

# FCD-155E

## STM-1/OC-3 Add/Drop Multiplexer



STM-1/OC-3 add/drop multiplexer that transports LAN and traditional (TDM) traffic over SDH/SONET networks

- STM-1/OC-3 PDH/Ethernet add/drop multiplexer for grooming LAN and legacy (TDM) traffic over SDH/SONET networks
- Ethernet traffic mapped to 1 VC-3/VC-4/STS-1, up to 3 VC-3/STS-1, up to 63 VC-12 or 84 VT-1.5
- 1+1 MSP/APS redundancy
- PDH interface for 8 or 21 E1 (G.703), 8 or 28 T1 (G.703), 1 E3/T3, or 1 E3/T3 with 21/28 E1/T1 ports
- 10/100BaseT and GbE Ethernet interfaces with VLAN support and point-to-multipoint switching capability

FCD-155E is an STM-1/OC-3 add/drop multiplexer that transports LAN and traditional (TDM) traffic over SDH/SONET networks. When bandwidth granularity of the Ethernet channel is configured to 2 Mbps (VC-12) or 1.5 Mbps (VT-1.5), FCD-155E utilizes the SDH/SONET infrastructure for cost-effective connectivity.

Optional PDH interface modules include:

- 8- or 21-port E1
- 8- or 28-port T1
- Single-port E3/T3
- Single-port E3 with 21-port E1
- Single-port T3 with 21-port E1 or 28-port T1.



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## STM-1/OC-3 Add/Drop Multiplexer

Optional Ethernet interface configurations include:

- 2-port bridging 10/100BaseT
- 6-port 10/100BaseT (two bridging and four transparent ports)
- Single-port Ethernet 10/100/1000BaseT (RJ-45) or 1000BaseSX (SFP interface).

### NETWORK INTERFACE

The STM-1/OC-3 interfaces are user-configurable and provide a high-quality and high-availability link, as well as performance monitoring of the traffic path.

The STM-1/OC-3 link is supplied with an SFP socket (see *Ordering*). It is strongly recommended to order this device with **original RAD SFPs installed**. This will ensure that prior to shipping, RAD has performed comprehensive functional quality tests on the entire assembled unit, including the SFP devices. RAD cannot guarantee full compliance to product specifications for units using non-RAD SFPs.

The user can define the following SDH/SONET clock sources:

- Internal
- Recovered from the STM-1/OC-3 interface, including automatic selection based on SSM (Synchronization Status Messaging)

- External E1
- Station clock.

FCD-155E features an optional ADM configuration mechanism with SNCP path protection.

Optional 1+1 link protection mechanism (unidirectional MSP/APS) and SNCP path protection are also available.

Maintenance capabilities include user-activated local loopbacks and remote loopbacks on the STM-1/OC-3 main link and PDH tributaries.

### LAN INTERFACE

The 2-port 10/100BaseT or single-port Gigabit Ethernet interfaces include a built-in Ethernet bridge that supports VLAN according to IEEE 802.1Q and 802.1p.

The 4-port transparent LAN extension, without bridge functionality, creates total separation between customers, for security. The maximum frame length is 2 kB.

The 10/100BaseT LAN interface features autonegotiation for plug-and-play Ethernet connectivity and complies to IEEE 802.3/Ethernet V.2 standards. The interface also features VLAN stacking.

An optional Gigabit Ethernet port connects one LAN port to eight virtual groups. This option provides LAN extension over SDH/SONET networks with bridge functionality. The maximum frame length is 2 kB.

Ethernet traffic is mapped into SDH/SONET containers using VCAT and encapsulated with:

- Generic Framing Procedure (ITU-T G.7041, ANSI T1-105.02), framed mode
- Link Access Procedure for SDH/SONET (LAPS) protocols following draft recommendation ITU-T X.85/X.86.

Each user's Ethernet traffic can be mapped into SDH/SONET virtual containers in any of the following ways:

- Up to 63 × VC-12, or 84 × VT-1.5
- 3 × VC-3/STS-1
- 1 × VC-4.

Ethernet traffic can be switched to different bundles of virtually concatenated VCs (up to 8 bundles) according to a predefined group.

Link Capacity Adjustment Scheme (LCAS) is supported in compliance with the G.7042 standard, which allocates bandwidth according to Ethernet traffic.

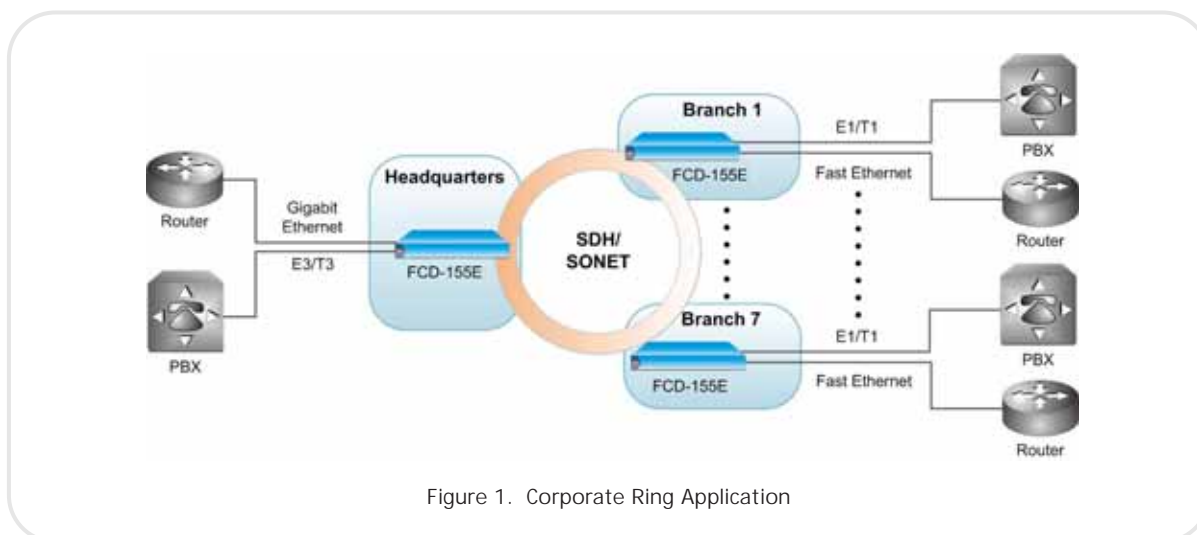


Figure 1. Corporate Ring Application

SDH/SONET media can transport basic Ethernet packets of up to 1536 bytes enabling connection to MPLS networks.

The Spanning Tree Protocol (STP) and Rapid Spanning Tree Protocol (RSTP) support Layer 2 ring applications.

### TDM INTERFACES

FCD-155E has an optional interface module consisting of 8 or 21 balanced E1 or 8 or 28 T1 ports that transfer transparent data in compliance with G.703. The unbalanced E1 interface is software-selectable.

An optional E3/T3 interface module transports unframed E3/T3 data over SDH/SONET.

Another optional interface module combines E3 or T3 with 21 E1 ports, or T3 with 28 T1 ports.

TDM traffic is mapped into SDH/SONET VC-12/VC-11/VC-3 or SONET VT1.5/STS-1 containers that can be placed anywhere within the STM-1/OC-3 bandwidth.

### MANAGEMENT

Remote units can be managed in the following ways:

- Via DCC using IP tunneling over OSI DCN based on ITU-T G.7712
- Via DCC based on IP/PPP protocols
- Via a dedicated virtual group containing at least one VC-12/VT-1.5 channel
- Inside the user traffic in a virtual group, separated from the user traffic by the GFP Channel ID or VLAN tag
- Out-of-band, via direct connection to one of the LAN ports.

Status and diagnostic information is defined, configured, and monitored using one of the following methods:

- ASCII terminal connected to the V.24/RS-232 control port
- Telnet host via management platform or LAN port
- Network management station running RADview, the RAD SNMP network management application

- TFTP applications to update software and upload/download remote configurations
- Web Based element manager.

### DIAGNOSTICS

FCD-155E has comprehensive diagnostic capabilities, including:

- Ethernet and SDH/SONET link monitoring
- Real-time alarms to alert the user of fault conditions. Alarms are reported to the management station and simultaneously relayed through a dry contact port.

### GENERAL

AC or DC power supplies are provided with an alarm-activated fan for forced-air cooling. They are available in redundant and mixed AC/DC power supply configurations.

FCD-155E is a compact 1U high 19-inch unit that can be mounted in a 19-inch rack with the optional rack-mount kit (see *Ordering*).

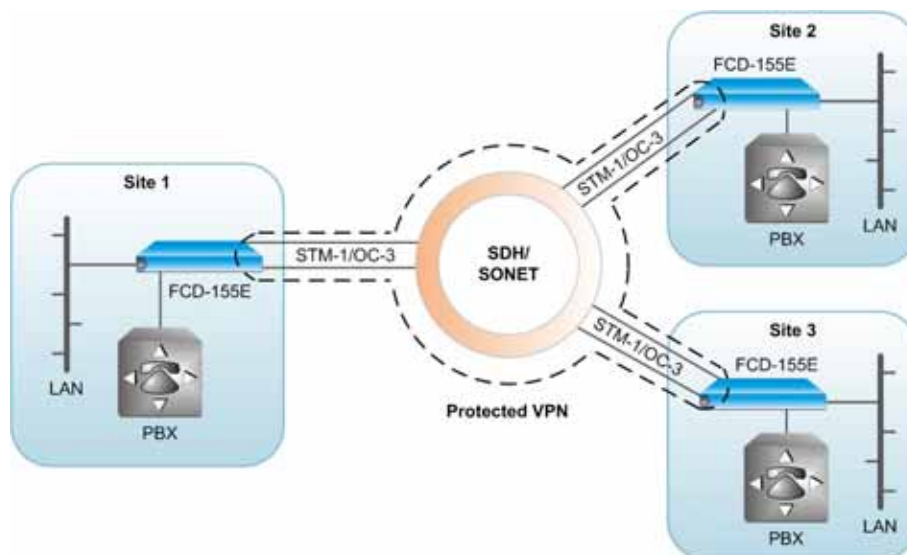


Figure 2. VPN over SDH/SONET

# FCD-155E

## STM-1/OC-3 Add/Drop Multiplexer

### Specifications

#### STM-1/OC-3 MAIN LINK

##### Number of Ports

1 (second link available for redundancy or ring support)

##### Bit Rate

155.52 Mbps  $\pm$ 20 ppm

##### SFP Transceivers

Characteristics: See *Table 1*

Options: See *Ordering*

##### Timing

Internal clock

Recovered from the STM-1/OC-3 interface

External clock from PDH tributary

Station clock

##### Compliance

SDH: ITU-T G.957

SONET: GR-253-core

##### Framing

SDH: ITU-T G.707, G.708, G.709

SONET: ANSI T1.105-1995,

GR-253-core

##### Line Code

NRZ

#### LAN INTERFACE (OPTIONAL)

##### Number of Ports

2 or 6 10/100BaseT ports

1 GbE

##### Compatibility

Relevant sections of IEEE 802.3u, 802.3x, 802.1D and 802.1Q

##### LAN Table

2,048 MAC addresses (2U) and 8,182

(GbE) with selectable automatic aging time

##### Data Rate

10BaseT: 10 Mbps

100BaseT: 100 Mbps

1000BaseT: 1000Mbps (Gigabit Ethernet)

Autonegotiation

##### Connectors (per port)

RJ-45, shielded

SFP socket (for transceivers, see *Ordering*)

Table 1. SFP Interface Characteristics

	Transceiver	Wavelength [nm]	Fiber Type [ $\mu$ m]	Transmitter Type	Connector Type	Input Power [dBm]		Output Power [dBm]		Typical Max. Range	
						(min)	(max)	(min)	(max)	[km]	[miles]
STM-1/OC-3 Uplink	SFP-1	1310	62.5/125 multimode	LED	LC	-30	-14	-20	-14	2	1.2
	SFP-2	1310	9/125 single mode	Laser	LC	-28	-8	-15	-8	15	9.3
	SFP-3	1310	9/125 single mode	Laser	LC	-34	-10	-5	0	40	24.8
	SFP-4	1550	9/125 single mode	Laser	LC	-34	-10	-5	0	80	49.7
	SFP-11	Copper uplink	Coaxial cable 75 $\Omega$	–	Mini-BNC	–	–	–	–	0.135*	0.08*
	SFP-18A	Tx - 1310	9/125 single mode (single fiber)	Laser (WDM)	LC	-28	-8	-5	0	40	24.8
		Rx - 1550									
	SFP-18B	Tx - 1550	9/125 single mode (single fiber)	Laser (WDM)	LC	-28	-8	-5	0	40	24.8
		Rx - 1310									
	SFP-19A	Tx - 1490	9/125 single mode (single fiber)	Laser (WDM)	LC	-30	-8	0	+5	80	49.7
Rx - 1570											
SFP-19B	Tx - 1570	9/125 single mode (single fiber)	Laser (WDM)	LC	-30	-8	0	+5	80	49.7	
	Rx - 1490										
GbE User Port	SFP-5	850	50/125 multimode	VCSEL	LC	-17	0	-9.5	0	0.55	0.3
	SFP-6	1310	9/125 single mode	Laser	LC	-20	-3	-9.5	-3	10	6.2
	SFP-7	1550	9/125 single mode	Laser	LC	-22	-3	0	+5	80	49.7
	SFP-8D	1310	9/125 single mode	Laser	LC	-21	-3	0	-4	40	24.8

\* Using RG59 B/U.

**E1/T1 PDH INTERFACE****Number of Ports**

8 E1, 21 E1, 8 T1, or 28 T1

**Compatibility**

ITU-T Rec. G.703, unframed

**Nominal Data Rate**

E1: 2.048 Mbps

T1: 1.554 Mbps

**Line Code**

E1: HDB3

T1: B8ZS

**Impedance**

E1: 120Ω balanced or  
75Ω unbalanced

T1: 100Ω balanced

**Maximum Line Attenuation**

36 dB (LTU mode)

12 dB (DSU mode)

**Timing**

Source clock is recovered from the receive signal coming from the remote E1/T1 side

Locked to the SDH/SONET interface clock

**Connectors**

8 E1, 8 T1: DB-44

21 E1, 28 T1: DB-62

**E3/T3 PDH INTERFACE (OPTION)****Number of Ports**

1

**Compatibility**

ITU-T Rec. G.703, unframed

**Data Rate**

E3: 34.368 Mbps

T3: 44.736 Mbps

**Framing**

Unframed

**Line Code**

E3: HDB3

T3: B3ZS

**Line Impedance**

75Ω

**Connector**

2 BNC female

**Timing**

Source clock is recovered from the receive signal from the remote E3/T3 side

Locked to the SDH/SONET interface clock

**MANAGEMENT PORTS****Control Port**

Interface: V.24/RS-232

Connector: 9-pin D-type, female

Format: Asynchronous

Baud rate: 0.3–115.2 kbps

Selectable word format: 7 or 8 bits, no parity, 7 bit odd or even parity

**Out-of-Band Access**

Single Ethernet port FCD-155E version:  
NG ETH port

Other FCD-155E versions:

ETH 1 and ETH 2 ports (through internal Ethernet switch)

**INDICATORS****General**

PWR (green) – Power

TST (yellow) – Test

MAJ ALM (red) – Major alarm

MIN ALM (red) – Minor alarm LOC SYNC

LOSS (red) – Local loss of synchronization on the STM-1/OC-3 links

REM SYNC LOSS (red) – Remote loss of synchronization on the STM-1/OC-3 links

**ETH, MNG, GbE (per port)**

LINK (green) – LAN link integrity

ACT (yellow) – LAN data activity

**E1/T1 PDH Interface (per port)**

LOS (red) – Link signal loss

AIS (red) – Alarm indication signal on link

**E3/T3 PDH Interface**

LOS (red) – E3/T3 link signal loss

**STM-1/OC-3 Main Links**

LOS (red) – STM-1/OC-3 link signal loss

ON LINE (green) – STM-1/OC-3 link is active (indicator is on) or standby (indicator is blinking)

**Station Clock**

ON (green) – Station clock port is connected

LOS (red) – Station clock signal loss

**GENERAL****Power**

100 to 240 VAC ±10%, 50 to 60 Hz

-48 VDC (-40 to -72 VDC)

+24VDC

**Power Consumption**

30W

**Alarms**

Last 100 alarms are time stamped, stored, and available for retrieval

**Alarm Relay Port**

Operation: normally open, normally closed, using different pins

Connector: 9-pin, D-type, female

**Physical**

Height: 4.4 cm (1.7 in)

Width: 44.0 cm (17.3 in)

Depth: 25.4 cm (10.0 in)

Weight: 4.1 kg (9.0 lb)

**Environment**






Temperature: -10° to 60°C (14° to 140°F)

Humidity: Up to 90%, non-condensing

# FCD-155E

## STM-1/OC-3 Add/Drop Multiplexer

FCD-RIC Products Comparison Table

Feature	RIC-155 (Ver. 1.0) 	RIC-155GE (Ver. 2.0) 	RICi-155GE (Ver. 2.0) 	FCD-155 (Ver. 4.2) 	FCD-155E (Ver 1.2) 
Frame Size (Bytes)	64-1536	64-1664	64-9600	64-1536 2K for transparent 8 GbE	64-1536 2K for transparent 8 GbE
Ethernet Flows	No	No	Yes	No	No
QoS	802.3p	802.1p	802.1p Port-based	802.1p Port-based DSCP	802.1p Port-based DSCP
MEF Certification	No	No	MEF 9, MEF 14:EPL, EVPL	No	No
MAC Address Table	1,024	16,384	transparent	1024	1024
Number of Queues	N/A	4 (strict)	4 (strict)	4 (strict, WFQ 8,4,2,1)	4 (strict, WFQ 8,4,2,1)
Encapsulation	HDLC	HDLC	GFP (G.7041), LAPS (X.86)	GFP (G.7041), LAPS (X.86)	GFP (G.7041), LAPS (X.86)
Traffic Mapping	N/A	N/A	Port-based (All-in one bundling) User port + CE-VID User port + CE-VLAN priority	Port-based (All-in one bundling) User port + CE-VID	Port-based (All-in one bundling) User port + CE-VID
SDH/SONET Redundancy	No	No	APS 1+1	APS 1+1	APS 1+1 SNCP
Gigabit Ethernet Redundancy	No	No	Yes	Yes	Yes
Hot-Swappable Power Supplies	No	Yes	Yes	No	Yes
Power Supply Redundancy	No	Yes	Yes	No	Yes
Terminal/ADM Functionality	No	No	No	No	Yes
Number of E1/T1 Tributaries	N/A	N/A	N/A	4/8 E1 4/8 T1	8/21 E1 8/28 T1
Number of E3/T3 Tributaries	N/A	N/A	N/A	1 E3, 1 T3	1 E3, 1 T3
Possibility of E1/T1 and E3/T3 Combination	N/A	N/A	N/A	N/A	Yes

## Ordering

### STANDARD CONFIGURATIONS

FCD-155E/48R/2U/21E1  
 FCD-155E/AD/2U/21E1  
 FCD-155E/AD/6U/8E1  
 FCD-155E/48R/6U  
 FCD-155E/AC/6U/21E1  
 FCD-155E/AC/2U/21E1  
 FCD-155E/AC/2U/8E1  
 FCD-155E/48/2U/8E1  
 FCD-155E/48R/6U/21E1E3  
 FCD-155E/ACR/2U/21E1  
 FCD-155E-PACK1

### SPECIAL CONFIGURATIONS

**FCD-155E\*/&/&/\$**  
 STM-1/OC-3 Add/Drop Multiplexer

**Notes:** 1. SFP transceivers are not included in the chassis for the uplink and/or the fiber GbE interfaces (see SFP Transceivers).

2. The unit can come with E3/T3 and 21E1/28T1 installed together.

3. To manage the unit with IP tunneling, order FCD-155-PACK1 separately.

#### Legend

- \* Power supply:
  - AC** 100 to 240 VAC
  - AD** redundant 100 to 240 VAC and -48 VDC power supply
  - 48** -48 VDC
  - ACR** redundant AC power supply
  - 48R** redundant DC power supply
  - 24R** +24 VDC
- & LAN interface:
  - 2U** 2 bridging 10/100BaseT ports
  - 6U** 2 bridging and 4 transparent 10/100BaseT ports
  - GE** 1 10/100/1000BaseT (GbE) port, copper interface and SFP socket
- \$ PDH interface:
  - 8E1** 8 × E1 ports
  - 8T1** 8 × T1 ports
  - 21E1** 21 × E1 ports
  - 28T1** 28 × T1 ports
  - E3** 1 × E3 port
  - T3** 1 × T3 port
  - 21E1E3** 1 × E3 ports and 21 × E1 ports
  - 21E1T3** 1 × T3 ports and 21 × E1 ports
  - 28T1T3** 1 × T3 ports and 28 × T1 ports

### FCD-155-PACK1

Software key for activating the IP tunneling management option

### SFP TRANSCEIVERS

(For redundancy, order two SFP transceivers)

#### STM-1/OC-3 Uplink

- SFP-1** STM-1/OC-3, 1310 nm multimode LED, LC connector
- SFP-2** STM-1/OC-3, 1310 nm single mode laser (S1.1), LC connector
- SFP-3** STM-1/OC-3, 1310 nm, single mode laser, long haul (L1.1), LC connector
- SFP-4** STM-1/OC-3, 1550 nm single mode laser, long haul (L1.2), LC connector
- SFP-4D** STM-1/OC-3, 1550 nm single mode laser, long haul (L1.2), LC connector, DDM
- SFP-11** STM-1/OC-3, electrical interface, mini-BNC coaxial connector
- SFP-18a** STM-1/OC-3, Tx – 1310, Rx – 1550, 9/125 single mode (single fiber), laser (WDM), LC connector
- SFP-18b** STM-1/OC-3, Tx – 1550, Rx – 1310, 9/125 single mode (single fiber), laser (WDM), LC connector
- SFP-19a** STM-1/OC-3, Tx – 1490, Rx – 1570, 9/125 single mode (single fiber), laser (WDM), LC connector
- SFP-19b** STM-1/OC-3, Tx – 1570, Rx – 1490, 9/125 single mode (single fiber), laser (WDM), LC connector



## FCD-155E

## STM-1/OC-3 Add/Drop Multiplexer

## GbE User

- SFP-5** GbE, 850 nm multimode VCSEL
- SFP-6** GbE, 1310 nm single mode laser (LX-SM)
- SFP-7** GbE, 1550 nm single mode laser, long haul LX-H (ZX)
- SFP-8D** GbE, 1310 nm single mode laser, long haul (LX-H)

*Note: It is strongly recommended to order this device with **original RAD SFPs installed**. This will ensure that prior to shipping, RAD has performed comprehensive functional quality tests on the entire assembled unit, including the SFP devices. RAD cannot guarantee full compliance to product specifications for units using non-RAD SFPs.*

## SUPPLIED ACCESSORIES

## CBL-MINIBNC-BNC

Cable for adapting two mini-BNC connectors to full sized BNC connectors (supplied with SFP-11)

AC power cord (when AC power supply is ordered)

DC adapter plug (when DC power supply is ordered)

## RM-34

Hardware for mounting one unit in a 19-inch rack

## OPTIONAL ACCESSORIES

## CBL-DB9F-DB9M-STR

Control port cable

## FCD-155E-PS/AC

100–240 VAC power supply module

## FCD-155E-PS/48

-48 VDC power supply module

## CBL-G703-8/^

8E1/8T1 interface cables for the DB-44 connector (one cable required per interface):

## Legend

^ Connector type:

- RJ45** splits into 8 E1/T1 balanced RJ-45 connectors
- RJ45/X** splits into 8 E1/T1 balanced RJ-45 connectors (cross-cable)
- COAX** splits into 8 pairs of E1 unbalanced BNC male connectors
- OPEN** 8 × 4 unterminated free leads, 2m (6.6 ft)

## CBL-G703-14/#

14E1/14T1 interface cable for the DB-62 port connector

## CBL-G703-28/#

Two CBL-G703-14/# interface cables for the DB-62 port connector, to provide 21E1/28T1 capacity

## Legend

# Connector type:

- RJ45** splits into 14 E1/T1 balanced RJ-45 connectors
- COAX** splits into 14 pairs of E1 unbalanced BNC male connectors
- OPEN** 14 × 4 unterminated free leads 2m (6.6 ft)
- PATCH** for connection to 2 Telco connectors, 2m (6.6 ft)

## OP-A-ADAPTOR-28RJ

Patch panel, two CBL-G703-14/Patch cables are not included.

## OP-A-ADAPTOR-21BNC-FCD155E

Patch panel, includes two CBL-G703-14/Patch cables.

**International Headquarters**  
24 Raoul Wallenberg Street  
Tel Aviv 69719, Israel  
Tel. 972-3-6458181  
Fax 972-3-6498250, 6474436  
E-mail market@rad.com

**North America Headquarters**  
900 Corporate Drive  
Mahwah, NJ 07430, USA  
Tel. 201-5291100  
Toll free 1-800-4447234  
Fax 201-5295777  
E-mail market@rad.com

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