

T1 Framer

Features

- Monolithic T1 Framing Device
- CS62180B Supports SF(D4[®]), T1DM, ESF and SLC-96[®] Framing Formats
- CS62180B Contains Updated AIS and Carrier Loss Detection Criteria
- CS62180B is Pin Compatible with DS2180A, and DS2180

General Description

The CS62180B is a monolithic CMOS device which encodes and decodes T1 framing formats. The device supports bit-seven and B8ZS zero suppression, and bit-robbled signaling. Clear channel mode can be selected on a per channel basis.

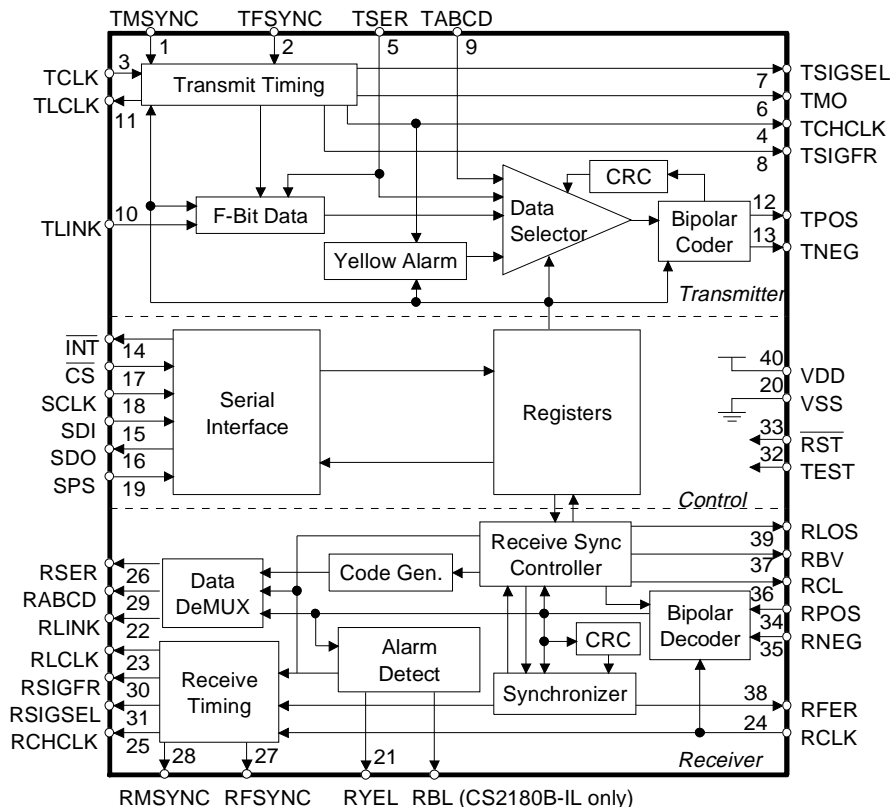
The serial interface has been enhanced to allow the CS62180B to share a chip select signal and register address space with the CS61535A, CS61574A, and CS61575 Line Interface Units.

Applications

- T1 Line Cards
- ISDN Primary Rate Line Cards

Ordering Information:

CS62180B-IL 44 Pin PLCC -40 to 85 °C



ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Min	Typ	Max	Units
DC Supply (Referenced to GND)	V _{DD}	-	-	6.0	V
Input voltage, any pin (Referenced to GND)	V _{IN}	-1.0	-	+7	V
Input Current, any pin (Note 1)	I _{IN}	-10	-	+10	mA
Ambient Operating Temperature	T _A	-40	-	85	°C
Storage Temperature	T _{STG}	-65	-	150	°C
Soldering Temperature for 10 s.	-	-	-	260	°C

Notes: 1. Transient current of up to 100 mA will not cause SCR latch-up.

WARNING: Operation at or beyond these limits may result in permanent damage to the device. Normal operation is not guaranteed at these extremes.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Units
DC Voltage	V _{DD}	4.5	5.0	5.5	V
Supply Current (Notes 2 and 3)	I _{DD}	-	3	10	mA
Ambient Operating Temperature	T _A	-40	25	85	°C
Power Consumption (Notes 2 and 3)	P _C	-	15	85	mW

Notes: 2. TCLK = RCLK = 1.544 MHz. If RCLK is static and RST is high, I_{DD} will typically be 1.0 mA.

3. Outputs open.

DIGITAL CHARACTERISTICS (T_A = -40 to 85 °C; V_{DD} = 5.0 V ±10%; GND = 0 V)

Parameter	Symbol	Min	Typ	Max	Units
High-Level Input Voltage (Note 4)	V _{IH}	2.0	-	V _{DD} +0.3	V
Low-Level Input Voltage	H _{IL}	-0.3	-	+0.8	V
High-level Output Voltage (Note 5)	V _{OH}	V _{DD} - 1.0	-	-	V
Low-Level Output Voltage (I _{OUT} = 1.6 mA)	V _{OL}	-	-	0.4	V
Output Current @ 2.4 V (Note 6)	I _{OH}	-	-	-1	mA
Output Current @ 0.4 V (Note 7)	I _{OL}	+4	-	-	mA
Input Leakage Current	I _{IL}	-	-	1	μA
Output Leakage Current (Note 8)	I _{LO}	-	-	1	μA
Input Capacitance	C _{IN}	-	-	5	pF
Output Capacitance	C _{OUT}	-	-	7	pF

Notes: 4. V_{IH} (min) = 2.2 V for V_{DD} = 5.25 to 5.5 V and T_A > 70 °C.

5. I_{OUT} = -100 μA. This guarantees the ability to drive one TTL load (V_{OH} = 2.4 V @ I_{OUT} = -40 μA).

6. All outputs except INT, which is open drain.

7. All outputs.

8. Applies to SDO when tristated.

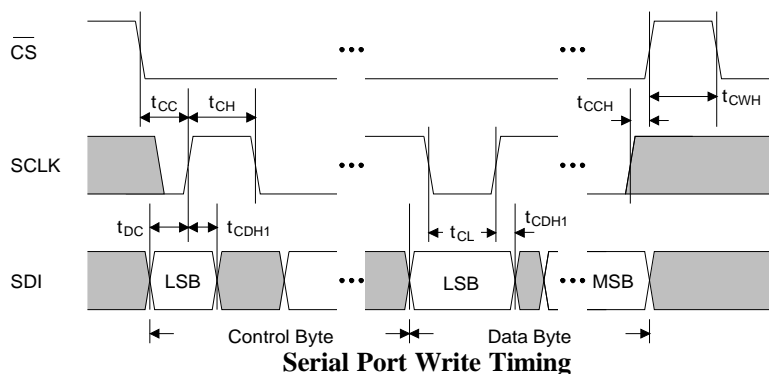
SWITCHING CHARACTERISTICS - SERIAL PORT

($T_A = -40$ to $85\text{ }^\circ\text{C}$; $V_{DD} = 5V \pm 10\%$; $V_{IH} = 2.0V$; $V_{IL} = 0.8V$; Maximum input rise & fall times of 10 ns)

Parameter	Symbol	Min	Typ	Max	Units
SDI to SCLK Setup	t_{DC}	50	-	-	ns
SCLK to SDI Hold	t_{CDH1}	50	-	-	ns
SCLK Low Time	t_{CL}	250	-	-	ns
SCLK High Time	t_{CH}	250	-	-	ns
SCLK Rise & Fall Times (Note 9)	t_R, t_F	-	-	500	ns
CS to SCLK Set up	t_{CC}	50	-	-	ns
SCLK to CS Hold	t_{CCH}	50	-	-	ns
CS Inactive Time	t_{CWH}	250	-	-	ns
SCLK to SDO Valid (Note 9)	t_{CDV}	-	-	200	ns
SCLK Rising to MSB of SDO Hold (Note 10)	t_{CDH2}	25	-	-	ns
CS to SDO High-Z	t_{CDZ}	-	-	75	ns

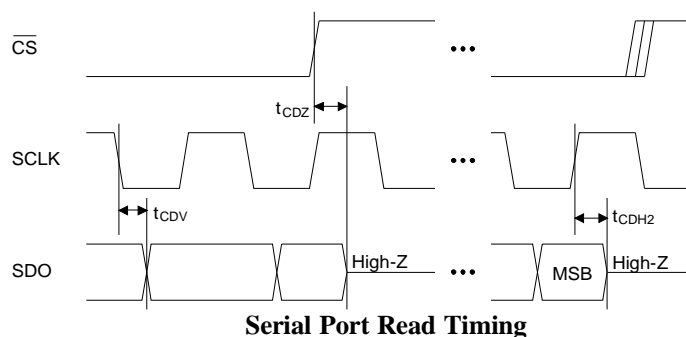
Notes: 9. Output load capacitance = 100 pF.

10. SDO goes High-Z after rising edge of SCLK for MSB, regardless of the state of \overline{CS} .



11. In the CS62180B, data is latched on the rising edge of SCLK.

12. Shaded regions indicate *don't care* states.



13. Serial port write must precede a port read to provide address information.

14. SDO will go High-Z: 1) if \overline{CS} returns high at anytime; 2) after outputting MSB.

SWITCHING CHARACTERISTICS - TRANSMITTER
 $(T_A = -40 \text{ to } 85 \text{ }^\circ\text{C}; V_{DD} = 5V \pm 10\%; V_{IH} = 2.0V; V_{IL} = 0.8V; \text{Maximum input rise \& fall times of } 10 \text{ ns})$

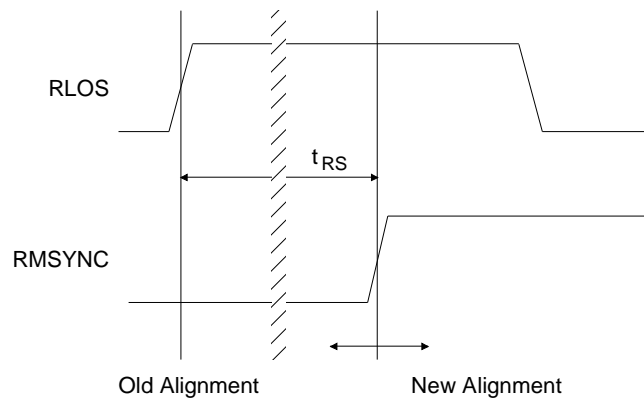
Parameter	Symbol	Min	Typ	Max	Units
TCLK Period	t_P	250	648	-	ns
TCLK Pulse Width	t_{WL}, t_{WH}	125	324	-	ns
TCLK Rise & Fall Times	t_F, t_R	-	20	-	ns
TSER, TABCD, TLINK Setup to TCLK Falling	t_{STD}	50	-	-	ns
TSER, TABCD, TLINK Hold from TCLK Falling	t_{HTD}	50	-	-	ns
TFSYNC, TMSYNC Setup to TCLK Rising	t_{STS}	-125	-	125	ns
TFSYNC, TMSYNC Pulse Width	t_{TSP}	100	-	-	ns
Propagation Delays					
TFSYNC to TMO, TSIGSEL, TSIGFR, TLCLK	t_{PTS}	-	-	75	ns
TCLK Rising to TCHCLK	t_{PTCH}	-	-	75	ns

SWITCHING CHARACTERISTICS - RECEIVER
 $(T_A = -40 \text{ to } 85 \text{ }^\circ\text{C}; V_{DD} = 5V \pm 10\%; V_{IH} = 2.0V; V_{IL} = 0.8V; \text{Maximum input rise \& fall times of } 10 \text{ ns})$

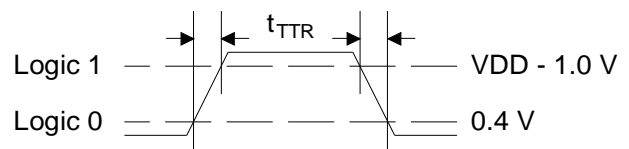
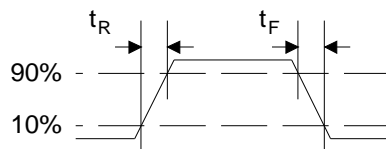
Parameter	Symbol	Min	Typ	Max	Units
Transition Time, All Outputs	t_{TTR}	-	-	20	ns
RCLK Period	t_P	250	648	-	ns
RCLK Pulse Width	t_{WL}, t_{WH}	100	324	-	ns
RCLK Rise & Fall Times	t_F, t_R	-	20	-	ns
RPOS, RNEG Setup to RCLK Falling	t_{SRD}	50	-	-	ns
RPOS, RNEG Hold to RCLK Falling	t_{HRD}	50	-	-	ns
Minimum RST Pulse Width on System Power Up or Restart	t_{RST}	1	-	-	μs
Propagation Delays					
RCLK to RMSYNC, RFSYNC, RSIGSEL, RSIGFR, RLCLK, RCHCLK	t_{PRS}	-	-	75	ns
RCLK to RSER, RABCD, RLINK	t_{PRD}	-	-	75	ns
RCLK to RYEL, RCL, RFER, RLOS, RBV	t_{PRA}	-	-	75	ns
Average Reframe Time (Notes 15 and 16)					
193S	RCR.2 = 0 RCR.2 = 1	t_{RS}	-	3.75	ms
			-	7.25	ms
193E	RCR.2 = 0 RCR.2 = 1	t_{RS}	-	7.5	ms
			-	14.5	ms
T1DM	t_{RS}	-	750	-	μs
SLC-96 [®]	t_{RS}	-	6.0	-	ms

Notes: 15. Average reframe time is the time from the rising edge of RLOS until the rising edge of RMSYNC which updates the receiver output timing.

16. With error free data.

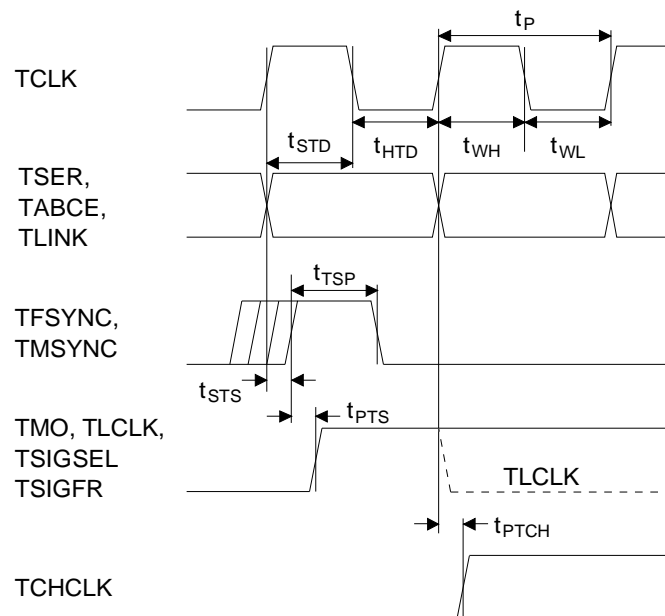


Reframe Timing.



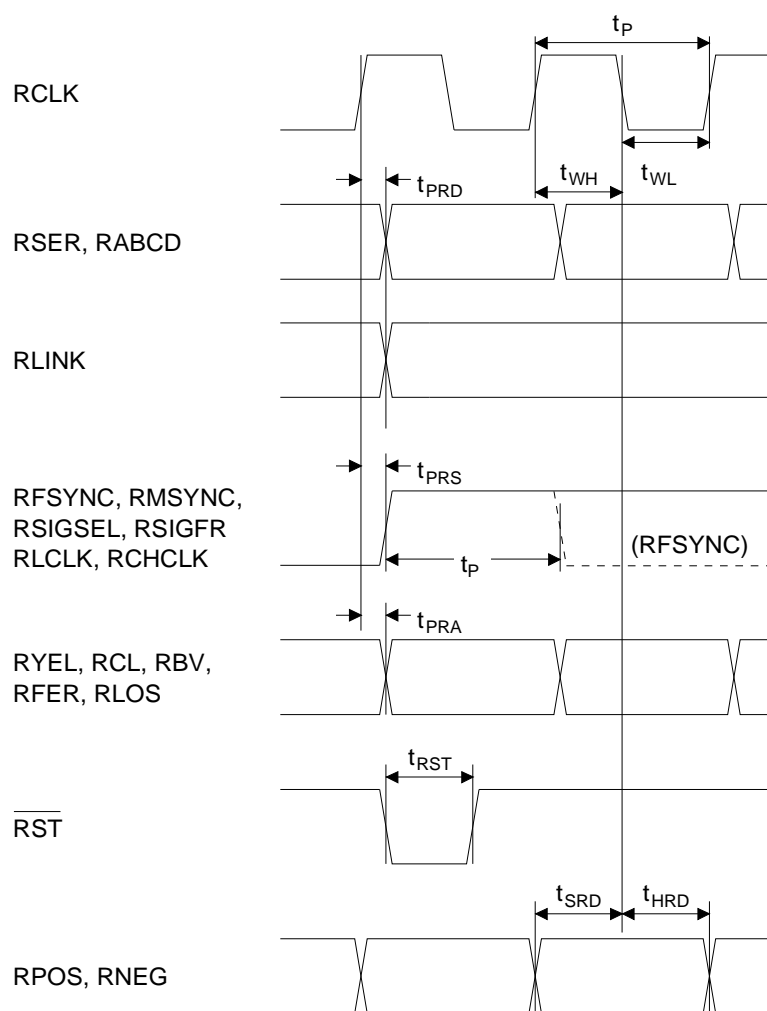
Rise and Fall Times for RCLK & TCLK.

Transition Times for All Receiver Outputs.



Note: TMO, TLCLK, TSIGSEL and TSIGFR are generally coincident with the rising edge of TCLK.

Transmitter Timing.



Receiver Timing.

GENERAL DESCRIPTION

The CS62180B is a monolithic CMOS circuit that encodes and decodes T1 (1.544 MHz) digital transmission formats for SF(D4[®]) (193S: 12 frames per superframe), ESF (193E: 24 frames per superframe), SLC-96[®] (SLC96: 72 frames per superframe) and DDS[®] T1DM (T1DM: 12 frames per superframe plus unique channel number 24) framing formats.

The CS62180B provides full support for individual clear channels, bit-robbled signaling, alarm detection and generation, zero suppression, and idle channels. An overview of the 193S, 193E, SLC-96[®] and T1DM framing formats is provided in the Applications Section. The device provides independent transmit and receive sides, with a shared serial controller interface for use with a host processor. A hardware mode is also available for operation independent of a host controller. The SLC-96[®] and T1DM formats can be selected only via the CS62180B serial controller interface.

The serial interface provides access to 16 on-chip control and status registers. The control registers are used to configure global parameters such as the framing format and zero suppression mode, as well as transmitter or receiver specific parameters. A hardware interrupt is provided, which can be configured via interrupt mask and status registers to signal any combination of alarm conditions.

Transmitter commands include enabling external framing bit, CRC, or S-bit insertion, declaring individual DS0 channels clear and/or idle, and enabling yellow and blue alarm modes in different formats. The receiver can be configured to replace individual incoming channels with idle or digital milliwatt (μ -LAW) codes, and a large variety of resync options are provided. Bipolar violations, CRC and framing errors are automat-

ically counted in another set of registers which can be arbitrarily reset via the serial interface to provide variable saturation points. The Receive Status Register (RSR) provides data on all error and alarm conditions, and in conjunction with the Receive Interrupt Mask Register (RIMR), can be configured to signal an interrupt on $\overline{\text{INT}}$ in response to any alarm condition.

Note: there are two different naming conventions in practice concerning the numbering of bits within a word. The most common convention in EE and Computer Science is to number the bits as 0 - 7, starting from the LSB. This is the convention used throughout this data sheet when referring to register bits. A different convention is used in the telecom literature when referring to the bits in a digital transmission stream. In this case, they are numbered 1 - 8, *starting from the MSB*. This convention is maintained in this data sheet whenever referring to the bits of a DS0 channel word.

CS62180B ENHANCEMENTS

Enhancements made in the CS62180B include the following. The SLC-96[®] and DDS[®] T1DM framing formats are supported in host mode. The AIS (Blue Code) detection is made compatible with TR-TSY-000191 requirements (unframed all ones), and a received-blue-alarm output pin is added to the PLCC package. The Receive Carrier Loss detection criteria is made compatible with the industry standard requirement of 175 ± 75 zeros. The receiver line code decoder is now universal. The decoder will automatically decode either AMI or B8ZS. The CS62180B B8ZS control option controls only the transmitter's encoder. The universal decoder simplifies the provisioning of B8ZS in the network. Lastly, the serial control interface was simplified. When writing data bytes on SDI, it is no longer necessary to have SDI valid for both the rising and falling edges of SCLK. Rather, SDI need be stable only on the rising edge of SCLK.

HOST MODE

Serial Interface

For applications in which the device is to interface with a host processor, the CS62180B can be configured to run in host mode by tying the Serial Port Select pin (SPS) to the +5V supply (VDD). This allows access to the serial port, providing a large number of configuration options via the 16 on-chip control and status registers.

Serial read/write timing, controlled by SCLK, is entirely independent of the transmit and receive timing. This allows the host microcontroller to monitor the status register and counters, modify configuration options, and issue commands asynchronously with the T1 system. A serial timing overview is provided in Figure 1.

All data transfers are initiated by setting Chip Select (\overline{CS}) low. Any read or write to the serial port is initiated by writing an 8-bit command word. The command word consists of 4 separate fields (see Figure 2). When reading from the port, data is output on the falling edge of SCLK, and held until the next falling edge.

All data is written to and read from the port LSB first. When writing to the port, SDI input data is sampled on the rising edge of SCLK.

D0 (LSB) is the R/\overline{W} field, and specifies whether the current operation is to be a read or a write: 1 = read, 0 = write. The second 4 bits (D1 - D4) contain the address field. Written LSB first, they specify which of the sixteen registers to access. D5 (Device Select) should be set to zero when addressing the CS62180B. However, if the CS62180B shares the same serial interface lines with a Cirrus TI Line Interface (see Figure 3), D5 will be set to a "1" when addressing the Line Interface device. The CS62180B will ignore any read/write commands with a "1" in D5,

allowing both parts to share \overline{CS} .

D6 is reserved, and must be set to 0 for normal operation.

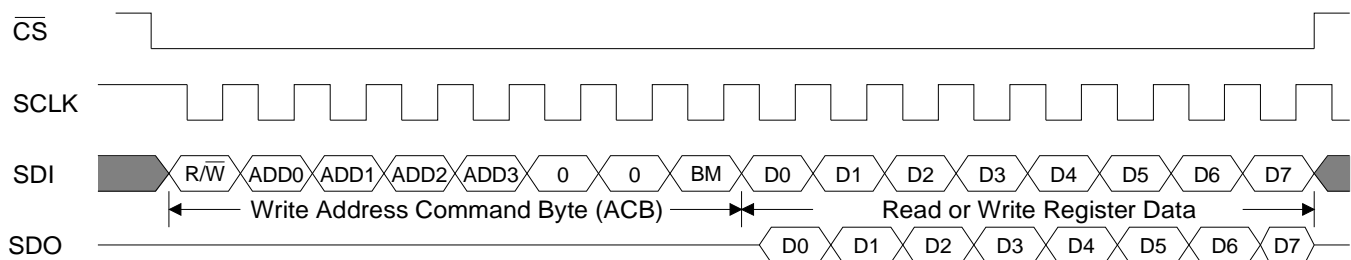


Figure 1. Serial Read/Write Timing

7	(MSB)	6	5	4	3	2	1	0	(LSB)							
BM		0		DS		ADD3		ADD2		ADD1		ADD0		R/W		
0	Individual	Set to "0"		0	CS62180B		(MSB) Register Address Field (LSB)								0	Write
1	Burst			1	Crystal										1	Read

Figure 2. Address Command Byte (ACB)

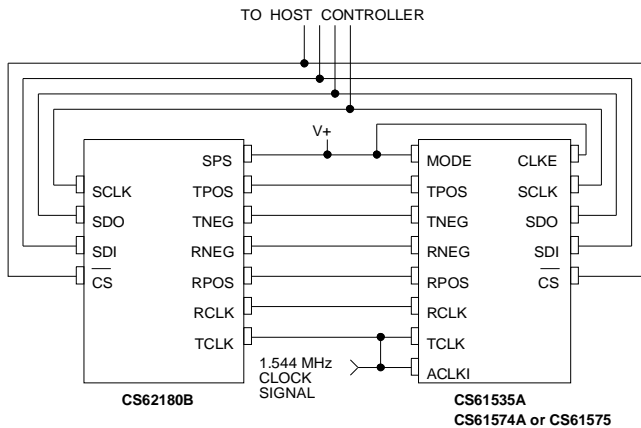


Figure 3. Interfacing to a Crystal T1 LIU.

D7 (MSB) specifies burst mode if set to 1. When using burst mode, the address field of the command word must be "0000", any other value will invalidate the command, and the CS62180B will simply ignore it. This effectively means that the command for a burst write is 80 (hex) and a burst read is 81 (hex).

Burst mode allows the sixteen registers to be consecutively read or written. Writing all registers allows fast initialization at power-up or system reset. (Note that the Receiver Status Register, RSR, is read-only, so a write during burst mode will have no effect.) When using burst mode, registers are read or written in address order, 0000 (RSR) to 1111 (RMR3). Burst mode ends on the first rising edge of \overline{CS} . See Table 1 for a complete list of the CS62180B on-chip registers.

ADDR	REGISTER NAME AND DESCRIPTION		(T) TRANSMIT (R) RECEIVE
0000	RSR	Receive Status Register - A read only register which reports all active receiver alarm conditions.	R
0001	RIMR	Receive Interrupt Mask Register - A mask which allows selection of individual alarm conditions for generation of hardware interrupt.	R
0010	BVCR	Bipolar Violation Count Register - A bipolar violation alarm is generated after this 8 bit counter surpasses it's user definable limit.	R
0011	ECR	Error Count Register - Two separate 4 bit counters, which record OOF errors, and frame bit or CRC errors. Like BVCR, each can be preset to a saturation point.	R
0100	CCR	Common Control Register - Selects global configuration options, such as: framing mode, zero suppression, or loopback.	T/R
0101	RCR	Receive Control Register - Selects receiver specific options, such as the resync algorithm or insertion of digital milliwatt codes.	R
0110	TCR	Transmit Control Register - Selects transmitter specific options, such as alarm generation, clear or idle channel enable, and external S-bit or CRC insertion.	T
0111 1000 1001	TIR1 TIR2 TIR3	Transmit Idle Registers - Each bit of the three TIR registers corresponds to an individual DS0 channel. When set, that channel is replaced with an idle code.	T
1010 1011 1100	TTR1 TTR2 TTR3	Transmit Transparent Registers - Each bit corresponds to a DS0 channel. When set, that signaling and B7 zero suppression is disabled for that channel.	T
1101 1110 1111	RMR1 RMR2 RMR3	Receive Mark Registers - Each bit corresponds to a DS0 channel. When set, the channel data is replaced with an idle or digital milliwatt code.	R

Table 1. On-Chip Registers

7	(MSB)	6		5		4		3		2		1		0	(LSB)
FM1		FRSR2		EYELMD		FM		YELS		B8ZS		B7		LPBK	
See Fig. 4b		0	B8ZS	0	FDL	See Fig. 4b		0	Bit 2	0	Disable	0	Transparent	0	Normal
		1	COFA	1	Bit 2			1	S-bit	1	Enable	1	B7 Stuffing	1	Loopback

Figure 4a. Common Control Register (CCR)

Common Control Register

The Common Control Register (CCR) determines global operating characteristics common to both the transmitter and receiver. It currently provides for selection of the framing mode (193S, 193E, SLC-96[®] or T1DM), the format of yellow alarms, the zero suppression format (B7 or B8ZS), loopback operation, and control of output to RSR.2.

See Figure 4a for an overview of the CCR.

Loopback

CCR.0: LPBK

Setting LPBK (CCR.0) to "1" puts the CS62180B into loopback mode.

While in loopback, the TPOS/TNEG and TCLK outputs are internally rerouted directly to the RPOS/RNEG and RCLK inputs, while an unframed, all "1's" stream is output on the TPOS/TNEG pins. All operating modes, except blue alarm transmission, remain functional during loopback. Note that enabling loopback will usually invoke an out-of-frame (OOF) error until the receiver can resync to the new framing alignment. See the section on the Receive Control Register (RCR) for a description of the resync options available.

Zero Suppression

CCR.1: B7

CCR.2: B8ZS

B7 and B8ZS select the zero suppression mode. Setting B7 (CCR.1) to "1" will enable bit 7 zero substitution. This causes any channel word

with all zeros to be transmitted with bit 7 (2nd LSB) forced to a "1". B7 mode only affects the transmitter, the receiver does not decode B7. Note that bit 7 stuffing can be disabled on an individual channel basis for clear channel transmission via the Transmit Transparent Registers TTR1 - TTR3 (see description of transmitter which follows).

B8ZS coding operates independent of channel boundaries, and is transparent to all other functions. When using B8ZS, the final transmission stream is examined before transmission, and any eight consecutive zeros will be replaced with a B8ZS code word before transmission.

If B8ZS (CCR.2) is set to a "1", B8ZS zero substitution will be enabled in the transmitter. Independent of the setting of CCR.2, any incoming B8ZS codes will be intercepted by the receiver and replaced with 8 zeros before being processed by the rest of the receive side. The receiver is always capable of receiving either AMI or B8ZS encoded data.

Note: For T1DM, CCR.1 and CCR.2 should be set to a "0" since DDS[®] equipment assures a 1-in-8 one's density.

193S Yellow Alarm Format

CCR.3: YELS

The CS62180B supports two different yellow alarm formats for 193S framing. Whichever format is selected, it will be used by both the transmit side, for yellow alarm generation, and the receive side, for alarm detection.

When using 193S framing, a "0" in YELS (CCR.3) will encode/decode yellow alarms as a "0" in bit 2 (2nd MSB) of all channels. Setting CCR.3 to "1" will cause yellow alarms to be encoded/decoded as a "1" is the S-bit position of frame 12.

Note: For T1DM and SLC-96[®], CCR.3 should be set to a "0".

Framing Format

CCR.4: FM

CCR.7: FM1

As shown in Figure 4b, CCR.4 and CCR.7 select the framing format.

See the text for the Transmit Control Register (TCR) and Receive Control Register (RCR) for further information on the particular options available for each framing format.

7	4	
FM1	FM	Format Selected
0	0	193S (D4)
0	1	193E (ESF)
1	0	SLC-96
1	1	T1DM

Figure 4b. Framing Format Selection

Note: Changing the framing mode does not force the receiver to resynchronize. A forced resync should be done to insure correct receiver synchronization after the framing mode is changed.

193E Yellow Alarm Format

CCR.5: EYELMD

The CS62180B supports two different yellow alarm formats for 193E framing. Whichever format is selected, it will be used by both the transmit side, for yellow alarm generation, and the receive side, for alarm detection.

When using 193E framing, a "0" in EYELMD (CCR.5) will encode/decode yellow alarms as a repeating sequence of 00FF (hex) on the 4 kHz facility data link (FDL). If CCR.5 is set, 193E yellow alarms will be handled as a "0" in bit 2 (2nd MSB) of all channels.

Control of RSR.2

CCR.6: FRSR2

CCR.6 allows you to change the meaning of D2 in the Receive Status Register (RSR.2). If CCR.6 is clear, RSR.2 will report the detection of B8ZS codes in the received T1 input. If CCR.6 is set to a "1", RSR.2 will be used to signal a Change of Frame Alignment (COFA). A COFA is reported when the last receiver resync resulted in a change of framing or multiframing alignment. Refer to the description of the Receive Status Register for further information.

TRANSMITTER

The transmit sides of the CS62180B have three types of inputs, the clock, sync, and data inputs. Control is handled through the serial port in host mode, and through the mode control pins in hardware mode (see the last section for a description of hardware mode operation).

Input Data

None of the data inputs are buffered, so the data at each input must be available at the appropriate time for the CS62180B to multiplex into the output stream. All inputs are sampled on the falling edge of TCLK. The delay from input to output is 10 TCLK cycles.

NRZ data for DS0 channels is input on TSER. Framing bits (F_T or FPS bits) and CRC data may either be generated internally or supplied by the host system. If this data is to be externally supplied, it must be inserted into the DS0 input stream at the appropriate frames and input via TSER.

S-bits may be generated internally, or externally provided via TLINK. FDL bits are always provided externally on TLINK. Bit-robbed signaling, when enabled, is always sampled at TABCD. The CS62180B muxes in data from these 3 sources (TSER, TLINK, and TABCD) automatically depending on the transmitter configuration.

Output Data

The completed T1 data stream, ready for line transmission, is output on TPOS/TNEG. For operation with a line interface which is transparent to line coding, the output can be set to dual-unipolar format by clearing bit 7 of the Transmit Control Register (TCR.7). TCR.7 should be set to a "1" for operation with a line interface which provides AMI or B8ZS coding. In this configura-

tion, the data will be output on TPOS in NRZ format, and TNEG will remain low. When operating in hardware mode, output defaults to the dual-unipolar format. TPOS and TNEG may not be tied together, so an external OR gate is recommended if NRZ output is required while in hardware mode.

Frame/Multiframe Synchronization

The CS62180B maintain timing for frame and multiframe alignment with internal counters driven by TCLK. The timing signals generated by those counters are output on TCHCLK, TMO, TSIGSEL, TSIGFR, and TLCLK. These counters determine when the CS62180B will insert F-bits and sample external signaling data. The frame and multiframe counters can be reset independently via TMSYNC and TFSYNC. If left to run without a sync pulse, the CS62180B will arbitrarily choose a framing alignment.

A low to high transition of TMSYNC, occurring near the rising edge of TCLK, resets the CS62180B's counters to mark the bit-period concurrent with the next falling edge of TCLK as the F-bit of the first frame of a new superframe. All other timing will be set to match the superframe alignment automatically. TMSYNC may be pulsed once at start-up and left low, or left running in sync with superframe timing.

A low to high transition of TFSYNC, occurring near the rising edge of TCLK, resets the CS62180B's counters to mark the bit-period concurrent with the next falling edge of TCLK as the F-bit of a new frame. If TMSYNC is used to set superframe alignment, frame alignment will also be set, and TFSYNC may be tied low. There is, of course, no harm in using both TMSYNC and TFSYNC together, as TFSYNC has no effect on multiframe alignment if it is in sync. If, however, TFSYNC is used out of sync with TMSYNC, the superframe align-

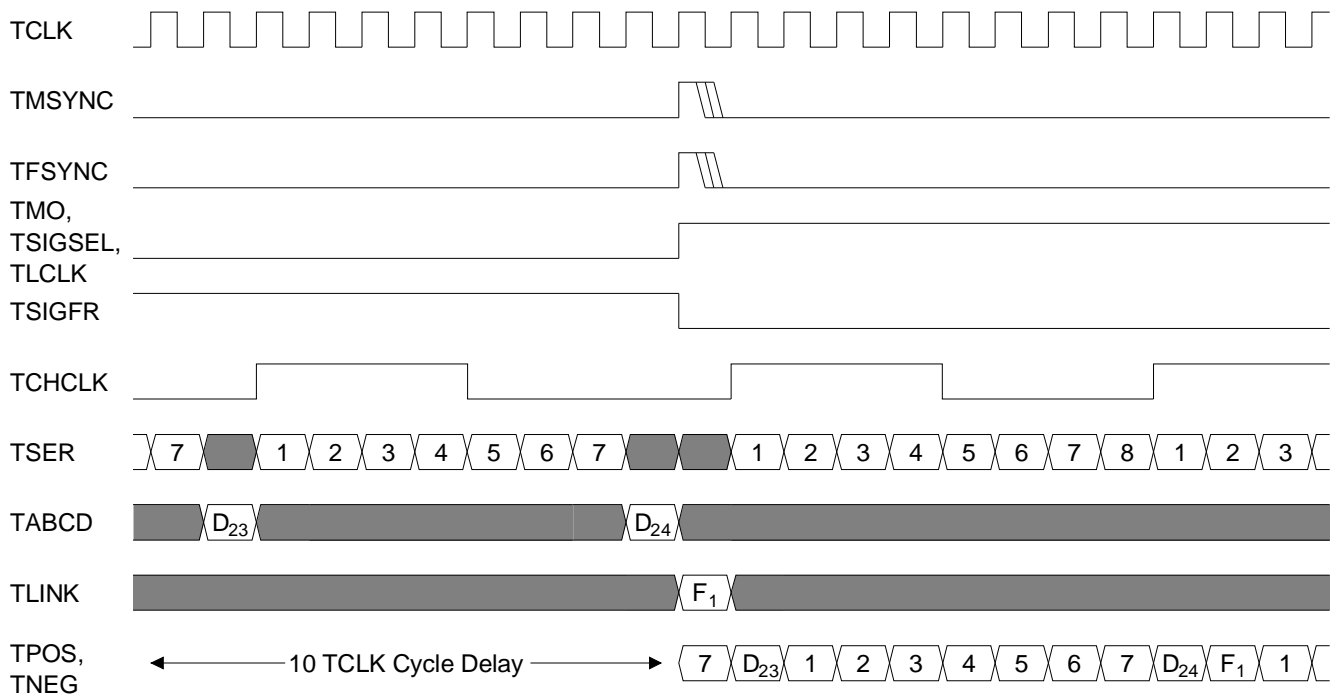


Figure 5. Bit Level Transmit Timing (193E, signaling enabled)

ment will be moved forward by the least number of bits necessary to be in alignment with the new frame boundary.

Figure 5 shows the bit-level timing (with signaling enabled). Note that the delay from input to output is 10 TCLK cycles. TCHCLK transitions high at the beginning of every DS0 channel (50% duty cycle).

193S Timing

Frame and multiframe timing is output on TCHCLK, TMO, TSIGSEL, TSIGFR, and TLCLK. TMO transitions high at the beginning of every superframe (50% duty cycle). TSIGFR goes high during signaling frames (every 6 frames). TLCLK is a 4 kHz clock for the TLINK input. TLCLK goes high during odd frames (external S-bit insertion).

TSIGSEL runs at twice the frequency of TMO. Logical combination of TMO and TSIGSEL provides a way to distinguish the 6th and 12th frames for external multiplexing of signaling

channels. TMO is high for channel A, and low for B. See Figure 6 for timing diagram.

193E Timing

Frame and multiframe timing is output on TCHCLK, TMO, TSIGSEL, TSIGFR, and TLCLK. TMO transitions high at the beginning of every superframe (50% duty cycle). TSIGFR goes high during signaling frames (every 6 frames). TLCLK is a 4 kHz clock for the TLINK input. TLCLK goes high during odd frames (FDL insertion).

TSIGSEL runs at twice the frequency of TMO. Logical combination of TMO and TSIGSEL provides a way to distinguish the 6th, 12th, 18th, and 24th frames for external multiplexing of signaling channels. TMO is high for channels A and B, and TSIGSEL is high for channels A and C. See Figure 7 for timing diagram.

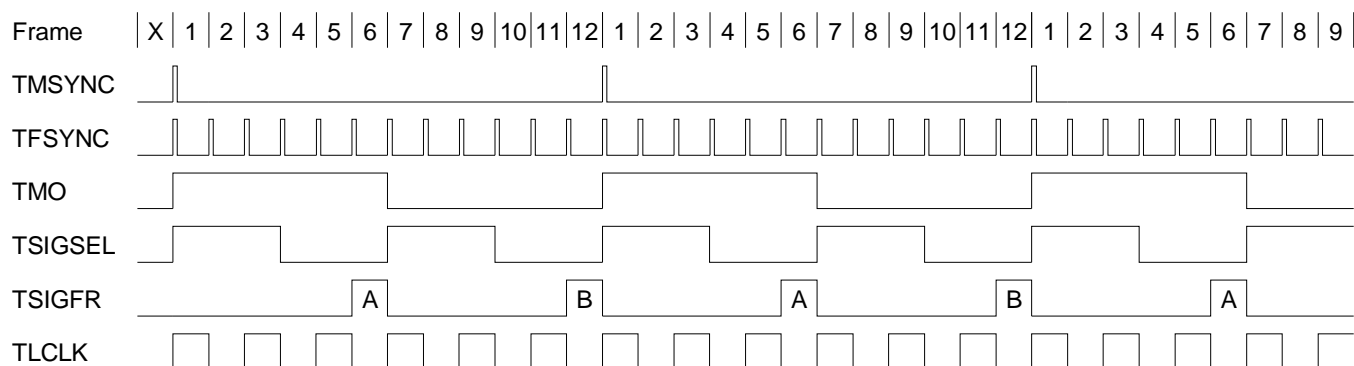


Figure 6. 193S Multiframe Transmit Timing

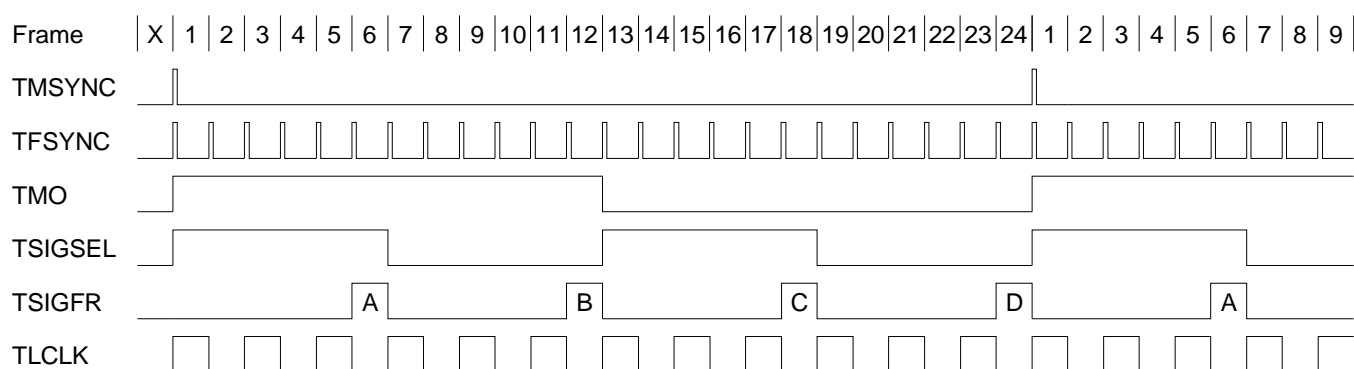


Figure 7. 193E Multiframe Transmit Timing

SLC-96[®] Timing

Figure A6 of the Application Section, shows the SLC-96[®] superframe structure. Note that in Figure A6, the first C bit (C1) resides in frame 12. A low to high transition of TMSYNC identifies Frame 1 of Figure A6.

Frame and multiframe timing is output on TCHCLK, TMO, TSIGSEL, TSIGFR and TLCLK. TSIGSEL can be used to identify the location of the DL bits. The TSIGSEL output is high during frames 58 to 11, and is low during frames 12 to 57. When TSIGSEL is low, the CS62180B accepts DL bits on TLINK at a 4 kHz rate. The DL bits which are input on

TLINK are: C1-C11, DC, DC, DC, M1-M3, A1, A2, S1-S4. "DC" signifies "don't care" bits. The DC-bit positions correspond to the spoiler bits. The CS62180B internally generates the spoiler bits. The data input on TLINK in the DC position is ignored by the CS62180B. TLCLK is a 4 kHz clock for the TLINK input. TLCLK goes high during odd frames.

TMO transitions high at the beginning of every 12th frame. TSIGFR goes high during signaling frames (every 6 frames). The rising edge of TMO identifies the 6th frame, and the falling edge of TMO identifies the 12th frame for external multiplexing of signaling channels. See Figure 8 for timing diagram.

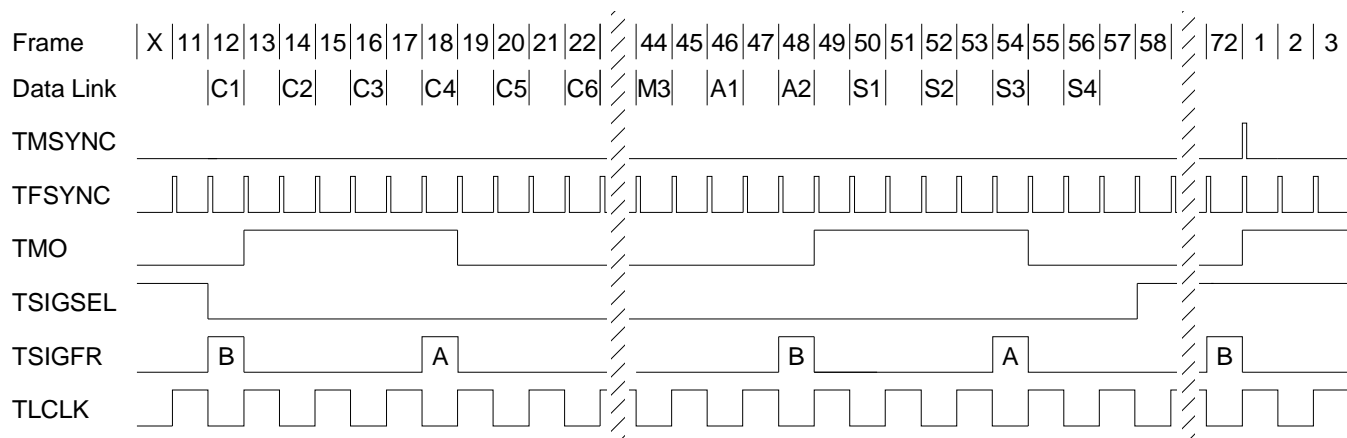


Figure 8. SLC-96® Multiframe Transmit Timing

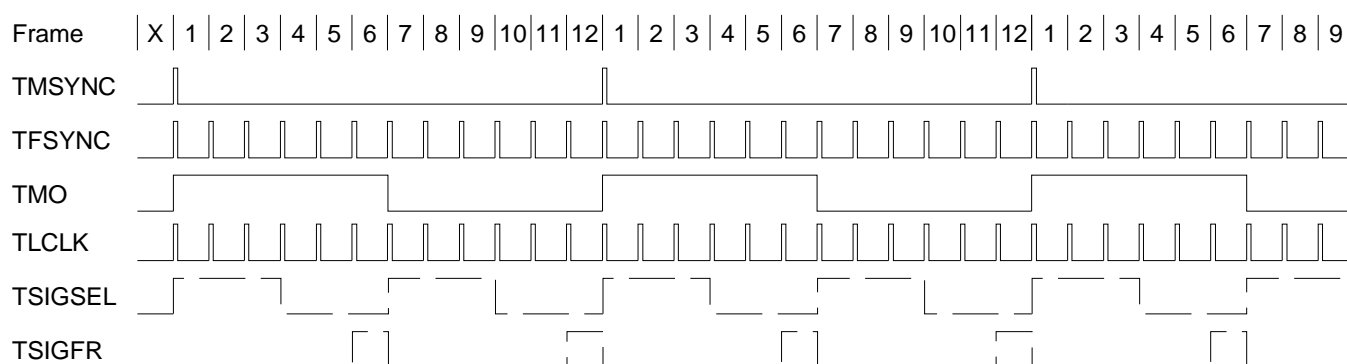


Figure 9. T1DM Multiframe Transmit Timing

T1DM Timing

Frame and multiframe timing is output on TCHCLK, TMO, and TLCLK. TMO transitions high at the beginning of every superframe (50% duty cycle). TSIGFR goes high during signaling frames (every 6 frames).

The channel 24 data link is input on TLINK using TLCLK. TLCLK is a 8 kHz clock with a duty cycle of 1 bit period high per frame. When TLCLK is high, TLINK will be sampled on the falling edge of TCLK. See Figure 9 and "Switching Characteristics - Transmitter" for timing diagrams.

TSIGSEL and TSIGFR serve no purpose in the T1DM mode and can be ignored. However, TSIGSEL and TSIGFR operate as in 193S mode.

7	(MSB)	6		5		4		3		2		1		0	(LSB)
ODF		TFPT		TCP		RBSE		TIS		193SI		TBL		TYEL	
0	Bipolar	0	Internal	0	Internal	0	Disabled	0	7F (Hex)	0	Internal	0	Normal	0	Normal
1	NRZ	1	External	1	External	1	Enabled	1	FF (Hex)	1	External	1	Blue Alarm	1	Yel. Alarm

Figure10. Transmit Control Register (TCR)

Transmitter Control Register (TCR)

When in host mode, there are a number of options available for transmitter configuration which can be enabled via the Transmit Control Register (TCR), Transmit Transparent Registers (TTR1 - TTR3), and Transmit Idle Registers (TIR1 - TIR3). Serial read and write operations to access these registers are explained in the *Serial Interface* section above. When operating in hardware mode, all control bits in the TCR default to "0" (except TCR.4, which defaults to "1" to enable bit-robbled signaling), and dynamic control is limited to the mode control pins as described under hardware mode below.

The TCR provides control to enable bit-robbled signaling, external framing bit, CRC, or S-bit insertion, and yellow and blue alarm modes. It also provides for two different idle code formats, and selection of bipolar or NRZ output. Figure 10 shows an overview of the Transmit Control Register.

Transmit Yellow Alarm

TCR.0: TYEL

Setting TYEL (TCR.0) to a "1" causes the CS62180B to automatically generate and transmit a yellow alarm in the appropriate format. In 193S mode the yellow alarm format used will be determined by the setting of CCR.3. In 193E mode, the yellow alarm format will be determined by the setting of CCR.5. See Common Control Register, above, for description of the available yellow alarm formats for 193S and 193E modes. In SLC-96[®] mode, the CS62180B does not generate the yellow alarm code. rather, the user transmits the

SLC-96[®] yellow alarm via the data link. In T1DM mode, the yellow alarm is transmitted in bit 5 of channel 24 (and CCR.3 should be set to a "0"). Clearing TCR.0 disables yellow alarm transmission.

Transmit Blue Alarm

TCR.1: TBL

Setting TBL (TCR.1) to a "1" generates a blue alarm; an unframed sequence of all "1's". If a framed, all "1's" signal is required, an FF (hex) idle code may be output on all channels via appropriate settings of TCR.3 and the TIR registers (see Transmit Idle Code Select below). Blue alarm (Alarm Indication Signal, or AIS) overrides all other transmission data, and a blue alarm is automatically output during loopback. Clearing TCR.1 disables blue alarm transmission.

193S, SLC-96[®] and T1DM S-bit Insertion

TCR.2: 193SI

TCR.2 is applicable to 193S, SLC-96[®] and T1DM modes, but not to the 193E mode.

In the 193S and T1DM modes, setting 193SI (TCR.2) to a "1" allows the S-bit (all even F-bits) to be externally supplied via TLINK. When TCR.2 is clear, the S-bit will be internally generated.

In the SLC-96[®] mode, setting 193SI (TCR.2) to a "1" allows the S-bit (selected even F-bits) to be externally supplied via TLINK, and the user must input all Fs, spoiler and DL bits. When TCR.2 is clear, the CS62180B generates the SLC-96[®] spoiler bits and Fs bits, and the user

inputs all other DL bits on TLINK using TLCLK.

Note: When using internal S-bit generation (TCR.2 = 0) in conjunction with external FT bit insertion (TCR.6 = 1), the CS62180B will logically 'OR' the value at TSER with the internally generated value. This means that the data on TSER during S-bit periods should always be "0" to avoid corrupting the generated Fs pattern.

Transmit Idle Code Select

TCR.3: TIS

Individual DS0 channels can be replaced with idle codes by setting the corresponding bits in the Transmit Idle Registers (TIR1 - TIR3) described below. TIS (TCR.3) selects which of two codes to use. A "0" in TCR.3 will cause a 7F (hex) to be inserted into the channels specified in the TIR. Setting TCR.3 to a "1" will select an FF (hex) code. By asserting all 24 channels idle in the TIR, this setting can be used to generate a "framed" blue alarm. Whichever mode is selected, bit-robbed signaling will still effect idle channels unless they are programmed clear (see *Transmit Transparent Registers*, below).

Robbed Bit Signaling Enable

TCR.4: RBSE

A "0" in RBSE (TCR.4) will disable bit-robbed signaling. Setting TCR.4 to a "1" will enable signaling in all channels. In this mode, data on TABCD is inserted into the LSB of all DS0 channels during signaling frames. For mixed voice and data transmission, individual DS0 channels can be programmed clear by setting the corresponding bits in the Transmit Transparent Registers (TTR1 - TTR3) described below.

CRC Pass-through

TCR.5: TCP

In 193E framing mode, the CRC bits (F-bit of frames 2, 6, 10, 14, 18, and 22) may be either generated internally, or supplied by the user. Clearing TCP (TCR.5) causes the CS62180B to generate and insert the CRC bits automatically. If TCR.5 is set to a "1", data for the CRC channel may be externally supplied. When using this mode, CRC bits are sampled from TSER, and must be externally multiplexed into the DS0 channel data at the F-bit times of CRC frames.

FT/FPS Pass Through

TCR.6: TFPT

When TFPT (TCR.6) is clear, the framing bits for 193S, T1DM and SLC-96[®] (FT), or 193E (FPS) are generated internally and automatically inserted into the outgoing data stream. Setting TCR.6 to a "1" allows the framing bits to be externally provided. When using this mode, framing bits are sampled from TSER, and must be externally multiplexed into the DS0 channel data at the F-bit times of the appropriate frames. See note under TCR.2, above.

Output Data Format

TCR.7: ODF

ODF (TCR.7) allows the format of the output data at TPOS/TNEG to be set to either dual-unipolar or NRZ format. Clearing TCR.7 selects for dual-unipolar format on TPOS/TNEG. Setting TCR.7 to a "1" causes data to be output on TPOS in NRZ format, and TNEG is held low. When operating in hardware mode, output defaults to the dual-unipolar format. TPOS and TNEG may not be tied together, so an external OR gate is recommended if NRZ is required while in hardware mode.

	7 (MSB)	6	5	4	3	2	1	0 (LSB)
TTR1	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1
TTR2	CH16	CH15	CH14	CH13	CH12	CH11	CH10	CH9
TTR3	CH24	CH23	CH22	CH21	CH20	CH19	CH18	CH17

"0" = Normal "1" = Corresponding DS0 Channel is Transparent. (Not signaling or B7 Insertion.)

Figure11. Transmit Transparent Registers (TTR1 - TTR3)

	7 (MSB)	6	5	4	3	2	1	0 (LSB)
TIR1	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1
TIR2	CH16	CH15	CH14	CH13	CH12	CH11	CH10	CH9
TIR3	CH24	CH23	CH22	CH21	CH20	CH19	CH18	CH17

"0" = Normal "1" = Corresponding DS0 Channel is Replaced with Idle Code. (See TCR.3)

Figure 12. Transmit Idle Registers (TIR1 - TIR3)

Transmit Transparent Registers (TTR)

The Transmit Transparent Registers allow individual DS0 channels to be programmed clear, disabling robbed bit signaling and B7 zero suppression for that channel (if selected, B8ZS is unaffected by transparent channels). There are 3 TTR registers: TTR1, TTR2, and TTR3. Each bit in the TTR registers corresponds to a DS0 channel: TTR1.0 = channel 1, TTR1.7 = channel 8, TTR2.7 = channel 16, etc. A channel is programmed clear by setting the bit which corresponds to that channel in the appropriate TTR register. See Figure 11.

Transmit Idle Registers (TIR)

By setting the appropriate bits in the Transmit Idle Registers, individual DS0 channels can be replaced with the idle code selected via TCR.3 (see above). If the idle channel is not also programmed clear (via TTR1 - TTR3), the code may be corrupted during signaling frames if robbed bit signaling is enabled (TCR.4 = 1). There are 3 TIR registers: TIR1, TIR2, and TIR3. Each bit in the TIR registers corresponds to a DS0 channel: TIR1.0 = channel 1, TIR1.7 = channel 8, TIR2.7 = channel 16, etc. A channel is programmed idle by setting the bit which corresponds to that channel in the appropriate TIR register. See Figure 12.

Transmission Insertion Hierarchy

Figures 13a - 13c give an overview of the decision hierarchy which determines the final composition of the output stream. It shows the various control options as inputs into decision branches of the flow chart, and the order in which the various optional signals are muxed into the final data stream.

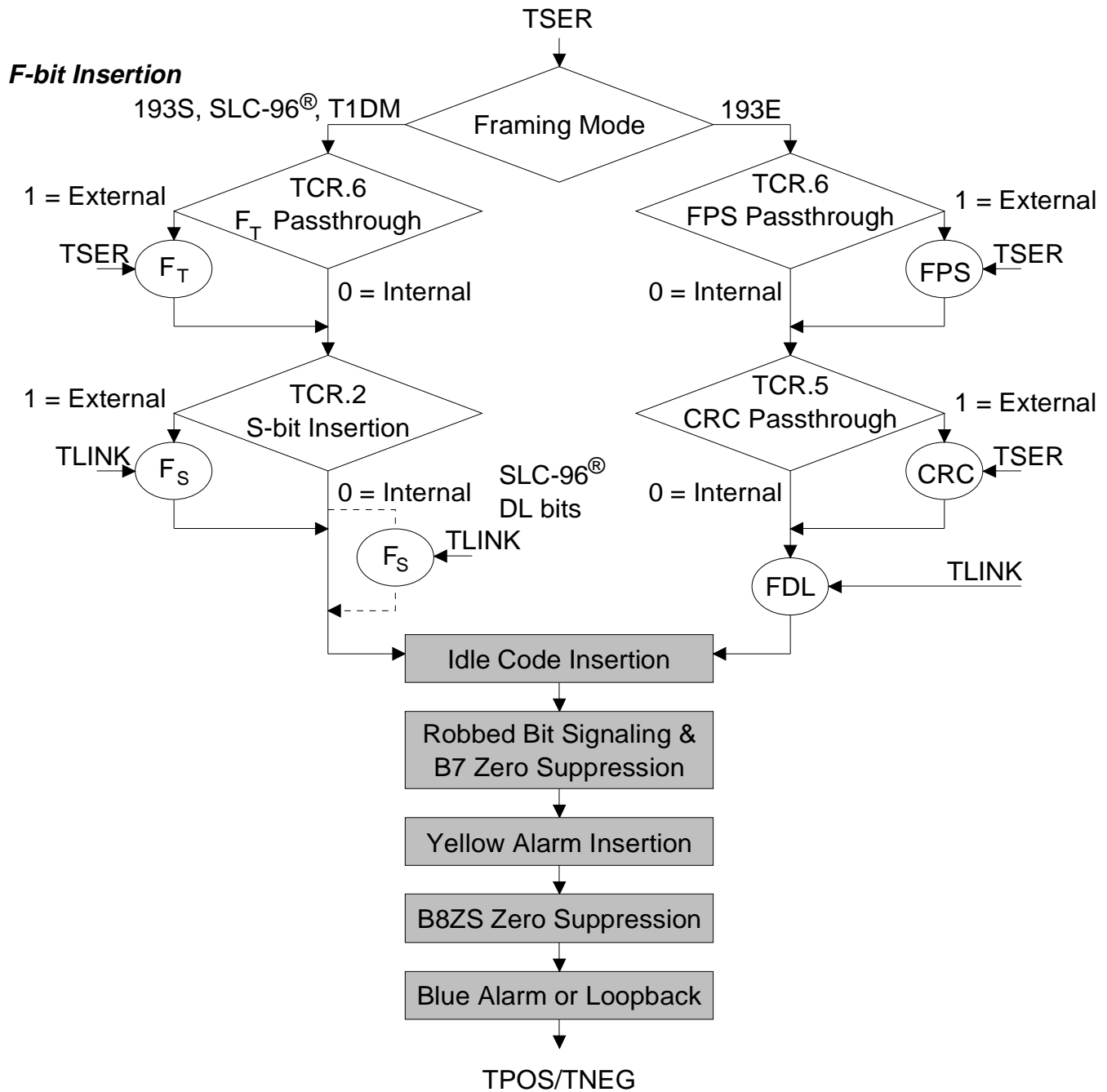


Figure 13a. Transmit Insertion Hierarchy: Framing Bits

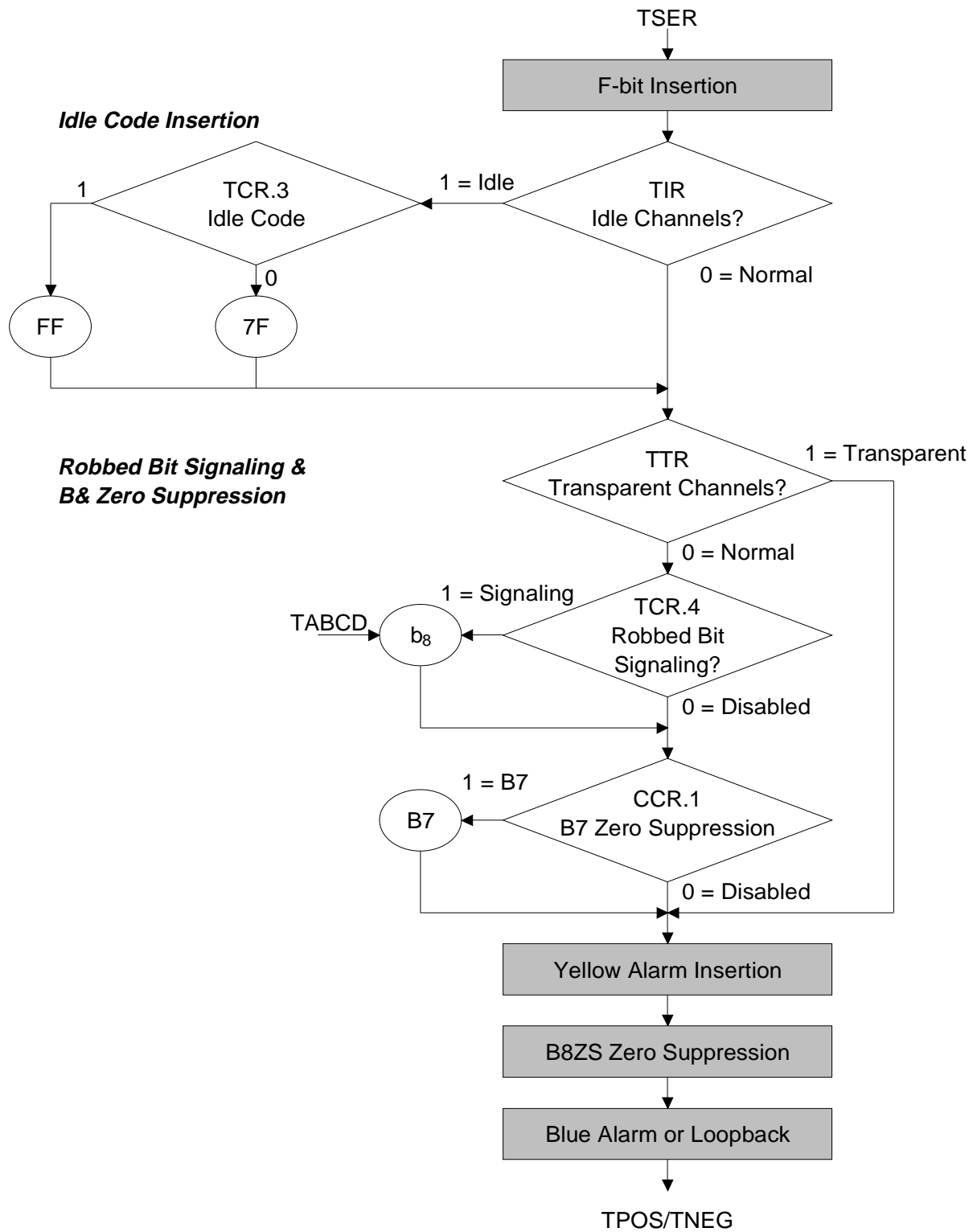


Figure 13b. Transmit Insertion Hierarchy: Idle Codes, Signaling, and B7

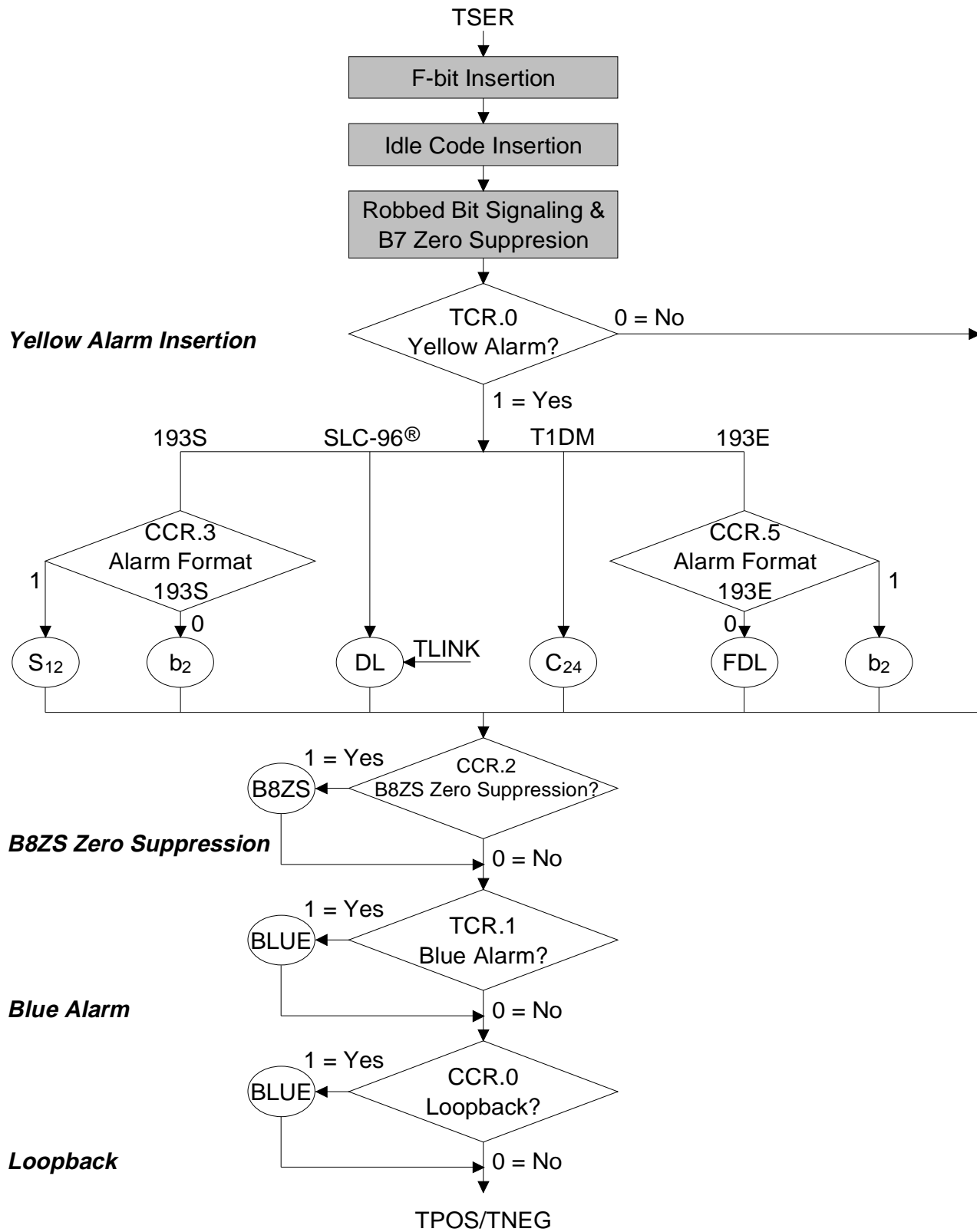


Figure 13c. Transmit Insertion Hierarchy: Alarms, B8ZS, and Loopback

RECEIVER

The receive sides of the CS62180B have only three inputs: the clock (RCLK), the incoming signal (RPOS/RNEG), and a reset pin ($\overline{\text{RST}}$). The receiver determines the framing synchronization of the incoming data, and outputs the timing information on the six timing clocks: RLCLK, RCHCLK, RFSYNC, RMSYNC, RSIGFR, and RSIGSEL. Alarms and error conditions are recorded in the Receive Status Register, and output in real time on the five status pins: RYEL, RCL, RBV, RFER, and RLOS. The decoded data is separated into its component channel, link, and signaling components and output on RSER, RLINK, and RABCD respectively.

When in host mode, the Receive Control Register allows control of the sync algorithm, and insertion of idle or digital milliwatt ($\mu\text{-LAW}$) codes into individual DS0 channels. The internal error counters can be accessed, and the Interrupt Mask Register can be programmed to specify the conditions under which a hardware interrupt is generated on INT. When running in hardware mode, receiver status can still be monitored on the status pins; and access to the error counters, sync algorithm, interrupt mask, and the insertion of idle codes are disabled.

Input Data

The receiver accepts the incoming T1 stream via RPOS/RNEG in dual-unipolar format. Tying RPOS/RNEG together disables the bipolar violation alarm and allows reception of data in NRZ format. Input data is sampled on the falling edge of RCLK. Delay from input at RPOS/RNEG to output on RSER is 13 RCLK periods.

Output Data

The receiver will attempt to sync and decode the framing format selected via CCR.4 and CCR.7. The decoded T1 stream is output in NRZ format on RSER, and updated every RCLK period. Output

data is latched on the rising edge of RCLK, and held until the next update.

Link and signaling data is always output on RLINK and RABCD respectively, independent of the transmitter configuration. RABCD outputs the LSB of every DS0 channel word, whether it is currently a signaling frame or not. The data is updated on the channel boundary, concurrent with the MSB, and held until the next update (8 or 9 bits). RLINK outputs either S-bit, SLC-96[®] DL or FDL bits, depending on the framing format. Data is updated 1 bit period prior to the Fs or FDL frame and held until the next update (2 frames).

Output Clocks

Several timing clocks are provided for identifying this data. The timing clocks are RLCLK, RCHCLK, RFSYNC, RMSYNC, RSIGFR, and RSIGSEL. Logical combination of these six signals allows easy extraction of any part of the received data stream. RMSYNC runs on a 50% duty cycle, and transitions high at the start of each new superframe output on RSER. RFSYNC transitions high at the start of every new frame. Individual DS0 channels are identified by RCHCLK, which runs on a 50% duty cycle and transitions high at the MSB of every individual time slot. Bit level timing is shown in Figure 14.

193S Timing

Link data can be identified by RLCLK, which goes high for all odd numbered frames. RSIGFR is high for signaling frames, and low at all other times. RSIGSEL runs at twice the frequency of RMSYNC. Logical combination of RMSYNC and RSIGSEL provides a way to distinguish the 6th and 12th frames for external multiplexing of signaling channels. RMSYNC is high for those frames containing A signaling bits, and low for frames containing B bits. Refer to Figure 15 for a timing diagram.

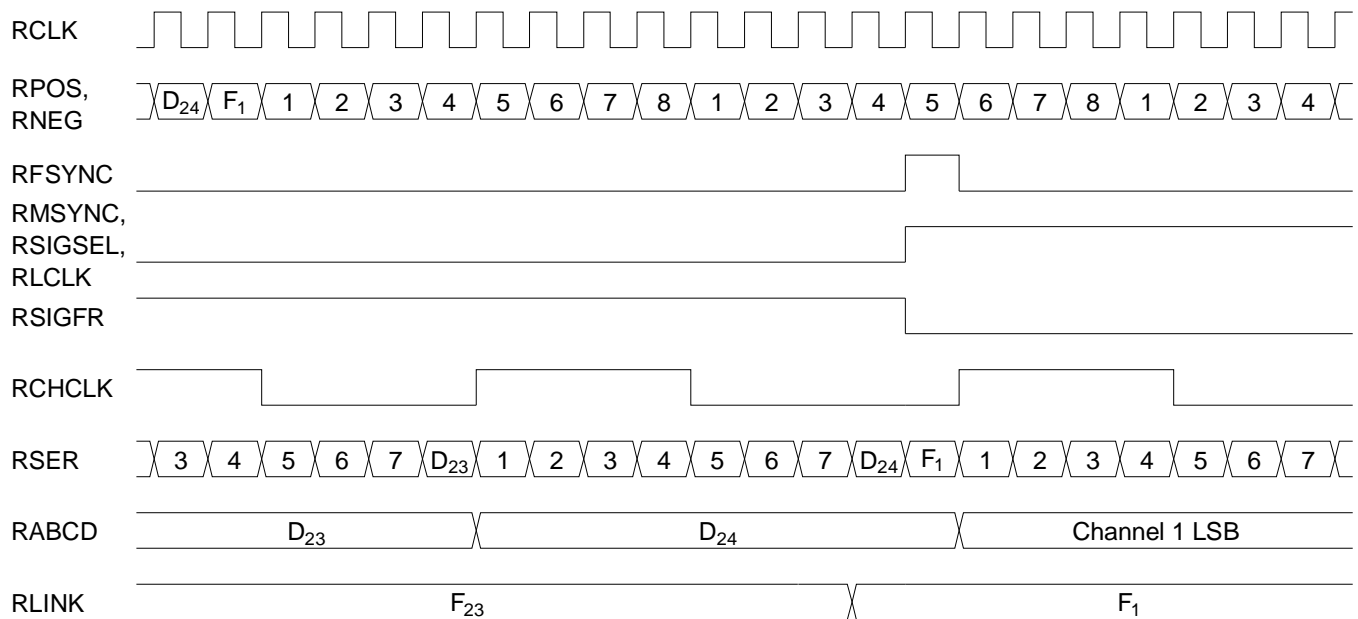


Figure 14. Bit Level Receive Timing (193E mode)

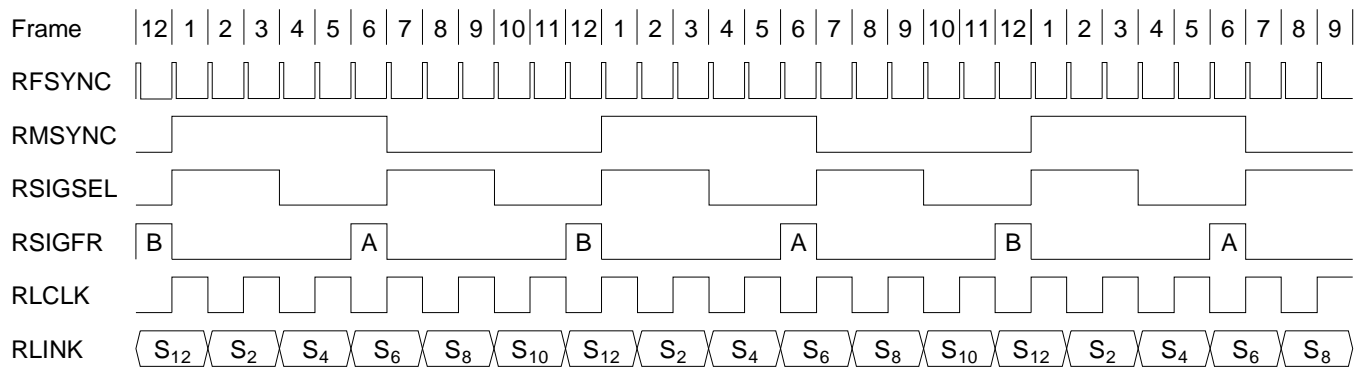


Figure 15. 193S Multiframe Receive Timing

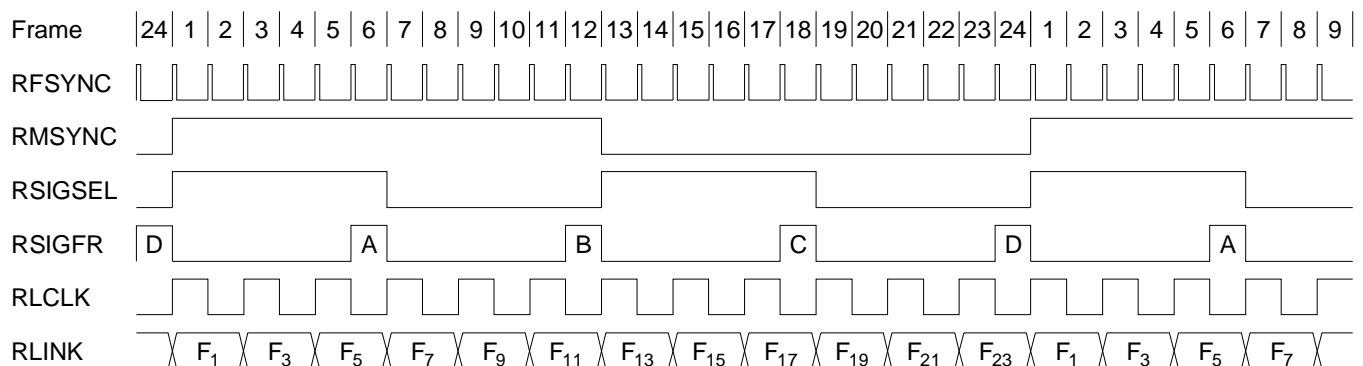


Figure 16. 193E Multiframe Receive Timing

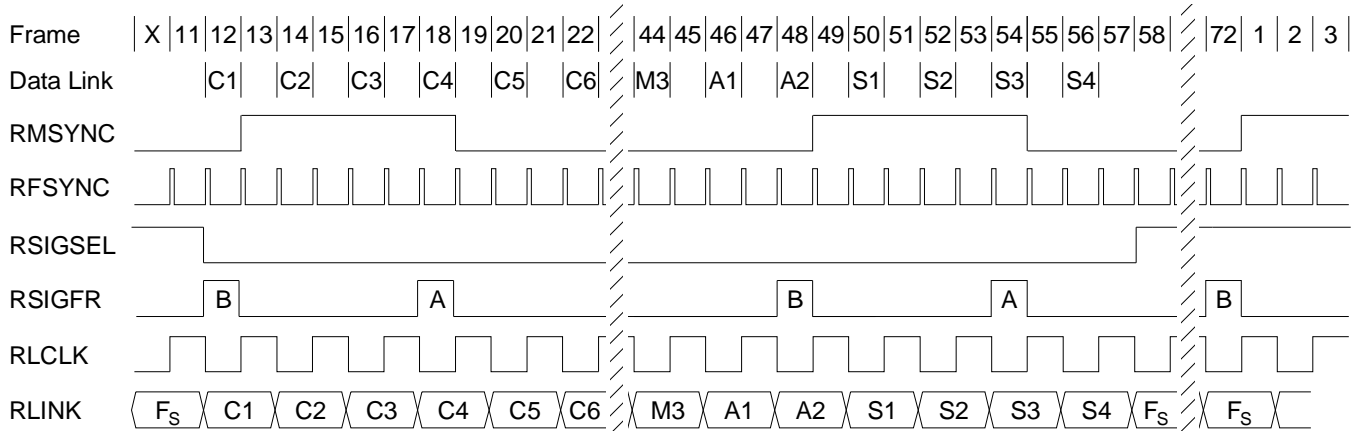


Figure 17. SLC-96® Multiframe Receive Timing

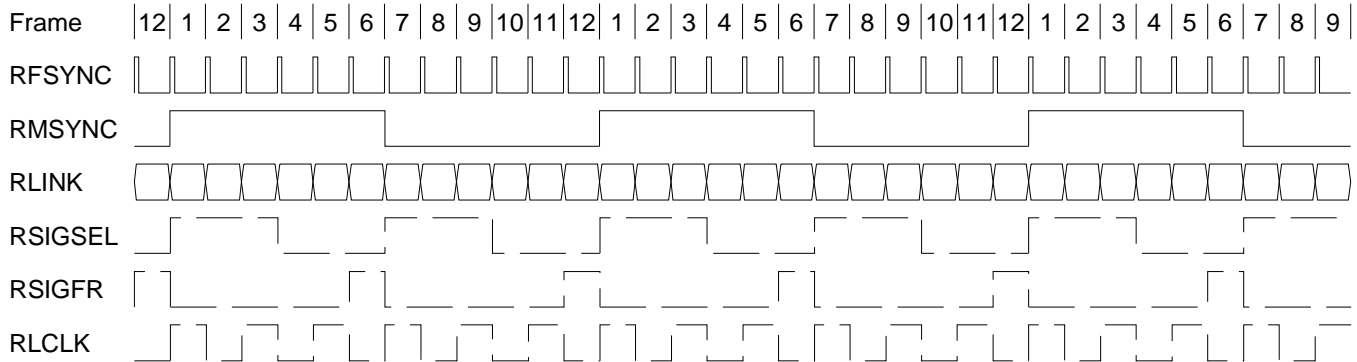


Figure 18. T1DM Multiframe Receive Timing

193E Timing

Link data can be identified by RLCLK, which goes high for all odd numbered frames. RSIGFR is high for signaling frames, and low at all other times. RSIGSEL runs at twice the frequency of RMSYNC. Logical combination of RMSYNC and RSIGSEL provides a way to distinguish the 6th, 12th, 18th, and 24th frames for external multiplexing of signaling channels. RMSYNC is high for frames containing A and B signaling bits, and RSIGSEL is high for frames with A and C bits. Refer to Figure 16 for a timing diagram.

SLC-96® Timing

The CS62180B will output 36 bits of the DL on RLINK using RLCLK. RSIGSEL can be used to locate the DL bits. RSIGSEL will be held high in those frames where F_s bits and the last spoiler bit are present (frames 58 to 11). RSIGSEL is held low in all other frames (frames 12 to 57). RSIGFR is high for signaling frames, and low at all other times. RMSYNC is high for frames containing A signaling bits, and low for frames containing B bits. Refer to Figure 17 for a timing diagram. In SLC-96® mode, the start of a new multiframe occurs on the second rising edge of RMSYNC which occurs while RSIGSEL is high. A multiframe synchronization signal can be generated from RMSYNC and RSIGSEL using the

7 (MSB)	6	5	4	3	2	1	0 (LSB)
ARC	OOF	RCI	RCS	SYNCC	SYNCT	SYNCE	RESYNC
0 OOF/RCL	0 2 out of 4	0 Disabled	0 Idle (7F)	0 Ft/FPS only	0 10 bits	0 Autoresync	rising edge triggered.
1 OOF only	1 2 out of 5	1 Enabled	1 Milliwatt	1 Fs/CRC	1 24 bits	1 Disabled	

Figure 19. Receive Control Register (RCR)

circuit shown in Figure A1 in the Applications section.

T1DM Timing

The 8 kHz link data can be sampled on RLINK using the falling edge of RFSYNC. Refer to Figure 18 and "Switching Characteristics–Receiver" for timing diagrams. RSIGFR, RSIGSEL and RLCLK serve no purpose in the T1DM mode and may be ignored.

Receive Control Register (RCR)

The RCR provides for insertion of either idle or digital milliwatt codes, and has six different control bits which enable a large number of options for tailoring the receiver resync behavior. Refer to Figure 19 for an overview of the RCR.

Receive Code Select/Insert

RCR.4: RCS

RCR.5: RCI

When enabled via RCI (RCR.5), the Receive Mark Registers are used to select individual DS0 channels for insertion of idle or digital milliwatt codes, as selected via RCS (RCR.4). There are three RMR registers: RMR1, RMR2, and RMR3 (Figure 20). Each bit in the RMR registers corre-

sponds to a received DS0 channel: RMR1.0 = channel 1, RMR1.7 = channel 8, RMR2.7 = channel 16, etc. A channel is marked for code insertion by setting the bit which corresponds to that channel in the appropriate RMR register. When RCR.5 is clear, code insertion is disabled, and the contents of the RMR registers are ignored.

RCS (RCR.4) selects whether to insert an idle code, or a digital milliwatt code, into the individual DS0 channels marked in the three Receive Mark Registers (RMR1 - RMR3). Clearing RCR.4 will select for an idle code (7F hex) to be inserted into marked channels. Setting RCR.4 to a "1" will cause a digital milliwatt code (μ -LAW format) to be inserted into all marked channels.

Receiver Synchronization

The receiver monitors the incoming signal for loss of frame alignment (based on FT or FPS bits only). Unless auto resync has been disabled via RCR.1 (see below), the receiver will automatically initiate a search for the correct framing alignment when loss of synchronization is detected, and RLOS (pin 39) will go high until a new framing alignment is declared.

	7 (MSB)	6	5	4	3	2	1	0 (LSB)
RMR1	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1
RMR2	CH16	CH15	CH14	CH13	CH12	CH11	CH10	CH9
RMR3	CH24	CH23	CH22	CH21	CH20	CH19	CH18	CH17

"0" = Normal "1" = Corresponding DS0 Channel is Replaced with Idle or Digital Milliwatt Code. (See RCR.4 and RCR.5)

Figure 20. Receive Mark Registers (RMR1 - RMR3)

When the receiver initiates an auto resync, RSIGFR is held low, but all other output timing will continue in the old alignment until the new framing is found. When the new framing alignment is qualified, the output timing will change to the new alignment at the beginning of the next superframe (or at the start of frame 13 in SLC-96[®] mode), and RLOS will return low one bit period before the F-bit of the second frame.

A receiver resync has no effect on the transmit side timing or configuration, and behavior of the output timing and RLOS pin is the same as that for an auto resync described above. This is in contrast to a reset initiated via the RST pin, which clears all internal registers on the falling edge, including the transmit side registers, resets the output timing while RST is low, and then initiates a receiver resync on the rising edge.

The time it takes the receiver to resync depends on resync algorithm selected via RCR.2 and RCR.3. The remaining bits in the RCR (1, 6, and 7) determine under what conditions an automatic resync will be initiated.

Forced Resync

RCR.0: RESYNC

RESYNC (RCR.0) can be used to force a receiver resync. Toggling RCR.0 will initiate a resync immediately on the rising edge. It must then be cleared and set again to initiate another resync. Toggling RCR.0 when going into loop-back mode will force the receiver to resync to the new frame alignment immediately. This is faster than waiting for the internal hardware to recognize an out-of-frame (OOF) condition and initiating an automatic resync.

Note: A forced resync should be issued after a change in framing mode to insure correct synchronization.

Auto Resync Conditions

RCR.1: SYNCE

RCR.6: OOF

RCR.7: ARC

SYNCE (RCR.1) can be set to a "1" to completely disable automatic resync. If RCR.1 is clear, a resync will automatically be initiated when the conditions specified by RCR.6 and RCR.7 are detected.

OOF (RCR.6) specifies how many framing bits (F_T or FPS channels only) must be in error before the receiver declares an out-of-frame (OOF) condition. A resync is always initiated (unless disabled) when an OOF is detected. If RCR.6 is clear, an OOF is declared if 2 out of 4 F_T or FPS bits are in error. If RCR.6 is set to a one, an OOF is declared if 2 out of 5 framing bits are errored. Note that the setting of RCR.6 also effects the reporting of OOF events to the Receive Status Register (RSR) and Error Count Register (ECR). Refer to the appropriate sections below for details.

ARC (RCR.7) declares whether the receiver will initiate a resync on an OOF event only, or resync on both OOF and carrier loss (RCL). If RCR.7 is cleared, the receiver will commence resync upon detection of either an OOF event (as defined by RCR.6 above), or an RCL. If RCR.7 is set, the receiver will only resync in response to an OOF condition.

Resync Algorithm

RCR.2: SYNCT

RCR.3: SYNCC

SYNCT (RCR.2) allows you to declare how many bits must be qualified in the framing pattern before the receiver declares synchronization. When RCR.2 is clear, 10 consecutive F_T or FPS framing bits preceding an RMSYNC rising edge must be qualified. Setting RCR.2 to a "1" requires the CS62180B to qualify 24 consecutive F_T or FPS bits preceding an RMSYNC

rising edge before declaring synchronization.

SYNCC (RCR.3) allows you to modify the algorithm employed to search for and qualify the framing alignment. There are two different qualifying conditions available for each framing mode, and the meaning of RCR.3 depends on which framing mode has been selected via CCR.4.

193S Resync

When operating with the 193S framing format, RCR.3 selects whether or not the CS62180B will qualify the F_S bits during resync.

If a non-standard S-bit pattern is being used, clearing RCR.3 will enable the device to first search for the F_T framing pattern to find frame alignment, and then only reset multiframe alignment if the F_S pattern can be found. This means that if a valid F_S pattern is not found, synchronization will be declared anyway, and the multiframe alignment indicated by RMSYNC may be false. The S-bits output on RLINK can be used to decode framing externally in such applications.

When using standard F_S signaling, setting RCR.3 to a "1" will cause the device to cross check the F_T and F_S patterns to find sync, and both patterns must be valid before sync is declared. Synchronization will be declared after the number of F_T bits selected by RCR.2 separated by valid F_S bits have been qualified. Note that in either setting, S-bit format yellow alarms are recognized by the synchronizer if they have been selected by setting CCR.3.

193E Resync

Clearing RCR.3 while in 193E mode will cause the CS62180B to use only the FPS framing pattern when looking for a valid framing alignment. If RCR.3 is set, the device will attempt to qualify the CRC bits after a can-

didate alignment has been found. If the CRC codes match, then the new alignment will be declared, if not, the device will try two more times. If the third CRC code does not qualify, then the device will start a new resync procedure and continue in this manner until a framing alignment can be verified with the CRC codes.

Note that after 24 ms, if there are still multiple candidates for framing alignment, the device will test the CRC codes to eliminate false candidates regardless of the setting of RCR.3. After the framing alignment has been found, it takes about 9 ms for the device to check the CRC codes for the first superframe. If that superframe fails, it takes about 3 ms to check each additional CRC code.

SLC-96[®] Resync

When operating with the SLC-96[®] framing format, the receiver should be programmed for F_S/F_T cross-coupling (RCR.3=1) and for minimum resync time (RCR.2=0). This causes the CS62180B to sync on the 10 valid F_T bits separated by valid F_S bits in frames 65 through 11, and prevents false synchronization to data link and/or spoiler bits.

Note: The CS62180B does not check SLC-96[®] multiframe alignment once synchronization is declared. In applications such as test equipment where the input data framing format may change or the multiframe alignment may change when the frame alignment does not, the datalink processor should check the phase between RSIGSEL and the DL spoiler bits on RLINK and issue a forced resync when multiframe alignment is incorrect. In the SLC-96[®] applications, a forced resync should be issued after the device is configured. Since the CS62180B defaults to the 193S framing mode at power up it may sync to SLC-96[®] data while in the 193S mode. If this occurs the multiframe alignment may be incorrect after the CS62180B is programmed for SLC-96[®] mode even though the frame alignment

Each of the eight bits of the RSR (Figure 21) corresponds to an alarm condition. A bit in the RSR is set when the corresponding alarm is detected. It will be cleared by a direct read (a burst read will have no effect) of the RSR, unless the alarm condition persists (see Alarm Servicing, below). TCLK is used to clock the internal circuitry which clears RSR after it is directly read; therefore, a 1.544 MHz signal must always be input to TCLK, even for a "receiver-only" application. The status pins which correspond to many of the RSR bits operate in real time. They go high when the error is detected, and return low either immediately, or as soon as the error condition is cleared. Alarms are reported synchronously with the emergence of the offending bits on RSER. See Figure 22, and the corresponding alarm description below for further description of status pin timing.

Receive Loss of Sync

RSR.0: RLOS

RLOS (RSR.0) goes high when a receiver resync is in progress. When the receiver is set to auto resync (RCR.1 = 0), the receiver will commence resync when an OOF event or loss of carrier is detected. If in response to an OOF, RLOS transitions high synchronously with the output of the offending F-bit on RSER (see RCR.6).

If in response to an RCL, RLOS goes high with the 128th ± 1 consecutive zero bit.

The RLOS pin will return low one bit period prior to the F-bit of the second frame after the new alignment has been declared (timing signals will reset at the start of the new superframe). Refer to *Receiver Synchronization*, above, for more information.

Receive Blue Alarm

RSR.1: RBL

RBL (RSR.1) will transition high when a blue alarm is detected, and is updated at the beginning of odd-numbered frames.

A blue alarm is reported whenever unframed all ones occurs, as per Bellcore TR-TSY-000191. The algorithm used is to simultaneously check for an out-of-frame (OOF) condition, and check for 14 or less zeros out of 13,895 bits. All bits, including frame bits, are tested. RBL goes high on a frame boundary. RBL goes low immediately (indicating the termination of the AIS condition) if OOF goes low, or if 15 or more zeros are counted and the number of bit periods is less than or equal to 13,895. RBL is reported on pin 3 of the 44-pin PLCC package. There is no status pin corresponding to RBL on the 40-pin DIP package.

B8ZS/COFA Detect

RSR.2: B8ZSD

B8ZSD (RSR.2) is a multifunction bit. It can be configured either to report the detection of B8ZS codes, or to indicate a change of framing alignment. This selection is performed through the setting of CCR.6 (see Common Control Register, above). There is no status pin corresponding to RSR.2.

If CCR.6 is clear, RSR.2 will go high every time a B8ZS code is detected in the incoming T1 data. This detector remains operational, whether or not B8ZS substitution has been enabled via CCR.2.

If CCR.6 is set to a "1", RSR.2 will go high in response to a Change of Frame Alignment (COFA). A COFA is reported when the last receiver resync resulted in a change of frame or multiframe alignment. RSR.2 will go high at the same time the timing signals are reset after a resync. (See *Receiver Synchronization*, above.)

Frame Bit Error

RSR.3: FERR

FERR (RSR.3) is set whenever a framing bit is in error.

193S Frame Bit Errors: The framing bits for the 193S is the F_T channel (odd F-bits). The RFER status pin (pin 38) signals the same F_T errors, but in addition, signals F_S errors as well. When signaling a frame bit error, RFER will go high simultaneously with the output of the offending F-bit on RSER, and hold for 2 bit periods.

193E Frame Bit Errors: The framing bits for the 193E mode are the FPS channel (F-bits of frames 4, 8, 12, 16, 20, and 24). The RFER status pin (pin 38) signals the same FPS errors, but in addition, signals CRC errors as well. When signaling a frame bit error, RFER will go high simultaneously with the output of the offending F-bit on RSER, and hold for 2 bit periods. When signaling a CRC error, RFER will transition high 1/2 bit before the new superframe to indicate a CRC error in the previous superframe. It goes high on the falling edge of RCLK, and is held for only one period, returning low on the next falling edge of RCLK.

SLC-96[®] Frame Bit Errors: The framing bits for the SLC-96[®] mode is the F_T channel (odd F-bits). The RFER status pin (pin 38) signals the same F_T errors, but in addition, signals F_S errors as well. The presence of DL bits in F_S bit positions will not be reported as frame bit errors on pin RFER, or in registers RSR.3 and ECR.0-3, and will not contribute to determining that an OOF condition exists. When signaling a frame

bit error, RFER will go high simultaneously with the output of the offending F-bit on RSER, and hold for two bit periods.

T1DM Frame Bit Errors: The framing bits for the T1DM mode are the F_T and F_S bits, plus the channel 24 sync word. The RFER status pin (pin 38) signals errors in the frame bits. RFER will go high simultaneously with the F-bit of the frame following the frame in which the error(s) occurred, and will remain high for two bit periods.

Receive Carrier Loss

RSR.4: RCL

Carrier loss is declared when 128 ± 1 consecutive zero's are detected at RPOS/RNEG. RCL (RSR.2) and the RCL pin (pin 36) transition high with the output of the $128^{\text{th}} \pm 1$ zero bit on RSER. The RCL pin will return low as soon as the next "1" is received at RPOS/RNEG.

Receive Yellow Alarm

RSR.5: RYEL

RYEL (RSR.5) transitions high when a yellow alarm is detected. The format of the alarm detected is determined by the settings of either CCR.3 or CCR.5, depending on the framing format being used. The RYEL pin (pin 21) will return low as soon as the alarm clears, that is, when the next expected alarm bit no longer indicates an alarm.

7 (MSB)	6	5	4	3	2	1	0 (LSB)
OOFD3	OOFD2	OOFD1	OOFD0	ESFD3	ESFD2	ESFD1	ESFD0
OOF Count				ESF Error Count			
Presetable. Saturates at 15 (1111).				Presetable. Saturates at 15 (1111).			

Figure 23. Error Count Register (ECR)

When using a bit 2 yellow alarm, in either 193S or 193E mode, a yellow alarm is defined as a "0" in bit 2 (2nd MSB) of every DS0 channel. RYEL will signal a bit 2 yellow alarm when 256 or more consecutive channels are detected with a "0" in bit 2. The alarm will clear at the next "1" detected in a bit 2 position.

When using an FDL yellow alarm in 193E mode, RYEL will declare a yellow alarm after 16 repetitions of "00FF" on the FDL. The alarm will clear at the next bit which is out of sequence.

When using an S-bit yellow alarm in 193S mode, RYEL will transition high whenever a "1" is detected in the F-bit of frame 12. The alarm is not cleared until a zero is detected in the F-bit of frame 12.

In T1DM mode, a yellow alarm is detected by checking the channel 24 sync word. In SLC-96[®] mode, the CS62180B does not recognize yellow alarms, rather, they are recognized by the user via the DL.

Error Count Saturation

RSR.6: ECS

ECS (RSR.6) monitors the status of the Error Count Register (ECR), as shown in Figure 23. The ECR provides two, separate, 4 bit counters at one register address: the ESF Error Count (D0 - D3), and the OOF Count (D4 - D7). RSR.6 will go high after either of these 4 bit counters becomes saturated (at 15), and new OOF or ESF event is detected (the 16th or greater).

The OOF Counter (D4 - D7) records the number of out-of-frame events. An OOF event occurs when 2 out of either 4 or 5 consecutive framing bits are in error, as defined by RCR.6. In 193S mode, the FT bits are monitored for OOF events, while in 193E mode, the FPS bits are used.

The ESF counter (D0 - D3) records the number of "Errored Superframes". An ESF event in 193E mode is defined as an OOF event, or a CRC error. The ESF counter will be advanced each time either event is detected. In 193S mode, the ESF counter records individual framing bit errors. If RCR.3 is set, requiring Fs bits to be qualified for synchronization, both FT and Fs bit errors will advance the ESF counter. If RCR.3 is clear, only FT bits will be monitored.

The OOF and ESF operate separately, each counting up from 0 (hex) and saturating at F (hex). The saturation threshold can be changed for each counter separately, by presetting the counter to some value higher than 0. Because they share the same register address, both counters must be read or written simultaneously. There is no status pin directly corresponding to the ECS bit, but FERR signals individual frame bit and CRC errors, and RLOS signals an OOF event. ECS counter increments are disabled when resync is in progress (RLOS high).

Bipolar Violation Count Saturation

RSR.7: BVCS

Individual Bipolar Violations are recorded in an 8 bit counter, the Bipolar Violation Count Register (BVCR), as show in Figure 24. The BVCR counts up from 0 (all "0's") to 255 (all "1's"). After reaching saturation at 255, every Bipolar

7 (MSB)	6	5	4	3	2	1	0 (LSB)
BVD7	BVD6	BVD5	BVD4	BVD3	BVD2	BVD1	BVD0
Counts individual Bipolar Violations. Sets RSR.7 high when overflows past 255 (11111111). Presetable to any starting value to limit the number of Bipolar Violations needed to overflow.							

Figure 24. Bipolar Violation Count Register (BVCR)

7 (MSB)	6	5	4	3	2	1	0 (LSB)
BVCS	ECS	RYEL	RCL	FERR	B8ZSD	RBL	RLOS
0	Disables interrupts for the corresponding bit of the RSR.						
1	Enables an interrupt whenever the corresponding bit of the RSR goes high.						

Figure 25. Receive Interrupt Mask Register (RIMR)

Violation received will cause BVCS (RSR.7) to be set to a "1". The BVCR can be preset, to a value greater than 0, to lower the threshold at which it saturates and signals an alarm in RSR.7. Bipolar Violations in valid B8ZS codes are never counted by the CS62180B. Note also that the Bipolar Violation monitoring circuit is disabled entirely when using NRZ input at RPOS/RNEG (selected by tying RPOS/RNEG together).

Individual Bipolar Violations are also reported in real time on RBV (pin 37). RBV will go high simultaneously with the output of the accused bit at RSER. It will only be held for that bit period, falling at the next bit, unless another violation is detected.

Interrupts

When operating in host mode, an interrupt pin, $\overline{\text{INT}}$ (pin 14), is provided to signal the host processor of alarm conditions. $\overline{\text{INT}}$ is an open drain output, and should be tied to the positive supply through a resistor. The $\overline{\text{INT}}$ pin can be programmed to respond whenever any bit of the Receive Status Register (RSR) goes high by setting the corresponding bit of the Receive Interrupt Mask Register (RIMR). Each bit of the RIMR is 'AND'ed with the corresponding bit of the RSR to determine the interrupt. Clearing any

bit in the RIMR will disable the interrupt for that alarm condition. When an interrupt has been signaled, the CS62180B must be serviced by the host processor to clear the alarm, as described below. Figure 25 shows an overview of the RIMR.

Alarm Servicing

The CS62180B must be serviced by the host processor to clear the interrupt. Clearing the appropriate bit (or bits, if more than 1 alarm condition exists) in the Receive Interrupt Mask Register (RIMR) will clear any interrupt unconditionally. The interrupt for that alarm will remain disabled until the bit in the RIMR is set again.

Depending on the type of alarm condition, an interrupt may also be cleared without changing the RIMR. If the alarm is in response to a counter saturation (see *Bipolar Violation Count Saturation* and *Error Count Saturation*, above), then the counter must be reset to a value other than all "1's" to clear the alarm. If the interrupt is in response to a real time event, then it may be cleared by a *direct* read (a burst read will have no effect) of the RSR. Note that reading the RSR will only clear the interrupt if the alarm condition no longer persists. For real time events of long duration, clearing the appropriate bits in the RIMR is the only way to clear the interrupt.

PIN NUMBER		REGISTER MAPPING	DESCRIPTION	FUNCTION
DIP	PLCC			
14	16	TCR.2	193S: S-bit Insertion	0 = Internal 1 = External
15	17	CCR.4	Framing Mode Select	0 = 193S 1 = 193E
16	18	TCR.0	Transmit Yellow Alarm	0 = Disabled 1 = Enabled
17	19	CCR.1	B7 Zero Suppression	0 = Transparent 1 = B7 Stuffing
18	20	CCR.2	B8ZS Zero Suppression	0 = Disabled 1 = Enabled

Table 2. Hardware Mode Control Pins

HARDWARE MODE

For stand alone applications or prototyping in which the device is to operate without a host processor, the CS62180B can be configured to run in hardware mode by tying the Serial Port Select pin (SPS) to ground (VSS). This disables the serial port and redefines pins 14-18 (16-20, PLCC) as mode control pins. All registers are cleared, with the exception of the control bits which are mapped to the mode control pins, and TCR.4, which is set to "1", enabling robbed bit signaling. This means that, with the exception of robbed bit signaling, the configuration of the CS62180B in hardware mode is the same as if it were in host mode with all control bits cleared. Dynamic control of a few of the control bits is provided by mapping them directly to pins 14-18 (16-20, PLCC). Operation of these pins is described in *Hardware Mode Control Pins* and Table 2. Note that the SLC-96[®] and T1DM framing formats are not supported in the hardware mode.

When operating in hardware mode, bit-robbed signaling is enabled for all channels. Signaling data sampled from TABCD is inserted into the 8th bit position (LSB) of every DS0 channel during signaling frames (every 6th frame). There is no facility for programming individual channels clear, however; all channels may be made transparent by tying TABCD to TSER.

When pulling 193SI high for external S-bit insertion in 193S mode, data is sampled from TLINK and inserted into the F-bits of even frames. The 193SI pin has no effect when the device is in 193E mode. When using 193E format, TLINK is sampled for insertion into every odd F-bit (FDL). CRC data is internally generated and cannot be externally supplied.

The receiver will initiate a resync if 2 of the previous 4 framing bits were in error. It will declare synchronization after 10 consecutive F-bits are qualified. When in 193E mode, CRC errors will be reported on RFER, but not used to qualify synchronization. Receiver status can be monitored via the status outputs: RYEL, RCL, RBV, RFER, and RLOS. There is no support for generating blue alarms or idle code insertion when in hardware mode.

Hardware Mode Control Pins

Framing Format

The FM pin allows selection of the framing mode for both transmit and receive sides. Holding this pin low selects 193S framing mode. 193E framing may be selected by pulling the FM pin high.

Yellow Alarm

A yellow alarm may be generated on the transmit side by pulling TYEL high. In 193S mode, bit 2 yellow alarms are supported internally. In 193E mode, FDL yellow alarms are supported. These formats are also detected by the receiver and reported on RYEL. Blue alarms are not supported in hardware mode, except for the transmission of all "1's" on TPOS/TNEG during loopback.

If S-bit yellow alarm is desired while in 193S mode, it may be externally provided via S-bit insertion, enabled by pulling the 193SI pin high. There is, however, no way to generate a bit 2 yellow alarm while in 193E mode. Moreover, the device will not decode either of these formats, while in hardware mode. If they are required, external alarm detection must be provided.

Zero Suppression

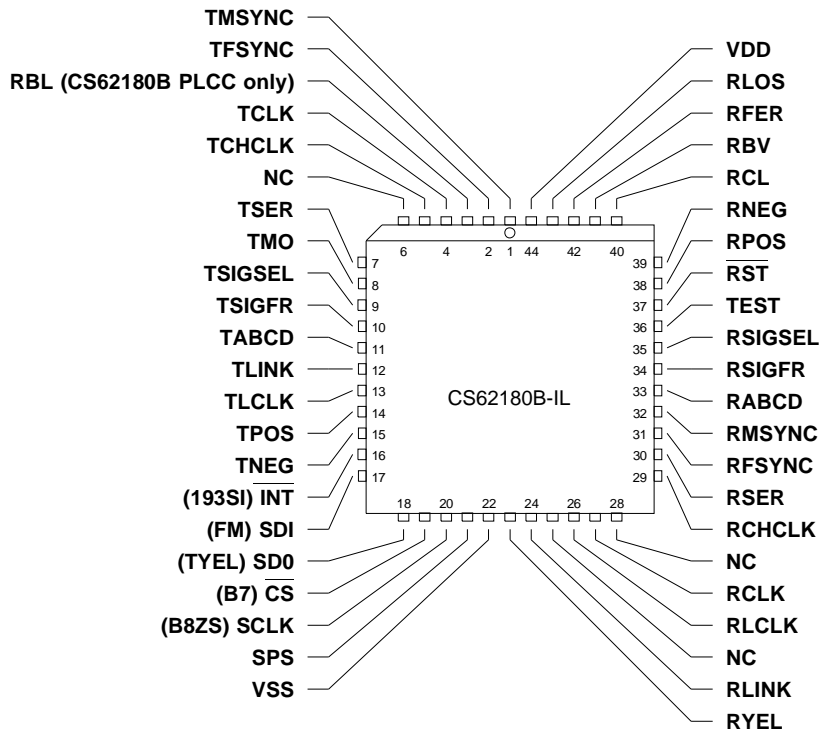
B7 selects the B7 zero suppression format for the transmitter. Pulling the B7 pin high enables bit 7 stuffing. Pulling the B8ZS pin high enables B8ZS encoding on the transmitter. The receiver is always capable of decoding either B8ZS or AMI-encoded data. Transparent mode may be selected by holding both pins low.

Loopback

Loopback is also provided in the hardware mode by simultaneously driving the B7 and B8ZS pins high. The previous state of the pins is maintained, and the selected zero suppression mode remains effective during loopback. While in loopback, an unframed all "1's" signal (Blue alarm) is output on TPOS/TNEG.

PIN DESCRIPTION

TRANSMIT MULTIFRAME SYNC	TMSYNC	1	40	VDD	POSITIVE POWER SUPPLY
TRANSMIT FRAME SYNC	TFSYNC	2	39	RLOS	RECEIVE LOSS OF SYNC
TRANSMIT CLOCK	TCLK	3	38	RFER	RECEIVE FRAME ERROR
TRANSMIT CHANNEL CLOCK	TCHCLK	4	37	RBV	RECEIVE BIPOLAR VIOLATION
TRANSMIT SERIAL DATA	TSER	5	36	RCL	RECEIVE CARRIER LOSS
TRANSMIT MULTIFRAME OUT	TMO	6	35	RNEG	RECEIVE NEGATIVE BIPOLAR DATA
TRANSMIT SIGNALING SELECT	TSIGSEL	7	34	RPOS	RECEIVE POSITIVE BIPOLAR DATA
TRANSMIT SIGNALING FRAME	TSIGFR	8	33	RST	RESET
TRANSMIT ABCD SIGNALING	TABCD	9	32	TEST	TEST MODE
TRANSMIT LINK DATA	TLINK	10	31	RSIGSEL	RECEIVE SIGNALING SELECT
TRANSMIT LINK CLOCK	TLCLK	11	30	RSIGFR	RECEIVE SIGNALING FRAME
TRANSMIT POSITIVE BIPOLAR DATA	TPOS	12	29	RABCD	RECEIVE ABCD SIGNALING
TRANSMIT NEGATIVE BIPOLAR DATA	TNEG	13	28	RMSYNC	RECEIVE MULTIFRAME SYNC
RECEIVE ALARM INTERRUPT	(193SI)INT	14	27	RSFYNC	RECEIVE FRAME SYNC
SERIAL DATA IN	(FM)SDI	15	26	RSER	RECEIVE SERIAL DATA
SERIAL DATA OUT	(TYEL)SDO	16	25	RCHCLK	RECEIVE CHANNEL CLOCK
CHIP SELECT	(B7)CS	17	24	RCLK	RECEIVE CLOCK
SERIAL DATA CLOCK	(B8ZS)SCLK	18	23	RLCLK	RECEIVE LINK CLOCK
SERIAL PORT SELECT	SPS	19	22	RLINK	RECEIVE LINK DATA
SIGNAL GROUND	VSS	20	21	RYEL	RECEIVE YELLOW ALARM



Power Supply Connections

VDD - Positive Supply, Pin 40 (PLCC, Pin 44).

Positive digital power supply. Nominally +5.0 Volts. VDD current requirements increase if RCLK is static, and if RST is held high.

VSS - Signal Ground, Pin 20 (PLCC, Pin 22).

Power supply ground. Nominally 0 volts.

Host Mode Serial Interface

Pins 14 - 18 (PLCC, 16 - 20) are multifunctional. When in Host mode, they operate as serial interface pins. When in hardware mode, they are redefined as mode control pins. Their hardware mode operation is described separately under *Hardware Mode Control Pins*, below.

SPS - Serial Port Select, Pin 19 (PLCC, Pin 21).

Must be tied to VDD to select host mode, allowing operation of serial port. Tying SPS to VSS selects hardware mode. Selecting hardware mode clears all internal registers except the common control register (CCR) and transmitter control register (TCR), and redefines pins 14 through 18 (PLCC, 16 - 20) as mode control pins.

Inputs

SDI - Serial Data In, Pin 15 (PLCC, Pin 17).

Serial data input for addressing and writing to on-board control registers. Data is input LSB first. Input data is latched on the rising edge of SCLK.

 $\overline{\text{CS}}$ - Chip Select, Pin 17 (PLCC, Pin 19).

$\overline{\text{CS}}$ low enables serial port for read or write. When $\overline{\text{CS}}$ transitions high, all data transfers are terminated, port control logic is disabled, and SDO is tri-stated to allow for multiprocessor interface.

SCLK - Serial Data Clock, Pin 18 (PLCC, Pin 20).

Used to read or write the serial port. Data at SDO is output on the falling edge of SCLK and held to the next falling edge. Input data on SDI is latched on the rising edge of SCLK.

Outputs

 $\overline{\text{INT}}$ - Receive Alarm Interrupt, Pin 14 (PLCC, Pin 16).

Pulled low to flag host controller when an alarm interrupt condition occurs. The user may select which alarm conditions will trigger an interrupt by appropriately setting the Receive Interrupt Mask Register (RIMR). $\overline{\text{INT}}$ is an open drain output, and should be tied to the positive supply (VDD) through a resistor.

SDO - Serial Data Out, Pin 16 (PLCC, Pin 18).

When reading the serial port, data is output LSB first. Data is updated on the falling edge of SCLK and held to the next falling edge. SDO goes to a high impedance state when CS is high or after the rising edge of SCLK corresponding to the output of the MSB (last bit output).

Hardware Mode Control Pins

Pins 14 - 18 (PLCC, 16 - 20) are multifunctional. When in Host mode, they operate as serial interface pins. When in hardware mode, they are redefined as mode control pins. Their host mode operation is described separately under *Host Mode Serial Interface*, above. SPS must be tied low to enable hardware mode.

193SI - 193S S-bit Insertion, Pin 14 (PLCC, Pin 16).

In hardware mode, this pin is redefined as a control pin and maps directly to TCR.2. Holding the pin low while in 193S framing format, configures the CS62180B to generate the Fs framing pattern internally for transmission. Pulling 193SI high allows external insertion of transmitted S-bits via TLINK.

FM - Frame Mode Select, Pin 15 (PLCC, Pin 17).

In hardware mode, this pin is redefined as a control pin and maps directly to CCR.4. Holding the FM pin low configures the CS62180B for 193S framing format, pulling it high selects the 193E format.

TYEL - Transmit Yellow Alarm, Pin 16 (PLCC, Pin 18).

In hardware mode, this pin is redefined as a control pin and maps directly to TCR.0. Pulling the TYEL pin high enables transmission of a yellow alarm in the default format. In 193S mode yellow alarms default to a "0" in bit 2 (D6) of all DS0 channels. In 193E mode, yellow alarms are encoded/decoded as a repeating pattern of 00FF (hex) on the FDL.

B7 - Bit 7 Zero Suppression, Pin 17 (PLCC, Pin 19).

In hardware mode, this pin is redefined as a control pin and maps directly to CCR.1. Holding the B7 pin low disables bit 7 stuffing (B7) for transparent operation. Pulling the pin high enables B7 zero suppression. Pulling the B7 and B8ZS pins high simultaneously puts the CS62180B into loopback operation.

B8ZS - Bipolar Eight Zero Suppression, Pin 18 (PLCC, Pin 20).

In hardware mode, this pin is redefined as a control pin and maps directly to CCR.2. On the CS62180B, pulling the B8ZS pin high enables B8ZS zero suppression in just the transmitter, since the CS62180B receiver is always capable of receiving either B8ZS or AMI-encoded data.

Pulling the B7 and B8ZS pins high simultaneously puts the CS62180B into loopback operation.

Transmitter

Inputs

TCLK - Transmit Clock, Pin 3 (PLCC, Pin 4).

1.544 MHz primary transmitter clock. Divided down internally to provide timing signals. TPOS and TNEG are updated on the rising edge of TCLK. Input transmission data (TSER, TABCD, and TLINK) is sampled on the falling edge of TCLK.

A 1.544 MHz signal must be input into TCLK even for those applications where the transmitter is not being used. TCLK is used by the circuitry which clears status registers after those registers have been directly read (non-burst mode read).

TMSYNC - Transmit Multiframe Sync, Pin 1 (PLCC, Pin 1).

A low to high transition of TMSYNC, occurring near the rising edge of TCLK, resets transmitter's frame and multiframe counters, identifying bit period (at TSER) concurrent with the next falling edge of TCLK as the F-bit of frame 1. If tied low, TFSYNC may be used to set frame alignment, and the CS62180B will arbitrarily choose multiframe alignment.

Internal channel, frame, and multiframe counters are output on TCHCLK, TMO, TSIGSEL, TSIGFR, and TLCLK.

TFSYNC - Transmit Frame Sync, Pin 2 (PLCC, Pin 2).

A low to high transition of TFSYNC, occurring near the rising edge of TCLK, resets transmitter's frame counters, identifying bit period (at TSER) concurrent with the next falling edge of TCLK as the F-bit of a new frame. If tied low, TMSYNC may be used to set both frame and multiframe alignment. Without any sync input, the CS62180B will arbitrarily choose both frame and multiframe alignment. Internal channel, frame, and multiframe counters are output on TCHCLK, TMO, TSIGSEL, TSIGFR, and TLCLK.

TSER - Transmit Serial Data, Pin 5 (PLCC, Pin 7).

Input data (NRZ format), sampled on the falling edge of TCLK. TSER may also be used to provide externally supplied data for insertion into F_T, FPS, and CRC channels. Refer to *Transmit Control Register*, bits 5 and 6. Delay from TSER to TPOS/TNEG is 10 TCLK periods.

TABCD - Transmit ABCD Signaling, Pin 9 (PLCC, Pin 11).

When enabled, by setting bit 4 of the Transmit Control Register (TCR), data provided on TABCD is inserted into the 8th bit position (LSB) of every DS0 channel during signaling frames. Those are frames 6 and 12 in 193S format, and 6, 12, 18, and 24 in 193E. Signaling on individual DS0 channels may be suppressed by declaring those channels transparent in the Transmit Transparent Registers (TTR). Signaling in hardware mode is always enabled. Delay from TABCD to TPOS/TNEG is 10 TCLK periods.

TLINK - Transmit Link Data, Pin 10 (PLCC, Pin 12).

In 193S framing mode, setting bit 2 of the Transmission Control Register (TCR) enables data on TLINK to be inserted into the S-bit channel (F-bit of all even frames). In 193E mode, TLINK is sampled for data to be inserted into the F-bit of all odd frames for the 4 kHz facility data link (FDL). In the SLC-96[®] mode, TLINK is sampled for data to be inserted into the DL. In T1DM mode, TLINK is sampled for data to be inserted into the channel 24 "A" data link. Delay from TLINK to TPOS/TNEG is 10 TCLK periods. In hardware mode, external S-bit insertion on TLINK is enabled by setting pin 14 (193SI) high.

*Outputs***TPOS, TNEG - Transmit Bipolar Data Outputs, Pins 12 and 13 (PLCC, Pins 14 and 15).**

Coded data for transmission, updated on rising edge of TCLK. If TCR.7 is clear, or the CS62180B is in hardware mode, data is output in dual-unipolar format. If TCR.7 is set to a "1", data is output on TPOS in NRZ format, and TNEG is held low. Delay from input to TPOS/TNEG is 10 TCLK periods.

TCHCLK - Transmit Channel Clock, Pin 4 (PLCC, Pin 5).

192 kHz clock which identifies DS0 channel boundaries. TCHCLK rises to indicate that the next bit input on TSER is the first bit (MSB) of the DS0 channel. TCHCLK has a 50% duty cycle.

TMO - Transmit Multiframe Out, Pin 6 (PLCC, Pin 8).

Output of internal multiframe counter. Rising edge marks beginning of multiframe, with 50% duty cycle. Internal multiframe counter can be set on the rising edge of TMSYNC. In 193S mode, TMO is high for frames 1-6, and low for frames 7-12, allowing easy distinction of signaling channels A and B. In 193E mode, TMO is high for 1-12, and low for 13-24, and can be used together with TSIGSEL to distinguish channels A, B, C, and D.

TSIGSEL - Transmit Signaling Select, Pin 7 (PLCC, Pin 9).

In 193S, 193E and T1DM modes, TSIGSEL runs at 2x TMO with a 50% duty cycle. Together with TMO, TSIGSEL provides a way to distinguish signaling channels A, B, C, and D in 193E mode. TMO is high for channels A and B. TSIGSEL is high for channels A and C (frames 1-6 and 13-18). In SLC-96[®] mode, TSIGSEL provides a way to distinguish when the DL bits are to input.

TSIGFR - Transmit Signaling Frame, Pin 8 (PLCC, Pin 10).

TSIGFR goes high during signaling frames only, remaining low at all other times. Signaling frames are frames 6 and 12 in 193S, SLC-96[®] and T1DM modes, and 6, 12, 18, and 24 in 193E mode.

TLCLK - Transmit Line Clock, Pin 11 (PLCC, Pin 13).

In 193S, 193E and SLC-96[®] modes, TLCLK runs at 4 kHz with a 50% duty cycle. It's high during odd numbered frames, and is useful for marking Fs or FDL channel timing (input on TLINK), and Ft, FPS, and CRC channels (input on TSER). In T1DM, TLCLK runs at 8 kHz, with a duty cycle of one bit period high per frame.

Receiver

Inputs

RCLK - Receive Clock, Pin 24 (PLCC, Pin 27).

1.544 MHz primary receiver clock. Receiver data is output on the rising edge, and input on the falling edge of RCLK. If no signal is present on RCLK, $\overline{\text{RST}}$ should be held low to minimize power consumption.

RPOS, RNEG - Receive Bipolar Data Inputs, Pins 34 and 35 (PLCC, Pins 38 and 39).

Recovered data, sampled on falling edge of RCLK. Tie pins together to receive NRZ data and disable bipolar violation monitoring circuitry. Delay from RPOS/RNEG to output at RSER is 13 RCLK periods.

$\overline{\text{RST}}$ - Reset, Pin 33 (PLCC, Pin 37).

Falling edge of $\overline{\text{RST}}$ clears all internal registers and resets receiver error counters. A receiver resync is forced when $\overline{\text{RST}}$ returns high. This resync effects only the receiver synchronization, and has no effect on transmit timing, but transmit control modes are cleared. The host processor should restore all control modes following a reset by writing the appropriate control registers. NOTE: *On system power-up, $\overline{\text{RST}}$ must be held low to insure initialization of all on-board registers.*

Outputs

RYEL - Receive Yellow Alarm, Pin 21 (PLCC, Pin 23).

Transitions high when a yellow alarm is detected, returns low when yellow alarm is cleared. When in Host mode, Yellow alarm formats for both 193S and 193E modes can be selected via bits 3 and 5 of the Common Control Register. When in hardware mode, the 193S mode defaults to bit 2 Yellow alarms, and the 193E mode defaults to FDL yellow alarms. Refer to bit 5 of the Receive Status Register (RYEL) for a description of alarm detection conditions.

RCL - Receive Carrier Loss, Pin 36 (PLCC, Pin 40).

On the CS62180B, RCL transitions high if 1281 consecutive "0's" are detected on RPOS and RNEG and returns low on the next "1".

RBL - Receive Blue Alarm, (CS62180B PLCC only, Pin 3).

Transitions high on a frame boundary if an unframed-all ones and an out-of-frame condition simultaneously occur. Returns low when either out-of-frame ends or zeros are detected.

RBV - Receive Bipolar Violation, Pin 37 (PLCC, Pin 41).

If a bipolar violation is detected, RBV goes high simultaneous with output of accused bit on RSER, low otherwise.

RFER - Receive Frame Error, Pin 38 (PLCC, Pin 42).

Transitions high with the output of an errored framing bit, and is held for 2 bit periods. F_T and F_S bits are tested in 193S and SLC-96[®] modes, and FPS bits are tested in 193E. In T1DM mode, the F_S, F_T and channel 24 sync bits are tested. Also signals CRC errors in 193E mode, by going high 1/2 bit before the next extended superframe, and holding for 1 period (from falling edge of RCLK to next falling edge).

RLOS - Receive Loss of Sync, Pin 39 (PLCC, Pin 43).

Transitions high during receiver resync, low otherwise. Transitions high when receiver begins a resync, and falls low one frame after new timing is declared.

RSER - Receive Serial Data, Pin 26 (PLCC, Pin 30).

Received data, output in NRZ format. Data on RSER is valid and stable on the falling edges of RCLK. Delay from RPOS/RNEG to RSER is 13 RCLK periods.

RABCD - Receive ABCD Signaling, Pin 29 (PLCC, Pin 33).

Signaling data extracted from LSB of DS0 channels during signaling frames is valid on RABCD during corresponding channel output on RSER (LSB is available on RABCD seven bit periods before it appears at RSER). During non-signaling frames, RABCD continues to output LSB concurrently with word on RSER. After update, data on RABCD is valid and stable on the falling edge of RCLK.

RLINK - Receive Link Data, Pin 22 (PLCC, Pin 24).

In 193S mode, S-bit data is output on RLINK one RCLK prior to start of corresponding even frame, and held for 2 frames until next update. In 193E mode, FDL data is output on RLINK one RCLK prior to start of corresponding odd frame, and held for 2 frames until next update. After update, data on RLINK is valid and stable on the falling edge of RCLK.

In SLC-96[®] mode, all F_s and DL bits are output on RLINK using RLCLK. In T1DM mode, channel 24 "A" link data is output on RLINK, and is valid and stable on the falling edge of RFSYNC.

RLCLK - Receive Link Clock, Pin 23 (PLCC, Pin 26).

RLCLK runs at 4 kHz with a 50% duty cycle. It's high during odd numbered frames. RCLK is useful for marking S-bit, DL or FDL channel timing, output on RLINK. RLCLK is present, but serves no useful purpose in the T1DM mode.

RCHCLK - Receive Channel Clock, Pin 25 (PLCC, Pin 29).

192 kHz clock which identifies DS0 channel boundaries output on RSER. RCHCLK is useful for parallel to serial conversion of DS0 channel data.

RFSYNC - Receive Frame Sync, Pin 27 (PLCC, Pin 31).

Goes high for one RCLK period concurrent with the F-bit of each new frame output on RSER, low otherwise. In the T1DM mode, the falling edge of RFSYNC can be used to sample the "A" link channel on RLINK.

RMSYNC - Receive Multiframe Sync, Pin 28 (PLCC, Pin 32).

Rising edge signals the F-bit of 1st frame of multiframe. RMSYNC runs on 50% duty cycle, high for frames 1-6 in 193S mode, distinguishing signaling channels A and B. In 193E mode, it's high for frames 1-12, and can be used with RSIGSEL to distinguish channels A, B, C, and D.

RSIGFR - Receive Signaling Frame, Pin 30 (PLCC, Pin 34).

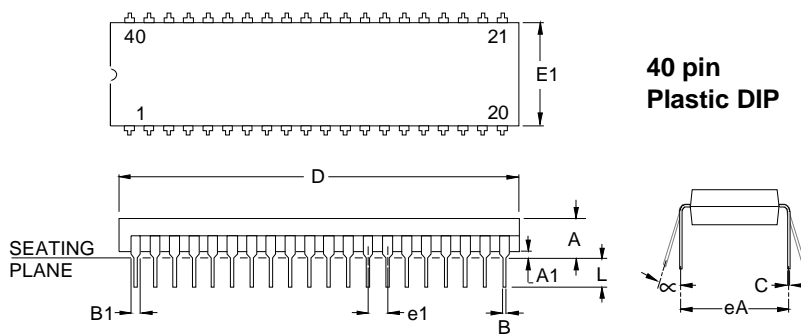
High during signaling frames, low at all other times, including resync. Serves no purpose in T1DM mode.

RSIGSEL - Receive Signaling Select, Pin 31 (PLCC, Pin 35).

In 193E mode, RSIGSEL goes high for frames 1-6 and 13-18, identifying signaling channels A and C. Used together with RMSYNC, which is high for channels A and B, it allows identification of all 4 signaling channels. In 193S mode, RSIGSEL goes high for frames 1-3 and 7-9. Serves no purpose in T1DM mode. In SLC-96[®] mode, RSIGSEL goes high in those frames where Fs bits (frames 59 to 11) and the last spolier bit (frame 58) are present; goes low in all other frames (frames 12 to 57).

Miscellaneous**TEST - Test Mode, Pin 32 (PLCC, Pin 36).**

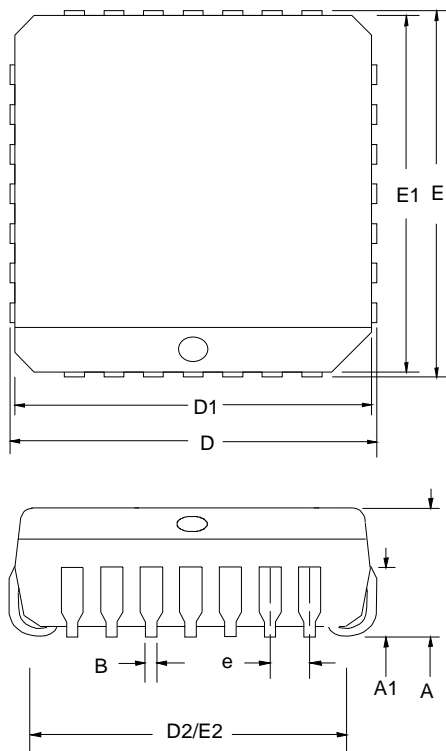
Tie to VSS for normal operation. Factory use only.



DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	3.94	4.32	5.08	0.155	0.170	0.200
A1	0.51	0.76	1.02	0.020	0.030	0.040
B	0.36	0.46	0.56	0.014	0.018	0.022
B1	1.02	1.27	1.65	0.040	0.050	0.065
C	0.20	0.25	0.38	0.008	0.010	0.015
D	51.69	52.20	52.71	2.035	2.055	2.075
E1	13.72	13.97	14.22	0.540	0.550	0.560
e1	2.41	2.54	2.67	0.095	0.100	0.105
eA	15.24	-	15.87	0.600	-	0.625
L	3.18	-	3.81	0.125	-	0.150
∞	0°	-	15°	0°	-	15°

NOTES:

1. POSITIONAL TOLERANCE OF LEADS SHALL BE WITHIN 0.25mm (0.010") AT MAXIMUM MATERIAL CONDITION, IN RELATION TO SEATING PLANE AND EACH OTHER.
2. DIMENSION eA TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION E1 DOES NOT INCLUDE MOLD FLASH.



DIM	NO. OF TERMINALS											
	28						44					
	MILLIMETERS			INCHES			MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX
A	4.20	4.45	4.57	0.165	0.175	0.180	4.20	4.45	4.57	0.165	0.175	0.180
A1	2.29	2.79	3.04	0.090	0.110	0.120	2.29	2.79	3.04	0.090	0.110	0.120
B	0.33	0.41	0.53	0.013	0.016	0.021	0.33	0.41	0.53	0.013	0.016	0.021
D/E	12.32	12.45	12.57	0.485	0.490	0.495	17.40	17.53	17.65	0.685	0.690	0.695
D1/E1	11.43	11.51	11.58	0.450	0.453	0.456	16.51	16.59	16.66	0.650	0.653	0.656
D2/E2	9.91	10.41	10.92	0.390	0.410	0.430	14.99	15.50	16.00	0.590	0.610	0.630
e	1.19	1.27	1.35	0.047	0.050	0.053	1.19	1.27	1.35	0.047	0.050	0.053

APPLICATIONS

System Connection Diagram

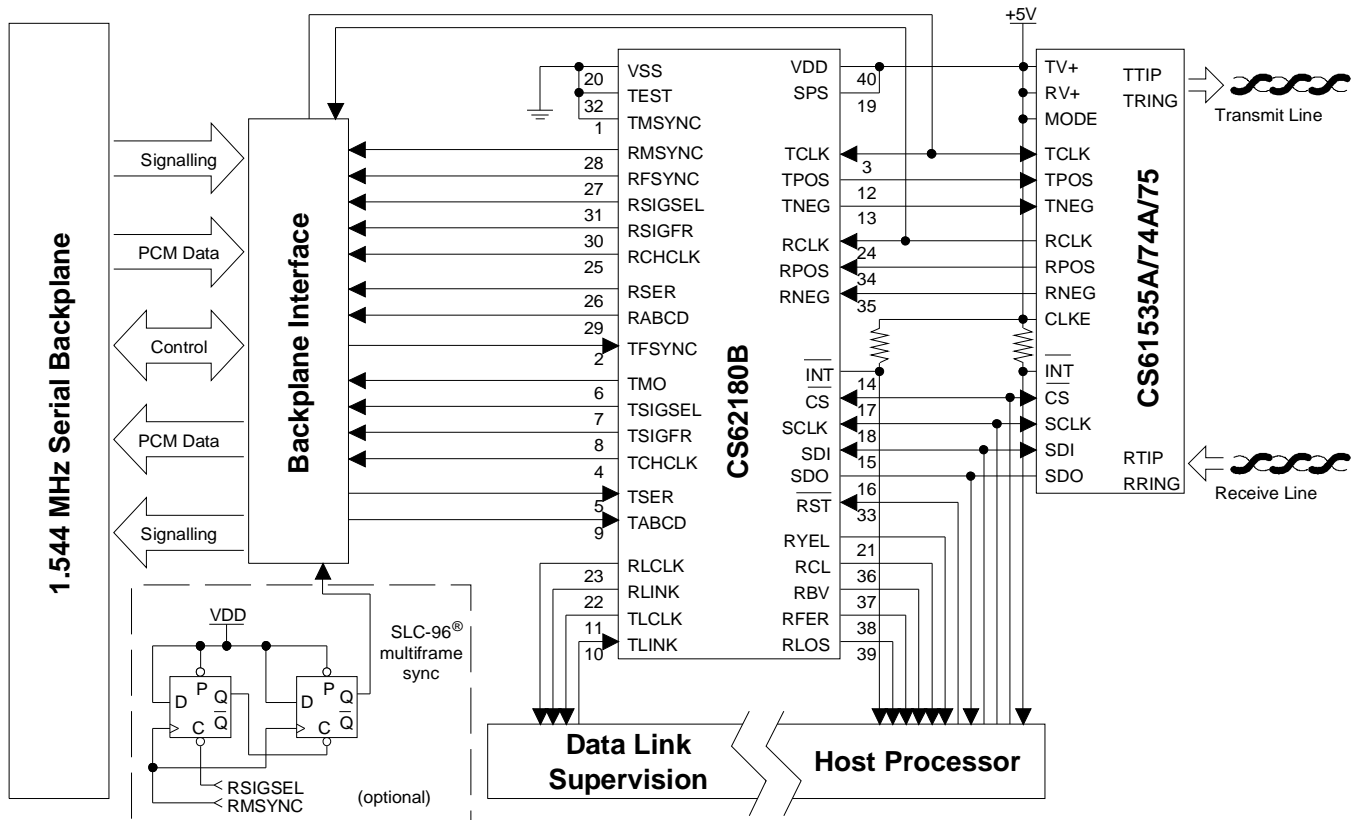


Figure A1. Typical System Connection

T1 Frame Formats

T1 is the basic format in the T-carrier PCM transmission system used in the United States. Detailed technical specifications can be found in ANSI T1.107-1988, ANSI T1.403-1993, ANSI T1.408-1990.

The T1 format time-division multiplexes 24 digitized voice (telephone) or data channels into a single, 1.544 Mbps data stream. This format is used primarily for transmission over dual twisted-pair cable with digital repeaters at 6000 ft. intervals. The T-carrier system also defines higher level formats for long-haul transmission via satellite or microwave relay. These higher level formats are constructed by multiplexing

several T1 lines into higher and higher data rates. Figure A2 gives an overview of the T-carrier hierarchy.

Level	Number of voice channels	Bit Rate (Mbps)
T-1	24	1.544
T-1C	48	3.152
T-2	96	6.312
T-3	672	44.736
T-4	4032	274.176

Figure A2. T-carrier Hierarchy

The T1 format provides a 64 kbps channel for each individual voice or data line. These PCM voice channels consist of 8-bit samples which are sampled at 8 kHz for a data rate of 64 kbps. A T1 frame is constructed by multiplexing 24 of these DS-0 channels and inserting a framing bit at the beginning of the series. This results in 192 bits of channel data, plus an F-bit, for a total of 1.544 Mbps (193 bits/frame transmitted at 8 kHz). See Figure A3.

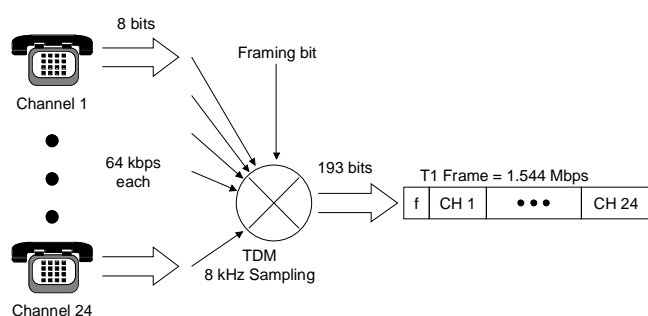


Figure A3. T1 Overview

Multiple T1 frames are then grouped into superframes of 12 or 24 frames to provide for framing and signaling synchronization. The older 193S or SF(D4[®]) format defines a superframe as 12 frames, with the F-bits carrying 2 channels of synchronization signals. The emerging 193E, or Extended Superframe Format (ESF) calls for 24 frames in a superframe. This allows the 24 F-bits

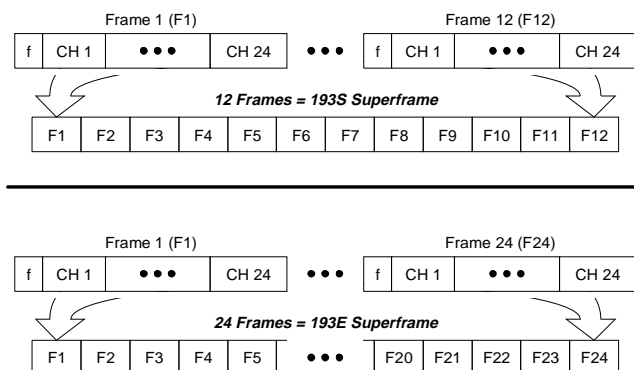


Figure A4. Framing Overview

to be divided into 3 separate channels for framing, CRC checks, and system messages.

Additional variations on T1 are used for Subscriber Loop Carrier (SLC-96[®]) and Digital Data Service (DDS[®]) T1DM.

193S Framing Format

Figure A5 shows the bit uses in the 193S framing format. The framing bits are divided into two channels. The odd F-bits are designated as the F_T (terminal framing) channel, which always carries a repeating pattern of "101010". This pattern allows synchronization to the frame boundaries, and distinguishes the even and odd frames. The even F-bits are designated as the F_S (signaling framing) channel. This channel carries a different synchronization code (001110) which identifies superframe alignment. The F_S channel can alternately be used as a message channel for system use, in which case there is no facility provided for multiframe synchronization.

193S Frame	F-bits		Channel bits		Signaling Options		
	F _T	F _S	Data	Signaling	T	2	4
1	1		1-8				
2		0					
3	0						
4		0					
5	1		1-7	Bit 8	-	A	A
6		1					
7	0						
8		1					
9	1		1-8				
10		1					
11	0						
12		0					

Figure A5. 193S Framing Format

during the 6th and 12th frames. The original LSB of the channel is actually replaced with the signaling data, hence this is known as "robbed-bit" signaling. The 6th and 12th frames can be treated as one, 2-state channel, allowing a 2-state signal to be updated twice every superframe. The two frames can also be treated as separate channels (A and B), yielding up to 4 separate codes for each channel every superframe. For voice grade applications, these signaling bits offer no noticeable degradation in the signal quality. When error-free data transmission is required however, robbed bit signaling can be disabled (transparent mode), and some other signaling facility must be provided by the host system.

193E Framing Format

The 193E or Extended Superframe Format allows much greater flexibility in both the use of the framing bits, and the number of signaling channels provided. As shown in Figure A6, the framing bits are divided into 3 channels. The FPS, or Framing Pattern Sequence, provides a synchronization signal for determining frame and superframe alignment. The FDL, or 4 kHz Facility Data Link, provides a dedicated channel for system messages. The CRC (Cyclic Redundancy Check) channel allows CRC check sums to be transmitted with each superframe to monitor line quality. As with the 193S format, every 6th frame is designated as a signaling frame. The 4 signaling frames (6, 12, 18, and 24) can be multiplexed in different configurations to provide 2, 4, or 16-state signaling codes.

193E Frame	F-bits			Channel bits		Signaling Options			
	FPS	FDL	CRC	Data	Signaling	T	2	4	16
1		m		1-8					
2			C1						
3		m							
4	0								
5		m		1-8	Bit 8	-	A	A	A
6			C2						
7		m							
8	0								
9		m		1-8					
10			C3						
11		m							
12	1					-	A	B	B
13		m		1-8					
14			C4						
15		m							
16	0								
17		m		1-8	Bit 8	-	A	A	C
18			C5						
19		m							
20	1								
21		m		1-8					
22			C6						
23		m							
24	1					-	A	B	D

Figure A6. 193E Framing Format

SLC-96[®] Framing Format

The SLC-96[®] T1 format is used between the Local Digital Switch (LDS) and a SLC-96[®] Remote Terminal (RT). The framing format is a SF(D4[®]) superframe format with specialized Data Link (DL) information bits. The DL bits consist of Concentrator (C), Spoiler (S), Maintenance (M), Alarm (A) and Protection Line Switch (PLS) bits as shown in Figure A7.

T1DM Framing Format

The T1DM T1 format is used for DDS[®] service among hub and local intermediate DDS[®] offices. As shown in Figure A8, the framing format is a SF(D4[®]) superframe format with a specialized channel 24 structure. The T1DM accepts up to 23 DS-0 signals and inserts one seven-bit byte from each signal into the first twenty-three 8-bit channel slots of the DS1 frame. The 24th channel slot contains a special synchronizing byte as shown in Figure A9. DDS[®] equipment insures that every DS0 channel contains at least one "1". Therefore, neither B8ZS nor bit-7 zero substitution should be selected in the CS62180B.

SLC-96®		F-bits		Channel bits	
Frame	F _T	F _S	DL	Data	Signaling
1	1			1-8	
2		0			
3	0				
4		0			
5	1			1-7	Bit 8 (A)
6		1			
7	0				
8		1			
9	1			1-8	
10		1			
11	0				
12			C1		
13	1			1-7	Bit 8 (B)
14			C2		
15	0				
16			C3		
17	1			1-7	Bit 8 (A)
18			C4		
19	0				
20			C5		
21	1			1-8	
22			C6		
23	0				
24			C7		
25	1			1-7	Bit 8 (B)
26			C8		
27	0				
28			C9		
29	1			1-7	Bit 8 (A)
30			C10		
31	0				
32			C11		
33	1			1-8	
34			S=0		
35	0				
36			S=1		

SLC-96®		F-bits		Channel bits	
Frame	F _T	F _S	DL	Data	Signaling
37	1			1-8	
38			S=0		
39	0				
40			M1		
41	1			1-7	Bit 8 (A)
42			M2		
43	0				
44			M3		
45	1			1-8	
46			A1		
47	0				
48			A2		
49	1			1-7	Bit 8 (A)
50			PLS1		
51	0				
52			PLS2		
53	1			1-7	Bit 8 (A)
54			PLS3		
55	0				
56			PLS4		
57	1			1-8	
58			S=1		
59	0				
60		0			
61	1			1-7	Bit 8 (B)
62		0			
63	0				
64		0			
65	1			1-7	Bit 8 (A)
66		1			
67	0				
68		1			
69	1			1-8	
70		1			
71	0				
72		0			

Figure A7. SLC-96® Framing Format

T1DM		F-bits		Channel Bits
Frame	F _T	F _S		
1	1		1-7 (Bit 8 of user channels is reserved for network use)	
2		0		
3	0			
4		0		
5	1			
6		1		
7	0			
8		1		
9	1			
10		1		
11	0			
12		0		

Figure A8. T1DM Framing Format

Bit	Assignment
0	Synchronization Pattern = 1
1	Synchronization Pattern = 0
2	Synchronization Pattern = 1
3	Synchronization Pattern = 1
4	Synchronization Pattern = 1
5	Yellow Alarm: 0 = alarm; 1 = no alarm
6	8 kHz Data Link ("A" channel)
7	Synchronization Pattern = 0

Figure A9. T1DM Channel 24 Format

Alarms

Figure A10 shows a useful overview of the alarm operation in a PCM link. When an intermediate monitoring system (or central office repeater) detects a loss of signal, it transmits an all "1's" signal (Blue alarm, or Alarm Indication Signal) on the line to maintain clock recovery operation in the subsequent digital repeaters and the destination's receiver. The same Blue alarm may be used by the source transmitter if, for some reason, it cannot maintain normal functionality (such as during loopback).

When the loss of signal is detected at the intermediate monitor, an internal Red alarm (also known as a Service Alarm Indication, or Prompt Maintenance Alarm) is generated. While in a Red alarm mode, the monitor transmits a Yellow alarm back to the source's receiver, indicating a remote loss of alignment. This Yellow alarm informs the source that there's a problem farther down the line and it's transmission is not being received at the destination.

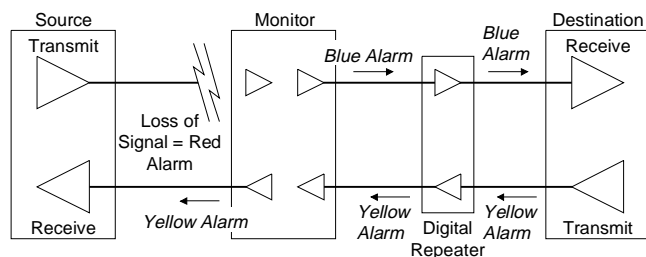


Figure A10. Alarm Operation on a T1 Link.

Zero Substitution

As was mentioned in the T1 overview, data is transmitted over dual twisted-pair cable with digital repeaters at 6000 ft. intervals. It is encoded in a bipolar AMI (Alternate Mark Inversion) format. Successive "1's" are encoded alternately as positive and negative voltage pulses. A zero is simply an absence of pulses. This means that a long stream of "0's" is indistinguishable from a dead line. Clock recovery

circuits in the network maintain clock synchronization by syncing to the "1's" pulses in the transmission stream. Synchronization may be lost if there are too many consecutive zero's, hence there is a general requirement that there be at least 12.5 % "1's" density in the transmission stream. Furthermore, no more than 15 consecutive "0's" are allowable. Various zero substitution schemes have been developed to meet these requirements. The CS62180B supports B7 and B8ZS zero suppression formats.

B7 Zero Substitution

B7 zero substitution guarantees at least one "1" in all DS0 channels. This satisfies the 12.5 % ones density, and guarantees that more than 15 consecutive zeros will never occur. In B7 substitution systems, the 7th bit (2nd LSB) of an all zero channel is forced to a "1". This strategy maintains 1's density in voice grade transmission, with negligible audible interference. The drawback with the B7 format is that it's impossible for the receiving end to detect and remove the changed bits. This makes B7 zero suppression unacceptable for clear channel transmission, in which the integrity of the data must be maintained.

B8ZS Zero Substitution

B8ZS (Bipolar Eight Zero Substitution) satisfies the one's density requirement without corrupting transmission data. Instead of operating on individual channels, the B8ZS format looks at the entire transmission stream. Any eight consecutive zeros are replaced with an 8 bit code. This code uses specific bipolar violations of the AMI format to distinguish it from the ordinary data. If the last "1" transmitted before a string of zeros was encoded as a positive pulse, then the B8ZS code for the next eight bits will be 000+-0+-. Similarly, if the last "1" was a negative pulse, then the code will be 000-+0+-. In either case, bipolar violations occur in the fourth and seventh bits. These violations are decoded as a string of

zeros by the CS62180B if B8ZS is enabled. The received B8ZS code is replaced with eight zeros before any other processing is done on the incoming data. Note also that even if B8ZS is not enabled, the CS62180B monitors the incoming signal for B8ZS codes, and reports them on RSR.2 (if CCR.6 = 0).

A serious provisioning problem exists in the network regarding B8ZS. It is sometimes difficult to selectively turn-on B8ZS on all segments of an end-to-end path through the network, especially when some equipment types, such as M13s, sometimes require that all four lines on a line card be configured the same way. It is thereby highly desirable that all receivers in the network be able to receive B8ZS independent of the provisioning of B8ZS on the corresponding transmitter. Therefore, the CS62180B has its B8ZS receiver turned on all of the time, and bit CCR.2 controls only the B8ZS encoder in the transmitter. The CS62180B reports B8ZS occurrences on RSR.2. B8ZS substitutions will not increment the Bipolar Violation Count register.

Digital Milliwatt Code

The Digital Milliwatt code is the digital representation of a 0 dBm0, 1 kHz signal. It's used as a test reference for calibrating channel bank equipment as specified in AT&T Publication 43801.

Revision	Date	Changes
PP1	May 1996	Initial Release
PP2	15 December 2003	Remove end-of-life part

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