

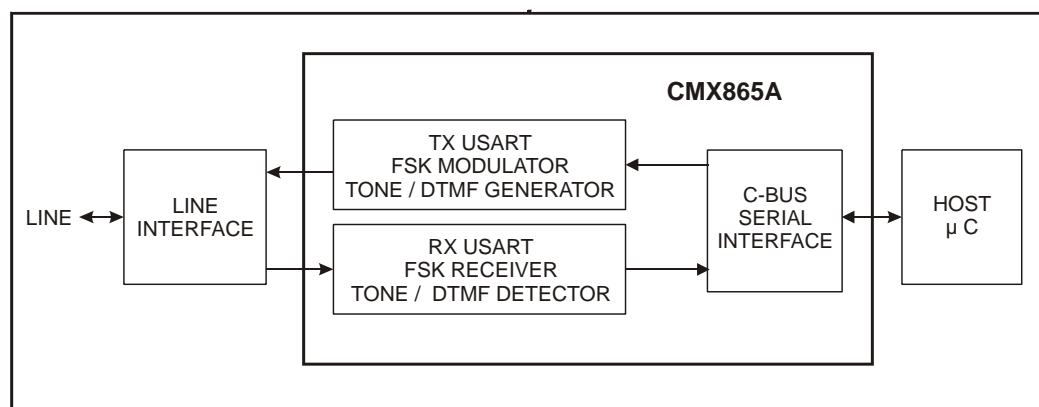
### CMX865A – DTMF CODEC AND TELECOM SIGNALLING COMBO

#### Features

- V.23 1200/75, 1200/1200, 75, 1200 bps FSK
- Bell 202 1200/150, 1200/1200, 150, 1200 bps FSK
- V.21 or Bell 103 300/300 bps FSK
- Low Voice Falsing DTMF Decoder
- DTMF/Tones Transmit and Receive
- Low Power - High Performance

#### Applications

- Wireless Local Loops
- SMS Phones
- Security Systems
- Remote Utility Meter Reading
- Industrial Control Systems
- Pay-Phones
- Set-Top Boxes



## 1. Brief Description

The CMX865A is a multi-standard modem for use in Wireless Local Loop, Short Message Service telephone based information and telemetry systems. Flexible line driver, hybrid and receiver circuits are integrated on chip, requiring only passive external components to build a 2 or 4-wire line interface.

A high-quality DTMF decoder with excellent immunity to falsing on voice and a standard DTMF encoder are included. Alternatively, these blocks can be used to transmit and detect user-specific, programmed single and dual-tone signals, simple melodies, call progress signals or modem calling and answering tones.

Host control and data transfer is via a high-speed serial bus that operates in normal and Powersave modes and which is compatible with most simple types of  $\mu C$  serial interface. An embedded USART allows multi-format asynchronous data and unformatted synchronous data to be received or transmitted as 8-bit bytes.

The CMX865A operates from a single 3.0V to 3.6V supply over a temperature range of  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and is available in 16-pin SOIC (D4) and 16-pin TSSOP (E4) packages.

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It is always recommended that you check for the latest product datasheet version from the Datasheets page of the CML website: [[www.cmlmicro.com](http://www.cmlmicro.com)].

## 2. Block Diagram

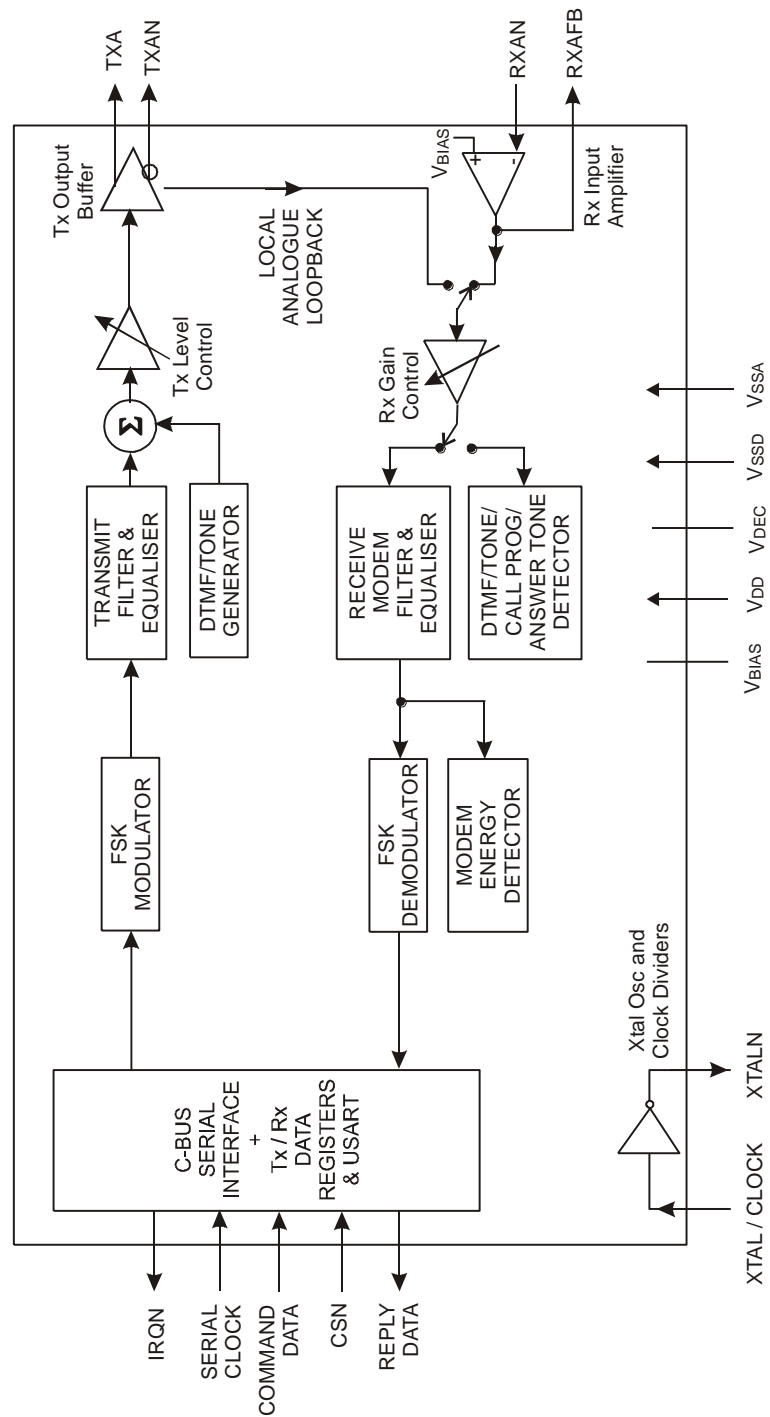


Figure 1 Block Diagram

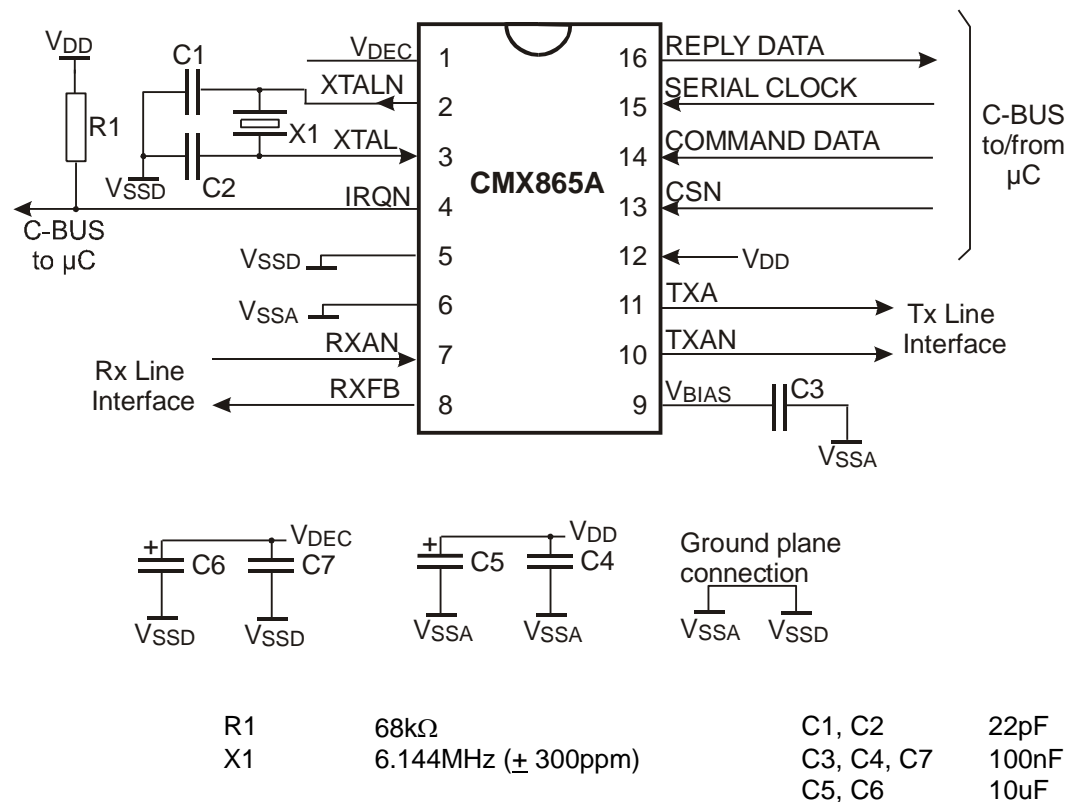
### 3. Signal List

| CMX865A<br>(D4 and E4) |              | Signal |  | Description |
|------------------------|--------------|--------|--|-------------|
| Pin No.                | Name         | Type   |  |             |
| 1                      | VDEC         | Power  | Internally generated 2.5V supply voltage. Must be decoupled to VSSD by capacitors mounted close to the device pins. No other connections allowed.  |             |
| 2                      | XTALN        | O/P    | The output of the on-chip Xtal oscillator inverter.  |             |
| 3                      | XTAL/CLOCK   | I/P    | The input to the oscillator inverter from the Xtal circuit or external clock source.   |             |
| 4                      | IRQN         | O/P    | A 'wire-ORable' output for connection to a $\mu$ C Interrupt Request input. This output is pulled down to VSS when active and is high impedance when inactive. An external pull-up resistor is required i.e. R1 of Figure 2. |             |
| 5                      | VSSD         | Power  | The digital negative supply rail (ground).   |             |
| 6                      | VSSA         | Power  | The analogue negative supply rail (ground).  |             |
| 7                      | RXAN         | I/P    | The inverting input to the Rx Input Amplifier  |             |
| 8                      | RXAFB        | O/P    | The output of the Rx Input Amplifier.  |             |
| 9                      | VBIAS        | O/P    | Internally generated bias voltage of approximately $V_{DD}/2$ , except when the device is in 'Powersave' mode when VBIAS will discharge to VSS. Should be decoupled to VSS by a capacitor mounted close to the device pins.  |             |
| 10                     | TXAN         | O/P    | The inverted output of the Tx Output Buffer.   |             |
| 11                     | TXA          | O/P    | The non-inverted output of the Tx Output Buffer.   |             |
| 12                     | VDD          | Power  | The positive supply rail. Levels and thresholds within the device are proportional to this voltage.  |             |
| 13                     | CSN          | I/P    | The C-BUS chip select input from the $\mu$ C.  |             |
| 14                     | COMMAND DATA | I/P    | The C-BUS serial data input from the $\mu$ C.  |             |
| 15                     | SERIAL CLOCK | I/P    | The C-BUS serial clock input from the $\mu$ C.   |             |
| 16                     | REPLY DATA   | T/S    | A 3-state C-BUS serial data output to the $\mu$ C. This output is high impedance when not sending data to the $\mu$ C.   |             |

#### Notes:

I/P     =     Input  
 O/P     =     Output  
 BI      =     Bidirectional  
 T/S     =     3-state Output  
 NC      =     No Connection

#### 4. External Components



Resistors  $\pm 5\%$ , capacitors  $\pm 20\%$  unless otherwise stated

**Figure 2 Recommended External Components for a Typical Application**

This device is capable of detecting and decoding small amplitude signals. To achieve this, VDD, VDEC and VBIAS should be decoupled close to the package and the receive path protected from extraneous in-band signals.

It is recommended that the printed circuit board is laid out with low impedance analogue and digital ground planes. The analogue ground plane should be a solid area under the analogue section of the device defined by pins 6 – 11, plus associated external components. The digital ground plane should be a solid area under the digital section of the device defined by pins 1 – 5 and 13 – 16, plus associated external components. The two ground planes should be connected together at a suitable point and connected into the board ground.

The VSS connections to the Xtal oscillator capacitors C1 and C2 should also be low impedance and preferably be part of the digital VSS ground plane to ensure reliable start up of the oscillator.

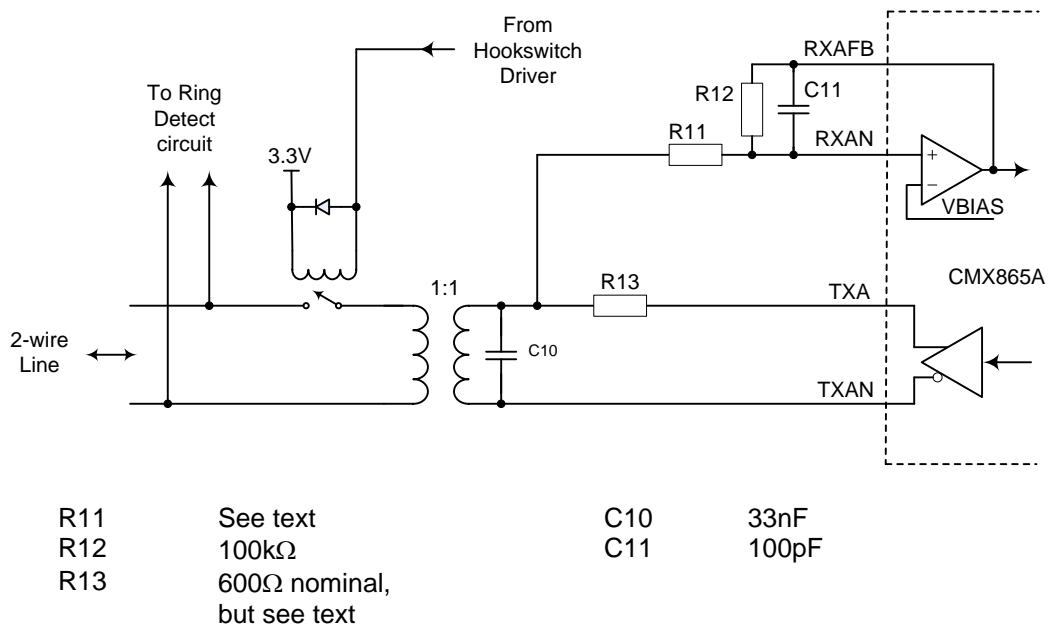
For best results, an Xtal oscillator design should drive the clock inverter input with signal levels of at least 40% of VDD peak-to-peak. To obtain Xtal oscillator design assistance, please consult your Xtal manufacturer.

#### 4.1. Line Interface (DAA)

A line interface circuit is needed to provide dc isolation and to terminate the line. Typical interface circuits are described below.

#### 4.1.1. 2-Wire Line Interface

Figure 3 shows a simplified interface for use with a 600Ω 2-wire line. The complex line termination is provided by R13 and C10, high frequency noise is attenuated by C10 and C11, while R11 and R12 set the receive signal level into the modem. For clarity the 2-wire line protection circuits have not been shown.

Resistors  $\pm 5\%$ , capacitors  $\pm 20\%$ 

### Figure 3 Typical 2-Wire Line Interface Circuit

Resistor R13 is used to match the ac impedance of the interface to the line. With an ideal transformer this resistor would be equal to the desired impedance (e.g.  $600\Omega$ ); however in practice with a real transformer, R13 should be set such that the interface as a whole presents the desired impedance. Line transformer manufacturers normally provide guidance in this regard.

The transmit line signal level is determined by the voltage swing between the TXA and TXAN pins, less 6dB due to the line termination and less the loss in the line coupling transformer.

Allowing for 1dB loss in the transformer, then with the Tx Mode Register set for a Tx Level Control gain of 0dB the nominal transmit line levels will be:

|                           | VDD = 3.3V        |
|---------------------------|-------------------|
| Tx modem modes            | -9.2dBm           |
| Single tone transmit mode | -9.2dBm           |
| DTMF transmit mode        | -5.2 and -7.2 dBm |

For a line impedance of  $600\Omega$ ,  $0\text{dBm} = 775\text{mV}_{\text{rms}}$ . See also section 7.1.3.

In the receive direction, the signal detection thresholds within the CMX865A are proportional to VDD and are affected by the Rx Gain Control gain setting in the Rx Mode Register. The signal level into the CMX865A is affected by the line coupling transformer loss and the values of R11 and R12 of Figure 3.

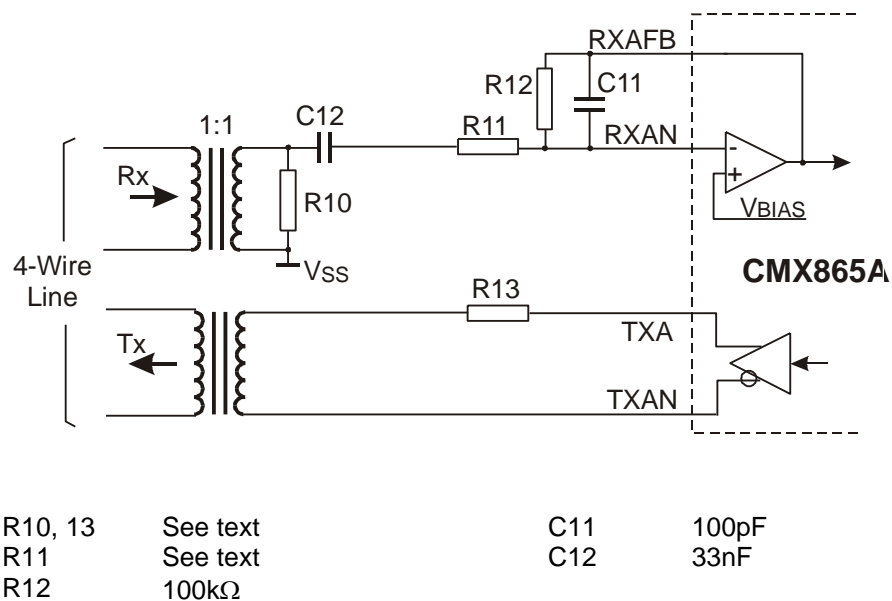
Assuming 1dB transformer loss, the Rx Gain Control programmed to 0dB and  $R12 = 100\text{k}\Omega$ , then for correct operation (see section 7.1.3) the value of  $R11$  should be equal to  $500 / V_{DD} \text{ k}\Omega$  i.e.  $150\text{k}\Omega$  at 3.3V.

For best Rx performance it is recommended that the transformer coupling arrangement should provide at least 7dB trans-hybrid loss. This is achieved by minimising the amount of the transmitted signal presented to the receiver as measured at RXAFB.

#### 4.1.2. 4-Wire Line Interface

Figure 4 shows a simplified interface for use with a  $600\Omega$  4-wire line. The line terminations are provided by  $R10$  and  $R13$ , the values of which are dependent on the choice of transformer: line transformer manufacturers normally provide guidance in this regard. High frequency noise is attenuated by  $C11$  while  $R11$  and  $R12$  set the receive signal level into the modem.

Transmit and receive line level settings and the value of  $R11$  are as for the 2-wire circuit.

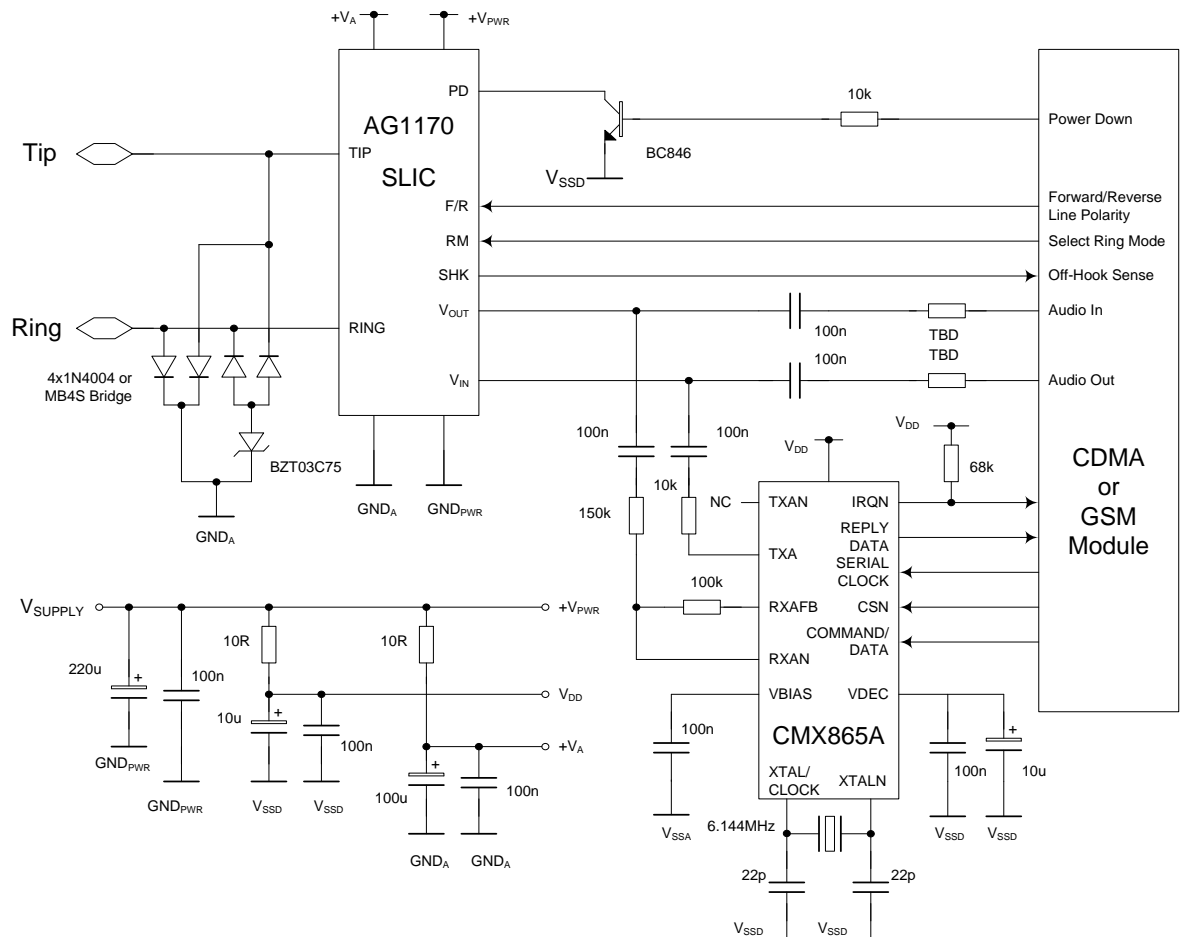


Resistors  $\pm 5\%$ , capacitors  $\pm 20\%$

**Figure 4 Typical 4-Wire Line Interface Circuit**



### 4.1.3. Wireless Local Loop Interface



### Figure 5 The CMX865A in a Wireless Local Loop Application

The above circuit is a simplified representation of a typical design. In practice, the actual circuit design and external components should be implemented with due regard to the datasheets of the SLIC and wireless module. Particular emphasis should be given to the design of the power supply decoupling arrangement in order to minimise the effects of noise currents between the ICs.

## 5. General Description

The CMX865A transmit and receive operating modes are independently programmable.

The transmit mode can be set to any one of the following:

- V.21 modem. 300bps FSK (Frequency Shift Keying).
- Bell 103 modem. 300bps FSK.
- V.23 modem. 1200 or 75 bps FSK.
- Bell 202 modem. 1200 or 150 bps FSK.
- DTMF transmit.
- Single tone transmit (from a range of modem calling, answer and other tone frequencies).
- User programmed tone or tone pair transmit (programmable frequencies and levels).
- Disabled.

The receive mode can be set to any one of the following:

- V.21 modem. 300bps FSK.
- Bell 103 modem. 300bps FSK.
- V.23 modem. 1200 or 75 bps FSK.
- Bell 202 modem. 1200 or 150 bps FSK.
- DTMF decode.
- 2100Hz and 2225Hz answer tone detect.
- Call progress signal detect.
- User programmed tone or tone pair detect.
- Disabled.

The CMX865A may also be set into a powersave mode which disables all circuitry except for the C-BUS interface.

### 5.1. TXA/TXAN Differential Output

With a transformer-based interface, a differential output is required to provide sufficient power to the line from a 3.3V supply. Active interfaces such as SLICS and COICS have high-impedance I/O so can be driven single-ended from either TXA or TXAN. The states of TXA and TXAN are automatically set according to the selected operating mode.

| CMX865A Mode                                  | Transmit mode enabled<br>(\$E1 b15-12 ≠ 0000) | Transmit mode disabled<br>(\$E1 b15-12 = 0000) |
|---|---|--|
| Receive mode enabled<br>(\$E2 b15-12 ≠ 0000)  | Vdd/2   | Vdd/2  |
| Receive mode disabled<br>(\$E2 b15-12 = 0000) | Vdd/2   | High-impedance                                 |

**Table 1 TXA/TXAN state with selected operating mode**

This enables the correct bias conditions to be applied to a transformer-based interface for both transmitting and receiving modes. When both transmit and receive modes are disabled, the transmit output pins go to a high-impedance state and the output amplifiers are power saved. The high-impedance state is useful to allow other devices to share the line interface using only passive components. See Section 6.2.

Switches are provided on TXA and TXAN to allow these pins to assume a high-impedance state. For normal modem operation TXA and TXAN should always be set to "output connected", General Control register \$E0 b15-b14 = 00. The 'output disconnected' mode is provided to improve reception of caller-ID signals when using a transformer based design. See Section 5.11.2.

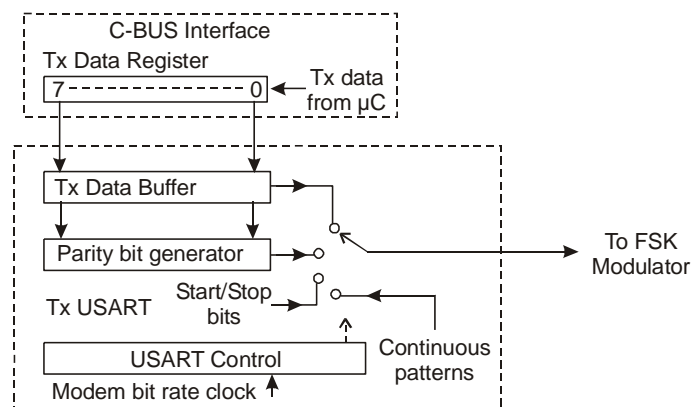
### 5.2. Tx USART

A flexible Tx USART is provided for all modem modes. It can be programmed to transmit continuous patterns, Start-Stop characters or Synchronous Data.

In both Synchronous Data and Start-Stop modes the data to be transmitted is written by the  $\mu$ C into the 8-bit C-BUS Tx Data Register from which it is transferred to the Tx Data Buffer.

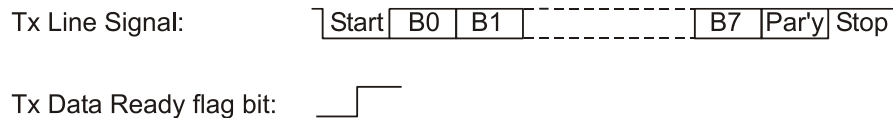
If Synchronous Data mode has been selected the 8 data bits in the Tx Data Buffer are transmitted serially, b0 being sent first.

In Start-Stop mode a single Start bit is transmitted, followed by 5, 6, 7 or 8 data bits from the Tx Data Buffer - b0 first - followed by an optional Parity bit then - normally - one or two Stop bits. The Start, Parity and Stop bits are generated by the USART as determined by the Tx Mode Register settings and are not taken from the Tx Data Register.



**Figure 6 Tx USART**

Every time the contents of the C-BUS Tx Data Register are transferred to the Tx Data Buffer the Tx Data Ready flag bit of the Status Register is set to 1 to indicate that a new value should be loaded into the C-BUS Tx Data Register. This flag bit is cleared to 0 when a new value is loaded into the Tx Data Register.



**Figure 7 Tx USART Function (Start-Stop mode, 8 Data Bits + Parity)**

If a new value is not loaded into the Tx Data Register in time for the next Tx Data Register to Tx Data Buffer transfer then the Status Register Tx Data Underflow bit will be set to 1. In this event the contents of the Tx Data Buffer will be re-transmitted if Synchronous Data mode has been selected, or if the Tx modem is in Start-Stop mode then a continuous Stop signal (1) will be transmitted until a new value is loaded into the Tx Data Register.

In all modes the transmitted bit and baud rates are the nominal rates for the selected modem type, with an accuracy determined by the XTAL frequency accuracy.

### 5.3. FSK Modulator

Serial data from the USART is fed to the FSK modulator if a V.21, V.23, Bell 103 or Bell 202 mode has been selected.

The FSK modulator generates one of two frequencies according to the transmit mode and the value of the current transmit data bit.

### 5.4. Tx Filter and Equaliser

The FSK modulator output signal is fed through the Transmit Filter which limits the out-of-band signal energy to acceptable limits. In 1200bps modem modes this block includes a fixed compromise line equaliser which is automatically set for the particular modulation type and frequency band being employed. This fixed compromise line equaliser may be enabled or disabled by b10 of the General Control Register. The amount of Tx equalisation provided compensates for one quarter of the relative amplitude and delay distortion of ETS Test Line 1 over the frequency band used.

### 5.5. DTMF/Tone Generator

In DTMF/Tones mode this block generates DTMF signals (with programmable twist) or single or dual frequency tones.

### 5.6. Tx Level Control and Output Buffer

The outputs (if present) of the Transmit Filter and DTMF/Tone Generator are passed through the programmable Tx Level Control and Tx Output Buffer to the pins TXA and TXAN. The Tx Output Buffer has symmetrical outputs to provide sufficient line voltage swing at low values of VDD and to reduce harmonic distortion of the signal.

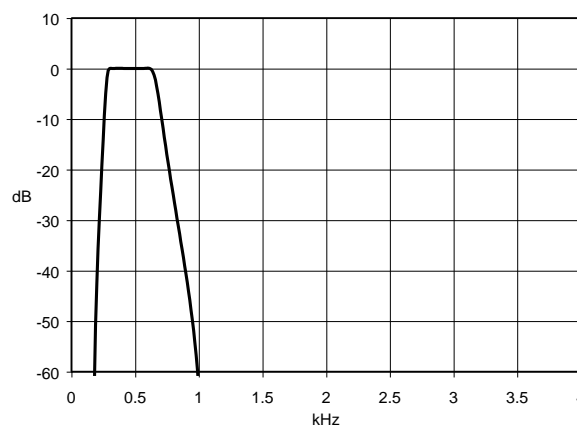
### 5.7. Rx DTMF/Tones Detectors

In Rx Tones Detect mode the received signal, after passing through the Rx Gain Control block, is fed to the DTMF / Tones / Call Progress / Answer Tone detector. The user may select any one of four separate detectors:

The DTMF detector detects standard DTMF signals. A valid DTMF signal will set b5 of the Status Register to 1 for as long as the signal is detected.

The programmable tone pair detector includes two separate tone detectors (see Figure 17). The first detector will set to 1 b6 of the Status Register for as long as a valid signal is detected, the second detector sets b7 to 1, and b10 of the Status Register will be set to 1 when both tones are detected.

The call progress detector measures the amplitude of the signal at the output of a 275 - 665 Hz bandpass filter and sets b10 of the Status Register to 1 when the signal level exceeds the measurement threshold.



**Figure 8 Response of Call Progress Filter**

The Answer Tone detector measures both amplitude and frequency of the received signal and sets b6 or b7 of the Status Register to 1 when a valid 2225Hz or 2100Hz signal is received.

### 5.8. Rx Modem Filtering and Demodulation

When the receive part of the CMX865A is operating as a modem, the received signal is fed to a bandpass filter to attenuate unwanted signals and to provide fixed compromise line equalisation for 1200bps modem modes. The characteristics of the bandpass filter and equaliser are determined by the chosen receive modem type and frequency band. The line equaliser may be enabled or disabled by b10 of the General Control Register and compensates for one quarter of the relative amplitude and delay distortion of ETS Test Line 1.

The responses of these filters, including the line equaliser and the effect of external components used in Figure 3 and Figure 4, are shown in Figure 9 to Figure 11:

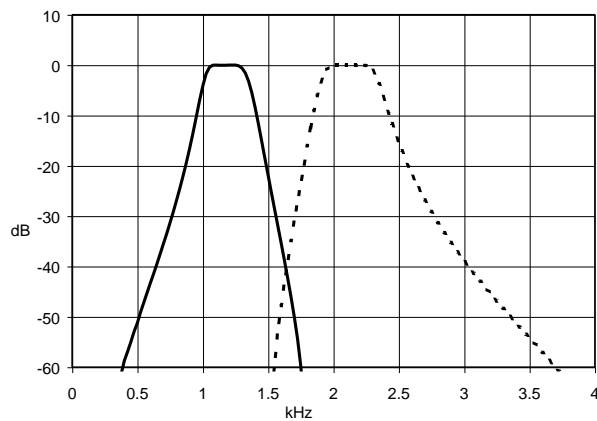


Figure 9 Bell 103 Rx Filters

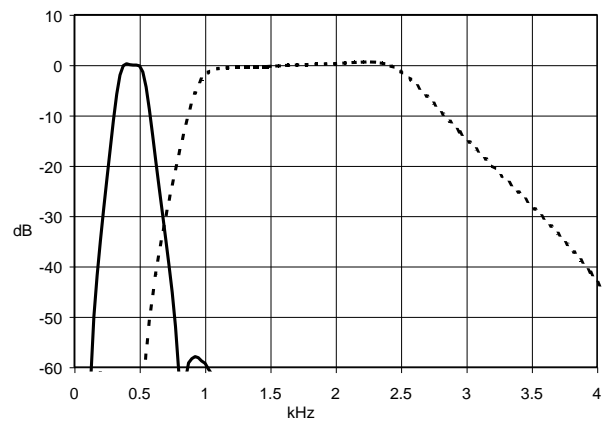


Figure 10 V.23/Bell 202 Rx Filters

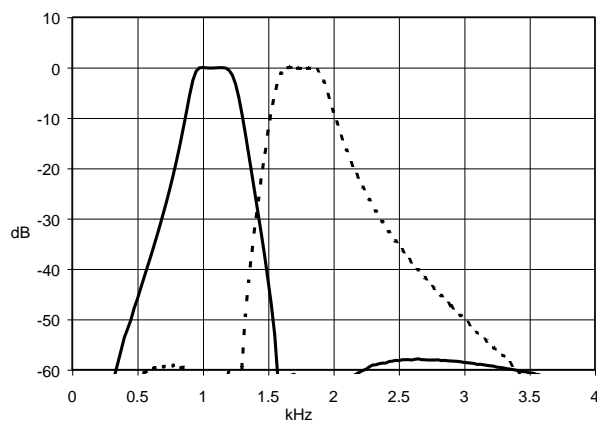


Figure 11 V.21 Rx Filters

The signal level at the output of the Receive Modem Filter and Equaliser is measured in the Modem Energy Detector block, compared to a threshold value, and the result controls b10 of the Status Register.

The output of the Receive Modem Filter and Equaliser is also fed to the FSK demodulator.

The FSK demodulator recognises individual frequencies as representing received 1 or 0 data bits:

The FSK demodulator produces a serial data bit stream which is fed to the Rx pattern detector and USART block, see Figure 12.

The demodulator input is also monitored for continuous alternating 1s and 0s.

### 5.9. Rx Modem Pattern Detectors

See Figure 12.

The 1010.. pattern detector will set b9 of the Status Register when 32 bits of alternating 1s and 0s have been detected.

The 'Continuous 0s' detector sets b8 of the Status Register when 32 consecutive 0s have been detected.

The 'Continuous 1s' detector sets b7 of the Status Register when 32 consecutive 1s have been detected.

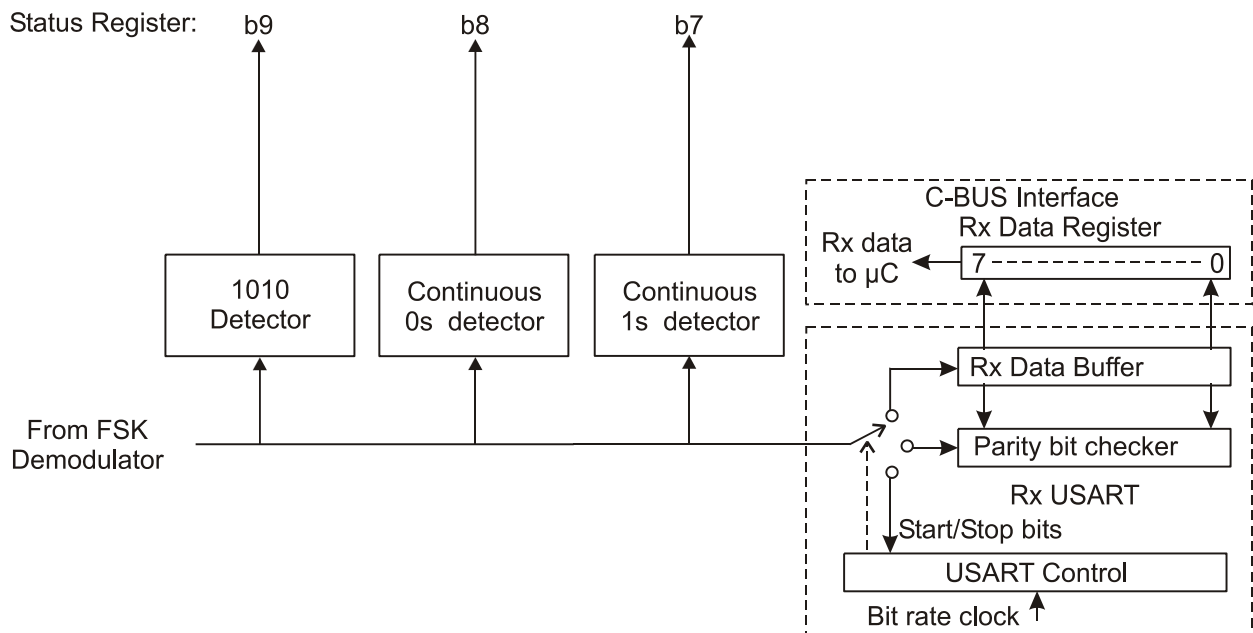
All of these pattern detectors will hold the 'detect' output for 12 bit times after the end of the detected pattern unless the received bit rate or operating mode is changed, in which case the detectors are reset within 2 msec.

### 5.10. Rx Data Register and USART

A flexible Rx USART is provided for all modem modes. It can be programmed to treat the received data bit stream as Synchronous data or as Start-Stop characters.

In Synchronous mode the received data bits are all fed into the Rx Data Buffer which is copied into the C-BUS Rx Data Register after every 8 bits.

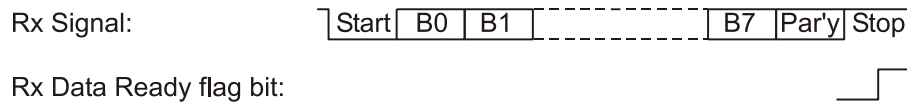
In Start-Stop mode the USART Control logic looks for the start of each character, then feeds only the required number of data bits (not parity) into the Rx Data Buffer. The parity bit (if used) and the presence of a Stop bit are then checked and the data bits in the Rx Data Buffer copied to the C-BUS Rx Data Register.



**Figure 12 Rx Modem Data Paths**

Whenever a new character is copied into the C-BUS Rx Data Register, the Rx Data Ready flag bit of the Status Register is set to '1' to prompt the  $\mu$ C to read the new data and, in Start-Stop mode, the Even Rx Parity flag bit of the Status Register is updated.

In Start-Stop mode, if the Stop bit is missing (received as a '0' instead of a '1') the received character will still be placed into the Rx Data Register and the Rx Data Ready flag bit set, but the Status Register Rx Framing Error bit will also be set to '1' and the USART will re-synchronise onto the next '1' – '0' (Stop – Start) transition. The Rx Framing Error bit will remain set until the next character has been received.



**Figure 13 Rx USART Function (Start-Stop mode, 8 Data Bits + Parity)**

If the  $\mu$ C has not read the previous data from the Rx Data Register by the time that new data is copied to it from the Rx Data Buffer then the Rx Data Overflow flag bit of the Status Register will be set to 1.

The Rx Data Ready flag and Rx Data Overflow bits are cleared to 0 when the Rx Data Register is read by the  $\mu$ C.

A received character which has all bits '0', including the Stop and any Parity bits, will always cause the Rx Framing Error bit to be set to 1 and the USART to re-synchronise onto the next 1 – 0 transition.

### 5.11. C-BUS Interface

This block provides for the transfer of data and control or status information between the CMX865A's internal registers and the  $\mu$ C over the C-BUS serial bus. Each transaction consists of a single Register Address byte sent from the  $\mu$ C which may be followed by one or more data bytes sent from the  $\mu$ C to be written into one of the CMX865A's Write Only Registers, or one or more bytes of data read out from one of the CMX865A's Read Only Registers, as illustrated in Figure 14.

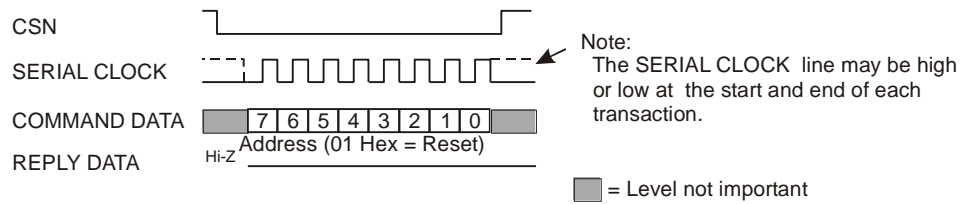
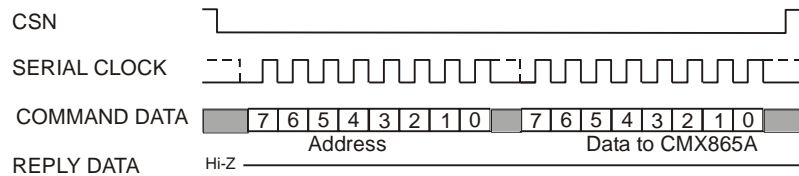
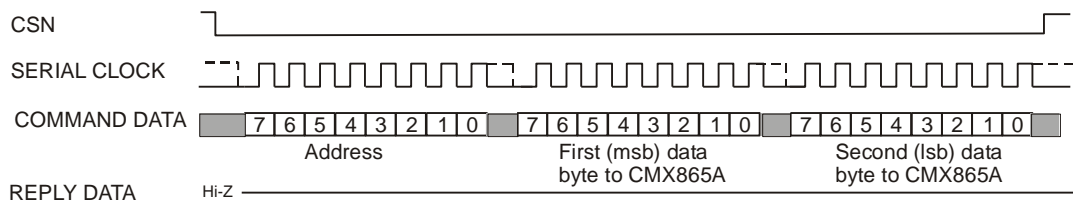
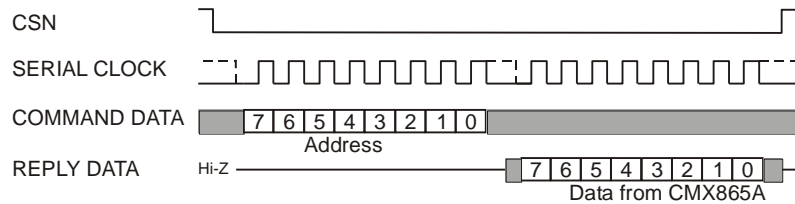
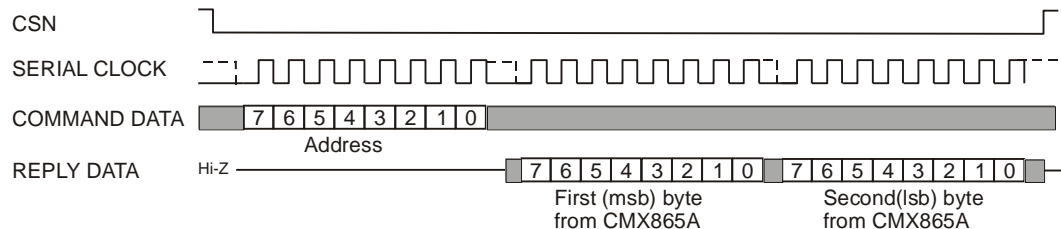
Data sent from the  $\mu$ C on the Command Data line is clocked into the CMX865A on the rising edge of the Serial Clock input. Reply Data sent from the CMX865A to the  $\mu$ C is valid when the Serial Clock is high. The CSN line must be held low during a data transfer and kept high between transfers. The C-BUS interface is compatible with most common  $\mu$ C serial interfaces and may also be easily implemented with general purpose  $\mu$ C I/O pins controlled by a simple software routine. Figure 23 gives detailed C-BUS timing requirements.

The following C-BUS addresses and registers are used by the CMX865A:

|  |              |
|--|--------------|
| General Reset Command (address only, no data). | Address \$01 |
| General Control Register, 16-bit write only.   | Address \$E0 |
| Transmit Mode Register, 16-bit write-only.     | Address \$E1 |
| Receive Mode Register, 16-bit write-only.      | Address \$E2 |
| Transmit Data Register, 8-bit write only.      | Address \$E3 |
| Receive Data Register, 8-bit read-only.        | Address \$E5 |
| Status Register, 16-bit read-only.             | Address \$E6 |
| Programming Register, 16-bit write-only.       | Address \$E8 |

Note: The C-BUS addresses \$E9, \$EA and \$EB are allocated for production testing and should not be accessed in normal operation.



**a) Single byte from  $\mu$ C****b) One Address and one Data byte from  $\mu$ C****c) One Address and 2 Data bytes from  $\mu$ C****d) One Address byte from  $\mu$ C and one Reply byte from CMX865A****e) One Address byte from  $\mu$ C and 2 Reply bytes from CMX865A****Figure 14 C-BUS Transactions**

### 5.11.1. General Reset Command

#### General Reset Command (no data) C-BUS address \$01

This command resets the device and clears all bits of the General Control, Transmit Mode and Receive Mode Registers and b15 and b13-0 of the Status Register.

The CMX865A will automatically perform a power-on reset when power is first applied, however, it is good practice to issue a C-BUS General Reset command. This action will cause the device to enter a powersave state (General Control Register bit 8 will be cleared to '0').

To bring the device out of powersave, please refer to the description of bits 7 and 8 in the General Control Register, Section 5.11.2.

### 5.11.2. General Control Register

#### General Control Register: 16-bit write-only. C-BUS address \$E0

This register controls general features of the CMX865A such as the Powersave, Loopback mode and the IRQ mask bits. It also allows the fixed compromise equalisers in the Tx and Rx signal paths to be disabled if desired.

All bits of this register are cleared to 0 by a General Reset command.

|      |             |            |    |    |    |     |   |     |     |            |   |               |   |   |   |   |
|------|-------------|------------|----|----|----|-----|---|-----|-----|------------|---|---------------|---|---|---|---|
| Bit: | 15          | 14         | 13 | 12 | 11 | 10  | 9 | 8   | 7   | 6          | 5 | 4             | 3 | 2 | 1 | 0 |
|      | TXAN<br>off | TXA<br>off | 0  | 0  | LB | Equ | 0 | Pwr | Rst | Irqn<br>en | 0 | IRQ Mask Bits |   |   |   |   |

**General Control Register b13, b12, b9, b5: Reserved, set to 0**

#### General Control Register b15: Disconnect TXAN Output

This bit allows the TXAN output to be disconnected and set to high impedance. See below for conditions applying to the setting of this bit.

|         |  |
|---------|--|
| b15 = 1 | TXAN output disconnected                       |
| b15 = 0 | TXAN output connected (normal modem operation) |

#### General Control Register b14: Disconnect TXA Output

This bit allows the TXA output to be disconnected and set to high impedance. See below for conditions applying to the setting of this bit.

|         |   |
|---------|---|
| b14 = 1 | TXA output disconnected                       |
| b14 = 0 | TXA output connected (normal modem operation) |

#### Requirements when using TXA/TXAN set to disconnected (b14=1 and/or b15=1)

1. While TXA/TXAN are set to disconnected, call progress mode must not be enabled.
2. If call progress mode has been previously enabled, a General Reset command must be sent before TXA/TXAN are set to disconnected.

**General Control Register b11: Analogue Loopback Test Mode**

This bit controls the analogue loopback test mode. Note that in loopback test mode both Transmit and Receive Mode Registers should be set to the same modem type and band or bit rate.

|         |                                      |
|---------|--------------------------------------|
| b11 = 1 | Local analogue loopback mode enabled |
| b11 = 0 | No loopback (normal modem operation) |

**General Control Register b10: Tx and Rx Fixed Compromise Equalisers**

This bit allows the Tx and Rx fixed compromise equalisers in the modem transmit and receive filter blocks to be disabled.

|         |   |
|---------|---|
| b10 = 1 | Disable equalisers                      |
| b10 = 0 | Enable equalisers (1200bps modem modes) |

**General Control Register b8: Powerup**

This bit controls the internal power supply to most of the internal circuits, including the Xtal oscillator and VBIAS supply. Note that the General Reset command clears this bit, putting the device into Powersave mode.

|        |   |
|--------|---|
| b8 = 1 | Device powered up normally  |
| b8 = 0 | Powersave mode (ALL circuits, except C-BUS interface, are disabled) |

**When power is first applied to the device**, the following powerup procedure should be followed to ensure correct operation.

- i. (Power is applied to the device)
- ii. Issue a General Reset command
- iii. Write to the General Control Register (address \$E0) setting both the Powerup bit (b8) and the Reset bit (b7) to '1' – leave in this state for a minimum of about 20ms – it is required that the crystal initially runs for this time in order to clock the internal logic into a defined state. The device is now powered up, with the crystal and VBIAS supply operating, but is otherwise not running any transmit or receive functions.
- iv. The device is now ready to be programmed as and when required. Examples:
  - A General Reset command could be issued to clear all the registers and therefore powersave the device.
  - The Reset bit in the General Control Register could be set to '0' as part of a routine to program all the relevant registers for setting up a particular operating mode.

**When the device is switched from Powersave mode to normal operation** by setting the Powerup bit to '1', the Reset bit should also be set to '1' and should be held at '1' for about 20ms while the internal circuits, Xtal oscillator and V<sub>BIAS</sub> stabilise before starting to use the transmitter or receiver.

**General Control Register b7: Reset**

Setting this bit to 1 resets the CMX865A's internal circuitry, clearing all bits of the Transmit and Receive Mode Registers, the Programming Register and b13-0 of the Status Register.

|        |  |
|--------|--|
| b7 = 1 | Internal circuitry in a reset condition. |
| b7 = 0 | Normal operation                         |

**General Control Register b6: IRQNEN (IRQN O/P Enable)**

Setting this bit to 1 enables the IRQN output pin.

|        |  |
|--------|--|
| b6 = 1 | IRQN pin driven low (to Vss) if the IRQ bit of the Status Register = 1 |
| b6 = 0 | IRQN pin disabled (high impedance)                                     |

**General Control Register b4-0: IRQ Mask Bits**

These bits affect the operation of the IRQ bit of the Status Register as described in section 5.11.7

**5.11.3. Transmit Mode Register**

**Transmit Mode Register: 16-bit write-only. C-BUS address \$E1**

This register controls the CMX865A transmit signal type and level. All bits of this register are cleared to 0 by a General Reset command, or when b7 (Reset) of the General Control Register is 1.

|                      |    |    |    |                       |    |    |   |            |   |   |                            |   |                                    |   |   |   |
|----------------------|----|----|----|-----------------------|----|----|---|------------|---|---|----------------------------|---|------------------------------------|---|---|---|
| Bit:                 | 15 | 14 | 13 | 12                    | 11 | 10 | 9 | 8          | 7 | 6 | 5                          | 4 | 3                                  | 2 | 1 | 0 |
| Tx mode = modem      |    |    |    | Tx level              |    |    | 0 | 0          | 0 | 0 | Start-stop /<br>synch data |   | # data bits /<br>synch data source |   |   |   |
| Tx mode = DTMF/Tones |    |    |    | Tx level              |    |    | 0 | DTMF Twist |   |   | DTMF or Tone select        |   |                                    |   |   |   |
| Tx mode = Disabled   |    |    |    | Set to 0000 0000 0000 |    |    |   |            |   |   |                            |   |                                    |   |   |   |

**Tx Mode Register b15-12: Tx Mode**

These 4 bits select the transmit operating mode.

| B15 | b14 | b13 | b12 |                      |                             |
|-----|-----|-----|-----|----------------------|-----------------------------|
| 1   | 0   | 0   | 1   | V.21 300bps FSK      | High band (Answering modem) |
| 1   | 0   | 0   | 0   | "                    | Low band (Calling modem)    |
| 0   | 1   | 1   | 1   | Bell 103 300bps FSK  | High band (Answering modem) |
| 0   | 1   | 1   | 0   | "                    | Low band (Calling modem)    |
| 0   | 1   | 0   | 1   | V.23 FSK             | 1200bps                     |
| 0   | 1   | 0   | 0   | "                    | 75bps                       |
| 0   | 0   | 1   | 1   | Bell 202 FSK         | 1200bps                     |
| 0   | 0   | 1   | 0   | "                    | 150bps                      |
| 0   | 0   | 0   | 1   | DTMF / Tones         |                             |
| 0   | 0   | 0   | 0   | Transmitter disabled |                             |

**Tx Mode Register b11-9: Tx Level**

These three bits set the gain of the Tx Level Control block.

| b11 | b10 | b9 |         |
|-----|-----|----|---------|
| 1   | 1   | 1  | 0dB     |
| 1   | 1   | 0  | -1.5dB  |
| 1   | 0   | 1  | -3.0dB  |
| 1   | 0   | 0  | -4.5dB  |
| 0   | 1   | 1  | -6.0dB  |
| 0   | 1   | 0  | -7.5dB  |
| 0   | 0   | 1  | -9.0dB  |
| 0   | 0   | 0  | -10.5dB |

**Tx Mode Register b8: Reserved, set to 0**

**Tx Mode Register b7-5: DTMF Twist (Tx DTMF Mode)**

These three bits allow for adjustment of the DTMF twist to compensate for the frequency response of different external circuits. The device varies the twist by making changes to the upper tone-group levels. Note that the twist cannot be adjusted mid-tone.

| b7 | b6 | b5 |  |
|----|----|----|--|
| 0  | 0  | 0  | +2.0dB twist (normal setting when external response is flat)           |
| 0  | 0  | 1  | +1.0dB twist   |
| 0  | 1  | 0  | +1.5dB twist   |
| 0  | 1  | 1  | +2.5dB twist   |
| 1  | 0  | 0  | +3.0dB twist   |
| 1  | 0  | 1  | +3.5dB twist   |
| 1  | 1  | 0  | +4.0dB twist   |
| 1  | 1  | 1  | +4.5dB twist (do not use in conjunction with the 0dB Tx level setting) |

**Tx Mode Register b4-3: Tx Data Format (Tx Modem Modes)**

These two bits select Synchronous or Start-stop mode and the addition of a parity bit to transmitted characters in the Start-stop mode.

| b4 | b3 |  |
|----|----|--|
| 1  | 1  | Tx Synchronous mode                                    |
| 1  | 0  | Tx Start-stop mode, no parity                          |
| 0  | 1  | Tx Start-stop mode, even parity bit added to data bits |
| 0  | 0  | Tx Start-stop mode, odd parity bit added to data bits  |

**Tx Mode Register b2-0: Tx Data and Stop Bits (Tx Start-Stop Modes)**

In Tx Start-stop mode these three bits select the number of Tx data and stop bits.

| b2 | b1 | b0 |                          |
|----|----|----|--------------------------|
| 1  | 1  | 1  | 8 data bits, 2 stop bits |
| 1  | 1  | 0  | 8 data bits, 1 stop bit  |
| 1  | 0  | 1  | 7 data bits, 2 stop bits |
| 1  | 0  | 0  | 7 data bits, 1 stop bit  |
| 0  | 1  | 1  | 6 data bits, 2 stop bits |
| 0  | 1  | 0  | 6 data bits, 1 stop bit  |
| 0  | 0  | 1  | 5 data bits, 2 stop bits |
| 0  | 0  | 0  | 5 data bits, 1 stop bit  |

**Tx Mode Register b2-0: Tx Data Source (Tx Synchronous Mode)**

In Tx Synchronous mode (b4-3 = 11) these three bits select the source of the data fed to the Tx FSK modulator.

| b2 | b1 | b0 |                                  |
|----|----|----|----------------------------------|
| 1  | x  | x  | Data bytes from Tx Data Buffer   |
| 0  | 1  | 1  | Continuous 1s                    |
| 0  | 1  | 0  | Continuous 0s                    |
| 0  | 0  | x  | Continuous alternating 1s and 0s |

**Tx Mode Register b3-0: DTMF/Tones Mode**

If DTMF/Tones transmit mode has been selected (Tx Mode Register b14-12 = 001), then b7-5 should be set to 000 and b4-0 will select a DTMF signal, a fixed tone or one of four programmed tones or tone pairs for transmission.

b4 = 0: Tx fixed tone or programmed tone pair

| b3 | b2 | b1 | b0 | Tone frequency (Hz) |   |
|----|----|----|----|---------------------|---|
| 0  | 0  | 0  | 0  | No tone             |   |
| 0  | 0  | 0  | 1  | 697                 |   |
| 0  | 0  | 1  | 0  | 770                 |   |
| 0  | 0  | 1  | 1  | 852                 |   |
| 0  | 1  | 0  | 0  | 941                 |   |
| 0  | 1  | 0  | 1  | 1209                |   |
| 0  | 1  | 1  | 0  | 1336                |   |
| 0  | 1  | 1  | 1  | 1477                |   |
| 1  | 0  | 0  | 0  | 1633                |   |
| 1  | 0  | 0  | 1  | 1300                | (Calling tone)                              |
| 1  | 0  | 1  | 0  | 2100                | (Answer tone)                               |
| 1  | 0  | 1  | 1  | 2225                | (Answer tone)                               |
| 1  | 1  | 0  | 0  | Tone pair TA        | Programmed Tx tone or tone pair, see 5.11.8 |
| 1  | 1  | 0  | 1  | Tone pair TB        | “   |
| 1  | 1  | 1  | 0  | Tone pair TC        | “   |
| 1  | 1  | 1  | 1  | Tone pair TD        | “   |

b4 = 1: Tx DTMF

| b3 | b2 | b1 | b0 | Low frequency (Hz) | High frequency (Hz) | Keypad symbol |
|----|----|----|----|--------------------|---------------------|---------------|
| 0  | 0  | 0  | 0  | 941                | 1633                | D             |
| 0  | 0  | 0  | 1  | 697                | 1209                | 1             |
| 0  | 0  | 1  | 0  | 697                | 1336                | 2             |
| 0  | 0  | 1  | 1  | 697                | 1477                | 3             |
| 0  | 1  | 0  | 0  | 770                | 1209                | 4             |
| 0  | 1  | 0  | 1  | 770                | 1336                | 5             |
| 0  | 1  | 1  | 0  | 770                | 1477                | 6             |
| 0  | 1  | 1  | 1  | 852                | 1209                | 7             |
| 1  | 0  | 0  | 0  | 852                | 1336                | 8             |
| 1  | 0  | 0  | 1  | 852                | 1477                | 9             |
| 1  | 0  | 1  | 0  | 941                | 1336                | 0             |
| 1  | 0  | 1  | 1  | 941                | 1209                | *             |
| 1  | 1  | 0  | 0  | 941                | 1477                | #             |
| 1  | 1  | 0  | 1  | 697                | 1633                | A             |
| 1  | 1  | 1  | 0  | 770                | 1633                | B             |
| 1  | 1  | 1  | 1  | 852                | 1633                | C             |

#### 5.11.4. Receive Mode Register

**Receive Mode Register: 16-bit write-only. C-BUS address \$E2**

This register controls the CMX865A receive signal type and level.

All bits of this register are cleared to 0 by a General Reset command, or when b7 (Reset) of the General Control Register is 1.

|      |                        |    |    |    |                       |    |   |                                 |   |   |                  |   |   |                        |   |   |
|------|------------------------|----|----|----|-----------------------|----|---|---------------------------------|---|---|------------------|---|---|------------------------|---|---|
| Bit: | 15                     | 14 | 13 | 12 | 11                    | 10 | 9 | 8                               | 7 | 6 | 5                | 4 | 3 | 2                      | 1 | 0 |
|      | Rx mode = Modem        |    |    |    | Rx level              |    |   | 0                               | 0 | 0 | Start-stop/Synch |   |   | No. of bits and parity |   |   |
|      | Rx mode = Tones detect |    |    |    | Rx level              |    |   | DTMF/Tones/Call Progress select |   |   |                  |   |   |                        |   |   |
|      | Rx mode = Disabled     |    |    |    | Set to 0000 0000 0000 |    |   |                                 |   |   |                  |   |   |                        |   |   |

##### Rx Mode Register b15-12: Rx Mode

These 4 bits select the transmit operating mode.

| B15 | b14 | b13 | b12 |                     |                            |
|-----|-----|-----|-----|---------------------|----------------------------|
| 1   | 0   | 0   | 1   | V.21 300bps FSK     | High band (Calling modem)  |
| 1   | 0   | 0   | 0   | "                   | Low band (Answering modem) |
| 0   | 1   | 1   | 1   | Bell 103 300bps FSK | High band (Calling modem)  |
| 0   | 1   | 1   | 0   | "                   | Low band (Answering modem) |
| 0   | 1   | 0   | 1   | V.23 FSK            | 1200bps                    |
| 0   | 1   | 0   | 0   | "                   | 75bps                      |
| 0   | 0   | 1   | 1   | Bell 202 FSK        | 1200bps                    |
| 0   | 0   | 1   | 0   | "                   | 150bps                     |
| 0   | 0   | 0   | 1   | Tones               | Detect                     |
| 0   | 0   | 0   | 0   | Receiver disabled   |                            |

##### Rx Mode Register b11-9: Rx Level

These three bits set the gain of the Rx Gain Control block.

| b11 | b10 | b9 |         |
|-----|-----|----|---------|
| 1   | 1   | 1  | 0dB     |
| 1   | 1   | 0  | -1.5dB  |
| 1   | 0   | 1  | -3.0dB  |
| 1   | 0   | 0  | -4.5dB  |
| 0   | 1   | 1  | -6.0dB  |
| 0   | 1   | 0  | -7.5dB  |
| 0   | 0   | 1  | -9.0dB  |
| 0   | 0   | 0  | -10.5dB |

**Rx Mode Register b5-3: Rx USART Setting (Rx Modem Modes)**

These three bits select the Rx USART operating mode.

| b5 | b4 | b3 |                            |
|----|----|----|----------------------------|
| 1  | 1  | 1  | Rx Synchronous mode        |
| 1  | 1  | 0  | Rx Start-stop mode         |
| 1  | 0  | x  | Reserved                   |
| 0  | x  | x  | Rx USART function disabled |

**Rx Mode Register b2-0: Rx Data Bits and Parity (Rx Start-Stop Modes)**

In Rx Start-stop mode these three bits select the number of data bits (plus any parity bit) in each received character. These bits are ignored in Rx Synchronous mode.

| b2 | b1 | b0 |                      |
|----|----|----|----------------------|
| 1  | 1  | 1  | 8 data bits + parity |
| 1  | 1  | 0  | 8 data bits          |
| 1  | 0  | 1  | 7 data bits + parity |
| 1  | 0  | 0  | 7 data bits          |
| 0  | 1  | 1  | 6 data bits + parity |
| 0  | 1  | 0  | 6 data bits          |
| 0  | 0  | 1  | 5 data bits + parity |
| 0  | 0  | 0  | 5 data bits          |

**Rx Mode Register b2-0: Tones Detect Mode**

In Tones Detect Mode (Rx Mode Register b14-12 = 001) b8-3 should be set to 000000. These three bits select the detector type.

| b2 | b1 | b0 |                                   |
|----|----|----|-----------------------------------|
| 1  | 0  | 0  | Programmable Tone Pair Detect     |
| 0  | 1  | 1  | Call Progress Detect              |
| 0  | 1  | 0  | 2100Hz, 2225Hz Answer Tone Detect |
| 0  | 0  | 1  | DTMF Detect                       |
| 0  | 0  | 0  | Disabled                          |

While TXA/TXAN are set to disconnected, call progress mode must not be enabled. See General Control register b15 and b14, Section 5.11.2.

**5.11.5. Tx Data Register**

**Tx Data Register: 8-bit write-only. C-BUS address \$E3**

|      |                             |   |   |   |   |   |   |   |
|------|-----------------------------|---|---|---|---|---|---|---|
| Bit: | 7                           | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|      | Data bits to be transmitted |   |   |   |   |   |   |   |

In Tx Synchronous mode, this register contains the next 8 data bits to be transmitted. b0 is transmitted first.

In Tx Start-Stop mode, the specified number of data bits will be transmitted from this register (b0 first). A Start bit, a Parity bit (if required) and Stop bit(s) will be added automatically.

This register should only be written to when the Tx Data Ready bit of the Status Register is 1.



### 5.11.6. Rx Data Register

**Rx Data Register: 8-bit read-only. C-BUS address \$E5**

|                    |   |   |   |   |   |   |   |   |
|--------------------|---|---|---|---|---|---|---|---|
| Bit:               | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Received data bits |   |   |   |   |   |   |   |   |

In Rx synchronous mode, this register contains 8 received data bits, b0 of the register holding the earliest received bit, b7 the latest.

In Rx Start-Stop mode, this register contains the specified number of data bits from a received character, b0 holding the first received bit. Unused bits are set to 0.

### 5.11.7. Status Register

**Status Register: 16-bit read-only. C-BUS address \$E6**

All the bits of this register (except b15-14) are cleared to 0 by a General Reset command, or when b7 (Reset) of the General Control Register is 1. Bit b13 of this register will automatically be set to 1 after the General Control Register Reset bit (b7) has been cleared to 0 and the CMX865A is ready to accept any parameters sent to the Programming Register (\$E8).

|      |     |    |    |                                  |    |    |   |   |   |   |   |   |   |   |   |   |
|------|-----|----|----|----------------------------------|----|----|---|---|---|---|---|---|---|---|---|---|
| Bit: | 15  | 14 | 13 | 12                               | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|      | IRQ | 0  | PF | See below for uses of these bits |    |    |   |   |   |   |   |   |   |   |   |   |

The meanings of the Status Register b12-0 depend on whether the receive circuitry is in Modem or Tones Detect mode.

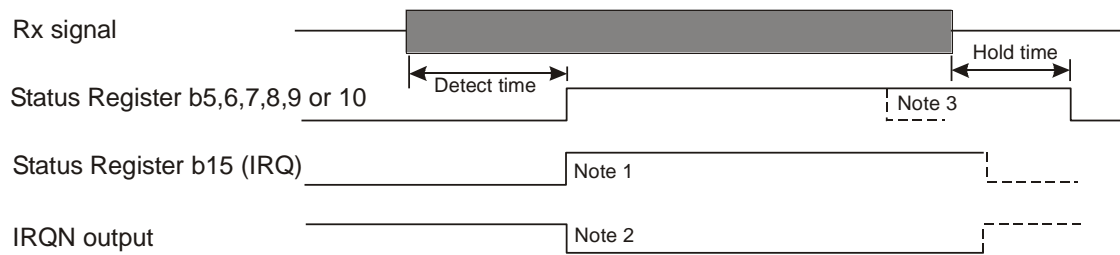
**Status Register bits:**

|     | <b>Rx Modem modes</b>  | <b>Rx Tones Detect modes</b>   | <b>** IRQ Mask bit</b> |
|-----|--|--|------------------------|
| b15 | IRQ  |  |                        |
| b14 | 0  |  | -                      |
| b13 | Programming Flag bit. See 5.11.8                                       |  | b4                     |
| b12 | Set to 1 on Tx data ready.<br>Cleared by write to Tx Data Register     |  | b3                     |
| b11 | Set to 1 on Tx data underflow.<br>Cleared by write to Tx Data Register |  | b3                     |
| b10 | 1 when energy is detected in Rx modem signal band                      | 1 when energy is detected in Call Progress band or when both programmable tones are detected | b2                     |
| b9  | 1 when '1010..' pattern is detected                                    | 0  | b1                     |
| b8  | 1 when continuous 0s detected  | 0  | b1                     |
| b7  | 1 when continuous 1s detected  | 1 when 2100Hz answer tone or the second programmed tone is detected                          | b1                     |
| b6  | Set to 1 on Rx data ready. Cleared by read from Rx Data Register       | 1 when 2225Hz answer tone or the first programmed tone is detected                           | b0                     |
| b5  | Set to 1 on Rx data overflow. Cleared by read from Rx Data Register    | 1 when DTMF code is detected   | b0                     |
| b4  | Set to 1 on Rx framing error   | 0  | -                      |
| b3  | Set to 1 on even Rx parity   | Rx DTMF code b3, see Table 3   | -                      |
| b2  | 0  | Rx DTMF code b2  | -                      |
| b1  | 0  | Rx DTMF code b1  | -                      |
| b0  | FSK frequency demodulator output                                       | Rx DTMF code b0  | -                      |

**Table 2 Status Register**

Notes: \*\* This column shows the corresponding IRQ Mask bits in the General Control Register. A 0-to-1 transition on any of the Status Register b13-5 will cause the IRQ b15 to be set to 1 if the corresponding IRQ Mask bit is 1. The IRQ bit is cleared by a read of the Status Register or a General Reset command or by setting b7 or b8 of the General Control Register to 1.

The operation of the data demodulator and pattern detector circuits within the CMX865A does not depend on the state of the Rx energy detect function.



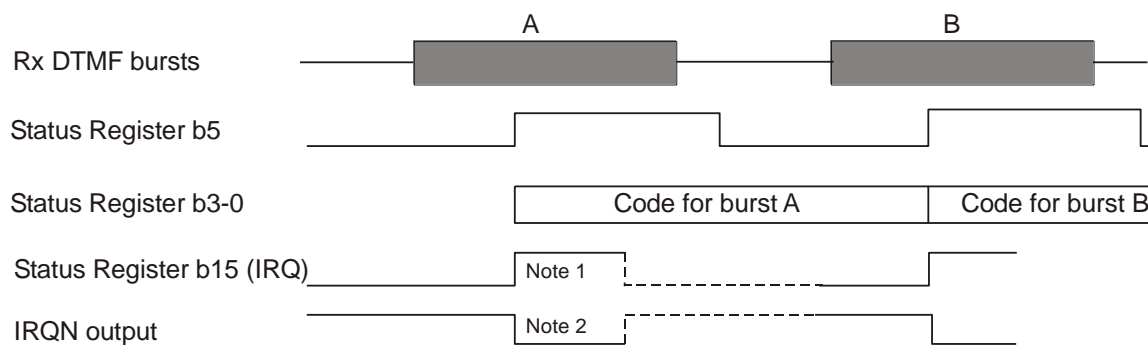
- Notes:
1. IRQ will go high only if appropriate IRQ Mask bit in General Control Register is set to 1. The IRQ bit is cleared by a read of the Status Register.
  2. IRQN o/p will go low when the IRQ bit is high if the IRQNEN bit of General Control Register is set to 1.
  3. In Rx Modem modes Status Register b5 and b6 are set to 1 by a Rx Data Ready or Rx Data Underflow event and cleared by a read of the Rx Data Register

**Figure 15 Operation of Status Register b10-5**

The IRQN output pin will be pulled low (to Vss) when the IRQ bit of the Status Register and the IRQNEN b6 of the General Control Register are both 1.

Changes to Status Register bits caused by a change of Tx or Rx operating mode can take up to 150µs to take effect.

In Rx modem modes b2-1 will be 0 and b0 will show the output of the frequency demodulator, updated at 8 times the nominal data rate.



- Notes:
1. IRQ will go high only if the IRQ Mask b0 in the General Control Register is set to 1. The IRQ bit is cleared to 0 by a read of the Status Register.
  2. IRQN o/p will go low when the IRQ bit is high if the IRQNEN bit of the General Control Register is set to 1.

**Figure 16 Operation of Status Register in DTMF Rx Mode**

| b3 | b2 | b1 | b0 | Low frequency (Hz) | High frequency (Hz) | Keypad symbol |
|----|----|----|----|--------------------|---------------------|---------------|
| 0  | 0  | 0  | 0  | 941                | 1633                | D             |
| 0  | 0  | 0  | 1  | 697                | 1209                | 1             |
| 0  | 0  | 1  | 0  | 697                | 1336                | 2             |
| 0  | 0  | 1  | 1  | 697                | 1477                | 3             |
| 0  | 1  | 0  | 0  | 770                | 1209                | 4             |
| 0  | 1  | 0  | 1  | 770                | 1336                | 5             |
| 0  | 1  | 1  | 0  | 770                | 1477                | 6             |
| 0  | 1  | 1  | 1  | 852                | 1209                | 7             |
| 1  | 0  | 0  | 0  | 852                | 1336                | 8             |
| 1  | 0  | 0  | 1  | 852                | 1477                | 9             |
| 1  | 0  | 1  | 0  | 941                | 1336                | 0             |
| 1  | 0  | 1  | 1  | 941                | 1209                | *             |
| 1  | 1  | 0  | 0  | 941                | 1477                | #             |
| 1  | 1  | 0  | 1  | 697                | 1633                | A             |
| 1  | 1  | 1  | 0  | 770                | 1633                | B             |
| 1  | 1  | 1  | 1  | 852                | 1633                | C             |

**Table 3 Received DTMF Code: Status Register b3-0**

### 5.11.8. Programming Register

#### Programming Register : 16-bit write-only. C-BUS address \$E8

This register is used to program the transmit and receive programmed tone pairs by writing appropriate values to RAM locations within the CMX865A. Note that these RAM locations are cleared by Powersave or Reset operations.

The Programming Register should only be written to when the Programming Flag bit (b13) of the Status Register is 1. The act of writing to the Programming Register clears the Programming Flag bit. When the programming action has been completed (normally within 150µs) the CMX865A will set the bit back to 1.

When programming Transmit or Receive Tone Pairs, do not change the Transmit or Receive Mode registers until programming is complete and the Programming Flag bit has returned to 1.

#### Transmit Tone Pair Programming

4 transmit tone pairs (TA to TD) can be programmed.

The frequency (max 3.4kHz) and level must be entered for each tone to be used.

Single tones are programmed by setting both level and frequency values to zero for one of the pair.

Programming is done by writing a sequence of up to seventeen 16-bit words to the Programming Register. The first word should be 32768 (8000 hex), the following 16-bit words set the frequencies and levels and are in the range 0 to 16383 (0-3FFF hex):

| Word | Tone Pair | Value written    |
|------|-----------|------------------|
| 1    |           | 32768            |
| 2    | TA        | Tone 1 frequency |
| 3    | TA        | Tone 1 level     |
| 4    | TA        | Tone 2 frequency |
| 5    | TA        | Tone 2 level     |
| 6    | TB        | Tone 1 frequency |
| 7    | TB        | Tone 1 level     |
| ---  | ---       | -----            |
| ---  | ---       | -----            |
| 16   | TD        | Tone 2 frequency |
| 17   | TD        | Tone 2 level     |

The frequency values to be entered are calculated from the formula:

Value to be entered = desired frequency (Hz) \* 3.414

i.e. for 1kHz the value to be entered is 3414 (or 0D56 in Hex).

The level values (measured at TXA or TXAN) to be entered are calculated from the formula:

Value to be entered = desired  $V_{rms}$  \* 93780 / VDD

i.e. for 0.5Vrms at VDD = 3.3V, the value to be entered is 14209 (3781 in Hex).

This will give a signal of 1.0Vrms when measured between TXA and TXAN pins, or approximately 0.45Vrms when measured across the line, with the component values in section 4.1.

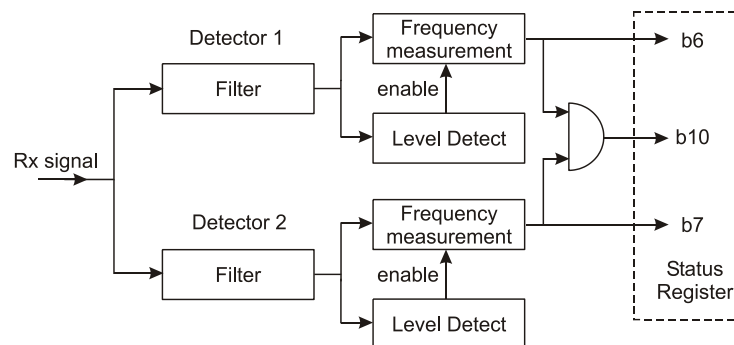
Programming a no-tone pair is done by writing zero to all four tone pair words.

Note that allowance should be made for the transmit signal filtering in the CMX865A which attenuates the output signal for frequencies above 2kHz by 0.25dB at 2.5kHz, by 1dB at 3kHz and by 2.2dB at 3.4kHz.

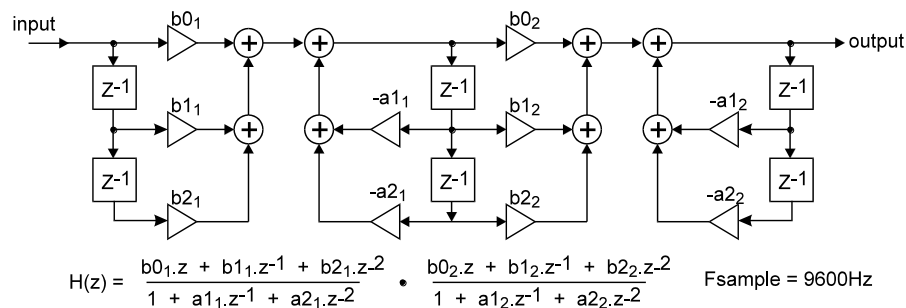
After resetting the device, by toggling the Reset bit (b7) of the General Control Register (\$E0), the tone pairs TA, TB and TC are set to notone and TD is set to generate 2130Hz + 2750Hz at approximately –20dBm for each tone, when measured at either TXA or TXAN pin.

### Receive Tone Pair Programming

The programmable tone pair detector is implemented as shown in Figure 17. The filters are 4<sup>th</sup> order IIR sections. The frequency detectors measure the time taken for a programmable number of complete input signal cycles, and compare this time against programmable upper and lower limits.



**Figure 17 Programmable Tone Detectors**



**Figure 18 Filter Implementation**

Programming is done by writing a sequence of twenty-seven 16-bit words to the Programming Register. The first word should be 32769 (8001 hex), the following twenty-six 16-bit words set the frequencies and levels and are in the range 0 to 32767 (0000-7FFF hex).

| Word | Value written                         | Word | Value written                         |
|------|---------------------------------------|------|---------------------------------------|
| 1    | 32769                                 | 15   | Filter #2 coefficient b2 <sub>1</sub> |
| 2    | Filter #1 coefficient b2 <sub>1</sub> | 16   | Filter #2 coefficient b1 <sub>1</sub> |
| 3    | Filter #1 coefficient b1 <sub>1</sub> | 17   | Filter #2 coefficient b0 <sub>1</sub> |
| 4    | Filter #1 coefficient b0 <sub>1</sub> | 18   | Filter #2 coefficient a2 <sub>1</sub> |
| 5    | Filter #1 coefficient a2 <sub>1</sub> | 19   | Filter #2 coefficient a1 <sub>1</sub> |
| 6    | Filter #1 coefficient a1 <sub>1</sub> | 20   | Filter #2 coefficient b2 <sub>2</sub> |
| 7    | Filter #1 coefficient b2 <sub>2</sub> | 21   | Filter #2 coefficient b1 <sub>2</sub> |
| 8    | Filter #1 coefficient b1 <sub>2</sub> | 22   | Filter #2 coefficient b0 <sub>2</sub> |
| 9    | Filter #1 coefficient b0 <sub>2</sub> | 23   | Filter #2 coefficient a2 <sub>2</sub> |
| 10   | Filter #1 coefficient a2 <sub>2</sub> | 24   | Filter #2 coefficient a1 <sub>2</sub> |
| 11   | Filter #1 coefficient a1 <sub>2</sub> | 25   | Freq measurement #2 ncycles           |
| 12   | Freq measurement #1 ncycles           | 26   | Freq measurement #2 mintime           |
| 13   | Freq measurement #1 mintime           | 27   | Freq measurement #2 maxtime           |
| 14   | Freq measurement #1 maxtime           |      |                                       |

**Table 4 Programming Register: Filter Coefficients**

The coefficients are entered as 15-bit signed (two's complement) integer values (the most significant bit of the 16-bit word entered should be zero) calculated as  $8192 * \text{coefficient value}$  from the user's filter design program (i.e. this allows for filter design values of -1.9999 to +1.9999).

The design of the IIR filters should make allowance for the fixed receive signal filtering in the CMX865A which has a low pass characteristic above 1.5kHz of 0.4dB at 2kHz, 1.2dB at 2.5kHz, 2.6dB at 3kHz and 4.1dB at 3.4kHz.

'ncycles' is the number of signal cycles for the frequency measurement.

'mintime' is the smallest acceptable time for ncycles of the input signal expressed as the number of 9.6kHz timer clocks. i.e.  $\text{'mintime'} = 9600 * \text{ncycles} / \text{high frequency limit}$ .

'maxtime' is the highest acceptable time for ncycles of the input signal expressed as the number of 9.6kHz timer clocks. i.e.  $\text{'maxtime'} = 9600 * \text{ncycles} / \text{low frequency limit}$ .

The level detectors include hysteresis. The threshold levels - measured at the 2 or 4-wire line with unity gain filters, using the line interface circuits described in section 4.1, 1.0dB line coupling transformer loss and with the Rx Gain Control block set to 0dB - are nominally:

|               |          |
|---------------|----------|
| 'Off' to 'On' | -44.5dBm |
| 'On' to 'Off' | -47.0dBm |

Note that if any changes are made to the programmed values while the CMX865A is running in Programmed Tone Detect mode they will not take effect until the CMX865A is next switched into Programmed Tone Detect mode.

After resetting the device, by toggling the Reset bit (b7) of the General Control Register (\$E0), all previously programmed filter coefficients are lost and the programmable tone pair detector is set to act as a simple 2130Hz + 2750Hz detector.

## 6. Application Notes

DAA designs, application notes, FAQs and other design resources can be found on the CML website.

### 6.1. Simple voice record and playback on the CMX865A

In alarm panels and telecom terminals there is frequently a requirement to record and playback voice signals. The CMX865A has a codec at the front end and this can be accessed via a test mode. The record and playback path can be handled independently so voice samples can be either recorded or pre-recorded as required. By arranging the CMX865A signal input source to be switched, voice signals can be recorded locally via a microphone. This application note gives a starting point for evaluation of this function.

The codec interface transfers a pair of signed, 16-bit words in both directions every 1/9600 second. This gives an effective sample rate of 19.2ks/s in both receive (ADC) and transmit (DAC) paths. Because the CMX865A is intended for telecom use, additional filtering, particularly of the playback path may be desired. However, the method given has been found to produce toll-quality results provided attention is paid to the signal levels to be recorded.

To playback, the C-BUS test register DDW and the Tx Data register need to be written with a pair of 16-bit samples for the DAC path. The write to test register DDW causes the Programming Flag (PF flag) in the Status register to go low until the next pair of samples is required. The PF flag will then go high, providing a timing reference that indicates the next pair of samples can be written. As the CMX865A services the DAC path, it will also service the ADC path and deliver a pair of samples to the receive registers.

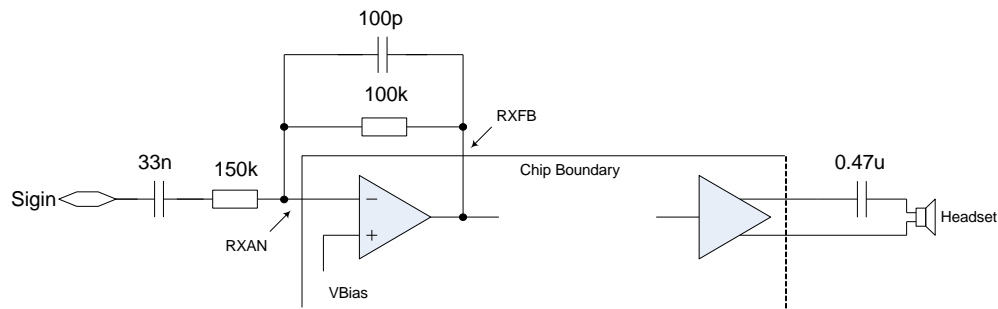
To record, it is necessary to write the DAC path to obtain the PF flag timing reference. This can be a dummy write of the test register DDW if no simultaneous transmit signal is required (use \$2000 if Tx bias is wanted). When the PF flag changes state from 0 to 1, the receive pair of samples from the ADC path are valid. These can be read from the test register DDR and the Rx Data register.

The test mode, used here to provide the record/playback facility, must not be called during normal modem operation. It can be called immediately following a standard modem operation or after a General Reset has been issued. A General Reset must be issued after the CMX865A has been used in this test mode before resuming normal modem function.

The set-up below was used with the following PE0002 script example to illustrate a simple speech recorder and playback device. The sound samples were recorded with a level at RXFB around 500mV pk-pk average and peaking at no more than +/- 1V. No anti-alias filters or reconstruction filters were used in the set-up. Users must ensure that the recording path is suitable for the signal source used and that the playback path meets the requirements applicable to the system in which it is to be used.

To reduce the amount of data storage required a simple decimation method discards one of the samples from each of the receive path pair. To reduce the noise on transmit, the sample rate is increased using a simple interpolation method. The average of the current and previous sample are used to replace the sample discarded in the decimation process.





**Figure 19 Voice Record and Playback - Test Set-up**

```
;This PE0002 script provides test access to the codec in the CMX865A allowing speech
;to be recorded and played back.
;
; Data transfers are synchronised using the Programming Flag bit of the C-BUS Status
;Register.
;
;Set up the C-BUS General Mode Reg ($E0) as required. Interrupts cannot be used. Then:
;   Wait for b13 of the Status Reg to be 1
;   Write $C012 to the C-BUS test register ($E9)
;   Repeat the following for the required recording length.
;       Wait for b13 of the Status Reg to go to 1.
;       Write 0 to the C-BUS Tx Data Reg ($E3)
;       Write codec word #2 to the C-BUS Debug Data Write ($EA), doing
;       this will clear b13 of the Status Reg.
;       Read A/D word #1 from the C-BUS Rx Data Reg ($E5)
;       Read A/D word #2 from the C-BUS Debug Data Read Reg ($EB)
;   Finish by sending a General Reset to the CMX865A.
;
;The data written to the codec is 16-bit signed. The values read from the codec
;are 15-bit signed. In this test mode, the C-BUS Tx and Rx Data Registers are set
;to 2-character mode. The normal CMX865A Tx and Rx functions are disabled while this
;routine runs.
;
*****
Gain          const 2          ;set the gain here n x 2 (sets no of asl operations)
temp0         word 0           ;G/P var
temp1         word 0           ;G/P var
temp2         word 0           ;G/P var
count         word 0           ;G/P counter 0
GEN_RESET     const $01        ;General Reset Register
cbusgcr       const $E0        ;General Control Register
cbustxd       const $E3        ;Tx data reg
cbusrxd       const $E5        ;Rx data register
cbussr       const $E6        ;Status Register
cbuspr       const $E8        ;Programming Register
cbusddar      const $E9        ;Test Register
cbusddw       const $EA        ;Test Data Write
cbusddr       const $EB        ;Test Data Read
TestMode      const $C012      ;Word to invoke test mode
VoiceFrame    buffer 60000     ;Array for coded voice
BufferSize    const 60000     ;Make BufferSize = VoiceFrame array length
;
*****

; Reset and Powerup the CMX865A
jsr GenReset          ;General Reset is only needed if it hasn't been
                      ;called since powering on.
jsr Status_wait        ;Wait until Programming flag (PF) is set.
```

```

; Start the test mode
copy TestMode *cbusddar      ;Write C012H to Test register.
jsr Status_wait              ;Wait for PF flag

;RecordMode
; Read approx 15 seconds of voice data into array
copy 0 *cbustxd              ;Zero DAC for alternate codec writes
copy 0 count                  ;Initialise count
while count < BufferSize
copy 0 *cbusddw              ;Dummy write to codec. This write triggers the PF
                                ;flag
    jsr Status_wait          ;Wait for PF flag
    copy *cbusrxd VoiceFrame[count++] ;Get 1st sample
;    copy *cbusddr VoiceFrame[count++] ;Simple decimation- discard 2nd
                                ;sample
endwhile

;Copy Voiceframe to PC file for evaluation if required.
; fopenw "ADCRecordData.txt"      ;Create/open the PC file to write.
; copy 0 count                    ;Initialise count.
; while count < BufferSize        ;Copy the entire array to the file.
;     filew "%04x" VoiceFrame[count++]
;     microdelay 8                ;Use microdelay or delay to prevent
; endwhile                        ;Text Out Buffer overflows.

;Playback mode
dialog "Ready to playback"
copy 0 count
while count < BufferSize
    copy VoiceFrame[count++] temp1 ;Initialise temp1/temp2 for
                                ;simple averaging.
    copy VoiceFrame[count] temp2

;Simple averaging interpolation
    add temp1 temp2
    asr 1 temp2

;Add gain as required
    lsl Gain temp1
    lsl Gain temp2
;and write them
    jsr Status_wait              ;Wait for PF flag then
    copy temp1 *cbustxd          ;write the averaged samples.
    copy temp2 *cbusddw
endwhile

    jsr Status_wait              ; Wait for PF flag.
    copy 0 *cbustxd              ; Done so zero the DACs to silence them.
    copy 0 *cbusddw

stop

;***** Read Status register and return when b13 set *****
Status_wait
copy *cbussr temp0            ; Read Status reg into temp0.
and $2000 temp0                ; Mask off unwanted bits.
jmpc temp0 != $2000 Status_wait ; If PF flag (b13) not set, loop.
return

;*****

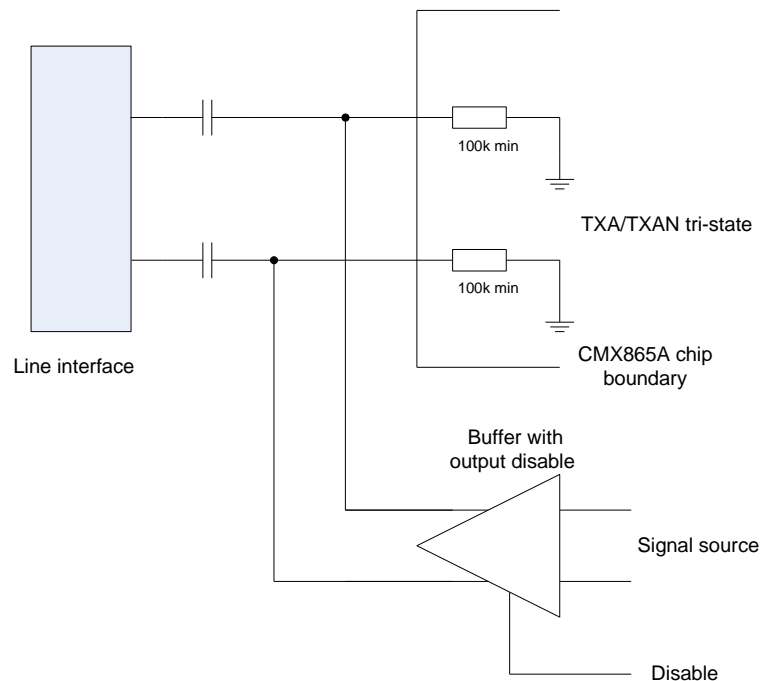
;***** Send a General Reset to device 1 *****
GenReset
register 1 GEN_RESET 0         ;Set data length of C-BUS port $01
copy 0 *GEN_RESET              ;Send General Reset.
copy $0180 *cbusgcr            ;Set Powerup (b8) and Reset (b7).
delay 50                       ;Wait 50ms for bias to settle.
copy $0100 *cbusgcr            ;Clear Reset bit (b7).
return                          ;CMX865A ready to use.

;*****

```

## 6.2. Mixing external signals such as voice onto the transmit path

The state of the transmit output pins TXA and TXAN depends on the operating mode selected. When both the transmit and receive modes are disabled, TXA and TXAN become tri-state. See Table 1. Because these paths are high impedance, a signal path can be connected to them without significant loss. The tri-state impedance is around 100k so the signal source impedance should be around 10k or less. The signal source must also have a tri-state capability to ensure that when the CMX865A is transmitting, the transmit signal is not excessively attenuated.



**Figure 20 Mixing signals onto the line interface**

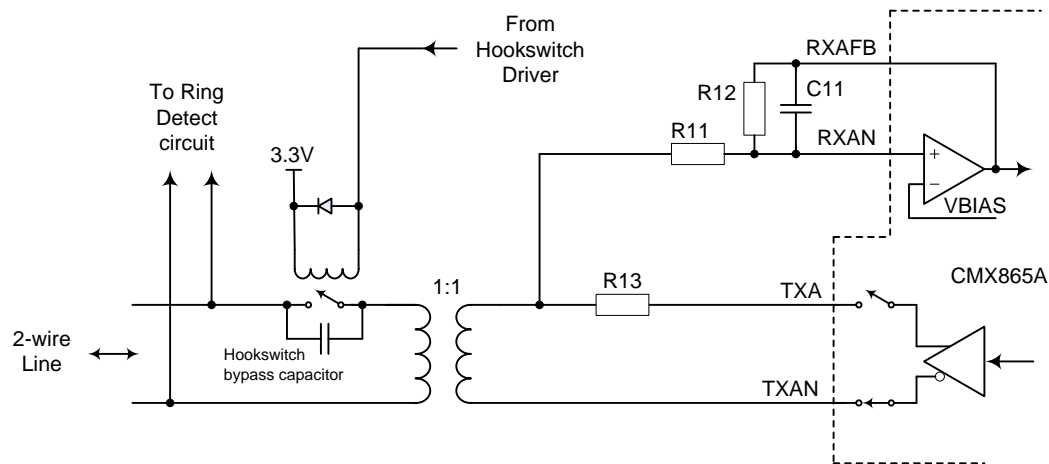
Ac coupling is shown in Figure 20 above but will not be necessary if the line interface does not require it. If ac coupling is used, the capacitor values should be chosen to pass the lowest frequency components without excessive attenuation. For the CMX865A, the lowest frequency component is around 300Hz.

The device that is buffering the signal source above could be an op-amp or other device such as a speech codec. The source signal level should not exceed the maximum ratings for the CMX865A output pins. For single-ended line interfaces, use either TXA or TXAN only.

## 6.3. Receiving on-hook Caller-ID

When the modem is on-hook it is unable to receive signals across the line interface, thus preventing it from receiving Caller-ID signals. It is common practice to arrange a capacitive signal path across the hookswitch allowing these signals to reach the modem. This capacitor must have a low value so that the on-hook ac impedance requirement is not exceeded. Having a low-value capacitor presents a high impedance to the Caller-ID signal which is then attenuated by the transformer terminating impedance. If the termination components can be switched out of circuit the transformer presents a (theoretically) infinite impedance to the hookswitch bypass capacitor, resulting in less attenuation of the Caller-ID signal. In practice an improvement of a few dB is available. Setting either TXA or TXAN to “disconnected” effectively switches out the line termination without removing the dc bias conditions. The method is illustrated in

Figure 21 below. This method is acceptable in an on-hook state but if the switches are opened in an off-hook state, the return loss of the interface is unacceptable and significant reflections of the received signal may occur. Opening and closing the switches may also cause unwanted transients to appear on the line.



### Figure 21 Using TXAN for improved Caller-ID reception

## 7. Performance Specification

### 7.1. Electrical Performance

#### 7.1.1. Absolute Maximum Ratings

Exceeding these maximum ratings can result in damage to the device.

|   | Min. | Max.           | Units |
|---|------|----------------|-------|
| Supply ( $V_{DD} - AV_{SS}$ ) or ( $V_{DD} - DV_{SS}$ ) | -0.3 | +4.0           | V     |
| Voltage on any pin (except $V_{DEC}$ ) to $V_{SS}$      | -0.3 | $V_{DD} + 0.3$ | V     |
| Voltage between $AV_{SS}$ and $DV_{SS}$                 | -50  | +50            | mV    |
| Current into or out of $V_{DD}$ and $V_{SS}$ pins       | -50  | +50            | mA    |
| Current into or out of any other pin                    | -20  | +20            | mA    |

| D4 Package  | Min. | Max. | Units                  |
|---|------|------|------------------------|
| Total Allowable Power Dissipation at $T_{amb} = 25^{\circ}\text{C}$ |      | 540  | mW                     |
| ... Derating  |      | 5.4  | mW/ $^{\circ}\text{C}$ |
| Storage Temperature   | -55  | +125 | $^{\circ}\text{C}$     |
| Operating Temperature   | -40  | +85  | $^{\circ}\text{C}$     |

| E4 Package  | Min. | Max. | Units                  |
|---|------|------|------------------------|
| Total Allowable Power Dissipation at $T_{amb} = 25^{\circ}\text{C}$ |      | 870  | mW                     |
| ... Derating  |      | 8.7  | mW/ $^{\circ}\text{C}$ |
| Storage Temperature   | -55  | +125 | $^{\circ}\text{C}$     |
| Operating Temperature   | -40  | +85  | $^{\circ}\text{C}$     |

#### 7.1.2. Operating Limits

Correct operation of the device outside these limits is not implied.

|  | Notes | Min. | Max. | Units              |
|--|-------|------|------|--------------------|
| Supply ( $V_{DD} - AV_{SS}$ ) and ( $V_{DD} - DV_{SS}$ ) |       | 3.0  | 3.6  | V                  |
| Supply rise time (10% to 90%)                            |       |      | 25   | ms                 |
| Operating Temperature                                    |       | -40  | +85  | $^{\circ}\text{C}$ |

### 7.1.3. Operating Characteristics

For the following conditions unless otherwise specified:

$V_{DD} = 3.0V$  to  $3.6V$  at  $T_{amb} = -40$  to  $+85^{\circ}C$ ,

Xtal Frequency =  $6.144MHz \pm 0.03\%$  (300ppm)

0dBm corresponds to 775mVrms.

| DC Parameters   | Notes | Min. | Typ. | Max. | Units    |
|---|-------|------|------|------|----------|
| $I_{DD}$ (Powersave mode)   | 1, 2  | -    | 6.5  | -    | $\mu A$  |
| (Reset but not powersave, $V_{DD} = 3.3V$ )   | 1, 3  | -    | 3.0  | 4.0  | mA       |
| (Running, $V_{DD} = 3.3V$ )   | 1     | -    | 4.0  | 7.0  | mA       |
| Logic '1' Input Level   |       | 70%  | -    | -    | $V_{DD}$ |
| Logic '0' Input Level   |       | -    | -    | 30%  | $V_{DD}$ |
| Logic Input Leakage Current ( $V_{in} = 0$ to $V_{DD}$ ),<br>(excluding XTAL/CLOCK input) |       | -1.0 | -    | +1.0 | $\mu A$  |
| Output Logic '1' Level ( $I_{OH} = 2$ mA)   |       | 80%  | -    | -    | $V_{DD}$ |
| Output Logic '0' Level ( $I_{OL} = -3$ mA)  |       | -    | -    | 0.4  | V        |
| IRQN O/P 'Off' State Current ( $V_{out} = V_{DD}$ )                                       |       | -    | -    | 1.0  | $\mu A$  |

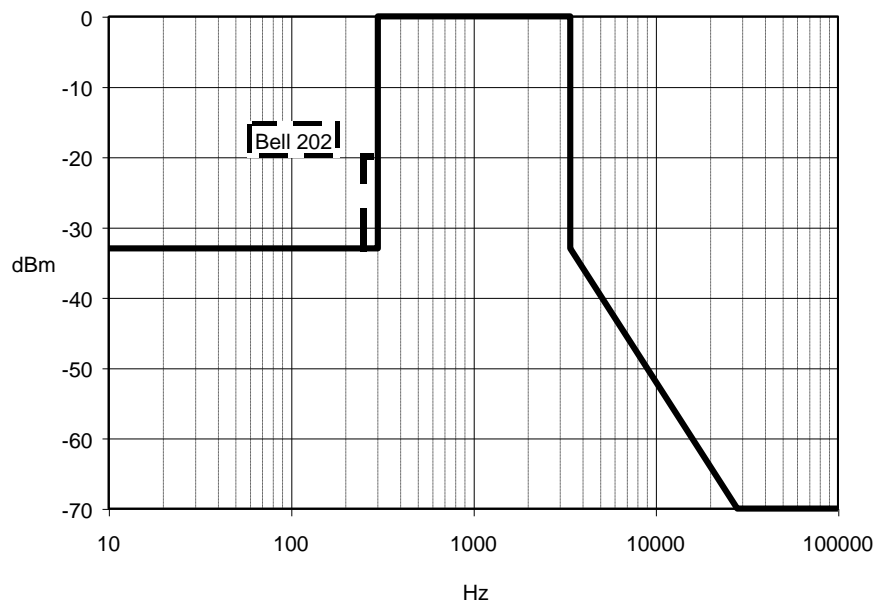
- Notes:
1. At  $25^{\circ}C$ , not including any current drawn from the CMX865A pins by external circuitry other than X1, C1 and C2.
  2. All logic inputs at  $V_{SS}$  except for CSN which is at  $V_{DD}$ .
  3. General Mode Register b8-7 set to 11.

| XTAL/CLOCK Input<br>(timings for an external clock input) | Notes | Min. | Typ. | Max. | Units |
|---|-------|------|------|------|-------|
| 'High' Pulse Width  |       | 30   | -    | -    | ns    |
| 'Low' Pulse Width   |       | 30   | -    | -    | ns    |

| <b>Transmit V.21 FSK Mode</b>          | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
|--|--------------|-------------|-------------|-------------|--------------|
| Baud rate                              | 5            | –           | 300         | –           | Baud         |
| Mark (logical 1) frequency, high band  |              | 1647        | 1650        | 1653        | Hz           |
| Space (logical 0) frequency, high band |              | 1847        | 1850        | 1853        | Hz           |
| Mark (logical 1) frequency, low band   |              | 978         | 980         | 982         | Hz           |
| Space (logical 0) frequency, low band  |              | 1178        | 1180        | 1182        | Hz           |
| <b>Transmit Bell 103 FSK Mode</b>      | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
| Baud rate                              | 5            | -           | 300         | -           | Baud         |
| Mark (logical 1) frequency, high band  |              | 2222        | 2225        | 2228        | Hz           |
| Space (logical 0) frequency, high band |              | 2022        | 2025        | 2028        | Hz           |
| Mark (logical 1) frequency, low band   |              | 1268        | 1270        | 1272        | Hz           |
| Space (logical 0) frequency, low band  |              | 1068        | 1070        | 1072        | Hz           |
| <b>Transmit V.23 FSK Mode</b>          | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
| Baud rate                              | 5            | -           | 1200/75     | -           | Baud         |
| Mark (logical 1) frequency, 1200 baud  |              | 1298        | 1300        | 1302        | Hz           |
| Space (logical 0) frequency, 1200 baud |              | 2097        | 2100        | 2103        | Hz           |
| Mark (logical 1) frequency, 75 baud    |              | 389         | 390         | 391         | Hz           |
| Space (logical 0) frequency, 75 baud   |              | 449         | 450         | 451         | Hz           |
| <b>Transmit Bell 202 FSK Mode</b>      | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
| Baud rate                              | 5            | -           | 1200/150    | -           | Baud         |
| Mark (logical 1) frequency, 1200 baud  |              | 1198        | 1200        | 1202        | Hz           |
| Space (logical 0) frequency, 1200 baud |              | 2197        | 2200        | 2203        | Hz           |
| Mark (logical 1) frequency, 150 baud   |              | 386         | 387         | 388         | Hz           |
| Space (logical 0) frequency, 150 baud  |              | 486         | 487         | 488         | Hz           |
| <b>DTMF/Single Tone Transmit</b>       | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
| Tone frequency accuracy                |              | -0.2        | -           | +0.2        | %            |
| Distortion                             | 6            | -           | 1.0         | 2.0         | %            |

- Notes:
5. Tx signal % baud or bit rate accuracy is the same as XTAL/CLOCK % frequency accuracy.
  6. Measured between TXA and TXAN pins with Tx Level Control gain set to 0dB, 1k2Ω load between TXA and TXAN, at  $V_{DD} = 3.3V$  (levels are proportional to  $V_{DD}$  - see section 4.1). Level measurements for all modem modes are performed with random transmitted data. 0dBm = 775mVrms.

| Transmit Output Level   | Notes | Min.  | Typ. | Max.  | Units |
|---|-------|-------|------|-------|-------|
| Modem and Single Tone modes   | 6     | -3.2  | -2.2 | -1.2  | dBm   |
| DTMF mode, Low Group tones  | 6     | -1.2  | -0.2 | + 0.8 | dBm   |
| DTMF twist (level of high group tones wrt low group) setting accuracy | 6     | -1.0  | -    | +1.0  | dB    |
| Tx output buffer gain control accuracy                                | 6     | -0.25 | -    | +0.25 | dB    |



**Figure 22 Maximum Out of Band Tx Line Energy Limits (see note 7)**

- Notes:
7. Measured on the 2 or 4-wire line using the line interface circuits described in section 4.1 with the Tx line signal level set to  $-9.2\text{dBm}$  for FSK or single tones,  $-5.2\text{dBm}$  and  $-7.2\text{dBm}$  for DTMF tones. Excludes any distortion due to external components such as the line coupling transformer.



| <b>Receive V.21 FSK Mode</b>                  | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
|---|--------------|-------------|-------------|-------------|--------------|
| Acceptable baud rate                          |              | 297         | 300         | 303         | Baud         |
| Mark (logical 1) frequency, high band         |              | 1638        | 1650        | 1662        | Hz           |
| Space (logical 0) frequency, high band        |              | 1838        | 1850        | 1862        | Hz           |
| Mark (logical 1) frequency, low band          |              | 968         | 980         | 992         | Hz           |
| Space (logical 0) frequency, low band         |              | 1168        | 1180        | 1192        | Hz           |
| <b>Receive Bell 103 FSK Mode</b>              | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
| Acceptable baud rate                          |              | 297         | 300         | 303         | Baud         |
| Mark (logical 1) frequency, high band         |              | 2213        | 2225        | 2237        | Hz           |
| Space (logical 0) frequency, high band        |              | 2013        | 2025        | 2037        | Hz           |
| Mark (logical 1) frequency, low band          |              | 1258        | 1270        | 1282        | Hz           |
| Space (logical 0) frequency, low band         |              | 1058        | 1070        | 1082        | Hz           |
| <b>Receive V.23 FSK Mode</b>                  | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
| <b>1200 baud</b>                              |              |             |             |             |              |
| Acceptable baud rate                          |              | 1188        | 1200        | 1212        | Baud         |
| Mark (logical 1) frequency                    |              | 1280        | 1300        | 1320        | Hz           |
| Space (logical 0) frequency                   |              | 2080        | 2100        | 2120        | Hz           |
| <b>75 baud</b>                                |              |             |             |             |              |
| Acceptable baud rate                          |              | 74          | 75          | 76          | Baud         |
| Mark (logical 1) frequency                    |              | 382         | 390         | 398         | Hz           |
| Space (logical 0) frequency                   |              | 442         | 450         | 458         | Hz           |
| <b>Receive Bell 202 FSK Mode</b>              | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
| <b>1200 baud</b>                              |              |             |             |             |              |
| Acceptable baud rate                          |              | 1188        | 1200        | 1212        | Baud         |
| Mark (logical 1) frequency                    |              | 1180        | 1200        | 1220        | Hz           |
| Space (logical 0) frequency                   |              | 2180        | 2200        | 2220        | Hz           |
| <b>150 baud</b>                               |              |             |             |             |              |
| Acceptable baud rate                          |              | 148         | 150         | 152         | Baud         |
| Mark (logical 1) frequency                    |              | 377         | 387         | 397         | Hz           |
| Space (logical 0) frequency                   |              | 477         | 487         | 497         | Hz           |
| <b>Rx Modem Signal</b>                        | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
| Signal level                                  | 8            | -45         | -           | -9          | dBm          |
| Signal to Noise Ratio (noise flat 300-3400Hz) |              | 20          | -           | -           | dB           |

Notes: 8. Rx 2 or 4-wire line signal level assuming 1dB loss in line coupling transformer with Rx Gain Control block set to 0dB and external components as section 4.1.

| <b>Rx Modem Energy Detector</b>               | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
|---|--------------|-------------|-------------|-------------|--------------|
| Detect threshold ('Off' to 'On')              | 8, 9         | -           | -           | -43.0       | dBm          |
| Undetect threshold ('On' to 'Off')            | 8, 9         | -48.0       | -           | -           | dBm          |
| Hysteresis                                    | 8, 9         | 2.0         | -           | -           | dB           |
| <b>Detect ('Off' to 'On') response time</b>   |              |             |             |             |              |
| 300 and 1200baud                              | 8, 9         | 8.0         | -           | 30.0        | ms           |
| 150 and 75baud                                | 8, 9         | 16.0        | -           | 60.0        | ms           |
| <b>Undetect ('On' to 'Off') response time</b> |              |             |             |             |              |
| 300 and 1200baud                              | 8, 9         | 10.0        | -           | 40.0        | ms           |
| 150 and 75baud                                | 8, 9         | 20.0        | -           | 80.0        | ms           |
| <b>Rx Answer Tone Detectors</b>               | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
| Detect threshold ('Off' to 'On')              | 8, 10        | -           | -           | -43.0       | dBm          |
| Undetect threshold ('On' to 'Off')            | 8, 10        | -48.0       | -           | -           | dBm          |
| Hysteresis                                    | 8, 10        | 2.0         | -           | -           | dB           |
| Detect ('Off' to 'On') response time          | 8, 10        | 30.0        | 33.0        | 45.0        | ms           |
| Undetect ('On' to 'Off') response time        | 8, 10        | 7.0         | 18.0        | 25.0        | ms           |
| <b>2100Hz detector</b>                        |              |             |             |             |              |
| 'Will detect' frequency                       |              | 2050        | -           | 2160        | Hz           |
| 'Will not detect' frequency                   |              | -           | -           | 2000        | Hz           |
| <b>2225Hz detector</b>                        |              |             |             |             |              |
| 'Will detect' frequency                       |              | 2160        | -           | 2285        | Hz           |
| 'Will not detect' frequency                   |              | 2335        | -           | -           | Hz           |
| <b>Rx Call Progress Energy Detector</b>       | <b>Notes</b> | <b>Min.</b> | <b>Typ.</b> | <b>Max.</b> | <b>Units</b> |
| Bandwidth (-3dB points) See Figure 8          |              | 275         | -           | 665         | Hz           |
| Detect threshold ('Off' to 'On')              | 8, 11        | -           | -           | -37.0       | dBm          |
| Undetect threshold ('On' to 'Off')            | 8, 11        | -42.0       | -           | -           | dBm          |
| Detect ('Off' to 'On') response time          | 8, 11        | 30.0        | 36.0        | 45.0        | ms           |
| Undetect ('On' to 'Off') response time        | 8, 11        | 6.0         | 8.0         | 50.0        | ms           |

- Notes:
9. Thresholds and times measured with continuous binary '1'. Fixed compromise line equaliser enabled. Signal switched between off and -33dBm.
  10. 'Typical' value refers to 2100Hz or 2225Hz signal switched between off and -33dBm. Times measured wrt. received line signal.
  11. 'Typical' value refers to 400Hz signal switched between off and -33dBm.

| DTMF Decoder   | Notes  | Min.  | Typ. | Max.  | Unit              |
|--|--------|-------|------|-------|-------------------|
| Valid input signal levels<br>(each tone of composite signal) | 8      | -31.0 | -    | 2.0   | dBm               |
| Not decode level<br>(either tone of composite signal)        | 8      | -     | -    | -38.0 | dBm               |
| Twist = High Tone/Low Tone                                   |        | -10.0 | -    | 10.0  | dB                |
| Frequency Detect Bandwidth                                   |        | ±2.2  | -    | -     | %                 |
| Frequency Not Detect Bandwidth                               |        | -     | -    | ±3.5  | %                 |
| Max level of low frequency noise (i.e. dial tone)            |        |       |      |       |                   |
| Interfering signal frequency ≤ 550Hz                         | 12     | -     | -    | 0.0   | dB                |
| Interfering signal frequency ≤ 450Hz                         | 12     | -     | -    | 10.0  | dB                |
| Interfering signal frequency ≤ 200Hz                         | 12     | -     | -    | 20.0  | dB                |
| Max. noise level wrt. signal                                 | 12, 13 | -     | -    | -10.0 | dB                |
| DTMF detect response time                                    | 15     | -     | 40.0 | -     | ms                |
| DTMF de-response time  |        | -     | -    | 30.0  | ms                |
| Status Register b5 high time                                 |        | 14.0  | -    | -     | ms                |
| 'Will Detect' DTMF signal duration                           |        | 40.0  | -    | -     | ms                |
| 'Will Not Detect' DTMF signal duration                       |        | -     | 25.0 | -     | ms                |
| Pause length detected  |        | 30.0  | -    | -     | ms                |
| Pause length ignored   |        | -     | -    | 15.0  | ms                |
| Falsing performance  | 14     | -     | 13   | -     | falses/<br>30mins |

Notes:

- 12. Referenced to DTMF tone of lower amplitude.
- 13. Flat Gaussian Noise in 300-3400Hz band.
- 14. Mitel CM7291 test tape, 1kHz reference tone set to 775mVrms.
- 15. See Figure 16. The decode time is directly affected by signal quality but, for good signals, will always be much less than the 100ms required for PSTN use.

| Receive Input Amplifier        | Notes | Min.  | Typ.  | Max.  | Units |
|--------------------------------|-------|-------|-------|-------|-------|
| Input impedance (at 100Hz)     |       | 10.0  |       |       | Mohm  |
| Open loop gain (at 100Hz)      |       |       | 10000 |       | V/V   |
| Rx Gain Control Block accuracy |       | -0.25 |       | +0.25 | dB    |

| C-BUS Timings (See Figure 23) |                                       | Notes | Min. | Typ. | Max. | Units   |
|-------------------------------|---------------------------------------|-------|------|------|------|---------|
| $t_{CSE}$                     | CSN-Enable to Clock-High time         |       | 100  | -    | -    | ns      |
| $t_{CSH}$                     | Last Clock-High to CSN-High time      |       | 100  | -    | -    | ns      |
| $t_{LOZ}$                     | Clock-Low to Reply Output enable time |       | 0.0  | -    | -    | ns      |
| $t_{HIZ}$                     | CSN-High to Reply Output 3-state time |       | -    | -    | 1.0  | $\mu$ s |
| $t_{CSOFF}$                   | CSN-High Time between transactions    |       | 1.0  | -    | -    | $\mu$ s |
| $t_{NXT}$                     | Inter-Byte Time                       |       | 200  | -    | -    | ns      |
| $t_{CK}$                      | Clock-Cycle time                      |       | 200  | -    | -    | ns      |
| $t_{CH}$                      | Serial Clock-High time                |       | 100  | -    | -    | ns      |
| $t_{CL}$                      | Serial Clock-Low time                 |       | 100  | -    | -    | ns      |
| $t_{CDS}$                     | Command Data Set-Up time              |       | 75.0 | -    | -    | ns      |
| $t_{CDH}$                     | Command Data Hold time                |       | 25.0 | -    | -    | ns      |
| $t_{RDS}$                     | Reply Data Set-Up time                |       | 50.0 | -    | -    | ns      |
| $t_{RDH}$                     | Reply Data Hold time                  |       | 0.0  | -    | -    | ns      |

Maximum 30pF load on each C-BUS interface line.

Note: These timings are for the latest version of the C-BUS as embodied in the CMX865A.

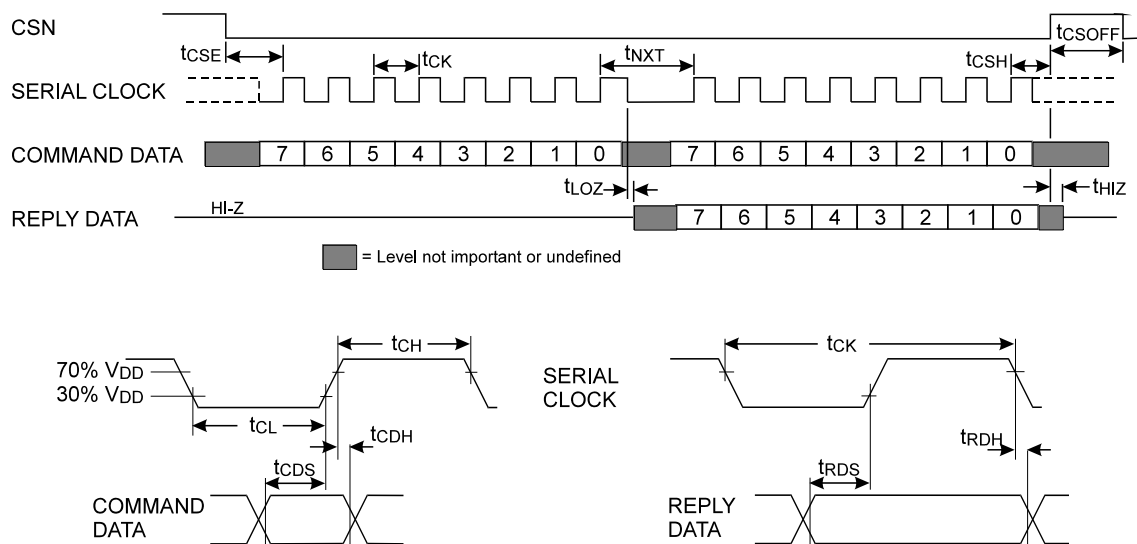
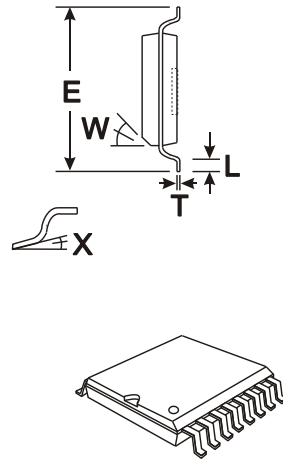
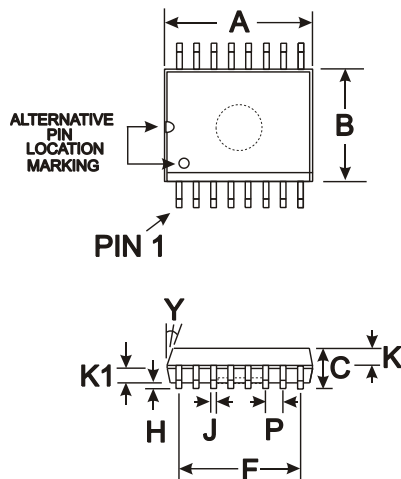


Figure 23 C-BUS Timing

## 7.2. Packaging



| DIM. | MIN.          | TYP.          | MAX. |
|------|---------------|---------------|------|
| * A  | 0.395 (10.03) | 0.413 (10.49) |      |
| * B  | 0.286 (7.26)  | 0.299 (7.59)  |      |
| C    | 0.088 (2.24)  | 0.105 (2.67)  |      |
| E    | 0.390 (9.90)  | 0.419 (10.64) |      |
| F    |               | 0.350 (8.89)  |      |
| H    | 0.003 (0.08)  | 0.020 (0.51)  |      |
| J    | 0.013 (0.33)  | 0.020 (0.51)  |      |
| K    |               | 0.041 (1.04)  |      |
| K1   |               | 0.041 (1.04)  |      |
| L    | 0.016 (0.41)  | 0.050 (1.27)  |      |
| P    |               | 0.050 (1.27)  |      |
| T    | 0.009 (0.23)  | 0.0125 (0.32) |      |
| W    |               | 45°           |      |
| X    | 0°            |               | 10°  |
| Y    |               | 7°            |      |

NOTE :

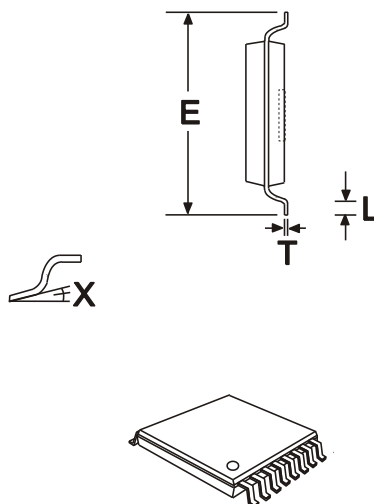
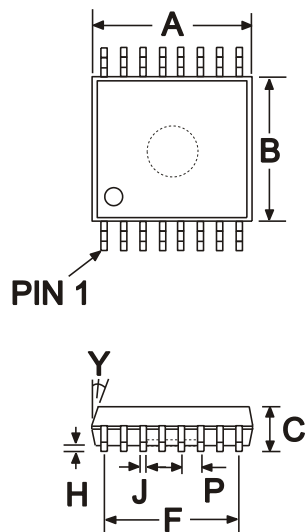
- \* A & B are reference datum's and do not include mold deflash or protrusions.

All dimensions in inches (mm.)

Angles are in degrees

Co-Planarity of leads within 0.004" (0.1mm)

Figure 24 16-pin SOIC (D4) Mechanical Outline: **Order as part no. CMX865AD4**



| DIM. | MIN. | TYP. | MAX. |
|------|------|------|------|
| * A  | 4.90 |      | 5.10 |
| * B  | 4.30 |      | 4.50 |
| C    |      |      | 1.20 |
| E    | 6.20 |      | 6.60 |
| F    |      | 4.55 |      |
| H    | 0.05 |      | 0.15 |
| J    | 0.17 |      | 0.30 |
| L    | 0.45 |      | 0.75 |
| P    |      | 0.65 |      |
| T    | 0.08 |      | 0.20 |
| X    | 0°   |      | 8°   |
| Y    |      | 12°  |      |

NOTE :

- \* A & B are reference data and do not include mold deflash or protrusions.

All dimensions in mm

Angles are in degrees

Figure 25 16-pin TSSOP (E4) Mechanical Outline: **Order as part no. CMX865AE4**

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