DB1065
User's Manual

MX465 CTCSS Encoder / Decoder Development Kit

MX•COM, INC.

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1. General Information

1.1 Introduction

This manual provides general information to support the installation and operation of the DB1065 Development Kit, a complete test platform to demonstrate and test the MX465 CTCSS encoder/decoder.

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1.2 Warranty

The DB1065 hardware has been developed and is provided to help designers develop designs based on the MX465 CTCSS Encoder / Decoder IC. Every reasonable effort has been made to provide high quality and performance in pursuit of that goal.

Toward that end, MX-COM, Inc. would value any suggestions to improve the DB1065's manual and suggestions concerning the DB1065's hardware design.

Since experiments and designs are the responsibility of the DB1065 user, MX-COM, Inc.'s liability regarding the use of the DB1065 is in all cases limited to the DB1065 purchase price.

No other warranty is expressed or implied.

1.3 DB1065 Features

The DB1065 Development Kit includes many useful features including those highlighted in Table.

Features	Applications
• MX•COM MiXed Signal CMOS Design	• Mobile Radio Channel Sharing
• 47 CTCSS Tones + Notone	• Repeater Control
• TX/RX Speech Filters	• Wireless Intercom Traffic Control
• Parallel Programming using Dip Switch Serial mode also available	• Hookswitch Supervision
• Meets TIA/EIA-603 Land Mobile Standard	• Simultaneous Voice Plus Control Signaling
• Improved SINAD	• Remote Control
• Easy µP Interface	

Table 1 DB1065 Features

1.4 Handling Precautions

Like most development boards, the DB1065 is designed for use in office and laboratory environments. The following practices will help ensure its proper operation.

1.4.1 Static Protection

The DB1065 uses low power CMOS circuits which can be partially or completely damaged by electrostatic discharge. Partially damaged circuits can function erroneously and provide misleading test results which can be time consuming (and extremely frustrating) to resolve. Please observe common industrial static handling precautions when un-packing or handling the printed circuit board.

1.4.2 Cleanliness

Because some DB1065 circuits are very high impedance, it is important to maintain their cleanliness. All flux and other contaminants should be thoroughly removed after making any additions or modifications to the circuit board.

1.5 Unpacking

After reviewing the instructions in section 1.4, Handling Precautions, check to make sure that each of the following items are provided in the quantities indicated:

Item	Description	Quantity
1.	DB1065 User's Manual	1
2.	DB1065 board	1
3.	MX465 data sheet	1

2. Electrical Performance

2.1 Absolute Maximum Ratings

Exceeding these maximum ratings can result in damage to the device. Operation of the device outside the operating limits is not implied.

Absolute Maximum Ratings	Min.	Max.	Units	Note
B+ Supply Voltage input	-0.30	25.00	volts DC	
+5V Supply Voltage input	-0.30	7.00	volts DC	
Voltage on logic inputs or outputs	-0.30	5.30	volts DC	1
Voltage on analog input or outputs	-0.40	20.00	volts DC	
Storage Temperature	0.00	85.00	°C	
Operating Temperature	0.00	50.00	°C	

2.2 Operating Characteristics

For the following conditions unless otherwise specified:
T=25C, DC supply voltage B+ = +12VDC, GND = 0V
0dB ref. = 750mV$_{rms}$ (V$_{DD}$ = 5VDC)
Composite CTCSS test Signal: 300 mVrms 1KHz test tone, 75 mVrms band limited 6KHz gaussian white noise, 30 mVrms CTCSS tone
Xtal Frequency = 4.0mhz, 100ppm max
For additional Operation Characteristics refer to MX-COM MX465 data sheet

Characteristic	Minimum	Typical	Maximum	Units	Note
Supply voltage					
B+ DC Supply Voltage Input	8	12	25	VDC	
+5V DC Supply Voltage Input	3	5	7	VDC	
DC Supply Current		6	10	ma	
Input Logic specifications for $\overline{PTT}$, PTL, $\overline{CS}$, $\overline{MONITOR}$					
Input Low Voltage			1.50	VDC	1
Input High Voltage	3.50			VDC	1
Output Logic Specifications for DECODE (open collector output)					
Output Current (sink)		10		mA	
Analog Outputs TXOUT, RXOUT, TONEOUT					
Impedance		1000		Ω	
TXOUT Level		750		mVrms	
RXOUT Level		500		mVrms	
TONEOUT Level	500			mVrms	
Analog Inputs TXIN, RXIN					
Impedance		1000		Ω	
TXIN Level	100	300		mVrms	
RXIN Level	30	500		mVrms	
TX and RX Audio Filter					
Total Harmonic Distortion		2	5	%THD	2
Output Noise Level (input AC gnd)		2		mVrms	
Passband	300		3000	Hz	
Bandpass Ripple	-1		1	dB	
Passband Gain at 1KHz		0		dB	
CTCSS Decoder					
Input signal level	30		436	mVrms	2
Response Time			250	ms	3,4,5
Deresponse Time		180.00	250	ms	3,4,5
Upper Decode Band Edge	1.005 F$_i$		.995 F$_{i+1}$	Hz	3,6

Characteristic	Minimum	Typical	Maximum	Units	Note
Lower Decode Band Edge	1.005 F_{i-1}		.995 F_i	Hz	3,6
Encoder					
Tone Output Level	548	775		mVrms	
Tone Frequency Accuracy (f error)	-0.30		0.30	%f_O	
Total Harmonic Distortion		2	5	%THD	

Notes
1. Valid for +5VDC on Vdd to the MX465 IC.
2. Measured referenced to 0dB= 1KHz tone referenced to 300 mVrms
3. Composite Signal Test Condition
4. f_0>100Hz (for 100 Hz>f_0>67Hz: t=100/f_0Hz X 250ms)
5. Per TIA/EIA-603
6. Only for the F_i in TIA /EIA-603, where F_i is the program tone.

2.3 Prerequisites and Required Equipment

2.3.1 Prerequisites
In order to effectively use the DB1065 Development Kit, the user should refer to the MX-COM data sheet for the MX465.

2.3.2 Power Supply
A user provided +12VDC regulated power supply is required to power the development card when connected to the B+ input. A regulated +5VDC supply is used when powering the DB1065 from the +5V input.

2.4 Limitations
The DB1065 development board is designed to support the serial operation of the MX465 but the user must design and connect external hardware to use this function in the MX465. Refer to the MX465 data bulletin for additional assistance for using the MX465 in serial mode. All input and output analog and logic functions may be evaluated using the parallel mode of operation.

3. Quick Start

3.1 Introduction
This section allows quick setup and test verification of the DB1065 Development Kit.

3.2 First...
Review sections 1.4, Handling Precautions; 1.5, Unpacking and 2.4, Limitations sections above. (Quick start?!!) Don't worry, those sections are very short and help you to avoid damaging the DB1065 or your equipment.

3.3 Second - Setup
a. Connect a +12VDC power supply to B+ and GND.
b. Refer to Figure 1: Test Equipment Connections, on page 7 and Figure 7: DB1065 Schematic, on page 20 to connect test equipment to the DB1065 development board.
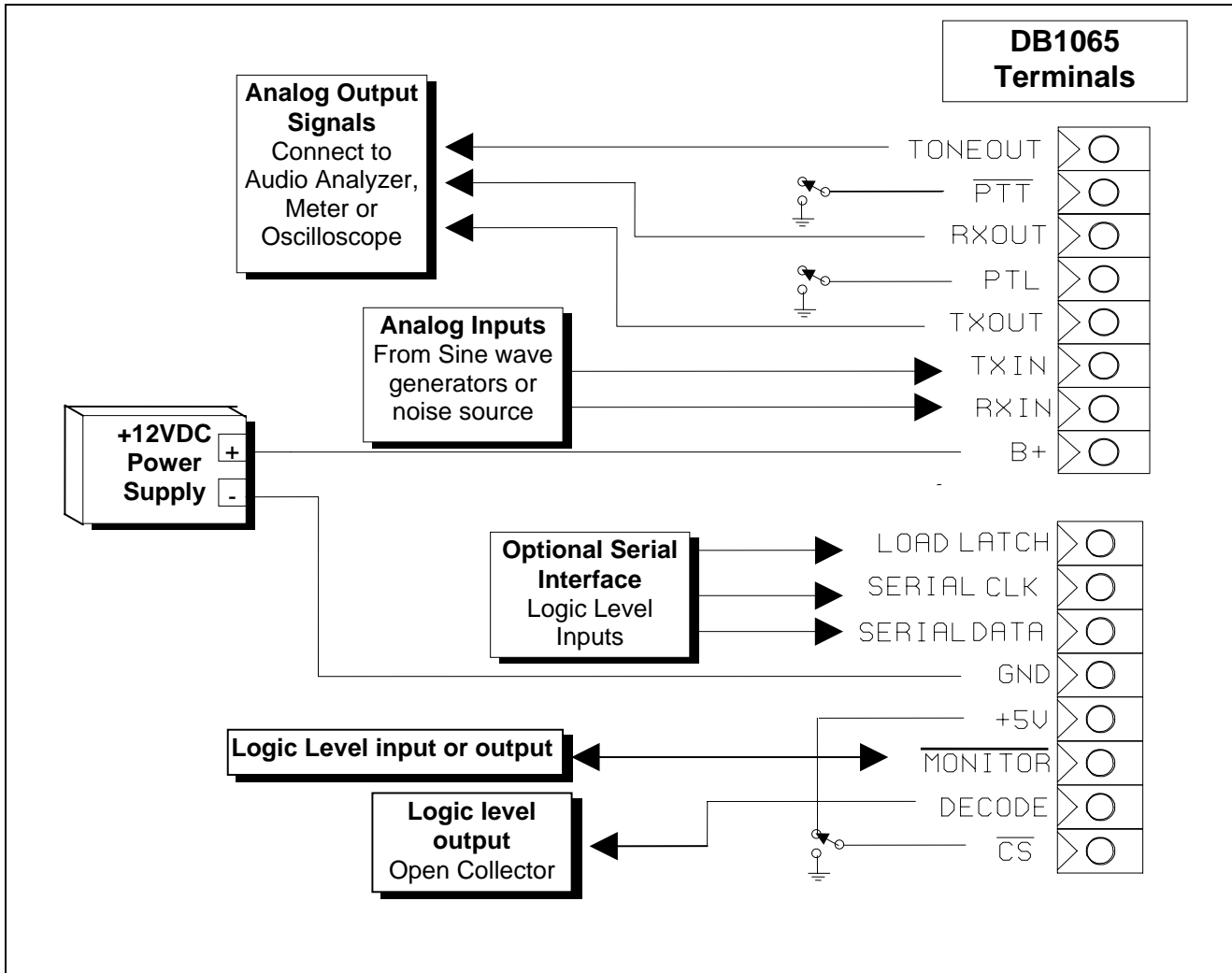
Figure 1: Test Equipment Connections

3.4 Third - Select and Execute a Test

3.4.1 CTCSS encoder verification

a. With the external power supply off, connect an oscilloscope or audio analyzer to TONEOUT. Ensure test equipment's ground is tied to GND on the DB1065.
b. Set the dip switches D0-D5 for a CTCSS tone selected from Table 4: CTCSS Tones on page 17.
c. Connect $\overline{PTT}$ to GND.
d. Apply power.
e. Adjust R3 for an amplitude of 300 mVrms.
f. Measure the amplitude, frequency and or distortion of the CTCSS tone on TONEOUT. The frequency should correspond to the setting of the dip switch in reference to Table 4: CTCSS Tones starting on page 17.

3.4.2 Transmit audio path verification

a. Using an audio signal generator, set for a 1KHz sine wave at 300 mVrms, connect the audio signal generator to TXIN.
b. Connect an oscilloscope or audio analyzer to TXOUT.
c. Measure the output level and calculate the gain difference between TXIN and TXOUT.
20*log Vin/Vout where Vin = TXIN and Vout = TXOUT.
d. Calculate the level that represents -3 dB below the output level at TXOUT for a 1khz sine wave.

$$10^{\frac{-3dB}{20}} \otimes TXOUT$$ which equals .707 X TXOUT = -3dB level

e. Lower the frequency of the signal generator until the -3dB level is reached.
f. Measure the output frequency of the signal generator. This will be the lower -3dB band edge of the TX audio filter.
g. Raise the frequency of the signal generator until the -3dB level is reached.
h. Measure the output frequency of the signal generator. This frequency will be the upper -3dB band edge of the TX audio filter.
h. Remove ground from $\overline{PTT}$. The 1KHz signal applied to TXIN should not be present at the TXOUT connection.

3.4.3 CTCSS decoder verification

a. Remove ground from $\overline{PTT}$.
b. Measure the logic level on the $\overline{MONIT0R}$ output. With no CTCSS tone it should be greater than 3 volts dc.
c. Connect an audio signal generator to RXIN. Adjust the audio generator's level to 50 mVrms and its frequency to equal the CTCSS tone frequency ($\pm$ 1 hertz) as set on the dip switch D0-D5 using Table 4: CTCSS Tones starting on page 17.
d. Measure the logic level on the $\overline{MONIT0R}$ output. It should be less than 1 volt dc when detecting a CTCSS tone.
e. Connect CARRIER SENSE to +5VDC. $\overline{MONIT0R}$ output should go to a hi logic level (>3VDC).

3.4.4 Receive audio path verification

a. Ensure $\overline{PTT}$ and PTL is not connected to ground.
b. Using an audio signal generator, set for a 1khz sine wave at 300 mVrms, connect the audio signal generator to RXIN.
c. Connect an oscilloscope or audio analyzer to RXOUT.
d. Measure the output level and calculate the gain difference between RXIN and RXOUT.
20*log Vin/Vout where Vin = RXIN and Vout = RXOUT.
e. Calculate the level that represents -3 dB below the output level at RXOUT for a 1khz sine wave.

$$10^{\frac{-3}{20}} \otimes RXOUT$$ or .707 X RXOUT = -3dB level

f. Lower the frequency of the signal generator until the -3dB level is reached.
g. Measure the output frequency of the signal generator. This will be the lower -3dB band edge of the RX audio filter.
h. Raise the frequency of the signal generator until -3dB level is reached.
i. Measure the output frequency of the signal generator. This will be the upper -3dB band edge of the RX audio filter.
j. Connect ground to PTL. RX path audio should not be present at the RXOUT connection.

4. Fourth - Explore

By using the basic verification tests for receive and transmit, the performance of the MX465 can be explored by varying the frequency and level of the audio input signals. The following examples provide additional tests that can be performed.

4.1 Measuring CTCSS Encoder response time

Use the CTCSS encoder verification on page 7 to set up to test encoder response time. Connect one channel of a storage scope to $\overline{PTT}$ and another channel of a storage scope to TONEOUT. Set the scope to trigger on $\overline{PTT}$. Connect and disconnect the $\overline{PTT}$ to ground and measure the time difference from $\overline{PTT}$ going from a logic level high to a logic low and a 90% steady level CTCSS tone amplitude output on TONEOUT.

4.2 Measuring CTCSS Decoder response time

Use the CTCSS decoder verification on page 8 to set up to test decoder response time. Connect one channel of a storage scope to RXIN and another channel of a storage scope to $\overline{MONIT0R}$. Set the scope to trigger on RXIN. Turn the CTCSS tone off and on by connecting and disconnecting the signal generator. Measure the time difference from applying CTCSS tone to RXIN (where the CTCSS tone level reaches 90% of a full steady state level) to $\overline{MONIT0R}$ changing from a logic level hi to a logic level low (were the logic level reaches 90% of steady low state).

4.3 Measuring CTCSS Decoder band width

Use the CTCSS decoder verification on page 8 to set up to evaluate decoder bandwidth. Adjust the frequency of the audio generator above and below the CTCSS tone's center frequency and measure the band edge where $\overline{MONIT0R}$ changes from a hi (indicating no tone present) to a low (indicating a CTCSS tone was detected).

4.4 Measuring CTCSS response at different SINADs

A composite signal summing network can be bread boarded to simulate adverse signal conditions. This consists of an opamp with three summing nodes. Separate signal generators are used to simulate the 3 basic types of audio signals that may be present at RXAUDIO's input. One signal generator is used to simulate the CTCSS tone frequency and level. A noise generator that is 6khz band limited gaussian noise simulates background noise. The audio sine wave generator simulates the voice channel. A SINAD meter may be connected to the RXIN audio path to measure SINAD of the input signal to the MX465's CTCSS decoder.
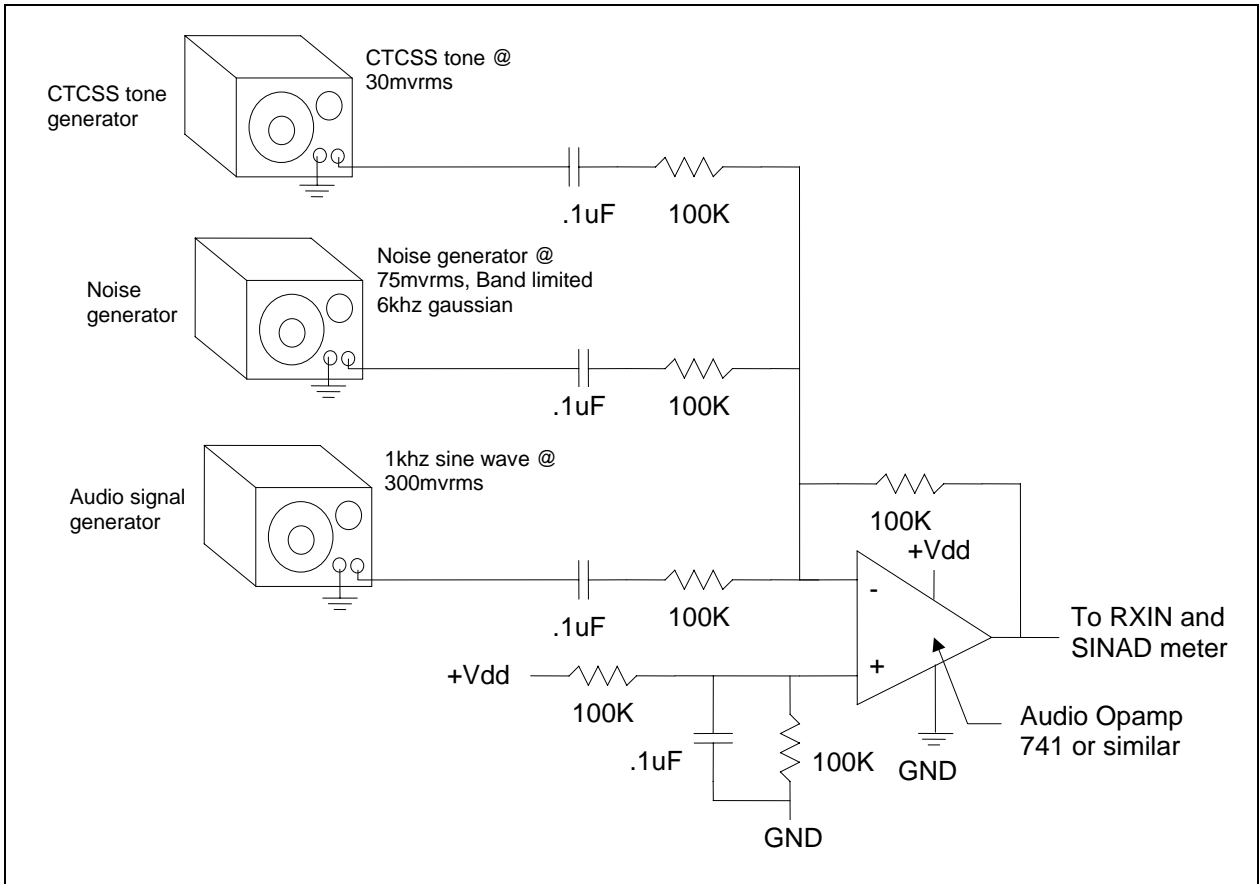
Figure 2: Composite test signal circuit diagram

Using the circuit above and setting the signal generators to the levels shown in the diagram simulates a CTCSS signal in a worst case condition. The performance of the DB1065 can be measured with a SINAD meter connected to RXIN while each signal generator is varied to simulate different signaling conditions.

4.5 Performance at other operating voltages

The DB1065's performance may be evaluated at supply voltages other than the +5VDC supplied from the on board regulator.
a. Turn power supply off.
b. Disconnect the power supply's connection to J1 the B+ connection on the DB1065.
c. Set the power supply for an output of +5VDC.
d. Turn power supply off and connect it to the +5V J12 of the DB1065.
e. Turn on the power supply.

As an example, a DB1065 was configured to detect a 67Hz CTCSS tone using the following configuration shown in Figure 3.

Figure 3: Testing at different supply voltages

Measuring supply current at different supply voltages in the configuration shown in Figure 3 would result in a typical graph as shown in Figure 4.
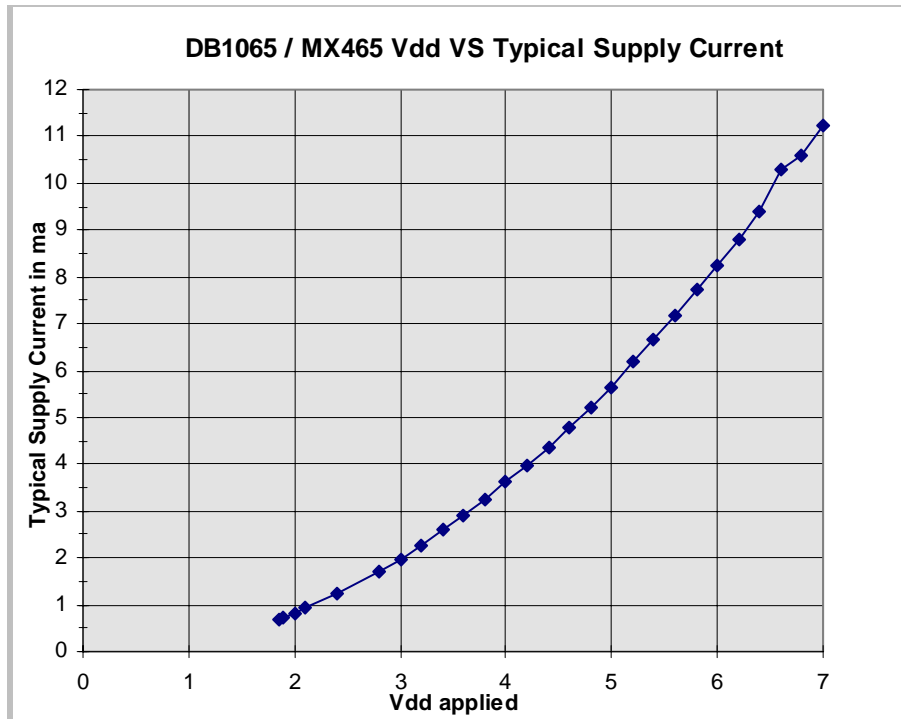
Figure 4: Supply Voltage Vs Typical Supply Current

Other performance characteristics may be measured and plotted in a similar manner. Please refer to the MX465's specifications in section 2, Electrical Performance, on page 3 regarding maximum and m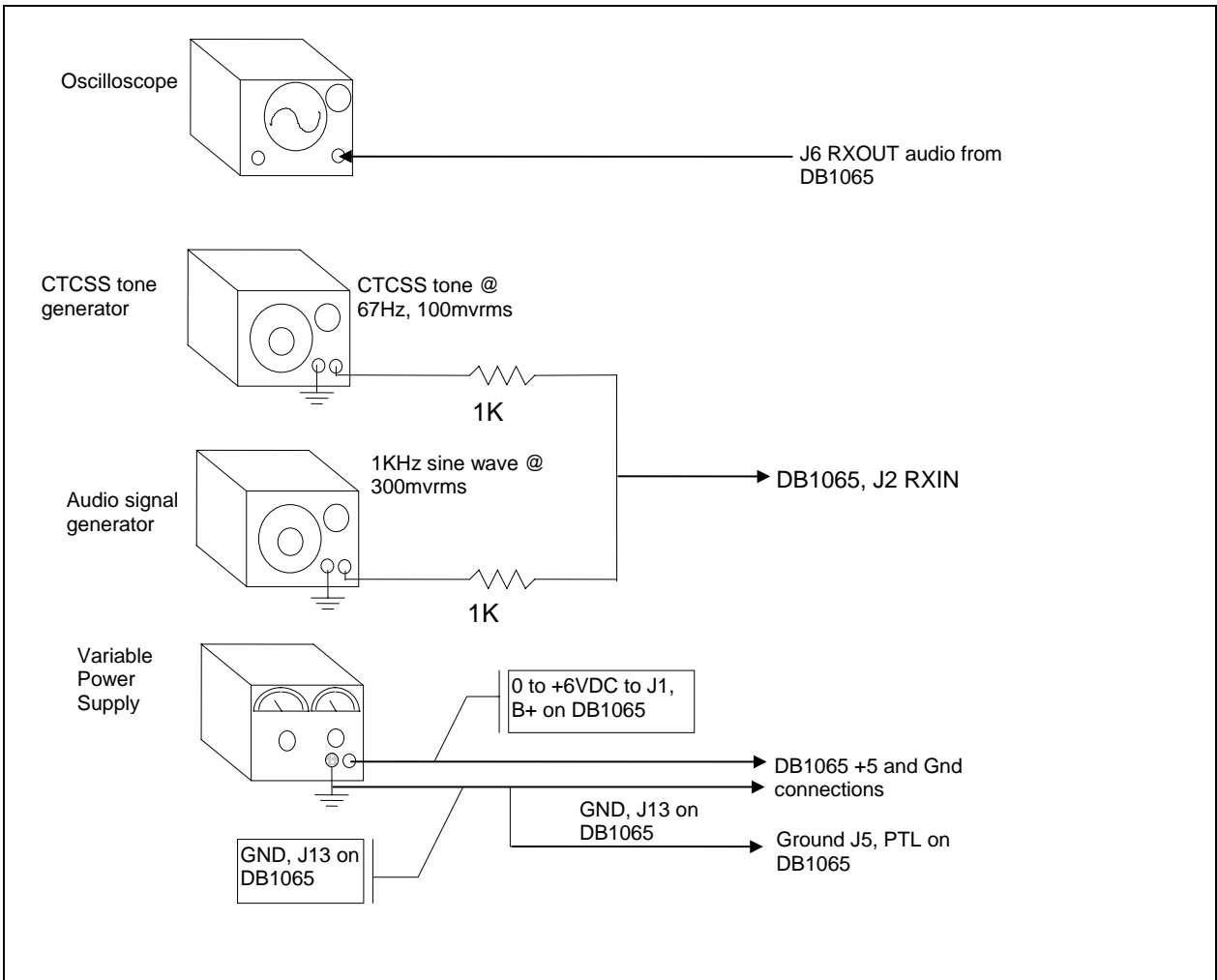inimum operating limits each device is tested to meet. Section 2's information is used by the designer in regard to designing a circuit using the MX465 based on a device's electrical properties.

4.6 Connecting the DB1065 to a system

The DB1065 may be connected to a radio system by connecting wires to the terminal strips or the DB1065's smaller circuit may be broken out of the development board.

Refer to Figure 5: Breaking Out Small Circuit, on Page 13. Before snapping the smaller circuit out the traces on the snap lines must be cut by carefully breaking off the three tabs containing the terminal strips and dip switch. Try and avoid bending or flexing the smaller circuit as the surface mount components are damaged easily. A set of tin snips can be also be used to cut out the smaller board and trim up the excess or rough edge left on the smaller board.

Holes for soldering wires have been provided around the edge of the smaller inside circuit. Refer to Figure 8: Component view Assembly Drawing, to connect wires appropriately. Solder jumpers in the smaller circuit, E1 through E6, provide a method to select one CTCSS tone for operation. Refer to Figure 9: Solder View Assembly Drawing, for reference to solder jumpers.
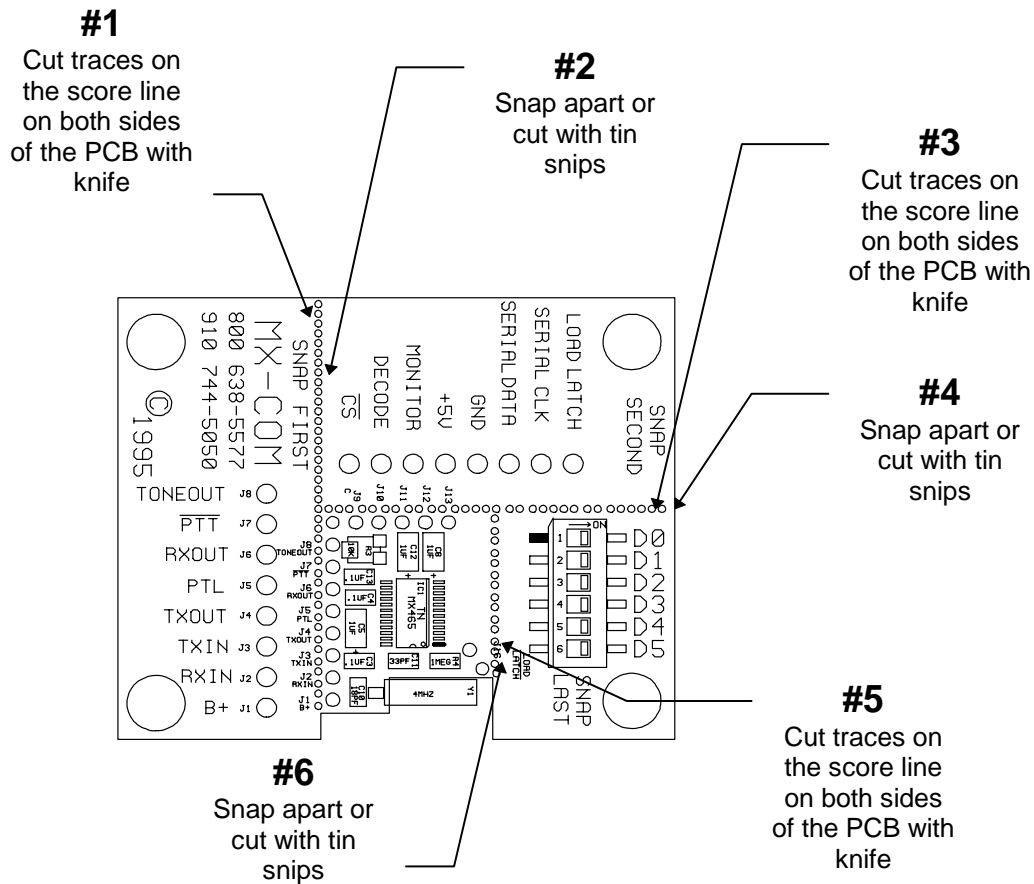
Figure 5: Breaking Out Small Circuit

4.7 TIA / EIA 603

Additional performance measurements are detailed in TIA / EIA - 603 standard. Section 6 outlines Standards for Subaudible Signaling for Land Mobile FM or PM Communications Equipment.

TIA / EIA standards may be obtained from

(TIA's address)
Telecommunications Industry Association
2001 Pennsylvania Ave. NW
Suite 800
Washington, DC 2006
Phone: (202) 457-5430
Fax: (202) 457-4939

(EIA's address)
Electronic Industries Association
1722 Eye Street, NW
Suite 440
Washington, DC 20006
Phone: (202) 457-4936
Fax: (202) 457-4966

An alternative source is Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112 Phone: (800) 854-7179 (They accept Credit card orders) Global is a company that specializes in reprinting standards and is a good source to quickly get many types of standards.

5. Hardware

5.1 Introduction

This section describes the PCB hardware and its adjustment.

5.2 Description

5.2.1 Functional Layout of Circuitry

The block diagram of the MX465 shown below shows internal connections to the MX465. Refer to Figure 7: DB1065 Schematic, on page 20 for external circuitry on the DB1065 circuit board.
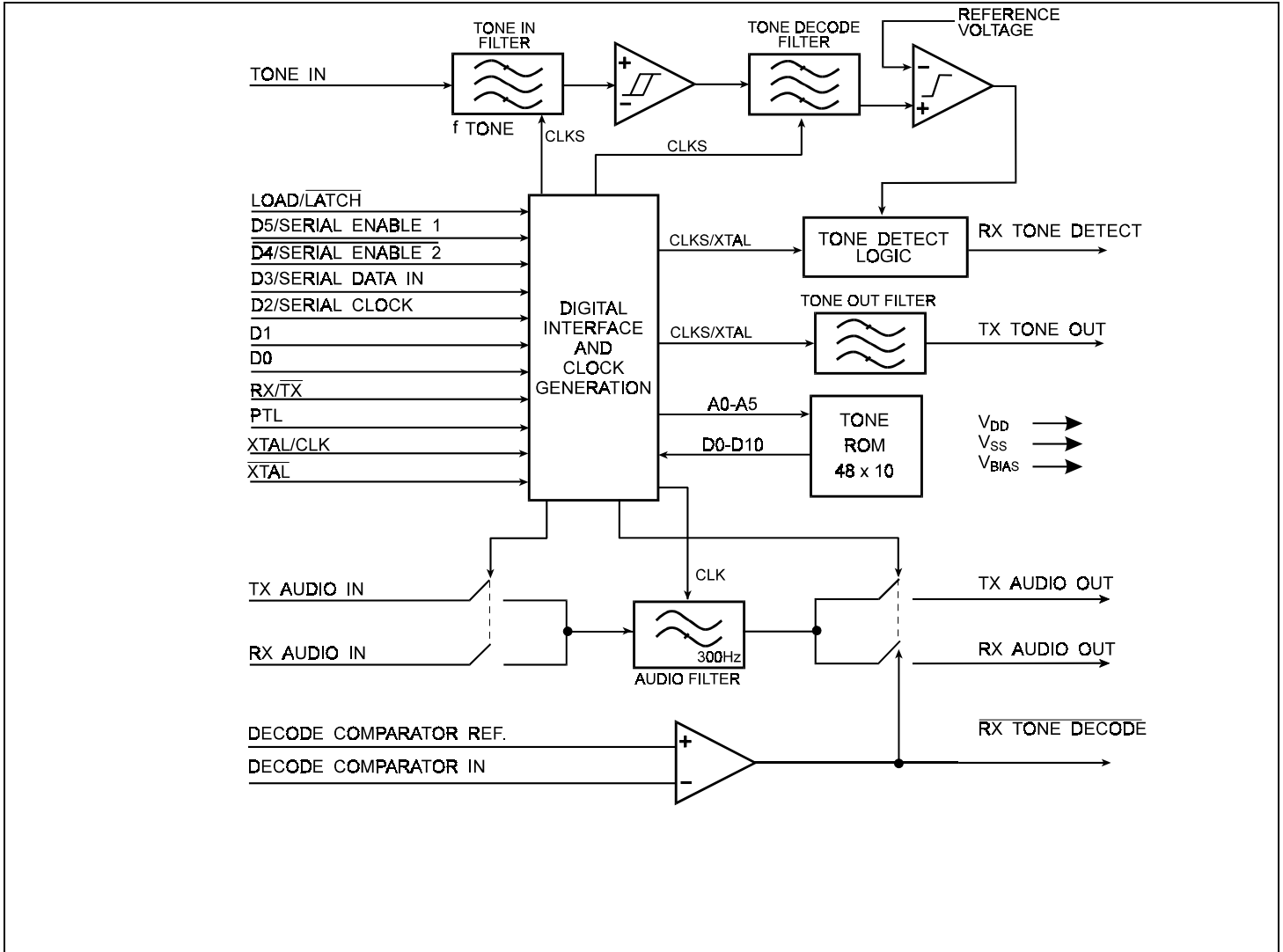
5.2.2 Connectors

Clamping connectors are distributed around the perimeter of the DB1065 motherboard as shown in Figure 8: Component view Assembly Drawing, on page 21. Silk-screen labels are provided on the motherboard to identify the connections listed in **Error! Reference source not found.**. Refer to Figure 7: DB1065 Schematic, on page 20 in reference to the electrical connections to the MX465.

Name	Ref. Desg.	Description
+B	J1	This is the positive supply pin usually connected to +12VDC.
RXIN	J2	This is the input to the audio band pass filter in RX mode.
TXIN	J3	This is the TX Audio Input pin. In the TX mode it may be pre-filtered, using the TX audio path, Thus helping to avoid talkoff due to intermodulation of low frequency speech components with the transmitted CTCSS tone.
TXOUT	J4	This is the band pass filtered transmit audio output pin. In TX mode the pin outputs audio present at the TX audio input pin.
PTL	J5	In RX mode this pin operates as a "Push To Listen" function by enabling the RX audio path, thus overriding the tone squelch function. Tying PTL to ground will inhibit audio through the RX audio path till a CTCSS tone is decoded or "No Tone" is selected on D0-D5
RXOUT	J6	This is the band pass filtered receive audio output pin. This pin outputs audio when RX tone DECODE is true or PTL is true or when Notone is programmed.
$\overline{PTT}$	J7	Logic level input pulled low to enable transmitt mode.
TONEOUT	J8	The CTCSS sine wave output appears on this pin under control of the $\overline{PTT}$ input. The level is adjusted using R3.
CARRIER SENSE	J9	Input that can be connected to the radios carrier sense logic to enable the CTCSS decoder only when a carrier is present.
DECODE	J10	This is an open collector output used to mute the RX audio path or control squelch circuitry in a system. It provides a path to ground when a CTCSS tone is not present and is open collector when a CTCSS tone is detected.
$\overline{MONIT0R}$	J11	This pin will have a +5VDC output till a CTCSS tone is detected. Alternatively this pin can be used to disable the open collector DECODE output pin and can be connected to a system's "Push To Listen", or $\overline{MONIT0R}$ function.
+5V	J12	This pin is an alternative supply pin that can be connected to an external DC supply to evaluate performance of the MX465 at supply voltages below 7.0 VDC.
GND	J13	Connection to ground.
SERIAL DATA	J14	In serial operation, Data to control the MX465 is clocked in on this logic input. Refer to the MX465's data sheet for operation.
SERIAL CLOCK	J15	Control data is clocked into the MX465 based on the rising and falling edge of this logic input.
LOAD $\overline{LATCH}$	J16	Data is either in the process of loading into the MX465 control registers or is latched into the MX465's internal registers using this logic input pin.

Table 2: Connector Signal Descriptions

6. Logic Table for operation

6.1 I/O Conditions

	Input Pin Condition			Output Pin Condition		Result/Function				
D0-D5	$\overline{\text{PTT}}$	PTL	CTCSS Tone in	DECODE	$\overline{\text{MONITOR}}$	Tone Transmitter Enabled	TX Audio Path Enabled	Tone Decoder Enabled	RX Audio Path Enabled	Notes
Tone	0	0	X	0	1	Yes	Yes	No	No (bias)	1
No Tone	0	X	X	0	1	No (bias)	Yes	No	No (bias)	2
Tone	1	0	No	0	1	No (bias)	No	Yes	No (bias)	3a
Tone	1	1	No	0	1	No (bias)	No	Yes	Yes	3b
Tone	1	X	Yes	o/c	0	No (bias)	No	Yes	Yes	4
No Tone	1	X	X	o/c	0	No (bias)	No	Yes	Yes	5

Table 3: Combinations of input/output conditions

Notes: o/c = Open circuit
   X = don't care
1. Normal tone transmit condition.
2. Notone programmed in TX mode, tone transmit O/P set to $V_{DD}/2$. TX audio path enabled.
3a. Normal decode standby.
3b. Normal decode standby with PTL used to enable audio.
4. Normal decode of correct CTCSS tone condition, PTL has no effect.
5. Notone programmed in RX mode, tone transmit O/P (o/c). RX audio path enabled.

6.2 CTCSS Programming

Tone			Programming Inputs, Switch (Solder Jumper)						
Nominal Frequency (Hz)	MX465 Frequency (Hz)	Δf_0 (%)	D5 (E6)	D4 (E5)	D3 (E4)	D2 (E3)	D1 (E2)	D0 (E1)	Hex
67.0	66.98	-0.029	1	1	1	1	1	1	3F
69.3	69.32	0.024	1	1	1	0	0	1	39
71.9	71.901	0.001	0	1	1	1	1	1	1F
74.4	74.431	0.042	1	1	1	1	1	0	3E
77.0	76.965	-0.046	0	0	1	1	1	1	0F
79.7	79.677	-0.029	1	1	1	1	0	1	3D
82.5	82.483	-0.021	0	1	1	1	1	0	1E
85.4	85.383	-0.020	1	1	1	1	0	0	3C
88.5	88.494	-0.007	0	0	1	1	1	0	0E
91.5	91.456	-0.048	1	1	1	0	1	1	3B
94.8	94.76	-0.042	0	1	1	1	0	1	1D
97.4	97.435	-0.036	1	1	1	0	1	0	3A
100.0	99.96	-0.040	0	0	1	1	0	1	0D
103.5	103.429	-0.069	0	1	1	1	0	0	1C
107.2	107.147	-0.05	0	0	1	1	0	0	0C
110.9	110.954	0.049	0	1	1	0	1	1	1B

	Tone			Programming Inputs, Switch (Solder Jumper)						
	Nominal Frequency (Hz)	MX465 Frequency (Hz)	Δf_0 (%)	D5 (E6)	D4 (E5)	D3 (E4)	D2 (E3)	D1 (E2)	D0 (E1)	Hex
	114.8	114.84	0.035	0	0	1	0	1	1	0B
	118.8	118.793	-0.006	0	1	1	0	1	0	1A
	123.0	123.028	0.023	0	0	1	0	1	0	0A
	127.3	127.328	0.022	0	1	1	0	0	1	19
	131.8	131.674	-0.095	0	0	1	0	0	1	09
	136.5	136.612	0.082	0	1	1	0	0	0	18
	141.3	141.323	0.016	0	0	1	0	0	0	08
	146.2	146.044	-0.107	0	1	0	1	1	1	17
	151.4	151.441	0.027	0	0	0	1	1	1	07
	156.7	156.875	0.112	0	1	0	1	1	0	16
•	159.8	159.936	0.085	1	1	0	0	0	1	31
	162.2	162.311	0.069	0	0	0	1	1	0	06
	167.9	167.708	-0.114	0	1	0	1	0	1	15
	173.8	173.936	0.078	0	0	0	1	0	1	05
	179.9	179.654	-0.137	0	1	0	1	0	0	14
•	183.5	183.680	0.098	1	1	0	0	1	0	32
	186.2	186.289	0.048	0	0	0	1	0	0	04
•	189.9	190.069	0.089	1	1	0	0	1	1	33
	192.8	192.864	0.033	0	1	0	0	1	1	13
•	196.6	196.329	-0.138	1	1	0	1	0	0	34
•	199.5	199.312	-0.094	1	1	0	1	0	1	35
	203.5	203.645	0.071	0	0	0	0	1	1	03
•	206.5	206.207	-0.142	1	1	0	1	1	0	36
	210.7	210.848	0.070	0	1	0	0	1	0	12
	218.1	217.853	-0.113	0	0	0	0	1	0	02
	225.7	225.339	-0.160	0	1	0	0	0	1	11
•	229.1	229.279	0.078	1	1	0	1	1	1	37
	233.6	233.359	-0.103	0	0	0	0	0	1	01
	241.8	241.970	0.070	0	1	0	0	0	0	10
	250.3	250.282	-0.007	0	0	0	0	0	0	00
•	254.1	254.162	0.024	1	1	1	0	0	0	38
	Notone		N/A	1	1	0	0	0	0	30
	Serial input mode		N/A	1	0	Data	Clock	X	X	2X

• Not specified in the TIA/EIA tone set

Table 4: CTCSS Tones

7. Troubleshooting

Ideally, this section would not be required...however, sometimes the least expected (OK, the undesired) occurs. This section is intended to answer the most common questions and provide some helpful troubleshooting suggestions.

7.1 Suggestions

- **Use an oscilloscope**
  Because transmit and receive are biased a.c. signals, an oscilloscope is an invaluable troubleshooting tool to probe and verify signal levels
- **Check for loose connections or jumpers**

Make sure the power supplies used are sufficiently noise free. Also make sure there are no unintended noise sources radiating into the test setup.

7.2 If you still need help

If you have read this section, reexamined your test setup, and still cannot figure out what is wrong, please contact us for additional assistance. Please be ready to describe the problem or symptoms and the steps you have taken to try to correct them. We can be reached at

> MX-COM, Inc.
> 4800 Bethania Station Rd.
> Winston-Salem, NC 27105-1201
>   - telephone (910) 744-5050
>   - telephone (800) 638-5577
>   - fax (910) 744-5054

8. Retrofitting from older designs

The following is a brief list of differences between older generation MX-COM CTCSS encoder/decoders and the MX465. For full details refer to each device's individual data sheets.

8.1 Comparison Specifications

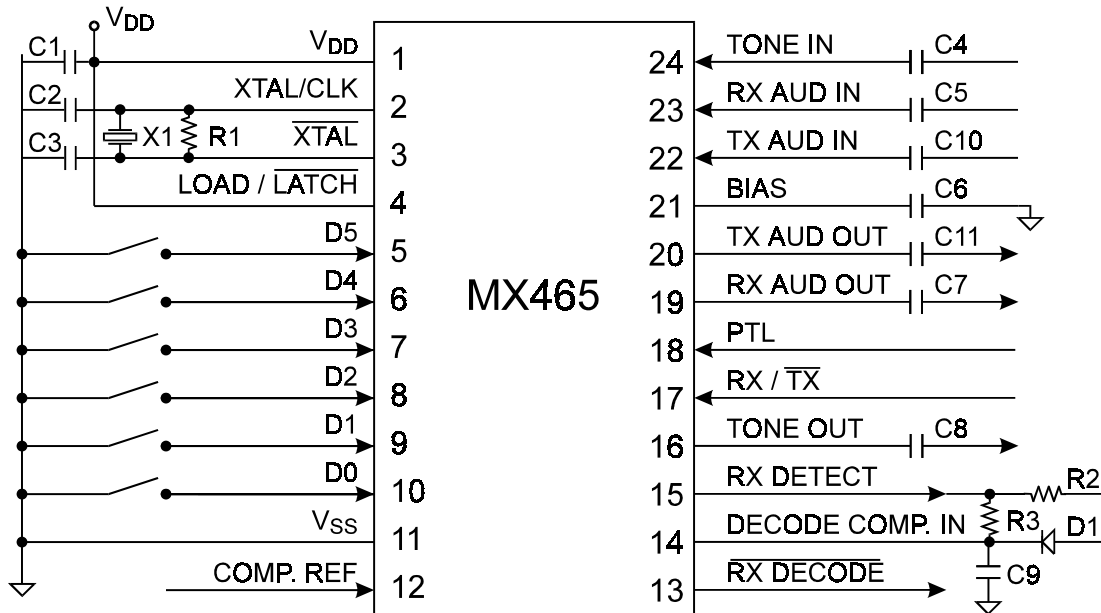|	MX365	MX365A	MX165A	MX165B	MX165C	MX465
CTCSS TONES	38 + No tone 37 = EIA 220 A plus 97.4Hz	**39 + No Tone 37 = EIA 220 B plus 69.3Hz & 97.4Hz**	39 + No tone 37 = EIA 220 B plus 69.3Hz & 97.4Hz	**39 + No Tone 39= TIA/EIA 603**	**47 + No Tone 39 = TIA/EIA 603 plus** •**159.8Hz,** •**183.5Hz,** •**189.9Hz,** •**196.6Hz,** •**199.5Hz,** •**206.5Hz,** •**229.1Hz,** •**254.1Hz**	**47 + No Tone 39 = TIA/EIA 603 plus** •**159.8Hz,** •**183.5Hz,** •**189.9Hz,** •**196.6Hz,** •**199.5Hz,** •**206.5Hz,** •**229.1Hz,** •**254.1Hz**
Supply Voltage	Min: 4.5V Typ: 5.0V Max: 5.5V	Min: 4.5V Typ: 5.0V Max: 5.5V	Min : **3.0V** Typ: **3.75V** Max: **4.5V**	Min: 3.0V Typ: 3.75V Max: 4.5V	Min: **2.75V** Typ: **3.75/5.0V** Max: **5.5V**	Min: **2.75V** Typ: **3.75/5.0V** Max: **5.5V**
0dB ref Composite Signal	300mVrms 0dB 1kHz test tone, -12dB noise (band limited 6kHz gaussian white noise), -20dB f_0 CTCSS tone.	308mVrms 0dB 1kHz test tone, -12dB noise (band limited 6kHz gaussian white noise), -20dB f_0 CTCSS tone.	100mVrms 0dB 1kHz test tone, -12dB noise (band limited 6kHz gaussian white noise), -20dB f_0 CTCSS tone.	100mVrms 1kHz test tone at 300mVrms, 75mVrms noise (band limited 6kHz gaussian white noise), 30mVrms CTCSS tone.	750mVrms 0dB 1kHz test tone, -12dB noise (band limited 6kHz gaussian white noise), -20dB f_0 CTCSS tone.	750mVrms 0dB 1kHz test tone, -12dB noise (band limited 6kHz gaussian white noise), -20dB f_0 CTCSS tone.

8.2 External Components Comparison

Figure 6: Comparison of External Components for Older CTCSS ICs

EXTERNAL COMPONENTS	MX365	MX365A	MX165A	MX165B	MX165C	MX465
R1	1M	1M	1M	1M	**4.7M**	**4.7M**
R2	560k	560k	560k	560k	560k	560k
R3	820k	820k	820k	820k	820k	820k
X1	1MHz	1MHz	1MHz	1MHz	1MHz	**4MHz**
C1	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF
C2	68pF	68pF	68pF	68pF	**18pF**	**18pF**
C3	33pF	33pF	33pF	33pF	33pF	33pF
C4	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF
C5	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF
C6	0.47uF	0.47uF	0.47uF	0.47uF	0.47uF	0.47uF
C7	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF
C8	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF
C9	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF
C10	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF
C11	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF	0.1uF
D1	Small signal	Small signal	Small signal	Small signal	Small signal	Small signal

Resistors ±10%, Capacitors ±20%, Xtal 100ppm max

Note : The values specified for R1, C2 and C3 have been found to be satisfactory when used with a crystal (X1) whose equivalent series resistance is ≤ to 1000 ohms. The crystal manufacturer should be consulted to determine optimum values for different crystals.
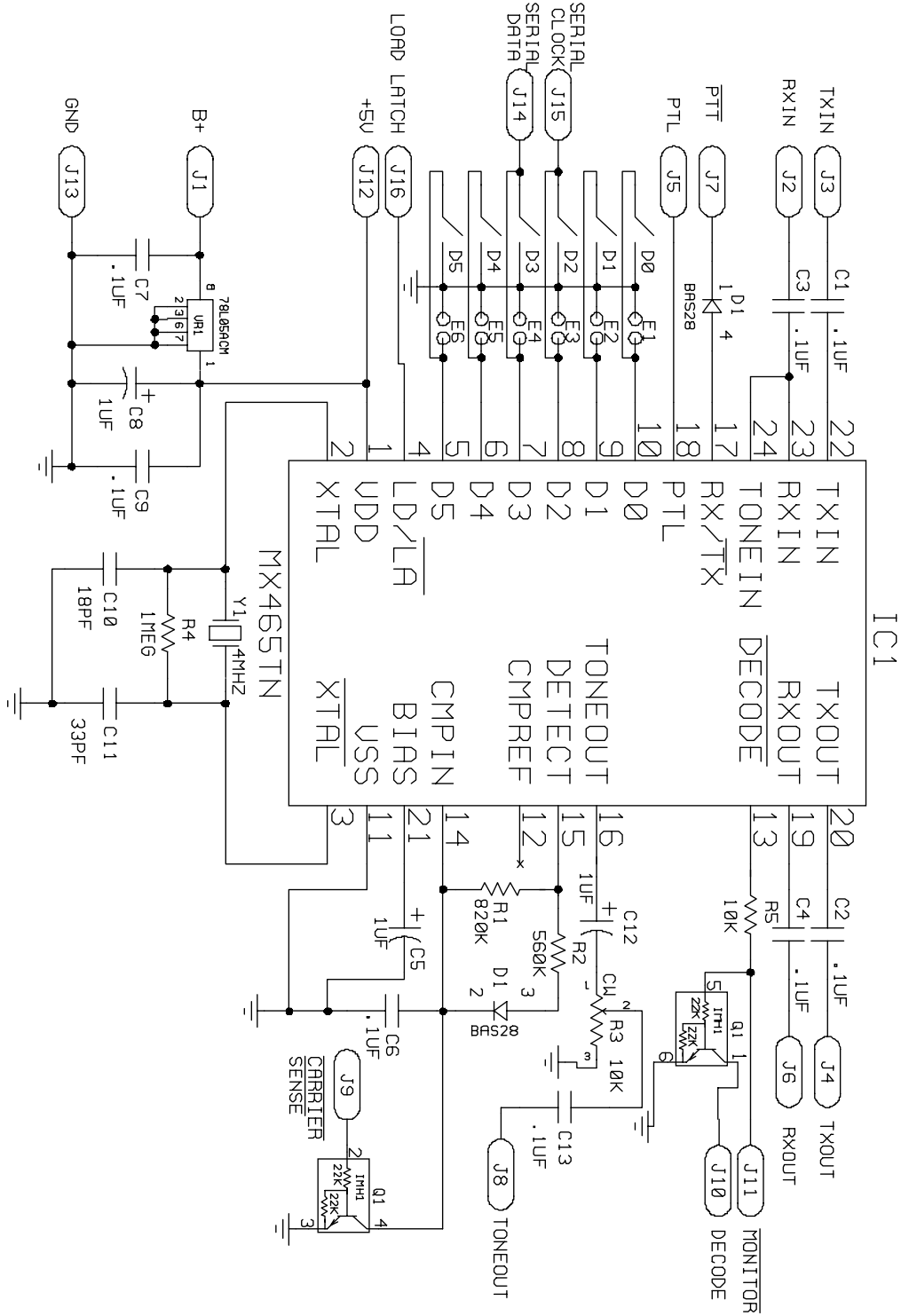
9. Schematic

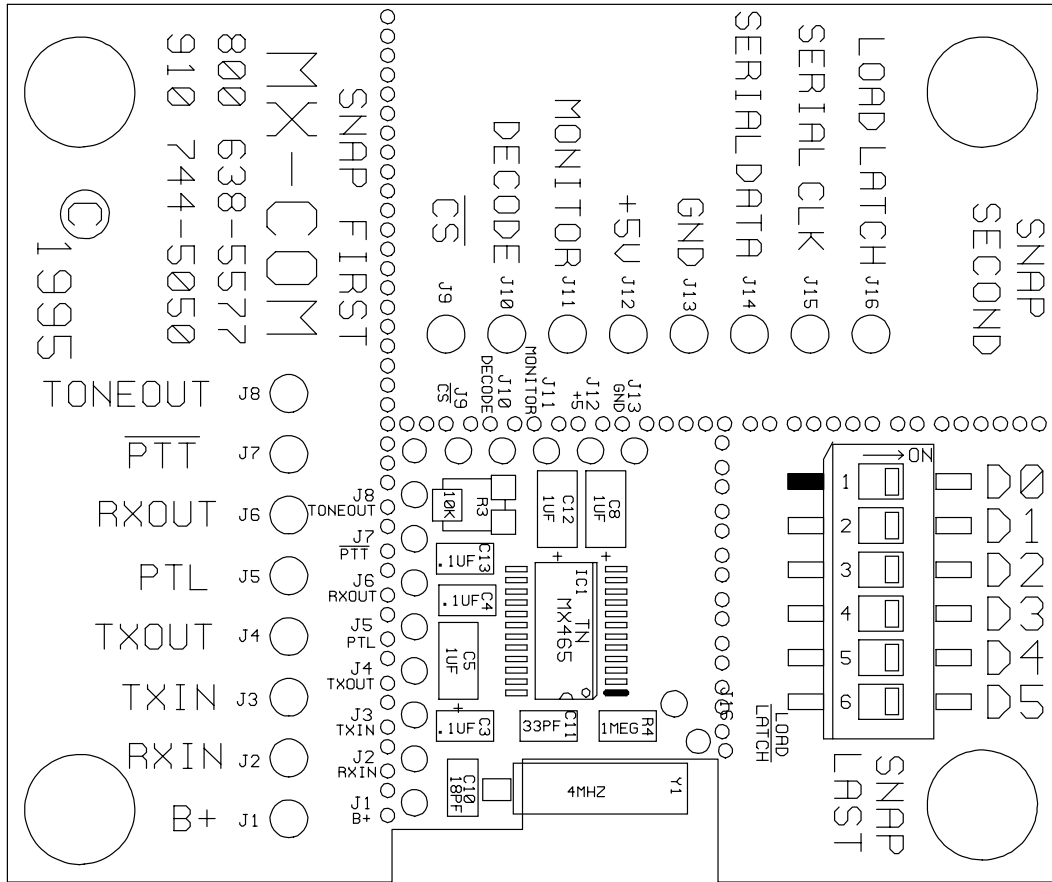**Figure 7: DB1065 Schematic**

10. Component layout
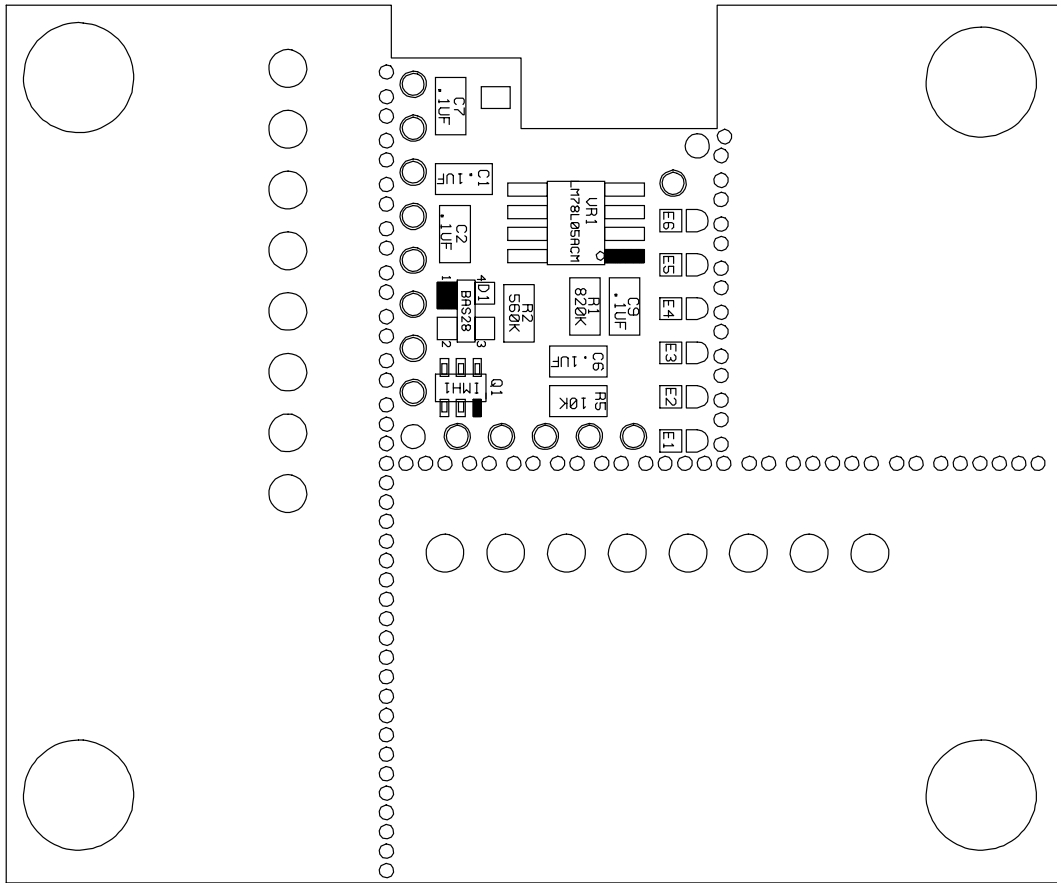

Figure 8: Component view Assembly Drawing

Figure 9: Solder View Assembly Drawing

CML Microcircuits

COMMUNICATION SEMICONDUCTORS

CML Product Data

In the process of creating a more global image, the three standard product semiconductor companies of CML Microsystems Plc *(Consumer Microcircuits Limited (UK), MX-COM, Inc (USA) and CML Microcircuits (Singapore) Pte Ltd)* have undergone name changes and, whilst maintaining their separate new names *(CML Microcircuits (UK) Ltd, CML Microcircuits (USA) Inc and CML Microcircuits (Singapore) Pte Ltd*), now operate under the single title **CML Microcircuits**.

These companies are all 100% owned operating companies of the CML Microsystems Plc Group and these changes are purely changes of name and do not change any underlying legal entities and hence will have no effect on any agreements or contacts currently in force.

CML Microcircuits Product Prefix Codes

Until the latter part of 1996, the differentiator between products manufactured and sold from MXCOM, Inc. and Consumer Microcircuits Limited were denoted by the prefixes MX and FX respectively. These products use the same silicon etc. and today still carry the same prefixes. In the latter part of 1996, both companies adopted the common prefix: CMX.

This notification is relevant product information to which it is attached.

CML Microcircuits (USA) [formerly MX-COM, Inc.] Product Textual Marking

On CML Microcircuits (USA) products, the '**MX-COM**' textual logo is being replaced by a '**CML**' textual logo.

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