

**STEL-1209**  
**Data Sheet**

**STEL-1209/CE**  
**BPSK/QPSK/16 QAM**  
**Burst Modulator Assembly**

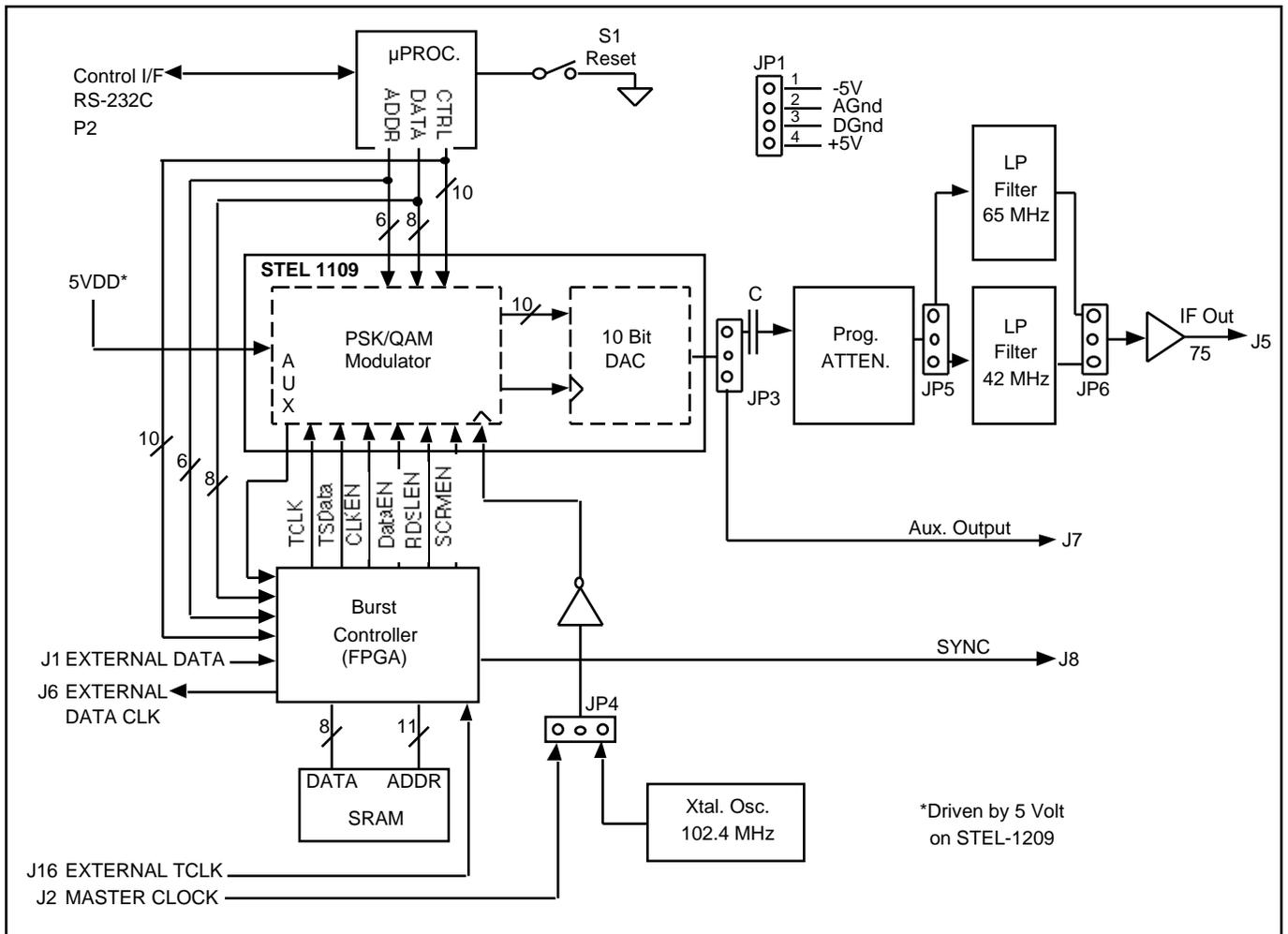
## KEY FEATURES

- n** Evaluation tool for STEL-1109 digital modulator ASICs
- n** Burst or continuous BPSK, QPSK, 16QAM modulator at rates up to 10 Msps
- n** On-board or external clock capability
  - Up to 165 MHz
- n** Up to 65 MHz output frequency
- n** High frequency resolution
  - 24 bits, 10 Hz @ 165 MHz
- n** Digitally filtered data results in low modulation side lobes
  - Typically -52 dBc
- n** High spectral purity
  - Typically -50 dBc

## BURST MODE PARAMETERS:

- n** Default at burst QPSK modulation
  - Data rate at 2.56 Mbps
- n** Programmable packet length
  - 1 to 16,381 symbols of data
- n** Programmable guard time
  - 2 to 16,382 symbols
- n** Programmable burst quantity
  - 1 to 10 million and auto repeat
- n** Programmable preamble size
  - 0 to 255 symbols of data
- n** Master or slave mode

## BLOCK DIAGRAM



WCP 52841.c-5/9/97

## DESCRIPTION

The STEL-1209 is the latest member in Stanford Telecom's line of BPSK/QPSK Burst Modulator board level products. It uses the STEL-1109 ASIC to provide all the convenience of supporting BPSK, QPSK, or 16QAM up-stream modulation with a maximum data rate of 10 Mbps, 20 Mbps, and 40 Mbps; respectively. The STEL-1109 has a Reed-Solomon encoder, a scrambler, a differential encoder, a 10 bit DAC, and many more features needed to build robust communication systems that satisfy today's demanding requirements. For further feature details please refer to the STEL-1109 ASIC data sheet.

Besides the STEL-1109, there is additional logic circuitry implemented in Altera's FPGA to provide burst BPSK, QPSK, and 16QAM modulation modes. Several improvements in these burst modulation modes are included; e.g. external/internal preamble and data sources; variable bursts quantity (includes single to 10 -million and auto repeat); variable packet length, guard time, and preamble size (including zero preamble size). This flexibility allows the STEL-1209 to be customized easily into customers' specific environment. Connectors J3 and J4 are digital test pins provided for easy monitoring of the burst control/signal timing relationships.

With a 0.35 micron ASIC process the STEL-1109 can support a maximum clock frequency of 165 MHz. The frequency of the output modulated carrier is programmable between 5 to 65 MHz; the upper limit is approximately 40% of the master clock. The STEL-1209 has a 102.4 MHz crystal oscillator on-board. Hence, its maximum modulated carrier frequency can be set to 40 MHz. However, an external clock (+10 to +13 dBm) can be selected as the master (through connector J2 and jumper JP4) and carrier frequency of 65 MHz can be achieved easily. An obvious difference between this board and its predecessor (STEL-1208) is the absence of a DAC. A 10 bit DAC is built in the STEL-1109 and observable spur level is -50 dB or better. It has a pair of differential current outputs which swings  $\pm 0.96$  volt peak-to-peak at 50 ohm termination. Single-ended output of the DAC (using transformer T1 as a double to single-ended converter) can be obtained from J7 (expects 50 or 75 ohm termination impedance from instrumentation). Also included is a choice between

two output low pass filters (jumper JP5 and JP6) with cut-off frequency at 42 and 65 MHz. The output of the filter is amplified and is obtainable from J5 (75 ohm source impedance). JP3 routes the DAC output to either J7 or J5.

The board (running at 102.4 MHz in continuous modulation mode) takes about 430 mA at the 5 volt supply. Power is supplied to the board through JP1. Its pins are clearly labeled on the board (pin 1 = -5 volt, pin 2 = AGND, pin 3 = DGND, pin 4 = VCC (+5 volt)). Reversing the polarity of the supply pins would cause damage to the board. When clock enable line is taken low (grounded), the board consumes 200 mA or less. Current drawn on the -5 volt supply is 10 mA. There are two 5 volt to 3.3 volt converters on the board and the design serves to demonstrate the inter-operability of the STEL-1109 in a 5 volt or 3.3 volt system. The STEL-1109 ASIC, which is a 3.3V device, consumes 1.8 mA/MHz in continuous mode. Current consumption by the ASIC can be easily measured by connecting pin 2 of JP9 (see package outline) to a 3.3 V power supply that has a current meter.

STEL-1209's operating mode can be modified by writing new values to the STEL-1109 and the burst controller's registers. These registers can be read and written through a Graphical User Interface (GUI) program that comes with the STEL-1209 board. The GUI software allows the user to select different modulation methods, preamble size, interpolation ratio, etc. with the ease of button clicking on a Personal Computer running Microsoft's Windows 95 operating system. A serial cable with 9 pin D-sub connector must be connected between P2 of the STEL -1209 and the PC's COM port for the GUI software to work. At power up or upon reset, the STEL -1209 is automatically loaded with default values to give repeating QPSK burst modulation (50% duty cycle) centered at 10 MHz (master mode). This default mode allows the STEL-1209 to communicate with the STEL -9244, up-stream burst demodulator. External data must be provided to connector J1 (75 ohm unipolar unbalance) to complete the communication loop. Clock for the external data is provided through connector J6 (75 ohm unipolar unbalance).

## SPECIFICATIONS

Output Frequency Range:

5 MHz to 65 MHz using an external clock frequency of 165 MHz (or up to 40 MHz using the provided on-board clock at 102.4 MHz).

Resolution:

10 Hz @  $f_{CLK}$  165 MHz (24 bits)

J2 -- Master Clock Input:

To use the on-board 102.4 MHz crystal oscillator, jump pin 2 and pin 3 on JP4.

To use an external master clock, jump pin 1 and pin 2 on JP4.

Maximum Frequency,  $f_{CLK(MAX)} = 165$  MHz

BNC connector, input power at +10 dBm to +13 dBm, A.C. coupled, 50 Ohms

J16 -- External TCLK Input:

BNC connector, HCMOS levels.

J7 -- Aux. Output:

SMB connector for single ended DAC output. Transformer T1 is used to do the double-to-single ended conversion.

JP3 is used to route the single ended output to either J7 or J5.

J8 -- SYNC Output:

BNC connector, HCMOS levels

Pulse covering the period of bursting symbols. This signal (equivalent to DATAENO inverted) can be used as a scope trigger.

J5 -- IF Output:

BNC connector, 75 Ohms.

Output power: + 0 dBm @ default settings

Return loss: 15 dB

Stop band: 30 dB at 85 MHz with 65 MHz LPF

Note: The output level of the DAC falls as the carrier frequency rises according to the equation:

$$V_{OUT} = \frac{V_{OUT(DC)}(\text{sine } f)}{f}$$

$$\text{where : } f = \frac{\bullet f_{OUT}}{f_{CLK}}$$

Note: The on-board low pass filter (LPF) cut-off frequency can be selected between 42 MHz or 65 MHz by properly configuring JP5 and JP6.

J1 -- External Serial Data Input:

BNC connector, HCMOS levels.

Output Level Control:

The output level can be controlled over a range of 15 dB in 1 dB steps by means of the control software supplied.

P2 -- RS-232C Control Interface:

Connector Type: 9-pin Subminiature 'D', female (DCE).

Pin 2 TXD Pin 3 RXD

Pin 5 GND Pin 7 GND

Power Requirements (Typical):

JP1, pin 1: -5 volts  $\pm 5\%$ , 10 mA

JP1, pin 2: Analog GND

JP1, pin 3: Digital GND

JP1, pin 4: +5 volts  $\pm 5\%$ , 330 mA  
(@ fclk = 100 MHz)

Temperature Range, Ambient:

0-70° Operating

Connector J3:

Pin 1 NC Pin 2 NC

Pin 3 AUXCLK Pin 4 RDSLEN

Pin 5 SCRMEN Pin 6 CLKEN

Pin 7 TCLK Pin 8 DATAEN

Pin 9 TSDATA Pin 10 WRB

Pin 11 DSB Pin 12 DIFFEN

Pin 13 TXCLK\_B Pin 14 TXDATA\_B

Pin 15 BURSTGATE\_B Pin 16 CKSUM

Pin 17 DATAENO Pin 18 SYMPLS

Pin 19 BITCLK Pin 20 GND

Connector J4:

Pin 1 NC Pin 2 NC

Pin 3 EXT\_TCLK\_B Pin 4 SYMCLK

Pin 5 uP\_WRB Pin 6 uP\_RDB

Pin 7 CLKEN\_LOW Pin 8 (SPARE)

Pin 9 BURST Pin 10 (SPARE)

Pin 11 PREAMBLE\_SRAM Pin 12 LOAD\_RUN

Pin 13 (SPARE) Pin 14 uP\_BURSTGATE

Pin 15 Burst/Done Pin 16 (SPARE)

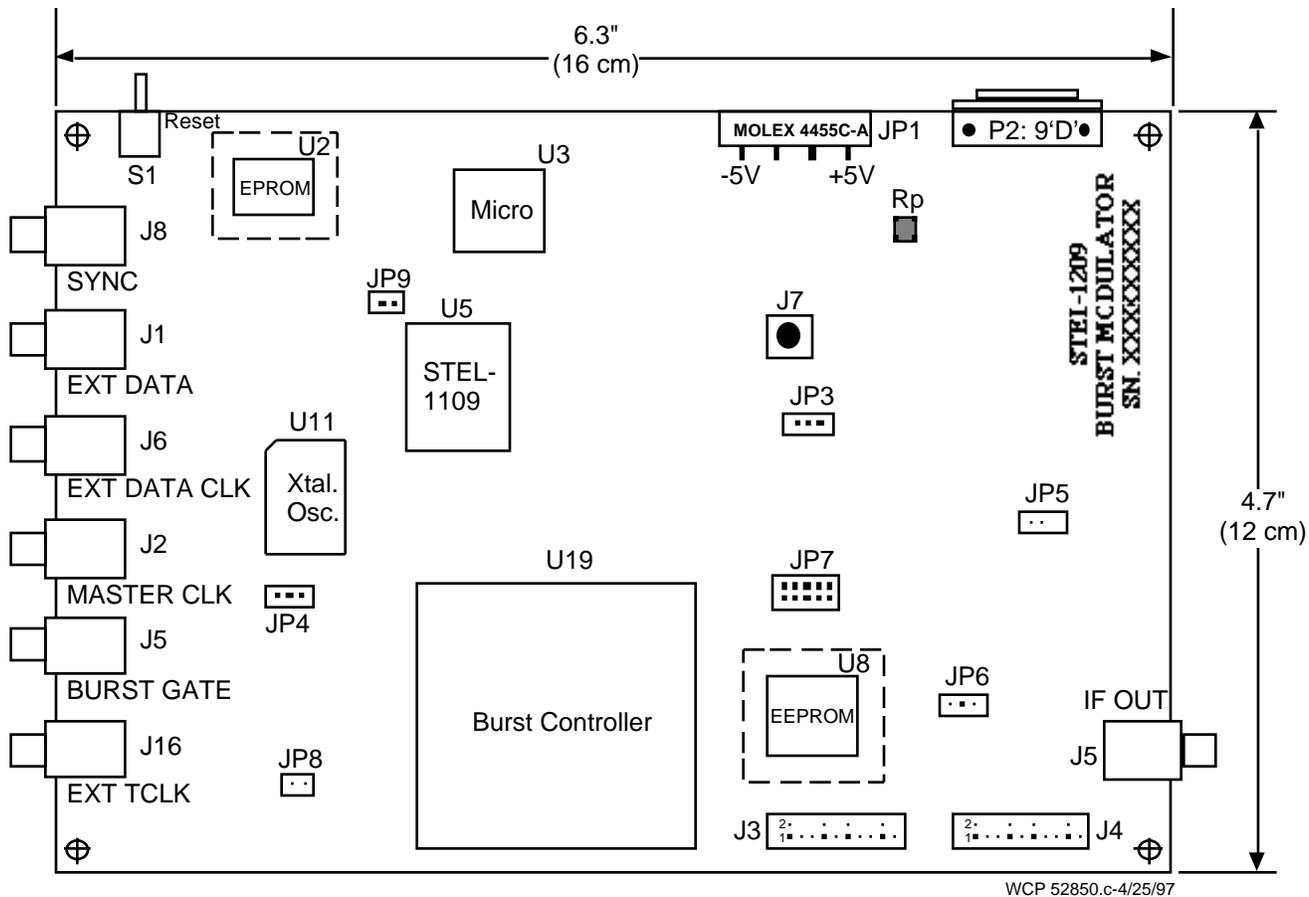
Pin 17 VCC (SPARE) Pin 18 VCC (SPARE)

Pin 19 NCO\_LOAD Pin 20 GND

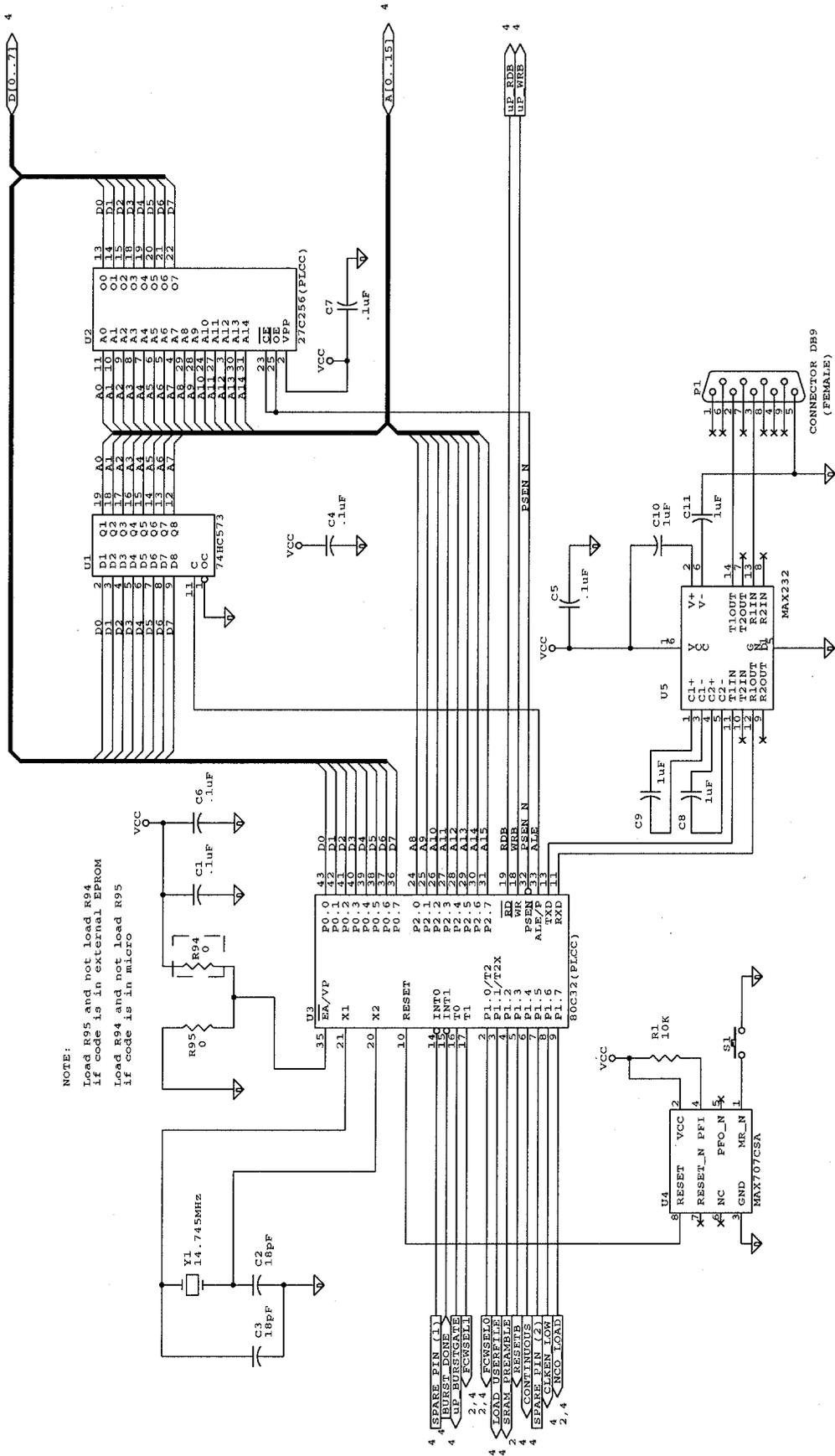
# ORDERING INFORMATION

To order, specify Model Number STEL-1209/CE. "CE" indicates a commercial grade, board-level product.

# PACKAGE OUTLINE

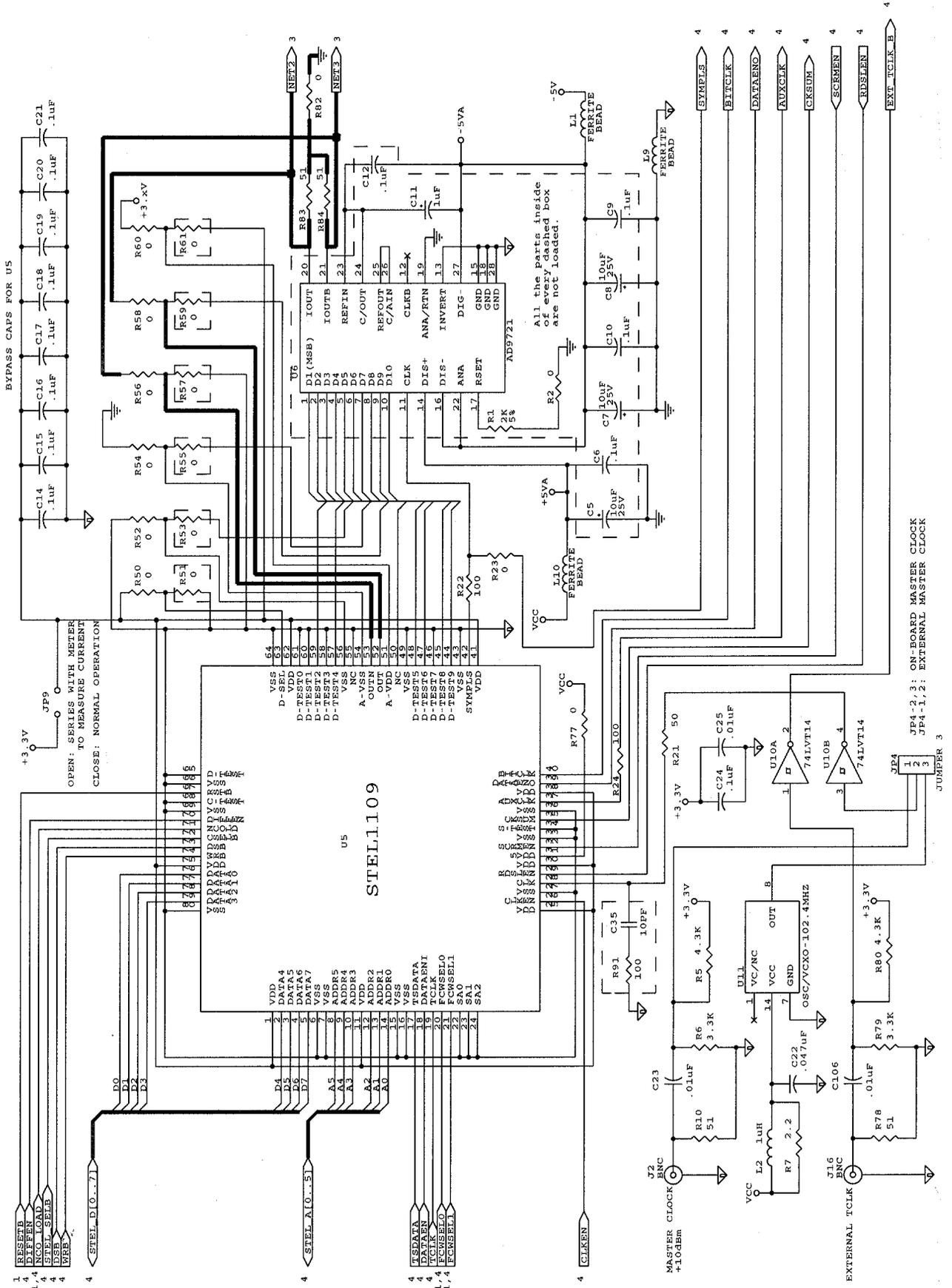


STEL-1209 SCHEMATIC DIAGRAM (1 of 4)

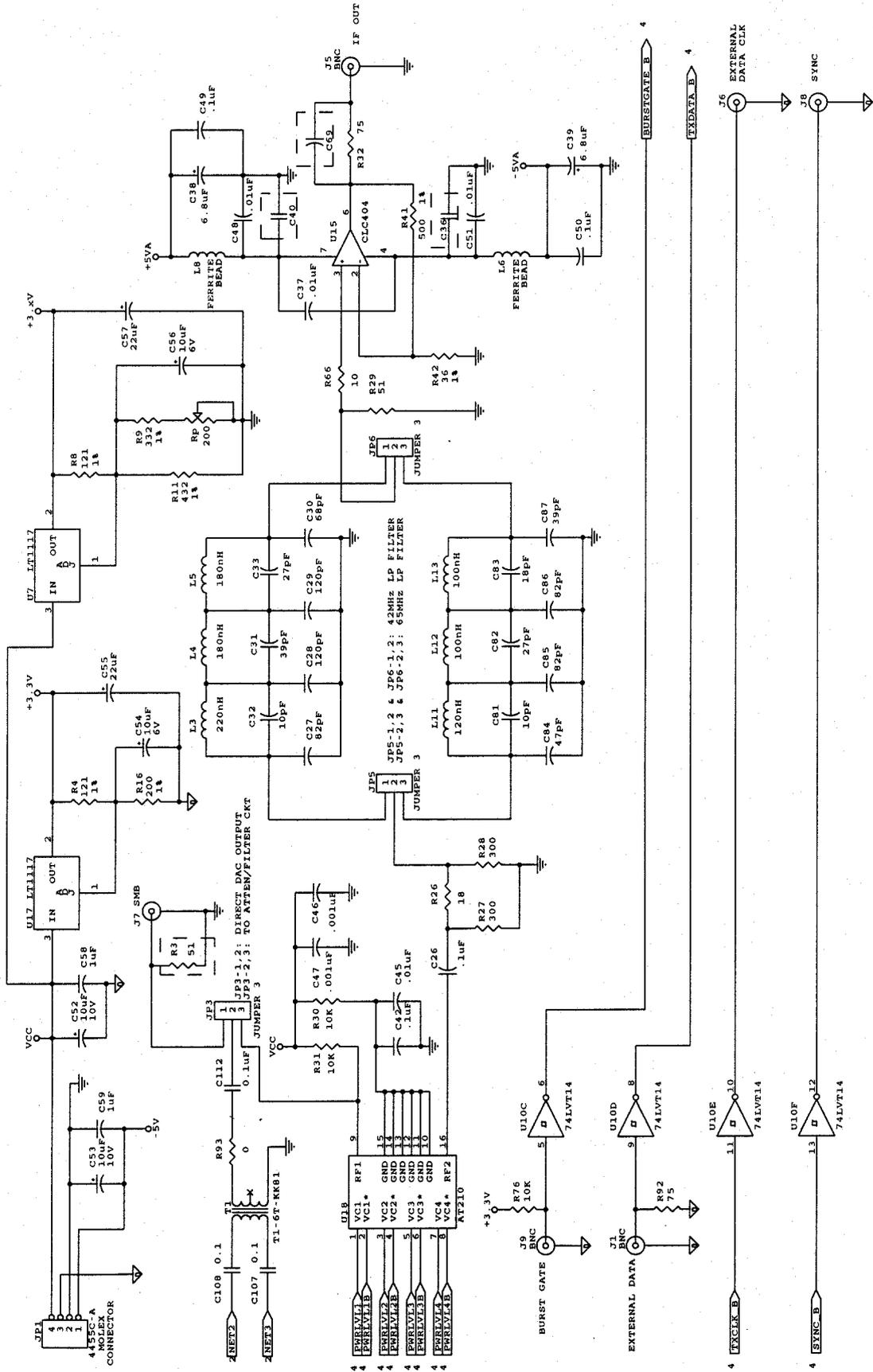


NOTE:  
 Load R95 and not load R94  
 if code is in external EPROM  
 Load R94 and not load R95  
 if code is in micro

STEL-1209 SCHEMATIC DIAGRAM (2 of 4)



STEL-1209 SCHEMATIC DIAGRAM (3 of 4)





## STEL-1209 EVALUATION BOARD SOFTWARE INTERFACE USER'S GUIDE

This Windows 95™ based software package is designed to make programming and debugging the operation of the STEL-1109 ASIC as easy as possible. It allows the desired configuration to be derived while working at a high level, eliminating the need to program the STEL-1109 at the register level. In addition, it gives the user the flexibility to select programmable features and settings in connection with our upstream demodulator; the STEL-9244. However, it is still necessary to have a good understanding of the capability of both the STEL-1209 and the STEL-1109 to be able to use this software tool effectively. Standard Windows 95 procedures are used in operating the menus and controls. Many of the buttons require only a single click to activate. Remember to press the Enter key for those buttons that require numerical or keyboard entry. Pressing the Enter key is essential for proper operation of the STEL-1209 board.

To install the software, run the program named, "a:\setup" and follow the instructions given on the screen.

When the software is started, a window will be opened with the default parameter settings. These parameters are also loaded into the STEL-1109 and the Burst Controller FPGA on the STEL-1209 board on power-up. The window incorporates a Menu Bar, three soft buttons, and a parameter entry area with bit mapped graphics near the top that resemble three folder tabs.

### Menu Bar Items

The menu bar is displayed at the top of the window and contains three menu items: File, View Registers, and Windows.

### FILE:

Under the File menu the following items can be accessed:

**Save Parameters As** - Saves the active window with its parameter settings for future use as a new file.

**Save Parameters** - Saves the active window with its parameter settings for future use, overwriting the previous values of the file with this name.

**Load Parameters** - Opens previously saved file with its parameter settings.

**View Parameters** - looking at contents of saved parameters in a text file format.

**Load User File** - Opens an ASCII hex/character format user supplied data file (text) for use as the input data source. This allows the user to transmit a fixed known data pattern. The user can load either ASCII hex or ASCII character (or both) formats within a single file such as the USERFILE.txt file comes with the GUI software installation disks. In burst mode, the data file contains both the preamble and the data information with preamble being loaded first and followed by the data.

**Exit** - Causes the program to terminate.

### VIEW REGISTERS:

This gives the user the capability to access both the write and the read registers of STEL-1109 ASIC.

**Read Registers** - When this item is selected, a new window showing the STEL-1109 read registers is opened. Each individual register value can be read from the board by hitting the <Enter> key at each register box. To read all register values at once, click the Query Registers command button.

**Write Registers** - When this item is selected, a new window showing the STEL-1109 write registers is opened. Each individual register can be programmed by entering a new value and then hitting the <Enter> key. To write all register values at once, click the Configure command button.

### WINDOWS:

This is a standard window menu.

### The Parameter Entry Area:

There are three screens to the Parameter Entry area. Each one of these screens can be accessed simply by clicking on the left mouse button once the cursor is positioned on the desired "folder tab". These folder tabs are labeled Main Parameters, Scrambler and FEC, and Filters; located at top of the screen. All the fields in the three taps can be individually downloaded by clicking an event choice or changing a value and pressing the <Enter> key. All the changes made on the three tabs will be updated in the Write Registers window, but not vice versa.

The Main Parameters screen is shown in the following page. The TAB key moves the cursor from field to field.

## MAIN PARAMETERS SCREEN

### SAMPLING RATE

#### Master Clock Frequency

The Master Clock Frequency window must be set (in Hz) to match the actual clock rate. The clock frequency to specify is either the external oscillator source connected to the J2 connector, or the on-board 102.4 MHz crystal oscillator (selected by JP4). The software enforced limit to this field is set (above the rated performance of the hardware) at 200 MHz. The following relationship must be formed between the master clock, interpolation ratio, and symbol rate:

$$\text{Master Clock} = 4 * \text{Interpolation Ratio} * \text{Symbol Rate}$$

#### Interpolation Ratio

The interpolation ratio determines the sampling rate of the FIR filter and the symbol rate of the modulator. The symbol rate will be equal to the Master Clock rate divided by four times the interpolation ratio.

#### Symbol Rate

For QPSK modulation, the symbol rate is half of the data rate. For 16QAM modulation, the symbol rate is one fourth the data rate. When choosing a symbol rate, be sure that the requirement is met with Master Clock and Interpolation Ratio as mentioned above in the Master Clock Frequency description. Symbol rate is a calculated field.

### BURST PARAMETERS

Note that the sum of the lengths of the preamble, packet size, and guard time must not exceed 16384.

#### Preamble Size

STEL-1209's preamble size is programmable between 0 and 255 symbols.

#### Packet Size

Minimum packet length is one and maximum packet length is given by  $\text{Packet Length(max)} = 16383 - \text{Guard Time} - \text{Preamble}$ . Default value for packet size is 512.

The screenshot shows the 'Parameters - STEL1209' window of the Stanford Telecom 1209 Evaluation Board software. The window is divided into several sections:

- Main Parameters:** Includes fields for Master Clock (102400000 Hz), Interpol. Ratio (20), Symbol Rate (1280000 sps), Burst Parameters (Preamble Size: 14, Packet Length: 512, Guard Time: 526), and Modulator Output (NCO Frequency: A, B, or C; Attenuation Step: 0 dB; Freeze NCO SIN output; Invert Spectrum).
- Scrambler and FEC:** Includes Modulation Format (Modulation Type: QPSK, Modulation Mode: Burst Autorepeat, Burst Qty: 1) and Data and Timing (Preamble Source: UserFile(SRAM), Data Source: External Source, Data Clock Source: External Tclk - Master Mode).
- Filters:** Includes Bit and Symbol Mapping (Mapper Type: QPSK, showing a constellation diagram) and FIR Filter Gain (Enable I1 Q1 I0 Q0).
- Comm Ports:** Includes COM1, COM2, COM3, and COM4.
- Communication Status:** Includes a Demo OFF checkbox and a 'Ready to Communicate' indicator.

At the bottom of the window, there are status bars: 'Select the Preamble Source UserFile (SRAM)/External' and 'COM2,9600,n,8,1'.

## Guard Time

The minimum guard time required between each burst is 2 symbols. The maximum guard time available is given by Guard Time (max) = 16383 - Packet Length - Preamble. The default guard time is 526 symbols which equals the sum of 14 preamble and 512 data symbols. This will burst on and off at a 50% duty cycle.

In conjunction with the STEL-9244 burst receiver, a 50% duty cycle makes it easy to test BER performance.

## MODULATOR OUTPUT

There are three Frequency Code Word registers in the STEL-1109. The active Frequency Code Word is indicated by the selected button (default is labeled A located just beneath the label "NCO Frequency (Hz)"). The content of the three Frequency Code Words are shown through the three boxes below the three buttons. Their content are modifiable but it will only take effect after the Enter key is pressed.

### Attenuation Step

This controls the attenuator on the STEL-1209 board in 1 dB steps, from 0 to 15 dB.

### Freeze NCO SIN output

This button collapses the constellation onto the I axis. It can be used in BPSK mode to rotate the constellation by 45°.

### Invert Spectrum

The output of the I- and Q-channel adder block in the STEL-1109 normally provides an output of the form  $I\cos(wt) + Q\sin(wt)$ . By selecting the Invert Spectrum button this will be changed to  $-I\cos(wt) + Q\sin(wt)$ . This interchanges the upper and lower sidebands of the signal, thereby inverting the spectrum.

## MODULATION FORMAT

### Modulation Type

Four buttons are provided to allow selection of any one of four modulation types; 16QAM, QPSK, BPSK, and continuous waveform (CW).

### Modulation Mode

Three modulation modes for each modulation type (except CW) are provided; Continuous, Burst Auto repeat, and Burst Qty. To transmit a fixed number of bursts, the desired number can be specified in the box provided below the Burst Qty button. The <Enter> key sends the specified number of bursts each time it is pressed but only when the Burst Qty box is the active box. When other parameters are edited, the Enter key

will not cause another burst cycle. For example, if the Burst Qty box has a value of 5, changing the preamble value to 2 and pressing the Enter key does not cause the Burst Controller to fire 5 bursts with 2 preamble symbols. Instead, the cursor has to re-select the Burst Qty box and the Enter key must be pressed again.

## DATA AND TIMING

### Preamble Source

The user has a choice of preamble sources. A specific pattern for the preamble can be pre-stored in internal SRAM or taken from J1 (external data source). Default preamble bit pattern is 11 11 11 00 00 11 00 00 00 00 00 00 00.

### Data Source

Likewise, data can be stored in internal SRAM or taken from external data source (J1). The STEL-1209 also has capability to generate two types of pseudo random codes; [10,3] and [23,18] that can be used in place of the data.

### Data Clock Source

The STEL-1209 can be configured to be self sufficient in terms of clock signals. In this state, the on-board 102.4 MHz crystal oscillator generates the master clock and all other clocks are derived from it. This state is called the master mode. It is also possible to configure the STEL-1209 board into slave mode in which an external continuous bit rate clock must be applied to J6 (EXT TCLK). This feature is useful in applications where data must be synchronized to an external reference clock. Select External TCLK if this is warranted by the application.

### Bit and Symbol Mapping

16QAM modulation requires all internal resources to map its constellation. In QPSK or BPSK, less constellation is needed and it is therefore possible to map these constellations (QPSK and BPSK's) to those vacated by the 16QAM constellation. Some amount of gain could thus be gained by the QPSK or the BPSK modulation.

## CONFIGURE

This button which is located at the lower right hand corner of the main screen can be used to do an overall loading of all the registers with values as presented by the GUI software.

## RESET 1209

This button resets the STEL-1209 board by software command.

## SCRAMBLER AND FEC SCREEN

This screen provides all the buttons that can be used to exercise the different features of the STEL-1109 like Reed-Solomon, Scrambler, and Differential Encoder.

### CONTROL SIGNALS

#### **Reed-Solomon Enable**

RSDLEN signal can be used to tell the STEL-1109 to turn on the Reed-Solomon engine. This is the H/W Control method and the corresponding button should be selected. Without using the RSDLEN signal, the Reed-Solomon engine can also be turned on by selecting the S/W Control and Enable buttons.

#### **Scrambler Enable**

SCRMEN signal can be used to tell the STEL-1109 to turn on the Scrambler engine. This is the H/W Control method and the corresponding button should be selected. Without using the SCRMEN signal, the Scrambler engine can also be turned on by selecting the S/W Control and Enable buttons.

#### **Differential Encoder Enable**

DIFFEN signal can be used to tell the STEL-1109 to turn on the Diff. Encoder engine. This is the H/W Control method and the corresponding button should be selected. Without using the DIFFEN signal, the Diff. Encoder engine can also be turned on by selecting the S/W Control and Enable buttons.

### SCRAMBLER

#### **Synchronization**

There are two scrambling types. Refer to STEL-1109 for more detail information on Frame and Self synchronization method.

## **Initial and Mask Registers**

The Scrambler can be programmed using 24-bit mask registers and its initialization words as seed. The Polynomial Display updates the randomizer selection in a polynomial form. The default is set for Davic standard.

### REED-SOLOMON ENCODER

#### **Primitive Polynomial**

There are two RS Encoder polynomials embedded in the STEL-1109 ASIC to choose from.

#### **Block Code Parameters**

N is the block length which can be programmed in the ranged of 3 to 255 bytes. K represents the number of actual message bytes in a block code. T tells the error correction capability in bytes ranging from 0 to 10. T is a calculated field based on the selection of N and K. The values chosen for N and K have to satisfy the condition that N-k must be an even number.

#### **Conversion and Transfer**

The serial input data stream is converted into 8-bit parallel words at the front end of RS Encoder. The serial to parallel converter can be programmed to make the first serial input bit the MSB or the LSB of 8-bit RS symbol. Likewise, the encoded words are converted back to serial data at the output of the RS Encoder. The parallel to serial converter can be programmed as well.

### CHANGE SCRAMBLER POSITION

The Scrambler and Reed-Solomon Encoder's position is interchangeable inside of STEL-1109 and this feature will give the user more flexibility towards specific applications.



## FILTERS SCREEN

The STEL-1109 provides a total of 32 taps for the FIR filter coefficients. The FIR filter architecture as provided calls for a symmetrical number of taps; thus, one only needs to enter the FIR coefficients 16 times.

### FIR AND INTERPOLATION FILTER

#### FIR Filter Bypass

This button allows the user data to bypass FIR filter processing. A useful feature in testing.

#### FIR Filter Shape

This GUI provides two commonly used FIR filter shapes for evaluation; Raised Cosine and Root Raised Cosine. The user has further flexibility to provide

their own FIR filter shape by choosing the custom button.

#### FIR Bandwidth

Allow user to program the FIR filter with 'alpha' in the range of 0 to 1. With each value entered, a new set of FIR Filter coefficients is calculated and displayed.

#### FIR Scaling

The calculated coefficients can be scaled down by entering a value from 1 to 0. This can avert the saturation of accumulators (internal to the STEL-1109) if a specific FIR Bandwidth is required (fixed), and the user wants to get as much power as possible from the IF output of the STEL-1209.

The screenshot shows the 'Stanford Telecom 1209 Evaluation Board' GUI. The 'Parameters - STEL1209' window is open, with the 'Filters' tab selected. The 'FIR and Interpolation Filter' section includes a checkbox for 'FIR Filter Bypass', radio buttons for 'FIR Filter Shape' (Raised Cosine, Rt. Raised Cosine, Custom Shape), and input fields for 'FIR Bandwidth' (0.4), 'FIR Scaling' (1), 'Interpolation Filter Gain' (9), and 'Interpolation Stages' (3). The 'FIR Filter Coefficients' section displays a 4x4 grid of input fields for coefficients, with values: 0, 31 | 0; 4, 27 | -9; 8, 23 | 15; 12, 19 | 13; 1, 30 | 6; 5, 26 | -4; 9, 22 | -28; 13, 18 | 186; 2, 29 | 6; 6, 25 | 13; 10, 21 | -77; 14, 17 | 381; 3, 28 | -4; 7, 24 | 28; 11, 20 | -77; 15, 16 | 511. The 'Communication Status' section shows 'Comm Ports' (COM1, COM2, COM3, COM4) with COM2 selected, and 'Demo OFF' checked. A traffic light icon is green, and a 'Ready to Communicate' message is displayed. 'Configure' and 'Reset 1209' buttons are at the bottom right. The status bar at the bottom right shows 'COM2,9600,n,8,1'.

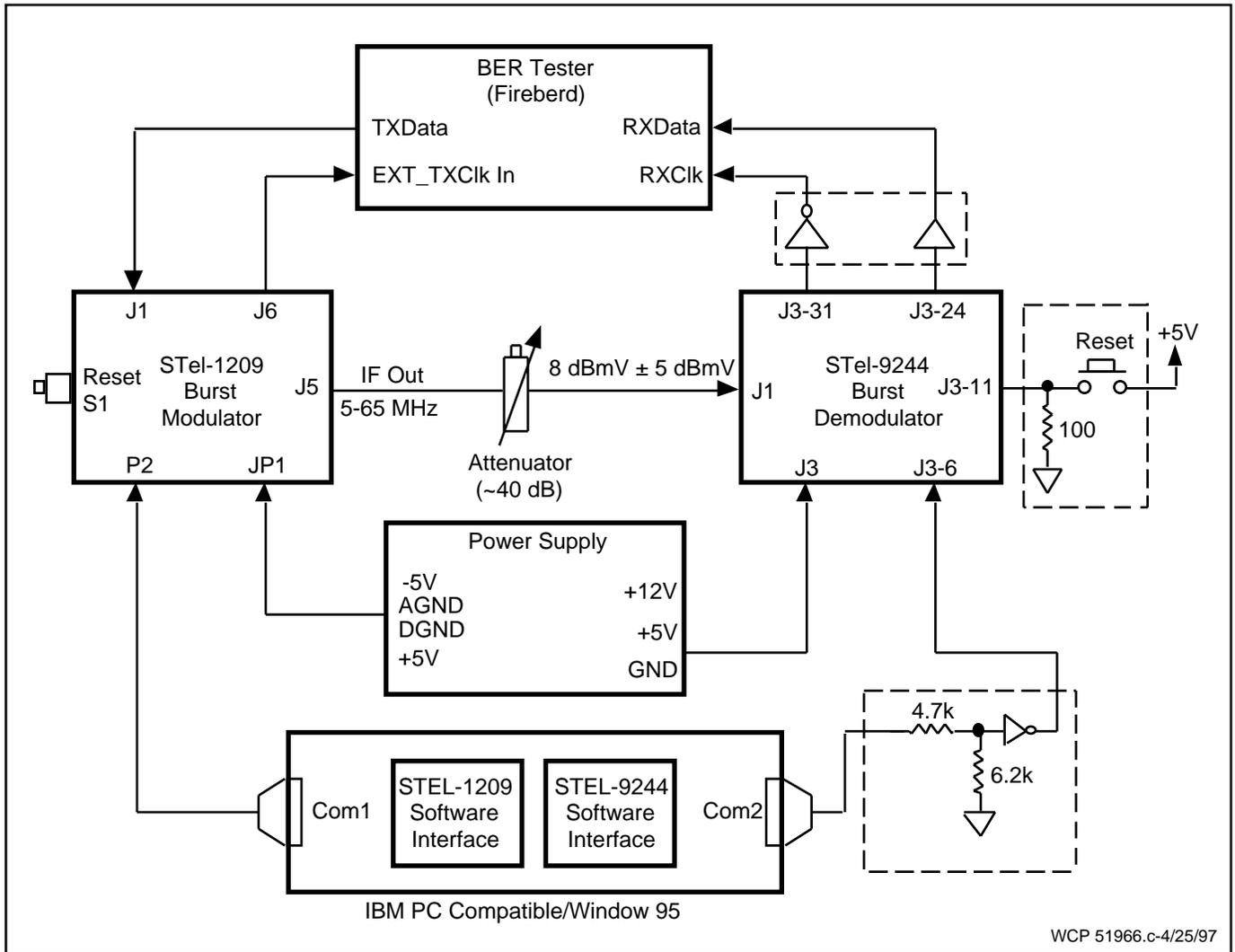
## Interpolation Filter Gain

This controls the gain through the interpolator. This gain needs to be set according to the interpolation ratio factor and the number of interpolation stages selected. Care must be taken in setting this parameter. For best spur performance and maximum output power, the filter gain should be maximized. However, if it is too large, the digital data will overflow internally (in the STEL-1109) and the output will be severely distorted. The gain factor can be set from 0 to 15, the actual gain doubling each time the factor is incremented by one.

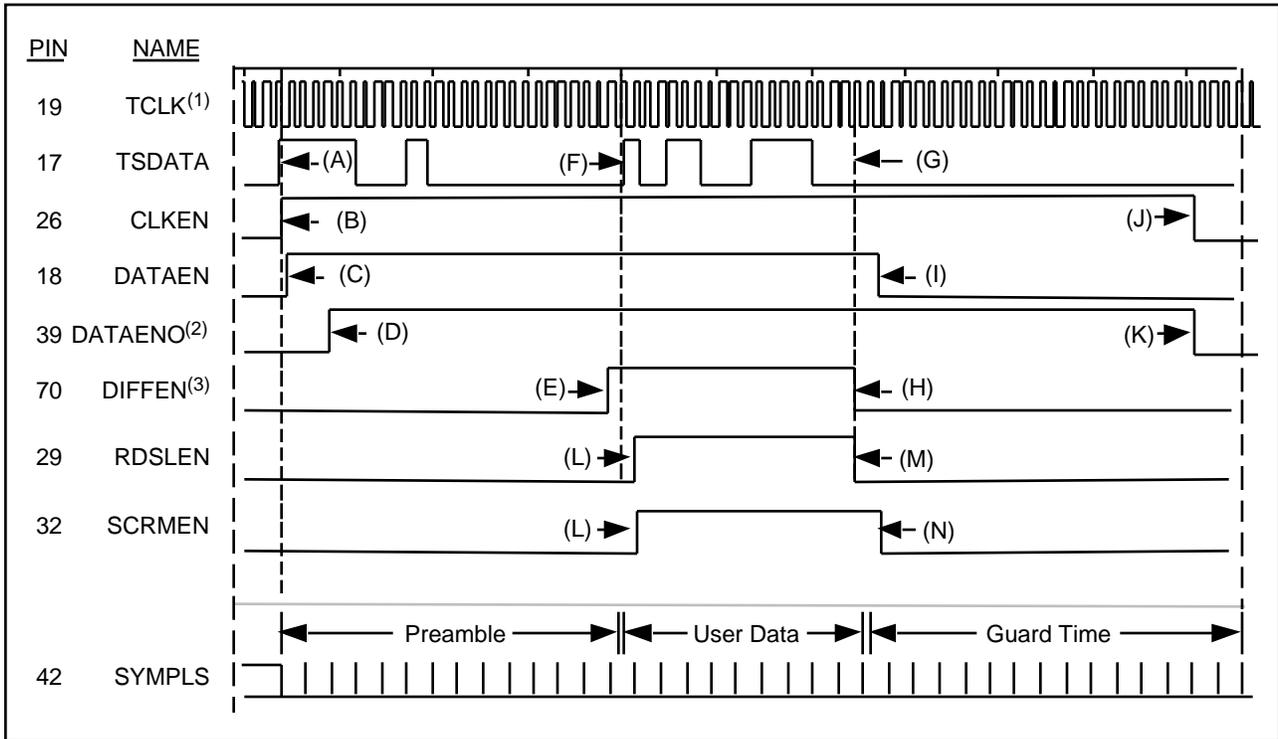
## Interpolation Stages

The number of interpolation stages used in the STEL-1109 can be varied from 1 to 3 by means of this field. Three stages should be used whenever possible, to minimize spur levels. However, it may be necessary to use fewer than three stages when the data rate is very slow relative to the master clock frequency. Otherwise, the interpolator gain will be too high and FIR filter coefficients will have to be scaled down to compensate. This will result in poor filter characteristics due to coefficient quantization.

## BER TEST SETUP



Slave Mode, QPSK  
 Burst Timing: Full Burst

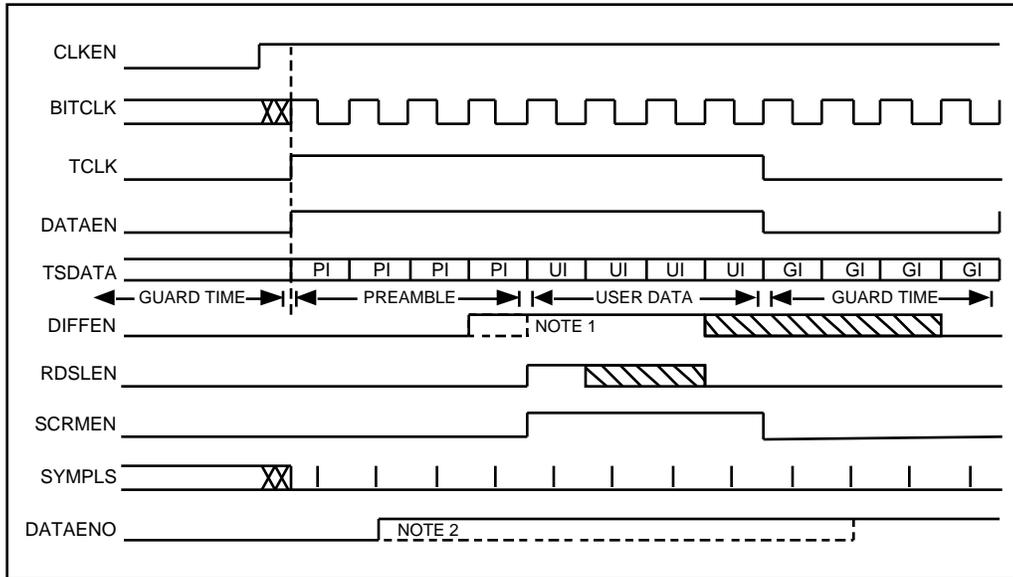


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NOTES:

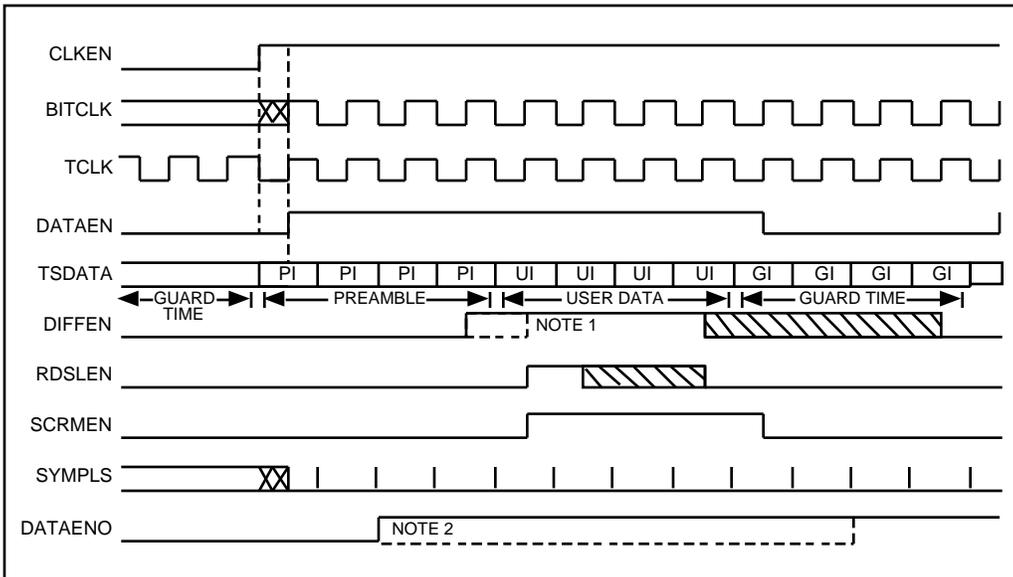
- (1) All input signals shown are derived from TCLK. Each edge is delayed from a TCLK edge by typically 6 to 18 nsec. DATAENO does not depend on TCLK but its edges are synchronized to TCLK. TCLK itself can be turned off after DATAENI goes low.
- (2) DATAENO shown at its minimum pipeline delay position. This is achieved by setting bit 6 of Configuration Register 36<sub>H</sub> to zero. Reed-Solomon cannot be used in this mode. If bit 6 is set high, allowing Reed-Solomon an additional pipeline delay of 8 bits is inserted into the data path. This will shift both edges of DATAENO to the right by 8 cycles of TCLK.
- (3) If the preamble is not encoded the same as the user data, the DIFFEN control can be toggled in mid transmission as shown. Otherwise, the DIFFEN control can be held high or low depending on encoding desired.
- (A) First data bit transition on falling edge of TCLK (first of 14 preamble symbols). The data will be valid on the next rising edge of TCLK.
- (B) CLKEN rises on the same falling edge of TCLK that the data starts on. CLKEN is allowed to rise any time earlier than shown.
- (C) DATAEN rises on the first rising edge of TCLK (middle of the first preamble bit).
- (D) DATAENO rises on the falling edge of TCLK (at the end of the second symbol).
- (E) DIFFEN rises on the rising edge of TCLK one symbol before the first user data symbol.
- (F) User data bits change on the falling edge of TCLK and must be valid during the next rising edge of TCLK.
- (G) End of user data. Note that the data is allowed to go away immediately after it is latched in by the rising of TCLK which occurs in the middle of the last user data bit.
- (H) DIFFEN goes low on rising edge of TCLK (last user data symbol).
- (I) DATAEN goes low on rising edge of TCLK (on the cycle of TCLK after the last user data bit).
- (J) CLKEN must stay high until any time on or after the point where DATAENO goes low.
- (K) DATAENO stays high until the 13th SYMPLS after DATAEN goes low.
- (L) RDSLEN and SCRMEN go high on the first rising edge of TCLK in the User Data.
- (M) RDSLEN goes low on the rising edge of TCLK (last user data symbol).
- (N) SCRMEN goes low on the rising edge of TCLK (on the cycle of TCLK after the last user data bit).

Master Mode, BPSK  
BURST TIMING SIGNAL RELATIONSHIPS



WCP 52911.c-5/6/97

Slave Mode, BPSK  
BURST TIMING SIGNAL RELATIONSHIPS

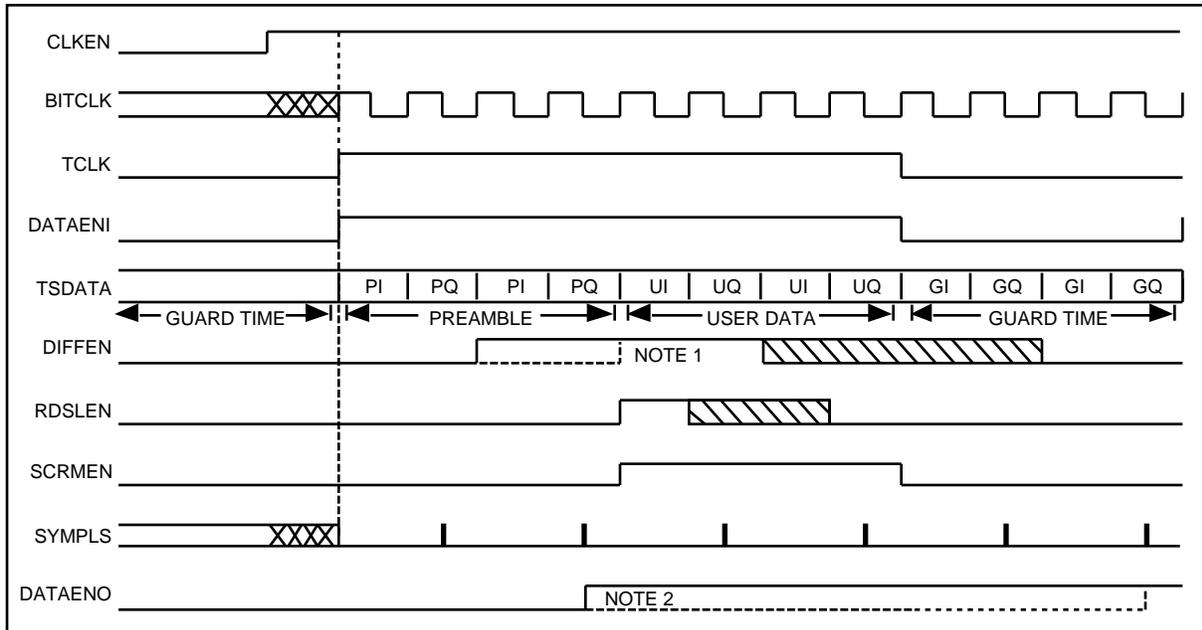


WCP 52912.c-5/6/97

NOTE 1: STEL receivers differentially decode relative to the last preamble symbol. To encode the first symbol against a "zero" symbol reference instead, bring DIFFEN high at the leading edge of the user data packet (dotted line).

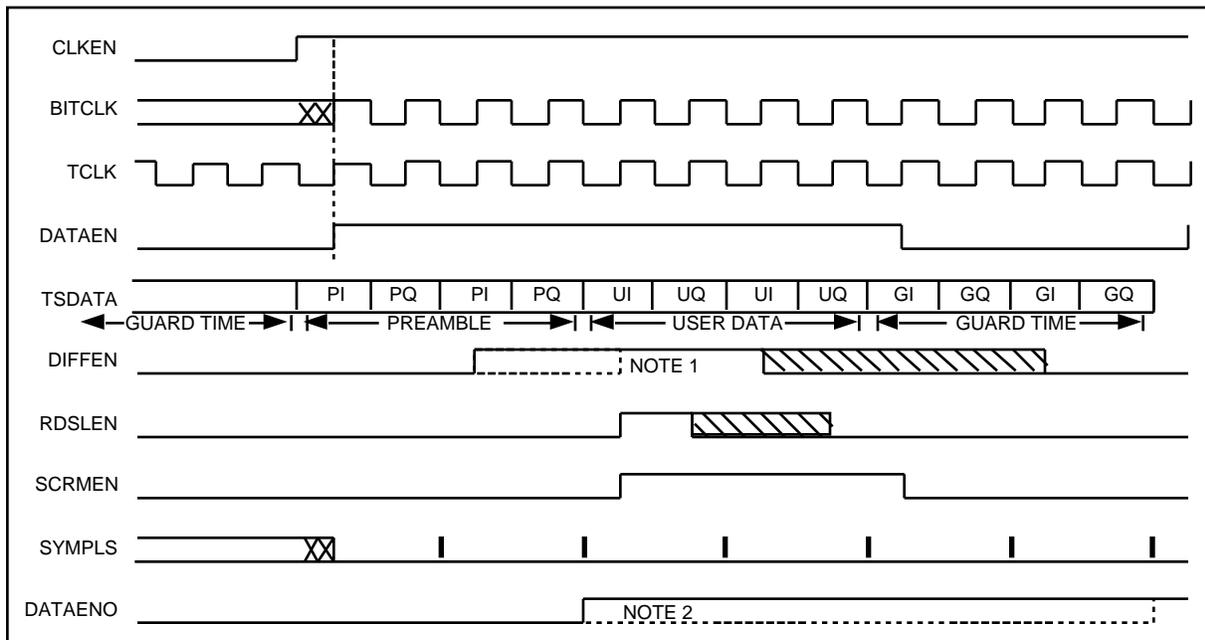
NOTE 2: If bit 6 of Configuration Register 36<sub>H</sub> is a "1" then the rising edge of DATAENO will be delayed by eight cycles of BITCLK (dotted line). This is required if the Reed-Solomon encoder is used.

Master Mode, QPSK  
BURST TIMING SIGNAL RELATIONSHIPS



WCP 52840.c-5/2/97

Slave Mode, QPSK  
BURST TIMING SIGNAL RELATIONSHIPS

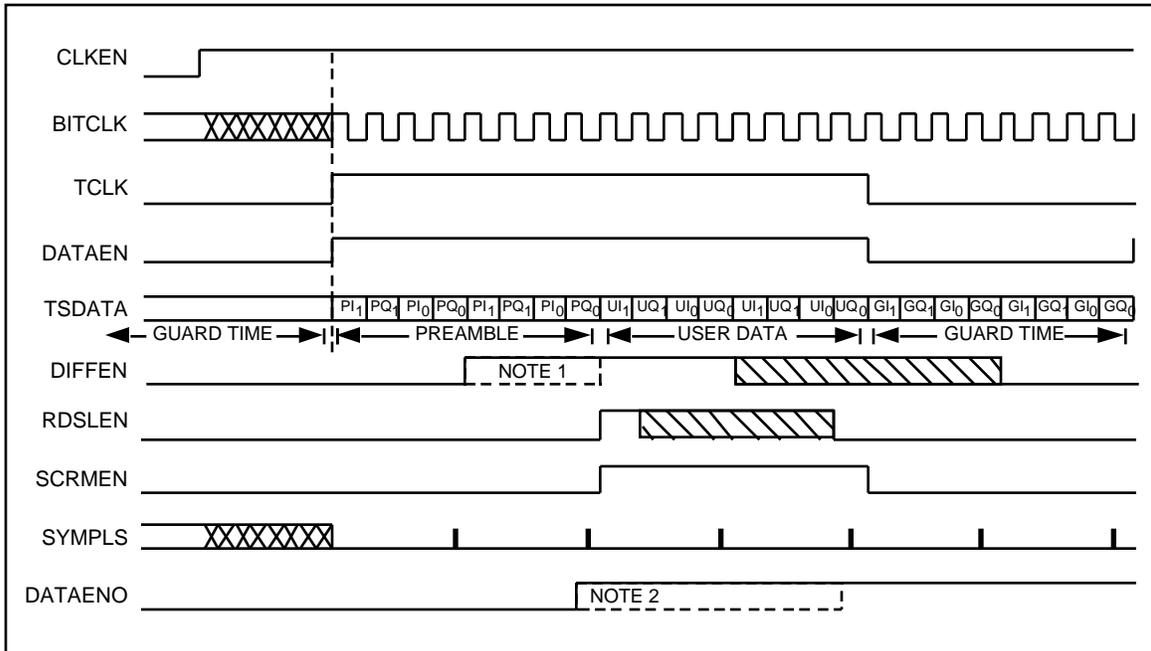


WCP 52839.c-5/7/97

NOTE 1: STEL receivers differentially decode relative to the last preamble symbol. To encode the first symbol against a "zero" symbol reference instead, bring DIFFEN high at the leading edge of the user data packet (dotted line).

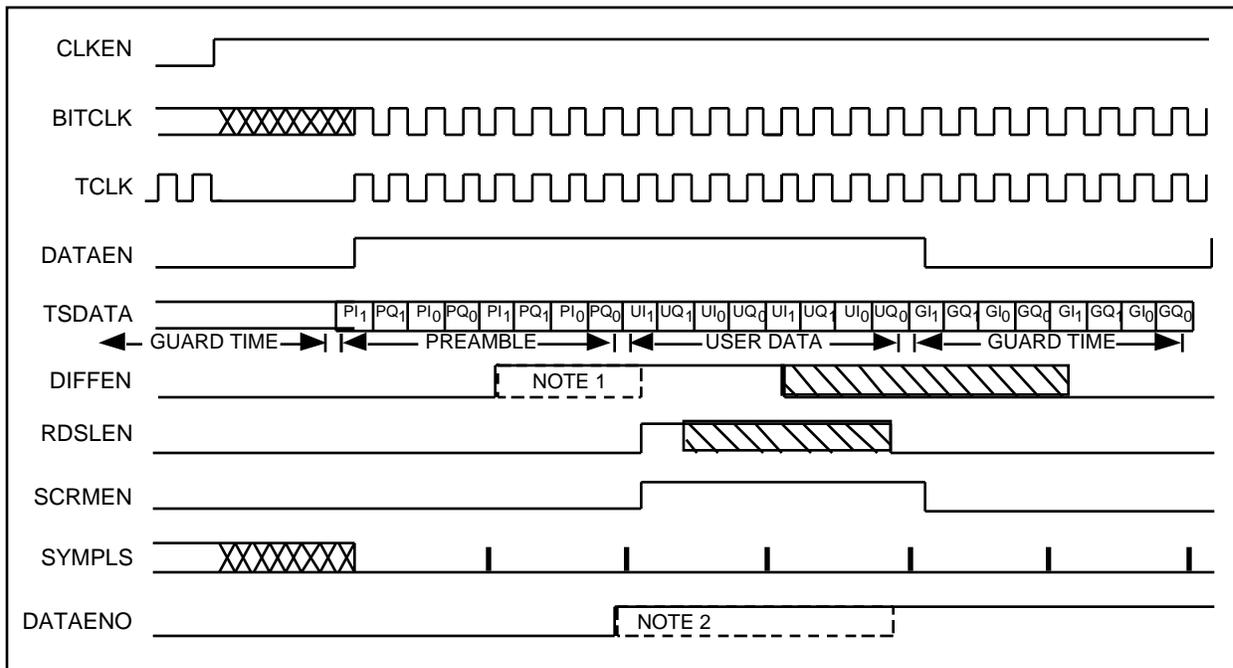
NOTE 2: If bit 6 of Configuration Register 36<sub>H</sub> is a "1" then the rising edge of DATAENO will be delayed by eight cycles of BITCLK (dotted line). This is required if the Reed-Solomon encoder is used.

Master Mode, 16QAM  
BURST TIMING SIGNAL RELATIONSHIPS



WCP 52913.c-5/6/97

Slave Mode (16QAM Shown)  
BURST TIMING SIGNAL RELATIONSHIPS

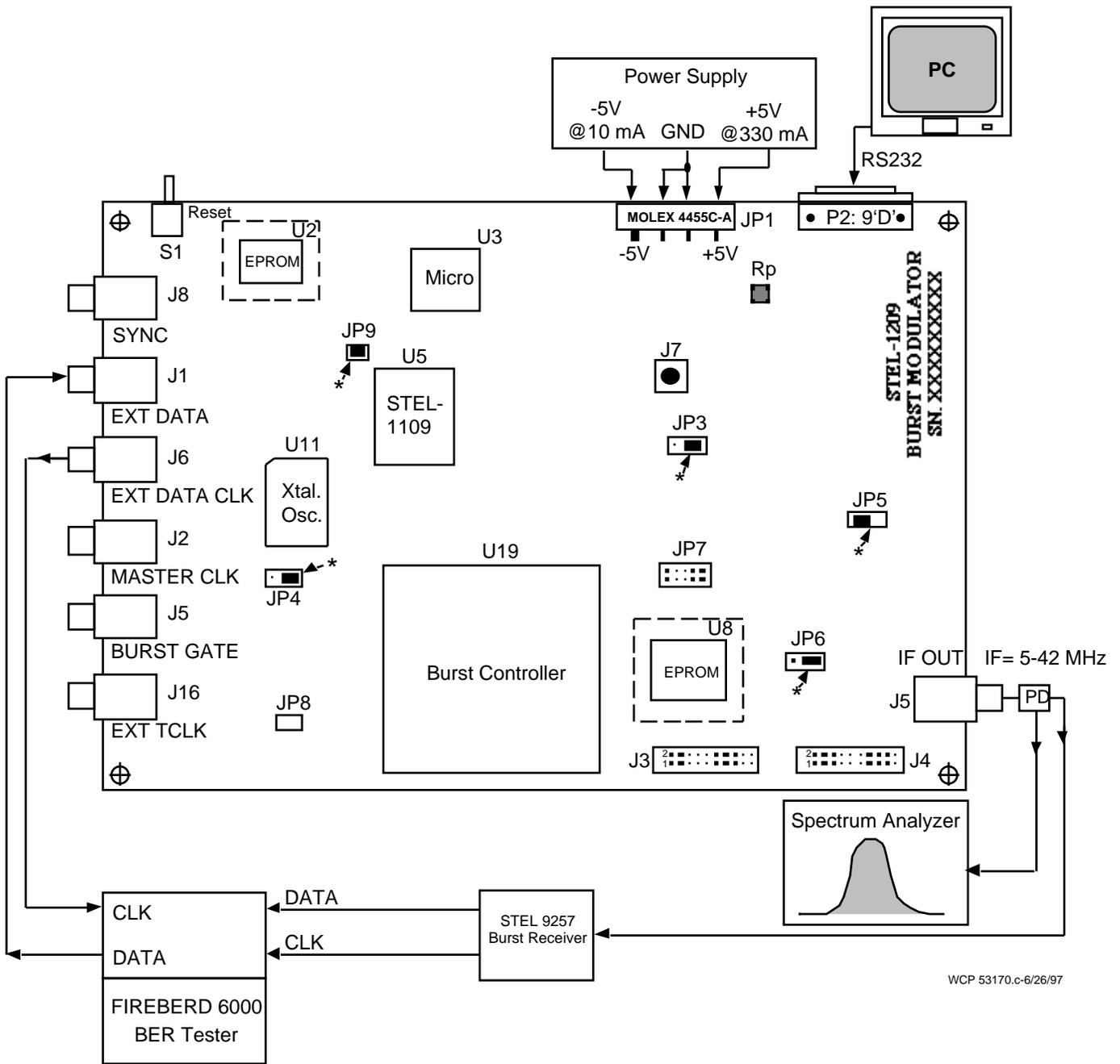


WCP 52914.c-5/7/97

NOTE 1: STEL receivers differentially decode relative to the last preamble symbol. To encode the first symbol against a "zero" symbol reference instead, bring DIFFEN high at the leading edge of the user data packet (dotted line).

NOTE 2: If bit 6 of Configuration Register 36<sub>H</sub> is a "1" then the rising edge of DATAENO will be delayed by eight cycles of BITCLK (dotted line). This is required if the Reed-Solomon encoder is used.

INITIAL SET-UP DIAGRAM



WCP 53170.c-6/26/97

STEL-1209 Default Setting:  
 1. Place All Jumpers As Shown With The \*

**STEL-1209 IC PARTS LIST**

<b>Reference Designator</b>	<b>Part Number</b>	<b>Manufacture</b>
U8	AT17C256	Atmel
U15	CLC404AJE	Comlinear
U18	AT-210	M/A-COM
U7,U17	LT1117CST	Linear Technology
T1	T1-6T-KK81	Mini-Circuit
U20	IDT6116SA35SO	IDT
U4	MAX707CSA	Maxim
U16	MAX232CSE	Maxim
U2	27C256-120JC	AMD
U1	MC74HC573ADW	Motorola
U10	74LVT14D	Philips
U3	P80C32EBA	Intel
U19	EPF81188AQC240-4	Altera

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WCP 970092A