Forwarding Mode: 80 Mbps</li> <li>• Full tunnel Mode: 30 Mbps</li> </ul> - Tunnel: 50



## CHAPTER 2. Hardware Overview

Chapter 2 describes the hardware overview.

The Ubigate iBG3026 is enclosed in a rack-mount 2U enclosure, designed for installation in a standard 19-inch and 23-inch rack. The unit is approximately 17.5 in. wide, 16 in. deep and 3.5 in. high. The chassis is enclosed at the front, except for status indicators and an air intake grill. All modules and all cabling, including power cables, are installed from the rear.

### iBG3026 Modularity

The iBG3026 is designed as a modular router, with much of the router's functionality defined by the installed modules. Except for the backplane and the fan tray unit, all active circuitry of the iBG3026 is on modules that may be installed from the rear of the unit. If any of these modules fails, it may be replaced without removing the unit from the rack and without modifying the rest of the router. Further, except for at least one power supply and the main board, all modules are optional.

The dual, redundant power supply modules provide both modularity and redundancy. Different modules provide various combinations of features (AC or DC input power, with or without Power-Over-Ethernet) while the two supplies offer redundant sourcing of router power, in case either of them fails.

### iBG3026 Routing and Switching Engine

The routing and switching engine (main board) installs at the top center of the chassis. It contains the central processor of the router; its core peripherals and memory; a Compact Flash connector; a number of external interfaces, including serial management ports, a Fast Ethernet management port, four Gigabit Ethernet ports [**two Small Form Factor Pluggable (SFP) fiber and two RJ45 10/100/1000 BASE-T**], and a USB port; and three slots for mini modules.

The VoIP, VPN/IPSec and VPN/SSL option cards are small daughter boards that mount on the main board before it is inserted into the chassis and that provide enhanced functionality for the router.

Up to three mini modules can be installed from the rear panel.

They mount directly onto the main board and provide a selection of voice or WAN interface ports to the iBG3026. Mini modules may be installed into an operating system. Mini modules shall be inserted with cables removed.

The Ethernet switch Gigabit card installs to the right of the main board and provides ten Gigabit Ethernet ports for the router (eight UTP ports plus two fiber optic ports). The Ethernet switch Gigabit card may be installed into an operating system. Ethernet switch Gigabit card shall be inserted with cables removed.

Either two standard network modules or a single double-wide network module can be installed below the main board and Ethernet switch Gigabit card.

Network modules provide a selection of high-capacity voice, WAN or Ethernet interface ports to the router. Network modules shall be inserted with cables removed.

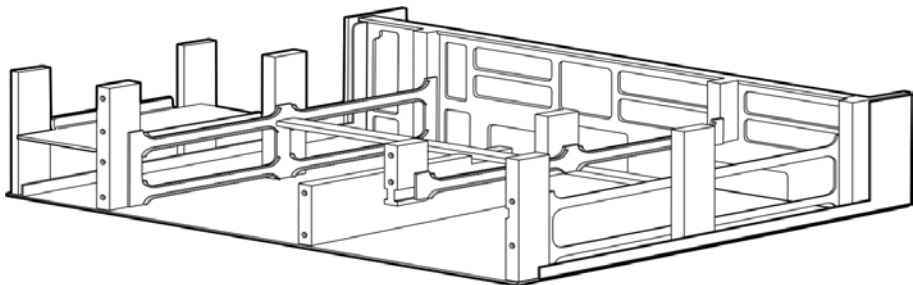
## iBG3026 Chassis

The iBG3026 is designed for mounting in a 19-inch or 23-inch rack.

Different mounting brackets are available for the different rack widths.

All router cabling, including AC or DC power and interface cables, are done at the rear of the unit.

Figure 2.1 is an isometric view of the router from the rear, with both the main chassis and the fan tray unit shown without the external enclosure.



**Figure 2.1 Isometric View**

The fan tray unit (Figure 2.2) mounts directly behind the front panel of the iBG3026 and contains four intake fans and an LED card. The LED card provides fan speed control and thermal sensing, in addition to holding the eight front panel LED indicators.

The backplane mounts directly behind the fan tray unit and provides for the interconnection of all of the modules in the iBG3026. It is a passive backplane with fixed connectors for the various modules. A floating connector on the fan tray unit and self-aligning connectors on the two power supplies and all of the logic modules are used to mate with the backplane. Both power connectors and high-density signal connectors are used for the four logic module positions.

Redundant power supplies install at the left end of the chassis (when viewed from the rear), with the power input connector and on/off switch/circuit breaker on the rear panel of each supply. Both AC and DC power supplies are available that operate redundantly, driving a +12 VDC power rail across the backplane. Local regulators on each logic module provide the required operating voltages. In addition, power supplies with Power-over-Ethernet capability drive a 48 VDC PoE rail across the backplane.

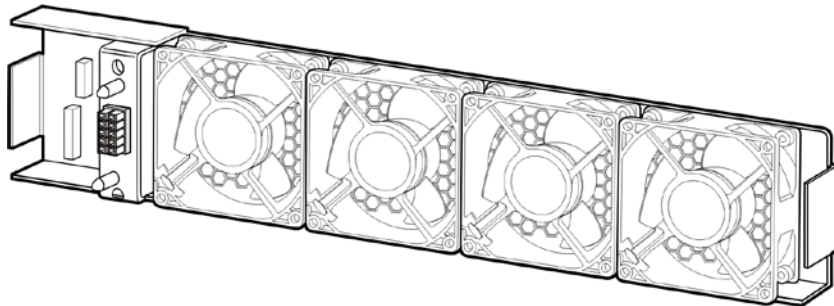


Figure 2.2 Fan Tray

## iBG3026 Boot Sequence

All circuitry within the iBG3026 (except the power supplies and fans) is reset to its initial state by the reset circuitry on the main board. During normal operation, the reset circuitry monitors an internal power supply of the main board and, after it reaches normal operating levels, generates a reset pulse to the routing processor and all of the other circuitry on the main board.

The main board reset circuitry also includes a watchdog timer. The watchdog timer causes the iBG3026 reset if the programmed interval elapses without the processor triggering the watchdog.

iBG3026 boot is the sequence of software-driven events starting from the reset pulse to the loading and running of the application image.

On reset, the processor starts executing instruction from a specific location in the boot ROM. This first software run is the boot loader. After CPU memory controller initialization, the boot loader locates, verifies, and runs a boot image also located in boot ROM. The boot image then continues with the necessary initialization to be able to decompress and move itself to RAM. Once moved to RAM, execution is given to boot software residing in RAM. At this point the more initialization of hardware and driver software is completed until application software can be loaded in to RAM from flash, or alternatively from a networked host. The application software prepares the iBG3026 for packet flow through the interfaces at which time the iBG3026 is fully up and running.

These are various software services that support the application software.

These include the file iBG3026, logging, iBG3026 monitoring, downloaded image validation and flash update.

## iBG3026 Front Panel

The front panel of the iBG3026 provides status of the router's performance and operation by using LEDs. Proper LED status is shown as following.

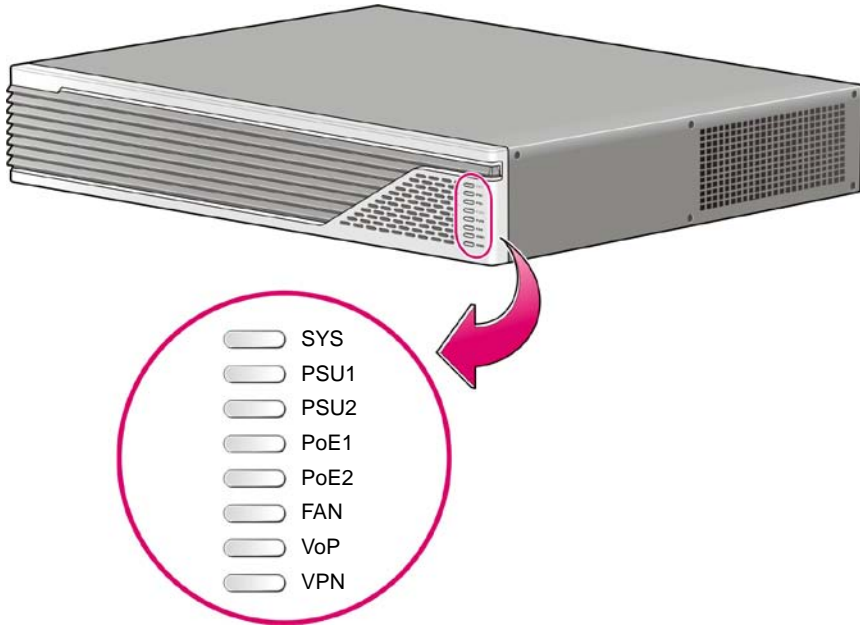


Figure 2.3 iBG3026 Front View

LED	Indication & Color	Description
SYS (Router Power)	Solid green	System is operating normally.
	Blinking green	Running ROM monitor with no errors detected.
	Amber	Router is receiving power but malfunctioning.
	Off	Router is not receiving power.
PSU1 (Power Supply 1)	Solid green	Power supply 1 installed and operating normally.
	Amber	Power supply 1 installed and powered off, or fault condition detected.
	Off	Power supply 1 not present.
PSU2 (Power Supply 2)	Solid green	Power supply 2 installed and operating normally.
	Amber	Power supply 2 installed and powered off, or fault condition detected.
	Off	Power supply 2 not present.

(Continued)

LED	Indication & Color	Description
PoE1 (PoE Power 1)	Solid green	-48 V power module 1 installed and operating normally.
	Amber	-48 V power module 1 installed and powered off, or fault condition detected.
	Off	-48 V power module 1 not present.
PoE2 (PoE Power 2)	Solid green	-48 V power module 2 installed and operating normally.
	Amber	-48 V power module 2 installed and powered off, or fault condition detected.
	Off	-48 V power module 2 not present.
FAN	Solid green	Fan is operating properly
	Amber	Fan present with failure
VoP	Solid green	VoP or IVM card present and enabled.
	Amber or Red	VoP or IVM card present with failure.
	Off	VoP and IVM card not present
VPN	Solid green	VPN card present and enabled.
	Amber or Red	VPN card present with failure.
	Off	VPN card not present

## iBG3026 Rear Panel

The iBG3026 rear panel provides connections for power and networking. The iBG3026 rear panel provides connections for one management Ethernet port, one USB port, a Compact Flash slot, two 10/100/1000 Base-T Ethernet ports, two Gigabit SFP ports, one console port, and one auxiliary port.

The rear panel has the following features.

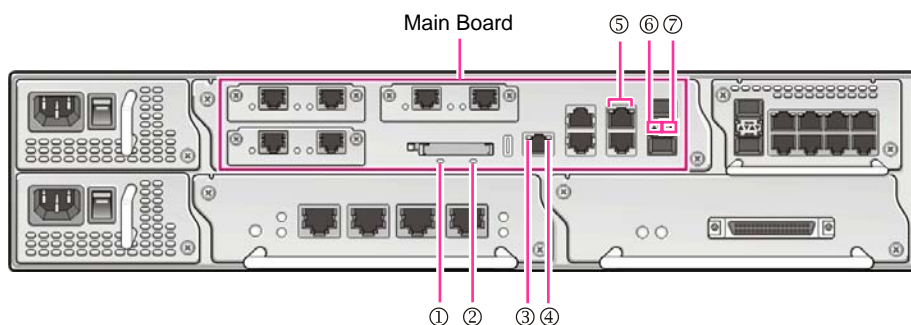


Figure 2.4 iBG3026 Main Board View

### Main Board LED Description

No.	LED	Indication & Color	Description
①	SYS RDY	Solid green	The module's power is normal status.
		Off	Power fail or removal status.
②	CF	Solid green	Compact Flash being accessed
		Off	Compact Flash not mounted or not being accessed.
③	Management port Left LED (Link)	Solid Green	The management Link connected.
		Green Blink	Link connect and transmit data
		Off	The management port is not connected.
④	Management port Right LED (Speed)	Solid Amber	The link Speed is 100 Mbps.
		Off	The link Speed is 10 Mbps.

(Continued)

No.	LED	Indication & Color	Description
⑤	UTP GbE Port LED	Solid Green	Link is established with speed 10/100 Mbps.
		Green Blink	Blinking green indicates transmit/receive activity with speed 10/100 Mbps.
		Solid Amber	Link is established with Speed 1 Gbps.
		Amber Blink	Blinking amber indicates transmit/receive activity with speed 1 Gbps.
		Off	Link fail or no connect.
⑥	GbE SFP Left LED	Solid Green	Link is established with speed 1 Gbps.
		Off	Link fail or no connect.
⑦	GbE SFP Right LED	Blinking Amber	Blinking amber indicates transmit/receive activity with speed 1 Gbps.
		Off	No activity

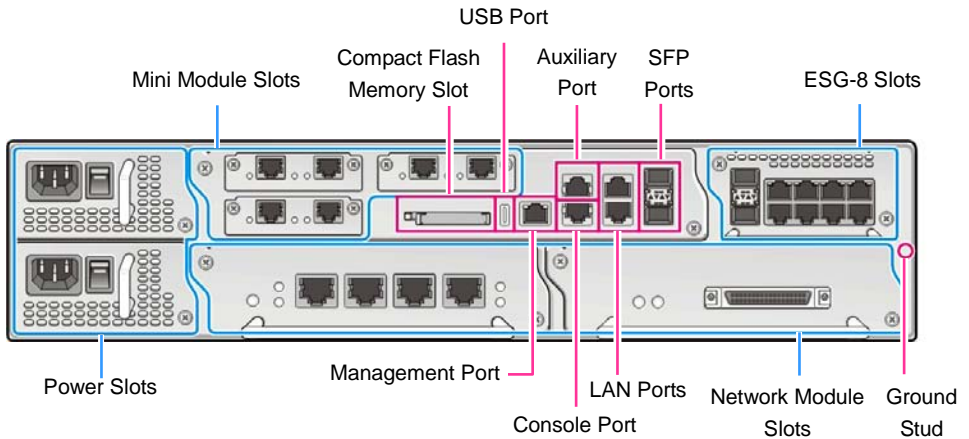


Figure 2.5 iBG3026 Rear View

## Rear Connector Description

Connector	Description
Power Slots	Power slots up to two power supplies for AC, AC with PoE, and DC with PoE.
Mini Module Slots	Up to three mini modules supporting a variety of interfaces
Compact Flash Memory Slot	Slot for Compact Flash memory card
USB Port	Supports USB1.1 interface
Management Port	Supports Fast Ethernet interface
Auxiliary Port	Serial ports supporting remote monitoring
Console Port	Serial ports supporting local monitoring and configuring
LAN Ports	Supports triple speed Ethernet interface
SFP Ports	Support optional Gigabit SFP modules
ESG-8 Slots	Slot for ESG-8 Gigabit Ethernet option module
Network Module Slots	Up to two network modules supporting a variety of Interfaces.
Ground Stud	Screw holes for grounding lug

## Compact Flash Memory Port

The Compact Flash memory card is used to store application code images and system configuration related files.

The Compact Flash memory cards support 64 MB, and 128 MB capacities.

## USB Port

The Universal Serial Bus (USB) port is USB 1.1 compliant. USB interface (Type A) configured as a host. USB flash memory module can be used to store an image or configuration file like a CF memory card. USB flash memory module is non-secure, but is available in 64 MB, 128 MB, or 256 MB capacities.

## Console Port

The console port is an RS-232, serial, asynchronous serial port that operates at 19200 bps. The console port is activated immediately after a reset and allows direct operator interaction with the routing processor using the Command Line Interface.

## Auxiliary Port

The RJ-45 auxiliary port is used for modem connection.

## Management Port

The management port is a Fast Ethernet port that can operate at either 10 Mbps or 100 Mbps. It can be used with telnet to access the Command Line Interface, used as an SNMP agent, or used for web-based management of the iBG3026. It can also be used with Trivial File Transfer Protocol (TFTP) and File Transfer Protocol (FTP) to download software images and configuration files and to upload configuration information.

## LAN Ports

The LAN Ports support two 10/100/1000 Base-T Unshielded Twisted Pair (UTP) ports and two Gigabit Ethernet SFP ports.

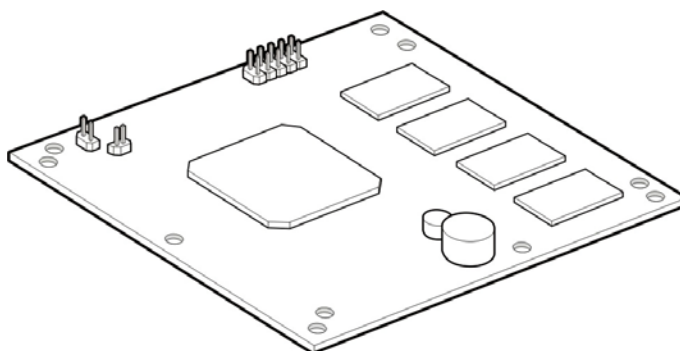
## Module indicators

Each module of the iBG3026 includes LED indicators to indicate overall module status and the status of individual interfaces on the module. See the individual module specifications for additional information.

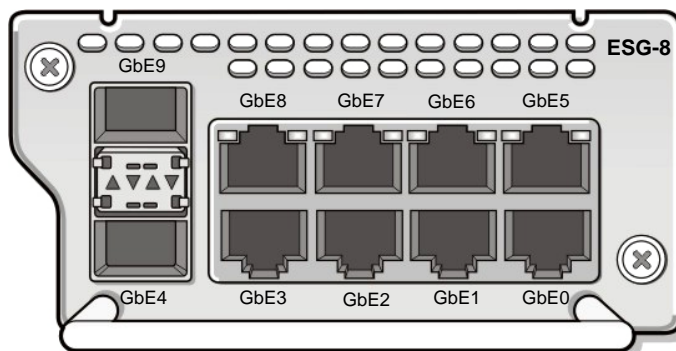
## Modules and Internal Option Cards Types

This section describes the modules supported in iBG3026 release 1.0, including internal option cards, mini modules that connect into dedicated slots in the chassis, network modules and the double-wide Ethernet switch Gigabit module which install into the expansion slot bay.

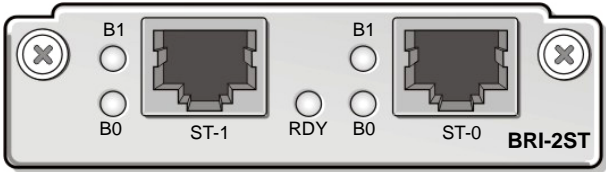
- Internal option card



- Ethernet switch Gigabit module



- Mini module



- Network module



- Double-wide network module

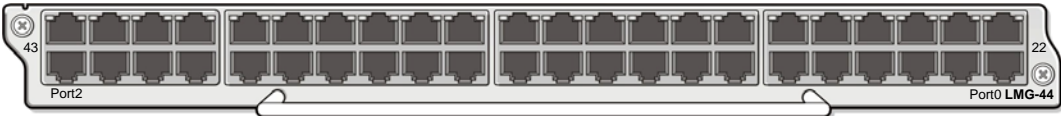


Figure 2.6 Modules and Internal Option Card

## Port Numbering

This section describes the port number conventions used on the iBG3026.

Ports on WAN and LAN module are numbered from right to left starting with port number zero. If there is more than one row of ports on a given module, the bottom row is numbered first from right to left starting at port zero, then the next row up is numbered from right to left starting with the next port number based on the lower rows last (left most) numbered port.

### LAN Ports

All LAN ports are referenced using a two-level 'slot/port' identifier.

#### Main Board LAN Ports Numbering

There are five LAN interfaces on the main processing unit—one 10/100 management port, two optical Gigabit Ethernet ports, and two copper Gigabit Ethernet ports. The one exception in the router to the port numbering rule is that the 10/100 Fast Ethernet management port is declared to be port 0/0. Then the Gigabit Ethernet ports follow the numbering rule and are numbered right to left bottom to top start with one.

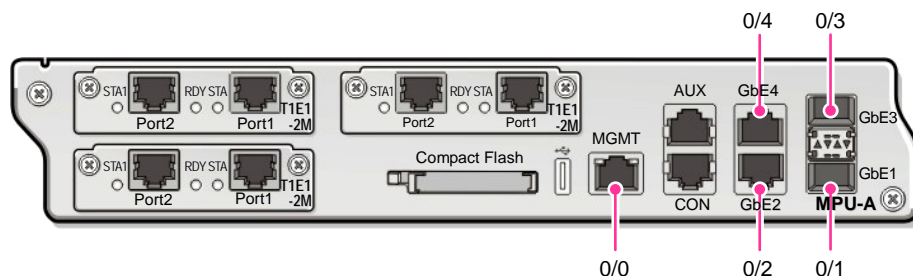


Figure 2.7 Main Board LAN Port Numbering

## Ethernet Switch Gigabit Module Ports Numbering

The switch option module has ten Gigabit Ethernet ports total. Two of them are optical ports and the others are copper ports. Ports are numbered as follows:

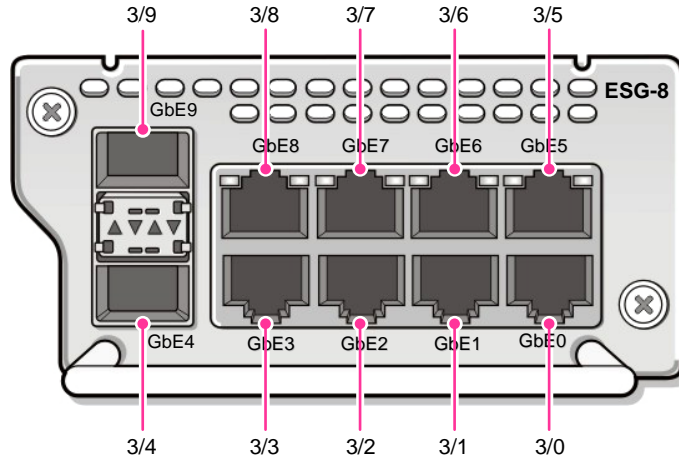


Figure 2.8 Ethernet Switch Gigabit Module Port Numbering

## LAN Modules Ports Numbering

There two types of LAN Module: 20-port and 44-port.

The 20-port LAN module numbering is as follows: (X = 1 or 2)

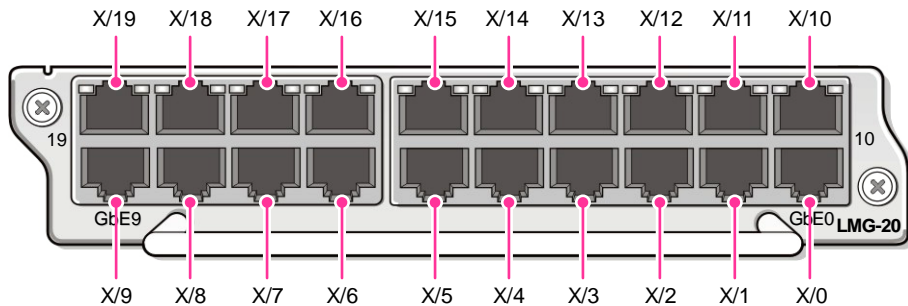


Figure 2.9 20-Port Network Module Port Numbering

The 44-port LAN module numbering is as follows:

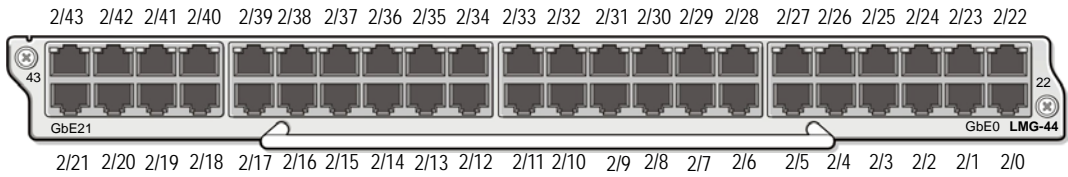


Figure 2.10 44-Port Network Module Port Numbering

## WAN Ports

There are two WAN module form factors, mini modules and network modules. Mini module can have two or four ports. WAN modules have one or four ports. The port numbering starts with port number zero on all WAN modules.

### Mini Module Ports Numbering

Mini modules have two or four ports. Port numbering is from right to left starting with port number zero: (X = 0, 1, or 2)

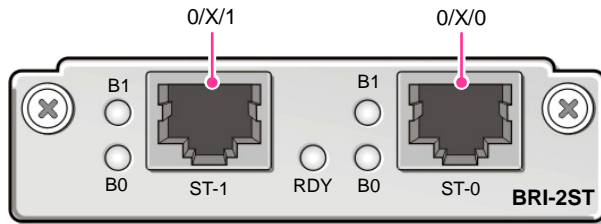


Figure 2.11 2-Port Mini Module Port Numbering

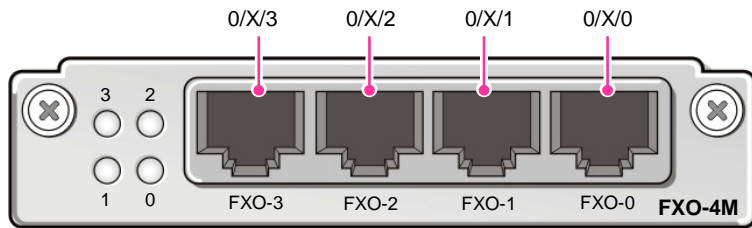


Figure 2.12 4-Port Mini Module Port Numbering

## WAN Module Ports Numbering

WAN modules come in one port or four port configurations.

The port numbering is also from right to left starting at port number zero:

(X = 1 or 2)

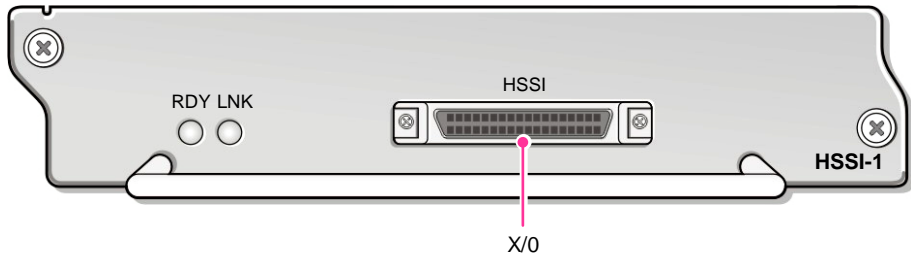


Figure 2.13 1-Port WAN Module Port Numbering

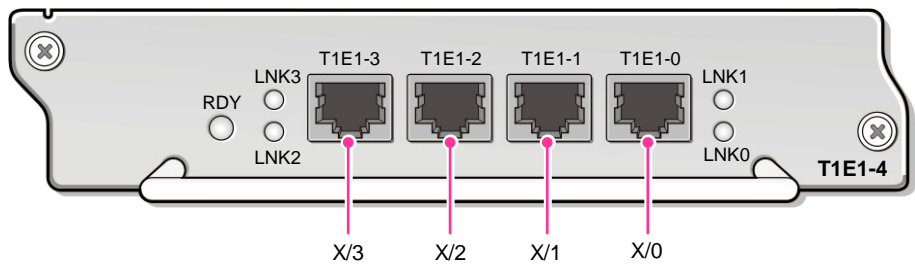


Figure 2.14 4-Port WAN Module Port Numbering

## Mini Modules

### Main Board Mini Module Ports Numbering

When a mini module is plugged into a carrier module, a three-level numbering reference is used to identify the ports on the mini module.

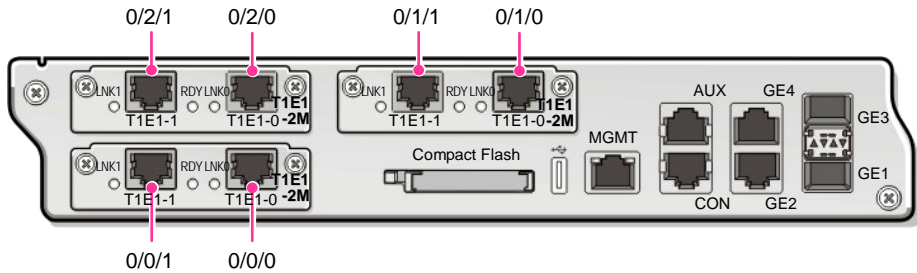


Figure 2.15 Main Board Mini Module Ports Numbering

### Voice Carrier Module Ports Numbering

Voice carrier modules can have voice-only mini modules plugged into them. Here is an example of a voice carrier module with a 2-port mini module in sub-slot 0, and a 2-port mini module in sub-slot 1: (X = 1 or 2)

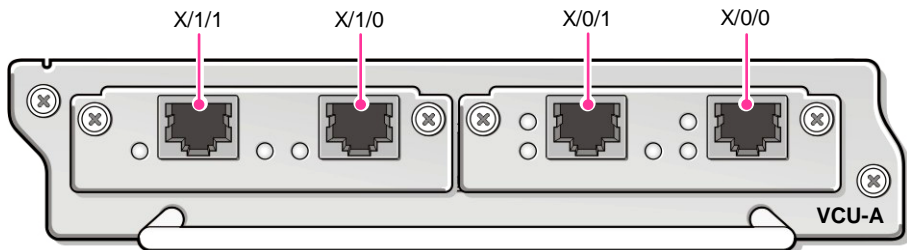


Figure 2.16 Voice Carrier and Mini Module Ports Numbering

## Port Numbering Examples

Port	Numbering	Corresponding Ports
Main board LAN Ports	0/0	Fast Ethernet management port.
	0/1 and 0/3	Optical Gigabit Ethernet ports.
	0/2 and 0/4	Copper Gigabit Ethernet ports.
Ethernet Switch Gigabit Module Ports	3/4	The lower optical Gigabit Ethernet ports.
	3/9	The upper optical Gigabit Ethernet port.
	3/0 thru 3/3	The lower four copper Gigabit Ethernet ports numbered from right to left.
	3/5 thru 3/8	The upper four copper Gigabit Ethernet ports numbered from right to left.
LAN Module Port	1/0 thru 1/9	The lower row of Ethernet ports numbered from right to left on the 20-port LAN module in slot 1, the right hand network module slot.
	2/10 thru 2/19	The upper row of Ethernet ports numbered from right to left on a 20-port LAN module in right hand network module slot.
	2/0 thru 2/21	Lower row of Ethernet ports numbered from right to left on a 44-port LAN module.
	2/22 thru 2/43	Upper row of Ethernet ports numbered from right to left on a 44-port LAN module.
WAN Module Port	1/0	Right most port on the WAN module in the right hand network module slot.
	2/3	Left most port of four ports on the WAN module in the left hand network module slot.
Mini Module Ports	0/0/0	Port zero on a mini module in sub-slot zero in main board in slot zero.
	0/2/3	Port three on a mini module in sub-slot two in main board in slot zero.
Voice Carrier Module (VCU-A) Port	1/0/0	Right most port on the voice mini module in the right hand sub-slot in the voice carrier module plugged into the right hand network module slot.
	2/1/3	Left most port on a four port voice mini module in the left hand sub-slot in the voice carrier module plugged into the left hand network module slot.

## Modules and Option Cards

### Internal Option Cards

#### VPN-A, VPN-SSL (IPSec VPN, SSL VPN Option Cards)

The IPSec VPN and SSL VPN option card provide high-performance security processing for packets passing through the iBG3026. It includes a security processor that is a part of the router subsystem. Like the VoIP option card, it is an internal card that mounts above the main board and must be installed onto the main board before it is inserted into the chassis. VPN option boards are not hot-swappable.

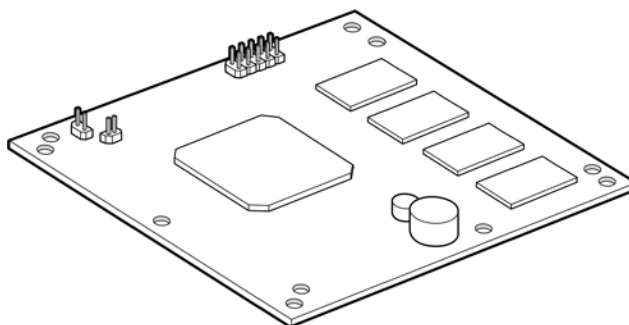


Figure 2.17 VPN-A, VPN-SSL Internal Option Card

#### VoP-32, VoP-64, VoP-128 (VoIP Option Cards)

The VoIP option card is the root of the voice subsystem and must be installed to have any voice features. It includes a VoIP Processing DSP and a TDM switch. It is an internal card that mounts above the main board and must be installed onto the main board before it is inserted into the chassis. VoP option boards are not hot-swappable.

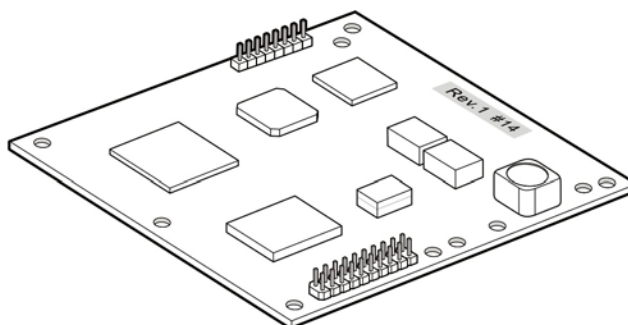


Figure 2.18 VoP-32, 64, 128 Internal Option Cards

## IVM-U2 (Integrated Voice Mail Option Card)

The IVM-U2 option card performs two main functions: VoIP function and VM (Voice Mail) function. Using this option card, iBG3026 can provide a voice gateway feature and voice mail feature. It must be installed on the dedicated slot of the main board before the main board is inserted into the chassis.

IVM-U2 is not hot-swappable.

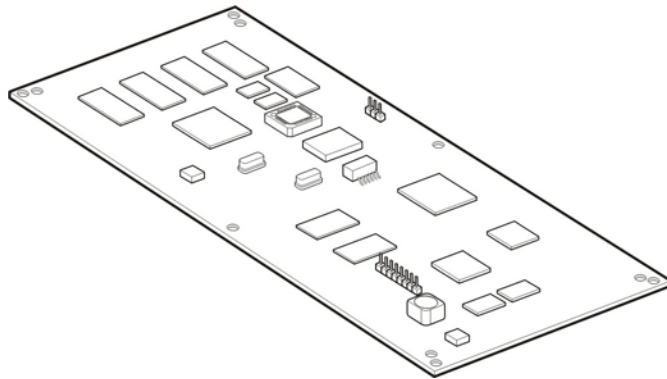


Figure 2.19 IVM Internal Option Card

## WAN Interface Module

### BRI-2ST (2-Port ISDN BRI S/T Mini Module)

This module provides two ISDN BRI S/T interface ports, each supporting two voice or data timeslots. Voice timeslots connect to the voice subsystem while data timeslots connect into the router subsystem.

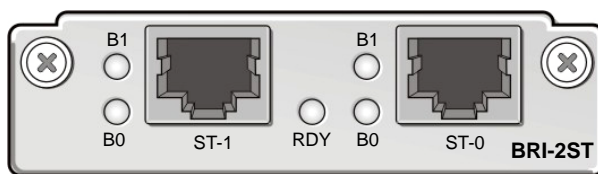


Figure 2.20 BRI-2ST Mini Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
RDY	GREEN	The module passed it's self-test and is available to the router
	OFF	Reset, Power down, Removal state
ST-0 B0	GREEN	Active connection on the first B channel in port 0
	OFF	Disconnected on the first B channel in port 0
ST-0 B1	GREEN	Active connection on the second B channel in port 0
	OFF	Disconnected on the second B channel in port 0
ST-1 B0	GREEN	Active connection on the first B channel in port 1
	OFF	Disconnected on the first B channel in port 1
ST-1 B1	GREEN	Active connection on the second B channel in port 1
	OFF	Disconnected on the second B channel in port 1

### BRI-2U (2-Port ISDN BRI U Mini Module)

This module provides two ISDN BRI U interface ports, each supporting two voice or data timeslots. The ISDN BRI U mini module interfaces to ISDN basic rate networks and supports two 64 Kbps B channels and a 16 Kbps D channel.

The ISDN BRI U mini module may be configured as either an LT (network end) or NT (CPE end). The ISDN BRI U mini module provides 2B1Q encoding

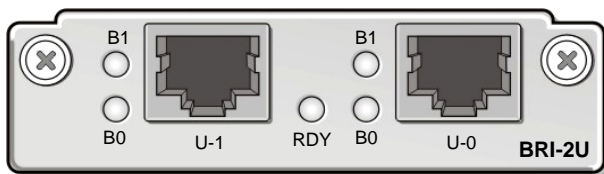


Figure 2.21 BRI-2U Mini Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
RDY	GREEN	The module passed it's self-test and is available to the router
	OFF	Reset, Power down, Removal state
U-0 B0	GREEN	Active connection on the first B channel in port 0
	OFF	Disconnected on the first B channel in port 0
U-0 B1	GREEN	Active connection on the second B channel in port 0
	OFF	Disconnected on the second B channel in port 0
U-1 B0	GREEN	Active connection on the first B channel in port 1
	OFF	Disconnected on the first B channel in port 1
U-1 B1	GREEN	Active connection on the second B channel in port 1
	OFF	Disconnected on the second B channel in port 1

## T1E1-2M (2-Port T1/E1 Mini Module)

This 2-Port T1/E1 mini module provides two T1 ports, each running at 1.544 Mbps and supporting 24 voice or data timeslots, or two E1 ports, each running at 2.048 Mbps and supporting 30 voice or data timeslots.

This module supports generic 1- or 2-port T1 or E1 trunk interfaces for voice, data, and integrated voice and data applications. The mini module provides basic structured and unstructured service for T1 or E1 networks.

The mini module can be used as trunk interfaces for voice and data services, as fractional  $n \times 64$ -kbps service for WANs (Frame Relay or leased line), or for time-division multiplexing (TDM) drop-and-insert (voice and data integration) services.

The T1/E1 mini modules provide voice and data access to the PSTN domain through TDM ports, and include an integrated Channel Service Unit/Data Service Unit (CSU/DSU).



Figure 2.22 T1E1-2M Mini Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
RDY	Green	The mini module is operational and power on.
	Off	Indicates the port is power down.
LNK 0	Green	Indicates the port is enabled. (Carrier Detect)
LNK 1	Amber	Indicates an alarm condition exists on the remote end of one of the T1/E1 ports. On Remote End, detected alarm condition: - RDI (Remote Detect Indication) - AIS (Alarm Indication Signal).
	Red	Indicates an alarm condition exists locally on one of the T1/E1 ports. Locally, detected alarm condition: - LOS (Loss of signal) - OOF (Out-of-Frame)
	Off	Indicates that the port is not enabled, and no alarms detected on any port.

## T1E1-4 (4-Port T1/E1 Network Module)

This module provides four T1 ports, each running at 1.544 Mbps and supporting 24 data timeslots, or four E1 ports, each running at 2.048 Mbps and supporting 30 data timeslots.

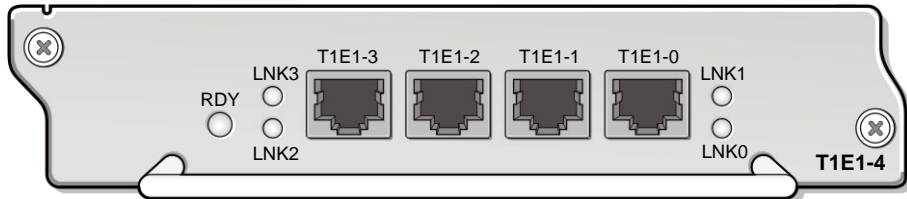


Figure 2.23 T1E1-4 Network Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
RDY	Solid Green	Network module is operational and power on.
	Off	Indicates the port is power down.
LNK 0	Green	Indicates the port is enabled. (Carrier Detect)
LNK 1	Amber	Indicates an alarm condition exists on the remote end of one of the T1/E1 ports. On Remote End, detected alarm condition: - RAI (Remote Alarm Indication) - AIS (Alarm Indication Signal).
LNK 2		
LNK 3	Red	Indicates an alarm condition exists locally on one of the T1/E1 ports. Locally, detected alarm condition: - LOS (Loss of signal) - LOF (Loss of frame)
	Off	Indicates no alarms detected on any port.

## WTE-4S (4-Port Serial Network Module)

This module provides four serial ports, each running in either DTE or DCE mode at a data rates up to 8.0 Mbps. The interface mode for each port may be independently selected as V.35, RS-232/V.28, RS-449/V.11, EIA-530, EIA-530A, or X.21/RS-422.

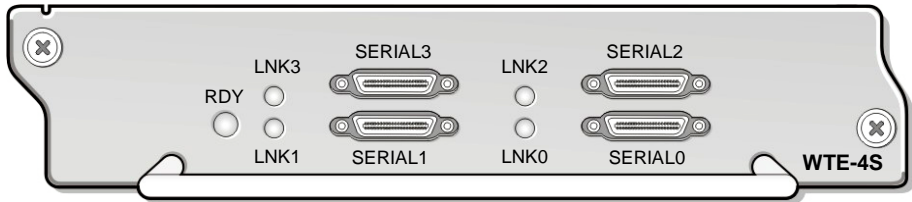


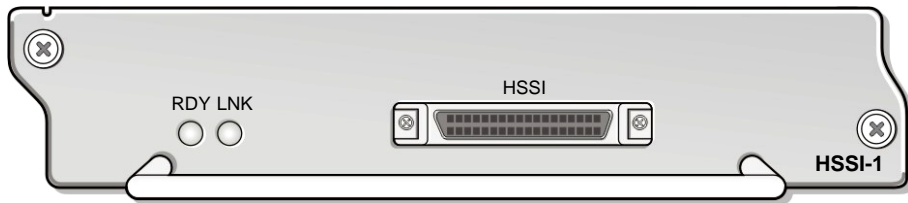
Figure 2.24 WTE-4S Network Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
RDY	Green	All diagnostics pass, and the network module is operational.
	Off	Power down or removal status.
LNK 0 LNK 1 LNK 2 LNK 3	Green	Green indicates normal operation. The module is connected to the external DSU, and the signals TA (DTE available) and CA (DCE available) are active.
	Red	Red indicates serial interface error. Mismatch between serial cable and interface type or operation mode.
	Amber	Loopback mode on
	Off	LED off indicates that the port is neither connected to the DSU nor in loopback mode.

## HSSI-1 (High-speed Serial Interface Network Module)

This module provides a single HSSI DTE or DCE serial port that operates at up to 52.0 Mbps.



**Figure 2.25 HSSI-1 Network Module**

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
RDY	Solid-green	The solid-green indicate that the module has passed its self-test and is available to the router.
	Off	Indicates the port is Power down.
LNK	Green	Green indicates normal operation. The module is connected to the external DSU, and the signals TA (DTE available) and CA (DCE available) are active.
	Red	Red indicates no ST (send time) alarm in DCE mode.
	Amber	Loop back mode on (LA, LB, LC)
	Off	LED off indicates that the port is neither connected to the DSU nor in loopback mode.

## WT3-1C (Channelized DS3 Network Module)

This module provides a single Digital Signal level-3 (DS3) port, operating at 44.736 Mbps. The DS3 serial data is channelized as either 28 independent T1 links or as 21 independent E1 links. Each T1 or E1 link is further channelized into 24 or 32 timeslots, respectively.

The module connects into the Router subsystem.

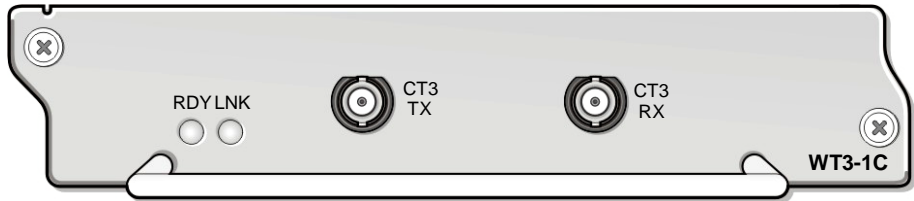


Figure 2.26 WT3-1C Module

LED	Indication & Color	Description
RDY	Solid-green	The solid-green indicate that the module has passed its self-test and is available to the router.
	Off	In the status of power-down or card-remove.
LNK	Green	Port is online with no alarms or failures. CD
	Amber	Port is online with alarms or remote failures. AIS, RDI/RAI
	Red	Port is active with a local alarm; failure detected. LOS, OOF
	Off	Port is not enabled.

## ATOP-1 (1-Port ADSL Over POTS Mini Module)

This mini module provides ADSL high-speed digital data transfer between a single CPE subscriber and the central office.

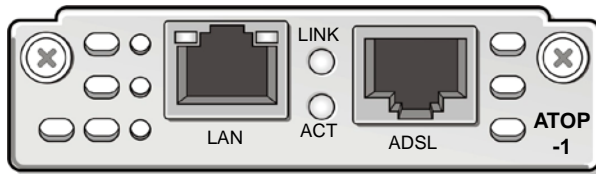


Figure 2.27 ATOP-1 Mini Module

The following table explains the LEDs states in detail.

### ADSL Port LEDs

LED	Indication & Color	Description
LINK	Solid Green	Indicates that the Link is established
	Blinking Green	Indicates that the Link is being established
	Off	Indicates that the port is not enabled
ACT	Solid Green	Indicates that the transmit/receive is not active
	Blinking Green	Indicates that the transmit/receive is active
	Off	Indicates that the port is not enabled

### LAN Port LEDs

LED	Indication & Color	Description
Link	Solid Green	Link is established with speed 10/100 Mbps.
	Off	Link failure or no connection.
Activity	Blinking Orange	Blinking orange indicates transmit/receive activity with speed 10/100 Mbps.
	Off	No activities.

## ATOI-1 (1-Port ADSL Over ISDN Mini Module)

This mini module provides ADSL high-speed digital data transfer between a single CPE subscriber and the central office.

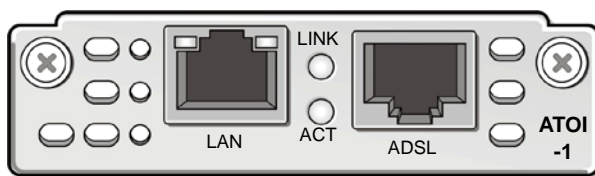


Figure 2.28 ATOI-1 Mini Module

The following table explains the LEDs states in detail.

### ADSL Port LEDs

LED	Indication & Color	Description
LINK	Solid Green	Indicates that the Link is established
	Blinking Green	Indicates that the Link is being established
	Off	Indicates that the port is not enabled
ACT	Solid Green	Indicates that the transmit/receive is not active
	Blinking Green	Indicates that the transmit/receive is active
	Off	Indicates that the port is not enabled

### LAN Port LEDs

LED	Indication & Color	Description
Link	Solid Green	Link is established with speed 10/100 Mbps.
	Off	Link failure or no connection.
Activity	Blinking Orange	Blinking orange indicates transmit/receive activity with speed 10/100 Mbps.
	Off	No activities.

## LAN Interface Modules

### ESG-8 (10-port Ethernet Switch Gigabit Module)

The Ethernet Switch Gigabit module provides ten Gigabit Ethernet ports that connect directly to an Ethernet switching subsystem. Eight RJ-45 10/100/1000 BASE-T ports and two Small Form Factor Pluggable (SFP) optical Gigabit Ethernet ports are available. The packet processor communicates with the Ethernet switch on the main board across Gigabit Ethernet links and it connects to each of the network modules.

SFP modules can be installed or removed without powering down the router.



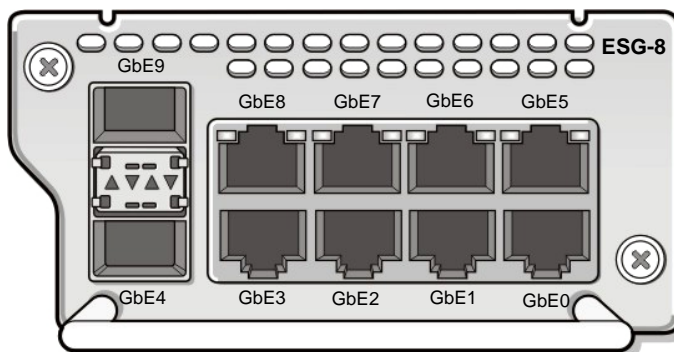
To comply with the Telcordia GR-1089 NEBS standard for electromagnetic compatibility and safety, connect only to intra-building or non-exposed wiring or cabling.

The 10-port Ethernet Switch Gigabit card supports the following SFP modules shown in the following table.

GbE SFP Transceiver Type	Vendor Part Number	Wavelength	Maximum Distance
1000 BASE-SX	AFBR-57L5APZ	850 nm	500 m
1000 BASE-LX/LH	AFCT-57L5APTZ	1310 nm	10 km



SFPs include a laser transceiver on the fiber-optic uplink port. Use of controls or adjustments of performance or procedures other than those specified in this manual may result in hazardous radiation exposure.



**Figure 2.29 ESG-8 Network Module**


The following table explains the LEDs states in detail.

LED	Indication & Color	Description
GbE Port LED (GbE0~GbE3, GbE5~GbE8)	Solid Green	Link is established with speed 10/100 Mbps.
	Blinking Green	Blinking green indicates transmit/receive activity with speed 10/100 Mbps.
	Solid Amber	Link is established with Speed 1 Gbps.
	Blinking Amber	Blinking Amber indicates transmit/receive activity with speed 1 Gbps.
	Off	Link Fail or no connect.
SFP Left LED	Solid Green	Link is established with speed 1 Gbps.
	Off	Link Fail.
SFP Right LED	Blinking Amber	Blinking Amber indicates transmit/receive activity with speed 1 Gbps.
	Off	No activity.

## ESF-10 (10-port Ethernet Switch Gigabit Module for SFP)

The Ethernet Switch Gigabit module for SFP provides ten Gigabit Ethernet ports that connect directly to an Ethernet switching subsystem. Ten Small Form Factor Pluggable (SFP) optical Gigabit Ethernet ports are available. The packet processor communicates with the Ethernet switch on the main board across Gigabit Ethernet links and it connects to each of the network modules.


SFP modules can be installed or removed without powering down the router.



To comply with the Telcordia GR-1089 NEBS standard for electromagnetic compatibility and safety, connect only to intra-building or non-exposed wiring or cabling.

The 10-port Ethernet Switch Gigabit card supports the following SFP modules shown in the following table.

GbE SFP Transceiver Type	Vendor Part Number	Wavelength	Maximum Distance
1000BASE-SX	AFBR-57L5APZ	850 nm	500 m
1000BASE-LX/LH	AFCT-57L5APTZ	1310 nm	10 km



SFPs include a laser transceiver on the fiber-optic uplink port. Use of controls or adjustments of performance or procedures other than those specified in this manual may result in hazardous radiation exposure.

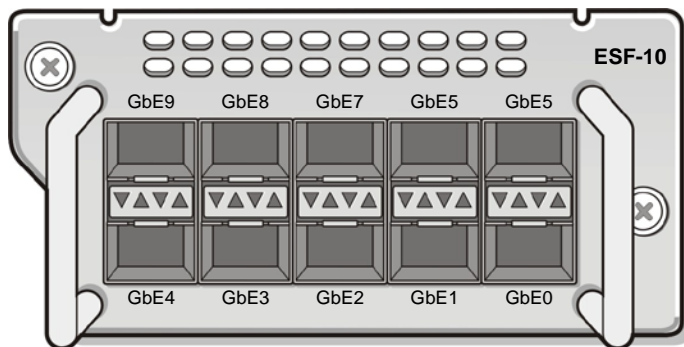


Figure 2.30 ESF-10 Network Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
SFP Left LED	Solid Green	Link is established with speed 1 Gbps.
	Off	Link Fail.
SFP Right LED	Blinking Amber	Blinking Amber indicates transmit/receive activity with speed 1 Gbps.
	Off	No activity.

## LMG-20 (20-Port Gigabit Ethernet Network Module)

This module provides 20 10/100/1000 Base-T Ethernet ports and installs in one of the bottom expansion slots.

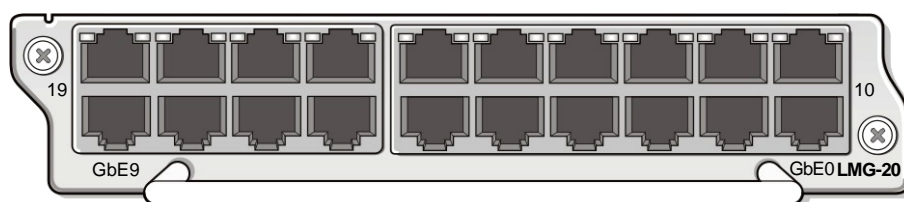


Figure 2.31 LMG-20 Network Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
Bi-color LED	Solid Green	Link is established with speed 10/100 Mbps.
	Blinking Green	Blinking Green indicates transmit/receive activity with speed 10/100 Mbps.
	Solid Amber	Link is established with speed 1 Gbps.
	Blinking Amber	Blinking Amber indicates transmit/receive activity with speed 1 Gbps.
	Led Off	Link Fail or No connect.

## LMF-20 (20-Port Fast Ethernet Network Module)

This module provides 20 10/100 Base-T Ethernet ports and installs in one of the bottom expansion slots.

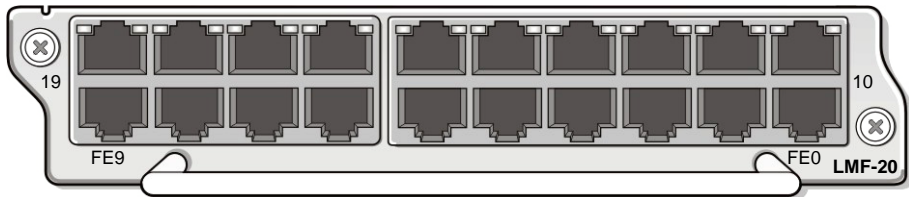


Figure 2.32 LMF-20 Network Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
(Link & Activity)	Solid Green	Link is established with speed 10/100 Mbps.
	Blinking Green	Blinking green indicates transmit/receive activity with speed 10/100 Mbps.
	Off	Link Fail or no connect.

## LMP-20 (20-Port PoE Fast Ethernet Network Module)

This module provides 20 10/100 Base-T Ethernet ports each capable of supporting Power over Ethernet devices. Install this module in one of the bottom expansion slots.

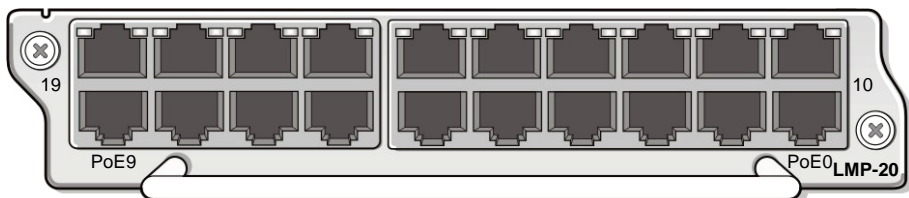


Figure 2.33 LMP-20 Network Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
(Link & Activity)	Solid Green	Link is established with speed 10/100 Mbps.
	Blinking Green	Blinking Green indicates transmit/receive activity with speed 10/100 Mbps.
	Off	Link Fail or no connect.

## LMG-44 (44-Port Gigabit Ethernet Network Module)

This module provides 44 10/100/1000 Base-T Ethernet ports and installs in both of the bottom expansion slots.

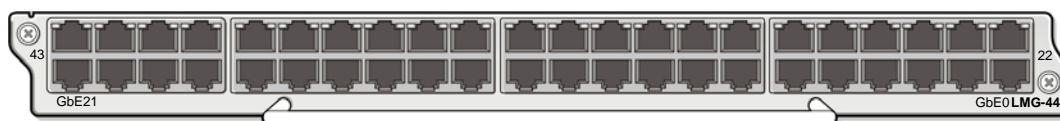


Figure 2.34 LMG-44 Network Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
Bi-color LED	Solid Green	Link is established with speed 10/100 Mbps.
	Blinking Green	Blinking Green indicates transmit/receive activity with speed 10/100 Mbps.
	Solid Amber	Link is established with speed 1 Gbps.
	Blinking Amber	Blinking Amber indicates transmit/receive activity with speed 1 Gbps.
	Led Off	Link Fail or No connect.

## LMGP-44 (44-Port PoE Gigabit Ethernet Network Module)

This module provides 44 10/100/1000 Base-T Ethernet ports each capable of supporting Power over Ethernet devices. Install this module in both of the bottom expansion slots.

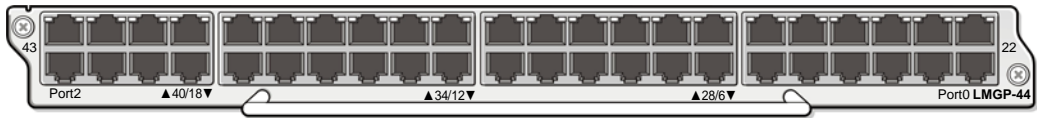


Figure 2.35 LMGP-44 Network Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
Bi-color LED	Solid Green	Link is established with speed 10/100 Mbps.
	Blinking Green	Blinking Green indicates transmit/receive activity with speed 10/100 Mbps.
	Solid Amber	Link is established with speed 1 Gbps.
	Blinking Amber	Blinking Amber indicates transmit/receive activity with speed 1 Gbps.
	Led Off	Link Fail or No connect.

## Voice Modules

### VCU-A (Voice Carrier Network Module)

This module installs as a network module and can hold any pair of mini modules. Thus, it can be used to add additional FXO, FXS/DID, E & M, T1/E1 or ISDN mini modules to the iBG3026. The maximum number of voice mini modules supported by an iBG3026 is seven (three mini module slots, two network modules with two voice mini modules each).

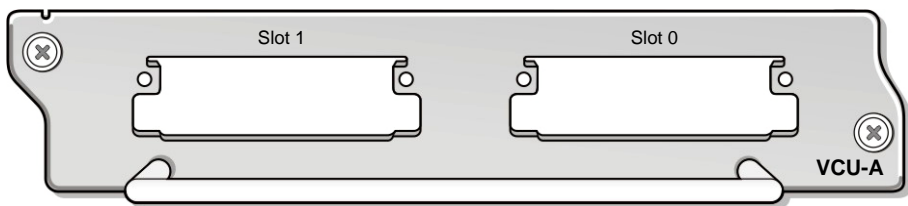


Figure 2.36 VCU-A Network Module

### FXO-2M (2-Port Analog FXO Mini Module)

This module provides two analog voice channel ports for connections to Plain Old Telephone Services (POTS) telephones. The voice channels connect to the voice subsystem.

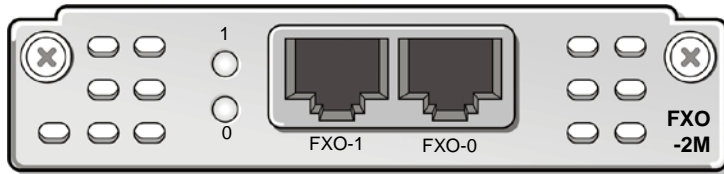


Figure 2.37 FXO-2M Mini Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
0	Green	The port0/1 connection is active.
1	Amber	The port0/1 connection is abnormal or initial state.
	Red	The port0/1 connection is in alarm status.
	Off	The port0/1 activity is occurring.

## FXO-4M (4-Port Analog FXO Mini Module)

This module provides four analog voice channel ports for connections to Plain Old Telephone Services (POTS) telephones. The voice channels connect to the voice subsystem.

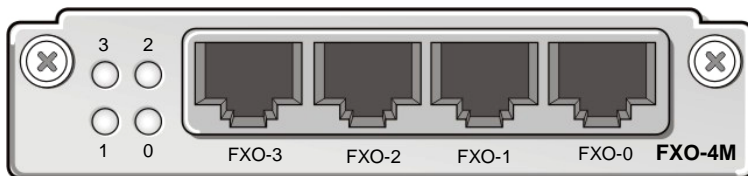


Figure 2.38 FXO-4M Mini Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
0	Green	The port0/1/2/3 connection is active.
1	Amber	The port0/1/2/3 connection is abnormal or initial state.
2	Red	The port0/1/2/3 connection is in alarm status.
3	Off	The port0/1/2/3 activity is occurring.

## FXS-2M (2-Port Analog FXS/DID Mini Module)

This module provides two analog voice channel ports for connections to PBX station lines or FXS/DID lines from a central office of the Public Switched Telephone Network (PSTN). The voice channels connect to the voice subsystem.

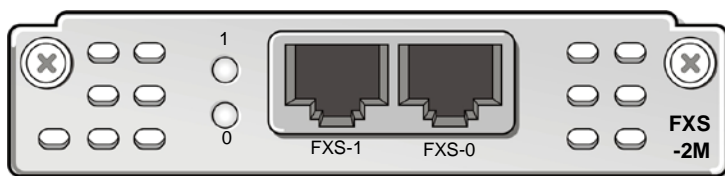


Figure 2.39 FXS-2M Mini Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
0	Green	The port0/1 connection is active.
1	Amber	The port0/1 connection is abnormal or initial state.

## FXS-4M (4-Port Analog FXS/DID Mini Module)

This module provides four analog voice channel ports for connections to PBX station lines or FXS/DID lines from a central office of the Public Switched Telephone Network (PSTN). The voice channels connect to the voice subsystem.

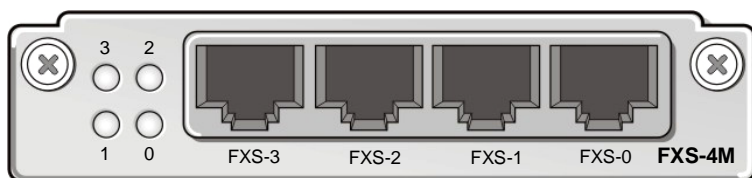


Figure 2.40 FXS-4M Mini Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
0	Green	The port0/1/2/3 connection is active.
1	Amber	The port0/1/2/3 connection is abnormal or initial state.
2		
3		

## E & M-2M (2-Port E & M Mini Module)

This module provides internetworking functions for POTS, and trunk interfaces. The E & M (Ear and Mouse) voice mini module is a mini module that mates with the main board and/or the voice carrier module. The E & M interface module is a mini module that slide into the voice network module.

The E & M mini module used:

Mainly between PBXs or other network-to-network telephony switches.

There are four main parameters defining the different analog E & M implementations:

- E & M Interface Types and Wiring Arrangement (Type I, II, III and V)
- Audio Implementation (two-wire/four-wire)
- Start Dial Supervision Signaling (immediate, wink and delay)
- Address Signaling (pulse, DTMF)

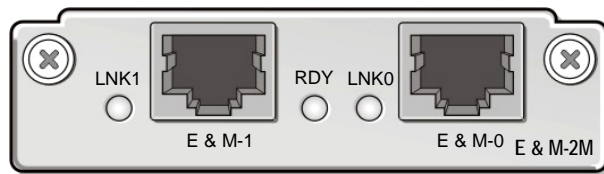


Figure 2.41 E & M-2M Mini Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
RDY	GREEN	The module passed it's self-test and is available to the router.
	OFF	Reset, power down, Removal state.
LNK0 LNK1	Green	The port0/1 connection is active.
	Amber	The port0/1 connection is abnormal or initial state.
	Red	The port0/1 connection is in alarm status.
	Off	No port0/1 activity is occurring.

## FXS-24 (24-Port Analog FXS/DID Network Module)

This module provides 24 analog voice channel ports for connections to POTS telephones. The voice channels connect to the voice subsystem.

(Actually, FXS-24 provides only 12 ports, and It will be increased 24 ports by FXS-4E sub-board. One FXS-4E sub-board provide 4 ports)

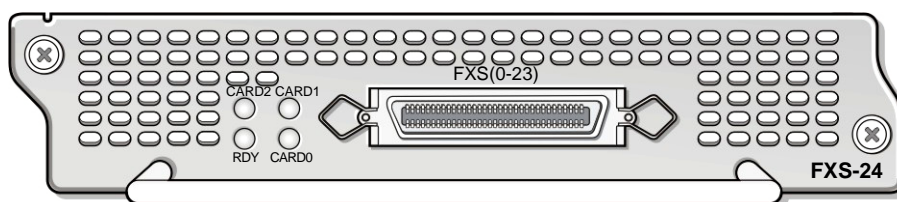


Figure 2.42 FXS-24 Network Module

The following table explains the LEDs states in detail.

LED	Indication & Color	Description
RDY	GREEN	All diagnostics pass, and the network module is operational.
	OFF	Reset, power down or removal status.
CARD0	Solid Green	Internal extension card present
CARD1	Off	Internal extension card not present
CARD2	Off	

## FXS-24 Extension Box

This module provides 24 port analog voice channel connector between FXS-24 module and telephones. It has 24 RJ-11 connector in the front side and 1 champ connector in the rear side.

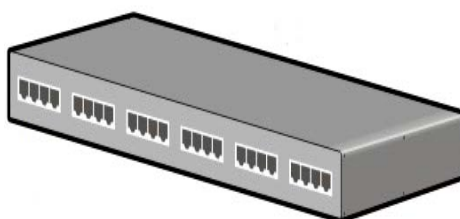


Figure 2.43 FXS-24 Extension Box

## iBG3026 Power System

The iBG3026 uses a distributed regulator power. All of the input and output voltages are isolated from chassis ground.

Two redundant power supplies may be installed, each capable of powering the entire router. Each supply has a single +12 Volts Direct Circuit (VDC) power output. For systems with Power-over-Ethernet (PoE) ports, an additional isolated +48 VDC power output is provided.

The backplane distributes the +12 VDC power rail to all modules and the +48 VDC power rail to the network modules. The main board further distributes the power rail to the mini modules and option cards.

Three power supply models available for your iBG3026. At least one power supply must be installed, with a second supply providing redundancy in case one supply fails.

Each power supply has its own power input connector, either a standard 3-prong AC power socket or a DC power terminal strip, and on/off switch/circuit breaker. Input power is isolated and may come from separate power mains to provide additional redundancy.

### AC Power Supply

Supplies +12 VDC at 275 W (23 A at nominal voltage) with an AC input between 90 and 264 VAC.

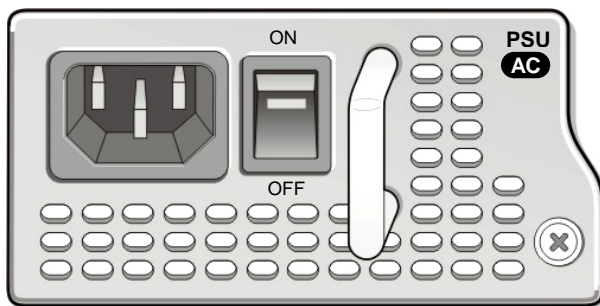


Figure 2.44 AC Power Supply

## AC Power Supply with PoE

Supplies +12 VDC at 275 W (23 A at nominal voltage) and 48 VDC at 360 W (7.5 A at 48 VDC) with an AC input between 90 and 264 VAC.

The 48 VDC supply is isolated from the +12 VDC supply.

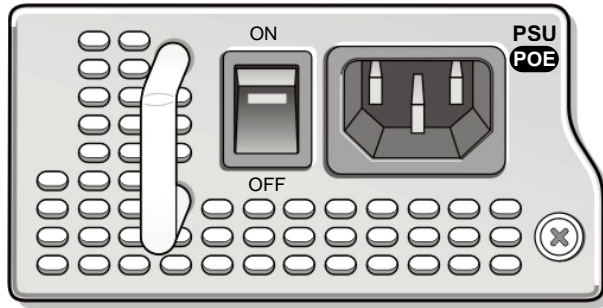


Figure 2.45 AC Power Supply with POE

## DC Power Supply with PoE

Supplies +12 VDC at 275 W (23 A at nominal voltage) and 48 VDC at 360 W (7.5 A at 48 VDC) with a DC input between 36 and 72 VDC.

The 48 VDC supply is isolated from the +12 VDC supply.

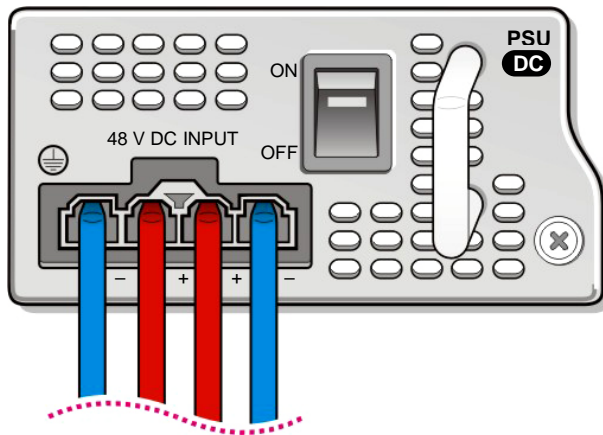


Figure 2.46 DC Power Supply with POE

## Power Supply Redundancy

Two power supplies may be installed in the iBG3026 chassis in a redundant configuration. The supplies provide load sharing such that, if one of the supplies fails, is turned off, or is removed, the other supply will take over the entire load without affecting iBG3026 operation. A failed power supply provides a status signal to the processor on the main board, so that the alarm condition can be reported. The failed supply can then be removed and replaced without affecting iBG3026 operation.

## iBG3026 Cooling System

The four fans that are part of the fan tray unit provide air circulation to cool the circuitry of the iBG3026. Air is drawn into the unit through a grid of small holes in the front panel. Air flows through openings in the backplane, across the circuit boards and out grids of holes on the rear panels of each module and at the rear side panels of the unit. Power supply cooling is done separately, with fans within each power supply pulling air through the front panel and out hole grids at the rear and side of the supply.

The LED card provides fan speed control and thermal sensing for the cooling iBG3026.

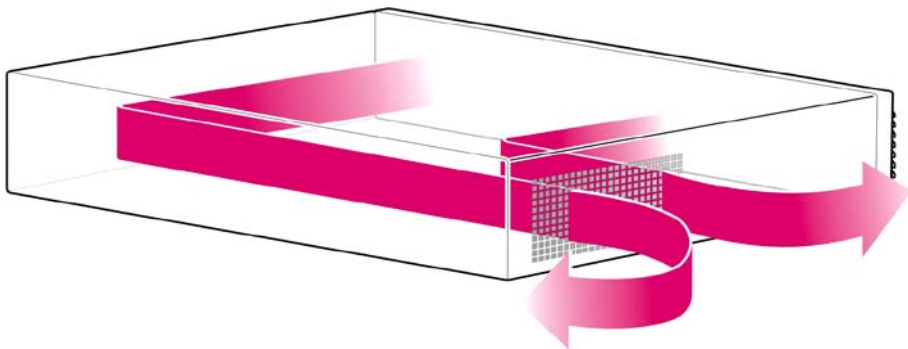


Figure 2.47 Air flow of the iBG3026



## CHAPTER 3. Software Overview

Chapter 3 describes the Software overview.

### Routing Engine and Packet Forwarding Engine

The router subsystem is a software-based router one and can support a variety of routing protocols. Packet headers may be examined and modified as required to support routing between links supporting different protocols. Received packets are moved into the main memory by the source interface using DMA. The routing processor on the main board examines each packet header in the main memory, makes the routing decision, modifies the packet as required, and connects the packet into the transmit queue for the appropriate destination. The destination interface then copies the packet from main memory using DMA and transmits the packet. Packet data is stored in data buffers that are separate from the descriptor structures used by the source and destination DMA Controllers. This allows the processor to get a packet ready for transmission without copying it from one buffer to another.

To support both switching and routing functionality for Ethernet packets, the iBG3026 includes an Ethernet subsystem connecting various modules in the iBG3026. The major components are:

- A Gigabit Ethernet switch on the main board provides switched connectivity between the routing processor, the Ethernet Switch Gigabit card, the two network modules, two RJ45 10/100/1000 BASE-T ports and two Small Form Factor Pluggable (SFP) optical Gigabit Ethernet ports on the panel of the main board.

- A 10-port Gigabit Ethernet packet processor, able to do IPv4 and IPv6 routing, on the Ethernet Switch Gigabit card provides routed connectivity between the switch on the main board, a high-performance backplane fabric, eight RJ45 10/100/1000 BASE-T ports and two SFP optical Gigabit Ethernet ports on the panel of the Ethernet Switch Gigabit card.
- A backplane mesh fabric linking the Ethernet Switch Gigabit card and the two network modules with 30 Gbps full-duplex links between each pair of modules

## Kernel

The operating system is a Real-Time Operating System (RTOS). It provides services for the application software such as multi-tasking, inter-task communications, interrupt and memory management. In addition, it provides a framework for the I/O and file systems.

## Processes

### Management Process

The management plane consists of Command Line Interface (CLI), Simple Network Management Protocol (SNMP), and the Web-based management interface of the iBG3026.

See the User Interface section for descriptions of the CLI and Web-based management interface.

### SNMP Architecture

To allow network management systems to remotely manage iBG3026 products, SNMP v1/v2/v3-as defined by RFC 1157 and version 2 (also called as v2c) as defined by RFCs 1903 is supported. The Structure of Management Interface-SMIV1 and SMIV2-as defined by RFC 1155 and 1902 are supported.

## MIB Information

A number of feature specific RFC standard Management Information Base (MIB)s and enterprise MIBs is implemented. The configuration guide has listed the respective MIBs that are implemented.

## Community-based Authentication

Community-based SNMP v2 is supported, i.e., SNMP v2c.

This SNMP framework associates each message with a 'community' as defined in SNMP v1 [RFC 1157].

## User-Based Security Model (USM)

The User-based Security Model (USM) for SNMP v3 [RFC2574] is supported.

To protect data integrity, USM uses MD5 and the Secure Hash Algorithm as keyed hashing algorithms for digest computation. This directly protects against data modification attacks, indirectly provides data origin authentication, and defends against masquerade attacks.

USM uses loosely synchronized monotonically increasing time indicators to defend against certain message stream modification attacks.

Automatic clock synchronization mechanisms based on the protocol are specified without dependence on third-party time sources and concomitant security considerations.

USM uses the Data Encryption Standard (DES) in the cipher block chaining (CBC) mode to protect against disclosure.

## View-Based Access Control Model (VACM)

The view-based access control model for SNMP [RFC2575], which controls access to management information, is supported.

For security reasons, it is often beneficial to restrict the access rights of some groups to only a subset of the management data in the management domain. To provide this capability, access to a context is through an MIB view, which details a specific set of managed object types within that context.

## Traps

All applicable standard and enterprise traps is implemented. The trap support also follows the AgentX architecture. The sub-agents will generate traps whenever necessary and forward it to the master-agent using AgentX protocol. The master-agent will form a trap Packet Data Unit (PDU) and forward it to the pre-configured network management station/trap receiving station. The iBG3026 product supports more than one traphost to send traps to.

## RMON

Remote network Monitoring (RMON-1) is supported for LAN (Ethernet) interfaces as prescribed by RFC 1757. RMON groups 1, 2, 3 and 9 are supported.

The following are the groups supported:

- The Ethernet Statistics Group  
The Ethernet statistics group contains statistics measured by the probe for each monitored Ethernet interface on this device. This group consists of the etherStatsTable.
- The History Control Group  
The history control group controls the periodic statistical sampling of data from various types of networks. This group consists of the historyControlTable.
- The Ethernet History Group  
The Ethernet history group records periodic statistical samples from an Ethernet network and stores them for later retrieval. This group consists of the etherHistoryTable

## Chassis Process

The chassis manger is responsible for detecting and the power-on initialization of the pluggable/removable modules. This software manages the status of the removable modules and notifies the application software when a change occurs. On iBG3026 power-up, the chassis manager determines which slots have modules inserted and then applies power to those slots. If a module is subsequently removed, the chassis manager receives an interrupt and notifies the application software the module is no longer in the iBG3026. The Chassis Manager maintains the state and status of module in the pluggable slots.

## Hot Swap

The hot swap feature is to enable a craft person to replace one module with another module (of the same type) without affection to the other system operations. For example, 4-port T1/E1 module can be replaced by another 4-port T1/E1 module but not by 4-port serial module.

This feature reduces the administrative overhead considerably, for configuration of each interface on the module and reconfiguration when a same type module is reinserted. A voice and WAN (except HSSI, CT3) module can be removed from a system and reinserted while the system is powered. For this case, data path for other non related active modules will not be impacted. Also, upon completion of this operation, the previous module configuration is to be restored.

A hardware interrupt is generated upon removal and insertion of a module. Thus, hot swap function allows the system to determine when a change occurs in the unit's physical configuration and indicate status to the user.

This feature is supported by following modules.

Type	Module Name
WAN module	- T1E1-2M, T1E1-4 - WTE-4S - BRI-2U, BRI-2ST
Voice Module	- FXS-4M, FXS-24 - FXO-4M - E & M-2M - VCU-A
Security Module	ISM

The module must be in administrative down (shutdown) state before removing. The swapping module must be a same type card and inserted to the same slot. The service of multi-link bundle which have multi-links on multi card, can be downed a short while.

## Routing Protocol Process

This section describes the routing protocol process of the iBG3026, including descriptions of:

- L2 Control Protocols, consisting of Spanning Tree Protocol (STP), Rapid Spanning Tree Protocol (RSTP), Multiple Spanning Tree Protocol (MSTP), Link Aggregation Control Protocol (LACP), GARP VLAN Registration Protocol (GVRP), GARP Multicast Registration Protocol (GMRP), and Internet Group Management Protocol (IGMP) Snooping
- Unicast Protocols, consisting of Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), and Routing Information Protocol (RIP).
- Multicast Protocols, consisting of Protocol Independent Multicast-Sparse Mode (PIM-SM), Distance Vector-Multicast Routing Protocol (DV-MRP).
- WAN Protocols, consisting of PPP, Frame Relay, High-level Data Link Control procedure (HDLC) and ISDN

### Layer2 Protocols

The Layer2 module consists of 3 major components, each running as a task:

- xSTP for Spanning Tree Protocol, this task includes VLAN Bridge module, Generic Attribute Registration Protocol (GARP)/GARP Multicast Registration Protocol (GMRP)/GARP VLAN Registration Protocol (GVRP) modules and Internet Group Management Protocol (IGMP) Snooping module.
- LACP for the link aggregation protocol
- Authentication Daemon (AUTHD) for 802.1x port authentication protocol

xSTP consists of Bridge and VLAN modules, GVRP and GMRP protocols, IGMP Snooping module, STP or RSTP or MSTP state machine and the communication modules to exchange messages with other components. RSTP covers STP functionality and MSTP covers RSTP functionality. Thus one Spanning Tree Protocol runs at the same time. xSTP is named for the common Spanning Tree Protocol and identifies one the these protocols.

Layer 2 Protocol	Description
Bridge	<p>LAN bridging allows extension of LAN by supporting connection of multiple LAN segments. MAC addresses of the datagram that flow through bridges are examined to build a table of known destinations. If the destination of a datagram is on the same segment as the source of the datagram, the bridge drops the datagram because forwarding is not required. However, if the destination is on another segment, the bridge transmits the datagram on that segment only. If the bridge does not know the destination segment, it transmits the datagram on all segments except the source segment (a technique known as flooding). Bridge Module is the elementary module in L2 Control Modules, which keep the Bridge, port and VLAN information. Each port and VLAN could be bound to a specific Bridge through a CLI command.</p>
VLAN	<p>The VLAN Module manages the table and information for 802.1q, 802.1p and 802.1v. In addition, Subnet-based and policy-based VLAN are implemented in iBG3026.</p>
GVRP	<p>GVRP provides the 802.1Q-compliant VLAN pruning and dynamic VLAN creation on 802.1Q trunk ports. GVRP module exchanges VLAN configuration information with other GVRP switches, prune unnecessary broadcast and unknown unicast traffic, and dynamically create and manage VLANs on switches connected through 802.1Q trunk ports.</p>
Multicast	<p>Two multicast modules are implemented for Layer 2 Multicast in iBG3026, GMRP and IGMP Snooping. These protocols can not be enabled at the same time. One or more links to be aggregated together to form a Link Aggregation Group (LAG), such that a MAC Client can treat the Link Aggregation Group as if it were a single link. This allows for faster connections between switches managed as a single connection.</p>
GMRP	<p>GMRP provides a mechanism that allows bridges and end stations to dynamically register group membership information with the MAC bridges attached to the same LAN segment and for that information to be disseminated across all bridges in the Bridged LAN that supports extended filtering services. A switch can exchange multicast group information with other GMRP switches, prune unnecessary broadcast traffic, and dynamically create and manage multicast groups.</p>
IGMP Snooping	<p>IGMP snooping module can passively snoop on IGMP packets to learn the IP Multicast group membership. IGMP snooping module supports IGMP v1, v2 and v3.</p>

(Continued)

Layer 2 Protocol	Description
Additional L2 Functions	Port Mirroring, Broadcast Storm Suppression and 802.3x Flow Control are implemented simply with the proper CLIs and NPF APIs.
LACP	<p>LACP runs as a task for link aggregation control protocol and management.</p> <p>One or more links to be aggregated together to form a Link Aggregation Group (LAG), such that a MAC Client can treat the Link Aggregation Group as if it were a single link. This allows for faster connections between switches managed as a single connection, load sharing and load balancing among the individual links within a logical connection, and a failure mechanism that allows a link to stay up at a reduced peak rate even if some of the physical ports go out of service.</p>
AUTHD	<p>AUTHD task runs for 802.1x port authentication control protocol and management. 802.1x-Port Authentication offers an effective framework for authenticating and controlling user traffic to a protected network. 802.1X ties the Extensible Authentication Protocol (EAP) to both the wired and wireless LAN media and supports multiple authentication methods, such as token cards, Kerberos, one-time passwords, certificates, and public key authentication.</p> <p>Variable authentication methods support with EAP (EAP-MD5, TLS, TTLS, PEAP) is dependent on the support of the client and the authentication server.</p> <p>RADIUS was primarily used by ISPs who authenticated username and password before the user got authorized to use the ISP's network. 802.1X does not specify what kind of back-end authentication server must be present, but RADIUS is the 'de-facto' back-end authentication server used in 802.1X.</p>

### Dual Stack

The primary functions performed by the Dual Stack (DS) involves providing the Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) support through socket interfaces to various applications in iBG3026 for both IPv4 and IPv6 and to support Smart Forwarder in layer-3 packet forwarding. The DS maintains the Forwarding Information Base for layer-3 routing performed at the CPU. The DS also provides support for implementing link layer functions such as ARP/NDP for Ethernet interfaces.

## Unicast Routing

Interior Gateway Protocols such as RIP, Routing Information Protocol next generation (RIPng), OSPF, and OSPFv3 are supported in the iBG3026 software.

## BGP

The Border Gateway Protocol (BGP) enables the sharing of routing data between multiple Autonomous Systems (AS) and domains to establish efficient, loop-free routes. It determines the best paths in networks and performs optimal routing between multiple autonomous systems.

When peer routers enter into capability negotiation, if only one side supports graceful restart capability, the session is not terminated.

BGP uses the Transmission Control Protocol (TCP) as its transport protocol.

Any two routers that communicate through a TCP connection with each other to exchange routing information are known as peers or neighbors.

## Multicast Routing Protocols

The iBG3026 multicast routing protocols are implemented as a modular architecture and each protocol is implemented as a separate protocol module. The following Multicast routing modules are supported.

Multicast Routing Protocols	Description
IGMPv2: Internet Group Membership Protocol	The Internet Group Management Protocol (IGMP) is used between IP hosts and IP routers. IP Host reports their multicast group membership to the neighboring multicast routers expressing their desire to receive multicast traffic destined for the group. Multicast routers use IGMP to learn, for each of their attached physical networks, which groups have members. IGMP should be enabled on both hosts and routers that want to receive multicast traffic.
MLDv1: Multicast Listener Discovery	The Multicast Listener Discovery Protocol (MLDv1) is used by IPv6 routers to discover the presence of multicast listeners (i.e., nodes that wish to receive multicast packets) on their directly attached links, and to discover, specifically which multicast addresses are of interest to those neighboring nodes.

(Continued)

Multicast Routing Protocols	Description
PIM-SM and PIM-SMv6: Protocol Independent Multicast-Sparse Mode	Protocol Independent Multicast (PIM) protocols route multicast packets to multicast groups. PIM is protocol independent because it can leverage whichever unicast routing protocol is used to populate unicast routing table. PIM-SM tries to send multicast data only to networks that have active receivers. This is achieved by having a common Rendezvous Point (RP) known to the senders and receivers and forming shared trees from the RP to the receivers. PIM-SMv6 is similar to the PIM-SM protocol but it is for Ipv6 networks.
DVMRP: Distance Vector Multicast Routing Protocol	Distance Vector Multicast Routing Protocol (DVMRP) is a multicast routing protocol that provides an efficient mechanism for connectionless datagram delivery to a group of hosts across an inter-network. It is a distributed protocol that dynamically generates IP multicast delivery trees using a technique called Reverse Path Multicasting. The Multicast routing protocol modules (DVMRP, PIM-SM and PIM-SMv6) are each separate protocol modules running as clients to the Network Services Module (NSM).

### WAN Protocols

iBG3026 uses network modules (up to 2) and mini modules (up to 3) for providing WAN connectivity. These modules are typically support T1 (E1) or T3 (E3) speeds. The protocols such as PPP and Frame Relay (including their multilink variations) are implemented in the iBG3026 to provide link layer connectivity.

WAN protocols interface with the (T1/E1 and T3/E3 framers through their device drivers) and with the VLAN/IP software forwarding engines in the iBG3026 CPU subsystem. Also, the ISDN subsystem interfaces with these modules to provide physical channels. WAN protocol stack architecture is based on the STREAMS, which is a general-purpose mechanism to implement communication services.

WAN Protocols	Descriptions
Frame Relay	Frame Relay (FR) is one of the widely used transport protocols for Wide Area Networking (WAN) community. The objective of including FR is to provide WAN connectivity to both remote routers and FR switches.

(Continued)

WAN Protocols	Descriptions
Frame Relay	<p>The protocol stack can provide both RFC1490 based multi-protocol encapsulation as well as PVC switching. Also, standard frame relay congestion management procedures based on frame relay traffic parameters-Bc, Be and CIR- (ingress policing, egress shaping/rate limiting) are supported.</p> <p>The following LMI types are supported-LMI Rev 1, Stratacom/Cisco LMI, T1.617 Annex D, Q.933 Annex A and alternately, the LMI can be disabled (None). Apart from these, fragmentation and inverse ARP is supported over FR PVCs.</p>
HDLC	<p>High-Level Data Link Control (HDLC) is a bit-oriented synchronous data link layer protocol developed by the International Organization for Standardization (ISO).</p> <p>The original ISO standards for HDLC were:            ISO 3309-Frame Structure            ISO 4335-Elements of Procedure            ISO 6159-Unbalanced Classes of Procedure            ISO 6256-Balanced Classes of Procedure</p> <p>The current standard for HDLC is ISO 13239, which replaces all of those standards. HDLC provides both connection oriented and connectionless service. HDLC can be used for point to multipoint connections, but is now used almost exclusively to connect one device to another, using what is known as Asynchronous Balanced Mode (ABM). The other modes are Normal Response Mode and Asynchronous Response Mode.</p>
PPP	<p>The Point-to-Point Protocol (PPP) provides a standard method for transporting multi-protocol datagram over point-to-point links. These links provide full-duplex simultaneous bi-directional operation and are assumed to deliver packets in order.</p> <p>PPP is comprised of 3 main components:            A method for encapsulating multi-protocol datagram.            In iBG3026, PPP is used on the links that use HDLC-like framing (on the WAN side over T1/T3 physical interfaces). The details of the encapsulations can be found in RFC1662 and RFC2516.            A Link Control Protocol (LCP) for establishing, configuring and testing the data-link connection. The details of this can be found in RFC 1661.            A family of Network Control Protocols (NCPs) for establishing and configuring different network layer protocols. There is a NCP for each network protocol for example, IPCP for IP networks.            Optionally, before PPP NCP is established, peers may need to authenticate themselves and any failure during this can result in the link termination.</p>

(Continued)

WAN Protocols	Descriptions
PPP	<p>There are two authentication protocols: Password Authentication Protocol (PAP) and Challenge Handshake Authentication Protocol (CHAP). In addition to the above, PPP will also interface with AAA for username/password validations.</p> <p>The PPP is the most ubiquitous WAN protocol today for internet access and/or leased line connectivity to a remote office. When the bandwidth requirements go beyond a single T1 (and DS3 being expensive or unavailable) multilink PPP can be used to create a bigger bandwidth pipe. Both Frame Relay and PPP use a common multilink library because of its efficiency.</p>
ISDN	<p>The WAN interfaces are typically connected using leased lines with interface such as T1/E1. There are chances that the T1/E1 links goes down due to various reasons thereby resulting in the loss of wan connectivity. The wan connectivity comes up only when the T1/E1 links are restored. Hence there is a need to have an alternate connectivity till the T1/E1 links are restored.</p> <p>When the primary connectivity (T1/E1) links go down, ISDN can be used as a secondary connection. ISDN can be used as dial up connection to connect to Internet or remote server for certain amount of time until the primary T1/E1 links are restored.</p> <p>ISDN can also exist as an independent interface to provide remote connectivity to Headquarters and/or for Internet connectivity very similar to the other interfaces like T1/E1. In certain countries the ISDN connections are not very expensive that they can be used as the primary connections as well.</p> <p>When the primary connectivity (T1/E1) links go down, ISDN can be used as a secondary connection. ISDN can be used as dial up connection to connect to Internet or remote server for certain amount of time until the primary T1/E1 links are restored.</p> <p>ISDN can also exist as an independent interface to provide remote connectivity to Headquarters and/or for Internet connectivity very similar to the other interfaces like T1/E1. In certain countries the ISDN connections are not very expensive that they can be used as the primary connections as well.</p> <p>The ISDN interface can be a mini module or a network module in iBG3026. The ISDN modules are:</p> <ul style="list-style-type: none"> <li>- 2-port ISDN BRI-S/T</li> <li>- 2-port ISDN BRI-U</li> </ul> <p>T1/E1 (mini and network module) with PRI support.</p> <p>The iBG3026 will support T1 and E1 interfaces (ISDN PRI). ISDN BRI and PRI user-side protocols shall be supported to provide interconnection of the iBG3026 System to PSTNs. iBG3026 can also act as a network side element.</p>

## Interface Process

The Interface Manager software contains WAN and LAN interface status and control functionality. This includes the CLI functions to control physical interfaces such as creating WAN bundles or setting Ethernet interface, and refers to the data structures to track the configuration, state of WAN, and LAN interfaces. It includes storage and retrieval from/to NVRAM of the current configuration of the interfaces. Each interface type has its own set of CLI commands for controlling the interface.

## Forwarding Process

This section describes the packet forwarding functions performed by the CPU subsystem of the iBG3026. The packet forwarding functions in the CPU is performed by the Smart Forwarder (SF) module in conjunction with the Dual TCP/IP Stack, Device Drivers and PSS modules. While the Smart Forwarder performs most of the forwarding functions, the Dual Stack is responsible for forwarding of packets with IP options received from both the PSS subsystem and from the Smart Forwarder. Smart Forwarder receives packets from the various LAN, WAN and MAN interfaces and performs layer 2 and layer 3 forwarding based on the packet type and configuration. SF also receives packets from the Dual Stack to be forwarded to LAN, Main board GbE, Management, WAN or MAN interfaces.

The major sub components of the Smart Forwarder are:

- Layer 2 Forwarding component: This component performs layer 2 forwarding functions.
- Layer 3 Forwarding component: This component performs IPv4 unicast, IPv4 multicast, IPv6 unicast and IPv6 multicast forwarding functions.
- Firewall/VPN component: This component performs the firewall and IPsec based VPN functions in conjunction with Layer 3 Forwarding component.
- ACL component: This component performs ACL based stateless firewall function for packets received on the WAN/MAN and Main board GbE interfaces.
- QoS component: This component performs the QoS functions for packets received from WAN/MAN interfaces as well as packets transmitted to WAN/MAN interfaces.
- Tunneling component: This component performs the GRE, IPsec and IPv6 tunneling functions.

# User Interfaces

## Command Line Interface

The Command Line Interface forms the link between the end user and the features of the device with a text-based interface. Users can issue commands that need to be executed on the iBG3026. The CLI provider's editor support for easy command editing/navigation, command history, and command completion.

You are presented with a command prompt when logged into the iBG3026. Each command is terminated by a new line (Enter key). The command string is passed on to the parser for syntax and semantic check. If the command has syntax error, the parser prints an error message and returns to prompt.

If the command is syntactically correct, the parser calls the target function defined in the CDF file. The function is executed and return value is displayed back at the prompt. It can be an error message or a confirmation message of the operation. Some commands can return a value zero and the parser displays the prompt again without any message.

The CLI supports Emacs editor keystrokes. This is provided to facilitate correction/editing commands while entering commands.

This is restricted to single line editing. Some example keystrokes include:

- CTRL-A: Takes the cursor to beginning of line
- CTRL-E: Takes the cursor to end of line (last character)

The CLI maintains the list of user entered commands. You can get the list of previously executed commands by entering 'UP-ARROW'.

The CLI stores a maximum of 100 commands. This is a configurable value.

## CLI Privilege Levels

The CLI supports four levels of privileges. PRIVILEGE\_ADMIN is the highest and PRIVILEGE\_NORMAL being lowest.

The order of privileges is:

- PRIVILEGE\_ADMIN 1
- PRIVILEGE\_CONFIGURE 2
- PRIVILEGE\_TEST 3
- PRIVILEGE\_NORMAL 4

## CLI Omnipresent Commands

The CLI supports omnipresent commands. The user at any level can execute these commands. These commands include: display, clear, save, show, ping, telnet, trace, mtrace, write, dir, erase. For details refer to the Command Reference.

## Web GUI (HTTP Server)

The Web GUI (iBG-DM) is an additional interface that is supported on the iBG3026 product. This allows end users to monitor and configure the device. The GUI is targeted at Novice and Intermediate users only. The supported browser is Internet Explorer 5.5+.

iBG-DM support web based management tool that allow you to configure LAN and WAN interfaces, routing, VoIP, Network address Translation (NAT), firewalls, Virtual Private Networks (VPNs) and other features on the router. Also iBG-DM provide simple fault, performance, security management functions.

The figure below shows network diagram when you use iBG-DM.

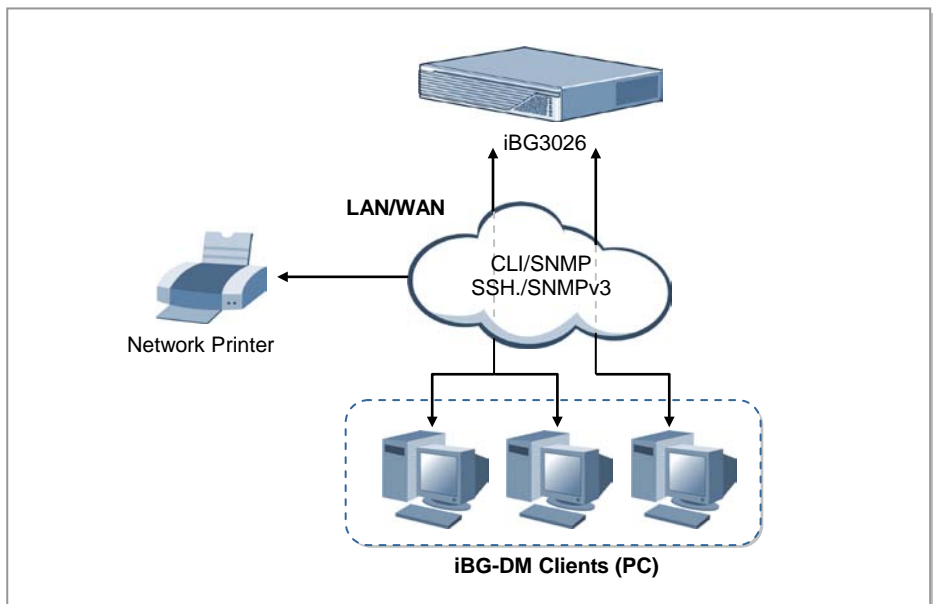


Figure 3.1 iBG-DM Management Network Diagram





## CHAPTER 4. Voice Features

---

Chapter 4 describes an overall voice feature that iBG3026 provides.

### Introduction to Voice Feature

Ubigate iBG3026 is a high-performance enterprise access router that provides a VoIP gateway. A VoIP gateway provides real-time, two-way voice communications between the packet network and circuit network.

## Network Architecture

The iBG3026 network architecture is shown in figure 4.1.

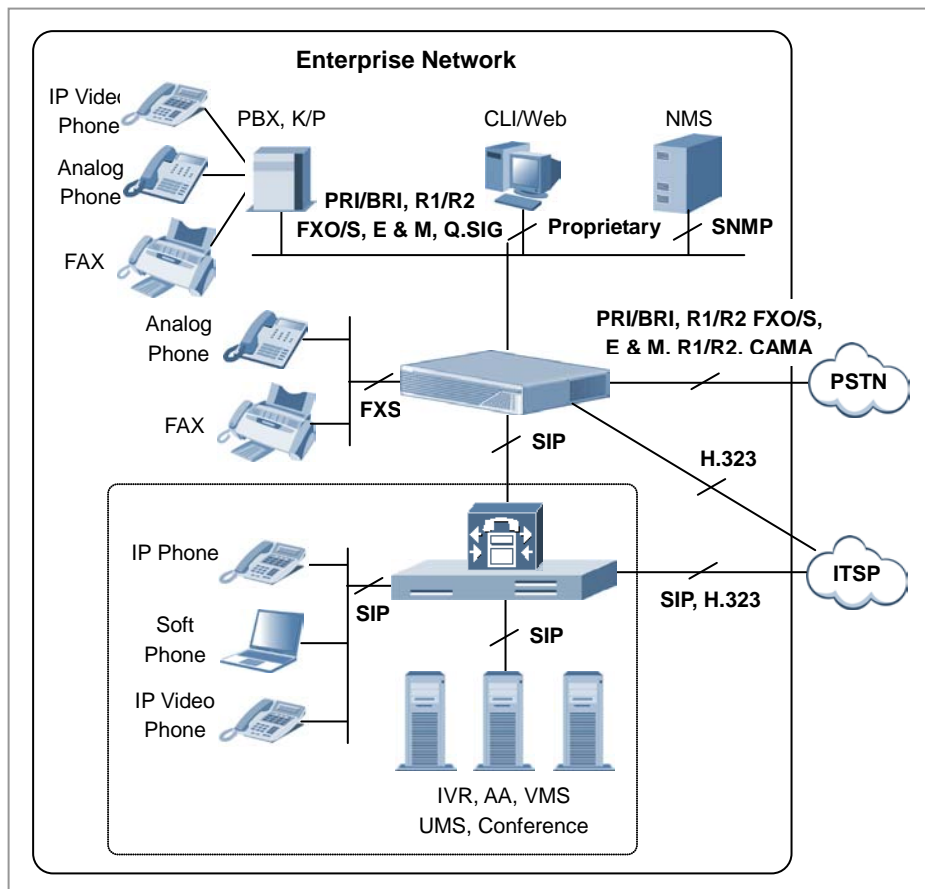


Figure 4.1 iBG3026 Network Diagram

The external entities that interwork with iBG3026 over a network are as follows:

### iBG3026

Ubigate iBG3026 acts as the interface between a traditional voice network and the IP network. It interfaces with traditional voice networks (PBX and PSTN) through digital trunk interfaces, such as T1/E1, ISDN PRI/BRI, and Q.SIG, and analog trunk interfaces, such as FXS/DID, FXO, CAMA, and E & M. Ubigate iBG3026 terminates the PSTN/ISDN and analog trunk signals and acts as a VoIP gateway, converting the TDM to IP packets and vice versa. It communicates with iPX using standard protocols, such as SIP.

### **IPX (Ubigate iPX)**

IP PBX performs call processing functions and interfaces with Ubigate iBG3026 over the packet network using VoIP protocols, such as SIP. IP PBX provides basic VoIP call services and a number of supplementary and application services by interworking with other application servers.

### **IP Phone/Soft Phone**

IP phone provides a generic voice call service over IP networks. To support basic and supplementary call services, it interfaces with Ubigate iPX using the standard RFC3261-based SIP protocol, with some additional extensions.

### **Analog Phone/FAX**

An analog phone is the terminal providing generic voice call service using the legacy analog line. FAX is the terminal providing fax service using the legacy analog line.

### **PBX, KTS**

PBX and key phone systems are voice hardware connecting in-house extension calls or external calls using legacy analog and digital trunks instead of the IP network.

### **CLI/Web**

This is the OAM interface provided by iBG3026 that controls various OAM functions in iBG3026 after accessing iBG3026 through CLI or the Web from a desktop or laptop computer.

### **NMS**

The Network Management System (NMS) is used to manage iBG3026 and iPX network devices.

### **IVR/AA/VMS/UMS/Conference Server**

This hardware provides various services, such as VMS, IVR, AA, and Conference, which are not provided by iBG3026 and iPX.

## Interface between Network Entities

The interface specifications for interworking with network entities are as follows:

### **iBG3026-iPX Interface**

Ubigate iBG and iPX use the Session Initiation Protocol (SIP) for call signaling. They use standard RFC3261-based SIP, with extensions. Samsung proprietary headers are used for VoIP services.

For management, a TCP/IP-based proprietary protocol is used in between to load subscriber profiles, feature and access-code information, and additional information for survivability.

### **iBG3026-PSTN Interface**

This is the interface used for interworking between existing PSTN and voice calls.

E & M, PRI, BRI, FXO, FXS/DID, R1, R2, and CAMA are used as signaling methods; T1, E1, Analog Trunk and Analog Line are used as physical layers.

- Analog I/F: FXO, FXS, DID, E & M
- Digital I/F: T1 CAS E & M/FXO/FXS, T1 R1, E1 R2 MFC/DTMF, ISDN-PRI/BRI (S/T, U)

### **iBG3026-Analog Phone Interface**

This is the interface used by Ubigate iBG3026 to provide voice calls to generic analog phones. FXS is used.

### **iBG3026-PBX Interface**

This is the interface iBG3026 uses to interwork with legacy PBX. PRI, BRI, R1, R2, FXO, E & M, Q.SIG, and DID are used as signaling methods. T1, E1, Analog Trunk, and Analog Line are used as the physical layers.

- Analog I/F: FXS, FXO, E & M
- Digital I/F: T1 CAS FXS/FXO/E & M, E1 R2 MFC/DTMF, ISDN-PRI/BRI (S/T, U), ISDN-Q.SIG

### **iBG3026-CLI/Web Interface**

This is the interface iBG3026 uses to interwork with CLI and Web Client to provide OAM functions. It uses the TCP/IP-based proprietary interface developed by Samsung.

### **iBG3026-NMS Interface**

The NMS uses this interface for integrated control of multiple iBG3026's. The interface uses the SNMP protocol and proprietary Samsung MIB.

## **Operation Mode**

When Ubigate iBG3026 operates as an SIP gateway, it can work in iPX interworking mode, in which it interworks with SIP networks via Ubigate iPX, or in stand-alone mode (or toll bypass mode), in which it directly interworks with other SIP gateways with or without an SIP server. When connectivity with Ubigate iPX fails, iBG automatically switches to survivable telephony mode to provide basic and limited call supplementary services without Ubigate iPX. The detailed operation mode is described below.

### **Call-Server (Ubigate iPX) Interworking Mode**

In iPX interworking mode, Ubigate iBG3026 registers in Ubigate iPX, and iPX manages multiple IP phones and iBG3026's. Generally, iBG3026 delivers voice calls to iPX via the SIP protocol. Ubigate iPX can decide to route a call to other iBG3026's, IP phones, or SIP/H.323 servers.

The generic network configuration in iPX interworking mode is shown in Figure 4.1. Figure 4.2 shows Ubigate iPX controlling the corporate VoIP network in a headquarters. Multiple Ubigate iBG3026's reside in individual branch offices. In addition, multiple IP phones exist in the headquarters and each branch. The company's iBG3026's and IP phones are registered in iPX, and iPX controls the overall routing of the internal and external calls.

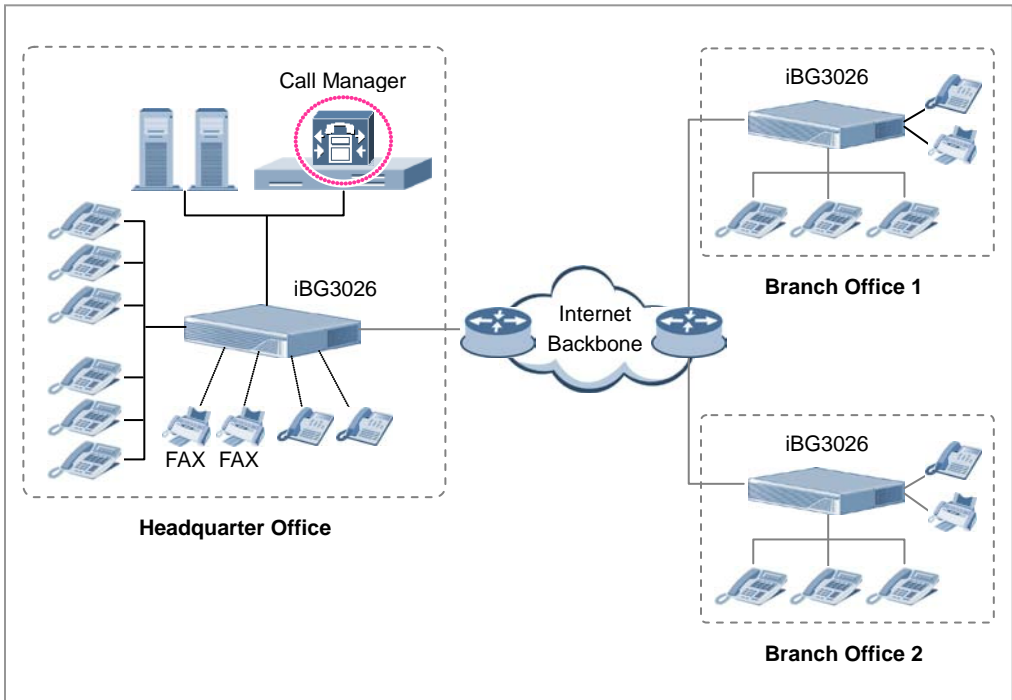


Figure 4.2 Example of iPX Interworking Mode Network Configuration

### Survivable Telephony Mode

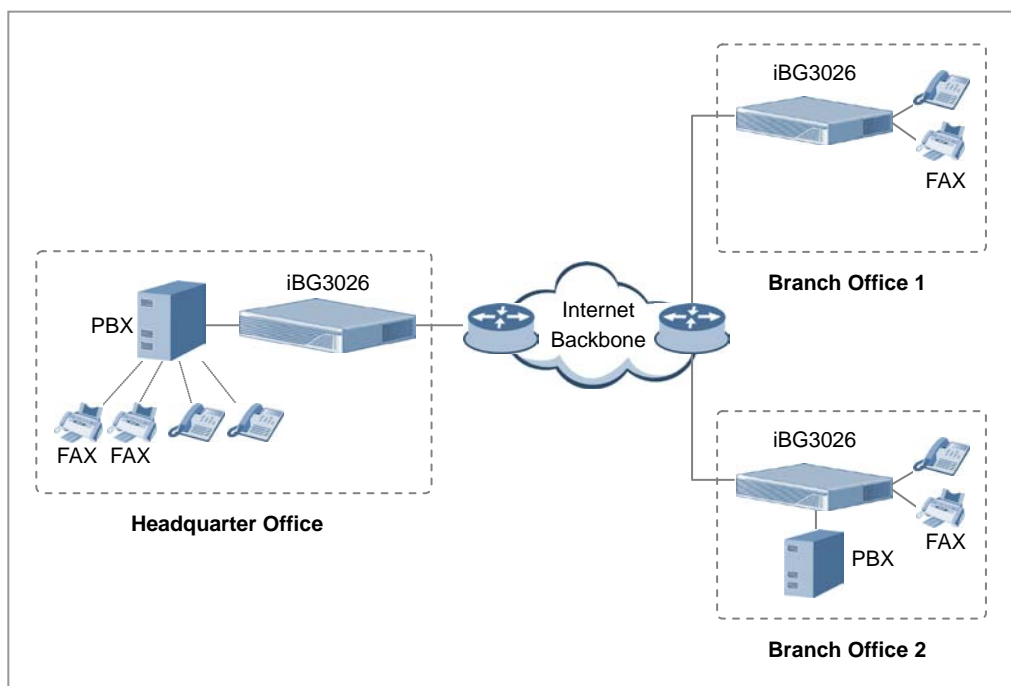
In call-server (iPX) interworking mode, all voice calls over the VoIP network are generally controlled by Ubigate iPX. All originating and terminating calls (IP and analog phones) will be unavailable if iPX fails (for example, because of link failure) or access to iPX is blocked. To respond to this status, Ubigate iBG3026 continuously monitors its connection to iPX. When it detects iPX failure, it automatically switches to survivable telephony mode in which iBG3026 can provide voice services independently.

In survivable telephony mode, the voice services in iPX interworking mode are limited.

### Stand-alone mode (or Toll Bypass mode)

In stand-alone mode, Ubigate iBG3026 provides SIP trunks for other SIP entities and can interwork with standard SIP servers, such as registrar, proxy, and redirect servers.

In this mode, iBG3026 makes decisions for all call processing and routing.



**Figure 4.3 Example of Stand-alone mode network configuration**

Figure 4.3 illustrates stand-alone mode network configuration.

In this configuration, Ubigate iPX and IP phones do not exist.

The internal calls of the headquarters and branch office 2 are controlled by the PBXs on each network. Outgoing calls to other branches are transmitted using the VoIP network through Ubigate iBG3026's.

## Key Features

This section presents the key features of Ubigate iBG3026 voice capability.

### VoIP Gateway

The VoIP gateway delivers voice calls between PSTN and IP networks. Ubigate iBG3026 acts as the interface between a traditional voice network and the IP network. It interfaces with the traditional voice networks (PBX and PSTN) through T1/E1/ISDN-PRI interfaces and analog trunk interfaces, such as DID, E & M, and FXO. Ubigate iBG3026 terminates PSTN/ISDN and analog trunk signals and acts as an interface with the IP network by interworking with SIP proxy, SIP registrar, SIP gateway, SIP terminal, H.323 gatekeeper, H.323 gateway, and others.

### SIP Signaling Support

Ubigate iBG3026 supports the standard RFC3261-based SIP protocol and a number of extensions/drafts to provide SIP-based VoIP services. Some of the protocols Ubigate iBG3026 supports are described below.

#### Direct Connection

Direct connection enables call processing without an SIP server. It is used when there is no Ubigate iPX or proxy server directly connected to the network.

To route calls, Ubigate creates SIP trunks that include all VoIP entities.

#### Indirect Connection via SIP Proxy Server

Indirect connection allows Ubigate iBG3026 to act as an SIP gateway for Ubigate iPX or an SIP proxy server.

With this indirect connection, Ubigate iBG3026 registers with the Ubigate iPX or SIP registrar, and outbound calls route to the server.

## H.323 Signaling Support

Ubigate iBG3026 acts as an H.323 gateway and interworks with other H.323 network entities residing on the network.

### H.323 Gateway Mode

In H.323 gateway mode, Ubigate iBG3026 serves as a gateway in a zone managed by H.323 Gatekeeper.

When Ubigate iBG3026 operates in H.323 gateway mode, it performs general GK registration procedures using RRQ.

A gatekeeper identifies iBG3026 as a gateway to be managed in a zone, and iBG3026 provides the H.323 gateway characteristics necessary for call signaling.

### H.323 Direct Mode

Direct mode enables call processing without H.323 registration.

It is used when signaling is performed directly between gateways without passing through a gatekeeper.

## PSTN Signaling Support

Ubigate iBG3026 acts as a VoIP gateway for interconnecting between legacy PSTN and VoIP networks. To interwork with PSTN seamlessly, iBG3026 supports various types of PSTN signaling that have been in use for several decades.

Ubigate iBG3026 supports the following PSTN signaling.

- Analog FXS: loop-start, ground-start
- Analog E & M: wink, immediate, delay
- Analog FXO: loop-start, ground-start
- Analog DID (Direct Inward Dial)
- ISDN BRI Q.931: user side
- T1-CAS E & M: wink, immediate, delay
- T1-CAS FXO: ground start, loop start
- T1-CAS FXS: ground start, loop start
- E1-CAS R2: MFC, DTMF

- T1/E1 ISDN PRI Q.931: user side, network side
- T1/E1 Q.SIG
- T1 R1

Ubigate iBG3026 supports the following R2 country variants.

- Australia
- Brazil
- China
- East Europe
- Hong Kong
- India
- ITU, Korea
- Thailand
- Mexico

Ubigate iBG3026 supports the following ISDN country variants.

- AT & T 4ESS (User Side-PRI, Network Side-PRI)
- AT & T 5ESS (User Side-PRI/BRI-Network Side-PRI/BRI)
- ETSI (User & Network Side-PRI/BRI)
- Australian Telecom (User Side-PRI/BRI and Network Side-PRI)
- National ISDN-1 (User Side-BRI)
- NTT (User & Network Side-PRI/BRI)
- Northern Telecom DMS-100 (User Side & Network Side-PRI/BRI)
- Northern Telecom DMS-250 (User Side & Network Side-PRI)
- National ISDN-2 (User & Network Side-PRI)
- Q.SIG (PRI)

## Voice Codecs

Ubigate iBG3026 acts as a VoIP gateway that converts the TDM to packets, and vice versa, and supports the following voice codecs:

- ITU-T G.711-Pulse code modulation (PCM) of voice frequencies
- ITU-T G.711 Appendix I-A high quality low-complexity algorithm for packet loss concealment with G.711
- ITU-T G.711 Appendix II-A comfort noise payload definition for ITU-T G.711 use in packet-based multimedia communication systems.
- ITU-T G.723.1-Dual rate speech coder for multimedia communications transmitting at 5.3 and 6.3 Kbit/s
- ITU-T G.723.1 Annex A-Speech coders: Silence compression scheme
- ITU-T G.726-40, 32, 24, 16 Kbit/s adaptive differential pulse code modulation (ADPCM)
- ITU-T G.729-Coding of speech at 8 Kbit/s using conjugate-structure algebraic-code-excited linear-prediction (CS-ACELP)
- ITU-T G.729 Annex A-Reduced complexity 8 Kbit/s CS-ACELP speech codec
- ITU-T G.729 Annex B-A silence compression scheme for G.729 optimized for terminals conforming to Recommendation V.70

## Security

Ubigate iBG3026 ensures voice security by providing functions, such as TLS and sRTP.

TLS ensures SIP signaling security and sRTP media security.

### TLS

TLS can provide hop-by-hop security for SIP messages transceived to or from a network entity.

### sRTP (Secure RTP)

sRTP is for encoding and transceiving end-to-end RTP data over an IP network to prevent conversation wiretapping.

## Call Routing and Digit Manipulation

### Call Routing

Incoming calls passing through Ubigate iBG3026 can be routed to the PSTN, such as port and trunk group, or to the VoIP network, such as the H.323 session target or SIP session target. Routing control is the procedure used to determine the route calls take from various destinations. The final route is determined based on various settings, such as dial plan, preference, and hunt scheme.

### Digit Manipulation

Ubigate iBG3026 allows digit manipulation of a dial string before it passes the dial string to the telephony device.

#### Digit Stripping and Prefixes

Digit stripping and prefixes make digit deletion and insertion possible before sending outbound POTS peers.

For digit stripping, Ubigate iBG3026 deletes the left-justified digits that explicitly match the destination pattern when iBG3026 matches a dial string to an outbound POTS dial peer.

For prefixes, iBG3026 may add specific digits to the front of the dialed string before it is forwarded to the telephony interface.

#### Forward Digits

Ubigate iBG3026 defines the number of digits and then forwards them to the telephony interface. It controls the number of digits stripped before the dialed string is passed to the telephony interface.

#### Digit Translation

Digit translation rules are used to manipulate the calling number (ANI) or called number (DNIS) digits for a voice call or to change the numbering type of a call. Translation rules are used to convert a telephone number into a different number before the call is matched to an inbound dial peer or before the call is forwarded by the outbound dial peer.

#### Call Block

Ubigate iBG3026 provides call blocking based on the calling or called number.

## Access Group

An access group is associated with an incoming VoIP call so that the terminating gateway can initiate appropriate services, such as number translation and incoming call control.

An access group consists of one or multiple access lists. Each access list is configured by IP address style.

## Trunk Group

A trunk group is a logical grouping of interfaces with the same signaling characteristics. The trunk group can be configured as the target of an outbound dial peer.

### Trunk Group Hunt Scheme

Ubigate iBG3026 provides trunk hunt schemes for outgoing calls.

A hunt scheme is a selection procedure for choosing an interface or voice port. A trunk group with several trunk group members uses a hunt scheme to select an idle channel for routing an outgoing call. Several hunt schemes are supported, as follows.

### Block/Unblock

If a trunk group is blocked or unblocked, each voice port is also blocked or unblocked because a trunk group is a set of voice ports. That is identical to the result of a busyout-forced operation on each voice port.

If a trunk group is blocked, Ubigate iBG3026 attempts to block a call as follows:

- For POTS signaling (R2-MFC) that supports a block mechanism, iBG3026 sends a block message.
- For POTS signaling (FXS, FXO, E & M, and T1-CAS) that does not support a block mechanism, iBG3026 plays a fast busy tone for an inbound call attempt or changes the line status to seize.
- For ISDN signaling, iBG3026 shuts down the ISDN signaling stack, by default, or sends a release message with a specific fail code.

### Multiple Trunk Group per Dial Peer

Multiple trunk group support permits up to 12 trunk groups to be provisioned as a target in a POTS dial peer. Because the dial peer can have more than one target destination, this capability reduces the number of dial peers that need configuration.

During a call setup request for an outbound call, the software searches for an idle channel in an outbound dial peer, using a list of trunk groups.

The trunk groups are searched sequentially by priority. If no idle channel is available in the highest priority trunk group, the next priority trunk group is searched. When a channel is found, the trunk group member containing the channel is used for the outbound call. If the call setup returns a glare condition and the software attempts a call retry, the search for another idle channel starts from the beginning of the list of multiple trunk groups.

## Call Admission Control (CAC)

Voice call admission control (CAC) is one of the techniques used to maintain reasonable voice quality. For real-time, delay-sensitive traffic, such as voice, it is better to deny network access when there is congestion than to allow traffic onto the network to be dropped and delayed.

CAC is a deterministic and informed decision made before a voice call is established and is based on whether the required network resources are available to provide suitable QoS for the new call.

### Local CAC

Local CAC mechanisms affect the outgoing Ubigate iBG3026. The CAC decision is based on nodal information, such as the maximum call status.

Ubigate iBG3026 provides CAC based on the system-wide maximum call number. CAC based on the system-wide maximum call number permits iBG3026 to deny incoming calls exceeding a preconfigured threshold, allowing the selection of a system-wide maximum call value. This feature helps ensure the quality of service of existing calls and reliability of system processes by preventing system overload caused by excessive incoming calls. The feature rejects new calls, with minor disruptions for system users. Administrators of iBG3026 set the threshold at which new calls are rejected.

Ubigate iBG3026 provides CAC based on the maximum call number per dial peer.

Ubigate iBG3026 also provides CAC based on the physical DS0 limitation.

## Resource-based CAC

Resource-based CAC mechanisms operate on the outgoing Ubigate iBG3026. The CAC decision is based on nodal information, such as the state of the CPU, memory, and DSP channel load level.

Ubigate iBG3026 provides CAC based on CPU utilization.

CAC based on CPU utilization permits iBG3026 to deny incoming calls exceeding a preconfigured threshold, allowing the selection of a system CPU load level value. This feature helps ensure the quality of service of existing calls and reliability of system processes by preventing system overload caused by excessive incoming calls. The feature rejects new calls, with minor disruptions for system users.

Administrators of iBG3026 set the threshold at which new calls are rejected. This CPU load threshold can be set anywhere from 20% to 90%.

Ubigate iBG3026 provides call admission control based on memory utilization.

CAC based on memory utilization permits iBG3026 to deny incoming calls exceeding a preconfigured threshold, allowing the selection of a system memory load level value. This feature helps ensure the quality of service of existing calls and reliability of system processes by preventing system overload caused by excessive incoming calls. The feature rejects new calls, with minor disruptions for system users.

Administrators of iBG3026 set the threshold at which new calls are rejected. This memory load threshold can be set anywhere from 20% to 90%.

Ubigate iBG3026 provides call admission control based on DSP utilization.

CAC based on DSP channel utilization permits iBG3026 to deny incoming calls exceeding a preconfigured threshold, allowing the selection of a system DSP channel load level value. This feature helps ensure the quality of service of existing calls and reliability of system processes by preventing system overload caused by excessive incoming calls. The feature rejects new calls, with minor disruptions for system users.

Administrators of iBG3026 set the threshold at which new calls are rejected. This DSP load threshold can be set anywhere from 20% to 100%.

## Voice Services

### FAX

Ubigate iBG3026 supports FAX pass-through and SIP/H.323 T.38 FAX relay.

#### T.38

Ubigate iBG3026 negotiates fax relay transmission by exchanging capability information in session description protocol (SDP) messages and H.323 messages.

T.38 Annex D procedures are used for the changeover from VoIP to fax mode during a call.

For SIP, a normal VoIP call is initially established using SIP INVITE requests. The DSP of iBG3026 must be informed that it can support T.38 mode when it is switched to voice mode. During the call, when the DSP of iBG3026 detects fax flags, iBG3026 initiates a SIP INVITE mid-call to signal the desire to change the media stream.

#### FAX Pass-through

Ubigate iBG3026 does not distinguish between a fax call and voice call.

Fax communication between two fax machines is carried entirely in-band over a voice call.

Fax up-speed is similar to pass-through in that the fax call is carried in-band over the voice call.

The difference is that, when using up-speed, iBG3026 is to some extent aware of the fax call. Although relay mechanisms are not employed, with up-speed, the gateways recognize a CED fax tone and automatically changes the voice codec to G.711, if necessary, and turn off echo cancellation (EC) and voice activity detection (VAD) for the duration of the call.

### DTMF Relay

The reliable DTMF relay feature provides reliable digit relay between different Ubigate iBG3026's or between iBG3026 and iPX when a low-bandwidth codec is used.

#### RFC2833

Ubigate iBG3026 supports RFC 2833 for reliable DTMF relay.

The iBG3026 relaying DTMF tones provides a standardized means of transporting DTMF tones in Real-time Transport Protocol (RTP) packets, according to section 3 of RFC 2833.

### **DTMF events through SIP signaling**

Ubigate iBG3026 supports the NOTIFY method for DTMF relay.

The SIP event notification mechanism uses the NOTIFY method to signal when certain telephony events take place. In order to send DTMF signals using the NOTIFY method, the gateway notifies the subscriber when DTMF digits are signaled by the originator. The notification contains a message body with a SIP response status line.

## **Ad-hoc Conference**

Ad-hoc conferencing provides the conferencing resources of the DSP contained in an Ubigate iBG3026 unit, providing high voice quality for supplementary services, such as 3-way iPX conferencing.

For ad-hoc conferencing, iBG3026 interworks with iPX using SIP, and the service is controlled by iPX.

## **Private Line Automatic Ringdown (PLAR)**

Ubigate iBG3026 provides PLAR (Private Line Automatic Ringdown) and OPX (off premises extension).

### **PLAR**

PLAR circuits have statically configured endpoints and do not require users to dial to connect calls. PLAR provides a mechanism to create a switched VoIP call without digit dialing.

### **PLAR OPX**

OPX allows remote users on Foreign Exchange Station (FXS) ports to appear to PBX as physical extensions. Ubigate iBG3026 offers toll-bypass VoIP services without providing dial tones or changing existing dial plans. OPX allows stations at remote sites to appear to a PBX as physically connected stations.

## LVBO (Local Voice Busy Out)

LVBO provides Ubigate iBG3026 with the ability to monitor the state of various network interfaces, LANs and WANs, and busy back the trunk to the PSTN interface if any of the monitored links fail.

If an ISDN line enters an LVBO state, a specific fail code is sent regarding the ISDN Inbound Call Attempt to indicate a busyout status.

For LVBO, the PSTN (FXS, FXO, E & M, and T1/E1 CAS) signaling line operates in the following way:

- If a call enters an analog FXS, a fast-busy tone is sent to indicate that the relevant line is busy.
- Regarding the inbound call attempt, such as FXO, E & M, T1-CAS FXS/FXO/E & M, and T1-R1, Ubigate iBG3026 enables a remote office to see that the relevant line is in busyout status.
- Since a block message exists for E1-R2, a block message is sent to a remote office to block the call attempt by a remote office; an unblock message is sent when the LVBO status is released, putting the line in idle status.

## Supplementary Services

Ubigate iBG3026 provides the following supplementary services for the iPX interworking mode, survivable telephony mode, and stand-alone mode.

### iPX Interworking Mode

When running in iPX interworking mode, Ubigate iBG3026 provides the supplementary services under iPX control.

- Calling Line Identification (CLID)
- Call Forward-All
- Call Forward-Busy
- Call Forward-NoAnswer
- Call Hold and Retrieve
- Call Park
- Call Pickup Group
- Call Pickup Direct
- Call Pickup Universal
- Call Restriction by User

- Call Waiting and Retrieve
- Call Transfer-Blind
- Call Transfer-Consultative
- Call Forwarding to VMS-All
- Call Forwarding to VMS-Busy
- Call Forwarding to VMS-NoAnswer
- Call Back Busy Subscriber
- Call Override
- Call Intrusion
- Privacy
- Wake-up Call
- Do Not Disturb (DND)
- Absentee Service (ABS)
- Conference calls
- Ad-hoc conference
- Group Call
- Distinctive Ring
- Music On Hold Service
- Malicious Call
- Follow Me

### **Survivable Telephony Mode**

When running in survivable telephony mode, Ubigate iBG3026 provides the following supplementary services to FXS and IP phone subscribers; these services interwork with iPX via iPX.

- Calling Line Identification (CLID)
- Call Forward-All
- Call Forward-Busy
- Call Forward-NoAnswer
- Call Hold and Retrieve
- Call Pickup Group
- Call Pickup Direct

- Call Pickup Universal
- Call Waiting and Retrieve
- Call Transfer-Blind
- Call Transfer-Consultative
- Distinctive Ring

### **Stand Alone Mode**

When running in a stand-alone mode, Ubigate iBG3026 provides the following supplementary services to interconnected FXS subscribers.

- Calling Line Identification (CLID)
- Call Hold and Retrieve
- Call Pickup Group
- Call Pickup Direct
- Call Pickup Universal
- Call Waiting and Retrieve
- Call Transfer-Blind
- Call Transfer-Consultative
- Distinctive Ring

## **E911 Support**

Ubigate iBG3026 supports Enhanced 911 (E911). E911 is an emergency telephone system capable of automatically displaying the callback number (and in some cases the location) of a person who dials emergency call numbers (911) to request emergency help from public safety agencies. The North American emergency E911 phone system consists of a voice network built largely outside the normal Public Switched Telephone Network (PSTN) on which common voice traffic rides. They are treated especially because they are routed differently within PSTN. Calls to emergency services are routed based on the calling number, not the called number. The calling number is checked against a database of emergency service providers that cross-references the service providers for the caller's particular location. When this information is known, the call is then routed to the proper Public Service Answering Point (PSAP), which, in turn, dispatches services to the caller's location.

## High Availability of Voice Feature

As enterprises extend their IP telephony and high-value application deployments from central sites to remote offices, one of the factors considered vital in deployment is the ability to cost-effectively provide backup redundancy functions at the remote branch office. However, the size and number of these small-office sites precludes most enterprises from deploying dedicated call-processing servers, unified messaging servers, or multiple WAN links to each site to achieve the high availability required.

Ubigate iBG3026 provides a high availability voice solution, as illustrated in table below.

Category	Local Call Server Through LAN	Remote Call Server Through WAN
WAN Link Fail (Call Server Alive)	PSTN Fallback - Analog call → PSTN - VoIP call → PSTN - Controlled by call server	Survivable Telephony - Analog call → PSTN - VoIP call → PSTN - Controlled by Ubigate iBG3026 (Call Server is down)
Call Server Down (WAN Link Alive)	Survivable Telephony - Analog call → PSTN, IP N/W - VoIP call → PSTN, IP N/W - Controlled by Ubigate iBG3026	Survivable Telephony - Analog call → PSTN, IP N/W - VoIP call → PSTN, IP N/W - Controlled by Ubigate iBG3026

### PSTN Fallback

Ubigate iBG3026 monitors the status of the IP network (WAN). When WAN failure is detected, it automatically redirects calls to the PSTN. When the WAN link is restored, call routing reverts back to the IP network. This feature is called PSTN fallback and allows an end user to have a reasonable guarantee of call completion.

## Survivable Telephony

Ubigate iBG3026 provides survivable telephony functionality, which is very important for remote branch offices connected over WAN links.

When a WAN link fails, and it is no longer possible to communicate with the call server (Ubigate iPX), it is then impossible to make a VoIP call.

In this case, Ubigate iBG3026 acts as a local PBX and SIP server, providing voice services for analog and IP phones.

While providing voice services, iBG3026 continuously monitors the call server or WAN for its service status. Once the call server has been restored, iBG3026 switches back to iPX interworking mode.

In survivable telephony mode, it can route outbound calls to the PSTN or VoIP network-SIP trunks, if available.

When Ubigate iBG3026 switches to survivable telephony mode, active calls within a branch are not affected by WAN or call server failure. They will last for the duration of the call.

In survivable telephony mode, iBG3026 provides the following services:

- Local extension IP phone dialing to/from IP phone
- IP phone to/from PSTN calls (VoIP trunks, if available)
- IP phone to/from analog device calls

It is recommended that all Ubigate iBG3026's in remote offices maintain direct links to the PSTN for backup callout capability. This is particularly important for maintaining emergency calling capability.

# Voice Deployment Scenario

In this section, various service scenarios handled by the Ubigate iBG3026 VoIP system are presented.

## PSTN Toll Bypass

Ubigate iBG3026 provides voice and fax toll bypass capabilities as shown in figure 4.4. In this scenario, a telephony device attached to a PBX or key phone system connects to iBG3026 through an analog or digital trunk connection. When iBG3026 is in iPX interworking mode, a call is established across the network by iBG3026 and iPX. The iPX communicates across the IP network using SIP or H.323. Packets are then routed over the IP network to their destination where the reverse operation is performed, completing the call over the IP network and bypassing the traditional toll network, PSTN. When iBG3026 is in stand-alone mode, a call is established across the IP network between iBG3026's, without iPX.

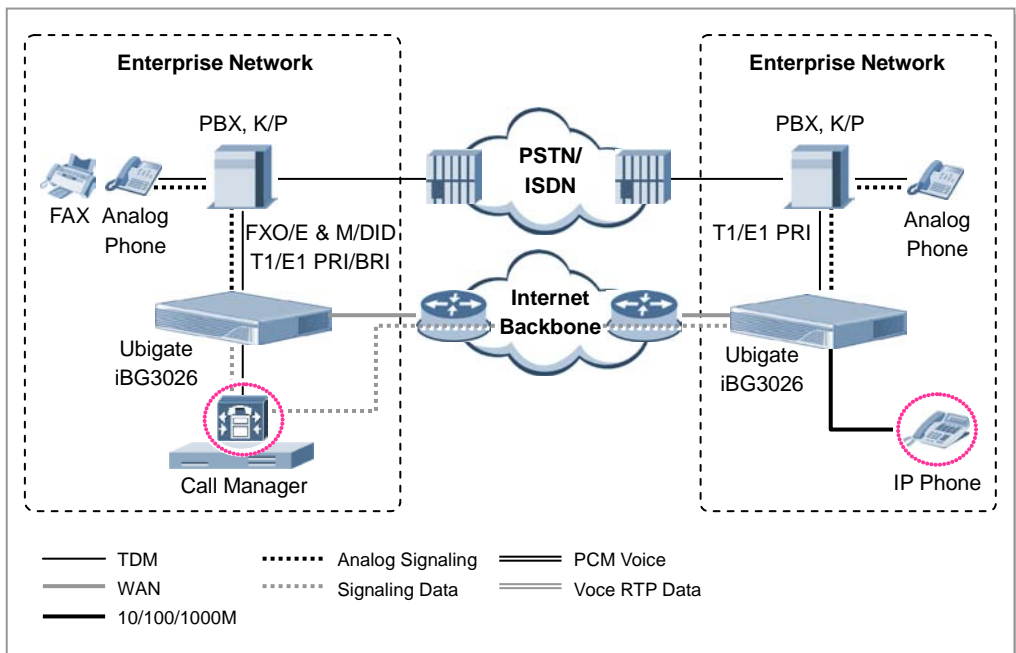


Figure 4.4 Toll Bypass for Voice and Fax services

## IP Phones

Figure 4.5 illustrates a second scenario involving an IP phone connected to Ubigate iBG3026. The SIP phone communicates directly with iPX using the SIP protocol that passes through iBG3026. The iPX's communicate with each other across the IP network via SIP to establish and maintain the call. The packets are then routed across the IP network from IP phone to IP phone, completing the connection. The second requirement for IP phones connected to iBG3026 is the connection of iBG3026 to the PBX or PSTN, enabling the IP phones to make calls to traditional phones. In this case, the IP phones communicate with the iPX and, in turn, the iPX establishes the call to the PBX or PSTN through iBG3026. The packets from the IP phone are then routed through DSP and delivered to the PBX or PSTN via analog or digital trunk lines.

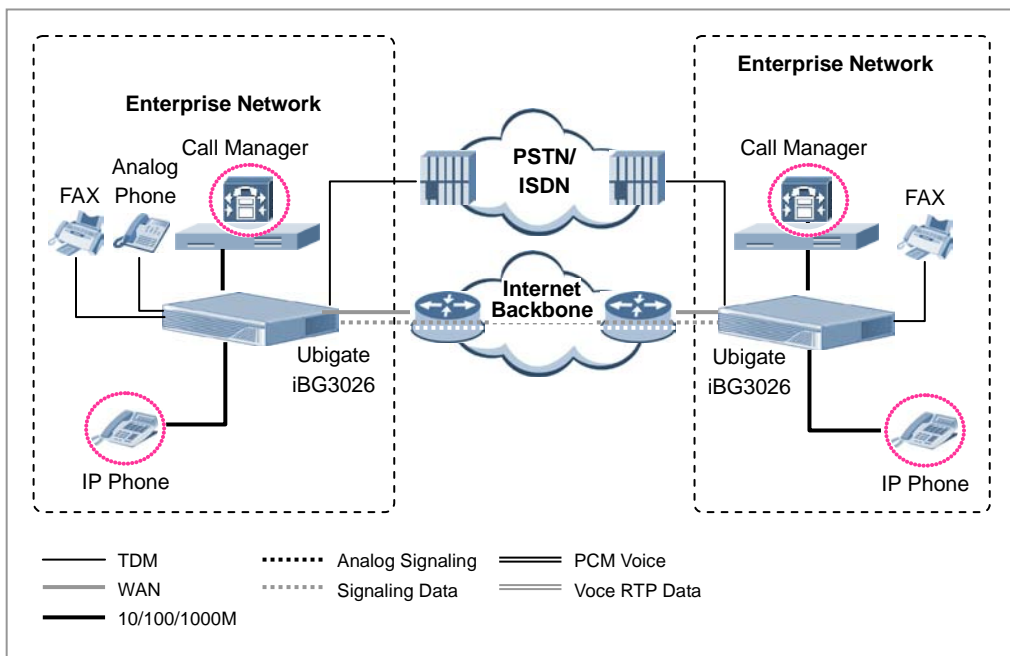


Figure 4.5 Connection to IP Phone, Analog Phone, and FAX

## Management System

Ubigate iBG3026's are controlled using several management systems or a command line interface (CLI), as shown in figure 4.6. There is an integrated graphical user interface (GUI) that allows users to configure iBG3026's. CLI is a text line interface permitting users to configure and view the status of individual, connected systems.

The network management system uses the Simple Network Management Protocol (SNMP) to communicate with iBG3026's. The SNMP 'get' and 'set' commands can be used to configure either system and retrieve current configuration and status information. These management systems can be located anywhere in the IP network.

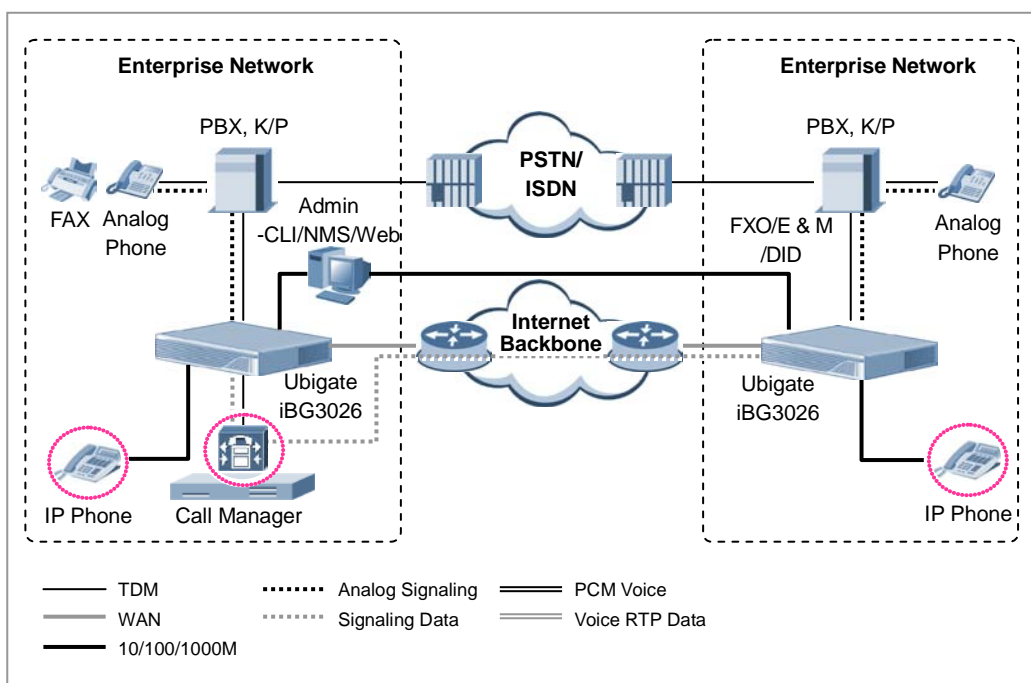


Figure 4.6 Management using CLI/GUI/NMS

## Performance and Capacity

For each an operation mode, a performance and a capacity of iBG3026 is as follow:

Item	Standalone Mode	iPX Interworking Mode	Survivable Telephony Mode	
			POTS to POTS/VoIP	VoIP to VoIP
BHCA	3840	3840	3840	6000
CPS (Call Per Second)	1.07	1.07	1.07	1.67
Max Station	128	200	200	200
AHT (Average Handle Time)	120	120	120	120
Concurrent Call	128	128	128	2





# ANNEX A. Cable Specifications

## Console Port Cable

### Cable Shape

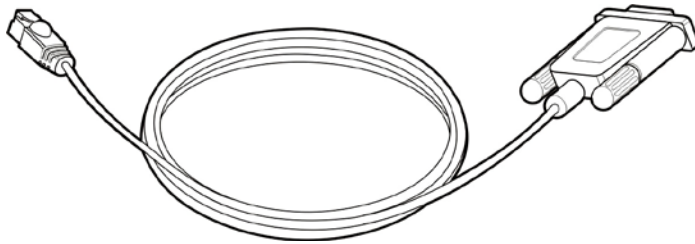


Figure A.1 Console Port Cable

### Cable Signaling and Pinout

Console Port (RJ-45)	Console Device (DB-9)	Console Port (RJ-45)	Console Device (DB-9)
Pin	Signal	Pin	Signal
1	RTS	8	CTS
2	DTR	6	DSR
3	TxD	2	RxD
4	GND	5	GND
5	GND	5	GND
6	RxD	3	TxD
7	DSR	4	DTR
8	CTS	7	RTS

# Auxiliary Port Cable

## Cable Shape

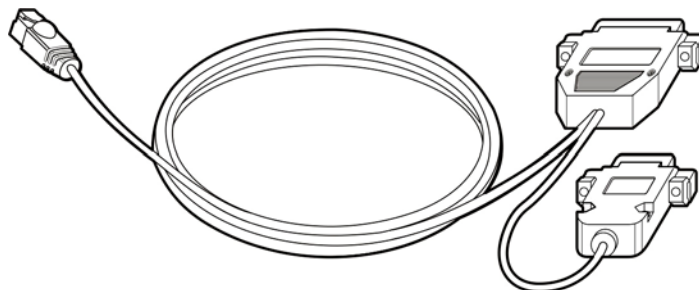


Figure A.2 Auxiliary Port Cable

## Cable Signaling and Pinout

Auxiliary Port (DTE)		Modem		
RJ-45 Pin	Signal	DB-9 Pin	DB-25 Pin	Signal
1	RTS	7	4	RTS
2	DTR	4	20	DTR
3	TxD	3	2	TxD
4	GND	5	7	GND
5	GND	5	7	GND
6	RxD	2	3	RxD
7	DSR	6	8	DCD
8	CTS	8	5	CTS

# BRI-2U Mini Module Cable

## Cable Shape

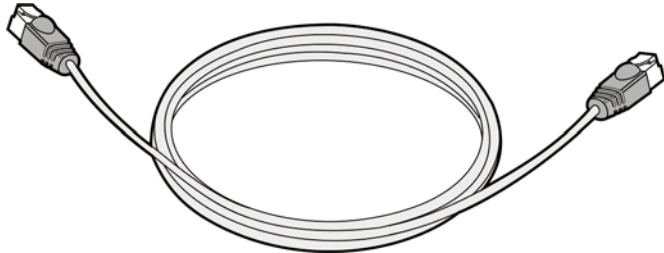


Figure A.3 BRI-2U Mini Module Cable

## Cable Signaling and Pinout

8 Pin <sup>1)</sup>	Function
3	No connection
4	Signal-Tip
5	Signal-Ring
6	No connection

1) Pins 1, 2, 7 and 8 are not used.

## BRI-2ST Mini Module Cable

### Cable Shape

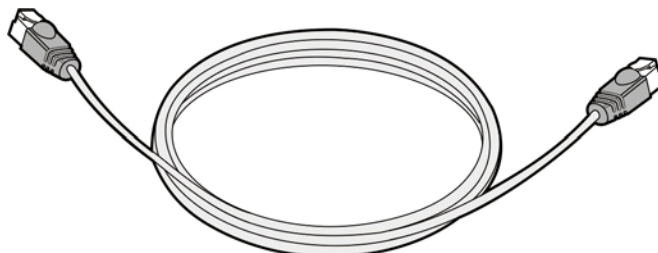


Figure A.4 BRI-2ST Module Cable

### Cable Signaling and Pinout

8 Pin <sup>1)</sup>	TE <sup>2)</sup>	NT <sup>3)</sup>	Polarity
3	Transmit	Receive	+
4	Receive	Transmit	+
5	Receive	Transmit	-
6	Transmit	Receive	-

- 1) Pins 1, 2, 7 and 8 are not used.
- 2) TE refers to terminal terminating layer 1 aspects of TE1, TA, and NT functional groups (this applies to the ISDN BRI S/T WIC).
- 3) NT refers to network terminating layer 1 aspects of NT1 and NT2 functional groups.

## ESG-8, LMG-20, LMF-20, LMP-20, LMG-44, LMGP-44 Module Cable

### Cable Shape

- Cable Length: 6/10 feet
- Standard, Straight-Through Wiring (both ends are the same)
- 10/100/1000 Base-T interfaces

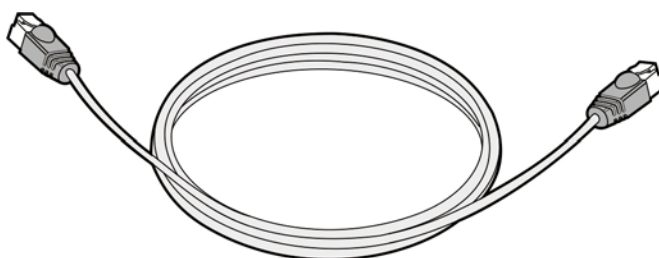


Figure A.5 ESG-8, LMG-20, LMF-20, LMP-20, LMG-44 Module Cable

### Cable Signaling and Pinout

RJ45 Pin #	Wire Color (T568A)	1000 Base-T Signal
1	White/Green	BI_DA+
2	Green	BI_DA-
3	White/Orange	BI_DB+
4	Blue	BI_DC+
5	White/Blue	BI_DC-
6	Orange	BI_DB-
7	White/Brown	BI_DD+
8	Brown	BI_DD-

# T1E1-4, T1E1-2M Module Cable

## Cable Shape

- RJ-48C to RJ-48C Cable

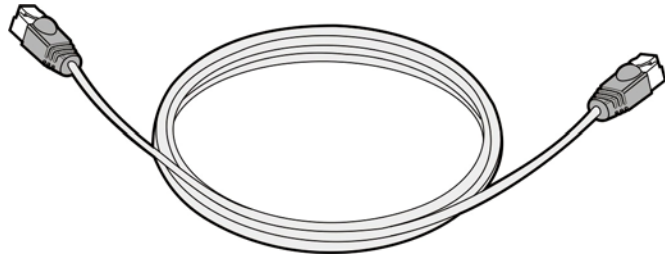


Figure A.6 T1E1-4, T1E1-2M Module Cable

## Cable Signaling and Pinout

RJ-11 connector		RJ-11 connector	
Pin	Signal	Signal	Pin
1	RXPING	TXRING	4
2	RXTIP	TXTIP	5
4	TXRING	RXRING	1
5	TXTIP	RXTIP	2

## HSSI-1 Module Cable

### Cable Shape

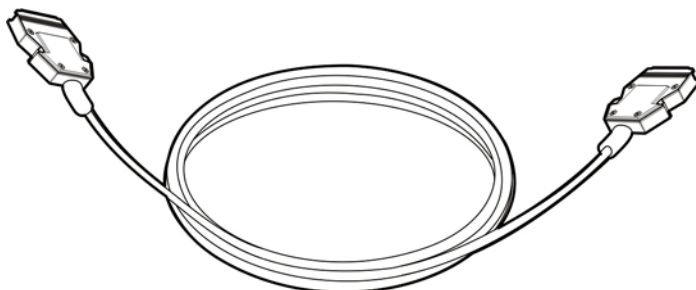


Figure A.7 HSSI-1 Module Cable

### Cable Signaling and Pinout

Signal	Pin No. + Side (Router End)	Direction <sup>1)</sup>	Pin No.-Side (DSU End)
SG (Signal Ground)	1	-	26
RT (Receive Timing)	2	←	27
CA (DCE Available)	3	←	28
RD (Receive Data Reserved)	4	←	29
LC (Loopback circuit C)	5	←	30
ST (Send Timing)	6	←	31
SG (Signal Ground)	7	-	32
TA (DTE Available)	8	→	33
TT (Terminal Timing)	9	→	34
LA (Loopback Circuit A)	10	→	35
SD (Send Data)	11	→	36
LB (Loopback Circuit B)	12	→	37
SG (Signal Ground)	13	-	38
5 (Ancillary to DCE)	14-18	→	39-43
SG (Signal Ground)	29	-	44
5 (Ancillary from DCE)	20-24	←	45-49
SG (Signal Ground)	25	-	50

1) Router is + side (DTE). DSU is-side (DCE).

## HSSI-1 Module Cable (Null Modem Case)

### Cable Shape

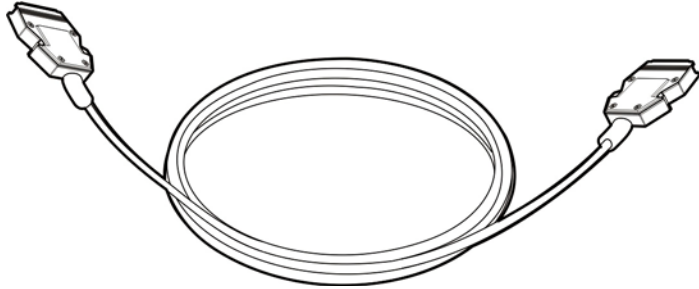


Figure A.8 HSSI-1 Module Cable (Null Modem Case)

### Cable Signaling and Pinout

Signal	From Pins	Direction <sup>1)</sup>	To Pins	Signal Name
RT (Receive Timing)	2, 27	→	9, 34	TT (Terminal Timing)
CA (DCE Available)	3, 28	→	8, 33	TA (DTE Available)
RD (Receive Data Reserved)	4, 29	→	11, 36	SD (Send Data)
LC (Loopback circuit C)	5, 30	→	10, 35	LA (Loopback A)
ST (Send Timing)	6, 31	→	6, 31	ST (Send Timing)
TA (DTE Available)	8, 33	→	3, 28	CA (DCE Available)
TT (Terminal Timing)	9, 34	→	2, 27	RT (Receive Timing)
LA (Loopback Circuit A)	10, 35	→	5, 30	LC (Loopback C)
SD (Send Data)	11, 36	→	4, 29	RD (Receive Data)
GND (Ground)	1, 26, 7, 32, 13, 38, 19, 44, 25, 50	-	1, 26, 7, 32, 13, 38, 19, 44, 25, 50	GND (Ground)
Loopback (not connected)	12, 37	-	-	-
-	-	-	12, 37	Loopback (not connected)
Not used	14-18, 20-24, 39-43, 45-49	-	14-18, 20-24, 39-43, 45-49	Not used

1) Router is + side (DTE). DSU is-side (DCE).

## FXS-24 Module Cable

### Cable Shape

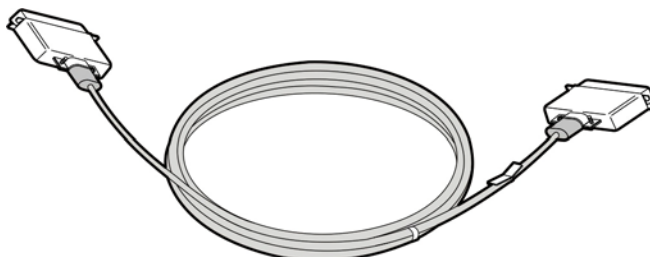


Figure A.9 FXS-24 Module Cable

### Cable Signaling and Pinout

RJ-21 (Left)	RJ-21 (Right)	Signal name	RJ-21 (Left)	RJ-21 (Right)	Signal name
1 26	1 26	TIP 1 RING 1	14 39	14 39	TIP 14 RING 14
2 27	2 27	TIP 2 RING 2	15 40	15 40	TIP 15 RING 15
3 28	3 28	TIP 3 RING 3	16 41	16 41	TIP 16 RING 16
4 29	4 29	TIP 4 RING 4	17 42	17 42	TIP 17 RING 17
5 30	5 30	TIP 5 RING 5	18 43	18 43	TIP 18 RING 18
6 31	6 31	TIP 6 RING 6	19 44	19 44	TIP 19 RING 19
7 32	7 32	TIP 7 RING 7	20 45	20 45	TIP 20 RING 20
8 33	8 33	TIP 8 RING 8	21 46	21 46	TIP 21 RING 21
9 34	9 34	TIP 9 RING 9	22 47	22 47	TIP 22 RING 22
10 35	10 35	TIP 10 RING 10	23 48	23 48	TIP 23 RING 23

(Continued)

RJ-21 (Left)	RJ-21 (Right)	Signal name	RJ-21 (Left)	RJ-21 (Right)	Signal name
11 36	11 36	TIP 11 RING 11	24 49	24 49	TIP 24 RING 24
12 37	12 37	TIP 12 RING 12	25 50	25 50	TIP 25 RING 25
13 38	13 38	TIP 13 RING 13	-	-	-

## E & M-2M Module Cable

### Cable Shape

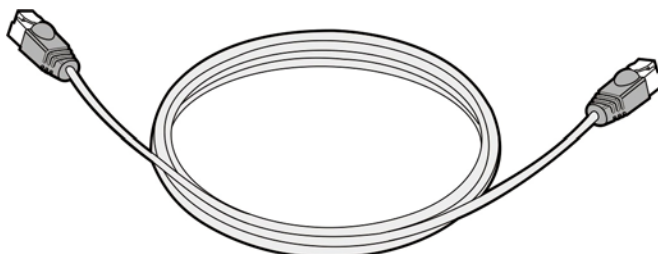


Figure A.10 E & M-2M Module Cable

### Cable Signaling and Pinout

Pin	Signal	Description	Two-Wire Operation, Type				Four-Wire Operation, Type			
			1	2	3	5	1	2	3	5
1	SB	-48 V signaling battery	-	SB	SB	-	-	SB	SB	-
2	M-lead	Signaling input	M	M	M	M	M	M	M	M
3	R	Ring, audio input	-	-	-	-	R	R	R	R
4	R or R1	Ring, audio input/output or output	R	R	R	R	R1	R1	R1	R1
5	T or T1	Tip, audio input/output or output	T	T	T	T	T1	T1	T1	T1
6	T	Tip, audio input	-	-	-	-	T	T	T	T
7	E-lead	Signaling output	E	E	E	E	E	E	E	E
8	SG	Signaling ground return	-	SG	SG	-	-	SG	SG	-

# FXO-2M, FXO-4M, FXS-2M, FXS-4M Module Cable

## Cable Shape

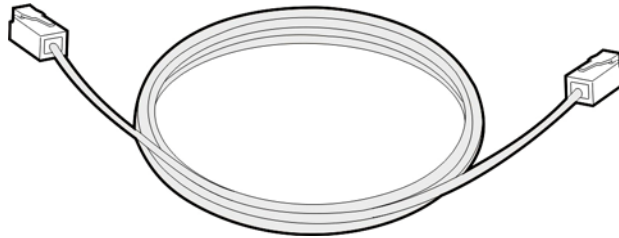


Figure A.11 FXO-2M, FXO-4M, FXS-2M , FXS-4M Module Cable

## Cable Signaling and Pinout

RJ-11 connector		RJ-11 connector	
Pin	Signal	Signal	Pin
1	-	-	1
2	-	-	2
3	Ring	Ring	3
4	Tip	Tip	4
5	-	-	5
6	-	-	6

## ATOP-1, ATOI-1 Module Cable

### Cable Shape

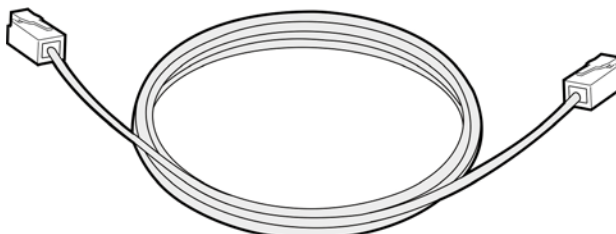


Figure A.12 ATOP-1, ATOI-1 Module Cable

### Cable Signaling and Pinout

RJ-11 connector		RJ-11 connector	
Pin	Signal	Signal	Pin
1	-	-	1
2	-	-	2
3	Ring	Ring	3
4	Tip	Tip	4
5	-	-	5
6	-	-	6

# WTE-4S Module Cable (X.21 DCE)

## Cable Shape

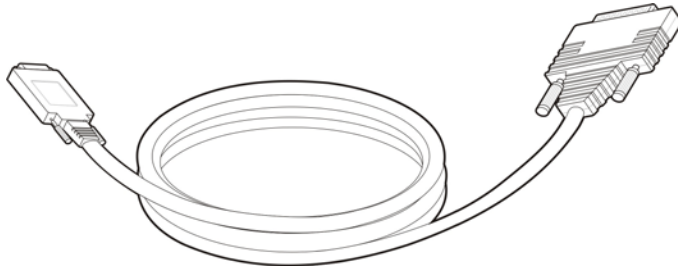


Figure A.13 WTE-4S Module Cable (X.21 DCE)

## Cable Signaling and Pinout

SMART Serial		DB15 Female	
PIN	Signal	Signal	PIN
21	-	-	-
SHELL	-	Shield GND	1
26	GND	Circuit GND	8
-	Not Used	Not Used	
8	O_RTS/CTS	INDICATION+	5
9	O_DTR/DSR+	INDICATION-	12
11	I_CTS/RTS+	CONTROL+	3
10	I_DSR/DTR+	CONTROL-	10
5	I_RXD/TXD+	TRANSMIT+	2
18	I_RXD/TXD-	TRANSMIT-	9
2	O_TXCE/RXC+	TIMING+	6
15	O_TXCE/RXC-	TIMING-	13
1	O_TXD/RXD+	RECEIVE+	4
14	O_TXD/RXD-	RECEIVE-	11
SHELL	-	-	SHELL

## WTE-4S Module Cable (X.21 DTE)

### Cable Shape

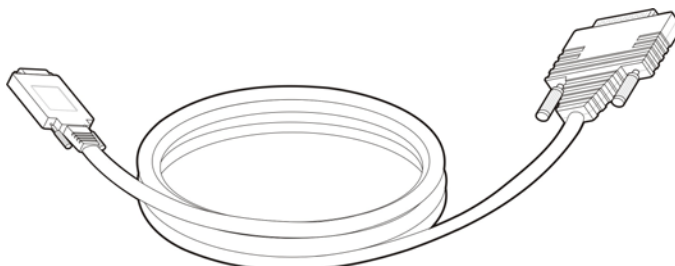


Figure A.14 WTE-4S Module Cable (X.21 DCE)

### Cable Signaling and Pinout

SMART Serial		DB15 Male	
PIN	Signal	Signal	PIN
21	-	-	-
24	-	-	-
SHELL	-	Shield GND	1
26	GND+	CCT GND	8
-	Not Used	Not Used	
11	I_CTS/RTS+	INDICATION+	5
10	I_DSR/DTR+	INDICATION-	12
8	O_RTS/CTS+	CONTROL+	3
9	O_DTR/DSR+	CONTROL-	10
1	O_TXD/RXD+	TRANSMIT+	2
14	O_TXD/RXD-	TRANSMIT-	9
4	I_RXC/TXCE+	TIMING+	6
17	I_RXC/TXCE-	TIMING-	13
5	I_RXD/TXD+	RECEIVE+	4
18	I_RXD/TXD-	RECEIVE-	11
SHELL	-	-	SHELL

# WTE-4S Module Cable (RS232 DCE)

## Cable Shape

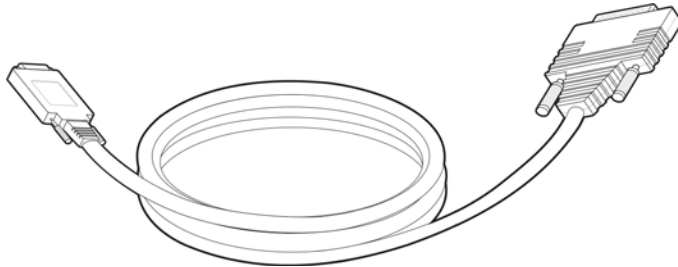


Figure A.15 WTE-4S Module Cable (RS232 DCE)

## Cable Signaling and Pinout

SMART Serial		DB25 Female	
PIN	Signal	Signal	PIN
23	-	-	-
SHELL	-	Shield GND	1
6	B_DCD/DCD+	DCD	8
19	GND+	GND	7
11	I_CTS/RTS+	RTS	4
12	I_DSR/DTR+	DTR	20
13	B_LL/LL+	LTST	18
26	GND+	GND	-
8	O_RTS/CTS	CTS	5
7	O_DTR/DSR+	DSR	6
5	I_RXD/TXD+	TXD	2
18	GND+	GND	-
4	I_RXC/TXCE+	TXCE	24
17	GND+	GND	-
3	B_TXC/TXC+	TXC	15
16	GND+	GND	-
2	O_TXCE/RXC+	RXC	17

(Continued)

SMART Serial		DB25 Female	
PIN	Signal	Signal	PIN
15	GND+	GND	-
1	O_TXD/RXD+	RXD	3
14	GND+	GND	-
SHELL	-	-	SHELL

# WTE-4S Module Cable (RS232 DTE)

## Cable Shape

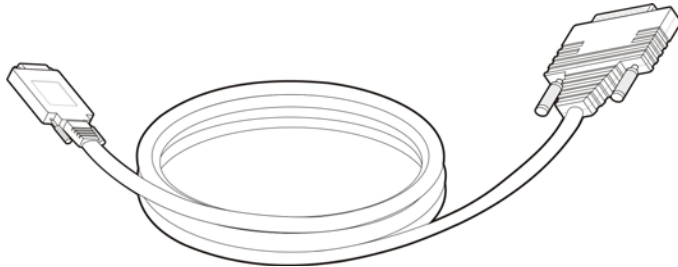


Figure A.16 WTE-4S Module Cable (RS232 DTE)

## Cable Signaling and Pinout

SMART Serial		DB25 Male	
PIN	Signal	Signal	PIN
23	-	-	-
24	-	-	-
SHELL	-	Shield GND	1
6	B_DCD/DCD+	DCD	8
19	GND+	GND	7
11	I_CTS/RTS+	CTS	5
12	I_DSR/DTR+	DSR	6
13	B_LL/LL+	LTST	18
26	GND+	GND	-
8	O_RTS/CTS	RTS	4
7	O_DTR/DSR+	DTR	20
1	O_TxD/RxD+	TXD	2
14	GND+	GND	-
2	O_TXCE/RXC+	TXCE	24
15	GND+	GND	-
3	B_TXC/TXC+	TXC	15
16	GND+	GND	-
4	I_RXC/TXCE+	RXC	17

(Continued)

SMART Serial		DB25 Male	
PIN	Signal	Signal	PIN
17	GND+	GND	-
5	I_RxD/TxD+	RXD	3
18	GND+	GND	-
SHELL	-	-	SHELL

# WTE-4S Module Cable (RS449 DCE)

## Cable Shape

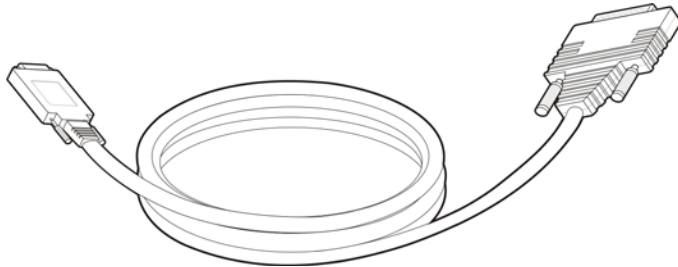


Figure A.17 WTE-4S Module Cable (RS449 DCE)

## Cable Signaling and Pinout

SMART Serial		DB37 Female	
PIN	Signal	Signal	PIN
SHELL	-	Shield GND	1
11	I_CTS/RTS+	RS+	7
10	I_CTS/RTS-	RS-	25
22	-	SG	19
-	-	RC	20
12	I_DTR/DSR+	TR+	12
25	I_DTR/DSR-	TR-	30
8	O_RTS/CTS+	CS+	9
9	O_RTS/CTS-	CS-	27
5	I_RXD/TXD+	SD+	4
18	I_RXD/TXD-	SD-	22
4	I_RXC/TXCE+	TT+	17
17	I_RXC/TXCE-	TT-	35
3	B_TXC/TXC+	ST+	5
16	B_TXC/TXC-	ST-	23
2	O_TXCE/RXC+	RT+	8
15	O_TXCE/RXC-	RT-	26

(Continued)

SMART Serial		DB37 Female	
PIN	Signal	Signal	PIN
1	O_TXD/RXD+	RD+	6
14	O_TXD/RXD-	RD-	24
7	O_DTR/DSR+	DM+	11
20	O_DTR/DSR-	DM-	29
6	B_DCD/DCD+	RR+	13
19	B_DCD/DCD-	RR-	31
13	B_LL/LL+	LL	10
26	GND+	SC	37
SHELL	-	-	SHELL

# WTE-4S Module Cable (RS449 DTE)

## Cable Shape

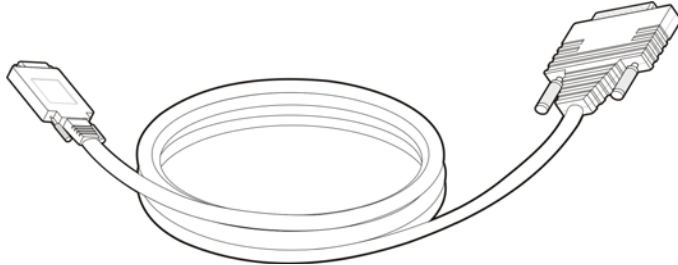


Figure A.18 WTE-4S Module Cable (RS449 DTE)

## Cable Signaling and Pinout

SMART Serial		DB37 Male	
PIN	Signal	Signal	PIN
SHELL	-	Shield GND	1
8	O_RTS/CTS	RS+	7
9	O_RTS/CTS-	RS-	25
22	-	SG	19
24	-	RC	20
7	O_DTR/DSR+	TR+	12
20	O_DTR/DSR-	TR-	30
11	I_CTS/RTS+	CS+	9
10	I_CTS/RTS-	CS-	27
1	O_TXD/RXD+	SD+	4
14	O_TXD/RXD-	SD-	22
2	O_TXCE/RXC+	TT+	17
15	O_TXCE/RXC-	TT-	35
3	B_TXC/TXC+	ST+	5
16	B_TXC/TXC-	ST-	23
4	I_RXC/TXCE+	RT+	8
17	I_RXC/TXCE-	RT-	26

(Continued)

SMART Serial		DB37 Male	
PIN	Signal	Signal	PIN
5	I_RXD/TXD+	RD+	6
18	I_RXD/TXD-	RD-	24
12	I_DTR/DSR+	TR+	11
25	I_DTR/DSR-	TR-	29
6	B_DCD/DCD+	RR+	13
19	B_DCD/DCD-	RR-	31
13	B_LL/LL+	LL	10
26	GND+	SC	37
SHELL	-	-	SHELL

# WTE-4S Module Cable (V.35 DCE)

## Cable Shape

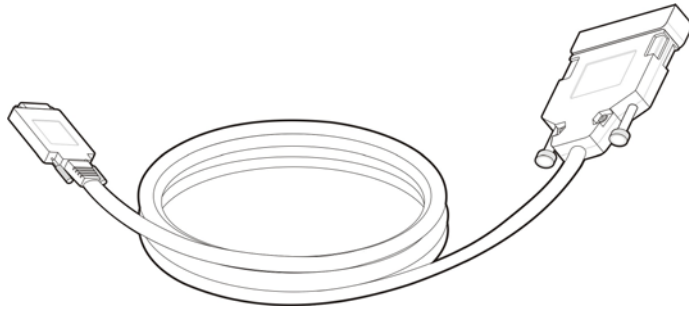


Figure A.19 WTE-4S Module Cable (V.35 DCE)

## Cable Signaling and Pinout

SMART Serial		V.35 RECEPT.	
PIN	Signal	Signal	PIN
22	-	-	-
23	-	-	-
SHELL	-	Shield GND	A
11	I_CTS/RTS+	RTS	C
12	I_DSR/DTR+	DSR	H
8	O_RTS/CTS	CTS	D
7	O_DTR/DSR+	DSR	E
6	B_DCD/DCD+	RLSD	F
19	GND+	-	-
13	B_LL/LL+	LT	K
26	-	GND	B
5	I_RXD/TXD+	SD+	P
18	I_RXD/TXD-	SD-	S
1	O_TXD/RXD+	RD+	R
14	O_TXD/RXD-	RD-	T
4	I_RXC/TXCE+	SCTE+	U
17	I_RXC/TXCE-	SCTE-	W

(Continued)

SMART Serial		V.35 RECEPT.	
PIN	Signal	Signal	PIN
2	O_TXCE/RXC+	SCR+	V
15	O_TXCE/RXC-	SCR-	X
3	B_TXC/TXC+	SCT+	Y
16	B_TXC/TXC-	SCT-	AA
SHELL	-	-	SHELL

# WTE-4S Module Cable (V.35 DTE)

## Cable Shape

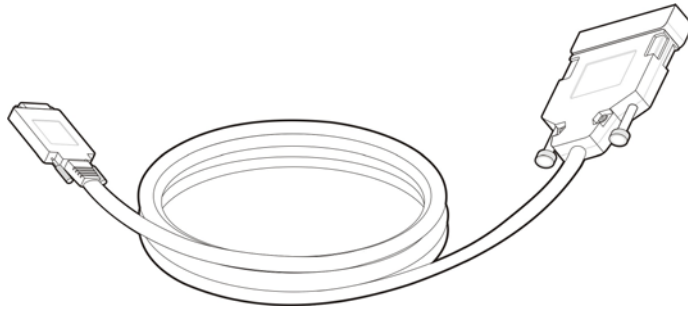


Figure A.20 WTE-4S Module Cable (V.35 DTE)

## Cable Signaling and Pinout

SMART Serial		V.35 RECEPT.	
PIN	Signal	Signal	PIN
22	-	-	-
23	-	-	-
24	-	-	-
SHELL	-	Shield GND	A
8	O_RTS/CTS	RTS	C
7	O_DTR/DSR+	DTR	H
11	I_CTS/RTS+	CTS	D
12	I_DSR/DTR+	DSR	E
6	B_DCD/DCD+	RLSD	F
19	GND+	-	-
13	B_LL/LL+	LT	K
26	GND	GND	B
1	O_TXD/RXD+	SD+	P
14	O_TXD/RXD-	SD-	S
5	I_RXD/TXD+	RD+	R
18	I_RXD/TXD-	RD-	T

(Continued)

SMART Serial		V.35 RECEPT.	
PIN	Signal	Signal	PIN
2	O_TXCE/RXC+	SCTE+	U
15	O_TXCE/RXC-	SCTE-	W
4	I_RXC/TXCE+	SCR+	V
17	I_RXC/TXCE-	SCR-	X
3	B_TXC/TXC+	SCT+	Y
16	B_TXC/TXC-	SCT-	AA
SHELL	-	-	SHELL

# WTE-4S Module Cable (RS530A DTE)

## Cable Shape

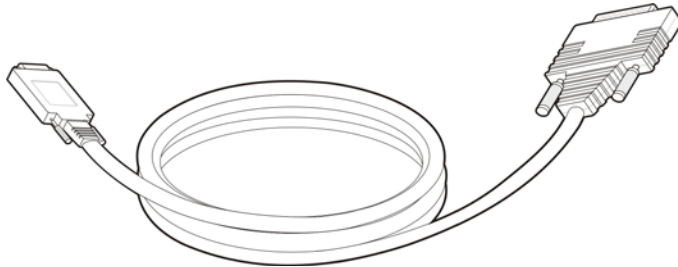


Figure A.21 WTE-4S Module Cable (RS530A DTE)

## Cable Signaling and Pinout

SMART Serial		DB25 Male	
PIN	Signal	Signal	PIN
21	-	-	-
22	-	-	-
24	-	-	-
SHELL	-	-	1
8	O_RTS/CTS	RTS+	4
9	O_RTS/CTS-	RTS-	19
7	O_DTR/DSR+	DTR+	20
20	GND+	GND	23
11	I_CTS/RTS+	CTS+	5
10	I_DSR/RTS-	CTS-	13
1	O_TXD/RXD+	TXD+	2
14	O_TXD/RXD-	RXD-	14
2	O_TXCE/RXC+	TXCE+	24
15	O_TXCE/RXC-	TXCE-	11
3	B_TXC/TXC+	TXC+	15
16	B_TXC/TXC-	TXC-	12

(Continued)

SMART Serial		DB25 Male	
PIN	Signal	Signal	PIN
4	I_RXC/TXCE+	RXC+	17
17	I_RXC/TXCE-	RXC-	9
5	I_RXD/TXD+	RXD+	3
18	I_RXD/TXD-	RXD-	16
12	I_DSR/DTR+	DSR+	6
25	GND	GND	-
6	B_DCD/DCD+	DCD+	8
19	B_DCD/DCD-	DCD-	10
13	B_LL/LL+	LL	18
26	GND	GND	7
SHELL	-	-	SHELL

# WTE-4S Module Cable (RS530 DTE)

## Cable Shape

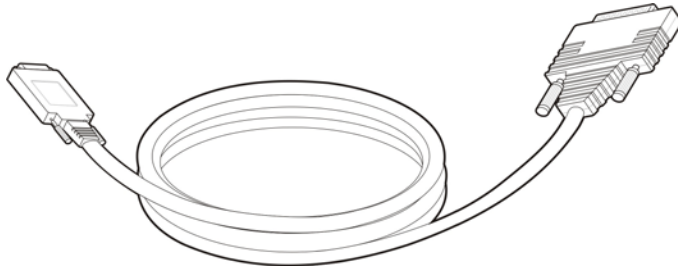


Figure A.22 WTE-4S Module Cable (RS530 DTE)

## Cable Signaling and Pinout

SMART Serial		DB25 Male	
PIN	Signal	Signal	PIN
21	-	-	-
23	-	-	-
24	-	-	-
SHELL	-	Shield GND	1
8	O_RTS/CTS	RTS+	4
9	O_RTS/CTS-	RTS-	19
7	O_DTR/DSR+	DTR+	20
20	O_DTR/DSR-	DTR-	23
11	I_CTS/RTS+	CTS+	5
10	I_DSR/RTS-	CTS-	13
1	O_TXD/RXD+	TxD+	2
14	O_TXD/RXD-	TxD-	14
2	O_TXCE/RXC+	TxCE+	24
15	O_TXCE/RXC-	TXCE-	11
3	B_TXC/TXC+	TxC+	15
16	B_TXC/TXC-	TxC-	12
4	I_RXC/TXCE+	RxC+	17

(Continued)

SMART Serial		DB25 Male	
PIN	Signal	Signal	PIN
17	I_RXC/TXCE-	RXC-	9
5	I_RXD/TXD+	RXD+	3
18	I_RXD/TXD-	RXD-	16
12	I_DSR/DTR+	DSR+	6
25	I?DSR/DTR-	DSR-	22
6	B_DCD/DCD+	DCD+	8
19	B_DCD/DCD-	DCD-	10
13	B_LL/LL+	LL	18
26	GND	GND	7
SHELL	-	-	SHELL



**This page is intentionally left blank.**



# ANNEX B. Open Source Announcement

Some software components of this product incorporate source code covered under the BSD License, libxml2 License and OpenSSL License etc.

**Acknowledgement:**

This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit (<http://www.openssl.org/>).

The software included in this product contains copyrighted software that is licensed under the GPL/LGPL. You may obtain the complete Corresponding Source code from us for a period of three years after our last shipment of this product by sending email to: [nswmanager@samsung.com](mailto:nswmanager@samsung.com)

If you want to obtain the complete Corresponding Source code in the physical medium such as CD-ROM, the cost of physically performing source distribution may be charged.

This offer is valid to anyone in receipt of this information.

Below is the list of components covered under BSD License, libxml2 License and OpenSSL License, which were used to develop software running in the main system.

Component	License	Component	License
OpenSSH	BSD License	TCP Dump	BSD License
pppd	BSD License	FreeBSD	BSD License
libxml2	libxml2 License	OpenSSL	OpenSSL License

Below is the list of components covered under the GNU General Public License, the GNU Lesser General Public License, BSD License and OpenSSL License, which were used to develop software running in the ADSL module.

Component	License	Component	License
net-snmp	BSD 2.0	RP PPP OE	GPL 2.0
libupnp	BSD 2.0	ebtables	GPL 2.0
T FTP	BSD 2.0	DNRD	GPL 2.0
Rinecrypt	BSD 2.0	wireless-tools	GPL 2.0
BusyBox	GPL 2.0	ez-ipupdate	GPL 2.0
U-Boot	GPL 2.0	Bridge Utility for Linux	GPL 2.0
GNU Zebra	GPL 2.0	ntpclient	GPL 2.0
MTD and JFFS2 improvements	GPL 2.0	uClinux(bc2684ctl)	GPL 2.0
ATM on Linux	GPL 2.0	Linux Kernel	GPL 2.0
iptables	GPL 2.0	7 Zip - LZMA SDK	LGPL 2.1
iproute2	GPL 2.0	V Config	LGPL 2.1
squashfs	GPL 2.0	OpenSSL	OpenSSL License

## ANNEX B. Open Source Announcement

---

Below is the list of components covered under GNU General Public License, MIT License and MD5 License, which were used to develop software running in the SGM module.

Component	License	Component	License
pci_agent	GPL 2.0	c-ares library	MIT License
Linux Kernel	GPL 2.0	ezxml	MIT License
u-boot	GPL 2.0	md5	MD5 License

Below is the list of components covered under the GNU General Public License and the MIT which were used to develop software running in the IVM module.

Component	License	Component	License
Ezxml	MIT License	u-boot	GPL 2.0
Linux Kernel 2.6.13	GPL 2.0	-	-

### GNU GENERAL PUBLIC LICENSE

Version 2, June 1991

Copyright (C) 1989, 1991 Free Software Foundation, Inc.  
51 Franklin Street, Fifth Floor, Boston, MA 02110-1301 USA

Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

#### Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public License is intended to guarantee your freedom to share and change free software--to make sure the software is free for all its users. This General Public License applies to most of the Free Software Foundation's software and to any other program whose authors commit to using it. (Some other Free Software Foundation software is covered by the GNU Lesser General Public License instead.) You can apply it to your programs, too.

When we speak of free software, we are referring to freedom, not price.

Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish), that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs; and that you know you can do these things.

To protect your rights, we need to make restrictions that forbid anyone to deny you these rights or to ask you to surrender the rights. These restrictions translate to certain responsibilities for you if you distribute copies of the software, or if you modify it. For example, if you distribute copies of such a program, whether gratis or for a fee, you must give the recipients all the rights that you have. You must make sure that they, too, receive or can get the source code. And you must show them these terms so they know their rights.

We protect your rights with two steps:

(1) copyright the software, and (2) offer you this license which gives you legal permission to copy, distribute and/or modify the software. Also, for each author's protection and ours, we want to make certain that everyone understands that there is no warranty for this free software. If the software is modified by someone else and passed on, we want its recipients to know that what they have is not the original, so that any problems introduced by others will not reflect on the original authors' reputations.

Finally, any free program is threatened constantly by software patents.

We wish to avoid the danger that redistributors of a free program will individually obtain patent licenses, in effect making the program proprietary. To prevent this, we have made it clear that any patent must be licensed for everyone's free use or not licensed at all.

The precise terms and conditions for copying, distribution and modification follow.

## TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0 This License applies to any program or other work which contains a notice placed by the copyright holder saying it may be distributed under the terms of this General Public License. The 'Program', below, refers to any such program or work, and a 'work based on the Program' means either the Program or any derivative work under copyright law: that is to say, a work containing the Program or a portion of it, either verbatim or with modifications and/or translated into another language. (Hereinafter, translation is included without limitation in the term 'modification'.) Each licensee is addressed as 'you'.

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope.

The act of running the Program is not restricted, and the output from the Program is covered only if its contents constitute a work based on the Program (independent of having been made by running the Program). Whether that is true depends on what the Program does.

- 1 You may copy and distribute verbatim copies of the Program's source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and give any other recipients of the Program a copy of this License along with the Program. You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.
- 2 You may modify your copy or copies of the Program or any portion of it, thus forming a work based on the Program, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:
  - a) You must cause the modified files to carry prominent notices stating that you changed the files and the date of any change.
  - b) You must cause any work that you distribute or publish, that in whole or in part contains or is derived from the Program or any part thereof, to be licensed as a whole at no charge to all third parties under the terms of this License.
  - c) If the modified program normally reads commands interactively when run, you must cause it, when started running for such interactive use in the most ordinary way, to print or display an announcement including an appropriate copyright notice and a notice that there is no warranty (or else, saying that you provide a warranty) and that users may redistribute the program under these conditions, and telling the user how to view a copy of this License. (Exception: if the Program itself is interactive but does not normally print such an announcement, your work based on the Program is not required to print an announcement.)

These requirements apply to the modified work as a whole.

If identifiable sections of that work are not derived from the Program, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Program, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Program.

In addition, mere aggregation of another work not based on the Program with the Program (or with a work based on the Program) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

- 3 You may copy and distribute the Program (or a work based on it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you also do one of the following:
  - a) Accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,
  - b) Accompany it with a written offer, valid for at least three years, to give any third party, for a charge no more than your cost of physically performing source distribution, a complete machine-readable copy of the corresponding source code, to be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,

## ANNEX B. Open Source Announcement

---

- c) Accompany it with the information you received as to the offer to distribute corresponding source code.  
(This alternative is allowed only for noncommercial distribution and only if you received the program in object code or executable form with such an offer, in accord with Subsection b above.)

The source code for a work means the preferred form of the work for making modifications to it. For an executable work, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the executable. However, as a special exception, the source code distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

If distribution of executable or object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place counts as distribution of the source code, even though third parties are not compelled to copy the source along with the object code.

4. You may not copy, modify, sublicense, or distribute the Program except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense or distribute the Program is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.
5. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Program or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Program (or any work based on the Program), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Program or works based on it.
6. Each time you redistribute the Program (or any work based on the Program), the recipient automatically receives a license from the original licensor to copy, distribute or modify the Program subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties to this License.
7. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Program at all. For example, if a patent license would not permit royalty-free redistribution of the Program by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Program.

If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply and the section as a whole is intended to apply in other circumstances.

It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system, which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

8. If the distribution and/or use of the Program is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Program under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.

9. The Free Software Foundation may publish revised and/or new versions of the General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Program specifies a version number of this License which applies to it and 'any later version', you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Program does not specify a version number of this License, you may choose any version ever published by the Free Software Foundation.

10. If you wish to incorporate parts of the Program into other free programs whose distribution conditions are different, write to the author to ask for permission. For software which is copyrighted by the Free Software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this. Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

## **NO WARRANTY**

11. BECAUSE THE PROGRAM IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY FOR THE PROGRAM, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM 'AS IS' WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. SHOULD THE PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

12. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR REDISTRIBUTE THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER PROGRAMS), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

## **END OF TERMS AND CONDITIONS**

### **How to Apply These Terms to Your New Programs**

If you develop a new program, and you want it to be of the greatest possible use to the public, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms.

To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the 'copyright' line and a pointer to where the full notice is found.

<one line to give the program's name and a brief idea of what it does.>  
Copyright (C) <year> <name of author>

This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or(at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  
See the GNU General Public License for more details.

You should have received a copy of the GNU General Public License along with this program; if not, write to the Free Software Foundation, Inc., 51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA.

Also add information on how to contact you by electronic and paper mail.

If the program is interactive, make it output a short notice like this when it starts in an interactive mode:

Gnomovision version 69, Copyright (C) year name of author  
Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type 'show w'.

## ANNEX B. Open Source Announcement

---

This is free software, and you are welcome to redistribute it under certain conditions; type 'show c' for details. The hypothetical commands 'show w' and 'show c' should show the appropriate parts of the General Public License. Of course, the commands you use may be called something other than 'show w' and 'show c'; they could even be mouse-clicks or menu items--whatever suits your program.

You should also get your employer (if you work as a programmer) or your school, if any, to sign a 'copyright disclaimer' for the program, if necessary. Here is a sample; alter the names:

Yoyodyne, Inc., hereby disclaims all copyright interest in the program 'Gnomovision' (which makes passes at compilers) written by James Hacker.

<signature of Ty Coon>, 1 April 1989  
Ty Coon, President of Vice

This General Public License does not permit incorporating your program into proprietary programs. If your program is a subroutine library, you may consider it more useful to permit linking proprietary applications with the library. If this is what you want to do, use the GNU Lesser General Public License instead of this License.

### GNU LESSER GENERAL PUBLIC LICENSE

Version 2.1, February 1999

Copyright (C) 1991, 1999 Free Software Foundation, Inc.  
51 Franklin Street, Fifth Floor, Boston, MA 02110-1301 USA

Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

[This is the first released version of the Lesser GPL. It also counts as the successor of the GNU Library Public License, version 2, hence the version number 2.1.]

#### Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public Licenses are intended to guarantee your freedom to share and change free software--to make sure the software is free for all its users.

This license, the Lesser General Public License, applies to some specially designated software packages--typically libraries--of the Free Software Foundation and other authors who decide to use it. You can use it too, but we suggest you first think carefully about whether this license or the ordinary General Public License is the better strategy to use in any particular case, based on the explanations below.

When we speak of free software, we are referring to freedom of use, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish); that you receive source code or can get it if you want it; that you can change the software and use pieces of it in new free programs; and that you are informed that you can do these things.

To protect your rights, we need to make restrictions that forbid distributors to deny you these rights or to ask you to surrender these rights. These restrictions translate to certain responsibilities for you if you distribute copies of the library or if you modify it.

For example, if you distribute copies of the library, whether gratis or for a fee, you must give the recipients all the rights that we gave you. You must make sure that they, too, receive or can get the source code. If you link other code with the library, you must provide complete object files to the recipients, so that they can relink them with the library after making changes to the library and recompiling it. And you must show them these terms so they know their rights.

We protect your rights with a two-step method: (1) we copyright the library, and (2) we offer you this license, which gives you legal permission to copy, distribute and/or modify the library.

To protect each distributor, we want to make it very clear that there is no warranty for the free library. Also, if the library is modified by someone else and passed on, the recipients should know that what they have is not the original version, so that the original author's reputation will not be affected by problems that might be introduced by others.

Finally, software patents pose a constant threat to the existence of any free program. We wish to make sure that a company cannot effectively restrict the users of a free program by obtaining a restrictive license from a patent holder.

Therefore, we insist that any patent license obtained for a version of the library must be consistent with the full freedom of use specified in this license.

Most GNU software, including some libraries, is covered by the ordinary GNU General Public License. This license, the GNU Lesser General Public License, applies to certain designated libraries, and is quite different from the ordinary General Public License. We use this license for certain libraries in order to permit linking those libraries into non-free programs.

When a program is linked with a library, whether statically or using a shared library, the combination of the two is legally speaking a combined work, a derivative of the original library. The ordinary General Public License therefore permits such linking only if the entire combination fits its criteria of freedom. The Lesser General Public License permits more lax criteria for linking other code with the library.

We call this license the ‘Lesser’ General Public License because it does Less to protect the user's freedom than the ordinary General Public License. It also provides other free software developers Less of an advantage over competing non-free programs. These disadvantages are the reason we use the ordinary General Public License for many libraries. However, the Lesser license provides advantages in certain special circumstances.

For example, on rare occasions, there may be a special need to encourage the widest possible use of a certain library, so that it becomes a de-facto standard. To achieve this, non-free programs must be allowed to use the library. A more frequent case is that a free library does the same job as widely used non-free libraries. In this case, there is little to gain by limiting the free library to free software only, so we use the Lesser General Public License.

In other cases, permission to use a particular library in non-free programs enables a greater number of people to use a large body of free software.

For example, permission to use the GNU C Library in non-free programs enables many more people to use the whole GNU operating system, as well as its variant, the GNU/Linux operating system.

Although the Lesser General Public License is Less protective of the users’ freedom, it does ensure that the user of a program that is linked with the Library has the freedom and the wherewithal to run that program using a modified version of the Library.

The precise terms and conditions for copying, distribution and modification follow. Pay close attention to the difference between a ‘work based on the library’ and a ‘work that uses the library’. The former contains code derived from the library, whereas the latter must be combined with the library in order to run.

## TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0 This License Agreement applies to any software library or other program which contains a notice placed by the copyright holder or other authorized party saying it may be distributed under the terms of this Lesser General Public License (also called ‘this License’). Each licensee is addressed as ‘you’.

A ‘library’ means a collection of software functions and/or data prepared so as to be conveniently linked with application programs (which use some of those functions and data) to form executables.

The ‘Library’, below, refers to any such software library or work which has been distributed under these terms.

A ‘work based on the Library’ means either the Library or any derivative work under copyright law: that is to say, a work containing the Library or a portion of it, either verbatim or with modifications and/or translated straightforwardly into another language. (Hereinafter, translation is included without limitation in the term ‘modification’.)

‘Source code’ for a work means the preferred form of the work for making modifications to it. For a library, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the library.

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope.

The act of running a program using the Library is not restricted, and output from such a program is covered only if its contents constitute a work based on the Library (independent of the use of the Library in a tool for writing it).

Whether that is true depends on what the Library does and what the program that uses the Library does.

1 You may copy and distribute verbatim copies of the Library’s complete source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and distribute a copy of this License along with the Library.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

2 You may modify your copy or copies of the Library or any portion of it, thus forming a work based on the Library, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:

- a) The modified work must itself be a software library.
- b) You must cause the files modified to carry prominent notices stating that you changed the files and the date of any change.
- c) You must cause the whole of the work to be licensed at no charge to all third parties under the terms of this License.

- d) If a facility in the modified Library refers to a function or a table of data to be supplied by an application program that uses the facility, other than as an argument passed when the facility is invoked, then you must make a good faith effort to ensure that, in the event an application does not supply such function or table, the facility still operates, and performs whatever part of its purpose remains meaningful. (For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional:

if the application does not supply it, the square root function must still compute square roots.) These requirements apply to the modified work as a whole.

If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works.

But when you distribute the same sections as part of a whole which is a work based on the Library, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it. Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Library. In addition, mere aggregation of another work not based on the Library with the Library (or with a work based on the Library) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

- 3 You may opt to apply the terms of the ordinary GNU General Public License instead of this License to a given copy of the Library. To do this, you must alter all the notices that refer to this License, so that they refer to the ordinary GNU General Public License, version 2, instead of to this License. (If a newer version than version 2 of the ordinary GNU General Public License has appeared, then you can specify that version instead if you wish.) Do not make any other change in these notices. Once this change is made in a given copy, it is irreversible for that copy, so the ordinary GNU General Public License applies to all subsequent copies and derivative works made from that copy. This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

- 4 You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.  
If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

- 5 A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a 'work that uses the Library'. Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.  
However, linking a 'work that uses the Library' with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a 'work that uses the library'.  
The executable is therefore covered by this License. Section 6 states terms for distribution of such executables.  
When a 'work that uses the Library' uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

- 6 As an exception to the Sections above, you may also combine or link a 'work that uses the Library' with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer's own use and reverse engineering for debugging such modifications.  
You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

- a) Accompany the work with the complete corresponding machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable “work that uses the Library”, as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)
  - b) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user’s computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.
  - c) Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.
  - d) If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.
  - e) Verify that the user has already received a copy of these materials or that you have already sent this user a copy. For an executable, the required form of the ‘work that uses the Library’ must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.
- It may happen that this requirement contradicts the license restrictions of other proprietary libraries that do not normally accompany the operating system. Such a contradiction means you cannot use both them and the Library together in an executable that you distribute.
- 7. You may place library facilities that are a work based on the Library side-by-side in a single library together with other library facilities not covered by this License, and distribute such a combined library, provided that the separate distribution of the work based on the Library and of the other library facilities is otherwise permitted, and provided that you do these two things:
    - a) Accompany the combined library with a copy of the same work based on the Library, uncombined with any other library facilities. This must be distributed under the terms of the Sections above.
    - b) Give prominent notice with the combined library of the fact that part of it is a work based on the Library, and explaining where to find the accompanying uncombined form of the same work.
  - 8. You may not copy, modify, sublicense, link with, or distribute the Library except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense, link with, or distribute the Library is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.
  - 9. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Library or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Library (or any work based on the Library), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Library or works based on it.
  - 10. Each time you redistribute the Library (or any work based on the Library), the recipient automatically receives a license from the original licensor to copy, distribute, link with or modify the Library subject to these terms and conditions. You may not impose any further restrictions on the recipients’ exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties with this License.

11. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Library at all. For example, if a patent license would not permit royalty-free redistribution of the Library by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Library. If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply, and the section as a whole is intended to apply in other circumstances.

It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice. This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

12. If the distribution and/or use of the Library is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Library under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.

13. The Free Software Foundation may publish revised and/or new versions of the Lesser General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.  
Each version is given a distinguishing version number. If the Library specifies a version number of this License which applies to it and 'any later version', you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Library does not specify a license version number, you may choose any version ever published by the Free Software Foundation.

14. If you wish to incorporate parts of the Library into other free programs whose distribution conditions are incompatible with these, write to the author to ask for permission. For software which is copyrighted by the Free Software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this.  
Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

### NO WARRANTY

15. BECAUSE THE LIBRARY IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY FOR THE LIBRARY, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE LIBRARY 'AS IS' WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE LIBRARY IS WITH YOU. SHOULD THE LIBRARY PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

16. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR REDISTRIBUTE THE LIBRARY AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE LIBRARY (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE LIBRARY TO OPERATE WITH ANY OTHER SOFTWARE), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

### END OF TERMS AND CONDITIONS

[How to Apply These Terms to Your New Libraries](#)

If you develop a new library, and you want it to be of the greatest possible use to the public, we recommend making it free software that everyone can redistribute and change. You can do so by permitting redistribution under these terms (or, alternatively, under the terms of the ordinary General Public License).

To apply these terms, attach the following notices to the library. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the 'copyright' line and a pointer to where the full notice is found.

one line to give the library's name and an idea of what it does.

Copyright (C) year name of author

This library is free software; you can redistribute it and/or modify it under the terms of the GNU Lesser General Public License as published by the Free Software Foundation; either version 2.1 of the License, or (at your option) any later version.

This library is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

See the GNU Lesser General Public License for more details.

You should have received a copy of the GNU Lesser General Public License along with this library; if not, write to the Free Software Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA 02110-1301 USA. Also add information on how to contact you by electronic and paper mail.

You should also get your employer (if you work as a programmer) or your school, if any, to sign a 'copyright disclaimer' for the library, if necessary. Here is a sample; alter the names:

Yoyodyne, Inc., hereby disclaims all copyright interest in the library 'Frob' (a library for tweaking knobs) written by James Random Hacker.

Signature of Ty Coon, 1 April 1990 Ty Coon, President of Vice

That's all there is to it!

## libxml2 License

Except where otherwise noted in the source code (e.g., the files hash.c, list.c and the trio files, which are covered by a similar licence but with different Copyright notices) all the files are:

Copyright (C) 1998-2003 Daniel Veillard. All Rights Reserved.

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE DANIEL VEILLARD BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

Except as contained in this notice, the name of Daniel Veillard shall not be used in advertising or otherwise to promote the sale, use or other dealings in this Software without prior written authorization from him.

### LICENSE ISSUES

=====

The OpenSSL toolkit stays under a dual license, i.e. both the conditions of the OpenSSL License and the original SSLeay license apply to the toolkit. See below for the actual license texts. Actually both licenses are BSD-style Open Source licenses. In case of any license issues related to OpenSSL please contact [openssl-core@openssl.org](mailto:openssl-core@openssl.org).

### OpenSSL License

Copyright (c) 1998-2004 The OpenSSL Project. All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

1. Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
2. Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
3. All advertising materials mentioning features or use of this software must display the following acknowledgment:  
'This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit. (<http://www.openssl.org/>)'
4. The names 'OpenSSL Toolkit' and 'OpenSSL Project' must not be used to endorse or promote products derived from this software without prior written permission. For written permission, please contact [openssl-core@openssl.org](mailto:openssl-core@openssl.org).
5. Products derived from this software may not be called 'OpenSSL' nor may 'OpenSSL' appear in their names without prior written permission of the OpenSSL Project.
6. Redistributions of any form whatsoever must retain the following acknowledgment:  
'This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit (<http://www.openssl.org/>)'

THIS SOFTWARE IS PROVIDED BY THE OpenSSL PROJECT 'AS IS' AND ANY EXPRESSED OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE OpenSSL PROJECT OR ITS CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

This product includes cryptographic software written by Eric Young ([ey@cryptsoft.com](mailto:ey@cryptsoft.com)). This product includes software written by Tim Hudson ([tjh@cryptsoft.com](mailto:tjh@cryptsoft.com)).

**Original SSLeay License**

Copyright (C) 1995-1998 Eric Young (eay@cryptsoft.com)  
All rights reserved.

This package is an SSL implementation written by Eric Young (eay@cryptsoft.com).  
The implementation was written so as to conform with Netscapes SSL.

This library is free for commercial and non-commercial use as long as the following conditions are adhered to.  
The following conditions apply to all code found in this distribution, be it the RC4, RSA, lhash, DES, etc., code; not just the SSL code. The SSL documentation included with this distribution is covered by the same copyright terms except that the holder is Tim Hudson (tjh@cryptsoft.com).

Copyright remains Eric Young's, and as such any Copyright notices in the code are not to be removed. If this package is used in a product, Eric Young should be given attribution as the author of the parts of the library used. This can be in the form of a textual message at program startup or in documentation (online or textual) provided with the package.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

- 1 Redistributions of source code must retain the copyright notice, this list of conditions and the following disclaimer.
- 2 Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
- 3 All advertising materials mentioning features or use of this software must display the following acknowledgement:  
‘This product includes cryptographic software written by Eric Young (eay@cryptsoft.com)’  
The word ‘cryptographic’ can be left out if the routines from the library being used are not cryptographic related:-).
- 4 If you include any Windows specific code (or a derivative thereof) from the apps directory (application code) you must include an acknowledgement: ‘This product includes software written by Tim Hudson (tjh@cryptsoft.com)’

THIS SOFTWARE IS PROVIDED BY ERIC YOUNG ‘AS IS’ AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED.

IN NO EVENT SHALL THE AUTHOR OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

The license and distribution terms for any publically available version or derivative of this code cannot be changed. i.e., this code cannot simply be copied and put under another distribution license [including the GNU Public Licence.]

### BSD License

Copyright (c) 2000-2003 Intel Corporation  
All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

- Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
- Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
- Neither name of Intel Corporation nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS 'AS IS' AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL INTEL OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

### The MIT License

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

### RSA Data Security, Inc., MD5 message-digest algorithm

Copyright (C) 1991-2, RSA Data Security, Inc. Created 1991. All rights reserved.

License to copy and use this software is granted provided that it is identified as the "RSA Data Security, Inc. MD5 Message-Digest Algorithm" in all material mentioning or referencing this software or this function.

License is also granted to make and use derivative works provided that such works are identified as "derived from the RSA Data Security, Inc. MD5 Message-Digest Algorithm" in all material mentioning or referencing the derived work.

RSA Data Security, Inc. makes no representations concerning either the merchantability of this software or the suitability of this software for any particular purpose. It is provided "as is" without express or implied warranty of any kind.

These notices must be retained in any copies of any part of this documentation and/or software.



# ABBREVIATION

## 3

3DES                      Triple Data Encryption Standard

## A

AES                        Advanced Encryption Standard

AS                         Autonomous Systems

AUTHD                    Authentication Daemon

## B

BGP                        Border Gateway Protocol

BRI                        Basic Rate Interface

## C

CAC                        Call Admission Control

CAMA                     Centralized Automated Message Accounting

CHAP                     Challenge Handshake Authentication Protocol

CLI                        Command Line Interface

CPE                        Customer Premises Equipment

CSPF                      Constraint-based Shortest Path First

CSU                        Channel Service Unit

**D**

DDR SDRAM	Double Data Rate Synchronous Dynamic Random Access Memory
DID	Direct Inward Dialing
DMA	Direct Memory Access
DS	Dual Stack
DS3	Digital Signal level-3
DSP	Digital Signal Processor
DSU	Data Service Unit
DV-MRP	Distance Vector-Multicast Routing Protocol

**E**

E & M	Ear and Mouse
EAP	Extensible Authentication Protocol
EC	Echo Cancellation
ESD	Electrostatic Discharge Damage

**F**

FR	Frame Relay
FTP	File Transfer Protocol
FXO	Foreign Exchange Office
FXS	Foreign Exchange Subscriber

**G**

GARP	Generic Attribute Registration Protocol
GMRP	GARP Multicast Registration Protocol
GRE	Generic Routing Encapsulation
GUI	Graphic User Interface
GVRP	GARP VLAN Registration Protocol

**H**

HDLC	High-level Data Link Control
HSSI	High Speed Serial Interface

## I

IDS	Intrusion-Detection Systems
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IP PBX	Internet Protocol Private Branch Exchange
IPS	Intrusion-Prevention Systems
IPSec	Internet Protocol Security
IVM	Integrated Voice Mail

## L

L2TP	Layer 2 Tunneling Protocol
LACP	Link Aggregation Control Protocol
LAG	Link Aggregation Group
LAN	Local Area Network
LDP	Label Distribution Protocol
LLQ	Low-Latency Queuing
LSP	Label Switched Path

## M

MAC	Media Access Control
MLDv1	Multicast Listener Discovery Protocol
MLPP	Multi Level Precedence and Preemption
MPLS	Multi Protocol Label Switching
MSTP	Multiple Spanning Tree Protocol

## N

NCP	Network Control Protocol
NSM	Network Services Module

## O

OPX	Off Premises Extension
OSPF	Open Shortest Path First

**P**

PAP	Password Authentication Protocol
PDU	Packet Data Unit
PDU	Protocol Data Units
PIM	Protocol Independent Multicast
PIM-SM	Protocol Independent Multicast-Sparse Mode
PLAR	Private Line Automatic Ringdown
POTS	Plain Old Telephone Services
PSAP	Public Service Answering Point
PSTN	Public Switched Telephone Network

**Q**

QoS	Quality of Service
QRM	Quality of service Resource Manager

**R**

RIP	Routing Information Protocol
RIPng	Routing Information Protocol next generation
RMON	Remote Network Monitoring
RP	Rendezvous Point
RSTP	Rapid Spanning Tree Protocol
RSVP	Resource Reservation Protocol
RSVP-TE	Resource Reservation Protocol-Traffic Engineering
RTOS	Real-Time Operating System

**S**

SCM	Samsung iPX
SDP	Session Description Protocol
SF	Smart Forwarder
SFP	Small Form Factor Pluggable
SIP	Session Initiation Protocol
SLA	Service-Level Agreement
SMB	Service Message Block
SNMP	Simple Network Management Protocol
SODIMM	Small Outline Dual In-line Memory Module
STP	Spanning Tree Protocol

## T

TCP	Transmission Control Protocol
TDM	Time Division Multiplexer
TFTP	Trivial File Transfer Protocol
TLS	Transparent LAN Service

## U

UDP	User Datagram Protocol
USB	Universal Serial Bus
UTP	Unshield Twisted Pair

## V

VAD	Voice Activity Detection
VBO	Local Voice Busy Out
VC	Virtual Circuit
VCID	Virtual Circuit Identification
VDC	Volts Direct Circuit
VLAN	Virtual Local Area Network
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network

## W

WAN	Wide Area Network
-----	-------------------



**This page is intentionally left blank.**



# INDEX

## A

AC Power Supply..... 2-42  
 AC Power Supply with PoE ..  
 ..... 2-43  
 Access Group ..... 4-13  
 Ad-hoc Conference..... 4-17  
 Auxiliary Port..... 2-10

## B

Basic Connectivity ..... 1-6  
 BGP ..... 3-9  
 Branch Office Configuration  
 Example ..... 1-3  
 BRI-2ST (2-Ports ISDN BRI  
 S/T Mini Module)..... 2-21  
 BRI-2U (2-Ports ISDN BRI  
 U Mini Module)..... 2-22

## C

Call Admission Control  
 (CAC) ..... 4-14  
 Call Routing ..... 4-12  
 Call Routing and Digit  
 Manipulation ..... 4-12

Chassis Process.....3-4  
 CLI Omnipresent  
 Commands ..... 3-15  
 CLI Privilege Levels..... 3-14  
 Command Line Interface.....  
 ..... 3-14  
 Community-based  
 Authentication.....3-3  
 Compact Flash Memory Port  
 .....2-9  
 Complete Solution .....1-7  
 Console Port..... 2-10  
 Control Plane Architecture ....  
 .....1-8

## D

Data Plane Architecture....1-8  
 DC Power Supply with PoE2-  
 43  
 Deployment Scenario .....1-4  
 Digit Manipulation..... 4-12  
 Double-wide Network  
 Module..... 1-12, 2-12  
 DTMF Relay ..... 4-16  
 Dual Stack .....3-8

## E

- E&M-2M (2-Ports E&M Mini Module) ..... 2-40
- E1 WAN Interface ..... 1-11
- E911 Support ..... 4-20
- ESF-10 (10-port Ethernet Switch Gigabit Module).....  
..... 2-32
- ESG-8 (10-port Ethernet Switch Gigabit Module).....  
..... 2-30
- Ethernet LAN Interface .. 1-12
- Ethernet Option Module.....  
..... 1-12
- Ethernet Switch Gigabit Module ..... 2-11
- Ethernet Switch Gigabit Module Ports Numbering .....  
..... 2-14

## F

- FAX ..... 4-16
- Forwarding Process..... 3-13
- FXO-4M (4-Ports Analog FXO Mini Module) ..... 2-38
- FXS-24 (24-Ports Analog FXS/DID Network Module) ...  
..... 2-41
- FXS-4M (4-Ports Analog FXS/DID Mini Module) ... 2-39

## H

- H.323 Signaling ..... 4-9
- High Availability of Voice Feature ..... 4-21
- HSSI-1 (High-speed Serial Interface Network Module) ....  
..... 2-26

## I

- iBG3026 Boot Sequence.....  
..... 2-4
- iBG3026 Chassis..... 2-2
- iBG3026 Cooling System .....  
..... 2-44
- iBG3026 Front Panel..... 2-5
- iBG3026 Modularity..... 2-1
- iBG3026 Power System .....  
..... 2-42
- iBG3026 Product Specification ..... 1-10
- iBG3026 Rear Panel ..... 2-7
- iBG3026 Routing and Switching Engine ..... 2-1
- Interface..... 1-11
- Interface Between Network Entities..... 4-4
- Interface Process ..... 3-13
- Internal Option Card ..... 2-11
- Internal Option Cards .....  
..... 1-12, 2-19
- IP Phones ..... 4-24
- IP Telephony..... 1-6
- IPSec ..... 1-1

## K

Kernel .....	3-2
Key Features .....	4-8

## L

LAN Interface Modules ..	2-30
LAN Ports .....	2-10, 2-13
Layer2 Protocols.....	3-6
LMF-20 (20-Ports Fast Ethernet Network Module)....	2-34
LMG-20 (20-Ports Gigabit Ethernet Network Module)....	2-33
LMG-44 (44-Ports Gigabit Ethernet Network Module)....	2-35
LMGP-44 (44-Ports Gigabit Ethernet Network Module)....	2-36
LMP-20 (20-Ports PoE Fast Ethernet Network Module)....	2-34
Local CAC.....	4-14
LVBO (Local Voice Busy Out) .....	4-18

## M

Main Board LAN Ports Numbering .....	2-13
Main Board LED Description .....	2-7
Main Board Mini Module Ports Numbering.....	2-17

Management Port.....	2-10
Management Process .....	3-2
Management System ....	4-25
Memory .....	1-13
MIB Information .....	3-3
Mini Module Ports Numbering.....	2-15
Mini Modules .....	1-12, 2-17
Module indicators .....	2-10
Modules and Internal Option Cards .....	1-12
Multicast Routing Protocols .....	3-9

## N

Network Architecture .....	4-2
Network Module .....	2-12
Network Modules.....	1-12
Network Modules Ports Numbering.....	2-14
New Service Offering Example .....	1-6

## O

Operation Mode.....	4-5
---------------------	-----

## P

Performance and Capacity....	4-26
Performance and Scalability .....	1-2
Port Numbering .....	2-13
Port Numbering Examples ....	2-18

Power ..... 1-14  
 Power Supply Redundancy ..  
 ..... 2-44  
 Powerful Management ..... 1-2  
 Private Line Automatic  
 Ringdown (PLAR) ..... 4-17  
 Processes ..... 3-2  
 Product Architecture ..... 1-8  
 Product Specifications ... 1-10  
 PSTN Fallback ..... 4-21  
 PSTN Signaling ..... 4-9  
 PSTN Toll Bypass ..... 4-23

## Q

QoS ..... 1-1

## R

Real-Time Clock and  
 NVRAM ..... 1-14  
 Rear Connector Description  
 ..... 2-9  
 Resource-based CAC .... 4-15  
 RMON ..... 3-4  
 Rock-Solid ..... 1-3  
 Routing Engine and Packet  
 Forwarding Engine ..... 3-1  
 Routing Protocol Process 3-6

## S

Samsung' s Integrated  
 Switch Router ..... 1-1  
 Seamless Integration ..... 1-2  
 Secure Connectivity ..... 1-6  
 Security ..... 4-11

Security Features ..... 1-17  
 SIP Signaling ..... 4-8  
 SNMP Architecture ..... 3-2  
 Supplementary Services .....  
 ..... 4-18  
 Survivable Telephony .... 4-22  
 Switch/Router Features . 1-15

## T

T1 WAN Interface ..... 1-11  
 T1E1-2M (2-Ports T1/E1 Mini  
 Module) ..... 2-23  
 T1E1-4 (4-Ports T1/E1  
 Network Module) ..... 2-24  
 Toll Bypassing ..... 1-6  
 Traps ..... 3-4  
 Trunk Group ..... 4-13

## U

Unicast Routing ..... 3-9  
 USB Port ..... 2-9  
 User Interfaces ..... 3-14

## V

VCU-A (Voice Carrier  
 Network Module) ..... 2-37  
 Ventilation ..... 1-14  
 Versatility ..... 1-2  
 Voice Carrier Module Ports  
 Numbering ..... 2-17  
 Voice Codecs ..... 4-11  
 Voice Deployment Scenario  
 ..... 4-23  
 Voice Modules ..... 2-37

Voice Services ..... 4-16  
VoIP Gateway ..... 4-8  
VoP-32, VoP-64, VoP-128  
(VoIP Option Card)2-19, 2-20  
VPN..... 1-1

## **W**

WAN Interface Module... 2-21  
WAN Network Module Ports  
Numbering ..... 2-16  
WAN Ports ..... 2-15  
WAN Protocols..... 3-10  
Web GUI (HTTP Server) 3-15  
WT3-1C (Channelized DS3  
Network Module)..... 2-27  
WTE-4S (4-Ports Serial  
Network Module)..... 2-25



**This page is intentionally left blank.**

## WEEE SYMBOL INFORMATION



### Correct Disposal of This Product (Waste Electrical & Electronic Equipment)

*(Applicable in the European Union and other European countries with separate collection systems)*

This marking on the product, accessories or literature indicates that the product and its electronic accessories (e.g., charger, headset, USB cable) should not be disposed of with other household waste at the end of their working life. To prevent possible harm to the environment or human health from uncontrolled waste disposal, please separate these items from other types of waste and recycle them responsibly to promote the sustainable reuse of material resources.

Household users should contact either the retailer where they purchased this product, or their local government office, for details of where and how they can take these items for environmentally safe recycling.

Business users should contact their supplier and check the terms and conditions of the purchase contract. This product and its electronic accessories should not be mixed with other commercial wastes for disposal.

## BATTERY SYMBOL INFORMATION



### Correct disposal of batteries in this product

*(Applicable in the European Union and other European countries with separate battery return systems.)*

This marking on the battery, manual or packaging indicates that the batteries in this product should not be disposed of with other household waste at the end of their working life. Where marked, the chemical symbols Hg, Cd or Pb indicate that the battery contains mercury, cadmium or lead above the reference levels in EC Directive 2006/66.

If batteries are not properly disposed of, these substances can cause harm to human health or the environment.

To protect natural resources and to promote material reuse, please separate batteries from other types of waste and recycle them through your local, free battery return system.

## Ubigate iBG3026™ System Description

© 2007–2010 Samsung Electronics Co., Ltd.  
All rights reserved.

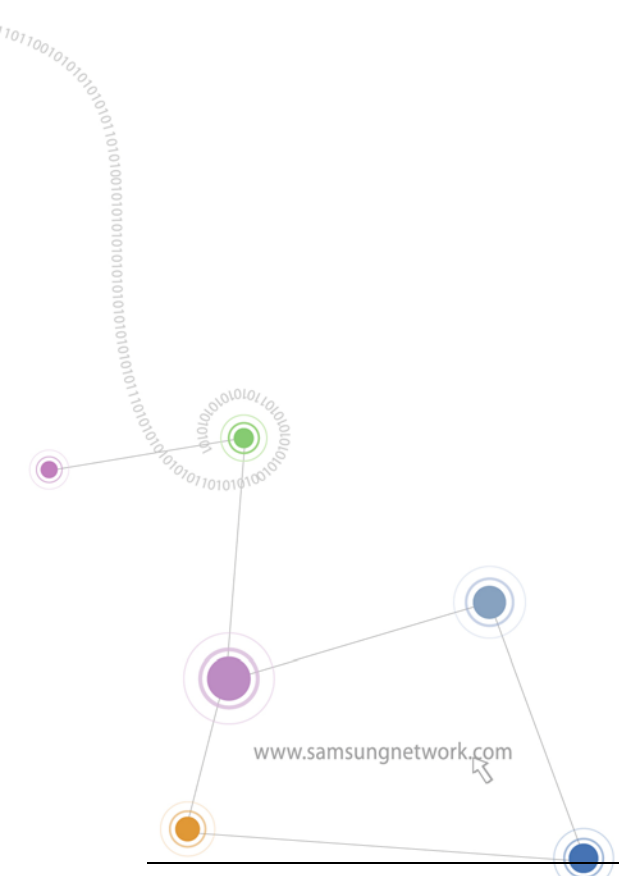
Information in this manual is proprietary to SAMSUNG  
Electronics Co., Ltd.

No information contained here may be copied, translated,  
transcribed or duplicated by any form without the prior written  
consent of SAMSUNG.

Information in this manual is subject to change without notice.



# System Description



**Homepage**  
[www.samsungnetwork.com](http://www.samsungnetwork.com)

