Ascend

Technical Backgrounder

Series56 Digital Modem Module

ASCEND

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1. Technology Background

The Series56™ Digital Modem is an evolutionary step integral to high-concentration remote access servers. Building on the industry standard Ascend MAX™ product line, the Series56 Digital Modem introduces new levels of bandwidth, flexibility and system performance.

Bandwidth

Traditionally, modems have been designed to work on standard analog telephone lines. When digital interfaces such as ISDN PRI and channelized T1 were used, the digital bitstream was converted into its analog signal before processing. The diagram below shows the traditional data path into a digital modem.

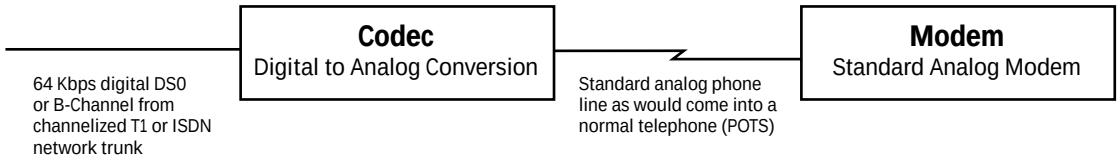

Figure 1 – Traditional datapath into a digital modem

The fact that the core of the telephone network evolved to a digital network extending to the customer premises in the form of ISDN PRI or channelized T1 had not been leveraged. With the introduction of the Series56 Digital Modems, the conversion has been eliminated with the standard analog modem being replaced by a digital bit pump. The datapath is simplified as shown below.

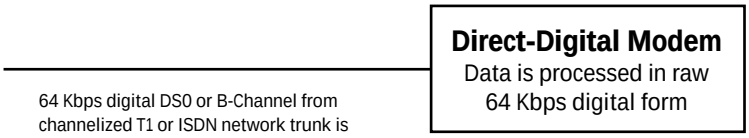

Figure 2 – Datapath into a Series56 Digital Modem

The elimination of the analog conversion within the digital modem has two significant side-effects:

- Improved performance and reliability for existing modem protocols
- Support for higher bandwidth modem protocols.

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Improved Performance and Reliability

When making standard voice calls, there is no guarantee that you will get a good connection. When you get a poor connection on a voice call, you can simply hang up and redial hoping to get a better circuit. Modems running over analog phone lines experience the same phenomenon. When modems get a poor connection, they fall back to lower data rates or possibly disconnect altogether.

When two modems connect (or when you make a voice call), it is not a simple piece of wire that is connecting the two ends of the call. Instead, many independent segments of the telephone network are chained together through switches. The diagram below shows a typical path of a phone call.

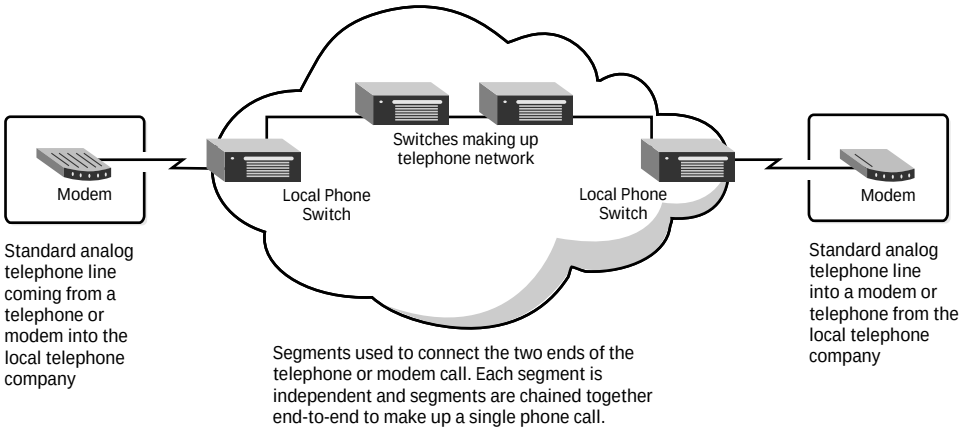

Figure 3 – Path through a telephone network of a modem or voice call

Each of the segments used to make an end-to-end telephone or modem call may be analog or digital. Today, the segments that connect the switches making up the telephone network are nearly always digital. The only segments that are analog are the last hops over the local loop into the modems or telephones that are located at the subscriber's residence.

On any analog segment there will be some amount of signal distortion and deterioration. Depending on the length and quality of the segment, the amount will vary. There is no distortion or deterioration on a digital segment; the fewer the analog segments in an end-to-end call, the better the quality of the call.

By eliminating the analog-to-digital conversion in the Series56 Digital Modem, one more of the analog segments has been removed from every call. In the best case prior to the elimination, there were two analog segments; now there is only one. With the Series56, as much as 50% of the distortion has been removed, greatly increasing the expected performance and reliability of existing standard modem protocols.

Higher Bandwidth Modem Protocols

The lowest level of modem communications is referred to as the modulation scheme. Examples of modulation schemes include the V.34 and V.32 families. It is these modulation schemes that define the raw bit rate at which the modems communicate. (For example, V.34 defines bit rates of up to 33.6 Kbps.)

The modem modulation bit rate includes neither data rate increases due to data compression nor the overhead associated with error control. The most common data compression and error control protocol in use with modems is the V.42 family. With optimum data characteristics, the 33.6 Kbps raw data rate represented by V.34bis could be leveraged to over 100 Kbps.

It is important not to confuse the raw bit rate communicated between modems with the final data rate delivered. Figure 4 shows the two communications levels.

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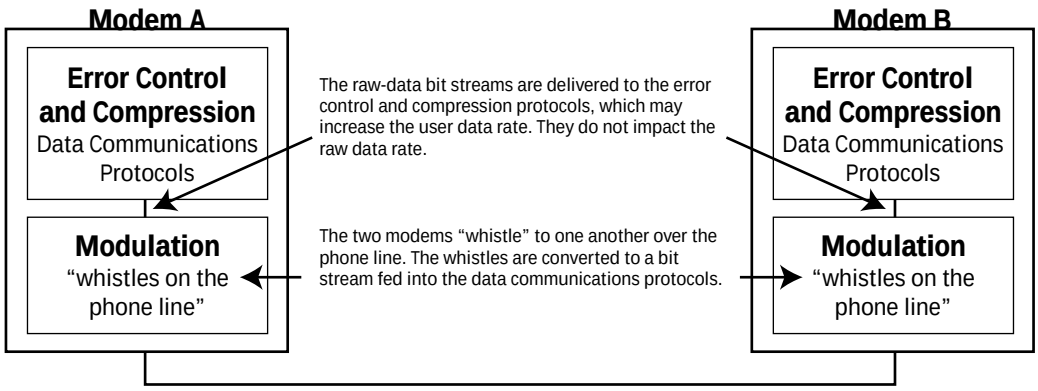

Figure 4 – Bit rate versus data rate in modem communications

Whenever the bit rate of a modem is referred to, it is generally the raw bit rate, not the data rate achieved after compression.

Until now, all of the modem modulation schemes have been designed with the assumption that at least two segments in the end-to-end modem call are analog. With this assumption, it is not possible to achieve a bit rate greater than 33.6 Kbps. However, with the introduction of the Series56, there may be only one analog segment. Assuming a single analog segment, the maximum achievable bit rate can be re-evaluated.

Ascend, in conjunction with several modem manufacturers, has developed the K56flex modem modulation scheme. The K56flex modulation scheme dynamically determines if there is only one analog segment in the end-to-end call. If it recognizes this optimum configuration and there is a K56flex-compatible modem at the far end, transmit bit rates as high as 56 Kbps can be achieved from the digital end; full standard V.34 bit rates are still achieved transmitting from the end connected to the analog segment.

If there is more than one analog segment or if the quality of the single analog segment is insufficient, K56flex falls back to V.34bis bit rates. Figure 5 below depicts the K56flex bit rates relative to V.34bis.

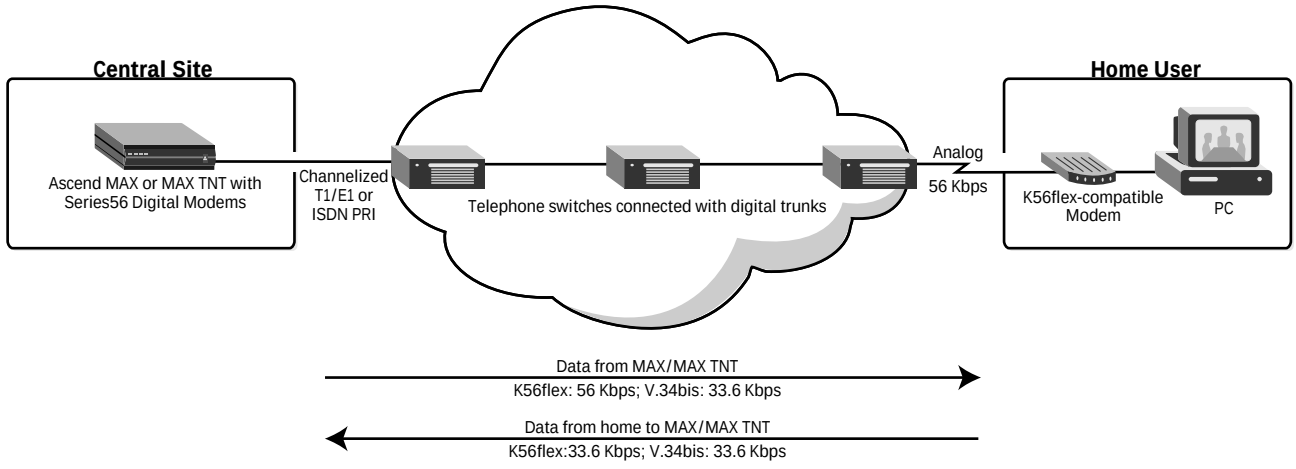

Figure 5 – K56flex performance relative to V.34bis: Maximum bit rates

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Flexibility

There are two primary levels of operation associated with a modem: bit-pump and control.

- The bit pump is the direct implementation of the modulation scheme: translating the voice-band data from the telephone network into a digital bit stream and vice versa.
- The control functions include the error control, compression and higher level call control functions.

Standards defining the control functions of a modem can change very frequently. Introduction of new control protocols and refinement of existing standards is an ongoing process. For this reason, all Ascend digital modem products have always supported fully field-upgradable control functions.

Until recently, evolution of the bit pump functionality has been slow. In the past, manufacturers did not consider it to be possible to communicate at modem speeds greater than V.34. Therefore, there was no reason to support field-upgradable bit pumps.

Figure 6 below depicts the software configuration of a system with traditional digital modems.

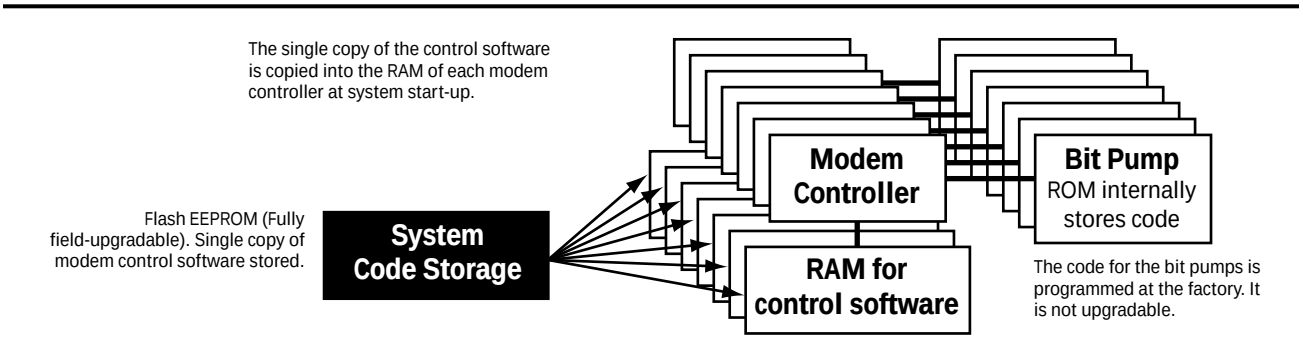

Figure 6 – Traditional software configuration of a system

With the new support of K56flex, and the foresight into the ongoing changes expected as the 56K standards evolve, the Series56 Digital Modem supports not only field-upgradable controller software but also field-upgradable bit pump software.

The code for the bit pumps is now stored in the system flash along with the controller software. Figure 7 depicts the change in code storage.

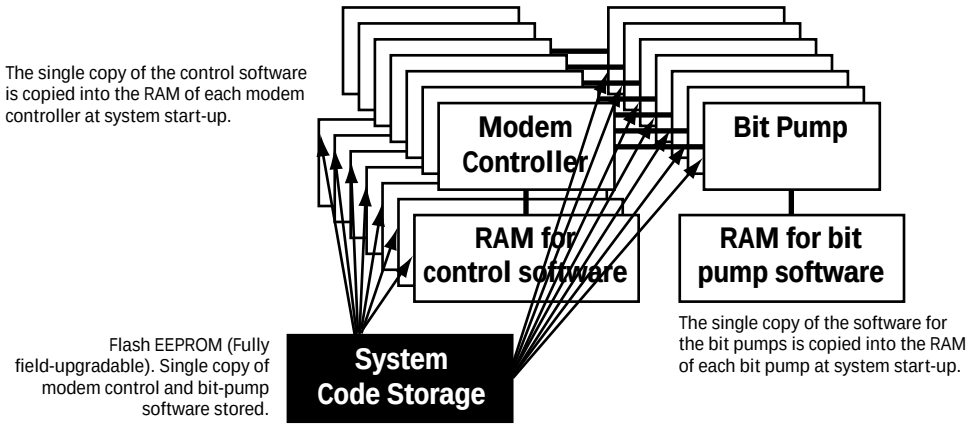

Figure 7 – Series56 Digital Modem software configuration

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With all of the components making up a digital modem now fully software programmable, the Series56 has the flexibility to support all current and future modulation schemes as well as control protocols without the need for any hardware upgrades.

Additionally, because of the general flexibility associated with the system software mechanism of the MAX and MAX TNT™ product lines, the bit pump and modem controller software can be upgraded remotely even during system operation, without any real-time interruption of the system services.

System Performance

Recently, two significant changes have occurred in the typical use of dial-up internetworking:

- The raw bit rate available on modems has increased from 14.4 Kbps less than two years ago to 56 Kbps: a quadrupling of bandwidth.
- The applications have evolved from interactive, text-based applications to highly graphic-intensive, often real-time applications.

In response to these changes, the remote access server must not only have increased bandwidth and flexibility at the modem level, but must also be able to process and forward the data more efficiently to the network.

Processing Hierarchy of Modem Data

In the previous sections, two levels of modem protocols were discussed: the modulation level and the error control/compression level. Though these are critical, they are only the first level of the data hierarchy. Figure 8 depicts the full data-processing hierarchy associated with a modem.

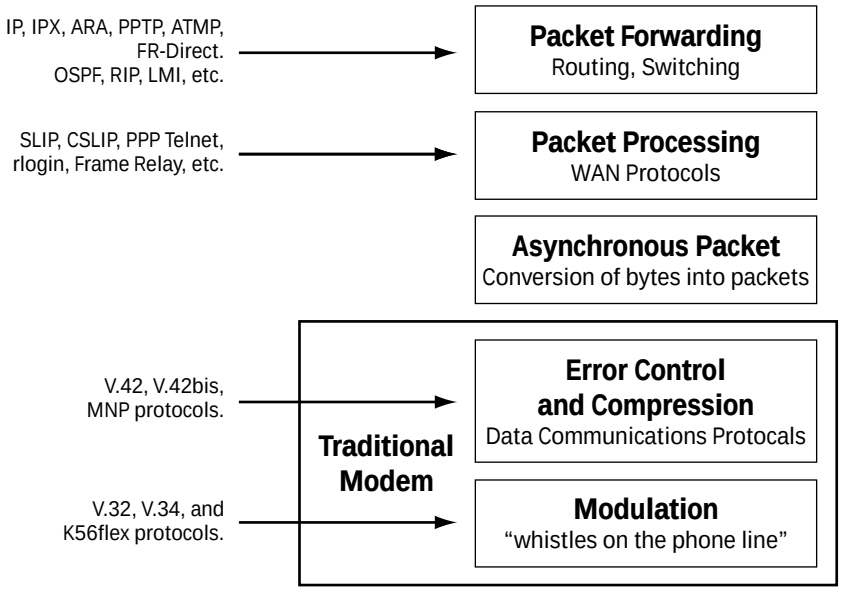

Figure 8 – Data processing hierarchy for a modem session

Traditional Processing Model

Prior to the introduction of the Series56 Digital Modem, the three packet layers were implemented in a single central processor. The central processor was responsible for the three layers for all modems in a system. The processor hierarchy is depicted in Figure 9.

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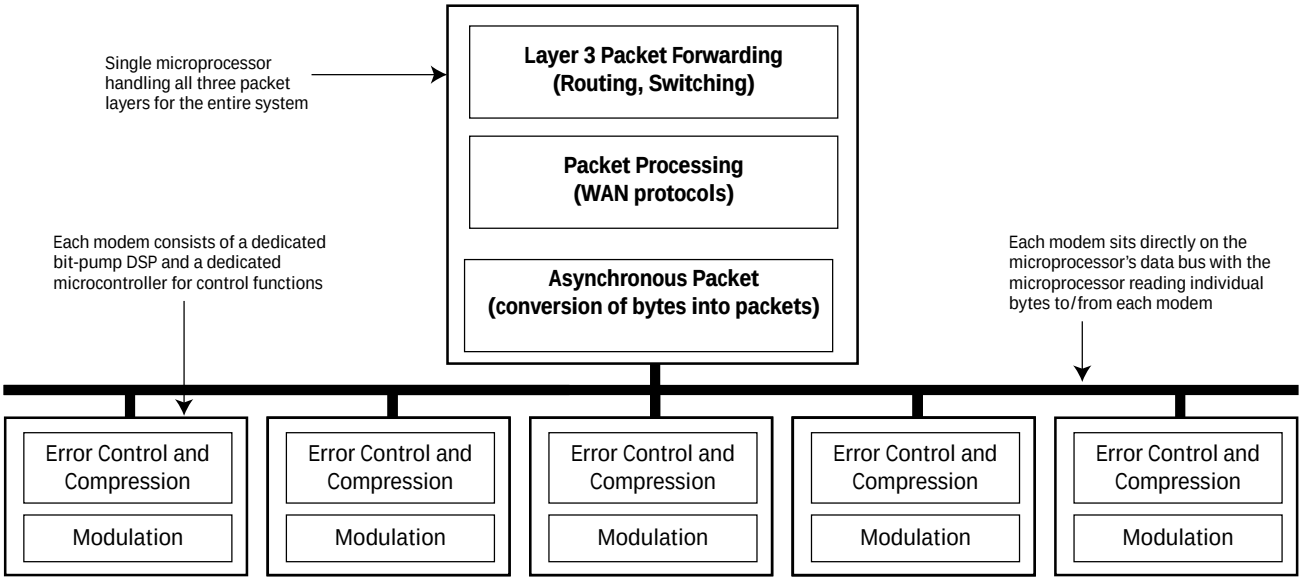

Figure 9 – Processor hierarchy in a traditional system

Series56 Processing Model

Of the three packet processing levels, the Asynchronous Packet level is the most processor intensive: It must retrieve each individual byte from the modems and intelligently aggregate them for processing by the higher layer. Likewise, it must do the same in reverse: convert packets of data into individual bytes for processing by the modem.

With the increase in both available bandwidth and more demanding user applications, the Series56 processor hierarchy is enhanced to create a non-blocking system. Specifically, for each group of modems, a dedicated high performance processor is inserted to perform the asynchronous packet layer. The diagram below depicts the Series56 processor hierarchy.

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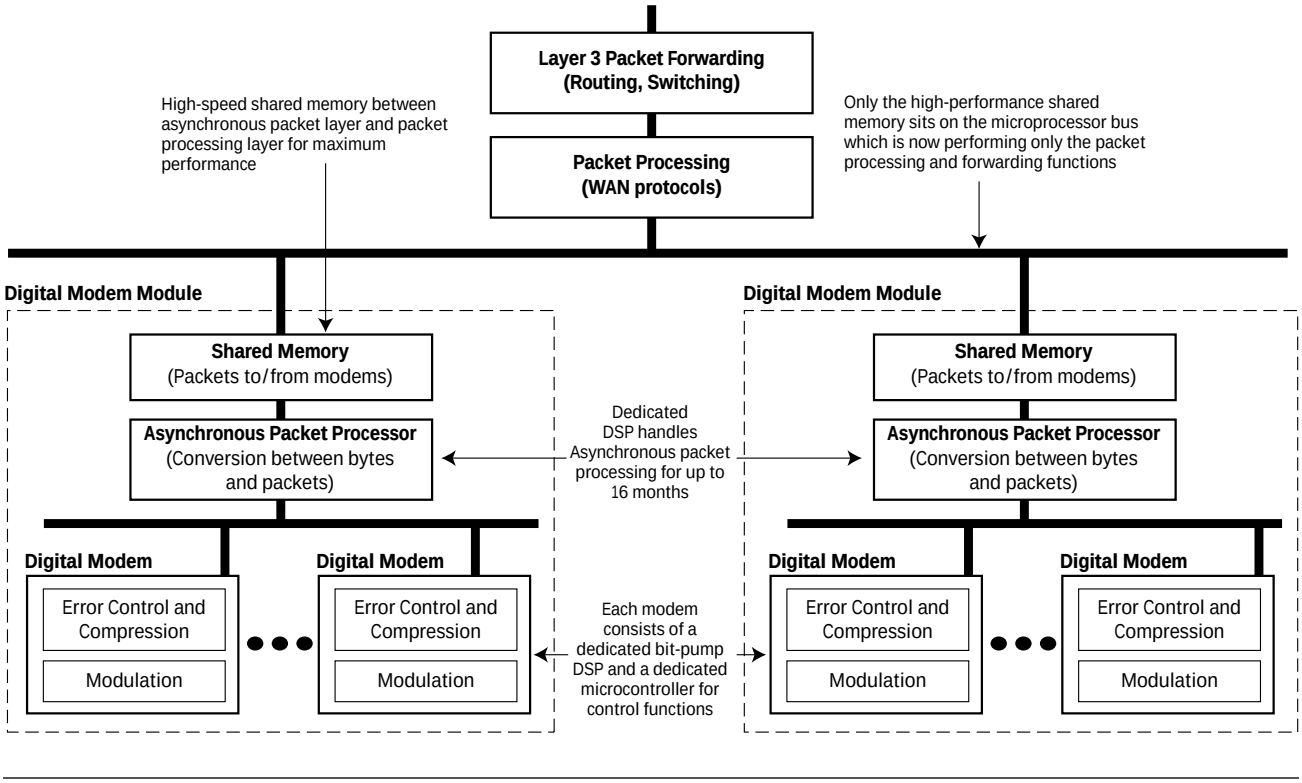

Figure 10 – Processor hierarchy in a Series56 system

The additional processing capability in Series56 modems separates the per-byte functions from the per-packet functions into separate processors. By making this separation, each processor is optimized for its specific task. The task optimization improves the system performance even beyond what might normally be expected by adding the additional processors.

The Series56 provides an processor architecture that supports extended duration full-bandwidth data flow from K56flex and future modems.

2. Summary

Ascend's new Series56 Digital Modems bring 56K connectivity to MAX and MAX TNT access switches. The Series56 modems include the K56flex technology jointly developed by Rockwell Labs and Lucent Systems. The new modems are capable of V.34bis and 56K operation and offer industry-leading access performance and more flexibility and extensibility that ever before. TheSeries56 Digital Modems modules provide:

- Simultaneous 33.6 and 56 Kbps operation
- Improved connection and system performance with a hierarchical DSP-based architecture
- Long-term hardware viability – software upgradeable to continue compliance with the 56 Kbps specification

The Series56 Digital Modems will be offered on the MAX 1800, MAX 20xx, MAX 40xx, and MAX TNT product lines. There are four Digital Modem modules in the Series56 line: 8-port, 12-port, 16-port, and 48-port modem modules.

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Worldwide and North American Headquarters
One Ascend Plaza
1701 Harbor Bay Parkway
Alameda, CA 94502, United States
Tel: 510.769.6001
Fax: 510.747.2300
E-mail: info@ascend.com
Toll Free: 800.621.9578
Fax Server: 415.688.4343
Web Site: http://www.ascend.com

European Headquarters
Rosemount House
Rosemount Avenue
West Byfleet
Surrey KT14 6NP, United Kingdom
Tel: +44 (0) 1932.350.115
Fax: +44 (0) 1932.350.199

Japan Headquarters
Level 19 Shinjuku Daiichi-Seimei Bldg.
2-7-1 Nishi-Shinjuku
Shinjuku-ku, Tokyo 163-07, Japan
Tel: +81.3.5325.7397
Fax: +81.3.5325.7399
Web Site: http://www.ascend.co.jp

Asia-Pacific Headquarters
Suite 1419, Central Building
1 Pedder Street
Central, Hong Kong
Tel: +852.2844.7600
Fax: +852.2810.0298

Latin, South America and the Caribbean Headquarters
One Ascend Plaza
1701 Harbor Bay Parkway
Alameda, CA 94502, United States
Tel: 510.769.6001
Fax: 510.747.2669

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