



# S-COM Controller Technical Training

Dave Maciorowski

22 February 2014

(Updated 26 February 2014)

*(Note: aligned with Release 1.4 plus some 1.5 Features)*

# Agenda

## Introduction

- Who is S-COM?

## The Basics

- Repeater Building Blocks
- What does a controller need to do?
- Common Terms
- Introducing the 7330

## Wiring It Up

- Connectors, Jumpers, Pots
- Power
- Input Logic Signals
- Output Logic Signals
- Audio
- A-to-D Input Signals
- CTCSS Encoder

## Basic Programming

- Testing on the Bench
- Initializing the Controller
- S-COM Command Formats
- Security
- Data Types
- Introduction to the Manual
- Getting Started with Programming Commands
- Testing Your Results

## Advanced Programming

- Ports and Paths
- More About Messages
- Receiver Timing
- Macros
- CTCSS Encoder
- Scheduler

## File Management

- Introducing SBOOT

## PC-Based Utilities

- S-COM Custom Audio Utility

## Other Controller Topics

- Digital Linking: IRLP, EchoLink, Allstar

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# Introduction

## Who Is S-COM?

### **Bob Schmid, WA9FBO**

#### **Founder and Owner of S-COM, LLC**

Bob's first controller was a SWTPC 6800 microcomputer, assembled from a kit in 1976 and used to control WR9AIN, a Quintron repeater in New Holstein, WI. Wire-wrapped versions were followed by the "Big Board" controller introduced in 1982.

The MRC-100 came out in 1984, followed by the 5K (1987), the 7K (1989), the 6K (1990), and the 7330 (2007), a total of about 4900 units. There are also customized controllers in commercial use, as well as air-to-ground interconnects for the airline industry.

S-COM continues to ship 7330s and is busy defining the next generation of repeater controllers and accessories.



### **Dave Maciorowski, WA1JHK**

#### **Hardware and Firmware Engineer**

Dave saw his first repeater in 1972 and was hooked on developing repeaters and repeater controllers. He built his first microprocessor-based controller in 1979. Dave began working with Bob and S-COM on 7K firmware in 1995 adding the Doug Hall RBI-1 support and continued adding features.

As a member of the 7330 development team, Dave specified many of the 7330 features and developed most of the 7330 firmware. He continues to support and enhance the 7330 while working on future controller architecture.



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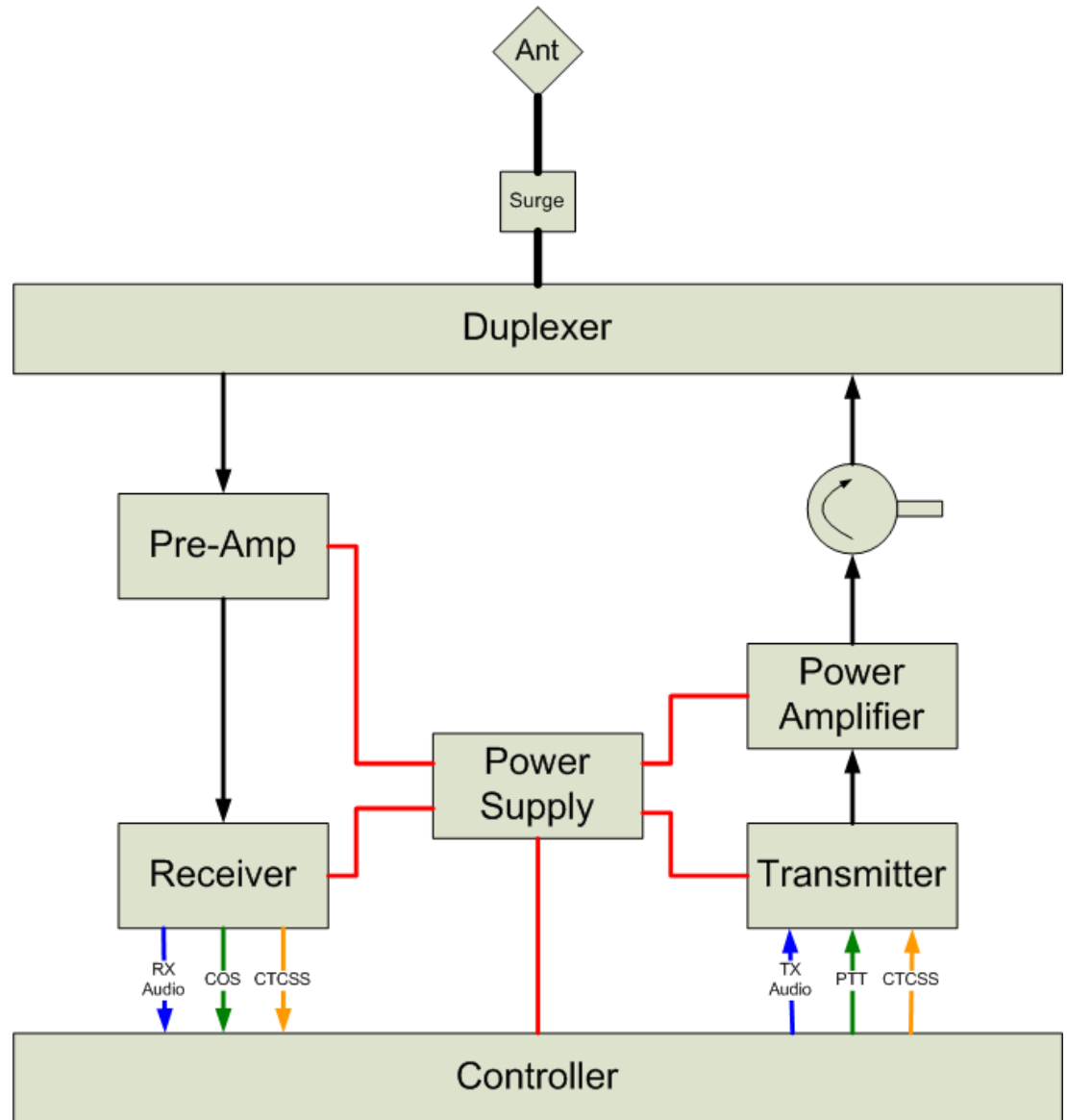
## Other Controller Topics

- Digital Linking: IRLP, EchoLink, Allstar

# The Basics

## Repeater Building Blocks

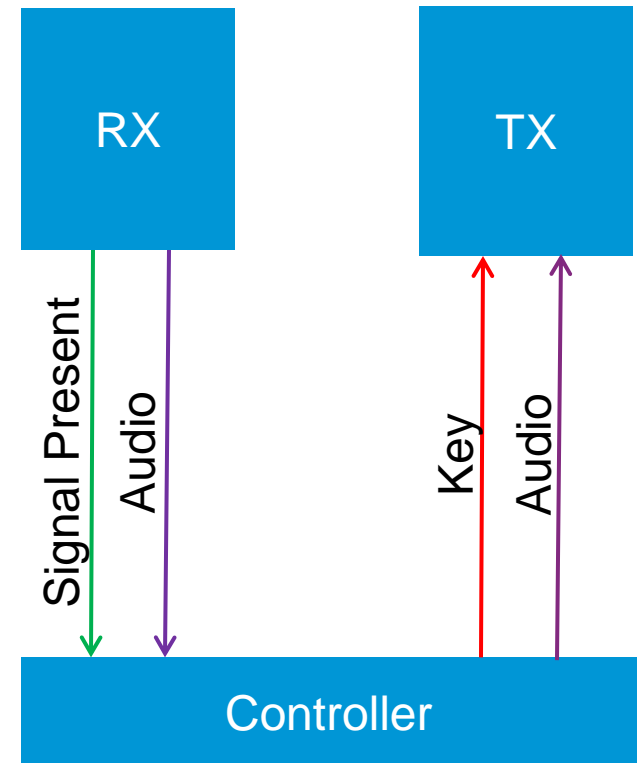
- Receiver
- Pre-Amplifier
- Transmitter
- Power Amplifier
- Isolator
- Controller
- Duplexer
- Antenna
- Feedline
- Lightning Suppressor
- Power Supply



# The Basics

## What Does A Controller Need To Do?

- Key a Transmitter In The Presence of a Valid Signal In a Receiver
  - Keying signal to Transmitter.
  - Valid Signal Presence signal from the receiver.
- Pass Audio from the Receiver to the Transmitter
  - Match the level, Perform filtering, if required.
  - Gate the audio
- Modulate the Transmitter with an ID Message
  - Key the transmitter during the message.
  - Send the message in CW or speech.
- Transmitter Control Point
  - Local or remote control of the transmitter.
- Timeout Timer
  - Prevent a received signal from keying the transmitter longer than some time.



# The Basics

## Common Terms

### **COR**

- Carrier-Operated Relay

### **COS**

- Carrier-Operated Switch

### **PTT**

- Push-To-Talk

### **CTCSS**

- Continuous Tone-Coded Squelch System
- PL, Private Line®
  - Motorola's name for CTCSS
- CG, Channel Guard®
  - General Electric's name for CTCSS

### **Reverse Burst®**

- Motorola name for squelch tail elimination

### **DCS**

- Digital Code Squelch
  - Continuous Digital Code Squelch System
- DPL®
  - Motorola's name for DCS
- DCG®
  - General Electric's name for CTCSS

### **Transmitter Hang Timer**

- Time transmitter is on after received signal becomes not present.
- Transmitter Tail

### **Audio Gate**

- Switch that turns off the receiver-to-transmitter audio path when received signal not present.

### **Chicken Burst**

- Technique to emulate Reverse Burst



# The Basics

## Introducing the S-COM 7330



- 3 Radio Ports
  - DTMF Decoder
  - Dual-Tone Generator with Remote Level Adjust
  - Real Speech Player with Remote Level Adjust
  - CTCSS Encoder with Reverse Burst
  - Digital Audio Delay
  - Path Any Receiver to Any Transmitter
  - Configurable Access Modes
- 4 Logic Inputs
- 8 Logic Outputs
- 3 Analog-to-Digital Inputs
- Time-of-Day Clock, Battery Backed, TCXO with 1 Minute Per Year Stability
- 13 Minutes of Custom Audio
- Firmware Updates via RS-232
- Custom Audio Loaded via RS-232
- 100 Setpoint Scheduler
- 300 Custom Macros

# The Basics

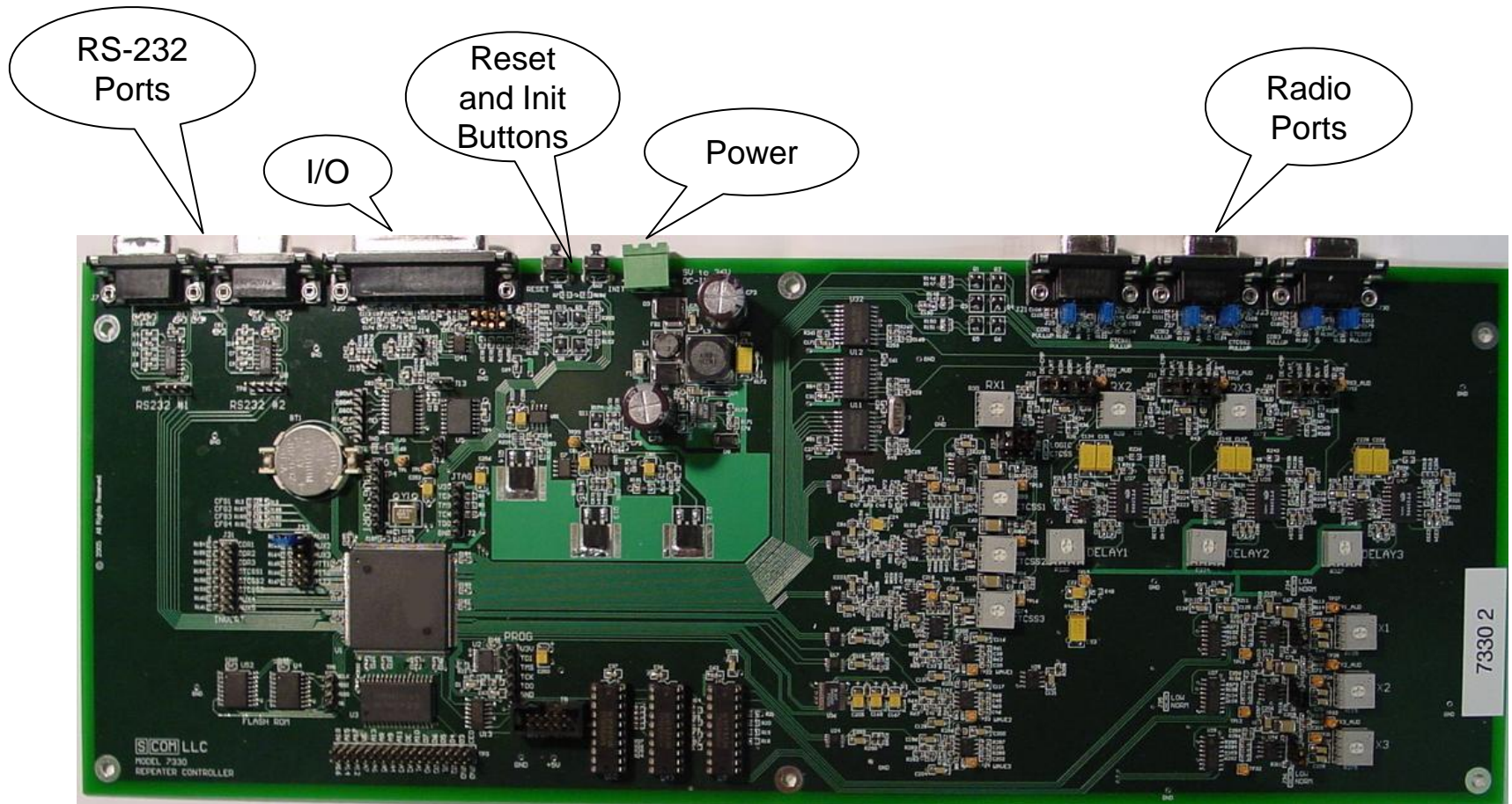
## Introducing the S-COM 7330



- 3 Radio Ports
  - DE9S
- Power
  - Locking 2-pin terminal strip connector
- INIT and RESET buttons
- I/O
  - DB25S
- Serial, RS-232
  - DE9S, DCE
  - DE9P, DTE
- Mating Connectors Included

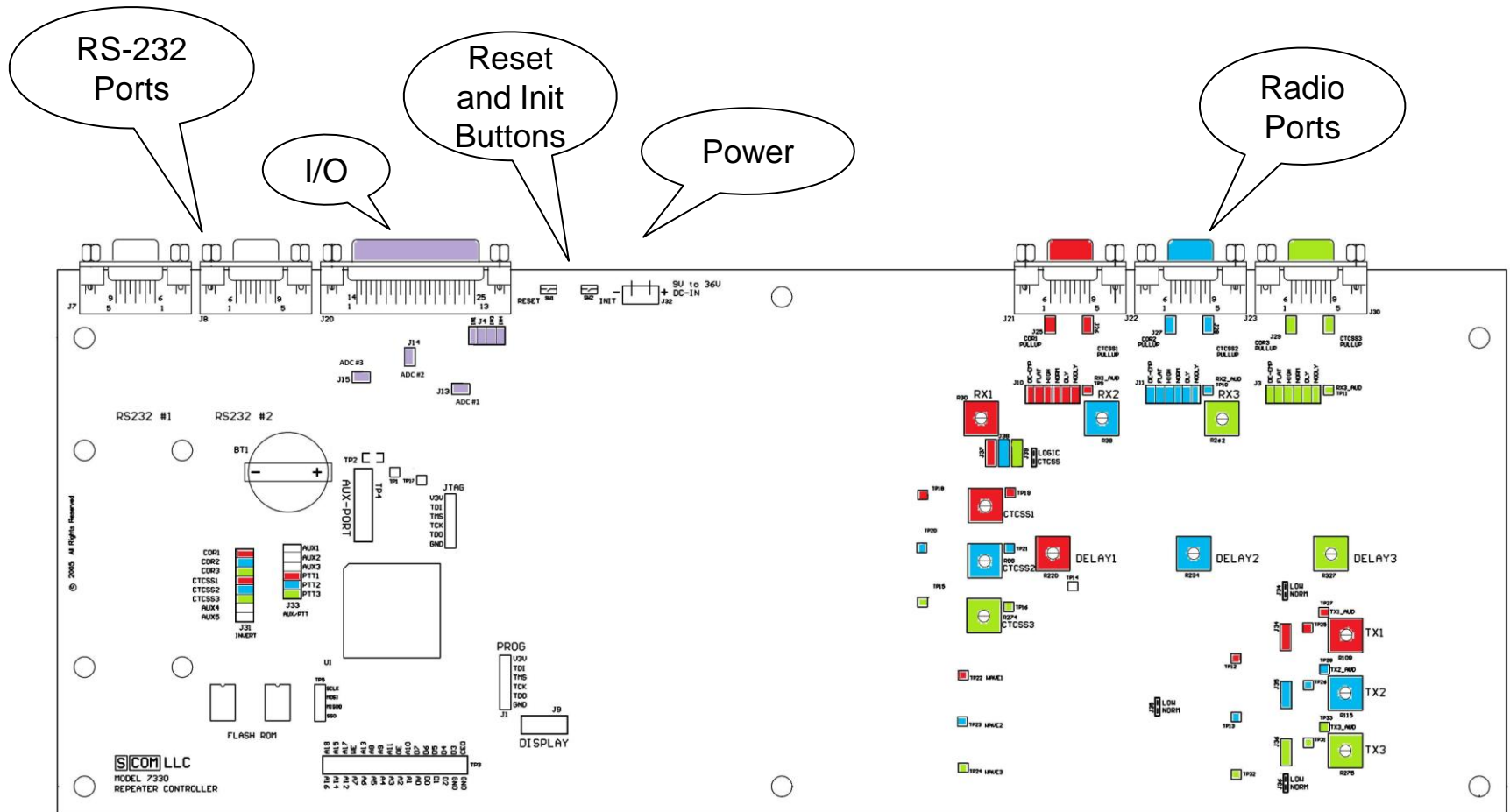
# The Basics

## Introducing the S-COM 7330



# The Basics

## Introducing the S-COM 7330



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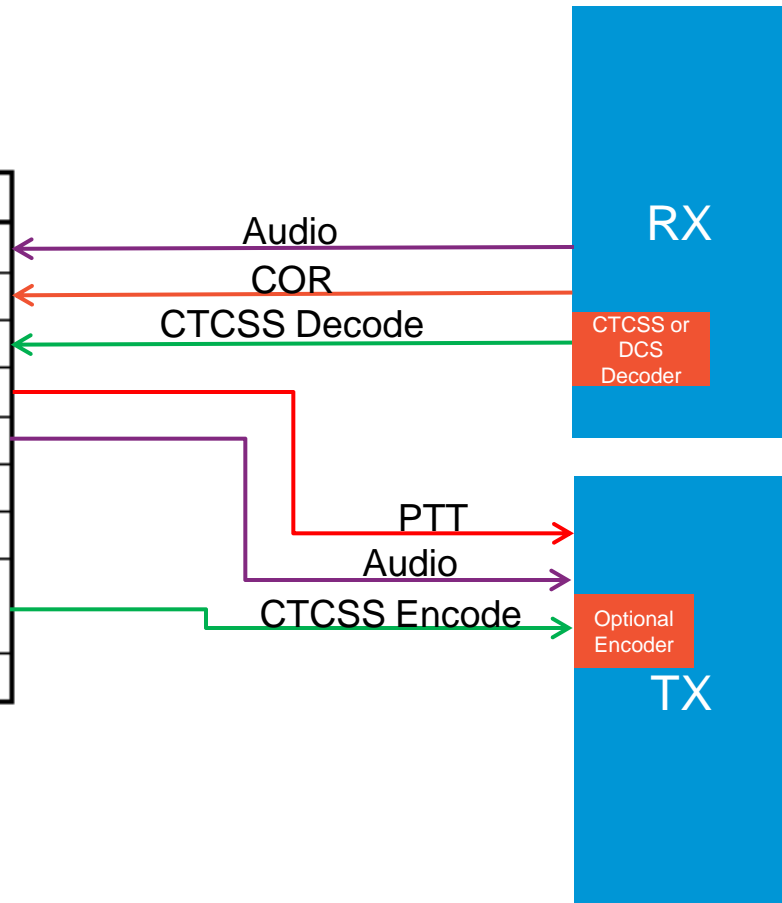
## Other Controller Topics

- Digital Linking: IRLP, EchoLink, Allstar

# Wiring It Up

## 7330 Connectors – Radio Port

Pin	Name	Type
1	Receiver Audio	Audio Input
2	Receiver COR	Logic Input
3	Receiver CTCSS Decode	Logic Input
4	Transmitter PTT	Logic Output
5	Transmitter Audio	Audio Output
6	Ground for Receiver Audio	Ground
7	Ground for CTCSS Audio	Ground
8	Transmitter CTCSS Audio or CTCSS Logic Output	Analog Output or Logic Output
9	Ground for Transmitter Audio	Ground



# Wiring It Up

## 7330 Connectors – I/O

Signal	Primary Use	Alternate
Logic Input	Logic Input	
Analog-to-Digital	Analog Readings	Logic Input

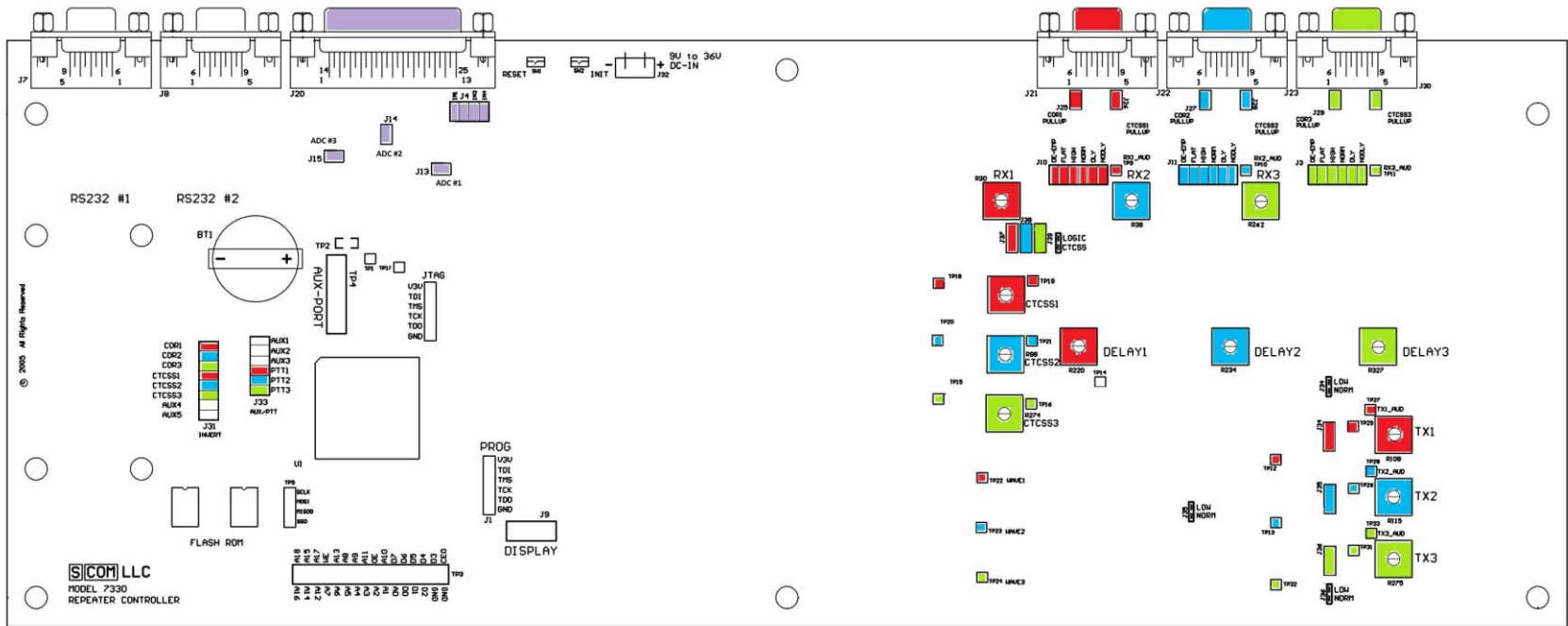
## I/O Connector

Pin	Name
1	Logic Output 1
2	Logic Output 2
3	Logic Output 3
4	Logic Output 4
5	Logic Output 5
6	Logic Output 6
7	A/D Input 3
8	A/D Input 2
9	A/D Input 1
10	Logic Input 1
11	Logic Input 2
12	Logic Input 3
13	Logic Input 4
14	Logic Output 7
15	Logic Output 8
16	Ground
17	Ground
18	Ground
19	Ground
20	Ground
21	Ground
22	Ground
23	Ground
24	Ground
25	Ground



# Wiring It Up

## 7330 Connectors, Jumpers and Pots



I/O

Radio Port 1

Radio Port 2

Radio Port 3

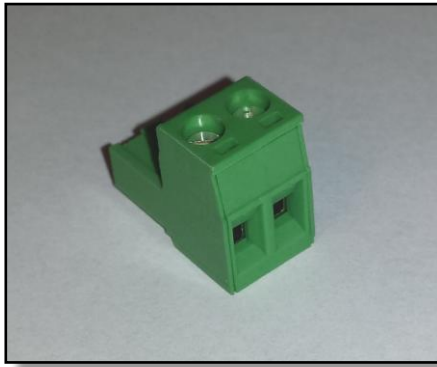
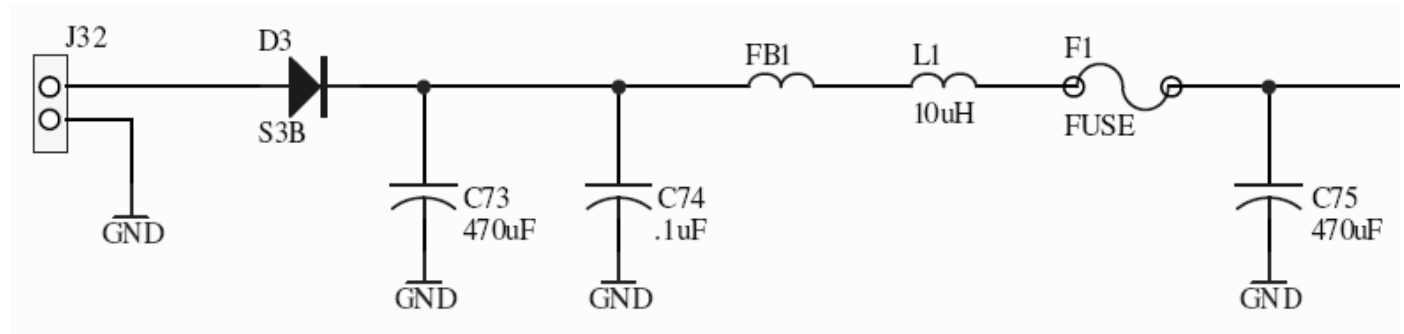


# Wiring It Up

Power Source

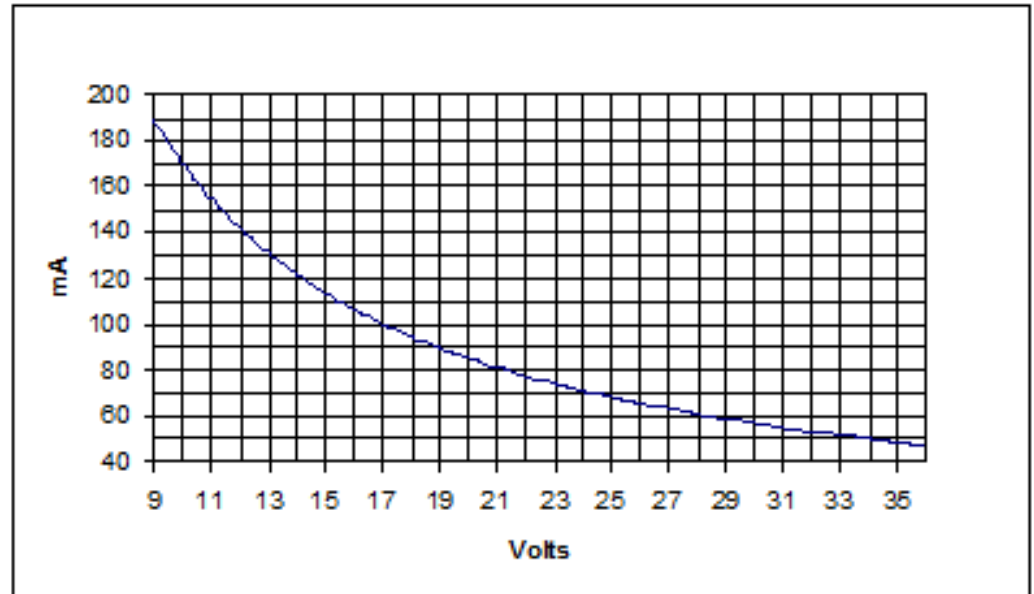
Requires

- 9V to 36V DC



Power Considerations

- Reverse Polarity Protected
- Factory-Replaceable Internal Fuse
- Recommend Fuse Externally In Plus Lead



# Wiring It Up

## Input Logic Signals

Signal	Primary Use	Alternate
COR	Receiver	Logic Input
CTCSS	Receiver	Logic Input
Logic Input	Logic Input	

## Radio Port Connector

Pin	Name	Type
1	Receiver Audio	Audio Input
2	Receiver COR	Logic Input
3	Receiver CTCSS Decode	Logic Input
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5	Transmitter Audio	Audio Output
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## I/O Connector

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3	Logic Output 3
4	Logic Output 4
5	Logic Output 5
6	Logic Output 6
7	A/D Input 3
8	A/D Input 2
9	A/D Input 1
10	Logic Input 1
11	Logic Input 2
12	Logic Input 3
13	Logic Input 4
14	Logic Output 7
15	Logic Output 8
16	Ground
17	Ground
18	Ground
19	Ground
20	Ground
21	Ground
22	Ground
23	Ground
24	Ground
25	Ground

# Wiring It Up

## Input Logic Signals

### Inputs

- COR, CTCSS, Logic Input
  - 48V Maximum with Pullup Jumper Out
  - 16V Maximum with Pullup Jumper In
  - Switching Threshold Set To 2.1V

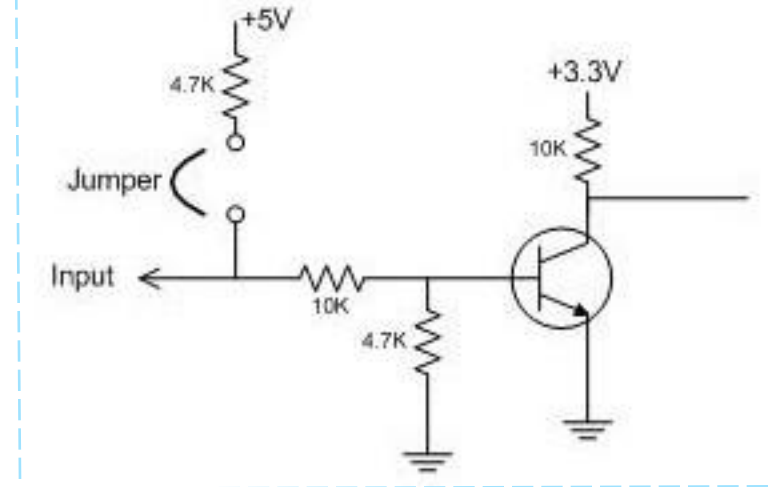
### Driver Considerations

- No Pullup Required If...
  - Driver Drives Above and Below Threshold Without Pullup
- Pullup Required If...
  - No Change Without Pullup

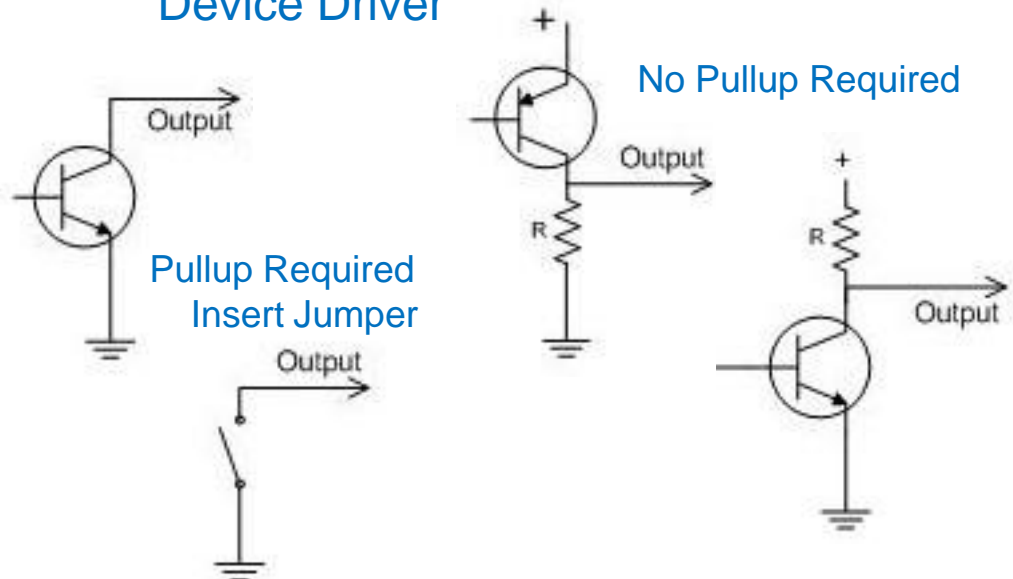
### Signal Inversion

- COR, CTCSS -- Jumper
- Logic Input -- Software Switch

## 7330 Logic Input

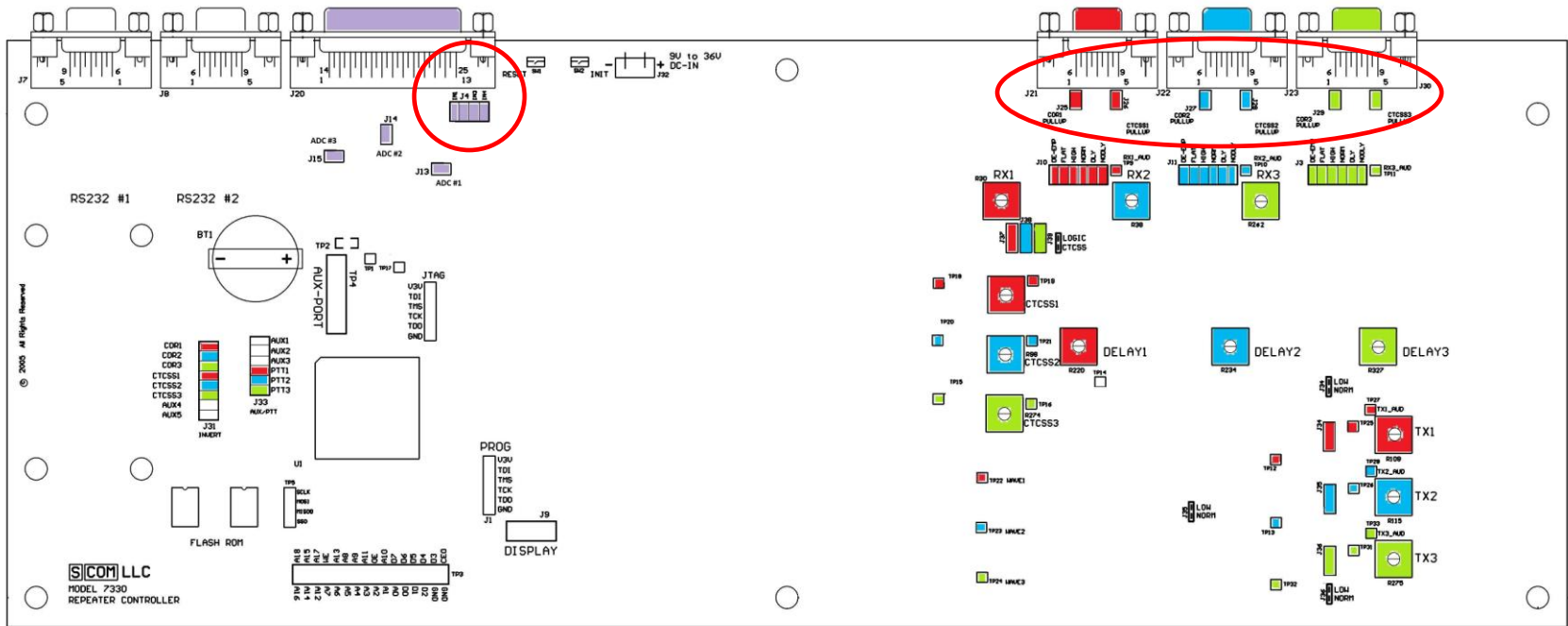


## Device Driver



# Wiring It Up

## Jumpers For Logic, COR, CTCSS Input Pullups



I/O

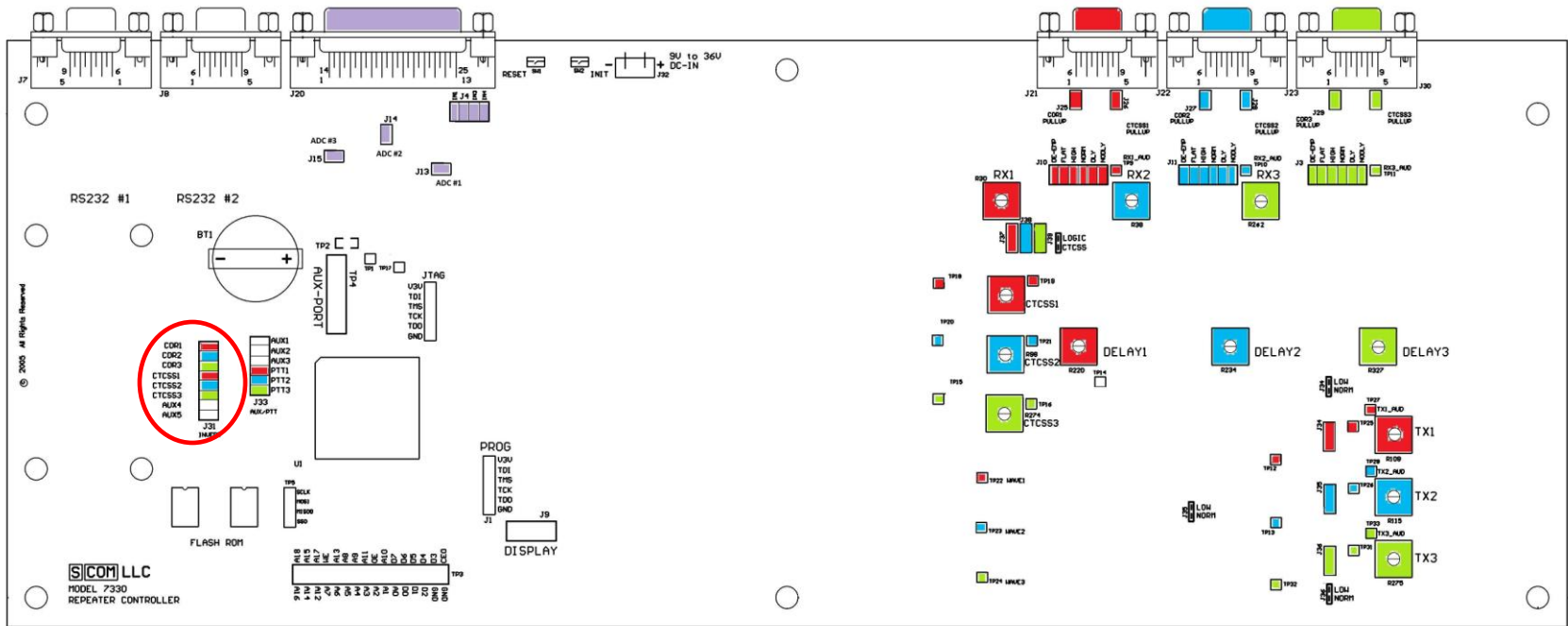
Radio Port 1

Radio Port 2

Radio Port 3

# Wiring It Up

## COR, CTCSS Inversion Jumpers



I/O

Radio Port 1

Radio Port 2

Radio Port 3

# Wiring It Up

## Output Logic Signals

Signal	Primary Use	Alternate
PTT	Transmitter	
CTCSS	Transmitter	Logic Output
Logic Outputs	Logic Output	

## Radio Port Connector

Pin	Name	Type
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15	Logic Output 8
16	Ground
17	Ground
18	Ground
19	Ground
20	Ground
21	Ground
22	Ground
23	Ground
24	Ground
25	Ground

# Wiring It Up

## Output Logic Signals

### Outputs

- PTT, Logic Output
  - Not Keyed, 50V Maximum
  - Keyed, 150-ma Current Sink

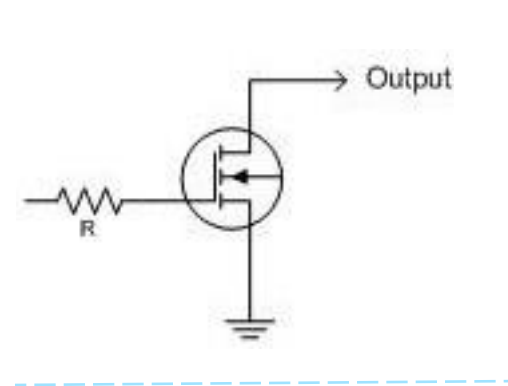
### Driver Considerations

- Socketed “Just In Case”
  - Easy recovery from damaged driver component
- Device Must A Pullup Resistor or Other Load

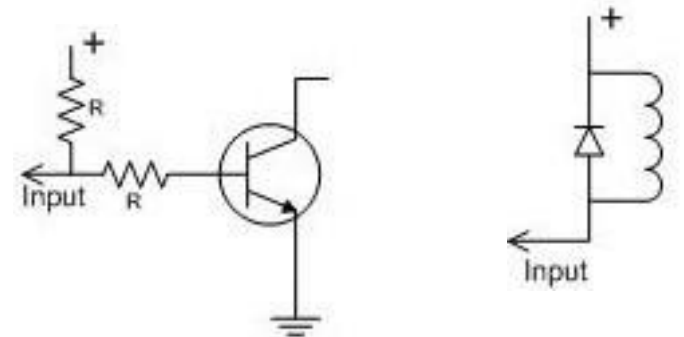
### Signal Inversion

- PTT
  - Jumper
- Logic Output
  - Command Controls Output Sense

## 7330 PTT and Logic Outputs

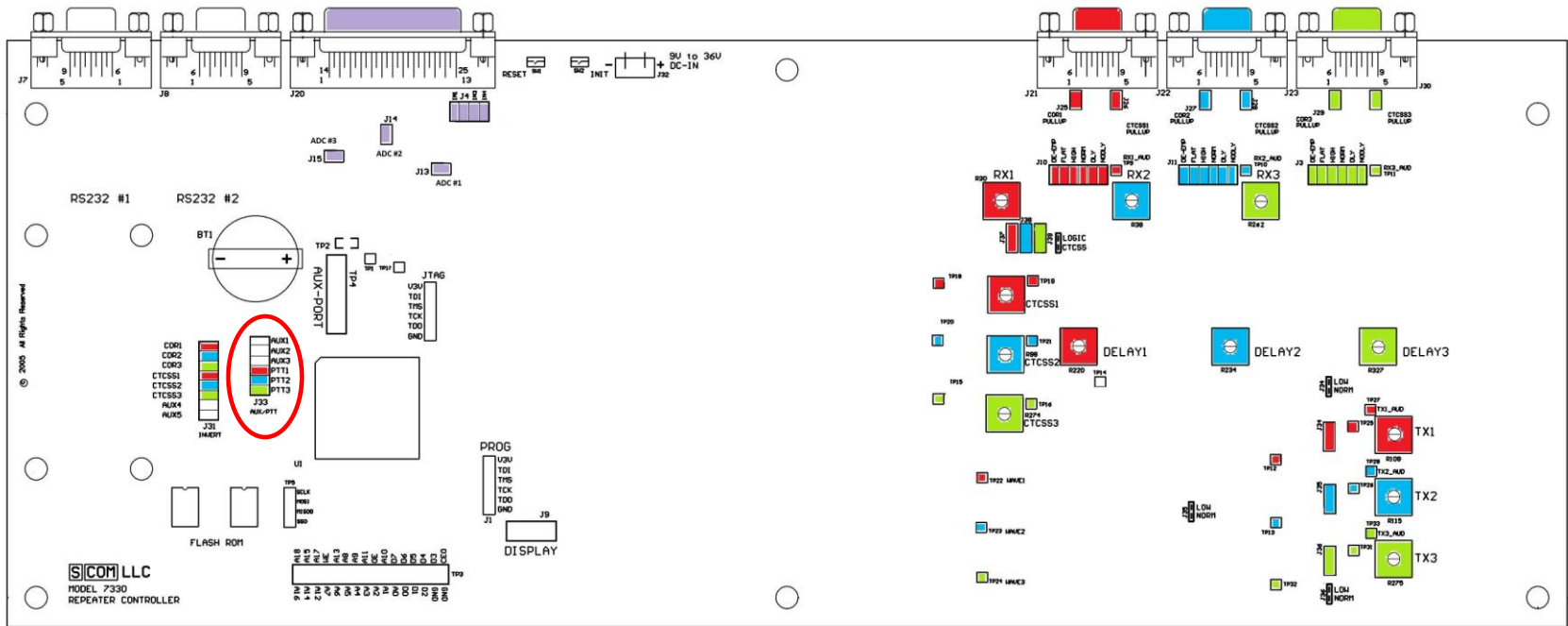


## Typical Device Loads



# Wiring It Up

## PTT Inversion Jumpers



I/O

Radio Port 1

Radio Port 2

Radio Port 3



# Wiring It Up

## Audio Input Signal

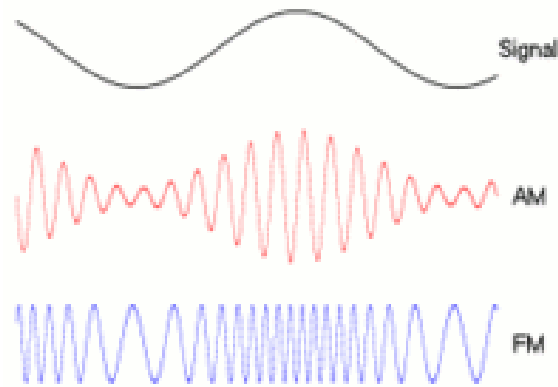
Signal	Use
Receiver Audio	Audio

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## Audio

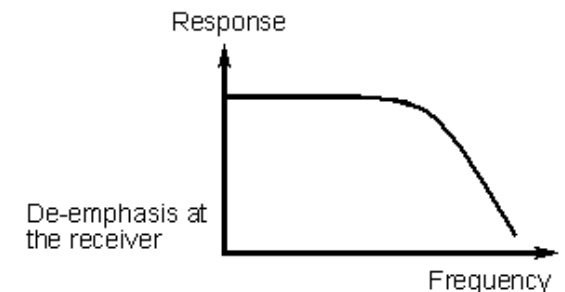
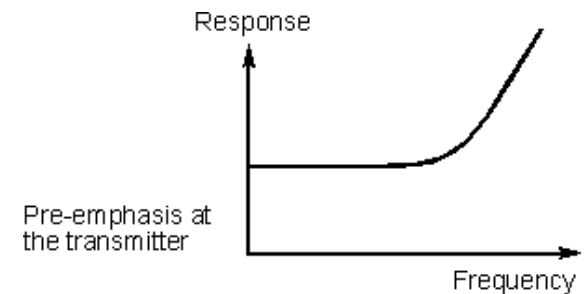
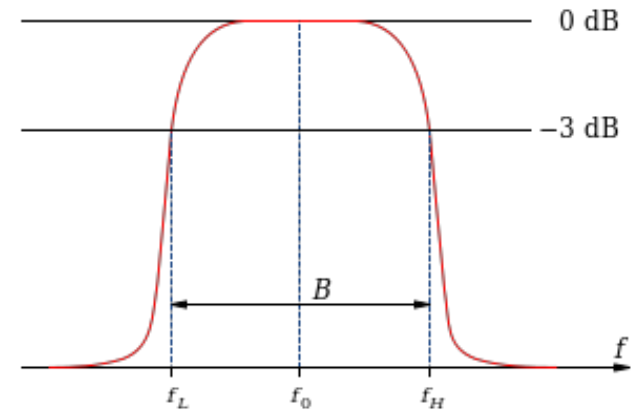


## Passband

- Analog FM radios only transmit and receive audio between 250 – 3500 Hz.
- Below 250 Hz is reserved for signaling and data.
- Above 3500 Hz is not needed for mobile communications.

## Pre-emphasis and De-emphasis

- Pre-emphasis at +6dB / Octave is applied to a FM signal being transmitted.
- De-emphasis of -6dB / Octave is applied to the signal being received.
- Why? To reduce unwanted noise.



# Wiring It Up

## Audio Input

### Audio Source Connection

- Impedance, 25K ohms or greater
- DC Load

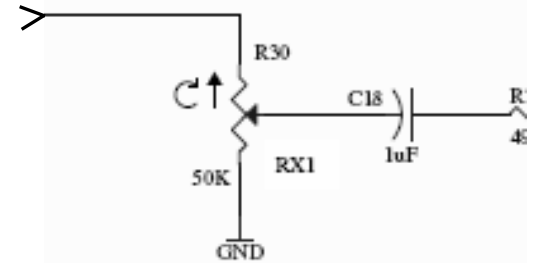
### Audio Processing

- Optional De-emphasis Filter
  - Jumper: DE-EMP or FLAT
- Selectable Gain Range
  - Jumper: HIGH for gain of 6.3x
  - Jumper: NORM for gain of 2x
- Audio Delay
  - Jumper: Delay or No-Delay
  - Pot Adjustable 30 to 250 mS

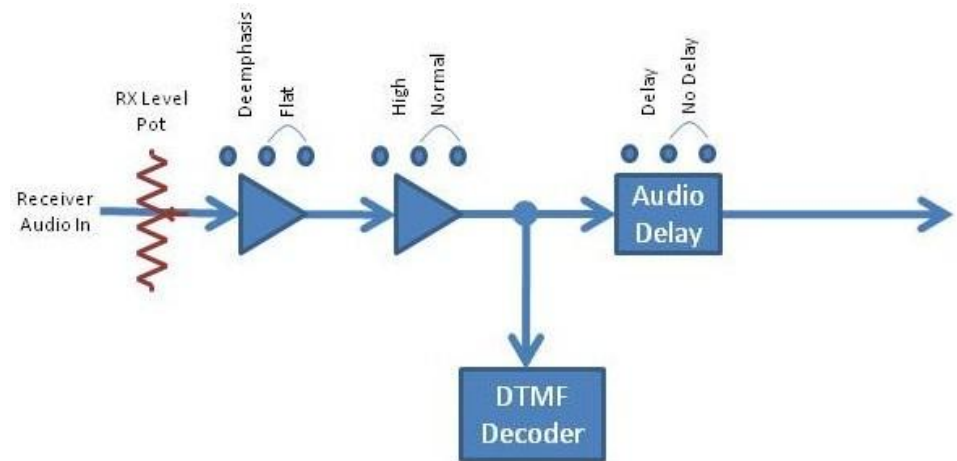
### Where to Get Receiver Audio?

- High side of the volume control

## 7330 Audio Input

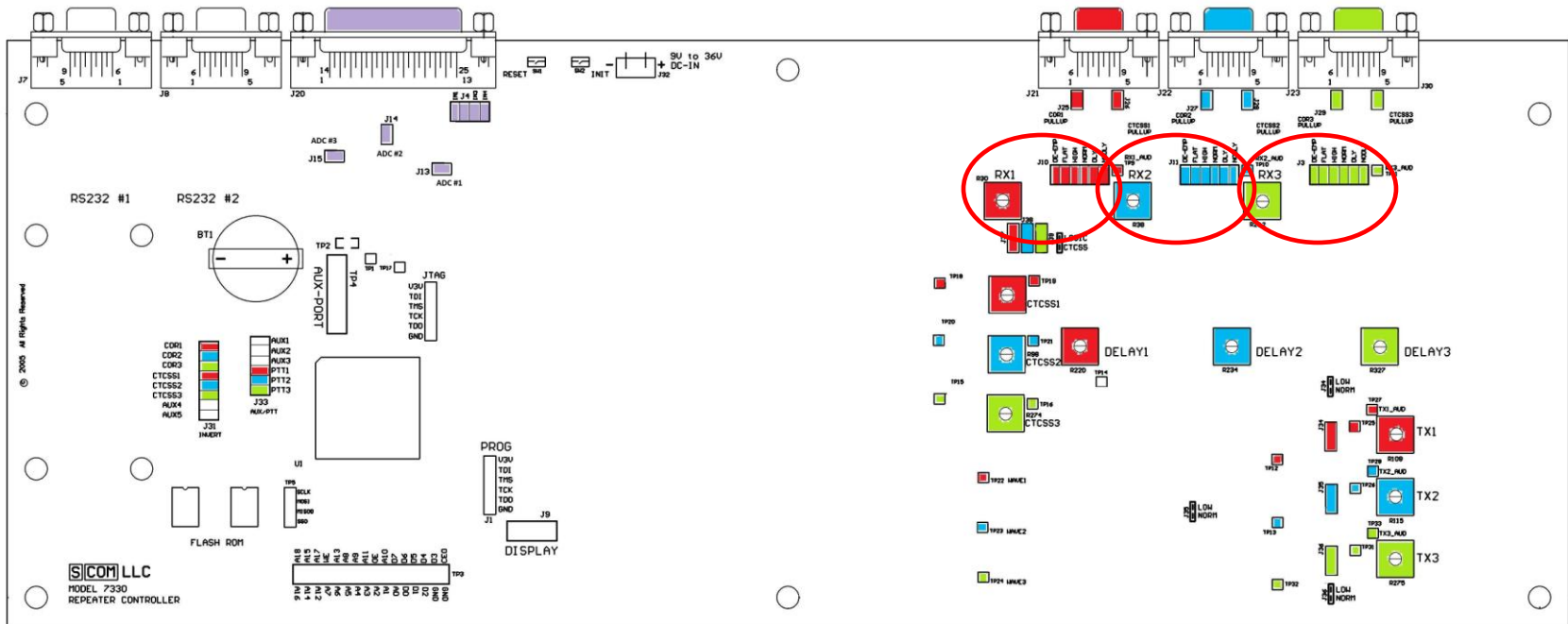


## 7330 Audio Processing



*Signaling Tones Must Be Filtered Before Reaching The Controller*

## Jumpers and Pots for Audio Input



I/O

## Radio Port 1

## Radio Port 2

## Radio Port 3

# Wiring It Up

## Audio Output Signal

Signal	Use
Transmitter Audio	Audio

## Radio Port Connector

Pin	Name	Type
1	Receiver Audio	Audio Input
2	Receiver COR	Logic Input
3	Receiver CTCSS Decode	Logic Input
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# Wiring It Up

## Audio Output

### Audio Connection

- Impedance
  - 600 Ohms
  - DC Load

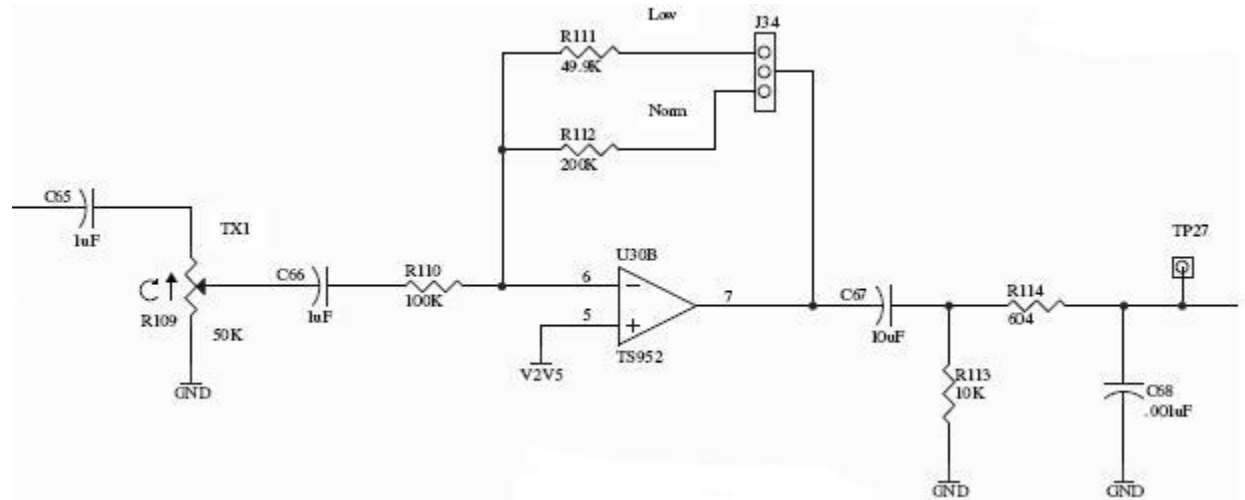
### Audio Processing

- Selectable Gain Range
  - Jumper: NORM
    - Driving >10K Ohm Load, 0-to-2Vpp (700mV rms)
    - Driving 600 Ohm Load, 0-to-1Vpp (350mV rms)
  - Jumper: LOW
    - Driving >10K Ohm Load, 0-to-0.5Vpp (175mV rms)
    - Driving 600 Ohm Load, 0-to-0.25Vpp (88mV rms)

### Where to Connect Transmitter Audio Input?

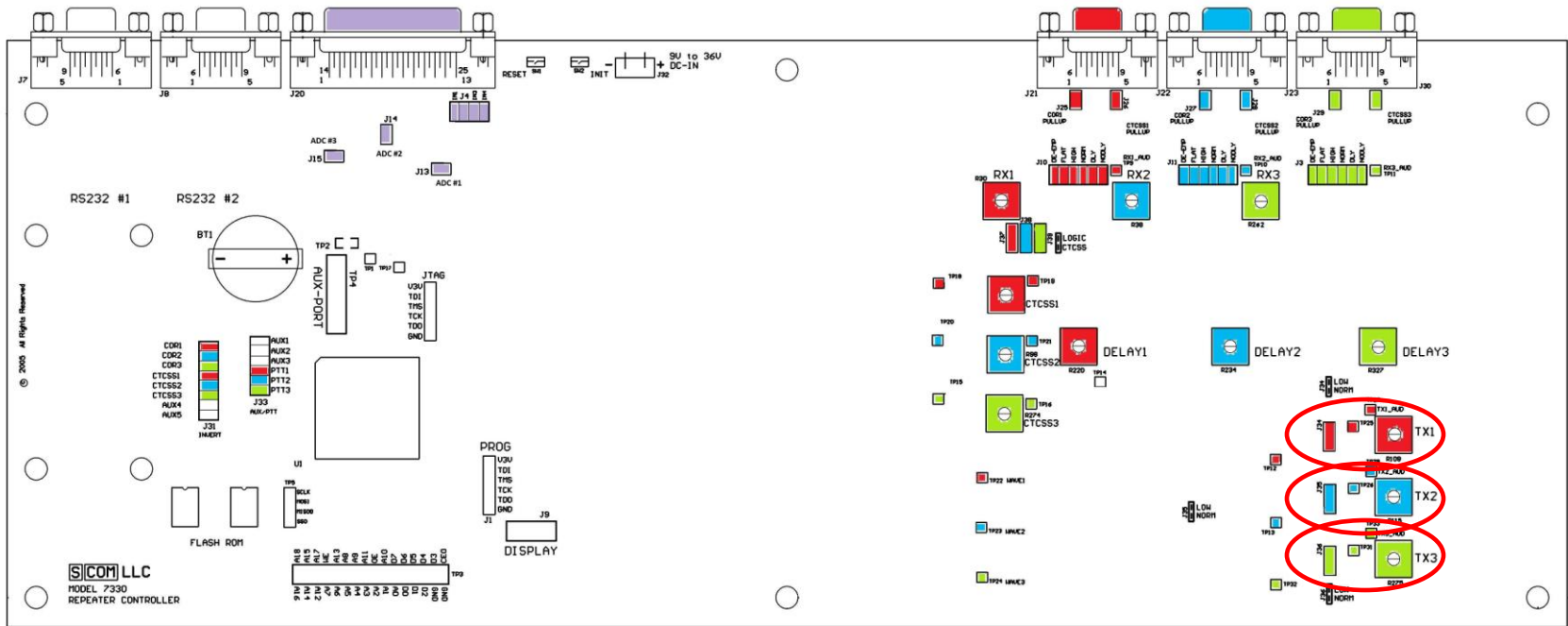
- Mic Input, May Require External Attenuation
- Line Input

## 7330 Audio Output



# Wiring It Up

## Jumpers and Pots for Audio Output



I/O

Radio Port 1

Radio Port 2

Radio Port 3

# Wiring It Up

## CTCSS Encoder Audio Output

Signal	Primary Use	Alternate Use
Transmitter CTCSS Encoder	Audio	Logic Output

### Radio Port Connector

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3	Receiver CTCSS Decode	Logic Input
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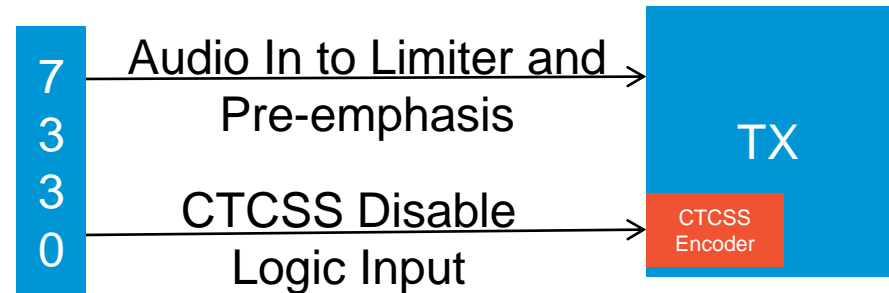
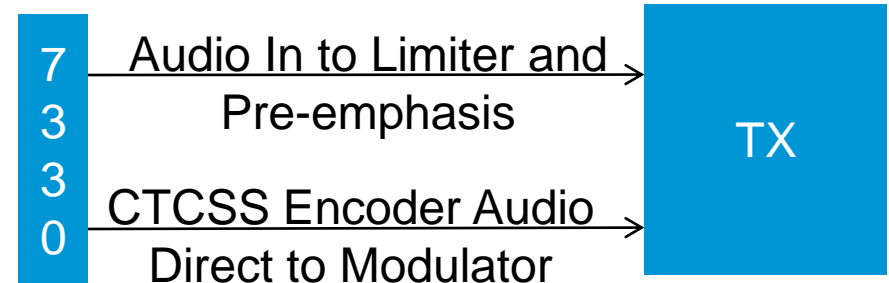
## CTCSS Encoder Considerations

### Internal CTCSS Encoder

- 7330 Generates the CTCSS Encoder Audio
- Complete Control of CTCSS Tone and Timing
- Must Be Driven Into Transmitter CTCSS Input

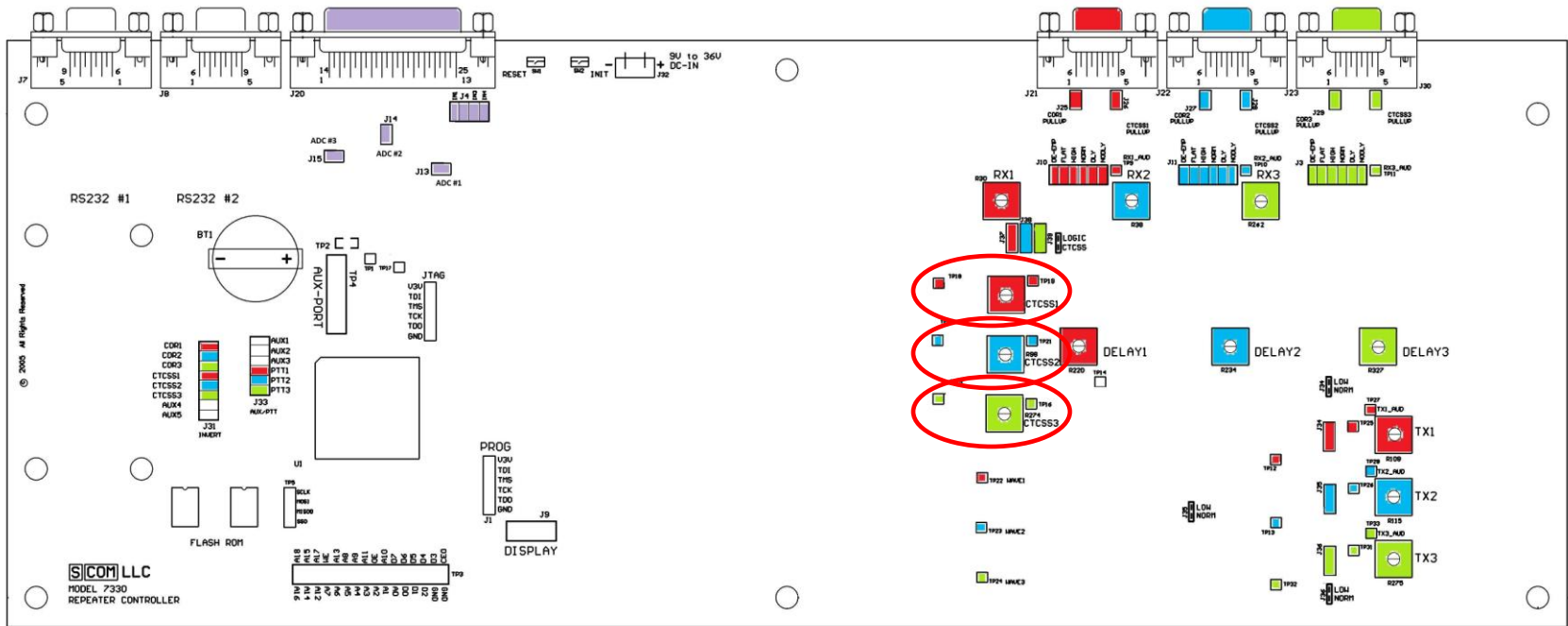
### External CTCSS Encoder

- Encoder Installed Inside Transmitter
  - E.g. Comm-Spec TS64
  - Vendor-Provided Encoder
- Controller Can Control a Logic Output Used to Disable the CTCSS Encoder
  - Only Works On Equipped Encoders
  - Used for “Chicken Burst”



# Wiring It Up

## CTCSS Encoder Audio Output



I/O

Radio Port 1

Radio Port 2

Radio Port 3

# Wiring It Up

## A-to-D Input Signals

Signal	Primary Use	Alternate
Analog-to-Digital	Analog Readings	Logic Input

## I/O Connector

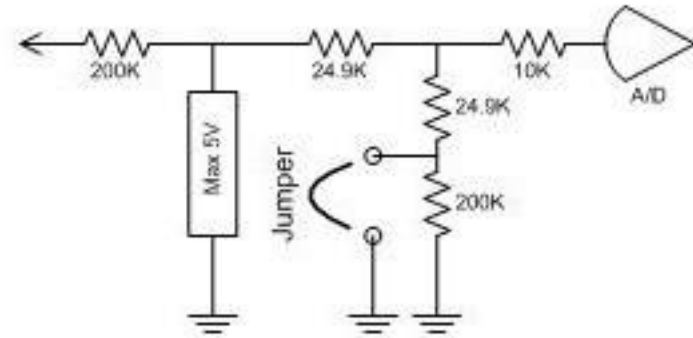
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4	Logic Output 4
5	Logic Output 5
6	Logic Output 6
7	A/D Input 3
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12	Logic Input 3
13	Logic Input 4
14	Logic Output 7
15	Logic Output 8
16	Ground
17	Ground
18	Ground
19	Ground
20	Ground
21	Ground
22	Ground
23	Ground
24	Ground
25	Ground

# Wiring It Up

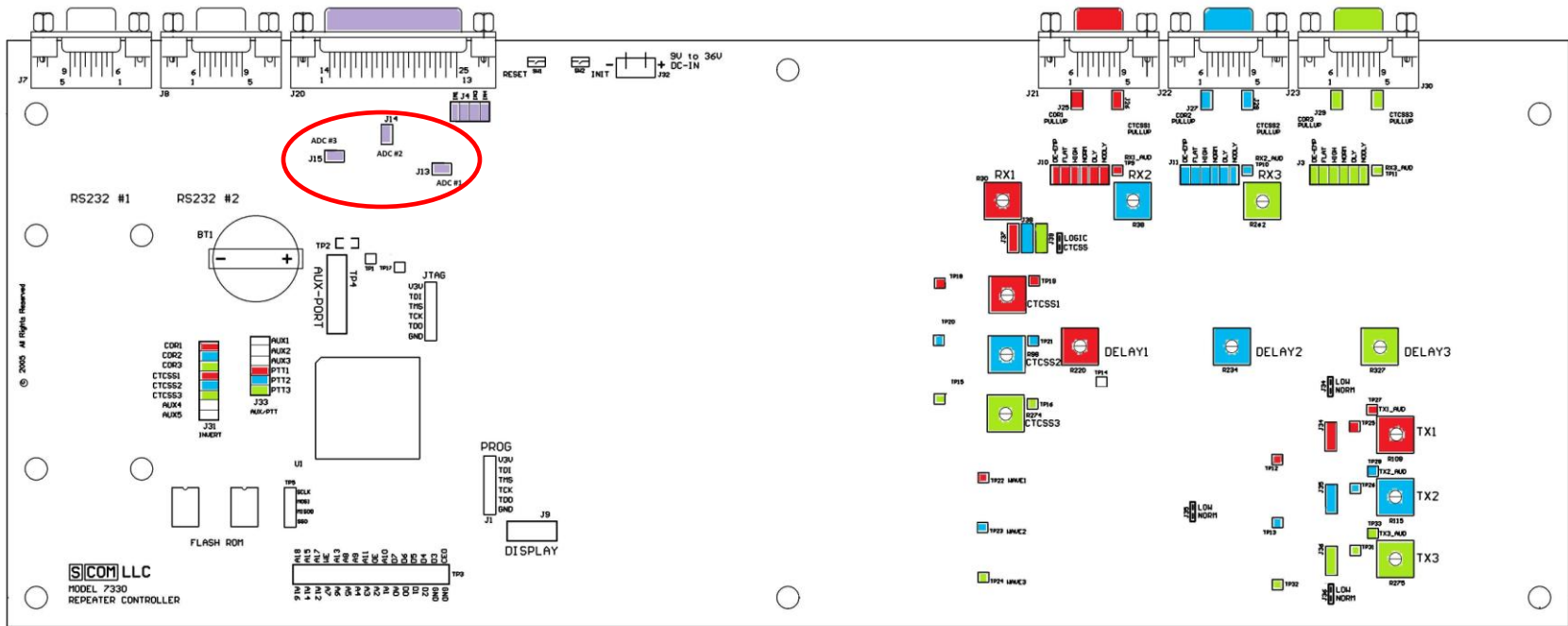
## Analog-to-Digital Input

### Input for Reading Analog Voltages

- Two Ranges
  - 0 thru 5 volt
  - 0 thru 25 volt
  - Set Range By Jumper



## Jumper for A-to-D Range



I/O

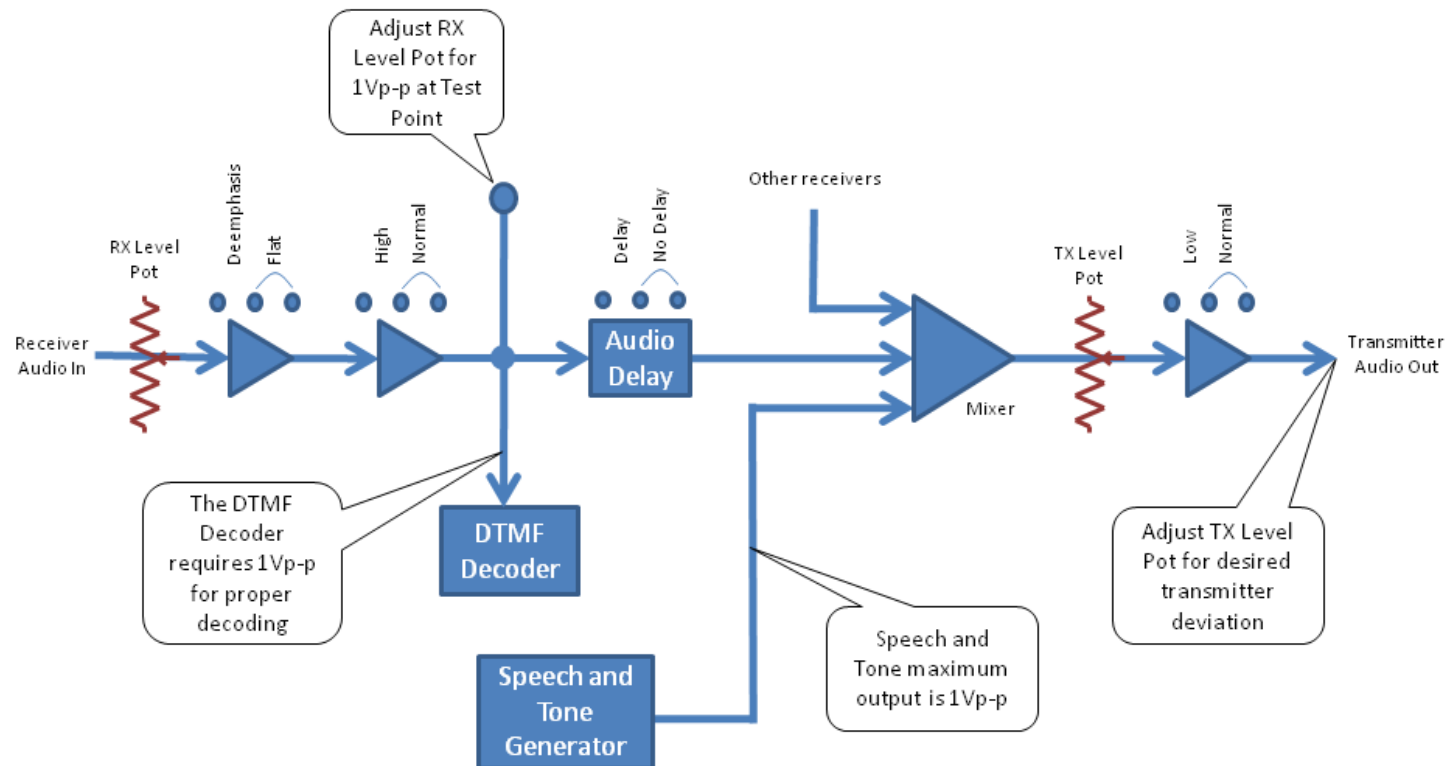
## Radio Port 1

## Radio Port 2

## Radio Port 3

# Wiring It Up

## Setting Audio Levels



# Wiring It Up

## Setting Audio Levels

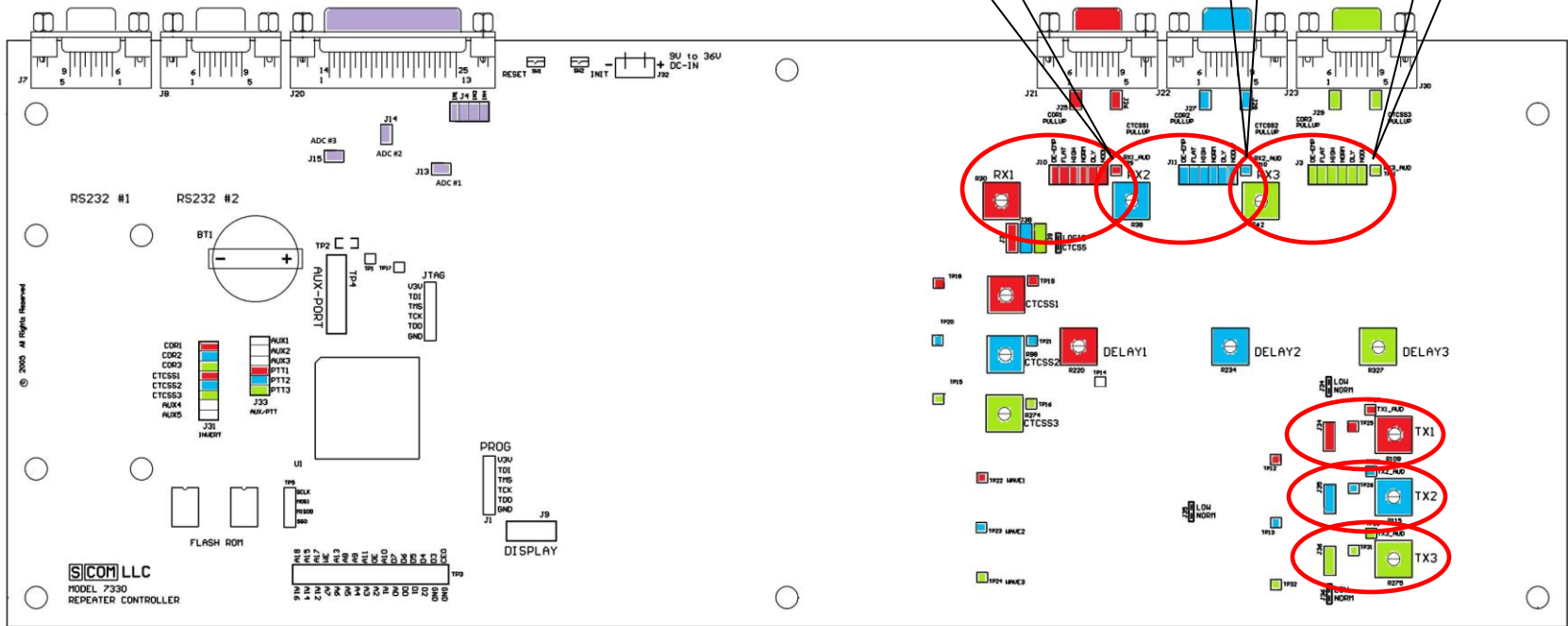
### Overview

Align your audio levels within the system using the following 4 steps

1. Set all receivers to the same voltage at the testpoint provided inside the controller for each receiver.  
S-COM 7330 uses 1 volt Peak-to-Peak (350mV rms).
2. Set all transmitters such that they deviate a maximum of 5 KHz deviation.
3. Set your CTCSS encode tone to 600-750 Hz deviation.
4. Set your controller audio processing to have flat audio.

# Wiring It Up

## Setting Audio Levels



I/O

Radio Port 1

Radio Port 2

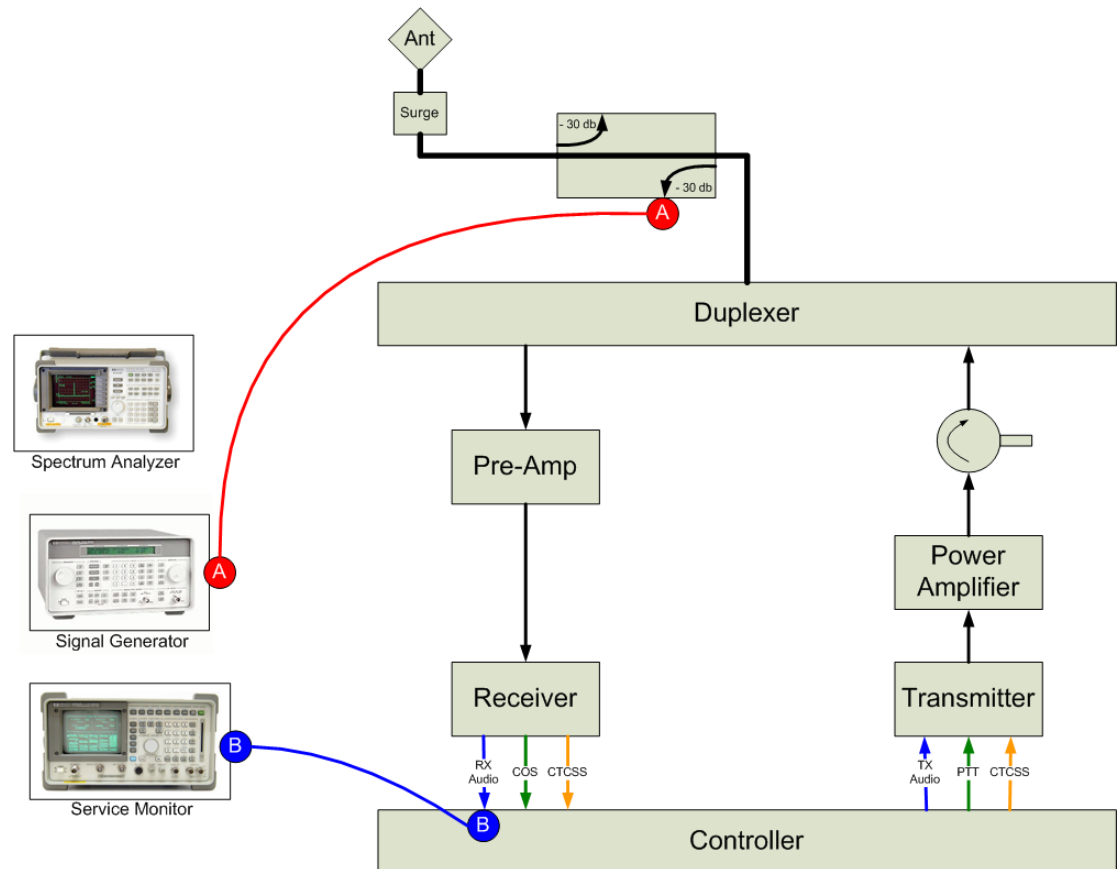
Radio Port 3



# Wiring It Up

## Step 1 - Setting audio input levels

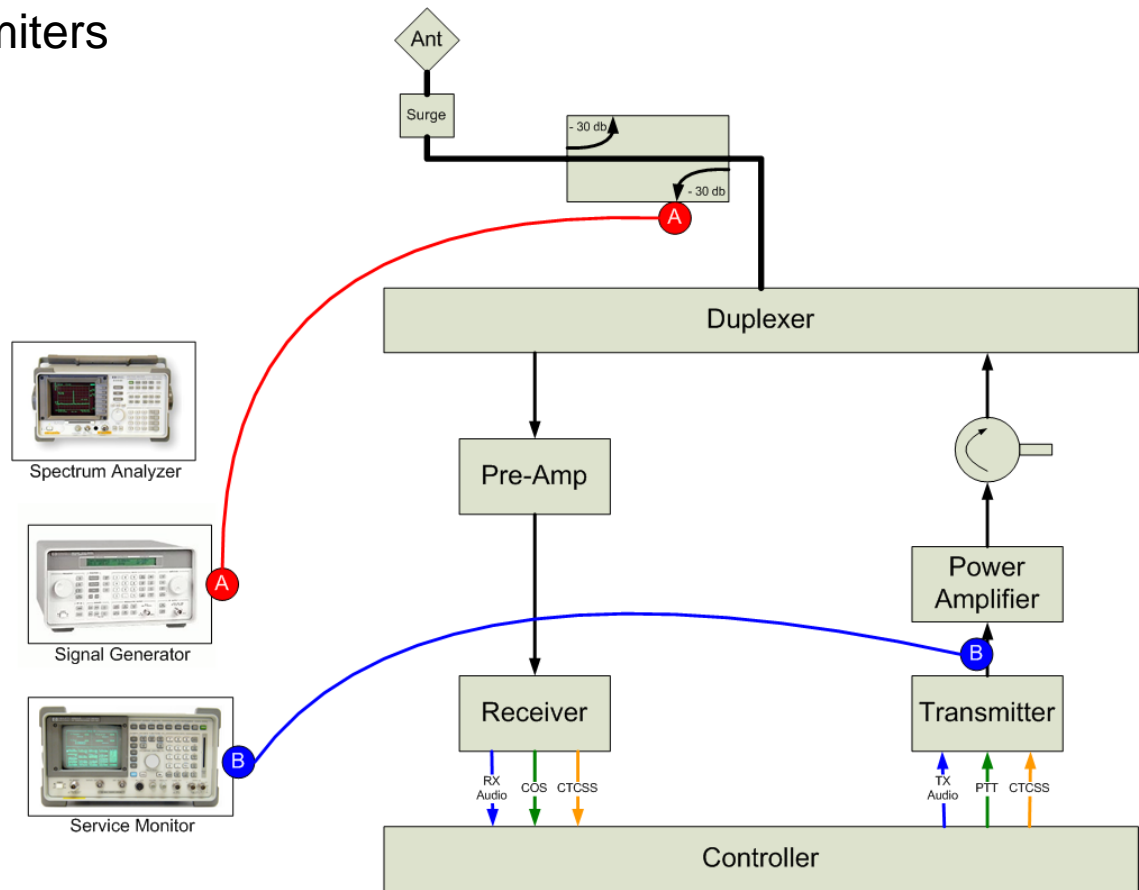
- Generate a strong RF signal on the input of each receiver.
- Signal should be a 1 kHz tone with 5 kHz of deviation.
- Set the controller RX audio input level adjust for 1 Vpp (350 V rms).
- Remember to adjust for any CTCSS tones.
- Repeat for all receivers connected to the controller



# Wiring It Up

## Step 2 - Setting Transmitter Limiters

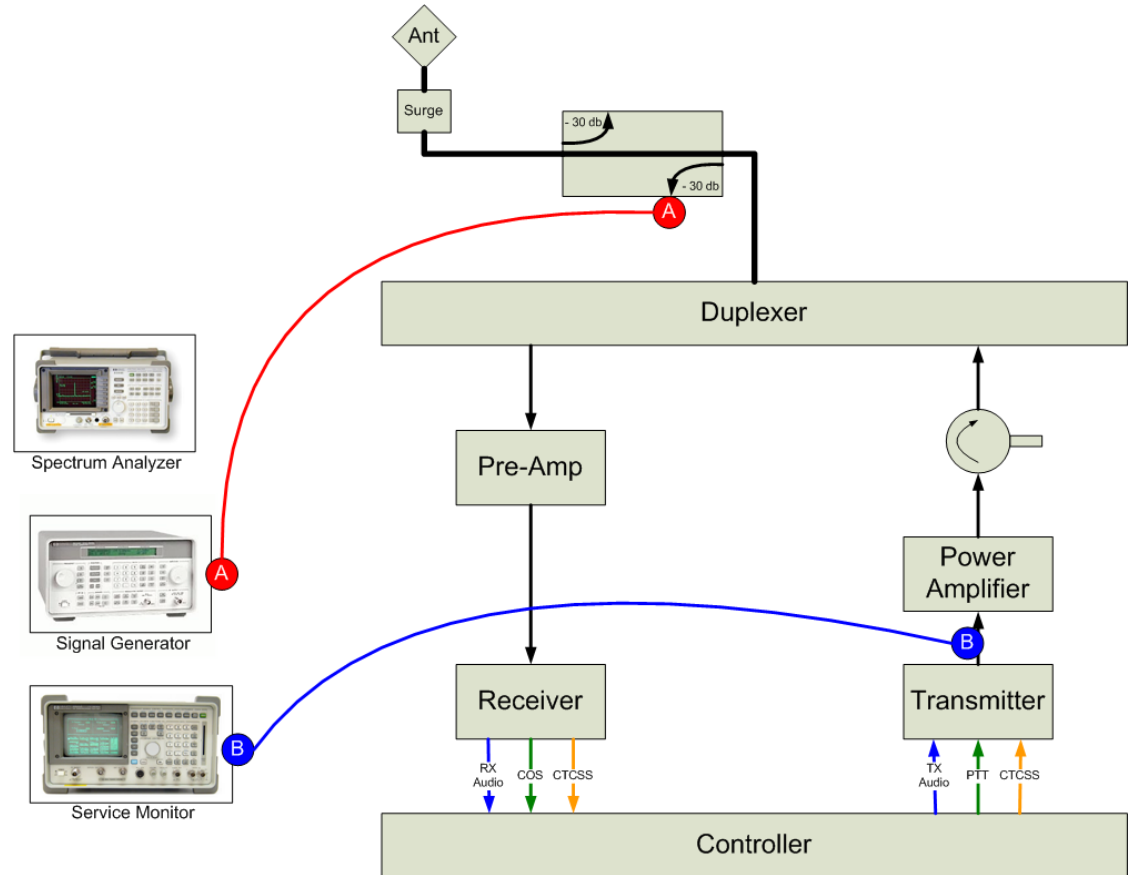
- Generate a strong RF signal on the input to a receiver.
- Signal should be a 1 kHz tone with 6-7 kHz of deviation.
- Set the repeater TX deviation control for a maximum of 5 kHz deviation.



# Wiring It Up

## Step 3 - Setting CTCSS level

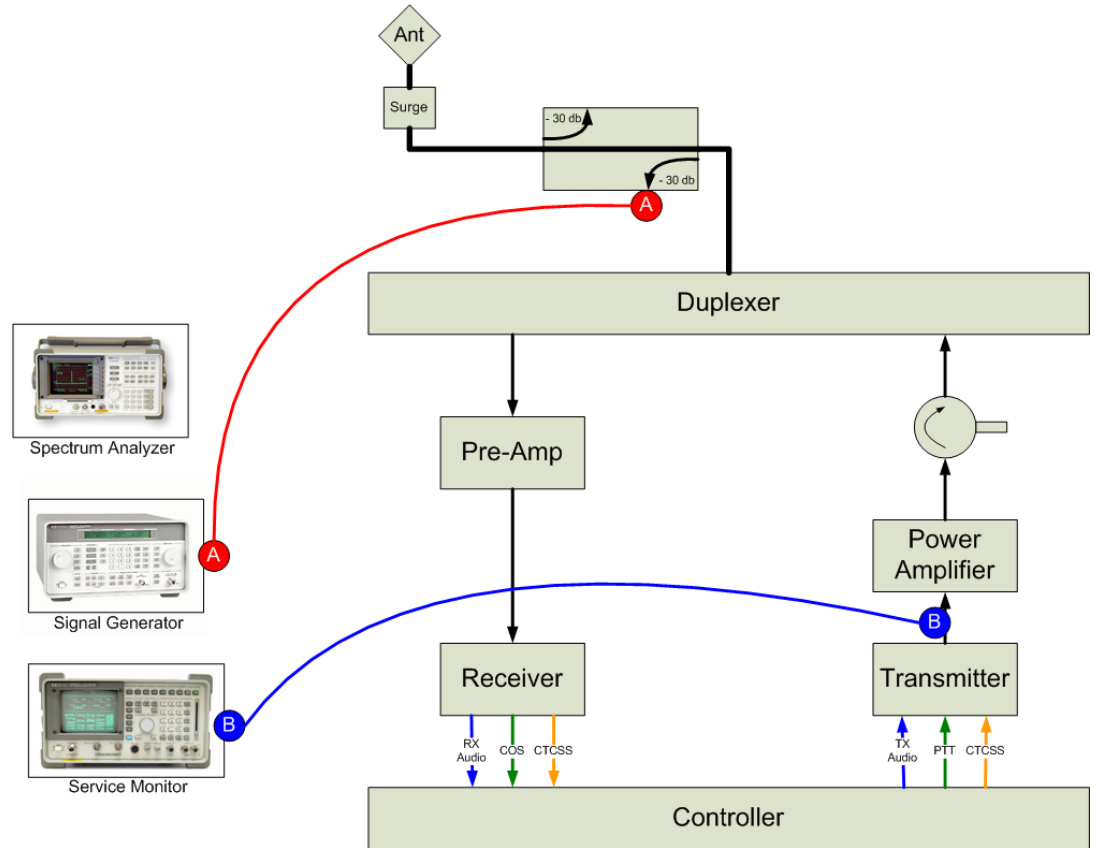
- Generate a strong RF signal on the input to a receiver. Or you can just PTT the transmitter if local control is possible.
- Signal should be a 0 kHz tone with 0 kHz of deviation.  
(dead carrier)
- Set the repeater TX CTCSS deviation control for 500 – 750 Hz deviation.
- Repeat for all transmitters which use CTCSS encode.



# Wiring It Up

## Step 4 - Setting for Flat Audio

- Generate a strong RF signal on the input to a receiver.
- Signal should be a 1 kHz tone with 3 kHz of deviation.
- Set the Controller TX Audio level adjust for 3 kHz deviation on the repeater output.
- Assure that any links have equal and flat audio across the controller.
- Remember to adjust for any CTCSS tones.



# Agenda

## Introduction

- Who is S-COM?

## The Basics

- Repeater Building Blocks
- What does a controller need to do?
- Common Terms
- Introducing the 7330

## Wiring It Up

- Connectors, Jumpers, Pots
- Power
- Input Logic Signals
- Output Logic Signals
- Audio
- A-to-D Input Signals
- CTCSS Encoder

## Basic Programming

- Testing on the Bench
- Initializing the Controller
- S-COM Command Formats
- Security
- Data Types
- Introduction to the Manual
- Getting Started with Programming Commands
- Testing Your Results

## Advanced Programming

- Ports and Paths
- More About Messages
- Receiver Timing
- Macros
- CTCSS Encoder
- Scheduler

## File Management

- Introducing SBOOT

## PC-Based Utilities

- S-COM Custom Audio Utility

## Other Controller Topics

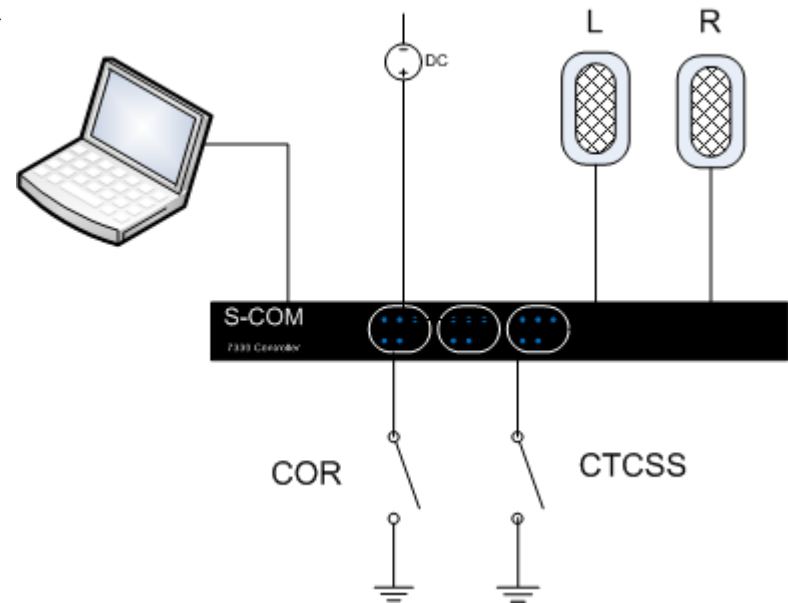
- Digital Linking: IRLP, EchoLink, Allstar

# Basic Programming

## Testing On The Bench

### What does it take?

- Bench Power Source, 9-36V DC >190ma
- Toggle Switches on COR and CTCSS
  - Pair for Each Radio Port
- Powered Computer Speakers
  - A Speaker Per Port
- LED for PTT
  - Optional, can use built-in LED
- DTMF Keypad
  - Optional, for testing DTMF commands
  - Commands can be entered on serial port
- Serial Port Cable to PC/Terminal
  - For Programming and Firmware Updates

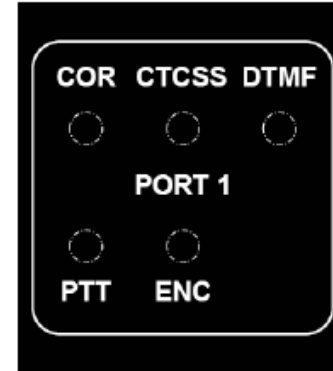


# Basic Programming

## Testing On The Bench

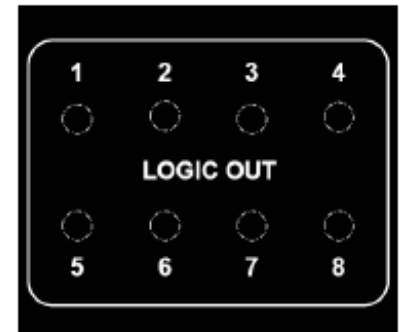
### Radio Port LEDs

- COR, CTCSS Logic Inputs
- PTT, CTCSS Encode Outputs
- DTMF Digit Valid



### Logic I/O LEDs

- Logic Inputs
- Logic Outputs



# Basic Programming

## “Initializing” A Controller

### Powerup Reset

- Applying Power is the same as pressing RESET
- Also called a *Warm Start*
- No change to programming

### Erase Programming

- Also called a *Cold Start*
- Changes all repeater configuration options to factory defaults
- *Exceptions*
  - Console serial port and baudrate unchanged





# Basic Programming

## S-COM Command Formats

### DTMF Commands

**<password>****<root>****<parameters>****<terminator>**

- Password
  - MPW, CPW, RBPW
- Root
  - Command number
  - E.g. 63, Set or Clear Software Switch
  - E.g. 09, Set Timer Reload Value
- Parameters
  - Identifier for Resource
  - Value to set resource to
  - E.g. Software Switch Number
- Terminator
  - Asterisk, \*
- Enter at Serial Console or via DTMF

## Example

**99 63 0100 1 \***

**99** Password, default is 99

**63** Root number,  
Set/Clear Software Switch

**0100** Switch Number

**1** Parameter

**\*** Terminator

*Note: Commands Usually  
Written With Space Between  
Command Elements For  
Readability.*

# Basic Programming

## S-COM Command Formats – DTMF Decoder Entry

### Special Keys

- Asterisk
  - Think of it as **Enter**
- Pound Sign
  - Think of it as **Clear Buffer**

### Valid DTMF Timing

- DTMF Digit ON at least 50 milliseconds
- DTMF digit OFF at least 50 milliseconds

### DTMF Interdigit Timing

- Clears the command buffer when a command is not completed by an Asterisk before it expires
  - Think of it as **Enter**
- Defaults to 5.00 seconds
  - Think of it as **Clear Buffer**

### Customization Options

- Execute on Interdigit Timer
- Execute on End-of-Transmission
- Execute on 4<sup>th</sup> Digit

# Basic Programming

## S-COM Command Formats – Serial Console Entry

### Console Prompt

- DTMF Command Format

### Special Keys

- ASTERISK
  - Optional On Serial Console
- BACKSPACE
  - For Line Editing
- SPACE
  - Ignored
  - Add for Readability
- SEMICOLON
  - Optional
  - Starts a Comment
  - Semicolon and Rest of Line Ignored

### Example

```
7330>996301001*
```

```
OK
```

```
7330>99 63 0100 1 * ; Set Switch
```

```
OK
```

```
7330>
```

99	Password, default is 99
63	Root number, Set/Clear Software Switch
0100	Switch Number
1	Parameter
*	Terminator

# Basic Programming

## S-COM Command Formats – Responses

### DTMF Responses

- Returned in CW by Default
- Common Ones Can Be Changed

### Serial Responses

- Text Responses
  - OK
  - Error: Followed By Reason

CW Response	Serial Port Response
OK	OK
?err1	Error: Wrong number of digits
?err2	Error: Incorrect digits
?notfound	Error: Macro name not found
?dirfull	Error: Macro directory full
?too big	Error: Macro exceeds 200 digits
?nameused	Error: Macro name already exists
?last	Error: Macro, cannot delete last command
	Error: Line too long
	Error: Invalid DTMF character
	Error: Serial input overflow or receive error

# Basic Programming

## Security

### Passwords

- Master Password
  - MPW
  - Can execute all root commands
- Control Operator Password
  - CPW
  - Can be restricted to subset of root commands
- Macro-Only Password
  - Always digits “DD”
  - Can only be used within a macro
  - Must be enabled
- Remote Base Password
  - RBPW
  - Used to control remote base radios
  - *Note: coming in a future 7330 release*

### Valid Passwords

- 2, 4, or 6 digits long
- Digits 0 thru 9 and A thru D.

### Defaults

- Master Password
  - 99
- Control Operator Password
  - Not Set

### Other Security Info

- Autopatch Password
  - APW
  - User password to make a phone call
  - *Note: previously used in S-COM MRC-100, 6K and 7K. Not available in 7330.*

# Basic Programming

## Data Types

### Basic/Simple Types

- Software Switch
- Counter
- Timer
- Message
- Macro
- Event-Triggered Macro
- Booleans
- Logic Inputs
- Logic Outputs

### Complex Types

- User Timer
- Activity Timer/Counter/Event-Triggered Macro
- Time-of-Day
- Scheduler Setpoint
- Analog Data Collection

# Basic Programming

## Data Types

### Type Number

Type Number	Type Name
00	Timers
03	Software Switch
04	Boolean
05	Scheduler Setpoint
06	User Timer

- *Note: This numbering is initially being used only in the If-Then-Else command. Future commands will also use it.*

### Resource Number

#### RPXX

- **R**, Resolution
  - Timers:
    - 0 = 10 millisecond
    - 1 = 100 millisecond
    - 2 = 1000 millisecond, 1 Second
  - All Others set to zero
- **P**, Port
  - 1 thru 3, Radio Ports
  - 9, Serial Port
- **XX**, Number 0 thru 99
- *Note: Resource number currently used on Timers, Software Switches, Booleans, Event-Triggered Macros, Messages, Counters*

# Basic Programming

## Data Types

Messages By Number			
Assign with (PW) 31 (number) (message contents) *			
Review with (PW) 34 (number) *			
Page	Number	Description	Default
Port-Specific Messages			
Replace the "r" with the Receiver Number			
Replace the "t" with the Transmitter Number			
9-27	0r00	Path 1t (RX1-TX) Courtesy Message	Single-Tone Beep
9-27	0r01	Path 2t (RX2-TX) Courtesy Message	Single-Tone Beep
9-27	0r02	Path 3t (RX3-TX) Courtesy Message	Single-Tone Beep
9-21	0r03	Path 1t (RX1-TX) Timeout Message	TO in CW
9-21	0r04	Path 2t (RX2-TX) Timeout Message	TO in CW
9-21	0r05	Path 3t (RX3-TX) Timeout Message	TO in CW
9-22	0r06	Path 1t (RX1-TX) Timeout End Message	TO in CW
9-22	0r07	Path 2t (RX2-TX) Timeout End Message	TO in CW
9-22	0r08	Path 3t (RX3-TX) Timeout End Message	TO in CW
12-5	0r09	TX Initial ID Message	ID in CW
12-5	0r10	TX Normal ID Message	ID in CW
12-5	0r11	TX Impolite ID Message	ID in CW
11-12	0r12	TX Dropout Message	None

General Purpose Switches		
Number	Page	Description
0000	4-6	Front Panel Enable
0001	22-2	Scheduler Enable
0002	21-9	Daylight Savings Time (USA) Enable
0003	5-8	Macro Erase Command Returns OK Enable
0004	5-17	Macro-Only Password Decoding Enable
0011	15-6	Logic Output Inversion 1
0012	15-6	Logic Output Inversion 2
0013	15-6	Logic Output Inversion 3
0014	15-6	Logic Output Inversion 4
0015	15-6	Logic Output Inversion 5

Port-Specific Counters		
Replace the "r" with the Receiver Number		
Replace the "t" with the Transmitter Number		
Number	Page	Description
0t00	11-21	TX End-of-Activity Counter
0t01	9-32	Path 1t End-of-Activity Counter
0t02	9-32	Path 2t End-of-Activity Counter
0t03	9-32	Path 3t End-of-Activity Counter

10ms Timers By Number		
Assign with (PW) 09 (number) (value) *		
Test with (PW) 76 00 (number) (nonzero macro) (zero macro) *		
Port-Specific Timers		
Replace the "r" with the Receiver/DTMF Decoder Number		
Replace the "t" with the Transmitter Number		
Number	Page	Description
0t00	11-6	TX Courtesy Delay
0t01	11-10	TX Dropout Delay
0t02	11-17	TX PTT Minimum Unkey Delay
0t03	11-4	TX Turn-On Message Delay Value
0r04	7-9	DTMF Decoder Interdigit Time
0r05	7-22	DTMF Decoder Mute Hang Time, First Digit
0r06	7-23	DTMF Decoder Mute Hang Time, Other Digits
0r07	7-18	DTMF Decoder Disconnect Time
0r08	7-7	DTMF Decoder Anti-Falsing Time
0r09	10-9	COR Anti-Kerchunker Key-Up Delay
0r10	10-25	COR Pulse-Triggered Macro Minimum Pulse Duration
0r11	10-26	COR Pulse-Triggered Macro Maximum Gap Duration
0r12	10-4	COR Filter Delay
0r13	10-6	CTCSS Filter Delay
0t14	6-40	Message Handler Inter-Page Delay Value
0t15	13-7	CTCSS Encoder Time Value
0t16	13-8	CTCSS Encoder Reverse Burst Time Value
0r17	10-15	RX Audio Gate Delay Timer Value
0r18	10-13	RX Flutter Filter Timer Value



# Basic Programming

## Introduction to Owner Manual Pages

### Description

#### Select Path Access Mode

Selects the access mode for each receiver-to-transmitter path.

- Programming the Path Access Mode does not affect the Path Enable/Disable Software Switch (see page 9-6).
- Enter the password, the two-digit root number, the two-digit path number, and a one-digit mode number.

### Syntax

Select RX1-TX2 Access Mode	(PW) 57 12 x *
Select RX2-TX2 Access Mode	(PW) 57 22 x *

(see table below)

### Parameters

#### Path Access Modes:

Mode	Access	Explanation
0	No Access	The receiver does not key the transmitter.
1	Carrier	The receiver keys the transmitter when the COR input is active.

### Responses

**Acknowledgment:** Sends OK message

#### Errors:

Error	Meaning
? err 1	wrong number of digits entered
? err 2	illegal digit entered

### Defaults

**Default:** All paths are in access mode 1 (Carrier).

#### Select Path Access Mode

Selects the access mode for each receiver-to-transmitter path.

- Programming the Path Access Mode does not affect the Path Enable/Disable Software Switch (see page 9-6).
- Enter the password, the two-digit root number, the two-digit path number, and a one-digit mode number.

#### Command Form:

Command	Form	Data Digit
Select RX1-TX1 Access Mode	(PW) 57 11 x *	(see table below)
Select RX2-TX1 Access Mode	(PW) 57 21 x *	
Select RX3-TX1 Access Mode	(PW) 57 31 x *	
Select RX1-TX2 Access Mode	(PW) 57 12 x *	
Select RX2-TX2 Access Mode	(PW) 57 22 x *	
Select RX3-TX2 Access Mode	(PW) 57 32 x *	
Select RX1-TX3 Access Mode	(PW) 57 13 x *	
Select RX2-TX3 Access Mode	(PW) 57 23 x *	
Select RX3-TX3 Access Mode	(PW) 57 33 x *	

#### Path Access Modes:

Mode	Access	Explanation
0	No Access	The receiver does not key the transmitter.
1	Carrier	The receiver keys the transmitter when the COR input is active.
2	CTCSS	The receiver keys the transmitter when the CTCSS input is active.
3	Carrier AND CTCSS	The receiver keys the transmitter when both the COR input and the CTCSS input are active.
4	Carrier OR CTCSS	The receiver keys the transmitter when either the COR input or the CTCSS input is active.
5	Anti-CTCSS	The receiver keys the transmitter when the COR input is active and the CTCSS input is inactive.
6	Always On	The receiver keys the transmitter regardless of the COR input and the CTCSS input.

**Acknowledgment:** Sends OK message

#### Errors:

Error	Meaning
? err 1	wrong number of digits entered
? err 2	illegal digit entered

**Default:** All paths are in access mode 1 (Carrier).

# Basic Programming

## Setting Time and Date

### Clock/Calendar

- Used by
  - Automatic Saving Time
  - Speaking the Date and Time
  - Scheduling Events

99 25 14 02 22 6 09 26 00 \*

### Set Clock and Calendar

#### Sets the clock and calendar.

- Enter all parameters shown below each time that you set the *Clock and Calendar*. Seconds are optional.
- All parameters consist of two digits except the day-of-week, which is one digit.
- The year parameter is needed for leap year correction.
- The clock and calendar is set when you release the (\*) button.
- Seconds are automatically set to 00 if not entered.

#### Command Form:

Command	Form	Data Digit
Set Clock and Calendar	(PW) 25 (year, month, day-of-month, day-of-week, hour, minute, second)*	from table below

Data Digit	Explanation
00-99	year
01-12 (January is 01)	month
01-31	day-of-month
0-6 (Sunday is 0)	day-of-week
00-23 (24-hour format)	hour
00-59	minute
00-59	second (optional)

**Acknowledgment:** Sends OK

#### Errors:

Error	Meaning
? err 1	wrong number of digits entered
? err 2	illegal parameter: any lettered key; month = 00 or greater than 12; day-of-month = 0 or greater than 31; day-of-week greater than 6; hour greater than 23; minute or second greater than 59.

**Default Condition:** 00:00:00 on Sunday, January 1, 2006. Note that the clock and calendar are only initialized if not running during a *Cold Start*.

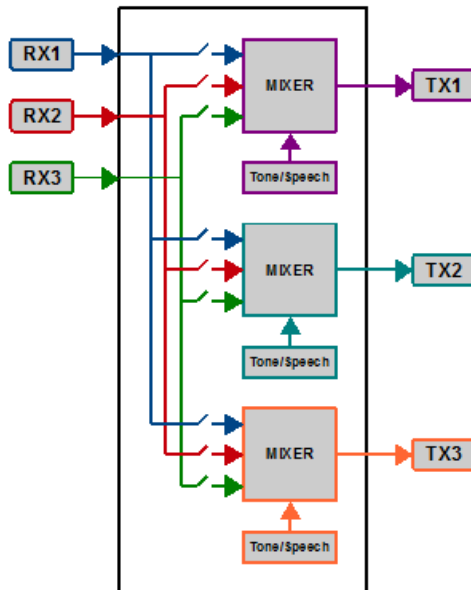
# Basic Programming

## Accessing the Repeater

### Set the Access Mode for each Path

- 9 Paths Connect All Rx to All Tx
- Unique Path for Each

99 57 11 3 \*



### Select Path Access Mode

Selects the access mode for each receiver-to-transmitter path.

- Programming the Path Access Mode does not affect the Path Enable/Disable Software Switch (see page 9-6).
- Enter the password, the two-digit root number, the two-digit path number, and a one-digit mode number.

#### Command Form:

Command	Form	Data Digit
Select RX1-TX1 Access Mode	(PW) 57 11 x *	(see table below)
Select RX2-TX1 Access Mode	(PW) 57 21 x *	
Select RX3-TX1 Access Mode	(PW) 57 31 x *	
Select RX1-TX2 Access Mode	(PW) 57 12 x *	
Select RX2-TX2 Access Mode	(PW) 57 22 x *	
Select RX3-TX2 Access Mode	(PW) 57 32 x *	
Select RX1-TX3 Access Mode	(PW) 57 13 x *	
Select RX2-TX3 Access Mode	(PW) 57 23 x *	
Select RX3-TX3 Access Mode	(PW) 57 33 x *	

#### Path Access Modes:

Mode	Access	Explanation
0	No Access	The receiver does not key the transmitter.
1	Carrier	The receiver keys the transmitter when the COR input is active.
2	CTCSS	The receiver keys the transmitter when the CTCSS input is active.
3	Carrier AND CTCSS	The receiver keys the transmitter when both the COR input and the CTCSS input are active.
4	Carrier OR CTCSS	The receiver keys the transmitter when either the COR input or the CTCSS input is active.
5	Anti-CTCSS	The receiver keys the transmitter when the COR input is active and the CTCSS input is inactive.
6	Always On	The receiver keys the transmitter regardless of the COR input and the CTCSS input.

Acknowledgment: Sends OK message

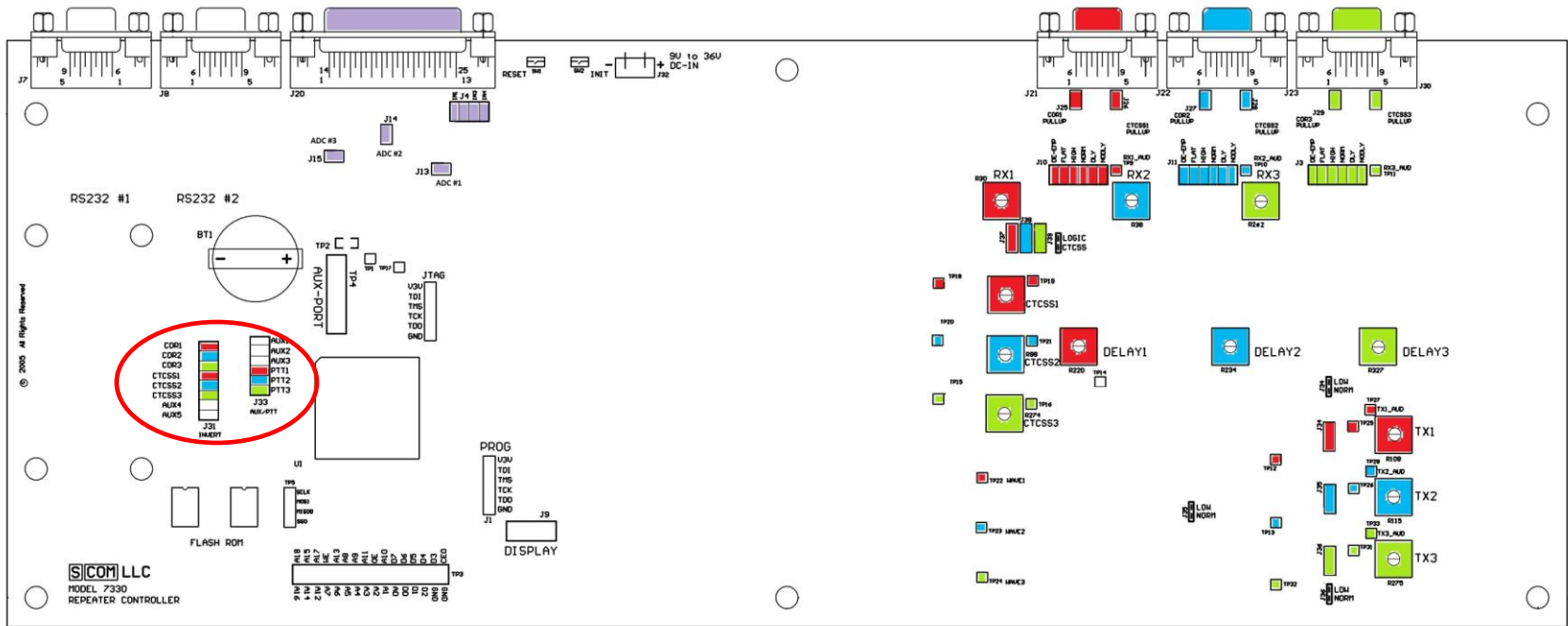
#### Errors:

Error	Meaning
? err 1	wrong number of digits entered
? err 2	illegal digit entered

Default: All paths are in access mode 1 (Carrier).

# Basic Programming

## COR, CTCSS, PTT Inversion Jumpers



I/O

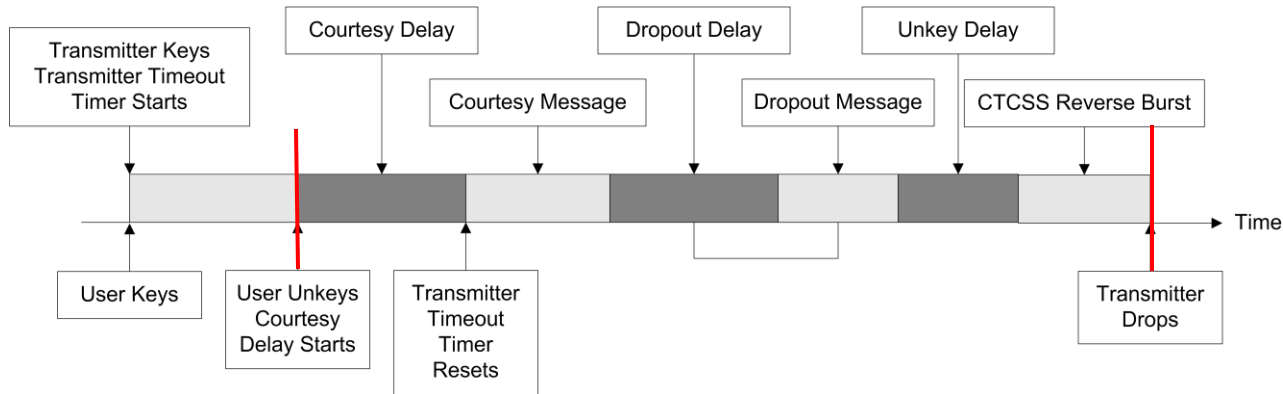
Radio Port 1

Radio Port 2

Radio Port 3

# Basic Programming

## Transmitter Tail Timing



From Beginning of Courtesy Delay  
Until Transmitter Drops Is Tail Time

### Defaults Appropriate For A Repeater

- Courtesy Delay
  - 0.50 second, default
- Dropout Delay
  - 3.00 second, default
- Unkey Delay
  - 0.10 second, default
- CTCSS Reverse Burst Delay
  - OFF, default

# Basic Programming

## Transmitter Tail Timing

- Set Courtesy Delay to 0.50 Second

99 09 0100 050 \*

- Set Dropout Delay to 3.00 Seconds

99 09 0101 300 \*

- Set PTT Unkey Delay to 0.75 Second

99 09 0102 75 \*

### Select Dropout Delay

Programs the Dropout Delay time value.

- Enter the password, the two-digit root number, the four-digit timer number and one to five digits from 0 to 65535 to set the delay to 0.00 to 655.35 seconds.
- To disable the delay, set its value to 0.

#### Command Form:

Command	Form	Data Digit
Select TX1 Dropout Delay	(PW) 09 0101 xxxxx *	xxxxx = 0-65535
Select TX2 Dropout Delay	(PW) 09 0201 xxxxx *	0-655.35 seconds
Select TX3 Dropout Delay	(PW) 09 0301 xxxxx *	

**Acknowledgment:** Sends OK message

#### Errors:

Error	Meaning
?err 1	wrong number of digits entered
?err 2	illegal digit entered

**Default:** Dropout Delay is 3.0 seconds

#### Examples:

To set TX1's Dropout Delay to 2.5 seconds, enter:

(PW) 09 0101 250 \*

To set TX2's Dropout Delay to 0.1 second, enter:

(PW) 09 0201 10 \*

# Basic Programming

## Introducing Messages

### Message Format

<type><characters>

- Type Identified by Message Control Characters
- A Message is Processed Left to Right  
An Even Number of Digits At a Time

Example:

9900 32 10 01 19 17 20 38 27

Sends in CW:

WA1JHK/R

Message Control Characters		
Control Character	Definition	Page
97xx	Message Routing characters follow	6-4
9900	CW characters follow	6-13
9901	CW Primary characters follow	6-13
9902	CW Secondary characters follow	6-13
9903	CW Speed Change characters follow	6-15
9904	CW Frequency Change characters follow	6-15
9905	CW Message Level characters follow	6-14
9910	Single-Tone Beep characters follow	6-21
9911	Single-Tone Beep Primary characters follow	6-21
9912	Single-Tone Beep Secondary characters follow	6-21
9913	Single-Tone Beep Message Level characters follow	6-22
9915	Dual-Tone Beep characters follow	6-31
9916	Dual-Tone Beep Primary characters follow	6-31
9917	Dual-Tone Beep Secondary characters follow	6-31
9918	Dual-Tone Beep Message Level characters follow	6-32
9920	Single-Tone page follows	6-38
9930	Two-Tone Sequential page follows	6-40
9940	5/6-Tone page follows	6-42
9950	DTMF page follows	6-44
9955	SELCAL page follows	6-52
9960	Speech characters follow	6-54
9961	Speech Primary characters follow	6-54
9962	Speech Secondary characters follow	6-54
9963	Speech Message Level characters follow	6-55
9991	Mixed Audio Allowed	6-6
9992	Non-Mixed Audio Only	6-6
9993	Pause characters follow	6-7
9999	Execute the macro that follows	6-8

# Basic Programming

## Identifier Message

### CW Messages

- Starts With Type
  - 9900
- Followed By Pairs Of Digits
  - Each digit-pair is a CW Character

9900 32 10 01 19 17 20 38 27

Sends in CW:

WA1JHK/R

CW Alphanumeric Characters			
Control Character 9900/9901/9902			
Character	Code	Character	Code
0	00	I	18
1	01	J	19
2	02	K	20
3	03	L	21
4	04	M	22
5	05	N	23
6	06	O	24
7	07	P	25
8	08	Q	26
9	09	R	27
A	10	S	28
B	11	T	29
C	12	U	30
D	13	V	31
E	14	W	32
F	15	X	33
G	16	Y	34
H	17	Z	35



# Basic Programming

## Identifier Message

### Programming the Normal Identifier Message

- Message Commands
  - Define A Message
  - Review A Message
  - Play A Message
- To Set An Identifier Message

99 31 0110 9900 32 10 01 19 17 20 38 27 \*

- To Review An Identifier Message

99 34 0110 \*

### Select/Review Identifier Messages

Define the Initial ID, Normal ID, and Impolite ID Messages for each transmitter.

- To change a message: enter the password, the 2-digit root number and 4-digit message number shown, followed by the desired message.
- Any message may be a combination of message types including CW, beeps, page tones, speech, etc.
- The maximum size of any message is 50 bytes (50 2-digit codes). You must count the control characters. Therefore, any message could have 46 CW characters, 23 synthesized speech words, etc.
- To delete a message, enter the password, the 4-digit root number, and the (\*); do not enter any message.
- If an *Initial ID Message* is not programmed, the *Normal ID Message* is sent.
- If an *Impolite ID Message* is not programmed, the *Normal ID Message* is sent.
- If the *Initial*, *Normal*, and *Impolite* messages for a transmitter are all deleted, the Identifier is disabled for that transmitter.

#### Command Form:

Command	Form	Default
Select Initial ID Message for TX1	(PW) 31 0109 (message) *	ID in CW, 587 Hz
Select Normal ID Message for TX1	(PW) 31 0110 (message) *	ID in CW, 587 Hz
Select Impolite ID Message for TX1	(PW) 31 0111 (message) *	none
Select Initial ID Message for TX2	(PW) 31 0209 (message) *	ID in CW, 698 Hz
Select Normal ID Message for TX2	(PW) 31 0210 (message) *	ID in CW, 698 Hz
Select Impolite ID Message for TX2	(PW) 31 0211 (message) *	none
Select Initial ID Message for TX3	(PW) 31 0309 (message) *	ID in CW, 1046 Hz
Select Normal ID Message for TX3	(PW) 31 0310 (message) *	ID in CW, 1046 Hz
Select Impolite ID Message for TX3	(PW) 31 0311 (message) *	none
Review Initial ID Message for TX1	(PW) 34 0109 *	none
Review Normal ID Message for TX1	(PW) 34 0110 *	none
Review Impolite ID Message for TX1	(PW) 34 0111 *	none
Review Initial ID Message for TX2	(PW) 34 0209 *	none
Review Normal ID Message for TX2	(PW) 34 0210 *	none
Review Impolite ID Message for TX2	(PW) 34 0211 *	none
Review Initial ID Message for TX3	(PW) 34 0309 *	none
Review Normal ID Message for TX3	(PW) 34 0310 *	none
Review Impolite ID Message for TX3	(PW) 34 0311 *	none

**Acknowledgment:** Sends OK message

#### Errors:

Error	Meaning
? err 1	wrong number of digits entered
? err 2	illegal digit entered

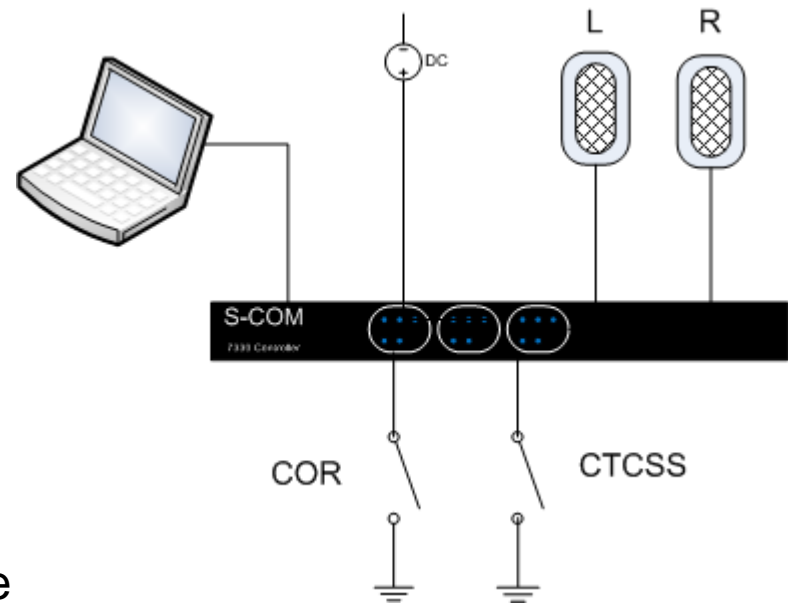
**Default Condition:** See table above.

# Basic Programming

## Testing Your Results

### How Do We Know It Works?

- Test Access Mode of COR-Only
  1. Close COR Switch
  2. See COR LED ON
  3. See PTT LED ON
  4. Open COR Switch
  5. See COR LED OFF
  6. Hear Courtesy Beep
  7. Hear CW ID
  8. See PTT LED OFF after Tx Tail Time



# Agenda

## Introduction

- Who is S-COM?

## The Basics

- Repeater Building Blocks
- What does a controller need to do?
- Common Terms
- Introducing the 7330

## Wiring It Up

- Connectors, Jumpers, Pots
- Power
- Input Logic Signals
- Output Logic Signals
- Audio
- A-to-D Input Signals
- CTCSS Encoder

## Basic Programming

- Testing on the Bench
- Initializing the Controller
- S-COM Command Formats
- Security
- Data Types
- Introduction to the Manual
- Getting Started with Programming Commands

- Testing Your Results

## Advanced Programming

- Ports and Paths
- More About Messages
- Receiver Timing
- Macros
- CTCSS Encoder
- Scheduler

## File Management

- Introducing SBOOT

## PC-Based Utilities

- S-COM Custom Audio Utility

## Other Controller Topics

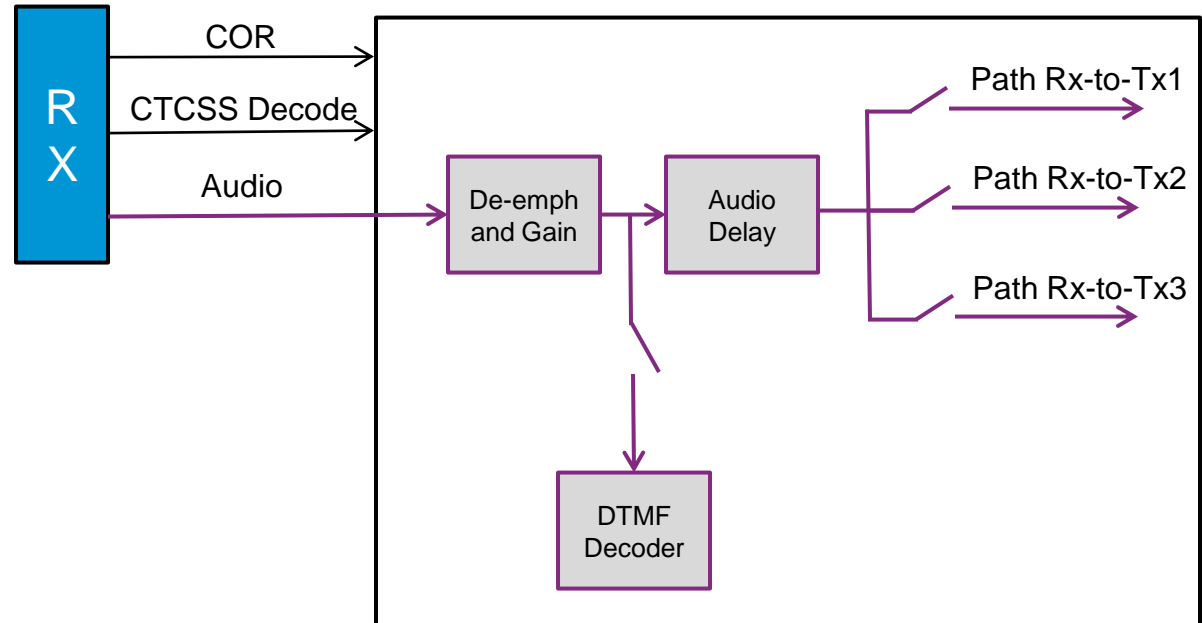
- Digital Linking: IRLP, EchoLink, Allstar

# Advanced Programming

## Introduction to Ports and Paths

### Receiver Port

- De-emphasis
- Gain
- Audio Delay
- DTMF Decoder
- Path Access Modes
- DTMF Access Modes
- Timers
- Software Switches
- Event-Triggered Macros

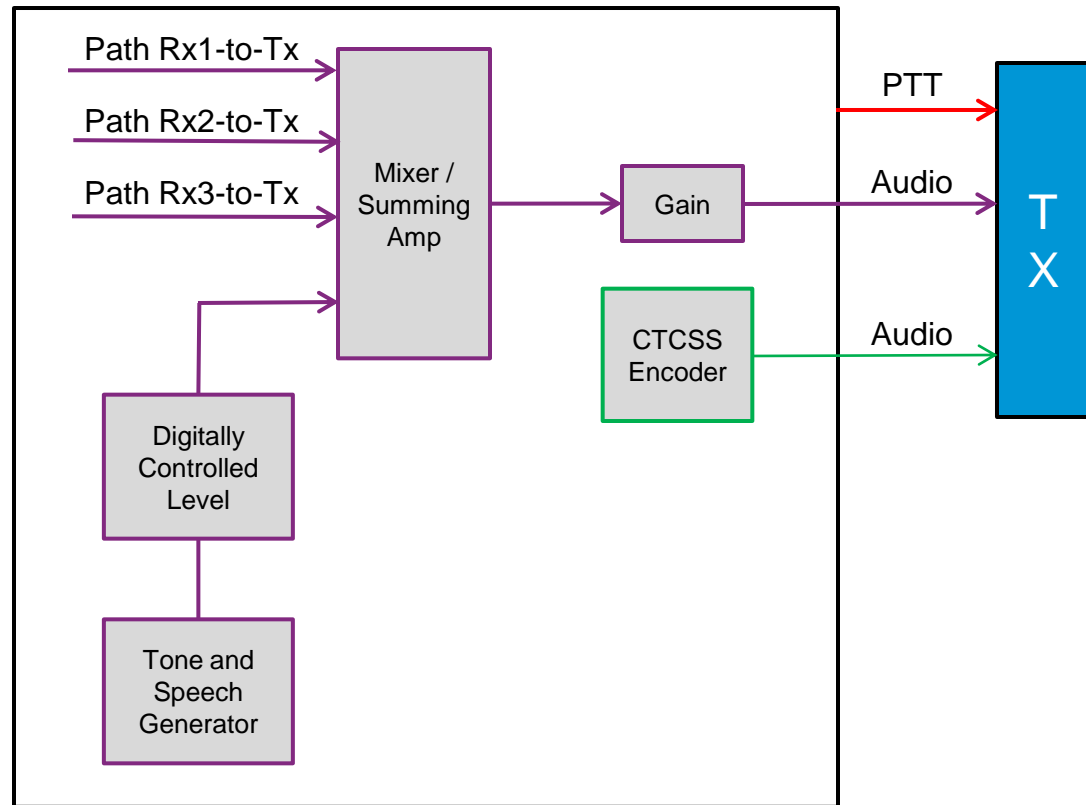


# Advanced Programming

## Introduction to Ports and Paths

### Transmitter Port

- Audio Summing
- Dual-Tone Generator
- Programmable Tone and Speech Levels
- Speech Generator
- Gain
- Timers
- Software Switches
- Event-Triggered Macros
- Messages



# Advanced Programming

## Introduction To Ports and Paths

### Paths

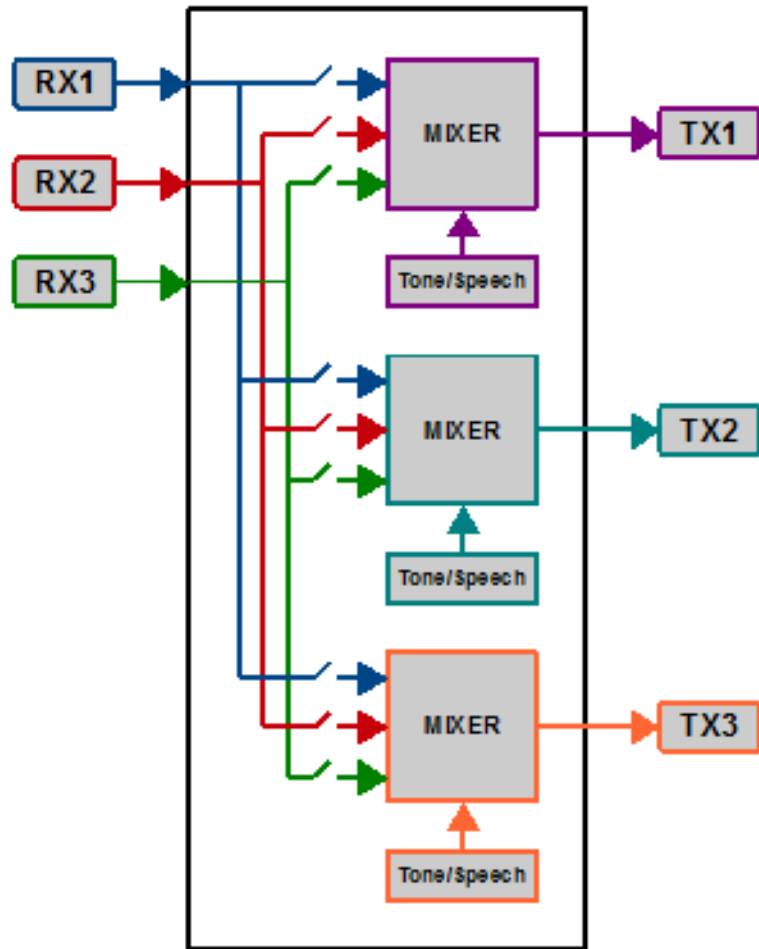
- Connect from any RX to any TX

### Example #1

- 3 Standalone Repeaters
  - RX1 to TX1
  - RX2 to TX2
  - RX3 to TX3
- ALL other paths OFF

### Example #2

- 2 Linked Repeaters
  - RX1 to TX1
  - RX1 to TX2, RX2 to TX2
  - RX2 to TX1
- 1 Standalone Repeaters
  - RX3 to TX3
- ALL other paths OFF

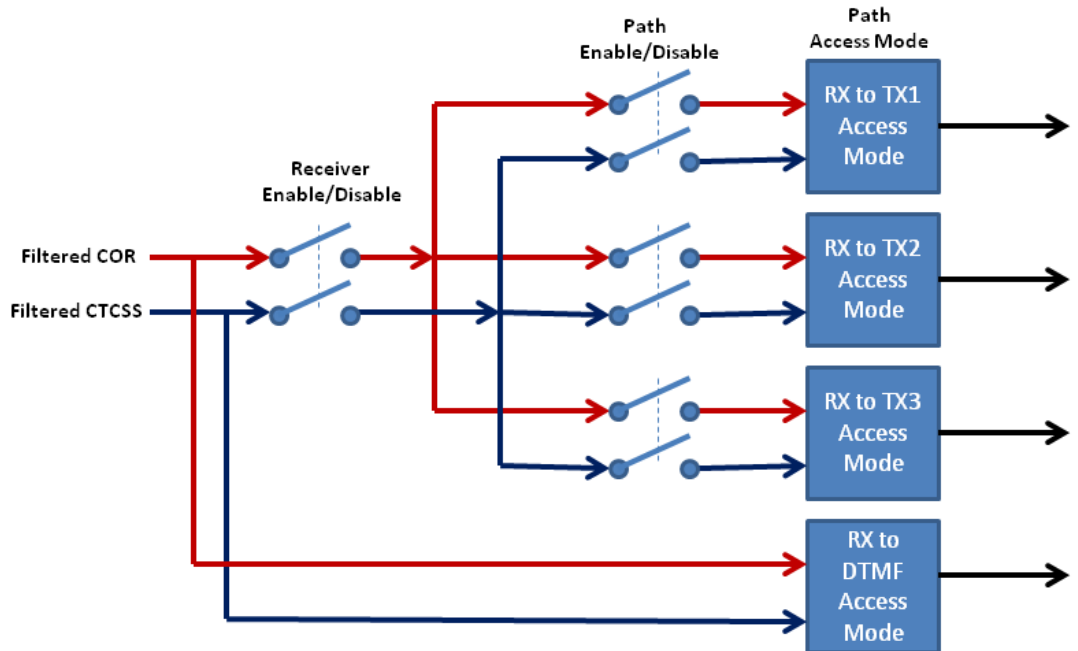


# Advanced Programming

## Introduction To Ports and Paths

### Paths

- Connect from any RX to any TX
- Set Access Mode by Path
- Enable/Disable by Path
- Enable/Disable by Receiver



# Advanced Programming

## Path Access Modes

### Access Modes

#### Unique Access Mode By Path

- No Access
- COR Only
- CTCSS Only
- COR AND CTCSS
- COR OR CTCSS
- Anti-CTCSS
  - COR AND NOT CTCSS
- Always On

## Select Path Access Mode

Selects the access mode for each receiver-to-transmitter path.

- Programming the Path Access Mode does not affect the Path Enable/Disable Software Switch (see page 9-6).
- Enter the password, the two-digit root number, the two-digit path number, and a one-digit mode number.

Command Form:		
Command	Form	Data Digit
Select RX1-TX1 Access Mode	(PW) 57 11 x *	(see table below)
Select RX2-TX1 Access Mode	(PW) 57 21 x *	
Select RX3-TX1 Access Mode	(PW) 57 31 x *	
Select RX1-TX2 Access Mode	(PW) 57 12 x *	
Select RX2-TX2 Access Mode	(PW) 57 22 x *	
Select RX3-TX2 Access Mode	(PW) 57 32 x *	
Select RX1-TX3 Access Mode	(PW) 57 13 x *	
Select RX2-TX3 Access Mode	(PW) 57 23 x *	
Select RX3-TX3 Access Mode	(PW) 57 33 x *	

### Path Access Modes:

Mode	Access	Explanation
0	No Access	The receiver does not key the transmitter.
1	Carrier	The receiver keys the transmitter when the COR input is active.
2	CTCSS	The receiver keys the transmitter when the CTCSS input is active.
3	Carrier AND CTCSS	The receiver keys the transmitter when both the COR input and the CTCSS input are active.
4	Carrier OR CTCSS	The receiver keys the transmitter when either the COR input or the CTCSS input is active.
5	Anti-CTCSS	The receiver keys the transmitter when the COR input is active and the CTCSS input is inactive.
6	Always On	The receiver keys the transmitter regardless of the COR input and the CTCSS input.

**Acknowledgment:** Sends OK message

**Errors:**

Error	Meaning
? err 1	wrong number of digits entered
? err 2	illegal digit entered

**Default:** All paths are in access mode 1 (Carrier).



# Advanced Programming

## Path Control

### Enable/Disable by Path

- Complete Control

### Examples

- Repeater
  - Path on Same Port ON
  - (Repeat Path ON)
- Linked Repeater
  - Paths Between Ports ON
- Simplex/Remote Base
  - Path on Same Port OFF
  - (Repeat Path OFF)
- Control Receiver
  - All Paths OFF

## Enable/Disable Path

Turns ON or OFF a specific path.

- Enabling or disabling a path does not change the programmed Path Access Mode for that path (see page 9-7).
- Enter the password, the two-digit root number, the four-digit software switch number, and one digit (0 to disable the path, 1 to enable it).

---

### Command Form:

Command	Form	Data Digit
Enable/Disable RX1-TX1 Path	(PW) 63 0141 x *	0 = OFF (disabled) 1 = ON (enabled)
Enable/Disable RX2-TX1 Path	(PW) 63 0142 x *	
Enable/Disable RX3-TX1 Path	(PW) 63 0143 x *	
Enable/Disable RX1-TX2 Path	(PW) 63 0241 x *	
Enable/Disable RX2-TX2 Path	(PW) 63 0242 x *	
Enable/Disable RX3-TX2 Path	(PW) 63 0243 x *	
Enable/Disable RX1-TX3 Path	(PW) 63 0341 x *	
Enable/Disable RX2-TX3 Path	(PW) 63 0342 x *	
Enable/Disable RX3-TX3 Path	(PW) 63 0343 x *	

---

**Acknowledgment:** Sends OK message

### Errors:

Error	Meaning
? err 1	wrong number of digits entered
? err 2	illegal digit entered

---

**Default:** All Paths are ON (enabled)

# Advanced Programming

## Configure Values by Path

### Timeout Timer

- Set Timeout Time
- Set Timeout Penalty Time
- Set Message to Play
- Set Macro to Execute
- Reset Timeout Timer Command

### Courtesy Message

- Set Courtesy Message
- Set Courtesy Macro

### Activity Timer/Counter/Macro

- Set Timer
- Set Counter
- Set Macro

### Select Path Timeout Value

Controls the maximum amount of time a path can be active.

- Enter the password, the two-digit root number, the four-digit timer number, and one to five digits from 0 to 65535 to set the path timeout timer to 0 to 65535 seconds.
- Set the timeout value to zero to disable the Path Timeout Timer.

**Command Form:**

Command	Form	Data Digit
Select RX1-TX1 Timeout Value	(PW) 09 2100 xxxxx *	xxxxx = 0-65535 = 0-65535 seconds
Select RX2-TX1 Timeout Value	(PW) 09 2101 xxxxx *	
Select RX3-TX1 Timeout Value	(PW) 09 2102 xxxxx *	
Select RX1-TX2 Timeout Value	(PW) 09 2200 xxxxx *	
Select RX2-TX2 Timeout Value	(PW) 09 2201 xxxxx *	
Select RX3-TX2 Timeout Value	(PW) 09 2202 xxxxx *	
Select RX1-TX3 Timeout Value	(PW) 09 2300 xxxxx *	
Select RX2-TX3 Timeout Value	(PW) 09 2301 xxxxx *	
Select RX3-TX3 Timeout Value	(PW) 09 2302 xxxxx *	

**Acknowledgment:** Sends OK message

**Errors:**

Error	Meaning
? err 1	wrong number of digits entered
? err 2	illegal digit entered

**Default:** All Path Timeout Timers default to 180 seconds (3 minutes).

**Examples:**  
The timeout timers are programmed in seconds. For example, if you wish to set the RX1-TX1 timeout timer to 4.5 minutes, multiply 4.5 minutes by 60 seconds/minute to get 270 seconds. Enter:  
(PW) 09 2100 270 \*  
To set the RX2-TX1 timeout timer to 10 minutes (600 seconds), enter:  
(PW) 09 2101 600 \*

# Advanced Programming

## More About Messages

### Message Format

<type><characters>

- Message Control Characters
  - Define A Message Type

#### Examples:

- CW, 9900 32 10 01 19 17 20 38 27
- Single-Tone Beep, 9910 23
- Dual-Tone Beep, 9915 05 09
- Single-Tone Page, 9920 0158 80
- 5/6-Tone Page, 9940 1136570
- DTMF Page, 9950 01 02 03
- SELCAL Page, 9955 0158 80
- Two-Tone Sequential Page, 9930 0018 10 0035 30
- Speech, 9960 0000 0001 0002 0003

Message Control Characters		
Control Character	Definition	Page
97xx	Message Routing characters follow	6-4
9900	CW characters follow	6-13
9901	CW Primary characters follow	6-13
9902	CW Secondary characters follow	6-13
9903	CW Speed Change characters follow	6-15
9904	CW Frequency Change characters follow	6-15
9905	CW Message Level characters follow	6-14
9910	Single-Tone Beep characters follow	6-21
9911	Single-Tone Beep Primary characters follow	6-21
9912	Single-Tone Beep Secondary characters follow	6-21
9913	Single-Tone Beep Message Level characters follow	6-22
9915	Dual-Tone Beep characters follow	6-31
9916	Dual-Tone Beep Primary characters follow	6-31
9917	Dual-Tone Beep Secondary characters follow	6-31
9918	Dual-Tone Beep Message Level characters follow	6-32
9920	Single-Tone page follows	6-38
9930	Two-Tone Sequential page follows	6-40
9940	5/6-Tone page follows	6-42
9950	DTMF page follows	6-44
9955	SELCAL page follows	6-52
9960	Speech characters follow	6-54
9961	Speech Primary characters follow	6-54
9962	Speech Secondary characters follow	6-54
9963	Speech Message Level characters follow	6-55
9991	Mixed Audio Allowed	6-6
9992	Non-Mixed Audio Only	6-6
9993	Pause characters follow	6-7
9999	Execute the macro that follows	6-8

# Advanced Programming

## Interruptable Messages

- Primary Characters replaced by secondary characters when a path is active
  - e.g. Replace Speech by CW
- Applies to these types
  - CW, Single-Tone Beep, Dual-Tone Beep, Speech
- How to read the table
  - CW, 9900 Always Plays
  - CW, 9901, Primary, Interruptable
  - CW, 9902, Secondary, Replaces Primary when active

Message Control Characters		
Control Character	Definition	Page
97xx	Message Routing characters follow	6-4
9900	CW characters follow	6-13
9901	CW Primary characters follow	6-13
9902	CW Secondary characters follow	6-13
9903	CW Speed Change characters follow	6-15
9904	CW Frequency Change characters follow	6-15
9905	CW Message Level characters follow	6-14
9910	Single-Tone Beep characters follow	6-21
9911	Single-Tone Beep Primary characters follow	6-21
9912	Single-Tone Beep Secondary characters follow	6-21
9913	Single-Tone Beep Message Level characters follow	6-22
9915	Dual-Tone Beep characters follow	6-31
9916	Dual-Tone Beep Primary characters follow	6-31
9917	Dual-Tone Beep Secondary characters follow	6-31
9918	Dual-Tone Beep Message Level characters follow	6-32
9920	Single-Tone page follows	6-38
9930	Two-Tone Sequential page follows	6-40
9940	5/6-Tone page follows	6-42
9950	DTMF page follows	6-44
9955	SELCAL page follows	6-52
9960	Speech characters follow	6-54
9961	Speech Primary characters follow	6-54
9962	Speech Secondary characters follow	6-54
9963	Speech Message Level characters follow	6-55
9991	Mixed Audio Allowed	6-6
9992	Non-Mixed Audio Only	6-6
9993	Pause characters follow	6-7
9999	Execute the macro that follows	6-8

Example Message, CW Replaces Speech

9961 0067 0045 0001 0054 0052 0055 9902 32 10 01 19 17 20 38 27

Example Command, Program Normal Identifier TX1

99 31 0110 9961 0067 0045 0001 0054 0052 0055 9902 32 10 01 19 17 20 38 27 \*

# Advanced Programming

## Message Levels

### Programmable

- Set Within a Message
- Default Level Set By Type

Message Type	Default Level
CW Level	12 (-6dB)
Single-Tone Beep Level	12 (-6dB)
Dual-Tone Beep Level	12 (-6dB)
Single-Tone Page Level	06 (-3dB)
Two-Tone Page Level	06 (-3dB)
Five-Six Tone Page Level	06 (-3dB)
DTMF Page Level	06 (-3dB)
SELCAL Page Level	06 (-3dB)
Speech Playback Level	00 (0dB)

Message Levels									
(PW) 10 <message type> <level> * (see page 6-10)									
Level	Value dB	Level	Value dB	Level	Value dB	Level	Value dB	Level	Value dB
00	0.0	20	-10.0	40	-20.0	60	-30.0	80	-40.0
01	-0.5	21	-10.5	41	-20.5	61	-30.5	81	-40.5
02	-1.0	22	-11.0	42	-21.0	62	-31.0	82	-41.0
03	-1.5	23	-11.5	43	-21.5	63	-31.5	83	-41.5
04	-2.0	24	-12.0	44	-22.0	64	-32.0	84	-42.0
05	-2.5	25	-12.5	45	-22.5	65	-32.5	85	-42.5
06	-3.0	26	-13.0	46	-23.0	66	-33.0	86	-43.0
07	-3.5	27	-13.5	47	-23.5	67	-33.5	87	-43.5
08	-4.0	28	-14.0	48	-24.0	68	-34.0	88	-44.0
09	-4.5	29	-14.5	49	-24.5	69	-34.5	89	-44.5
10	-5.0	30	-15.0	50	-25.0	70	-35.0	90	-45.0
11	-5.5	31	-15.5	51	-25.5	71	-35.5	91	-45.5
12	-6.0	32	-16.0	52	-26.0	72	-36.0	92	-46.0
13	-6.5	33	-16.5	53	-26.5	73	-36.5	93	-46.5
14	-7.0	34	-17.0	54	-27.0	74	-37.0	94	-47.0
15	-7.5	35	-17.5	55	-27.5	75	-37.5	95	-47.5
16	-8.0	36	-18.0	56	-28.0	76	-38.0	96	-48.0
17	-8.5	37	-18.5	57	-28.5	77	-38.5	97	-48.5
18	-9.0	38	-19.0	58	-29.0	78	-39.0	98	-49.0
19	-9.5	39	-19.5	59	-29.5	79	-39.5		

Example, CW Message Lower Than Default

9905 20 9900 32 10 01 19 17 20 38 27

# Advanced Programming

## Messages – Routing

### Route a Message to 1 or more Ports

- Route to a Single Port
  - 97 xx
  - Example: Route to port 2
    - 9720 9910 16
- Route to 2 Ports
  - 97 xy
  - Example: Route to ports 1 and 3
    - 9713 9910 16
- Route to 3 Ports
  - 97 xy z0
  - Example: Route to all 3 ports
    - 971230 9910 16
- Remember the rule: always pairs of digits

Message Control Characters		
Control Character	Definition	Page
97xx	Message Routing characters follow	6-4
9900	CW characters follow	6-13
9901	CW Primary characters follow	6-13
9902	CW Secondary characters follow	6-13
9903	CW Speed Change characters follow	6-15
9904	CW Frequency Change characters follow	6-15
9905	CW Message Level characters follow	6-14
9910	Single-Tone Beep characters follow	6-21
9911	Single-Tone Beep Primary characters follow	6-21
9912	Single-Tone Beep Secondary characters follow	6-21
9913	Single-Tone Beep Message Level characters follow	6-22
9915	Dual-Tone Beep characters follow	6-31
9916	Dual-Tone Beep Primary characters follow	6-31
9917	Dual-Tone Beep Secondary characters follow	6-31
9918	Dual-Tone Beep Message Level characters follow	6-32
9920	Single-Tone page follows	6-38
9930	Two-Tone Sequential page follows	6-40
9940	5/6-Tone page follows	6-42
9950	DTMF page follows	6-44
9955	SELCAL page follows	6-52
9960	Speech characters follow	6-54
9961	Speech Primary characters follow	6-54
9962	Speech Secondary characters follow	6-54
9963	Speech Message Level characters follow	6-55
9991	Mixed Audio Allowed	6-6
9992	Non-Mixed Audio Only	6-6
9993	Pause characters follow	6-7
9999	Execute the macro that follows	6-8



# Advanced Programming

## Messages – Mix/No-Mix

### Control User Audio Mute During Message

- Mixed Audio
  - Mix Message With User Audio
  - 9991
    - Example: Speech  
9991 9960 3000
- Non-Mixed Audio
  - Do NOT Mix Message With User Audio
  - Normally Used with Paging Tones
  - 9992
    - Example: Single-Tone Page  
9992 9920 0158 80
    - Example: DTMF Page  
9992 9950 01 02 03

Message Control Characters		
Control Character	Definition	Page
97xx	Message Routing characters follow	6-4
9900	CW characters follow	6-13
9901	CW Primary characters follow	6-13
9902	CW Secondary characters follow	6-13
9903	CW Speed Change characters follow	6-15
9904	CW Frequency Change characters follow	6-15
9905	CW Message Level characters follow	6-14
9910	Single-Tone Beep characters follow	6-21
9911	Single-Tone Beep Primary characters follow	6-21
9912	Single-Tone Beep Secondary characters follow	6-21
9913	Single-Tone Beep Message Level characters follow	6-22
9915	Dual-Tone Beep characters follow	6-31
9916	Dual-Tone Beep Primary characters follow	6-31
9917	Dual-Tone Beep Secondary characters follow	6-31
9918	Dual-Tone Beep Message Level characters follow	6-32
9920	Single-Tone page follows	6-38
9930	Two-Tone Sequential page follows	6-40
9940	5/6-Tone page follows	6-42
9950	DTMF page follows	6-44
9955	SELCAL page follows	6-52
9960	Speech characters follow	6-54
9961	Speech Primary characters follow	6-54
9962	Speech Secondary characters follow	6-54
9963	Speech Message Level characters follow	6-55
9991	Mixed Audio Allowed	6-6
9992	Non-Mixed Audio Only	6-6
9993	Pause characters follow	6-7
9999	Execute the macro that follows	6-8

# Advanced Programming

## Messages – Pause

### Pause Within A Message

- 0.1 Second Steps 0.1 thru 9.9 Seconds
  - 9993xx
- Pause Before A Message
  - Example: Pause 1.2 Seconds Before Message
    - 999312 9910 16
- Pause Within A Message
  - Example: Pause 0.8 Seconds Within A Message
    - 9910 16 999308 9910 16
- Pause After A Message
  - Example: Pause 2.0 Seconds After A Message
    - 9910 16 999320
- Remember the rule: always pairs of digits

Message Control Characters		
Control Character	Definition	Page
97xx	Message Routing characters follow	6-4
9900	CW characters follow	6-13
9901	CW Primary characters follow	6-13
9902	CW Secondary characters follow	6-13
9903	CW Speed Change characters follow	6-15
9904	CW Frequency Change characters follow	6-15
9905	CW Message Level characters follow	6-14
9910	Single-Tone Beep characters follow	6-21
9911	Single-Tone Beep Primary characters follow	6-21
9912	Single-Tone Beep Secondary characters follow	6-21
9913	Single-Tone Beep Message Level characters follow	6-22
9915	Dual-Tone Beep characters follow	6-31
9916	Dual-Tone Beep Primary characters follow	6-31
9917	Dual-Tone Beep Secondary characters follow	6-31
9918	Dual-Tone Beep Message Level characters follow	6-32
9920	Single-Tone page follows	6-38
9930	Two-Tone Sequential page follows	6-40
9940	5/6-Tone page follows	6-42
9950	DTMF page follows	6-44
9955	SELCAL page follows	6-52
9960	Speech characters follow	6-54
9961	Speech Primary characters follow	6-54
9962	Speech Secondary characters follow	6-54
9963	Speech Message Level characters follow	6-55
9991	Mixed Audio Allowed	6-6
9992	Non-Mixed Audio Only	6-6
9993	Pause characters follow	6-7
9999	Execute the macro that follows	6-8



# Advanced Programming

## Messages -- CW

### CW Messages

- Starts With Type
  - 9900
- Followed By Pairs Of Digits
  - Each digit-pair is a CW Character
- Always and Interruptable Versions
- Full CW Character Set
- In-Message Parameter Changes
  - Frequency Change
  - Speed Change
- Commands to set default Frequency and Speed

9900 32 10 01 19 17 20 38 27

Sends in CW:

WA1JHK/R

CW Characters						
Control Character 9900/9901/9902						
Character	Code	Character	Code	Character	Symbol	Code
0	00	I	18	Period	.	36
1	01	J	19	Comma	,	37
2	02	K	20	Fraction	/	38
3	03	L	21	Question	?	39
4	04	M	22	Word space		40
5	05	N	23	End-of-message	(AR)	41
6	06	O	24	Wait	(AS)	42
7	07	P	25	Break	(BK)	43
8	08	Q	26	Double dash	(BT)	44
9	09	R	27	End-of-work	(SK)	45
A	10	S	28	Hyphen	-	46
B	11	T	29	Colon	:	47
C	12	U	30	Semicolon	;	48
D	13	V	31	Parenthesis	( )	49
E	14	W	32	Apostrophe	'	50
F	15	X	33	Exclamation	!	51
G	16	Y	34	Quotation	"	52
H	17	Z	35	Understood	(SN)	53
				At-symbol	@	54

# Advanced Programming

## Messages – Custom Tones

### Custom Tone Frequencies

- Sample Table to the right
  - Entire table too large to add here
- Tone Code from table is used in commands
- 5 Hz steps from 260 Hz to 3000 Hz
- Easy to calculate
  - $\text{ToneCode} = (\text{Freq} - 260) / 5$

Tone Code Table								
Freq	Code	Freq	Code	Freq	Code	Freq	Code	Freq
260	0000	460	0040	660	0080	860	0120	1060
265	0001	465	0041	665	0081	865	0121	1065
270	0002	470	0042	670	0082	870	0122	1070
275	0003	475	0043	675	0083	875	0123	1075
280	0004	480	0044	680	0084	880	0124	1080
285	0005	485	0045	685	0085	885	0125	1085
290	0006	490	0046	690	0086	890	0126	1090
295	0007	495	0047	695	0087	895	0127	1095
300	0008	500	0048	700	0088	900	0128	1100
305	0009	505	0049	705	0089	905	0129	1105
310	0010	510	0050	710	0090	910	0130	1110
315	0011	515	0051	715	0091	915	0131	1115
320	0012	520	0052	720	0092	920	0132	1120
325	0013	525	0053	725	0093	925	0133	1125
330	0014	530	0054	730	0094	930	0134	1130
335	0015	535	0055	735	0095	935	0135	1135
340	0016	540	0056	740	0096	940	0136	1140
345	0017	545	0057	745	0097	945	0137	1145
350	0018	550	0058	750	0098	950	0138	1150
355	0019	555	0059	755	0099	955	0139	1155
360	0020	560	0060	760	0100	960	0140	1160
365	0021	565	0061	765	0101	965	0141	1165
370	0022	570	0062	770	0102	970	0142	1170
375	0023	575	0063	775	0103	975	0143	1175
380	0024	580	0064	780	0104	980	0144	1180
385	0025	585	0065	785	0105	985	0145	1185
390	0026	590	0066	790	0106	990	0146	1190
395	0027	595	0067	795	0107	995	0147	1195
400	0028	600	0068	800	0108	1000	0148	1200

# Advanced Programming

## Messages – Pre-defined Beeps

### Factory Fixed Frequency Beeps

- Standard Tones Defined In Two Digits

### Owner Fixed Frequency Beeps

- Standard Tones Defined In Two Digits
- Used In Beep Messages
- Example: Single-Tone Beeps
  - C3 C4 C5

9910 00 12 24

Factory-Fixed Frequency Beeps								
Control Character 9910/9901/9902								
Freq (Hz)	Note	Beep	Freq (Hz)	Note	Beep	Freq (Hz)	Note	Beep
262	C3	00	659	E4	16	1661	G#5	32
277	C#3	01	698	F4	17	1760	A5	33
294	D3	02	740	F#4	18	1865	A#5	34
311	D#3	03	784	G4	19	1976	B5	35
330	E3	04	831	G#4	20	2093	C6	36
349	F3	05	880	A4	21	2217	C#6	37
370	F#3	06	932	A#4	22	2349	D6	38
392	G3	07	988	B4	23	2489	D#6	39
415	G#3	08	1046	C5	24	2637	E6	40
440	A3	09	1109	C#5	25	2794	F6	41
466	A#3	10	1175	D5	26	2960	F#6	42
494	B3	11	1244	D#5	27	3136	G6	43
523	C4	12	1319	E5	28	3322	G#6	44
554	C#4	13	1397	F5	29	3520	A6	45
587	D4	14	1480	F#5	30	3729	A#6	46
622	D#4	15	1568	G5	31	3951	B6	47

Owner-Fixed Frequency Single-Tone Beeps		
Control Character 9910/9911/9912		
Beep Code	Frequency (Fill In)	Default (Hz)
48		500
49		750
50		1000
51		1250
52		1500
53		1750

# Advanced Programming

## Messages – Single-Tone Beep

### Single-Tone Beep Messages

- Always and Interruptable versions
- Standard and Custom Tone, Gap and Durations
- Commands to set Default Gap and Durations
- Default and Custom Message Level
- Example:
  - 350 Hz, Default Gap, 440 Hz at Default Durations

9915 05 09

Single-Tone Beep Parameters (General)	
Control Character 9910/9911/9912	
Beep Parameter	Code
Custom Single-Tone Beep	57xxxxyy
Custom Single-Tone Beep delay	58xx
Automatic beep gap OFF	55
Automatic beep gap ON	56

Single-Tone Beep Gap Change Characters	
Control Character 9910/9911/9912	
Beep Gap (ms)	Code
10	60
20	61
30	62
40	63
60	64
80	65
120	66
160	67
240	68
320	69

Single-Tone Beep Duration Change Characters	
Control Character 9910/9911/9912	
Beep Duration (ms)	Code
10	70
20	71
30	72
40	73
60	74
80	75
120	76
160	77
240	78
320	79

# Advanced Programming

## Messages – Dual-Tone Beep

### Dual-Tone Beep Messages

- Always and Interruptable versions
- Standard and Custom Tone, Gap and Durations
- Commands to set Default Gap and Durations
- Default and Custom Message Level
- Example:
  - 320 mS of simultaneous 350 Hz/440 Hz

9915 79 05 09

Dual-Tone Beep Parameters	
Control Character 9915/9916/9917	
Beep Parameter	Code
custom dual-tone beep	57xxxxxyyyzz
custom beep delay	58xx
automatic beep gap OFF	55
automatic beep gap ON	56

Dual-Tone Beep Gap Change Characters	
Control Character 9915/9916/9917	
Beep Gap (ms)	Code
10	60
20	61
30	62
40	63
60	64
80	65
120	66
160	67
240	68
320	69

Dual-Tone Beep Duration Change Characters	
Control Character 9915/9916/9917	
Beep Duration (ms)	Code
10	70
20	71
30	72
40	73
60	74
80	75
120	76
160	77
240	78
320	79

# Advanced Programming

## Messages -- Speech

### Speech Messages

- Always and Interruptable versions
- Standard Library, English
  - ~1600 Words
- Custom Library
  - User-Built Library
  - Up to 2000 “Words”
  - Up to 13 Minutes divided up any way you want
    - Could define 1 “Word”  
13 minutes long
    - Could define 2000 individual words
    - 7K Speech Synthesizer words  
available as a custom library
- Default and Custom Message Level

Speech Message Level Change	
Change	Code
Message Level	9963xx (xx = Msg Level)

Speech Intra-Message Delay		
Delay	Code	Data Digits
Speech Intra-Message Delay (10-990mS)	70xx	00-99 x 10mS
Speech Intra-Message Delay (100-9900mS)	71xx	00-99 x 100mS

- Example: Speak “WA1JHK”

9960 0067 0045 0001 0054 0052 0055

# Advanced Programming

## Messages -- Vocabulary

Numbers							
Word	Code	Word	Code	Word	Code	Word	Code
zero	0000	sixth	0012	twelve	0023	twentieth	0034
one	0001	seven	0013	thirteenth	0024	thirty	0035
first	0002	seventh	0014	fourteen	0025	forty	0036
two	0003	eighth	0015	fifteen	0026	fifty	0037
second	0004	ninth	0016	sixteen	0027	sixty	0038
three	0005	tenth	0017	seventeen	0028	seventy	0039
third	0006	eleven	0018	eighteen	0029	eighty	0040
four	0007	twelve	0019	nineteen	0030	ninety	0041
fourth	0008	thirteen	0020	twenty	0031	hundred	0042
five	0009	fourteen	0021		0032	thousand	0043
fifth	0010	fifteen	0022		0033	million	0044
six	0011						

Letters							
Word	Code	Word	Code	Word	Code	Word	Code
A	0045	H	0052	O	0059	U	0065
B	0046	I	0053	P	0060	V	0066
C	0047	J	0054	Q	0061	W	0067
D	0048	K	0055	R	0062	X	0068
E	0049	L	0056	S	0063	Y	0069
F	0050	M	0057	T	0064	Z	0070
G	0051	N	0058				

Measurements							
Word	Code	Word	Code	Word	Code	Word	Code
feet	0121	micro	0129	point	0137	Hertz	0145
meter	0122	milli	0130	Amps	0138	ohm	0146
meters	0123	kilo	0131	byte	0139	percent	0147
inch	0124	mega	0132	Celsius	0140	power	0148
mile	0125	minus	0133	current	0141	voltage	0149
miles	0126	plus	0134	degree	0142	volts	0150
pico	0127	decimal	0135	degrees	0143	watt	0151
nano	0128	dot	0136	Fahrenheit	0144	watts	0152

Calendar							
Word	Code	Word	Code	Word	Code	Word	Code
January	0071	Sunday	0083	day	0096	today	0109
February	0072	Monday	0084	days	0097	tomorrow	0110
March	0073	Tuesday	0085	hour	0098	tonight	0111
April	0074	Wednesday	0086	hours	0099	yesterday	0112
May	0075	Thursday	0087	minute	0100	weekday	0113
June	0076	Friday	0088	minutes	0101	weekend	0114
July	0077	Saturday	0089	second	0102	weekly	0115
August	0078	date	0090	seconds	0103	AM	0116
September	0079	time	0091	week	0104	PM	0117
October	0080	year	0092	morning	0105	noon	0118
November	0081	yearly	0093	afternoon	0106	oclock	0119
December	0082	month	0094	evening	0107	zulu	0120
		monthly	0095	night	0108		

All Words Alphabetic Listing							
Word	Code	Word	Code	Word	Code	Word	Code
A	0045	alert	0205	Arizona	0448	band	0223
abeam	0386	all	0206	Arkansas	0449	Bangor	0480
Abington	0388	Allenton	0421	armed	0450	bank	0481
Able	0387	Allentown	0422	army	0451	Barbara	0482
able	0389	aloft	0423	arrival	0452	barometric	0483
abnormal	0390	alpha	0424	as	0215	bars	0484
abort	0391	alternate	0425	ask	0217	base	0224
about	0392	altimeter	0426	Aspen	0453	bath	0485
above	0393	altitude	0427	assign	0454	Baton Rouge	0486
accelerate	0394	always	0428	assistance	0455	battery	0225
accelerated	0395	AM	0116	association	0218	baud	0487
access	0396	amateur	0207	astro	0456	Bavarian	0488
acknowledge	0397	amateurs	0208	at	0219	bay	0489

# Advanced Programming

## Messages – Paging

### Single-Tone Page Messages

- Always version only, never interruptable
- Custom Tones and Duration
- Default and Custom Inter-Page Delay
- Default and Custom Message Level

### Two-Tone Sequential Page Messages

- Always version only, never interruptable
- Custom Tones and Duration
- Default and Custom Inter-Page Delay
- Default and Custom Message Level

### 5/6-Tone Page Messages

- Always version only, never interruptable
- Default and Custom Inter-Page Delay
- Default and Custom Message Level

Message Control Characters		
Control Character	Definition	Page
97xx	Message Routing characters follow	6-4
9900	CW characters follow	6-13
9901	CW Primary characters follow	6-13
9902	CW Secondary characters follow	6-13
9903	CW Speed Change characters follow	6-15
9904	CW Frequency Change characters follow	6-15
9905	CW Message Level characters follow	6-14
9910	Single-Tone Beep characters follow	6-21
9911	Single-Tone Beep Primary characters follow	6-21
9912	Single-Tone Beep Secondary characters follow	6-21
9913	Single-Tone Beep Message Level characters follow	6-22
9915	Dual-Tone Beep characters follow	6-31
9916	Dual-Tone Beep Primary characters follow	6-31
9917	Dual-Tone Beep Secondary characters follow	6-31
9918	Dual-Tone Beep Message Level characters follow	6-32
9920	Single-Tone page follows	6-38
9930	Two-Tone Sequential page follows	6-40
9940	5/6-Tone page follows	6-42
9950	DTMF page follows	6-44
9955	SELCAL page follows	6-52
9960	Speech characters follow	6-54
9961	Speech Primary characters follow	6-54
9962	Speech Secondary characters follow	6-54
9963	Speech Message Level characters follow	6-55
9991	Mixed Audio Allowed	6-6
9992	Non-Mixed Audio Only	6-6
9993	Pause characters follow	6-7
9999	Execute the macro that follows	6-8



# Advanced Programming

## Messages – Run-Time Variables

### Speech or CW of Controller Variables

- Clock and Calendar Data
  - Hour and Minute
    - 12- and 24-Hour Time Format
    - AM/PM
    - “morning”, “afternoon”, “evening”
  - Day of Week
  - Day of Month
    - Cardinal or Ordinal
  - Month
  - Seconds
    - Useful for testing clock accuracy
- Software Version

### Coming Soon!

- Analog Input Readings
- Readback of many datatypes

Message Run-Time Variables			
Run-Time Variable	Meaning	Format	Example
9810	Hour & Minute, 12-hr format	CW	2 45
9811	AM/PM	CW	PM
9812	Hour & Minute, 24-hr format	CW	14 45
9813	Day of Week	CW	WED
9814	Month	CW	JAN
9815	Day of Month	CW	1
9816	Seconds	CW	27 in CW
9820	Hour & Minute, 12-hr format	Speech	Two forty-five
9821	AM/PM	Speech	PM
9824	Hour & Minute, 24-hr format	Speech	14 hours, 45 minutes
9825	same as 9824 without “hours” & “minutes”	Speech	Fourteen forty-five
9826	Day of Week	Speech	Wednesday
9827	Cardinal Day-of-Month	Speech	One
9828	Ordinal Day-of-Month	Speech	First
9829	Month	Speech	January
9831	“morning, afternoon, evening”	Speech	Afternoon
9832	Seconds	Speech	Twenty-seven
9896	Call Count	CW	105
9897	Call Count	Speech	One zero five
9898	Software Version	CW	300
9899	Software Version	Speech	Three point zero zero

*Note: Call Count is a leftover Autopatch variable that always reads zero.*

# Advanced Programming

## Receiver Timing

### COR/CTCSS Delay

- Programmable timers that filter narrow pulses on the COR and CTCSS logic inputs.
  - Disabled by default.
- Reduces nuisance repeater key-ups due to noise.

### Flutter Filter

- The opposite of the COR/CTCSS Delay.
- Programmable timer that filters narrow dropouts of weak signals.
  - Default is Disabled.
- Reduces the effects of “picket fencing”.
- Holds the audio path open to reduce audio dropouts.
- Minimizes Courtesy Beeps on weak signals.

### Anti-Kerchunk Filter

- COR filter that removes brief user “kerchunks”.
  - (NOBODY does THAT!)
  - Default is Disabled.
- *Key-up Delay* specifies minimum keyup time.
  - Default is 1.00 second.
- *Re-Arm Delay* specifies repeater idle time before the filter is re-armed.
  - Default is 60 seconds.
- *No-Hangtime Mode* keys the repeater during the *Key-Up Delay* time, but eliminates the tail if unkey occurs before the delay time.

# Advanced Programming

## Macros

### What's a Macro?

- A *Macro* is a list of controller commands or other macros that are executed in sequence.
- A *Macro* is assigned a unique name that is specified to cause execution of the sequence.
- Each macro is up to 200 digits long.
- Default is no macros defined.
- Directory and storage support 340 macros.
- Names are 1, 2, 3, or 4 DTMF digits.
  - DTMF digits 0 thru 9 and A thru D.
  - \* and # cannot be used.
  - Examples:

1\*

40B\*

789\*

### What are they good for?

- Speak the Date and Time
- Generate DTMF Pages
- Change which ports are linked
- Reset a Path Timeout Timer
- Speak a message when a Logic Input changes state.
- Perform custom timing sequences.
- Implement Rotating Identifier Messages
- Implement a Grandfather Clock
- Implement Top-of-the-Hour Meeting Announcements

# Advanced Programming

## Macros

### Create Macro

- Command to allocate storage, define the name used to execute the macro, and store the first command.
  - Added command must be valid.
  - Name must be unique.
  - Ex. **99** **20** 1234 **99** **63** 0141 1 \*

### Append To Macro

- Command to append additional commands to existing macro storage that will be executed in sequence.
  - Ex. **99** **29** 1234 **99** **63** 0142 1 \*

### Execute Macro

- Type the name of the macro to execute
  - Ex. 1234 \*

### Command Examples

```
7330>99 20 1234 99 63 0141 1 *
OK
7330>99 20 1234 99 15 12 23 15 *
Error: Macro name already exists
7330>99 29 4321 99 34 0110 *
Error: Macro name not found
7330>99 29 1234 99 34 0110 *
OK
7330>1234*
OK
7330>
```

# Advanced Programming

## Event-Triggered Macros

### Allow Controller Events To Trigger Macros

- Assign Macro commands to configure the macro name to be executed at an event
- Many, many events defined
  - Power-On Reset is commonly used.
  - Logic Inputs useful for alarm inputs.
  - PTT Active-to-Inactive used for Fan control.
- Ex. Set Power-On Reset Macro to 1234.

99 26 0000 1234 \*

#### Command Form:

Command	Form
Assign Macro to Any-Path-Active to TX1	(PW) 26 0102 (macro name) *
Assign Macro to All-Paths-Inactive to TX1	(PW) 26 0103 (macro name) *
Assign Macro to Any-Path-Active to TX2	(PW) 26 0202 (macro name) *
Assign Macro to All-Paths-Inactive to TX2	(PW) 26 0203 (macro name) *

General Event Macros		
Number	Page	Description
0000	5-28	Power-On Reset Macro
0001	5-31	Battery Good-to-Not-Good Macro
0061	14-2	Logic Input 1 Hi-to-Lo Macro
0062	14-2	Logic Input 1 Lo-to-Hi Macro
0063	14-2	Logic Input 2 Hi-to-Lo Macro

Port-Specific Event Macros		
Replace the "r" with the Receiver/DTMF Decoder Number		
Replace the "t" with the Transmitter Number		
Number	Page	Description
0r00	7-31	DTMF Decoder Any Long Tone Macro
0r01	7-25	DTMF Decoder Digit-Decoded Macro
0t02	11-30	Any-Path-Active To TX Macro
0t03	11-30	All-Paths-Inactive To TX Macro
0t04	11-15	TX Dropout Macro
0t05	11-19	PTT Inactive-to-Active Macro
0t06	11-19	PTT Active-to-Inactive Before Unkey Delay Macro
0t07	11-19	PTT Active-to-Inactive After Unkey Delay Macro
0t08	12-7	Initial ID Macro
0t09	12-7	Polite ID Macro
0t10	12-7	Impolite ID Macro
0t11	13-9	CTCSS Encoder Inactive-to-Active Macro
0t12	13-9	CTCSS Encoder Active-to-Inactive Macro
0t13	11-16	TX Start-of-Activity Macro
0t14	11-16	TX End-of-Activity Macro
0r15	10-19	COR Input Hi-to-Lo Macro
0r16	10-19	COR Input Lo-to-Hi Macro
0r17	10-20	CTCSS Input Hi-to-Lo Macro
0r18	10-20	CTCSS Input Lo-to-Hi Macro

# Advanced Programming

## CTCSS Encoder

### CTCSS Encoder

- Control internal or external CTCSS Encoder
- Internal CTCSS Encoder Hardware
  - Select from 65 subaudible tones
  - Select Mode for when tone is enabled.
  - Select Reverse Burst Option.

#### Modes:

Mode	Meaning
0	OFF
1	Follows transmitter PTT, but turns OFF before the Minimum Unkey Delay period
2	Follows transmitter PTT
3	Turns ON when transmitter PTT is keyed and OFF at the end of the CTCSS ON Time (ON time is programmable)
4	Turns ON when Any Path is Active to a selected transmitter, then a timer starts when All Paths are Inactive to that transmitter. When the timer expires the encoder is turned OFF (ON time is programmable).
5	Always ON

#### Reverse Burst Options:

Mode	Meaning
0	OFF
1	120-degree Reverse Burst
2	180-degree Reverse Burst

CTCSS Tone Numbers					
Tone #	Freq. Hz	EIA Code	Tone #	Freq. Hz	EIA Code
0	33.0	*	32	123.0	3Z
1	35.4	*	33	127.3	3A
2	36.6	*	34	131.8	3B
3	37.9	*	35	136.5	4Z
4	39.6	*	36	141.3	4A
5	44.4	*	37	146.2	4B
6	47.5	*	38	151.4	5Z
7	49.2	*	39	156.7	5A
8	51.2	*	40	159.8	*
9	53.0	*	41	162.2	5B
10	54.9	*	42	165.5	*
11	56.8	*	43	167.9	6Z
12	58.8	*	44	171.3	*
13	63.0	*	45	173.8	6A
14	67.0	XZ	46	177.3	*
15	69.4	*	47	179.9	6B
16	71.9	XA	48	183.5	*
17	74.4	WA	49	186.2	7Z
18	77.0	XB	50	189.9	*
19	79.7	SP	51	192.8	7A
20	82.5	YZ	52	196.6	*
21	85.4	YA	53	199.5	*
22	88.5	YB	54	203.5	M1
23	91.5	ZZ	55	206.5	8Z
24	94.8	ZA	56	210.7	M2
25	97.4	ZB	57	218.1	M3
26	100.0	1Z	58	225.7	M4
27	103.5	1A	59	229.1	9Z
28	107.2	1B	60	233.6	M5
29	110.9	2Z	61	241.8	M6
30	114.8	2A	62	250.3	M7
31	118.8	2B	63	254.1	0Z
			64	150.0	*

\* = not a standard code  
150.0 Hz Used by U.S. Military

# Advanced Programming

## CTCSS Encoder

### “Chicken Burst”

- Problem
  - Most amateur radios don’t respond to Reverse Burst.
  - Turning the CTCSS Encoder off before Tx unkeys eliminates unkey squelch burst in user radio.
  - Use Tx PTT Minimum Unkey Delay to implement “Chicken Burst”
  - Works with all radios.

### Example

- Setup internal encoder
  - Enable encoder on Tx1
  - 100.0 Hz
  - On whenever Tx is keyed
  - Reverse Burst 180-Degree
  - Support for “Chicken Burst”
- 99 02 1 1 2 \* ; set Tx1 mode, and reverse burst
- 99 03 1 26 \* ; set Tx1 frequency
- 99 09 0102 75 \* ; set Tx1 Unkey Delay 750 mS

# Advanced Programming

## Scheduler Setpoints

### Schedule Events Based On Time and Date

- Execute a macro based on combinations of month, day, day-of-week, hour, minute.
- Accepts wildcards to program recurring events
- Day Codes support special day matching
- Clock/Calendar provides accurate date/time
- Event stored in a Setpoint
  - e.g. 2nd Tuesday of the month
  - Ex., Speak Grandfather Clock macro 1234 every month, every day, every hour on the hour.
  - Macro speaks time.

99 28 00 1234 99 99 99 00 \*

99 20 1234 99 15 9824 \*

Scheduler Day Code Table			
Day Code	Explanation	Day Code	Explanation
01-31	calendar day-of-month	58	3rd Wednesday of month
32	weekdays (Mon-Fri)	59	3rd Thursday of month
33	weekends (Sat-Sun)	60	3rd Friday of month
34	Sundays	61	3rd Saturday of month
35	Mondays	62	4th Sunday of month
36	Tuesdays	63	4th Monday of month
37	Wednesdays	64	4th Tuesday of month
38	Thursdays	65	4th Wednesday of month
39	Fridays	66	4th Thursday of month
40	Saturdays	67	4th Friday of month
41	1st Sunday of month	68	4th Saturday of month
42	1st Monday of month	69	5th Sunday of month
43	1st Tuesday of month	70	5th Monday of month
44	1st Wednesday of month	71	5th Tuesday of month
45	1st Thursday of month	72	5th Wednesday of month
46	1st Friday of month	73	5th Thursday of month
47	1st Saturday of month	74	5th Friday of month
48	2nd Sunday of month	75	5th Saturday of month
49	2nd Monday of month	76	Last Sunday of month
50	2nd Tuesday of month	77	Last Monday of month
51	2nd Wednesday of month	78	Last Tuesday of month
52	2nd Thursday of month	79	Last Wednesday of month
53	2nd Friday of month	80	Last Thursday of month
54	2nd Saturday of month	81	Last Friday of month
55	3rd Sunday of month	82	Last Saturday of month
56	3rd Monday of month	99	every day (wild card)
57	3rd Tuesday of month		

Command	Form	Data Digit
Create setpoint	(PW) 28 (setpoint number, macro, month, day, hour, minute) *	from table below. (Use Day Code Table for day parameter.)



# Agenda

## Introduction

- Who is S-COM?

## The Basics

- Repeater Building Blocks
- What does a controller need to do?
- Common Terms
- Introducing the 7330

## Wiring It Up

- Connectors, Jumpers, Pots
- Power
- Input Logic Signals
- Output Logic Signals
- Audio
- A-to-D Input Signals
- CTCSS Encoder

## Basic Programming

- Testing on the Bench
- Initializing the Controller
- S-COM Command Formats
- Security
- Data Types
- Introduction to the Manual
- Getting Started with Programming Commands

- Testing Your Results

## Advanced Programming

- Ports and Paths
- More About Messages
- Receiver Timing
- Macros
- CTCSS Encoder
- Scheduler

## File Management

- Introducing SBOOT

## PC-Based Utilities

- S-COM Custom Audio Utility

## Other Controller Topics

- Digital Linking: IRLP, EchoLink, Allstar

# File Management

## Introducing SBOOT

### The SBOOT Menu

- Manage your controller files
  - Set the Clock/Calendar
  - Update Firmware
  - Load Speech Libraries
  - Save/Restore Controller Configuration
  - Configure the Serial Ports

SCOM 7330 SBOOT V1.4

#### 7330 Controller Storage Management

T - Show Time

Tmmddyyhhmmssw - Set Date and Time (w=0=Sunday)

S - Save Controller Configuration

R - Restore Controller Configuration

E - Erase Files

L - Load File from a PC to Flash

U - Upload File from Flash to a PC

D - Display Flash Directory

P - Set Baudrate of Console Port

N - Set Baudrate of Auxiliary Port

W - Set Console Port Number

B - Boot from Flash

X - Reboot SBOOT from Flash

H - Help

Time : 022114-222720-5

Battery: OK.

SBOOT>

# File Management

## Introducing SBOOT

### Flash Directory

- Displays Controller Information
- Display Filenames and Versions
  - Firmware Files
  - Configuration Files
  - Speech Files

#### Controller Information

Model Number : 7330  
Serial Number : Proto1  
Manufactured DT: 120113-124104-0  
Formatted DT : 120113-123940-0  
Customer Name : Dave's Proto

#### Firmware Files

Location	Name	Version	Date	Type
SYSTEM	BootROM	1.2.0		
SBOOT	7330_SBoot	1.3.1	1/27/2014	Program
MFG	No File			
DIAG	No File			
SCOM_A	7330	3.3.4	1/27/2014	Program
SCOM_B	No File			

#### Configuration Files

Location	Name	Version	Date	Type
CONFIG_A	W5JR140131		1/31/14 09:27	Configuration
CONFIG_B	No File			
CONFIG_C	No File			
CONFIG_D	No File			

#### Speech Files

Location	Name	Version	Date	Type
LIB	SCOM Sp Lib Eng	1.2.0	5/8/2011	Speech Library
CUSTOM	No File			

# File Management

## Introducing SBOOT

### Erase Files

- Prepare for a firmware update
- Free configuration space

### Load File from a PC to Flash

- Update Firmware
- Load a Custom Audio Library
- Load a Configuration File

Erase a File from Flash:

	Location	Description
0 -	SBOOT	-- File Management Utility
1 -	DIAG	-- Diagnostics
2 -	SCOM_A	-- 7330 Repeater Controller
3 -	LIB	-- Speech Library
4 -	CUSTOM	-- Custom Audio Library
5 -	CONFIG_A	-- Configuration A
6 -	CONFIG_B	-- Configuration B
7 -	CONFIG_C	-- Configuration C
8 -	CONFIG_D	-- Configuration D
Q -	Return to Main Menu	
H -	Redisplay these options	

Enter File Erase Option>

Load a File to Flash from a PC:

	Location	Description
0 -	SBOOT	-- File Management Utility
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8 -	CONFIG_D	-- Configuration D
Q -	Return to Main Menu	
H -	Redisplay these options	

Enter File Load Option>

# File Management

## Introducing SBOOT

### Save Controller Configuration

- Save the current controller configuration

### Restore Controller Configuration

- Restore the current controller configuration

### Upload File to a PC from Flash

- Upload a Configuration File for storage or cloning.

Save the Controller Configuration to a Flash File:

	Location	Description
5	- CONFIG_A	-- Configuration A
6	- CONFIG_B	-- Configuration B
7	- CONFIG_C	-- Configuration C
8	- CONFIG_D	-- Configuration D
Q	-	Return to Main Menu
H	-	Redisplay these options

Enter File Erase Option>

Restore a Controller Configuration from a Flash File:

	Location	Description
5	- CONFIG_A	-- Configuration A
6	- CONFIG_B	-- Configuration B
7	- CONFIG_C	-- Configuration C
8	- CONFIG_D	-- Configuration D
Q	-	Return to Main Menu
H	-	Redisplay these options

Enter File Erase Option>

Upload a File to a PC from Flash:

	Location	Description
0	- SBOOT	-- File Management Utility
1	- DIAG	-- Diagnostics
2	- SCOM_A	-- 7330 Repeater Controller
3	- LIB	-- Speech Library
4	- CUSTOM	-- Custom Audio Library
5	- CONFIG_A	-- Configuration A
6	- CONFIG_B	-- Configuration B
7	- CONFIG_C	-- Configuration C
8	- CONFIG_D	-- Configuration D
Q	-	Return to Main Menu
H	-	Redisplay these options

Enter File Load Option>

# Agenda

## Introduction

- Who is S-COM?

## The Basics

- Repeater Building Blocks
- What does a controller need to do?
- Common Terms
- Introducing the 7330

## Wiring It Up

- Connectors, Jumpers, Pots
- Power
- Input Logic Signals
- Output Logic Signals
- Audio
- A-to-D Input Signals
- CTCSS Encoder

## Basic Programming

- Testing on the Bench
- Initializing the Controller
- S-COM Command Formats
- Security
- Data Types
- Introduction to the Manual
- Getting Started with Programming Commands

- Testing Your Results

## Advanced Programming

- Ports and Paths
- More About Messages
- Receiver Timing
- Macros
- CTCSS Encoder
- Scheduler

## File Management

- Introducing SBOOT

## PC-Based Utilities

- S-COM Custom Audio Utility

## Other Controller Topics

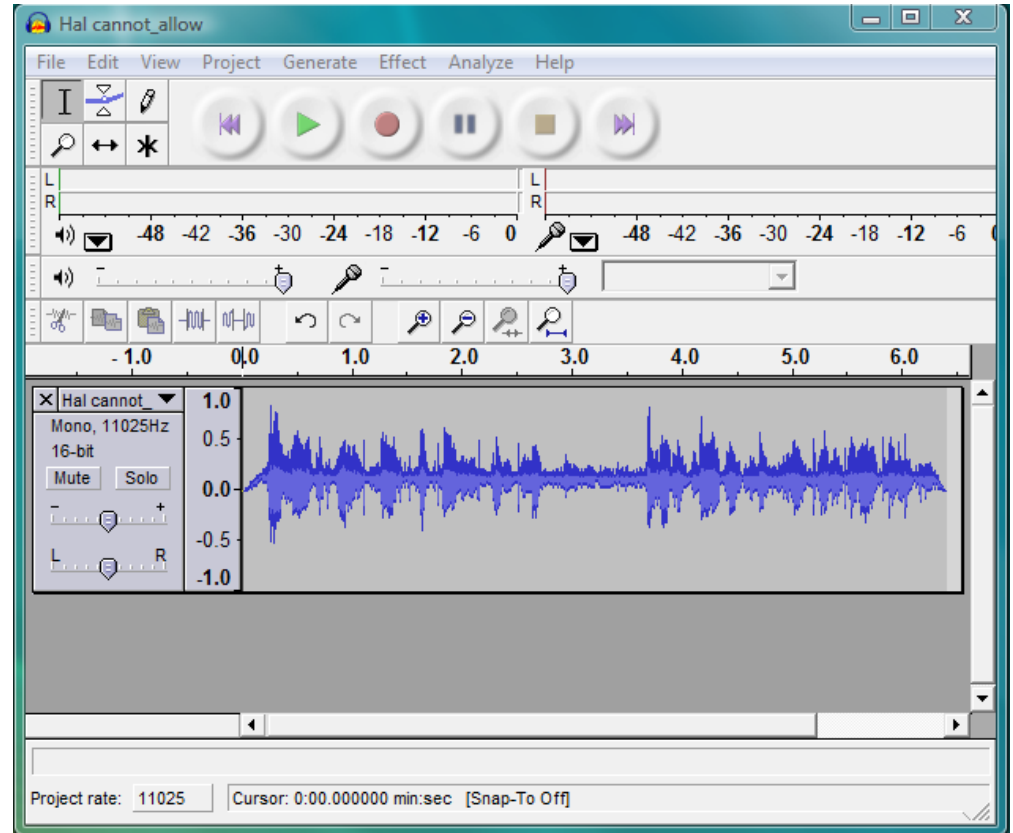
- Digital Linking: IRLP, EchoLink, Allstar

# PC-Based Utilities

## Custom Audio

### Add .wav Files to your Controller

- Use a program like Audacity or SoX to record or prepare custom audio.
- S-COM provides a utility to prepare the file for download to the controller.
- Your audio becomes “Words” in the controller that you can play just like the built-in vocabulary.
- Add up to 2000 new “Words” to the controller.
- Divide up 13 minutes of storage into as many or as few “Words” as you need.



# PC-Based Utilities

## Custom Audio Library

### Build a Custom Audio Library

- Assembles the converted .wav files into the format managed by the controller.

```
S-COM Build Speech Lib Utility, V1.0.0
Copyright S-COM, LLC. www.scomcontrollers.com All rights reserved, 2009
Pass 1: Create file list...Done
Number Files referenced in input file=12
Pass 2: getImageSize from all files...Done
Number of Bytes to Store Word Data=130116 (0x1FC44, Does not include
index and fileheader)
Number of SpeechLib Index Entries Required=3012 (0xBC4)
Pass 3: Build headers and Speech Library file...
Total File Size = 0x22E44
Flash Sectors Required to Store This File = 3 (0x3)...Done
[more...]
```



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## PC-Based Utilities

- S-COM Custom Audio Utility

## Other Controller Topics

- Digital Linking: IRLP, EchoLink, Allstar

# Other Controller Topics

## Future Topics

### Digital Linking

- Standards are a wonderful thing, everybody needs to have one.
  - IRLP
  - EchoLink
  - Allstar/APP\_RPT
  - DMR
  - D-STAR
  - C4FM

### Other Controller Functions

- Remote Base
- Autopatch

# Backup

# References

<http://www.scomcontrollers.com>

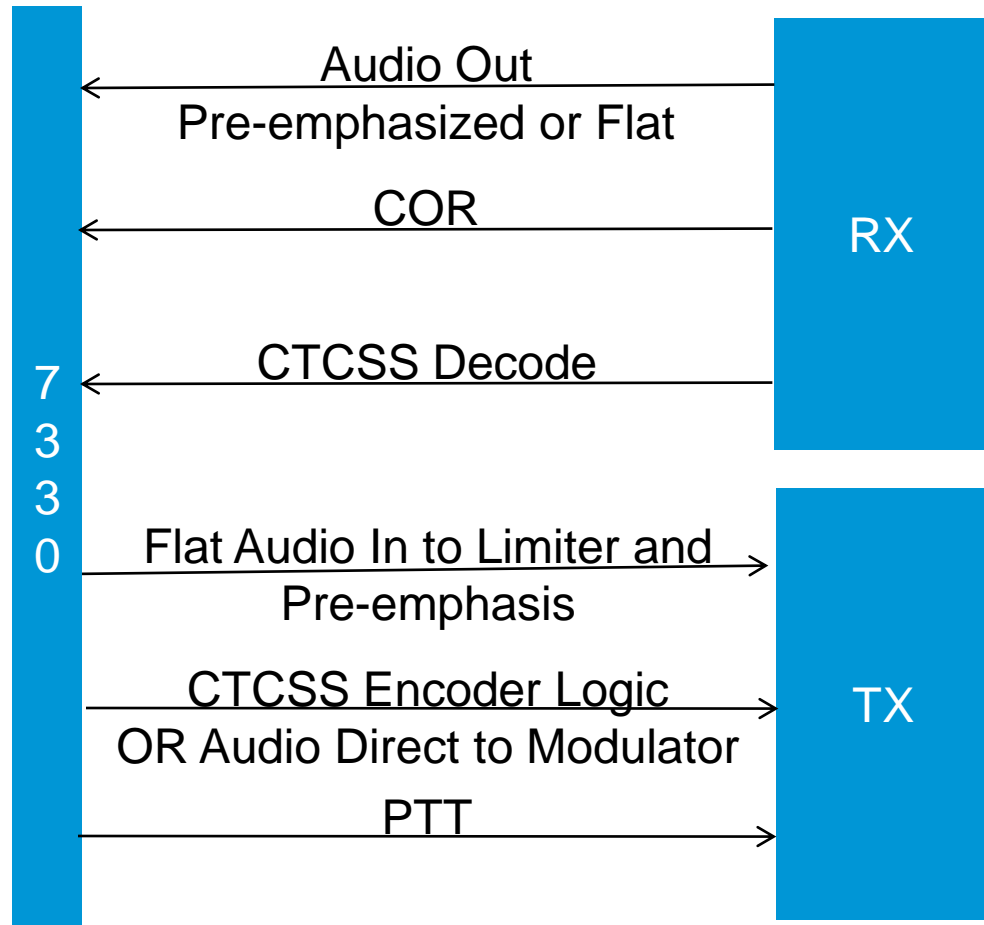
<http://www.repeater-builder.com/rbtip/>

<http://www.repeater-builder.com/tech-info/ctcss/ctcss-overview.html>

# Advanced Programming

## Port Resources

- Receiver
  - Audio
  - COR
  - CTCSS Decode
- Transmitter
  - Audio
  - PTT
  - CTCSS Encode
    - Audio OR
    - Logic



# Thank you