COMET

Combined E1/T1 Transceiver

Technical Overview

Issue 2: May 1998

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OVERVIEW

The PM4351 Combined E1/T1/J1 Transceiver (COMET), shown in Figure 1, is a feature-rich integrated circuit suitable for use in long haul and short haul T1 and E1 systems with a minimum of external circuitry. The COMET is software configurable, allowing feature selection without changes to external wiring.

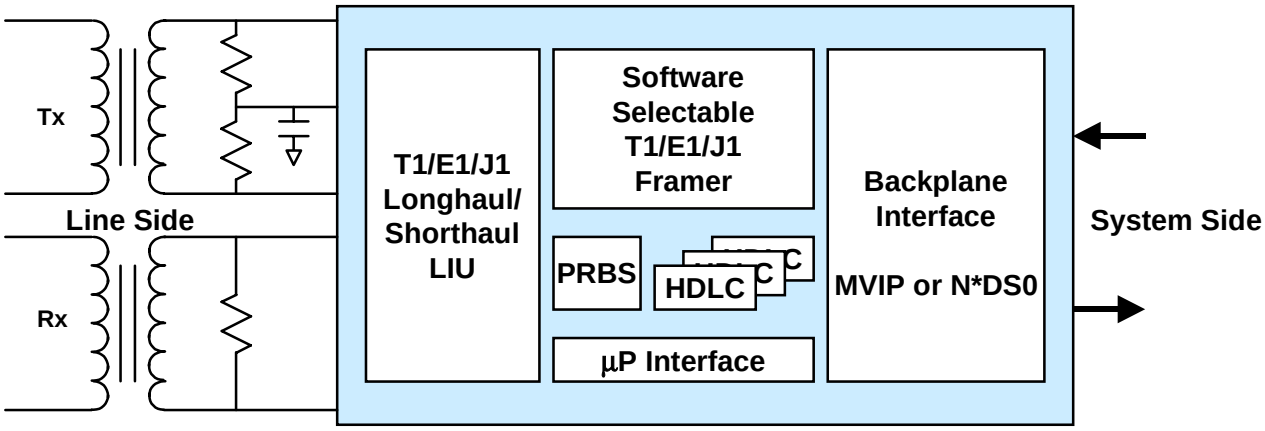

Figure 1: COMET Functional Overview

Analog circuitry is provided to allow direct reception of long haul E1, J1 and T1 compatible signals with up to 43 dB cable loss (at 1.024 MHz in E1 mode) or up to 36 dB cable loss (at 772 kHz in T1 mode) using a minimum of external components. Typically, only line protection, a transformer and a line termination resistor are required. Digital line inputs are provided for applications not requiring an analog T1, E1 or J1 interface.

The COMET recovers clock and data from the line and frames to incoming data. In T1 mode, it can frame to several DS-1 signal formats: SF, ESF, T1DM (DDS) and SLC®96. In E1 mode, the COMET frames to basic G.704 E1 signals and CRC-4 multiframe alignment signals, and automatically performs the G.706 interworking procedure. AMI, HDB3 and B8ZS line codes are supported. With its three internal HDLC controllers, the PM4351 COMET fully supports the V5 interfaces specified by ITU in ITU-T G.764 and ITU-T G.765 and by ETSI in ETS 300 324-1 and ETS 300 347-1. The T1, E1 and J1 modes of operation of COMET are shown in Table 1.

Table 1: Available modes of operation

Rate	Format	Specification	Shorthaul	Longhaul	Framer Only
T1 (1.544 Mbit/s)	SF	T1.403	√	√	√
	ESF	T1.403	√	√	√
E1 (2.048 Mbit/s)	PCM30	G.703/ G.704	√	Defacto spec of 43 dB of cable loss	√
	V5.1	G.964	√	Defacto spec of 43 dB of cable loss	√
J1 (1.544 Mbit/s)	PCM24	JT-G703/JT-G704	√	Not Applicable	√

The COMET supports detection of various alarm conditions such as loss of signal, pulse density violation, Red alarm, Yellow alarm, and AIS alarm in T1 mode and loss of signal, loss of frame, loss of signaling multiframe and loss of CRC multiframe in E1 mode. The COMET also supports reception of the remote alarm indication signal, remote multiframe alarm signal, alarm indication signal, and time slot 16 alarm indication signal in E1 mode. The presence of Yellow and AIS patterns in T1 mode and remote alarm and AIS patterns in E1 mode is detected and indicated. In T1 mode, the COMET integrates Yellow, Red, and AIS alarms as per industry specifications. In E1 mode, the COMET integrates Red and AIS alarms.

Performance monitoring with accumulation of CRC-6 errors, framing bit errors, line code violations, and loss of frame events is provided in T1 mode. In E1 mode, CRC-4 errors, far end block errors, framing bit errors, and line code violations are monitored and accumulated.

The COMET provides three receive HDLC controllers, each with a 128 byte FIFO, for the detection and termination of messages on the ESF data link (T1) or in the national use bits (E1). They can also terminate ISDN D channels and V5 C channels. These controllers can be directed to any arbitrary time slot in either T1 or E1 mode. In T1 mode, the COMET also detects the presence of in-band loop back codes and ESF bit oriented codes. Detection and optional debouncing of the 4-bit Sa-bit codewords defined in ITU-T G.704 and ETSI 300-233 is supported. An interrupt may be generated on any change of state of the Sa codewords.

Dual (transmit and receive) elastic stores for slip buffering and rate adaptation to backplane timing are provided. A signaling extractor that supports signaling debounce, signaling freezing, idle code substitution, digital milliwatt tone substitution, data inversion, and signaling bit fixing on a per-channel basis is provided. Receive side data and signaling trunk conditioning is also provided.

In T1 mode, the COMET generates framing for SF, ESF and T1DM (DDS) formats. In J1 mode, the COMET frames to a JT-G704 format. In E1 mode, the COMET generates framing for a basic G.704 E1 signal. The signaling multiframe alignment structure and the CRC multiframe structure may be optionally inserted. Framing can be optionally disabled.

Internal analog circuitry enables the direct transmission of long haul and short haul T1 and E1 compatible signals using a minimum of external components. Typically, only line protection, a transformer and an optional line termination resistor are required. Digitally programmable pulse shaping allows transmission of:

- DSX-1 compatible signals up to 655 feet from the cross-connect into 100 Ω twisted pair with integrated programmable pulse shaping.
- E1 short haul pulses into 120 ohm twisted pair or 75 ohm coaxial cable.
- E1 long haul pulses into 120 ohm twisted pair.
- Long haul DS-1 pulses into 100 Ω twisted pair with integrated support for LBO filtering as required by the FCC rules.

The programmable pulse shape which extends over 5 bit periods, allows customization of short haul and long haul line interface circuits to application requirements. Digital line inputs and outputs are provided for applications not requiring a physical T1 or E1 interface.

In the transmit path, the COMET supports signaling insertion, idle code substitution, digital milliwatt tone substitution, data inversion, and zero code suppression on a per-channel basis. Zero code suppression may be configured to Bell (bit 7), GTE, or DDS standards, and can also be disabled. Transmit side data and signaling trunk conditioning is also provided. Signaling bit transparency from the backplane may be enabled.

The COMET provides three transmit HDLC controllers, each with a 128 byte FIFO. These controllers may also be used for the transmission of messages on the ESF data link (T1) or national use bits (E1) and in any time slot. In T1 mode, the COMET can be configured to generate in-band loop back codes and ESF bit oriented codes. In E1 mode, transmission of the 4-bit Sa codewords defined in ITU-T G.704 and ETSI 300-233 is supported. These controllers can also be used to transmit ISDN D channel traffic and V5 C channel traffic at 64 kbit/s or portions of 64 kbit/s.

The COMET provides optional jitter attenuation in both the transmit and receive directions.

The COMET provides both a parallel microprocessor interface for controlling the operation of the device and serial PCM interfaces that allow backplane rates from 1.544 Mbit/s to 8.192 Mbit/s to be directly supported. Up to four COMET devices can be multiplexed on a byte-interleaved basis on a common bus with no additional arbitration logic. The COMET supports the Mitel ST® bus, AT&T CHI® and MVIP standards.

Additional COMET Documentation

A list of COMET documents is provided in table 2. Please contact PMC-Sierra for an updated list.

Document Number	Document Title
PMC-961230	COMET Short Form Datasheet
PMC-970605	COMET Technical Overview
PMC-970674	COMET Long Form Datasheet
PMC-980223	COMET Reference Design

Table 2: List of Available COMET Documentation

COMET FEATURE SET

- Monolithic device which integrates software selectable full-featured T1, E1 and J1 framers and T1, E1 and J1 short haul and long haul line interfaces.
- Meets or exceeds T1 and E1 shorthaul and longhaul network access specifications including ANSI T1.102, T1.403, T1.408, AT&T TR 62411, ITU-T G.703, G.704 as well as ETSI 300-011, TBR-12 and TBR-13.
- Provides encoding and decoding of B8ZS, HDB3 and AMI line codes.
- Provides receive equalization, clock recovery and line performance monitoring.
- Provides transmit jitter attenuation and digitally programmable long haul and short haul line build out.
- Provides on-board programmable binary sequence generators and detectors for error testing including support for patterns recommended in ITU-T O.151.
- Provides three full-featured HDLC controllers, each with 128-byte transmit and receive FIFO buffers.
- Automatically generates and transmits DS-1 performance report messages to ANSI T1.231and ANSI T1.408 specifications.
- Compatible with Mitel ST®-bus, AT&T CHI® and MVIP PCM backplanes, supporting rates of 1.544 Mbit/s, 2.048 Mbit/s, 4.096 Mbit/s, and 8.192 Mbit/s. Up to four COMET devices may be byte-interleaved on a single backplane with no external circuitry.
- Supports NxDS0 fractional bandwidth backplane.
- Provides an 8-bit microprocessor bus interface for configuration, control, and status monitoring.
- Uses line rate system clock.
- Provides a IEEE P1149.1 (JTAG) compliant test access port (TAP) and controller for boundary scan test.
- Implemented in a low power 5 V tolerant +3.3 V CMOS technology.
- Available in a high density 80-pin MQFP (14 mm by 14 mm) package.

- Provides a -40°C to +85°C Industrial temperature operating range.

Receiver section:

- Supports T1 signal reception for distances with up to 36 dB of cable attenuation (at 772 kHz).
- Supports E1 signal reception for distances with up to 43 dB of cable attenuation (at 1.024 MHz).
- Recovers clock and data using a digital phase locked loop for high jitter tolerance.
- Provides an alternative digital interface for applications without line interface units.
- Frames to ITU-T G.704 basic and CRC-4 multiframe formatted E1 signals. The framing procedures are consistent ITU-T G.706 specifications.
- Frames to DSX/DS-1 signals in D4, SF, ESF and SLC®96 formats.
- Frames to TTC JT-704 multiframe formatted J1 signals. Supports the alternate CRC-6 calculation for Japanese applications.
- Frames in the presence of and detects the “Japanese Yellow” alarm.
- Tolerates more than 0.3 UI peak-to-peak, high frequency jitter as required by AT&T TR 62411 and Bellcore TR-TSY-000170.
- Detects violations of the ANSI T1.403 12.5% pulse density rule over a moving 192-bit window.
- Provides loss of signal detection as per ITU-T G.775 and ANSI T1.231. Red, Yellow, and AIS alarm detection and integration are according to ANSI T1.231 specifications.
- Provides programmable in-band loopback activate and deactivate code detection.
- Supports line and path performance monitoring according to AT&T and ANSI specifications. Accumulators are provided for counting ESF CRC-6 errors, framing bit errors, line code violations and loss of frame or change of frame alignment events.
- Provides ESF bit-oriented code detection and an HDLC/LAPD interface for terminating the ESF facility data link.

- Supports polled or interrupt-driven servicing of the HDLC interface.
- Extracts the data link in ESF and T1DM (DDS) modes. Optionally extracts a datalink in the E1 national use bits.
- Extracts 4-bit codewords from the E1 national use bits as specified in ETS 300 233
- Extracts up to three HDLC links from arbitrary time slots to support the D-channel for ISDN Primary Rate Interfaces and the C-channels for V5.1/V5.2 interfaces.
- Detects the V5.2 link identification signal.
- Provides a two-frame elastic store buffer for backplane rate adaptation that performs controlled slips and indicates slip occurrence and direction.
- Provides DS-1 robbed bit signaling extraction, with optional data inversion, programmable idle code substitution, digital milliwatt code substitution, bit fixing, and two superframes of signaling debounce on a per-channel basis.
- Frames to the E1 signaling multiframe alignment when enabled and extracts channel associated signaling. Alternatively, a common channel signaling data link may be extracted from timeslot 16.
- Can be programmed to generate an interrupt on change of signaling state.
- Provides trunk conditioning which forces programmable trouble code substitution and signaling conditioning on all channels or on selected channels.
- Provides diagnostic, line loopbacks and per-DS0 line loopback.
- Provides an integral pattern detector that may be programmed to detect common pseudo-random sequences. The programmed sequence may be detected in the entire frame, or on an NxDS0 basis.
- Provides an integral pattern generator that may be programmed to generate common pseudo-random or repetitive sequences towards the backplane.
- Provides tristateable single-rail PCM and signaling data outputs for 1.544 Mbit/s, 2.048 Mbit/s, 4.096 Mbit/s or 8.192 Mbit/s backplane buses.

Transmitter section:

- Supports transfer of transmitted single rail PCM and signaling data from 1.544 Mbit/s, 2.048 Mbit/s, 4.096 Mbit/s or 8.192 Mbit/s backplane buses.
- Generates DSX-1 shorthaul and DS-1 longhaul pulses with programmable pulse shape compatible with AT&T, ANSI and ITU requirements.
- Generates E1 pulses compliant to G.703 recommendations.
- Provides a digitally programmable pulse shape extending up to 5 transmitted bit periods for custom long haul pulse shaping applications.
- Provides line outputs which are current limited and may be tristated for protection or in redundant applications.
- Provides an alternative digital interface for external line interface units.
- Provides a digital phase locked loop for generation of a low jitter transmit clock complying with all jitter attenuation, jitter transfer and residual jitter specifications of AT&T TR 62411 and ETSI TBR 12 and TBR 13.
- Provides a FIFO buffer for jitter attenuation and rate conversion in the transmit path.
- Provides a two-frame payload slip buffer to allow independent backplane and line timing.
- Provides an integral pattern generator that may be programmed to generate common pseudo-random or repetitive sequences. The programmed sequence may be inserted in the entire frame, or on an NxDS0 basis.
- Provides an integral pattern detector that may be programmed to detect common pseudo-random or repetitive sequences from the backplane.
- Transmits G704 basic and CRC-4 multiframe formatted E1 signals or D4, SF or ESF formatted DSX/DS-1 signals.
- Transmits TTC JT-G704 multiframe formatted J1 signals. Supports the alternate ESF CRC-6 calculation for Japanese applications.
- Transmits the “Japanese Yellow” alarm.
- Supports unframed mode and framing bit, CRC, or data link by-pass.

- Provides signaling insertion, programmable idle code substitution, digital milliwatt code substitution, and data inversion on a per channel basis.

- Provides trunk conditioning which forces programmable trouble code substitution and signaling conditioning on all channels or on selected channels.

- Provides minimum ones density through Bell (bit 7), GTE or DDS zero code suppression on a per channel basis.

- Detects violations of the ANSI T1.403 12.5% pulse density rule over a moving 192-bit window and optionally stuffs ones to maintain minimum ones density.

- Allows insertion of framed or unframed in-band loopback code sequences.

- Allows insertion of a data link in ESF or T1DM (DDS) DS-1 modes. Optionally inserts a datalink in the E1 national use bits.

- Supports 4-bit codeword insertion in the E1 national use bits as specified in ETS 300 233

- Inserts up to three HDLC links into arbitrary time slots to support the D-channel for ISDN Primary Rate Interfaces and the C-channels for V5.1/V5.2 interfaces.

- Supports transmission of the alarm indication signal (AIS) and the Yellow alarm signal. Supports “Japanese Yellow” alarm generation.

- Provides ESF bit-oriented code generation.

APPLICATION EXAMPLES

COMET is ideal for all T1/E1 framing and/or line interface requirements. These are typically found in the following applications:

- T1/E1/J1 Wireless Digital Loop Carriers (DLC's) and Cellular Base Stations
- T1/E1/J1 Internet Access Equipment
- T1/E1/J1 Channel Service Units (CSU)
- T1/E1/J1 Frame Relay Interfaces
- T1/E1/J1 ATM Interfaces
- T1/E1/J1 Multiplexers (CPE MUX)
- Digital Private Branch Exchanges (PBX)
- Digital Access Cross-Connect Systems (DACS) and Electronic DSX Cross-Connect Systems (EDSX)
- ISDN Primary Rate Interfaces (PRI)
- Test Equipment

Some examples of these applications are shown in the following figures. Figure 2 shows the PM4351 COMET used in a digital loop carrier application and illustrates the V5.1 interface that is standardized in ITU G.964.

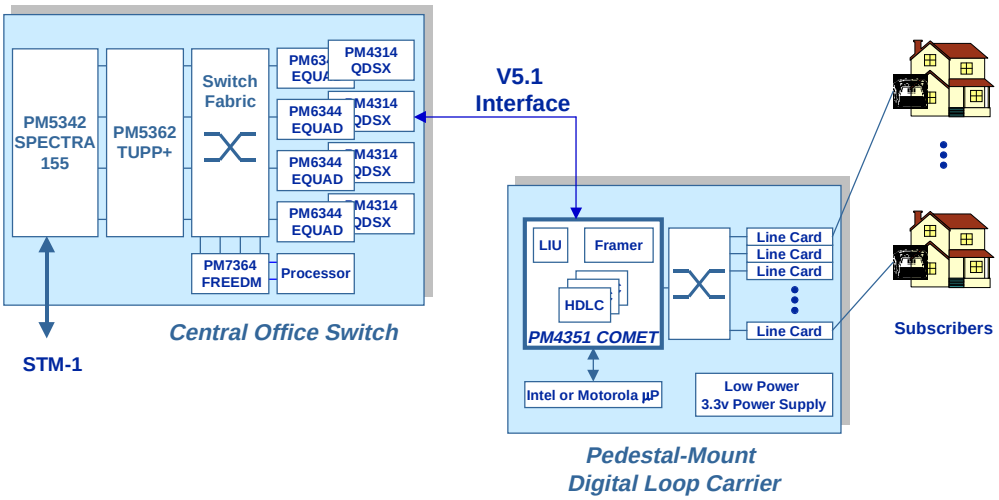

Figure 2: COMET Used for V5.1 Solutions

Figure 3 shows a base transceiver station that can be used in wireless applications throughout the world using the PM4351 COMET device with its software selectable T1, E1 and J1 characteristics.

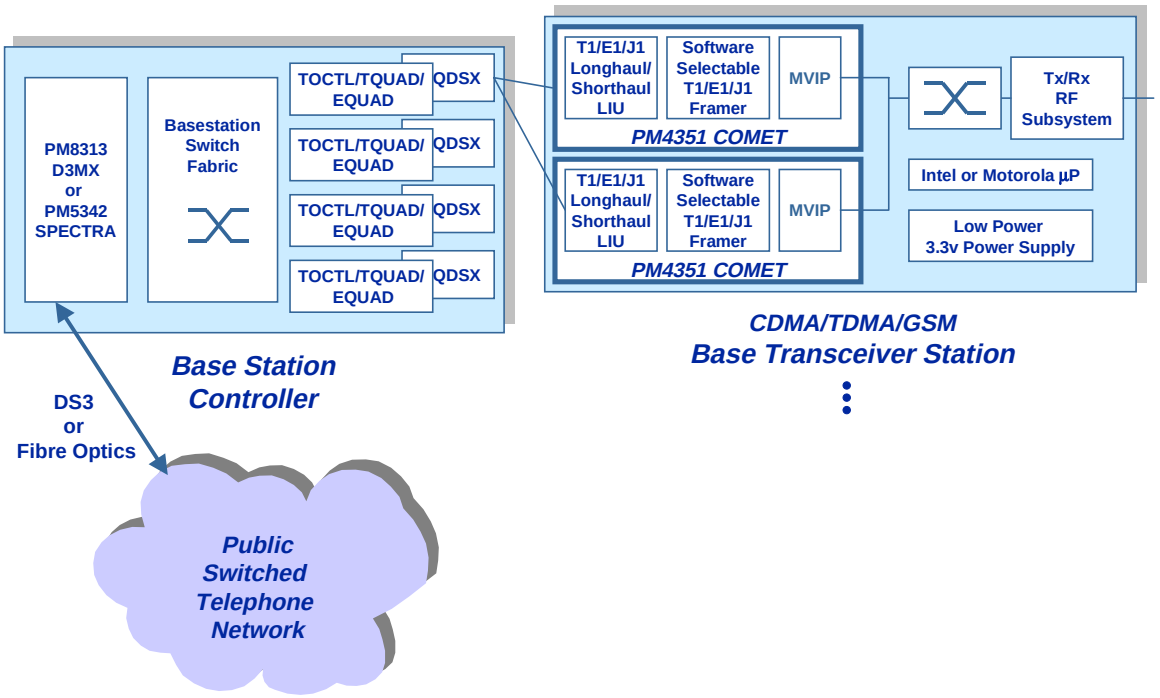

Figure 3: COMET Wireless Application

Figure 4 shows the PM4351 COMET device in a typical customer premise equipment (CPE) application – a Frame Relay Access Device. One of the requirements of such CPE applications is COMET's longhaul capability.

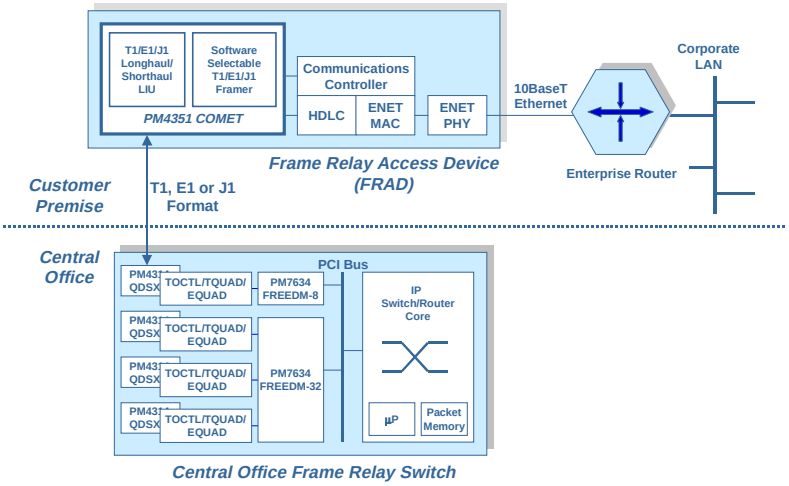

Figure 4: Frame Relay Access Device (FRAD) using COMET

COMET OPERATIONAL CHARACTERISTICS

The PM4351 COMET is an evolutionary product based largely on its successful predecessors, the PM4341A T1XC and the PM6341 E1XC. It not only fully supports the functionality of both the T1XC and the E1XC but has also implemented circuitry to meet all the latest T1 and E1 specifications from ANSI, ETSI, ITU and other standards organisations. In addition, forward thinking operational characteristics like 3.3 volt power supply requirements, crystal-less jitter attenuation, use of a line rate clock and IEEE 1149.1 JTAG boundary scan have been incorporated.

Specification Compliance

One of the primary design goals in the COMET development was compliance to all the latest T1 and E1 specifications. Particular attention was paid to the latest specifications from the European Telecommunications Standards Institute (ETSI). Two of the most relevant specifications that COMET complies to from this standards organisation are ETS 300 011 and ETS 300 233.

Particular attention was also paid to all of the relevant jitter attenuation and intrinsic jitter specifications. Two jitter attenuators are incorporated in the device, one in the transmit path and one in the receive path. The COMET meets all aspects of the TR62411, TBR12, TBR13, TBR4, and ETSI jitter specifications. Independent test results for jitter performance will also be available at time of sampling.

Backplane Flexibility

The backplane options of the COMET are fully flexibility enabling designers to meet many different requirements across many applications without any glue logic. In addition to the standard PCM interfaces, the backplane is functionally compatible with:

- MVIP, Mitel ST Bus, AT&T CHI Bus
- G.802 (T1 mapped into E1)

Compliance to these formats allows the backplane to support a byte-interleaved 4 x 2.048 MHz rate (up to 8.192 MHz). At the 4.096 and 8.192 MHz bus rates N COMETs can be multiplexed together ($N \leq 4$).

Features of the COMET backplane are:

- Each COMET can be assigned a number (0 to 3) in the bus which corresponds to a pre-defined slot on the bus (byte-interleaved).

- COMET automatically tri-states on the backplane during the interleaving process such that the bit streams can be processed on the TDM bus without any glue. The COMET backplane will default to tri-state to avoid bus contention during RESET.
- COMET has flexible clocking edges (rising or falling).
- The frame pulse can be programmed to any bit in the frame.
- COMET's NxDS0 modes operate at either 56 kbit/s or 64 kbit/s.
- Tx & Rx can be independently configured in timeslot assignments.
- T1 backplane format has optional inclusion of f-bit in NxDS0 mode.

Other miscellaneous features of the backplane are:

- In T1, f-bit in receive path can be forced high or low.
- The COMET can generate AIS (unframed all one's) in receive path which can be timed either to the receive line rate or to XCLK.
- The transmit frame pulse on the backplane can act as master or slave.
- The COMET can support two mappings of 1.544 MHz onto a 2.048 MHz backplane :
  - gap out fourth timeslot.
  - gap outside of first 24 timeslots.

Framer Operation

The COMET supports all the standard framing algorithms found in our existing T1 and E1 products. In T1 mode it will frame to T1DM, ESF, SF, and SLC®96 formats. It will also frame in the presence of an alternate G.704 SF Japanese yellow alarm. In E1 mode it will frame to G.704 E1 signals and CRC-4 multiframe alignment signals, and automatically performs the G.706 Annex B interworking procedure. AMI, HDB3 and B8ZS line codes are supported.

The last few years has seen the emergence of a homologation of various E1 requirements into a set of specifications released by the European Telecommunications Standards Institute (ETSI). COMET fully supports the framing requirements of these specifications. It supports, for instance, automatic interworking as per ETS 300 011. It also supports various national use bit functions such as:

- Extraction of four bit messages from ETS 300 233.
- Validation of those messages with the provision for an interrupt on change.
- Provision to process the HDLC packets on any combination of national use bits.

In addition to E1 specifications that have been released from ETSI, some newer E1 specifications have recently emerged from the International Telecommunications Union (ITU), G.764 and G.765, which specify V5.1 and V5.2 interfaces respectively for aggregation of E1 data streams. The COMET device is fully compliant to these

specifications, even when dealing with a V5.2 interface in an aggregation of multiple E1s. In this mode, the framer can detect the V5.2 link ID signal and provides a validation algorithm for detection of the steady-state condition of the link signal and an interrupt on change.
The COMET device also provides the following features:

- Has the ability to read current state of national use bits
- Supports RAI detection algorithm
- Includes I.431 alarm integration functions
- Generates interrupts for the CRC-4 multiframe pulse and the signaling multiframe pulse of basic the frame pulse for both Tx and Rx

The frame pulse of the COMET supports different configurations to allow flexibility across different applications. The receive sychronization (RSYNC) output is either the recovered clock or an 8 kHz signal. The 8 kHz signal is not affected by any change-of – frame events.

When BRFP is set to toggle every other frame, it is deterministic which frames contain the frame pulse. This means the ALTRFP mode of the BRFP output supports alignment to Ft vs. Fs bits in T1 and FAS vs. NFAS in E1. In particular, this supports extraction of the SLC®96 datalink, national use bits, etc. The frame pulse has the option to be forced low continuously for unframed mode.

Line Interface Operation

The line interface integrated in the COMET is compliant to all DSX-1, DS-1, E1 and J1 longhaul and shorthaul specifications. It meets the relevant specifications in the following areas:

- Pulse shapes to the various T1 and E1 standards.
- Input and output return loss
- Impedance to ground specifications
- Longitudinal balance specifications
- EMC and EMI specifications (FCC, CISPR, & CENELEC)
- Surge protection requirements.
- Short circuit current limiting specifications.

A full list of specifications the COMET complies to is listed in the COMET datasheet (PMC 970674) and includes G.703, T1.102, T1.403, T1.408, TR 62411, G.703, G.823, G.775, ETS 300 011 and ETS 300 166.

In T1 mode, the longhaul receiver meets the sensitivity requirements of T1.403 (36 dB or better). In E1 mode, COMET has sensitivity is 43 dB or better with the ability to equalize for

cross-talk. To date there is not a standard for E1 longhaul but with this ability to automatically equalize for various cable characteristics, the COMET should exceed any such requirements that arise. Cable models that COMET has been designed to equalize for include PIC, ABAM and Pulp in both T1 and E1 applications.

The COMET will have the ability to tri-state the outputs and will support all the required line coding functions including AMI, B8ZS and HDB3. It will support all the digital loss of signal functions that have been specified including the alternate LOS algorithms. The COMET device also complies to analog loss of signal requirements found in G.775. The LIU functions in the device can be bypassed allowing the COMET to function as a digital-only framer for such applications as HDSL modems.

HDLC Functionality

The COMET device contains three internal HDLC controllers to allow full flexibility to comply to all the requirements for both E1 and T1. These three HDLC channels fully support not only requirements for ESF datalinks, ISDN D-channels and V5.1/V5.2 C-channels, but also allow the freedom to support HDLC applications that may vary from the standard use of such channels. Each HDLC controller is trainable on any given timeslot, or N*8kbit/s portion thereof, and has a 128-byte FIFO in each of the transmit and receive datalinks. The HDLC channels are also trainable on any combination of the National Use Bits datalink. It should be noted that these bits occur only in NFAS frames.

Loopback Modes

The COMET device supports four loopback modes:

1. Line Loopback (Remote)
2. Local Loopback (Diagnostic)
3. Payload Loopback
4. Per-DS0 Loopback

Line loopback is defined as the Rx line interface looped back to the Tx line interface through CDRC and TJAT (refer to the block diagram in the PMC-970624 COMET datasheet). This loopback mode has an option for Rx AIS towards backplane and operates with the data stream in both dual rail and single rail configuration. Line coding will be preserved and TJAT can be bypassed and CDRC either enabled or disabled.

Local loopback loops the data stream from the TJAT block back through the CDRC block. The data stream is not passed through any of the analog line interface. This loopback mode has an option for Tx AIS towards the backplane and also operates with the data stream in both dual rail and single rail configuration.

Payload loopback is routed from Rx FRMR through ELST into XBAS/TRAN (similar to the Line loopback mode but the data stream does not go through BTIF or BRIF). This mode allows more depth into system test and fault isolation by further isolating the interface from the line. This mode loops the full payload back independent of backplane options. The Tx Timing can come from the Tx backplane or the Rx line timing. This loopback mode also has an option for Rx AIS towards the backplane.

Per-DS0 Loopback is the same as Payload Loopback except that any group of DS0s can be looped back.

Performance Monitoring and Alarm Integration

Performance monitoring with accumulation of CRC-6 errors, framing bit errors, line code violations, and loss of frame events is provided in T1 mode. In E1 mode, CRC-4 errors, far end block errors, framing bit errors, and line code violations are monitored and accumulated. In addition to specification compliance, the characteristics of the internal performance monitor has been enhanced to optionally automate the reporting structure to reduce the burden placed on the microprocessor.

The COMET device has the ability to automatically generate the performance report messages each second in compliance with the ANSI T1.231, T1.403 and T1.408 standards for T1 ESF applications. Alternatively, a one second interrupt is provided to allow an interrupt to the microprocessor to gather the performance monitor data. The performance report can only be transmitted if TDPR #1 is configured to insert the ESF Facility Data Link and the PREN bit of the TDPR #1 Configuration register is logic 1. The performance report takes precedence over incompletely written packets, but it does not pre-empt packets already being transmitted. In E1 mode, the automatic response complies to ETSI framing procedures and CRC interworking.

The alarm integration block detects the presence of Yellow, Red, and AIS Carrier Fail Alarms (CFA) in SF, T1DM, SLC®96, or ESF formats. The alarm detection and integration is compatible with the specifications defined in Bell Pub 43801, TA-TSY-000278, TR-TSY-000008, ANSI T1.403-1993, and TR-TSY-000191. Alarm detection and validation for SLC®96 is handled the same as SF framing format.

Pseudo-Random Test Pattern

The Pseudo Random Sequence Generator/Processor (PRGD) is a software programmable test pattern generator, receiver and analyzer. Two types of test patterns (pseudo random and repetitive) conform to ITU-T O.151, O.152, O.153, and O.161 standards.

The PRGD can be programmed to generate pseudo random patterns with lengths up to 32 bits or any user programmable bit pattern from 1 to 32 bits in length. In addition, the PRGD can insert single bit errors or a bit error rate between 10^{-1} to 10^{-7}.

The PRGD can be programmed to check for the generated pseudo random pattern. The PRGD can perform an auto-synchronization to the expected pattern and accumulates the total number of bits received and the total number of bit errors in two 32-bit counters. The counters accumulate either over intervals defined by writes to the Pattern Detector registers, upon writes to the Global PMON Update Register or automatically once a second. When an accumulation is forced, then the holding registers are updated, and the counters reset to begin accumulating for the next interval. The counters are reset in such a way that no events are missed. The data is then available in the holding registers until the next accumulation.

Signaling

Channel associated signaling (CAS) extraction from an E1 signaling multiframe or from SF, SLC®96 and ESF T1 formats is provided by the COMET device. This signaling information is not only accessible through the microprocessor registers, but is also brought out in hardware via external pins. On a per channel basis, any change of signaling provides an interrupt to allow the microprocessor to gather the new signaling data. The microprocessor can, of course, still poll the device for the data.

In T1 mode, the signaling data can be aligned either after the signaling extractor or before the T1 basic transmitter. This provides superframe alignment between the backplane and either the received DS-1 stream or the transmit DS-1 stream. The internal signaling alignment block maintains signaling bit integrity across superframe boundaries. One superframe or signaling-multiframe of signal freezing on the occurrence of slips is provided. Three superframes worth of signal buffering ensure that there is a greater than 95% probability that the signaling bits are frozen in the correct state for a 50% ones density out-of-frame condition, as specified in TR-TSY-000170 and BELL PUB 43801. With signaling debounce enabled, the per-channel signaling state must be in the same state for 2 superframes before appearing on the serial output stream.

SUMMARY OF THE COMET FEATURES AND BENEFITS

With the use of the PM4351 COMET device many cost-saving benefits are realized. Table 3 summarizes some of these key benefits.

Table 3: Summary of the features and benefits of the COMET

Feature	Benefit
Software switchable T1, E1 and J1 operation - provides full support of Japanese Yellow alarm and alternate CRC-6 calculation to TTC JT-704 - Fully supports G.704 and CRC-4 multiframe formatted signals - Frames to DSX/DS-1 signals in D4, SF, ESF and SLC®96 formats	Supports a single software selectable 3.3V design, particularly useful in developing common wireless systems for T1, E1 and J1 applications, resulting in reduced time to market and improved economies of scale.
Integral line interface unit (LIU) for use in longhaul/shorthaul T1/E1/J1 applications	A single, software selectable T1, E1 or J1 LIU design meeting the specifications for all line length specification increases flexibility and reduces both system cost and inventory costs.
Low power 5V tolerant 3.3V power supply	There is an aggressive movement to 3.3V technology in all application areas. COMET is the first device with the ability to eliminate 5V power supplies from newer T1/E1/J1 designs.
Meets -40° to +85°C industrial temperature operation range	The ability to support industrial temperature operation is critical for products used in outside plant applications or where wide temperature variances may occur.
Supports three integral HDLC controllers, each with 128-byte FIFOs	Three HDLC controllers not only support T1 ESF and T1DM data links, E1 national use bits and ISDN D-channels, but also provide full compliance to the V5 interfaces found in ITU G.964 and G.965 - *without any additional circuitry*.

Feature	Benefit
Provides “crystal-less” jitter attenuation Using a line rate clock as a reference	The ability to use a clean line rate clock from the backplane eliminates the need for crystals, reducing system costs and increasing reliability.
Provides diagnostic, line loopbacks and per-DS0 line loopback	The ability to provide various loopbacks improves diagnostic capabilities for fault isolation. Per-DS0 loopbacks allows fault diagnosis and line monitoring *without having to take the line out of service*.
Provides a pseudo-random bit sequence (PRBS) bit-error rate tester at line rate or N*DS0 rates	PRBS provides the capability of measuring the quality of the line without the use of expensive test equipment. PRBS at N*DS0 rates allows line monitoring *without having to take the line out of service.*
Slip buffers and jitter attenuators in both the transmit and receive direction	Provides a flexible backplane interface with more timing options, reducing both external circuitry and system costs.
Provides an IEEE P1149.1 JTAG test port	JTAG provides for internal input and output testing, reducing manufacturing costs.

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