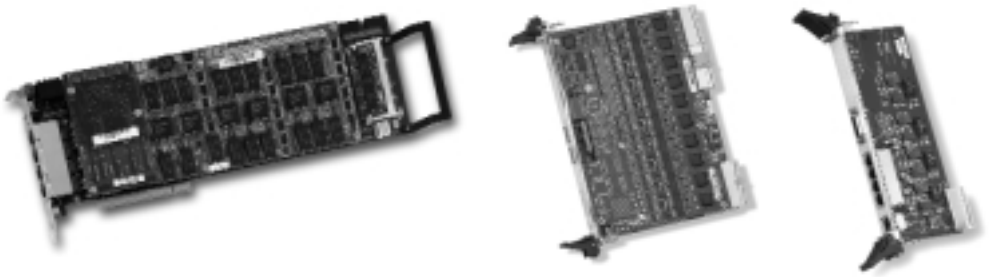
Datasheet

Intel® NetStructure™ DM/N960-4T1, DM/N1200-4E1, DM/T960-4T1, and DM/T1200-4E1 Digital Telephony Interface Boards

Provides Four T-1 or E-1 Network Interfaces

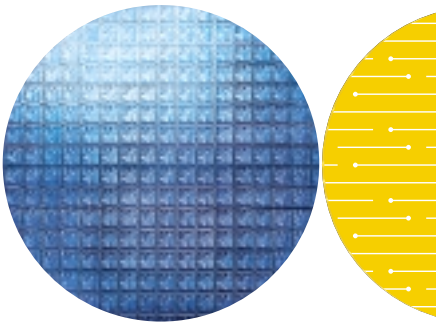


Intel® NetStructure™ DM/N and DM/T digital telephony interface boards provide a powerful set of advanced call processing and telephony networking features that developers can use to create large-scale switching solutions for enterprise and public networks. Offered on single-slot PCI and CompactPCI* format factors, each board provides access to four T-1 (1.544 Mb/s) or E-1 (2.048 Mb/s) digital network interfaces.

Powerful digital signal processors (DSPs) provide a rich set of call processing features, telephony tone signaling, reliable DTMF detection with local echo cancellation, and automated outbound call progress analysis with positive voice detection and positive answering machine detection.

Features and Benefits

- Four T-1 or E-1 digital interfaces with ISDN PRI Primary Rate connectivity in CT systems enable development of large-scale switching solutions for enterprise and public networks
- Choice of T-1 or E-1 digital network interfaces with internationally approved CAS and ISDN Primary Rate access lets applications connect to a variety of signaling networks worldwide, facilitating faster time-to-market with global deployment
- Optional tone signaling and outbound call progress analysis
- Unified call control access through Global Call API provides worldwide application portability and shortens development time by allowing the use of the same API for almost any network protocol
- Offered in industry-standard PCI or CompactPCI* form factors let developers build a single application that can be deployed on either form factor
- Downloadable signal and call processing firmware provides the flexibility necessary to enhance applications as needs change
- Built on the industry-standard ECTF H.100/H.110 CT Bus let applications expand through access to other communication boards, such as IP telephony, ATM, SS7, and DS3
- Software development kits (SDKs) for the Windows NT*, Windows* 2000, and Linux* operating systems can provide faster time to market



Intel in Communications

DM/N and DM/T boards are based on the DM3 architecture, which provides an environment that accelerates application development and provides a path for future growth. The boards support R4 application programming interfaces (APIs), providing interoperability with other boards that use the CT Bus and SCbus.

Applications can easily be ported to lower or higher density platforms and new features can be added with only minimum modifications, protecting investment in hardware and application code.

Table 1 lists the DM/N and DM/T boards that are currently available. All DM/N and DM/T boards support the PCI and Compact PCI form factors; the CT Bus; and the Windows NT, Windows 2000, and Linux operating systems.

Intel NetStructure Board	Ports	Tone Signaling With Call Progress	Network Interface
DM/N960-4T1	96	No	4 T-1
DM/N1200-4E1	120	No	4 E-1
DM/T960-4T1	96	Yes	4 T-1
DM/T1200-4E1	120	Yes	4 E-1

Table 1. DM/N and DM/T Boards

DM/N and DM/T boards may or may not have tones. The boards with tones are typically required for the E-1 R2MF and T-1 channel associated signaling (CAS) protocols, and to implement advanced features such as call progress analysis and automatic number identification/dialed number identification service (ANI/DNIS) information retrieval. With ISDN protocols, such information is typically included in the SETUP message, making it possible to use boards without tone support, providing significant savings.

DM/N and DM/T boards provide the following functionality in real time on all channels:

- Connects to 96 T-1 or 120 E-1 telephone channels via DSX-1 T-1 or CEPT E-1 termination
- Automatically answers calls using virtually any international telephony signaling protocol
- Detects DTMF and MF tones
- Places outbound calls and automatically tracks call progress

Downloadable Firmware

DM/N and DM/T boards consist of a baseboard with a RISC processor and four DS-1 digital network interfaces. (Different assemblies are used for T-1 and E-1.) An array of DSPs resides on a low-profile daughterboard. Telephony signaling protocols and tone processing features are downloaded to the board as firmware on power up, taking up residence on the various onboard processors. This approach enables simplified feature upgrade and expansion. Individual firmware components, such as a network interface protocol or a voice recording function, are referred to as resources.

Network Interface

DM/N and DM/T boards for T-1 support all T-1 robbed-bit signaling protocols and are fully compatible with all resource devices that use, or can be set to use, 1.544-MHz clocking and µ-law pulse code modulation (PCM). The E-1 versions of the DM/N and DM/T boards support all CEPT CAS protocols, and are fully compatible with interface devices that use, or can be set to use, 2.048 MHz clocking and A-law PCM (ITU-T recommendation G.703/704/711). The E-1 boards also support the clear channel feature, providing up to 124 bearer channels.

DM/N and DM/T boards also support ISDN PRI access for both T-1 and E-1. The T-1 protocol implementations comply with the North American standard ISDN PRI and the INS-1500 standard used in Japan. In North America and Japan, the ISDN Primary Rate includes 23 voice/data channels (B channels) and one signaling channel (D channel). The E-1 protocol implementations comply with the E-1 ISDN PRI protocols. The E-1 ISDN

Applications

- Switching/call completion
- Network call center
- Prepaid/debit card
- International callback
- Gateway switch

Primary Rate includes 30 voice/data channels (B channels) and two additional channels: one signaling channel (D channel) and one framing channel to handle synchronization. The key ISDN PRI features include

- Direct Dialing In (DDI) service, also known as DNIS, lets an application route incoming calls by automatically identifying the number the caller dialed
- Call-by-Call service selection lets an application select the most efficient bearer channel service, such as an 800 line or a WATS line, on a call-by-call basis
- User-to-User Information lets an application send proprietary messages to remote systems during call establishment
- LAP-D Layer 2 Access lets developers build a customized Layer 3 protocol
- Non-Facility Associated Signaling (NFAS) lets a single D-channel control multiple PRI trunks, providing significant savings in ISDN service subscription costs
- Facility, Notify, and Optional Information Elements (IEs) let applications work with network-specific supplementary services
- Protocol timers can be set dynamically with a configuration file
- A Maskable Layer 2 Control lets the application toggle between bringing Layer 2 up and down as desired

Intel maintains an extensive number of product approvals in international markets. See the list of globally approved products at http://resource.intel.com/globalapproval/globalapproval.asp.

Global Call API

The Global Call API provides a common signaling interface for network-enabled applications, regardless of the signaling protocol needed to connect to the local telephone network. The signaling interface provided by the Global Call API facilitates the exchange of call control messages between the telephone network and virtually any network-enabled application. The Global Call API lets developers create an application that can work with signaling systems worldwide, regardless of the network to which they are connected.

The Global Call API is ideal for high-density, network-enabled solutions for voice, data, and video where the supported hardware and signaling technology can vary widely. Rather than requiring the application to handle the low-level details, the Global Call API offers a consistent, high-level interface to the user, handling each country's unique protocol requirements in a way that is transparent to the application.

Software Support

DM/N and DM/T boards are supported by system software and SDKs for the Windows NT, Windows 2000, and Linux operating systems. These packages contain a set of tools for developing sophisticated, multimedia communications applications.

Tone Signaling

In addition to DTMF signaling, the DM/N and DM/T boards contain a robust set of features used for network tone signaling and control. The global tone detection (GTD) and global tone generation (GTG) features can detect and generate user-defined tones for solving special application situations, such as i-ntegration with a private branch exchange (PBX) or dealing with unique tones.

Perfect Call call progress analysis accurately monitors outbound calls, detects when calls are answered, and distinguishes

- Line ringing with no answer
- Line busy
- Problem completing call (such as operator intercept)
- Call answered by a human or answering machine
- Call answered by a fax machine or modem

Perfect Call is intelligently tolerant of the wide variation in call progress signaling tones found in central offices and PBXs around the globe, and offers accurate performance "out of the box." Patented DSP-based algorithms are used to accurately discriminate human speech from recorded human voice and from network noise.

High Availability CompactPCI*

DM/N and DM/T boards for CompactPCI provide a range of high-availability features.

Hot Swap (PICMG Specifications)

Hot swap capability includes like-for-like board replacement while the system is operational.

System Management

Three types of system management are provided.

- **Configuration management** — includes features, such as plug-and-play, individual board validation, automatic addressing, and automatic board configuration, to decrease the likelihood of procedural errors caused by inexperienced personnel
- **Performance management** — detailed monitoring at the port, DSP, or board level lets administrators balance system capacity and plan for future growth
- **SNMP** — SNMP-enabled computer telephony (CT) components lower the cost of ownership. SNMP can be integrated into an existing infrastructure, or a standard, off-the-shelf SNMP management platform can be deployed. Remote monitoring and configuration are possible at the board, network, or port level.

Clock Fallback

A fallback clock is provided on a separate board to provide redundancy in case of clock failure. In the event that the master clock fails, the fallback clock takes over to prevent any loss of data. An alarm message is generated in the system log, without interrupting service.

Rugged and Durable Design

CompactPCI uses the Eurocard 6U format and is especially suitable for large-scale PSTN systems where a high degree of availability and reliability are critical.

CT Bus Compatibility

The Intel implementation of the ECTF H.110 standards-based CT Bus on CompactPCI provides 4096 time slots for exchanging voice, network interface, speech recognition, or other media resources.

DM/N and DM/T boards can be used to develop sophisticated, multifunction CT systems for large-scale switching applications. DM/N and DM/T boards occupy a single computer backplane slot, and multiple DM/N and DM/T boards can be installed in a single computer, resulting in solutions with up to 1200+ ports per chassis.

DM/N and DM/T boards can operate in either terminate or hairpin configurations. In a terminate configuration, the products handle the processing of digital audio and telephony signaling. Additional system resources can access calls via the CT Bus. This configuration is ideal for voice messaging, unified messaging, and interactive voice response (IVR) applications.

In a hairpin configuration, the boards are connected via the CT Bus and can continuously pass all T-1/E-1 time slots through to each other. This configuration can switch call traffic between separate T-1 or E-1 lines, or can be placed in-line between a T-1/E-1 public network trunk and a digital switch. Calls on individual channels can either terminate at a call processing resource on a board, or “flow through” transparently from one DM/N and DM/T board to another. This configuration is ideal for call center, prepaid calling card, international call-back, and telecom resale applications.

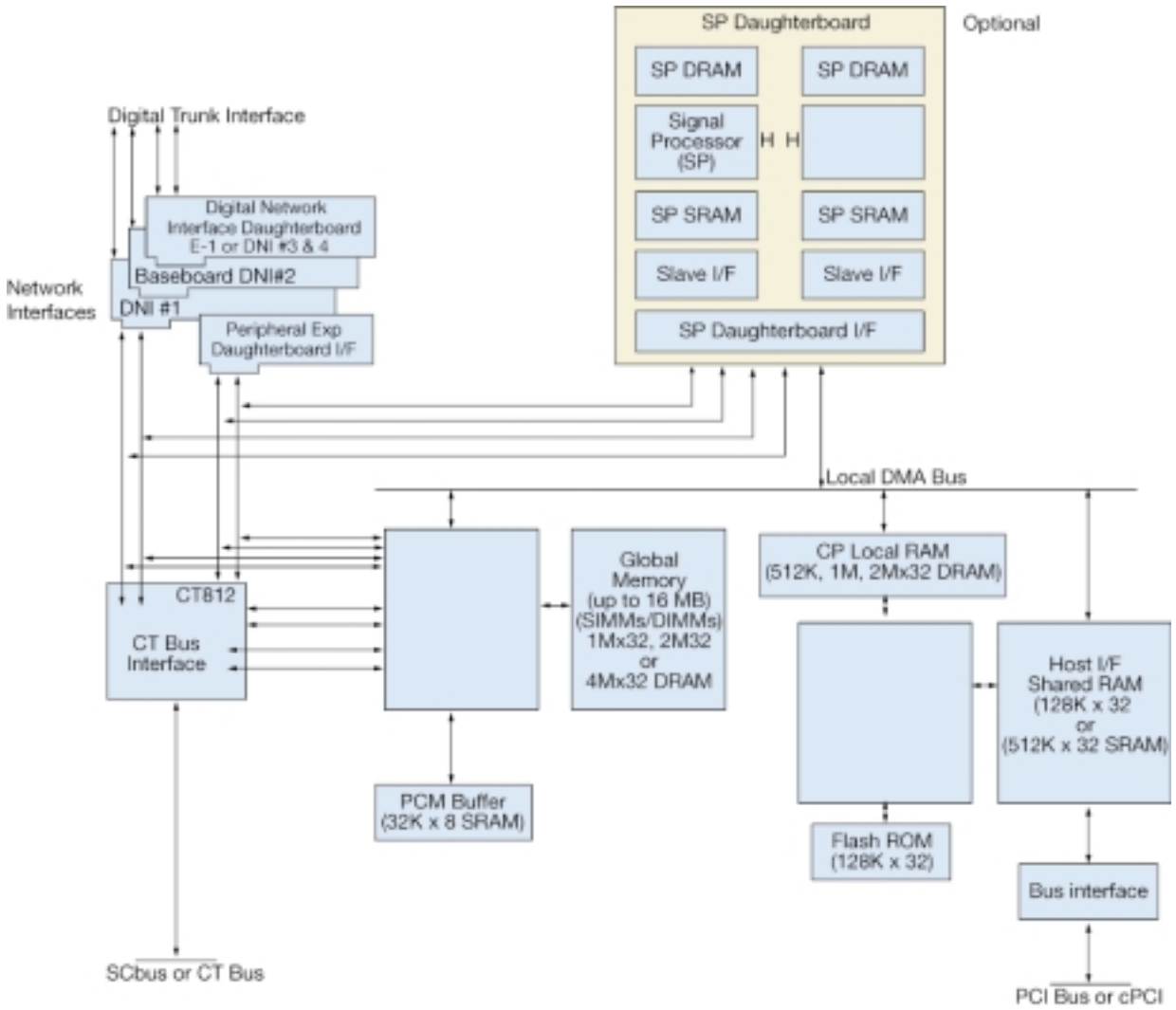


Figure 1. Block Diagram

Functional Description

DM/N and DM/T boards are based on the DM3 architecture. See Figure 1 for a block diagram. The architecture consists of a set of core specifications and firmware modules that are implemented on boards with various processors, including

- RISC processor for centralized control
- DSPs for media processing
- TDM bus interface (SCbus/CT Bus)
- Digital telephony network interfaces
- PCI bus interface

DM/N and DM/T boards support up to 96 T-1 or 120 E-1 channels of call processing via a bank of DSPs and four E-1 or T-1 digital trunk interface (DTI) circuits. The DTI circuits contain signaling services (ISDN, CAS, and CCS), plus any alarm handling and line maintenance services required by the installed networks. Each DTI includes software switchable clock circuits that can be set for all of the following modes:

- **Loop** – transmit clocking is slaved to the external network
- **Independent** – transmit clocking is derived from an onboard oscillator
- **Expansion or system** – transmit clocking is slaved to the SCbus/CT Bus; receive clocking is always slaved to the trunk interface

The control processor is a general-purpose Intel® i960® microprocessor. It is responsible for the initialization, configuration, and control of the various elements that make up the DM/N and DM/T boards, and controls the TDM bus interface, as well as the signaling protocols for the DTIs installed on the platform.

DM/N and DM/T boards also provide support for an optional DSP daughterboard with call progress analysis capabilities.

DSPs process the digitized voice data using downloaded resource firmware. Each DSP can perform the following signal analysis and operations:

For incoming data, each DSP performs the following operations:

- Detects the presence of tones — DTMF, MF, or application-defined single or dual tone
- Detects silence to determine whether the line is quiet and the caller is not responding

For outbound data, each DSP performs the following operations:

- Generates tones — DTMF, MF, or any application-defined general-purpose tone
- Dials out (makes an outbound call)
- Monitors and reports results
  - — line busy or congested
  - — operator intercept
  - — ring, no answer
  - — or if the call is answered, whether answered by a person, an answering machine, a facsimile, or a modem

Shared RAM on DM/N and DM/T boards enables communication between the host system and the i960 processor. A bank of global memory is also provided to facilitate communications between the control processor and the various DSPs. In addition to providing a data pathway between processors, the global memory can also serve as a repository for data that is to be shared among processors or which may not be storable within local memory associated with the processor.

Hardware Technical Specifications**

DM/N and DM/T Configuration

Digital interfaces	Four T-1 or four E-1
Maximum boards per system	Application, call traffic, and CPU dependent
Control processor	Intel® i960® CF @ 33 MHz, 66 MIPS
Control processor memory	Up to 8 MB local to control processor
Digital signal processors Up to 8 DSPs @ 100 Mips each	Motorola* 5630x, 1 K word program cache
DSP memory 128 K word SRAM local to each DSP	256 K word DRAM local to each DSP
Baseboard global memory	32-bit wide DRAM accessible to all signal processors and control processor

PCI Platform

Form factor	PCI long card, single-slot width
Host interface memory	512 KB
Bus compatibility	Rev 2.2 of PCI bus specification
Bus mode	Target and DMA master mode operation
Support	3.3 V or 5 V signaling environment (universal connectivity)
Computer telephony bus	ECTF H.100 compliant CT Bus, offering: • Onboard switching access to 4096 bi-directional 64 kb/s DS-0 time slots • SCbus interoperability through Intel provided adapter • 68-pin ribbon cable connector
Network connectors	Four RJ-48C on rear bracket

CompactPCI Platform

Form factor	6U Eurocard form factor, single-slot width
Host interface memory	512 KB
Bus compatibility	Rev 2.2 of PCI bus specification
Bus mode	Target and DMA master mode operation
Computer telephony bus	ECTF H.110 compliant CT Bus, offering onboard switching access to 4096 bi-directional 64 kb/s DS-0 time slots
Network connectors	Provided through rear I/O transition modules (not included with board) • BNC for 75 Ohm lines • RJ-48C for 100 Ohm and 120 Ohm lines

Telephone Interface: DSX 1 T-1

Clock rate	1.544 Mb/s ±32 ppm
Level	3.0 V (nominal)
Pulse width	323.85 ns (nominal)
Line impedance	100 Ohm ±10%
Other electrical characteristics	Complies with AT&T* TR62411 and ANSI T1.403-1989
Framing	SF (D3/D4), ESF for ISDN
Line coding	AMI AMI with B7 stuffing B8ZS
Clock and data recovery	Complies with AT&T TR62411 and Bellcore* TA-TSY-000170
Jitter tolerance	Complies with AT&T TR62411 and ANSI T1.403-1989
Connectors	RJ-48C
Telephony bus connector	H.100-style 68-pin fine pitch card edge connector
Loopback	Supports switch-selectable local analog loopback and software selectable local digital loopback
Zero code suppression	Bell ZCS (Jam bit 7), GTE ZCS (Jam bit 8), Digital Data Service ZCS, no zero code suppression

Hardware Technical Specifications (cont.)

Telephone Interface: CEPT E1

Network clock rate	2.048 Mb/s ±50 ppm
Internal clock rate	2.048 Mb/s ±32 ppm
Level	2.37 V (nominal) for 75 Ohm lines 3.0 V (nominal) for 120 Ohm lines
Pulse width	244 ns (nominal)
Line impedance	75 Ohm, unbalanced 120 Ohm, balanced
Other electrical characteristics	Complies with CCITT Rec. G.703
Framing	CCITT G.704-1988 with CRC4
Line coding	HDB3
Clock and data recovery	Complies with CCITT Rec. G.823-1988
Jitter tolerance	Complies with CCITT Rec. G.823, G.737, G.739, G.742-1988
Connectors	BNC for 75 Ohm lines RJ-48C for 120 Ohm lines
Telephony bus connector	H.100-style 68-pin fine pitch card edge connector
Loopback	Supports switch-selectable local analog loopback and software selectable local digital loopback

Power Requirements

Configuration	+5 VDC	+12 VDC	–12 VDC	+ 3.3 VDC
DM/N960-4T1-PCI	11.75 W	0.360 W	N/A	N/A
DM/N1200-4E1-PCI	11.75 W	0.360 W	N/A	N/A
DM/T960-4T1-PCI	19.25 W	0.360 W	N/A	N/A
DM/T1200-4E1-PCI	19.25 W	0.360 W	N/A	N/A
DM/N960-4T1-cPCI	10 W	1.1 W	N/A	2.04 W
DM/N1200-4E1-cPCI	10 W	1.1 W	N/A	2.04 W
DM/T960-4T1-cPCI	19.34 W	1.1 W	N/A	2.04 W
DM/T1200-4E1-cPCI	19.34 W	1.1 W	N/A	2.04 W

Cooling Requirements

Operating temperature	0°C to +50° C.
Cooling conditions per maximum temperature	50°C — 3.1 CFM per board 40°C — 2.1 CFM per board 30°C — 1.6 CFM per board
Storage temperature	–20° C to +70° C
Humidity	8% to 80% noncondensing

Safety and EMI Certifications

United States	PCI, CompactPCI FCC: EBZUSA-31207-XD-T UL: E96804
Canada	PCI, CompactPCI IC: 885 7969 A UL: E96804
Estimated MTBF	DM/N PCI (T-1 or E-1): 151,000 per Bellcore Method I DM/N CompactPCI (T-1 or E-1): 215,000 hours per Bellcore Method I DM/T PCI (T-1 or E-1): 87,000 hours per Bellcore Method I DM/T CompactPCI (T-1 or E-1): 106,000 hours per Bellcore Method I
Warranty	Intel® Telecom Products Warranty Information, see http://www.intel.com/network/csp/products/3144web.htm

Resource Technical Specifications**

DTMF Tone Detection

DTMF digits	0 to 9, *, #, A, B, C, D per Bellcore LSSGR Sec. 6
Dynamic range	T-1: –36 dBm to +3 dBm per tone, configurable by parameter† E-1: –39 dBm to +0 dBm per tone, configurable by parameter†
Minimum tone duration	32 ms; can be increased with software configuration
Interdigit timing	Detects like digits with a >45 ms interdigit delay. Detects different digits with a 0 ms interdigit delay.
Acceptable twist and frequency variation	T-1: Meets Bellcore LSSGR Sec. 6 and EIA 464 requirements E-1: Meets ITU-T Q.23 recommendations†
Noise tolerance	Meets Bellcore LSSGR Sec. 6 and EIA 464 requirements for Gaussian, impulse, and power line noise tolerance
Cut through	T-1: Local echo cancellation permits 100% detection with a >4.5 dB return loss line E-1: Digital trunks use separate transmit and receive paths to network. Performance dependent on far end handset's match to local analog loop.
Talk off	Detects less than 10 digits while monitoring Bellcore TR-TSY-000763 standard speech tapes (LSSGR requirements specify detecting no more than 470 total digits). Detects 0 digits while monitoring MITEL speech tape #CM 7291.

Global Tone Detection

Tone type	Programmable for single or dual
Maximum number of tones	Application dependent
Frequency range	Programmable within 300-3500 Hz
Maximum frequency deviation	Programmable in 5 Hz increments
Frequency resolution	±5 Hz – separation of dual frequency tones is limited to 62.5 Hz at a signal-to-noise ratio of 20 dB
Timing	Programmable cadence qualifier, in 10 ms increments
Dynamic range	T-1: Default set at –36 dBm to +3 dBm per tone, programmable E-1: Default set at –39 dBm to +0 dBm per tone, programmable

Global Tone Generation

Tone type	Generate single or dual tones
Frequency range	Programmable within 200 Hz to 4000 Hz
Frequency resolution	1 Hz
Duration	10 ms increments
Amplitude	T-1: –43 dBm to –3 dBm per tone nominal, programmable E-1: –40 dBm to 0 dBm per tone nominal, programmable

MF Signaling R1: T-1

MF digits	0 to 9, KP, ST, ST1, ST2, ST3 per Bellcore LSSGR Sec. 6, TR-NWT-000506 and CCITT Q.321
Transmit level	Complies with Bellcore LSSGR Sec. 6, TR-NWT-000506
Signaling mechanism	Complies with Bellcore LSSGR Sec. 6, TR-NWT-000506
Dynamic range for detection	–25 dBm to +3 dBm per tone
Acceptable twist	6 dB
Transmit frequency variation	Less than ±1 Hz

MF Signaling R2: E-1

MF digits	All 15 forward and backward signal tones per ITU-T Q.441
Transmit level	–8 dBm0 per tone nominal, per ITU-T Q.454; programmable
Signaling mechanism	Supports the R2 compelled signaling cycle and non-compelled pulse requirements per ITU-T Q.457 and Q.442
Dynamic range for detection	–35 dBm to –5 dBm per tone
Acceptable twist	7dB
Acceptable freq. variation	Less than ±1 Hz

Resource Technical Specifications (cont.)

Call Progress Analysis		
	Busy tone detection	Default setting designed to detect 74 out of 76 unique busy/congestion tones used in 97 countries as specified by ITU-T Rec. E., Suppl. #2. Default uses both frequency and cadence detection. Application can select frequency only for faster detection in specific environments.
	Ring back detection	Default setting designed to detect 83 out of 87 unique ring back tones used in 96 countries as specified by ITU-T Rec. E., Suppl. #2. Uses both frequency and cadence detection.
	Positive voice detection accuracy	>98% based on tests on a database of real world calls
	Positive voice detection speed	Detects voice in as little as 1/10th of a second
	Positive answering machine detection accuracy	>85% accurate based on application and environment
	Fax/modem detection	Pre-programmed
	Intercept detection	Detects entire sequence of the North American tri-tone. Other intercept tone sequences can be programmed.
	Dial tone detection before dialing	Application enable/disable; supports up to three different user definable dial tones; programmable dial tone drop out debouncing (when not part of regulatory approval).
Tone Dialing		
	DTMF digits	0 to 9, *, #, A, B, C, D per Bellcore LSSGR Sec. 6, TR-NWT-000506, ITU-T Q.23
	Frequency variation	Less than ±1 Hz
	Rate	10 digits/s, configurable by parameter†
	Level	T-1: –4.0 dBm per tone, nominal, configurable by parameter† E-1: –7.0 dBm per tone, nominal, country-specific†
Protocols		
	T-1 CAS	E&M (wink start, immediate start), loop start, ground start, Feature Group A, B, and D
	T-1 ISDN	NI-2, 4ESS, 5ESS, DMS100, DMS250, INS1500, Q.Sig
	E-1 CAS	Many country specific MFC-R2 variants
	E-1 ISDN	NET5, Q.Sig

Additional Components (with Item Market Names)

- Multidrop CT Bus cables (CBLCTB68C3DROP, CBLCTB68C4DROP, CBLCTB68C8DROP, CBLCTB68C12DROP, CBLCTB68C16DROP)
- CT Bus/SCbus adapter (CTBUSTOSCBUSADP)
- SCbus terminator kits (1SCBUS1TERMKIT, 2SCBUS1TERMKIT, 3SCBUS1TERMKIT)
- Rear I/O module for CompactPCI boards
  - — Not keyed (all chassis) – CPCIREARRJ48, CPCIREARE1120, REARIOV19E175
  - — Keyed/Guided (only for keyed/guided chassis) – CPCIREARRJ48KYD, CPCIREARE1120KY, REARIOV19E175KY
- 120 Ohm to 75 Ohm converter (supplied by a third party)

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