



Link Communications, Inc.
Radio System Control Products

8 Channel Analog/Voice-Data RTU Terminal
Manual Version: 2.13

<http://www.link-comm.com>

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Introduction:

Congratulations, you have purchased a very powerful tool for analysis and monitoring of your systems analog and control inputs. The RLC-ANG Analog telemetry controller will allow critical and beneficial information concerning your analog inputs, and once programmed, will allow a present voice recall of those parameters. Setting up and programming are easy and straight forward, once you have read the manual. Please take the time to read it before you try to start programming. This will save you a lot of confusion and frustration, as it should answer most of your questions.

The RLC-ANG analog telemetry controller consists of a radio port, an RS-232 serial port, 8 analog voltage inputs, 1 contact closure output and 1 dry contact logical input. The radio port is for inputting of DTMF tones for system programming and control, and output of the voice synthesizer readback information. The radio port consists of audio input, audio output, COR (Receiver Activity), PL (Private Line CTCSS) and PTT output. The RLC-ANG has a DTMF decoder that control from an external audio source. The RS-232 port also allows programming and recall of analog information in readable format or Modbus style RTU data format.

This manual consists of three main sections: setup and interfacing, programming and commands, and the appendices with commonly referenced tables and charts. A glossary has also been included at the end to explain some of the terms and abbreviations that are used throughout the manual.

We have attempted to explain everything in a way that is easy to understand, but some questions are inevitable. If you have carefully read the manual and still have questions, call us at (406) 482-7515, fax us at (406) 482-7547 or write to us at:

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Limited Warranty

COVERAGE:

Link Communications Inc. warrants that its products will be free from defects in materials and workmanship for a period of one year from the date of shipment. During this time, Link Communications Inc. will cover parts, labor and return shipping. If failure is caused by instances other than manufacturing defects, Link Communications Inc. will repair the product and bill the customer for parts and labor. Contact Link Communications Inc. for more information.

What Link Communications Inc. will not cover:

1. Too much voltage to the controller. The RLC-ANG operates at +11V to +15V, negative ground.
2. Damage to the controller by lightning, accident, or incorrect power hook-up.
3. Incorrect unit installation.
4. Damage caused by shipment (damage claims are handled by the carrier).
6. Repairs by other than Link Communications Inc.

THIS WARRANTY HOLDS ONLY TO THE ORIGINAL PURCHASER

HOW TO GET SERVICE

Please contact Link Communications Inc. for servicing information and authorization.

SOFTWARE

Link Communications Inc. holds the copyright on the RLC-ANG's software and hardware. Changes to the software and copying of the software is prohibited without the written consent of Link Communications Inc.

Setup and Interfacing

This section of the manual contains everything you should need to know to get your analog telemetry controller running. The numbered steps cover the basics, through connecting your radios and adjusting the RLC-ANG. After that there is information concerning the other input and output features of the RLC-ANG: the serial interface, the logical input lines, and the analog input lines.

Step #1: Check the Packing List

Your package should contain the following items:

- (1) RLC-ANG Analog Voice Telemetry Controller
- (1) 20 Pin I/O Connector (Black)
- (1) DB-9 Male Solder Connector
- (1) RLC-ANG Manual

If any of these parts are missing, contact Link Communications Inc.

Step #2: 20 Pin I/O Connector Pin-Out

- 1 - +12 Volts DC Input
- 2 - DC Ground
- 3 - DTMF Audio Input (10K Ω input)
- 4 - Voice Audio Output (600 Ω Output)
- 5 - Receiver COR Signal Input(Optional)
- 6 - Transmitter PTT Signal (Active Low Default)
- 7 - Receiver PL Signal Input (Optional)
- 8 - Dry Contact Closure Input
- 9 - Contact Closure Summed Alarm Output or User Toggled Output
- 10 - DC Ground
- 11 - Analog Input #1 (Default 00.0V - 16.0V Input; 00.0-5.00 Faceplate)
- 12 - DC Ground
- 13 - Analog Input #2 (Default 00.0V - 16.0V Input; 00.0-5.00 Faceplate)
- 14 - DC Ground
- 15 - Analog Input #3 (Default 00.0V - 16.0V Input; 00.0-5.00 Faceplate)
- 16 - Analog Input #4 (Default 00.0V - 16.0V Input; 00.0-5.00 Faceplate)
- 17 - Analog Input #5 (Default 00.0V - 16.0V Input; 00.0-5.00 Faceplate)
- 18 - Analog Input #6 (Default 00.0V - 16.0V Input; 00.0-5.00 Faceplate)
- 19 - Analog Input #7 (Default 00.0V - 16.0V Input; 00.0-5.00 Faceplate)
- 20 - Analog Input #8 (Default 00.0V - 16.0V Input; 00.0-5.00 Faceplate)

Analog 1,2,3,4,5,6,7,8 have a 10K Ω divider resistor, Do Not Exceed 20 Volts Input Voltage

*** Use DC Voltage Only, No not use -DC Voltage, Use Caution at Higher Voltages ***

*** See Analog Examples Section for Analog Circuit Examples ***

Step #3: Connect Power

- The RLC-ANG was designed to run off of 12V DC. 11V to 14V should work fine.
- Locate Pin #1 J2 (+12 Volts) Pin #2 J2 (Ground). J2 is the 20 pin connector
- Pin #1 is located next to P4, the RS-232 I/O Connector
- Connect +12V and Ground to the controller. WATCH THE POLARITY
- When power is applied to the RLC-ANG monitor, the DTMF Valid LED will flicker, and the Radio port transmitter will send out a voice message 'Controller Ready'. If an RS-232 terminal is connected the controller will send out the controllers software version and copyright notice. If the serial port is in RTU mode there will be no logon message.

Step #4: Connecting Your Receiver

The radio port is connected to pins 3 (Audio In), 4 (Audio Out), 5 (COR), 6 (PTT), 7 (PL)

When a COR and PL input are needed:

- When a full duplex radio is used in either repeater or link thru mode (see Command 31 for more detail) a COR signal is needed. For added security the PL input can also be implemented. These signals tell the RLC-ANG when the receiver is active and inactive. In repeater mode these signals tell the interface when to key up the transmitter and when to handle commands entered. In repeater mode and link pass thru mode the COR signal is required, and the PL signal is optional. For polite voice messages (Voice response waits for an inactive COR and/or PL input before speaking) the COR and/or PL inputs are required.

When a transceiver or half duplex radio is used to control the RLC-ANG, the COR and/or PL inputs are not required. When the COR and/or PL inputs are not used the DTMF execution mode must be set to timed execution. When in this mode the DTMF requested command will automatically be executed after a certain time has expired. The requested response will be impolite when no COR and/or PL input is used.

COR and PL Polarity:

The default polarity for these signals is active low. Command 29 is provided to allow the user the ability to specify the actual COR and PL polarities without any external switches. Refer to Command 29 for input configuration for your receivers COR and PL signals.

Connecting the Receiver Audio:

- 2 types of audio can be used on the controller:
 - Type 1: Deemphasized audio (Speaker Audio)
 - Type 2: Discriminator audio (Raw Unscelched Audio)
- If type 1 audio is used, locate the dip switch, position #1. Switch position #1 to the 'OFF' position to remove the -6dB deemphasis filter from the circuit. Type 1 audio is the controllers default position.
- If type 2 audio is used, switch position #1 needs to be in the 'ON' position to place the deemphasis filter into the circuit. Some discriminators can not directly drive the 10K Ω input impedance. If this is the case, a pre-driver or different audio access point will be required.
- The audio input is connected to pin #3 of the 20 pin connector

Adjusting you Receiver Audio:

- Timed Execution Adjustment

Locate R13 'Audio Input' resistor to adjust the input audio. When in timed execution mode, the audio is only used to control the DTMF decoder. Adjust the audio with a DTMF tone present until the DTMF Valid LED lights with a valid tone. If the LED flashes, the audio is to loud. If the LED flickers then the audio is to low.

- Full Duplex Mode Adjustment

Locate R13 'Audio Input' resistor to adjust the input audio. Also locate the test point labeled 'RX' (Located next to R25). Adjust the audio input to 1 volt peak-peak. When a DTMF signal is present, the DTMF valid LED will light if adjusted correctly.

Step #5: Connecting Your Transmitter

Transmitter PTT:

- The RLC-ANG produces a PTT signal when the voice is active, or a COR is received. This signal defaults to an active low (ground when in PTT) but can be changed by the user. Refer to Controller Set-Up for PTT polarity changes. This output is buffered with an open drain type driver capable of sinking 150mA. There is a built in 30V zener clamping diode to protect the PTT MOSFET from the high voltage spikes that can be caused by interfacing to a PTT relay coil. Your transmitter PTT input should be connected to pin #6 of the 20 pin connector.

Transmitter Audio Out:

- The RLC-ANG provides a 600Ω output impedance to your transmitter audio input.
- The transmitter audio is connected to pin #4 of the 20 pin connector.

The controllers audio output contains the voice readback information, and squelched receiver audio when the COR is used. There are 2 adjustments that effect the audio out levels: Voice level, and TX level. The voice level is adjusted using R29, and the TX level is adjusted using R17. Adjust the audio output to approximately 4 Khz. deviation. Audio output test points are labeled 'TX' and 'VC' and are located next to R25.

Step #6: Dip Switch Definitions

Locate the 4 position dip switch on the controller board. This switch controls some functions on the RLC-ANG controller.

- | | | |
|-----------|----|---|
| Switch #1 | - | Receiver -6dB Deemphasis Filter (Used with Discriminator Audio) |
| Switch #2 | - | Receiver Audio Mute Switch |
| | -- | This switch is used to mute Receiver Audio in Full-Duplex Mode |
| | -- | Is needed when Discriminator Audio or Un-Squelched Audio is used) |
| Switch #3 | - | LM335 Power Source, Assigned to Analog Input #1 |
| Switch #4 | - | LM335 Power Source, Assigned to Analog Input #2 |

*** All Switches Default to the ON Position ***

Serial Port Interfacing

There are 2 modes the RS-232 serial port operate in

- Standard terminal mode

This mode allows the user to enter data over the serial port for controller programming, message readback and input/output control. In this mode voice responses are followed by ASCII word readback being echoed over the serial port.

- RTU mode

When the RS-232 port is configured for RTU mode (See Commands 46,47) all serial packets must be formatted in Modbus style data. This mode no serial data is sent unless the master requests the information from the slave unit. The slaves address is programmed using Command 46. Only when the slaves address is matched will the RLC-ANG process and respond out the serial port. All data transferred is in HEX mode, not ASCII.

The serial system can not be accessed from the DTMF port decoder, only via a serial system. The RLC-ANG output is the RS-232 standard, $\pm 10V$.

Pin-Out Serial P4 Connector

- 1 - No Connection
- 2 - RS-232 Data Output (To Your Terminal)
- 3 - RS-232 Data Input (From your Terminal)
- 4 - No Connection
- 5 - Ground Reference
- 6 - No Connection
- 7 - No Connection
- 8 - No Connection
- 9 - No Connection

Local Terminal Interfacing

When using a local ASCII terminal at the RLC-ANG's location, an ASCII terminal can be used to communicate with the programming features of the RLC-ANG. The terminal's communication parameters default to:

```
Baud ..... 9600
Start Bits..... 1
Stop Bits ..... 1
Parity ..... N
Word Length ..... 8
```

These parameters will allow communication with the RLC-ANG. For serial port baud rate adjustment, see Command 35.

Operation/Programming Over the Serial Port: ASCII Mode

Control of the RLC-ANG over the serial port is much the same as controlling from a DTMF pad. When you control the interface with a DTMF pad the user gets a voice response from the controller. When you are operating from the serial port, a voice response is not an option. The responses over serial will be an exact visual response to the voice words spoken. If the response is "Battery Voltage Is 13.8 Volts" the serial port will respond with the message "Battery Voltage Is Thirteen Point Eight Volts". This response will allow the user to correctly control the interface remotely without responses missed.

Accessing the serial port is as simple as hitting the computers "Enter" key. If you are connected correctly to the RLC-ANG at the correct baud rate you should receive the prompt "DTMF>". Once this prompt is sent, you have gained control of the serial port.

Command entry over the serial port slightly varies from over the air entry. When DTMF entry is commanded, a DTMF command name followed by a command number is used (see Command 11,12). When serial entry is used, only the command number is used. This allows easy access with fewer keystrokes used. It is easy to remember the command number. The last 2 digits in DTMF entry are always the command number.

Valid data input from the serial port is "0123456789ABCD*#" These digits represent the DTMF keypads touch tone pad. Only these digits will be accepted for accessing the controllers command names.

The serial port also allows the user to enter commands without the responses being spoken over the radios transmitter. Command 35 allows the user to enable or disable voice responses when commands are entered serially.

The serial ports baud rate can be programmed from 300-9600 baud using Command 35. If your baud rate is wrong and you can not change it on your computer terminal, only DTMF tones will be able to re-program the rate to a new acceptable rate.

The serial ports echo can be controlled (See Command 035 section 8). This allows the controller to ignore random serial input that may come in over the serial port when a modem is connected. Refer to Appendix D for modem and computer connection precautions.

Your serial ports cable between the RLC-ANG and your serial terminal is a straight through DB-09 cable. Use the below table to wire special applications.

RLC-ANG DB-09	DB-09	DB-25	Modem, DB-25
2	2	3	2
3	3	2	3
5	5	7	7

Cable Wiring Diagram

Operation/Programming Over the Serial Port: RTU Mode

When in RTU mode the RLC-ANG utilizes the industry standard Modbus protocol.

There are several items that need to be set-up *before* entering into RTU mode.

- RTU's site address number: Ranges from 001..255 (0x01 hex .. 0xff hex)
- RTU's operational baud rate (300..9600 baud)
- RTU's data execution timer (10mS..9.9 seconds)

Once the RTU's parameters are set-up the controller can be placed into RTU mode. (Note: When the unit is in this mode, only valid modbus data will be accepted. This data is in hex, not ascii. Certain RTU's operate in either ascii or hex. Because of the remote nature of this device, and the CRC checksum error correction, hex mode is more reliable and faster.)

The following lists the RTU modbus commands utilized by the RLC-ANG

- 01 Read coil status
 - This command allows the master controller to read the latched output on the slave
 - 00001 Latched output line #1 (0x00 = output is off, high impedance)
- 02 Read input status
 - This command allows the master controller to read the dry contact input lines on the slave
 - 10001 Input line #1 current reading (0x00 = open or floating)
- 03 Read the holding registers
 - This command allows the master to read the following registers
 - 40001 .. 40008 Analog Inputs 1..8
 - 40009 .. 40016 Analog Inputs 1..8 High Extreme Reading
 - 40017 .. 40024 Analog Inputs 1..8 Low Extreme Reading
- 13 Cancel RTU mode back to ASCII mode
 - This command cancels RTU mode and returns the RLC-ANG back to ASCII terminal mode
 - 20001 With data 0xABCD cancels RTU mode
- 15 Write to multiple coils
 - This command allows the master controller to turn on/off the latch output line on the slave
 - 00001 Latched output line #1 (0x00 = output is off, high impedance)
- 16 Write multiple registers
 - 40001 .. 40008 Analog Inputs 1..8
 - 40009 .. 40016 Analog Inputs 1..8 High Extreme Reading
 - 40017 .. 40024 Analog Inputs 1..8 Low Extreme Reading

The only command that needs additional noting is the register location 20001. This is a special purpose register in its function. When the register is written a 0xABCD hex, the RTU will change operation from RTU mode over to ASCII terminal mode. This command is needed in order to access the programming features of the RLC-ANG controller without having a DTMF keypad available.

Summed Alarm Output Line or User Controller Output Line

The RLC-ANG provides the user with 1 contact closure output line. This line can be either a user output line or a summed alarm indication. Command 35 provides the user the ability to define the function of this line.

When this line is configured as an output line, the user is in control with its operation. The 2 states the line operates in is 'Contact ON' or 'Contact OFF'. When contact on command is issued, the open drain output goes to a ground state. When contact off command is issued the open drain output goes to an open (high impedance state). This line can be used to drive relays, external control outputs, community panels, and any function that requires a low impedance control. Commands 37, 38 provide the user the ability to turn the line on and off. These commands are only enabled when the line is set-up as a user function. Refer to Command 35 for output line configurations.

When this line is configured as a summed alarm indicate output the RLC-ANG will issue an active low ground state when an alarm is present on the system. This line 'ORs' all of the system alarms as an indication of system activity. When all of the system alarms are cleared this line returns to its off high impedance state.

Analog Input Lines

The RLC-ANG offers what most other controllers charge thousands for, 8 analog monitoring input lines. This is a nice feature that allows the site owner to monitor analog conditions like temperature, site voltages, forward and reflected transmitter power, heat sink temperature, and much more. The RLC-ANG defaults to measure 00.0 - 16.0 Volts with 62mV resolution. Several voltage conversion faceplates are provided to convert an input voltage to a number. The following faceplates take a 0-4 Volt input and convert it to a number that corresponds to the faceplate number. In order to read higher voltages that 16 Volts (Default Faceplate and Input Voltage Divider) an external voltage divider is needed. When connecting higher voltages to the RLC-ANG, the user must take pre-cautions in the connection of these voltages. Over voltage can damage the controllers buffer circuits. Resistors R34-R41 are provided to divide the input voltages down from 0-16 Volts to 0-4 Volts. If higher voltages are needed to be monitored, externally divide the voltages down to 0-16 Volts. The only inputs that need to remove (Clip one end of the resistor removes it from the circuit) the divider resistor is faceplates 0,6,7. All other inputs can operate up to 16 volts.

Faceplates:

- 0 - Input voltage of 0.00 - 4.00 Volts: Output number of 0.00 - 4.00** 15mV Resolution
- 1 - Input voltage of 00.0 - 16.0 Volts: Output number of 00.0 - 16.0* 62mV Resolution
- 2 - Input voltage of 00.0 - 16.0 Volts: Output number of 00.0 - 32.0* 125mV Resolution
- 3 - Input voltage of 00.0 - 16.0 Volts: Output number of 00.0 - 64.0* 250mV Resolution
- 4 - Input voltage of 00.0 - 16.0 Volts: Output number of 000.0 - 128.0* 0.5 V Resolution
- 5 - Input voltage of 00.0 - 16.0 Volts: Output number of 000 - 255* 1 Volt Resolution
- 6 - Celsius Temperature † 2 degrees Resolution: Uses the LM335 Sensor
- 7 - Fahrenheit Temperature † 3 degrees Resolution: Uses the LM335 Sensor
- 8 - Input voltage of 0.00 - 4.00 Volts: Output number of 000 - 100** 392mV Resolution
- 9 - Input voltage of 0.00 - 4.00 Volts: Output number of 000 - 360: Wind Direction
- 10 - Input voltages of 0.00 - 4.00 Volts: Output number of S0 - S9+60 (Signal Strength)
- 11 - Logical Faceplate: When input voltage is greater than 1/2 the requested scale=Closed
 When input voltage is less than 1/2 the requested scale=Open
- 12 - Logical Faceplate: When input voltage is greater than 1/2 the requested scale=Open
 When input voltage is less than 1/2 the requested scale=Closed
- 13 - Logical Faceplate: When input voltage is greater than 1/2 the requested scale=Low
 When input voltage is less than 1/2 the requested scale=High
- 14 - Logical Faceplate: When input voltage is greater than 1/2 the requested scale=High
 When input voltage is less than 1/2 the requested scale=Low
- 15 - Logical Faceplate: When input voltage is greater than 1/2 the requested scale=Off
 When input voltage is less than 1/2 the requested scale=On
- 16 - Logical Faceplate: When input voltage is greater than 1/2 the requested scale=On
 When input voltage is less than 1/2 the requested scale=Off
- 17 - Battery Voltage: This faceplate requires the divider resistor to be in place.
 Output number of 00.0 - 19.3 volts, 0.10 volt resolution
- 18 - Current Input This faceplate requires the divider resistor to be removed.
 Converts 4mA-20mA inputs to 4.0-20.0 number
 Requires an external 200 ohm resistor to be applied between the
 analog input and ground to convert current into voltage

It is important not to apply over 5 volts to the RLC-ANG analog inputs with the divider resistors removed. If this voltage level is exceeded, damage to the analog opamp will occur.

* To read voltages greater than 4.00 volts, you must use the voltage divider circuit shown on the next page.

** To read voltages lower than 4.00 volts, you must remove the voltage divider circuit shown on the next page.

† To read temperatures with the LM335 temperature sensors, you should need to power the sensors with a 1.5mA current source. Inputs 1,2 provide these current sources. To use the current source on input 1, switch position #3 to the 'ON' position. To use the current source on input 2, switch position #4 to the 'ON' position. The switches should be in the 'OFF' position for all other applications.

Analog Input Faceplates:

Resistor Division Values:

Faceplate	Converted Number Range	Division Resistor
Voltage #00	0.00 - 4.00	Remove Divide Resistor
Voltage #01	00.0 - 16.0	Default: 10k ohm
Voltage #02	00.0 - 32.0	Default: 10k ohm
Voltage #03	00.0 - 64.0	Default: 10k ohm
Voltage #04	00.0 - 128.0	Default: 10k ohm
Voltage #05	000 - 255	Default: 10k ohm
Fahrenheit Temperature #06	LM335 Temperature	Remove Divide Resistor
Celsius Temperature #07	LM335 Temperature	Remove Divide Resistor
0-100 Percent #08	000 - 100	Default: 10k ohm
0-360 Degree Wind #09	000 - 360	Default: 10k ohm
Signal Strength #10	S0 - S9 plus 60	Remove Divide Resistor
Logical Inputs #11-#16	See Previous Page	Default: 10k ohm
Batter Voltage Monitor #17	00.0 - 19.3 Volts	Default: 10k ohm
4mA .. 20mA Reading #18	0.8 - 4.00 Volts, 4mA - 20mA	Remove Divider Resistor and place an external 200 ohm resistor between the analog input and ground.

Voltage division resistors are provided on the controller to allow the input voltages to be divided to a voltage the controller can handle. All conversion faceplates operate from a 00.0-4.00 voltage input. The default input voltage division allows for 00.0-16.0 voltages to be input, with a number 00.0-16.0 to be spoken.

For example: Read an input temperature in fahrenheit degrees on Analog #1

- Connect the LM335 to Pin 11(+) Pin 10(-) Analog #1
- Switch; Dip Switch position 3 to the 'ON' position
- Remove Division Resistor R34 from the circuit
- Select Faceplate 7 to Analog Input 1 (Command 13)
 - Select faceplate #06
- Program message #01 to contain the response message
"The Repeater Temperature is XX Degrees"
- Command 09 programs the voice messages, slot #01
- Word numbers XXX XXX XXX XXX 225 XXX"
- Special word 225 refers to analog #1 conversion results
- The user now executes Command 01 to recall this analog reading
 - Refer to Command 01

Analog Alarms

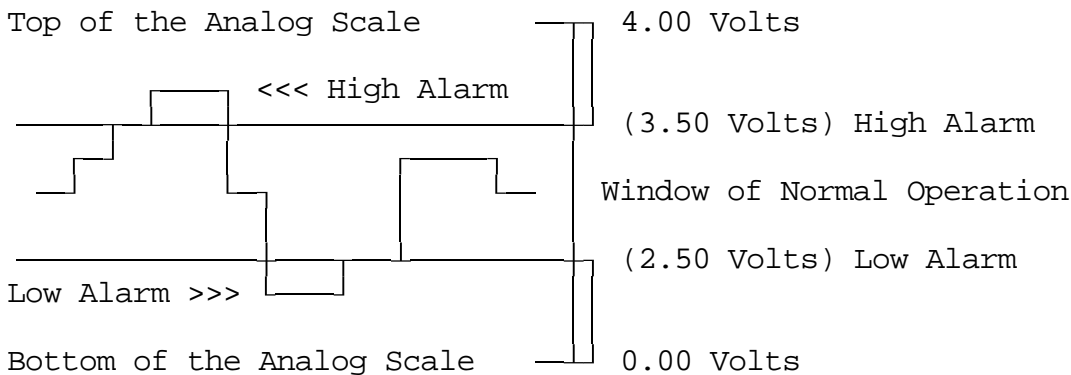
The RLC-ANG controller allows the user to program a high alarm point and a low alarm point/per analog channel. These alarm points let the user have a window of operation that the analog channel normally operates in, and alarm conditions when the analog channel goes out of its bounds.

For example:

When an analog line goes from a normal operation to a high alarm condition the analog lines high alarm message is sent. When an analog line goes from a normal operation to a low alarm condition the analog lines low alarm message is sent. When either a high alarm or low alarm operation clears the analog lines alarm to normal message is sent.

When a alarm condition is present, the alarm beacon message is sent out the radio port every xx.x minutes. The beacon time 'xx.x' is user programmable in 10 second increments. Refer to Commands 36 and 37 for timer programming.

When a beacon message is being broadcast out the radio port, the user can also acknowledge the alarm condition and cancel the beacon message. Refer to Command 41 for beacon message acknowledgement. Once any of the alarm lines change state, ie. goes from high alarm to normal, low alarm to normal..., the beacon message is re-enabled. This feature allows the monitoring stations to know of any changes concerning the monitoring points. If all alarms are cleared the beacon message is automatically disabled.



The above example shows a normal operating window of 1 volt with the high alarm point at 3.50 Volts, and the low alarm point of 2.50 Volts. If the voltage varies above, or below the set alarm points, the analog alarm beacon will announce the general alarm condition. The user can interrogate all analog alarms (see Command 42) to pin-point the alarm causing input. Each line can be individually interrogate for its high and low alarms conditions using Command 23.

The user inputs the alarm points using Command 21 and Command 22. The alarm points are entered as a number varying from 000 - 255. The controller will speak the alarm condition as a formatted and calibrated faceplate number. This allows the user to know the exact point where the alarm will occur. Each analog lines high and low alarms can be enabled or disabled using Command 24 and Command 25.

Analog High/Low Monitor

The RLC-ANG controller gives the user the ability to monitor the analog inputs high and low variations. The controller on reset sets the current highs and lows to the current analog reading. Once the analog lines begins to move, the controller tracks the changes, once a second, and logs the highest point and the lowest point. The user can read back each of the analog lines high, and low points using the either the DTMF Command 18 and Command 19 or by speaking a special voice word the High and Low information can be included in a voice message. Refer to voice word list at the end of this manual for the special analog high\low words.

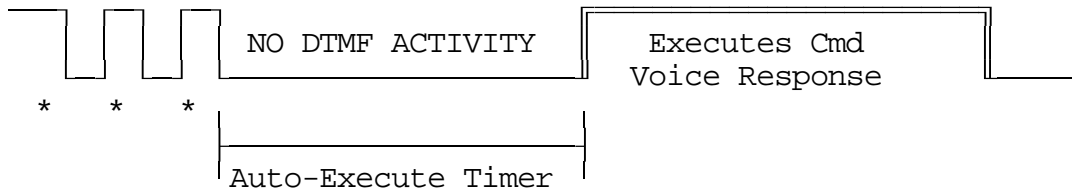
The analog high\low information can be reset to current input voltages using Command 17. A power on reset and user reset (see Command 45) will also reset the analog high\low information.

Diagram of Timers

The RLC-ANG controller operates off of several timers. These timers are programmed using Command 39 and recalled using Command 40. The following is a brief description of the timers and their operation.

Auto-Execute a command after lack of DTMF activity

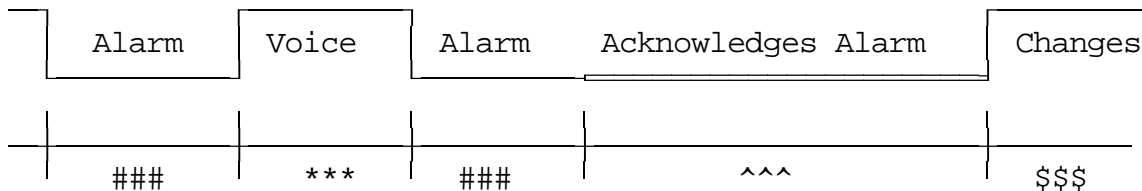
- Only used when in the Timed-Execution mode, not in COR (Full-Duplex Mode)



After a lack of DTMF activity (*), the controller will try to execute a command that matches the series of DTMF digits entered. The command name can be from 1 to 6 digits in length followed by a mandatory 2 digit command number. The command names default to 1 digits beginning with the DTMF digit '#'. The command number is always a 2 digit number ranging from 00..42. The Auto-Execute timer defaults to 3 seconds but can vary from 0.1 seconds up to 9.9 seconds. It is useful to have this timer long enough to handle slow DTMF inputs.

Analog Alarm Beacon timer

- Only applies when the analog alarms are enabled

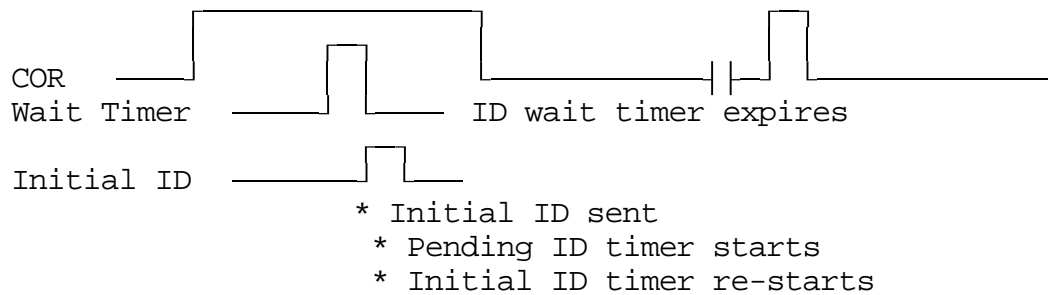


- ### - Analog lines in alarm, waiting Beacon timer expiration
- *** - Alarm Voice Beacon message sent
- ^^ - User acknowledges alarm condition, Beacon message bypassed
- \$\$\$ - Alarm condition changes, Alarm Voice Beacon message sent

If the analog input lines alarm is enabled, and the line goes outside of the normal operation (inside the window of normal operation), the analog alarm beacon message will be sent. The message will be sent every xx.x minutes (defaults to 3 minutes) from 10 seconds to 9990 seconds. If the user acknowledges the alarm condition, the beacon message will be canceled. If any of the analog alarm conditions changes, the beacon message will be re-enabled.

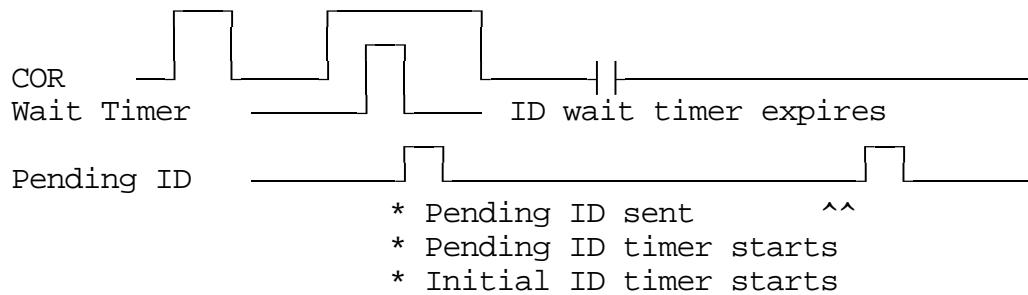
Repeater ID Cycles (Applies only when in repeater mode (02))

Initial ID needed, but COR active longer than wait timer



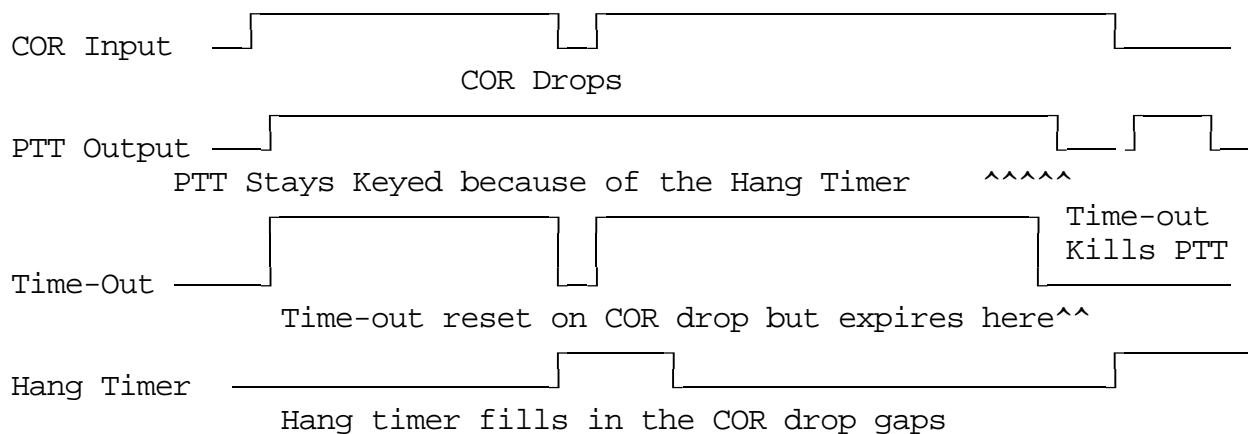
Initial ID Cycle

Pending ID needed, but COR active longer than wait timer



^^ Pending ID sent for the last time. The next ID will be sent when the pending ID timer expires and there is activity. The initial ID will only be resent if there is no activity for the length of the initial ID timer and that timer expires and there is activity. The pending ID will only be resend if there is activity after the pending ID timer expires.

Pending ID Cycle



PTT and Timer Cycle

Several Analog Input Examples

DTMF name lengths, and programming

The RLC-ANG allows the user to reprogram all of the DTMF commands from 1-6 digits in length. This enables the controller to fit in to your existing command structure with very few, if any DTMF conflicts. The commands default to a 1 digit configuration, with the first digit beginning with the DTMF digit '#'. The ending 2 digits following the up to 6 digit command name are always the command number. This number varies from 00..42. All 16 DTMF digits are legal in the command name.

Example: Want to change the DTMF command name from '#' to 150

- 1) Command 11 takes up to 6 digits of new command name data
- User enters: #11 150 <unkey> or <*> or <time execute> or <Enter>
- 2) Controller speaks the new name as '1 5 0'
- 3) New command name is 150 followed by 2 digits for the command number

00 : Recall Software Version

This command allows the user to recall what software version the RLC-ANG is programmed as. This command can also be used to test DTMF access.

Format:

<DTMF Name> 00

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where 00 is the command number associated with these commands

No errors are provided for this command.

01-08 : Recall User Voice Message Slots

These commands allow the user to readback the individual programmed voice message slots that contain the analog readings and messages. The messages are programmed using Command 09 and can be checked using Command 10.

Users will use these 8 commands to store up to 12 words of voice data that include any of the normal user words along with the special words. The special words include Analog 1-8 current reading, Analog 1-8 high readings and Analog 1-8 low readings. With word combination like these, messages can be built that allow the maximum information transferred in a little space.

Format:

<DTMF Name> plus <01..08>

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <01..08> is the command number associated with these commands

Default:

<DTMF Name> defaults to '#'

Number	Message Slot	Length
01	Slot #1	12 Words
02	Slot #2	12 Words
03	Slot #3	12 Words
04	Slot #4	12 Words
05	Slot #5	12 Words
06	Slot #6	12 Words
07	Slot #7	12 Words
08	Slot #8	12 Words

No errors are provided for these commands.

09 : Program Voice Message Slot

This command allows the user to program the many voice messages that the RLC-ANG supports. These voice messages include the 8 user message slots, 8 high alarm messages, 8 low alarm messages, 8 alarm to normal messages, repeater ID's, and repeater courtesy beep message. Refer to the voice word table at the end of the manual for valid voice words.

Format:

<DTMF Name>09 <Slot##><Voice Word Data>

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <09> is the command number associated with this command

Where <Slot##> is the 2 digit message slot storage number (See Below)

Where <Voice Word Data> is the 3 digit voice word number (See Below)

Default:

<DTMF Name> defaults to '#'

Message Slot #	Message Slot Length	Message Name
00	Not Programmable	RLC-ANG Software Version
01	12 Words	User 1 message slot (Command 01 recalls)
02	12 Words	User 2 message slot (Command 02 recalls)
03	12 Words	User 3 message slot (Command 03 recalls)
04	12 Words	User 4 message slot (Command 04 recalls)
05	12 Words	User 5 message slot (Command 05 recalls)
06	12 Words	User 6 message slot (Command 06 recalls)
07	12 Words	User 7 message slot (Command 07 recalls)
08	12 Words	User 8 message slot (Command 08 recalls)
09	15 Words	Repeater Initial ID (When in Repeater Mode)
10	15 Words	Repeater Pending ID (When in Repeater Mode)
11	10 Words	Analog 01 Low Alarm Message
12	10 Words	Analog 02 Low Alarm Message
13	10 Words	Analog 03 Low Alarm Message
14	10 Words	Analog 04 Low Alarm Message
15	10 Words	Analog 05 Low Alarm Message

16	10 Words	Analog 06 Low Alarm Message
17	10 Words	Analog 07 Low Alarm Message
18	10 Words	Analog 08 Low Alarm Message
19	10 Words	Analog 01 High Alarm Message
20	10 Words	Analog 02 High Alarm Message
21	10 Words	Analog 03 High Alarm Message
22	10 Words	Analog 04 High Alarm Message
23	10 Words	Analog 05 High Alarm Message
24	10 Words	Analog 06 High Alarm Message
25	10 Words	Analog 07 High Alarm Message
26	10 Words	Analog 08 High Alarm Message
27	10 Words	Analog 01 Alarm-Normal Message
28	10 Words	Analog 02 Alarm-Normal Message
29	10 Words	Analog 03 Alarm-Normal Message
30	10 Words	Analog 04 Alarm-Normal Message
31	10 Words	Analog 05 Alarm-Normal Message
32	10 Words	Analog 06 Alarm-Normal Message
33	10 Words	Analog 07 Alarm-Normal Message
34	10 Words	Analog 08 Alarm-Normal Message
35	10 Words	Analog Alarm Beacon Message
36	3 Words	Repeater Courtesy Beep Message

Example: I want my repeater initial ID message to be "This_is The K F 7 F W Repeater"

- 1) Locate repeater initial ID slot: Slot #09
- 2) Look-up the voice words:
 - 171 (This_is), 170 (The), 040 (K), 035 (F), 007 (7), 035 (F), 052 (W), 147 (Repeater)
- 3) Program the voice message slot:
 - #09 09 171 170 040 035 007 035 052 147 <Unkey> or <*>
- 4) Response is "This_is The K F 7 F W Repeater"

Example: I want my temperature sensor to read the current condition along with the high and low readings.

- 1) Assign Analog #1 input as a fahrenheit temperature sensor
 - Command 13: #13 1 06 Voice response: '1 is 6'
- 2) Analog calibration may be needed for new sensors. This example will use a -5 calibration
 - Command 15: #15 1 0 05 Voice response: '1 is minus 5'
- 3) Reset analog 1 high/low
 - Command 17: #171 Voice response: '1 is 0'
- 4) Locate user slot #1 to contain your voice data. Slot 01 is user #1 message storage
- 5) Build a message and look-up your voice words.
 - "The Temperature Is XX (High of XX) and (Low of XX) Degrees"
 - 170(The), 164(Temperature), 110(Is), 225(Analog 1), 241(High Read), 061(And), 233(Low Read), 086(Degrees)
- 6) Program your voice message
 - Command 09: #09 01 170 164 110 225 241 061 233 086 <unkey> or *
- 7) Your response: "The Temperature Is XX High of XX and Low of XX Degrees"

Errors when programming:

- Error 1 - Not enough or too much data entered
- Error 2 - Invalid mode

10 : Recall Voice Message Slot

This command allows the user to check the programming of a voice message slot. This is useful when programming up several messages. After you program the slot you simply request a playback of that message using Command 10.

Format:

<DTMF Name>10 <Slot##>

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <10> is the command number associated with this command

Where <Slot##> is the 2 digit message slot storage number (See Command 09)

Default:

<DTMF Name> defaults to '#'

Errors when programming:

Error 1 - Invalid message slot

Error 2 - Slot is turned off

11 : Program the DTMF Access Name

This command allows the user to program the DTMF access name used in executing the commands. This name can be from 1-6 digits in length. The default access name is '#' followed by 2 digits which are the command number.

Format:

<DTMF Name>11 <New DTMF Access Name>

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <11> is the command number associated with this command

Where <New DTMF Access Name> is the 1..6 digit new access name

Default:

<DTMF Name> defaults to '#'

Note: A minimum of 1 digit is required as the access name.

Example: I want to change my DTMF access name to '#12'

1) Execute Command 11: #11 #12 <unkey> or *

- The DTMF access name is now #12 followed by the command number

Errors when programming:

Error 1 - Too many or too few digits entered

12: Recall the DTMF Access Name

This command allows the user to recall what the DTMF command name is programmed as. If the user forgets what the DTMF command name are, then this command can not be executed because it requires the DTMF command name to execute. Therefore this command is mainly used by the serial port which does not use the DTMF command name in its access to commands.

Format:

<DTMF Name>12

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <12> is the command number associated with this command

Default:

<DTMF Name> defaults to '#'

Example: I forgot what the DTMF access name is and I need to find it

1) Execute Command 12 from the serial port: 12 <Enter>

- Serial response: Pound One Two

No Errors are provided for this command

13 : Assign an Analog Conversion Faceplate

This command allows the assignment of an analog conversion faceplate to any of the analog input lines. These conversion faceplates take the analog input voltage and convert it to a number that corresponds to the analog inputs voltage. This command only converts the input, Command 14 will handle the actual calibration of the converted number.

The conversion faceplates will handle both analog and logical conversions. This will allow logical changes like a contact closure to be assigned to an analog input.

Format:

<DTMF Name>13 # \$\$

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <13> is the command number associated with this command

Where '#' is the analog line number to assign the faceplate

Where '\$\$' is the requested analog conversion faceplate

Default:

All analog inputs default to faceplate 00: 0.00-5.00 volts conversion

Faceplate #	Input #1, Default	#2, Resistor Lifted	Conversion from volts to words
00	0.00-25.00 Volts	0.00-5.00 Volts	0<point>00 - 5<point>00
01	0.0-25.0 Volts	0.00-5.00 Volts	00<point>0 - 16<point>0
02	0.00-25.00 Volts	0.00-5.00 Volts	00<point>0 - 32<point>0
03	0.00-25.00 Volts	0.00-5.00 Volts	00<point>0 - 64<point>0
04	0.00-25.00 Volts	0.00-5.00 Volts	00<point>0 - 128<point>0
05	0.00-25.00 Volts	0.00-5.00 Volts	000 - 255
06	-----	Kelvin Temperature	Fahrenheit Temperature
07	-----	Kelvin Temperature	Celsius Temperature
08	0.00-25.00 Volts	0.00-5.00 Volts	000 - 100 (Percent)
09	0.00-25.00 Volts	0.00-5.00 Volts	000 - 360 (Wind direction)
10	0.00-25.00 Volts	0.00-5.00 Volts	S0..S9<plus>60 (Signal Level)
11	0.00-12.50 Volts	0.00-2.50 Volts	Open (Logical Faceplate)
11	12.52-25.00 Volts	2.52-5.00 Volts	Closed (Logical Faceplate)
12	0.00-12.50 Volts	0.00-2.50 Volts	Closed (Logical Faceplate)
12	12.52-25.00 Volts	2.52-5.00 Volts	Open (Logical Faceplate)

13	0.00-12.50 Volts	0.00-2.50 Volts	High (Logical Faceplate)
13	12.52-25.00 Volts	2.52-5.00 Volts	Low (Logical Faceplate)
14	0.00-12.50 Volts	0.00-2.50 Volts	Low (Logical Faceplate)
14	12.52-25.00 Volts	2.52-5.00 Volts	High (Logical Faceplate)
15	0.00-12.50 Volts	0.00-2.50 Volts	ON (Logical Faceplate)
15	12.52-25.00 Volts	2.52-5.00 Volts	OFF (Logical Faceplate)
16	0.00-12.50 Volts	0.00-2.50 Volts	OFF (Logical Faceplate)
16	12.52-25.00 Volts	2.52-5.00 Volts	ON (Logical Faceplate)
17	00.0-19.3 Volts	Not a valid reading	00<point>0 - 19<point>3
18	Not a valid reading	0.80-4.00 volts or 4mA-20mA with an external 200 ohm resistor across the analog input and ground	4<point>0 - 20<point>0 ** External resistor required to convert the 4mA-20mA current input into a voltage. **

Example: I have an LM335Z temperature sensor connected to analog #1

- 1) Lift resistor R34. This removes the voltage divider from the analog input
- 2) Turn on Switch #3 on the 4-position dip switch. This applies power to the analog input
- 3) Execute Command 13 to assign a faceplate
#13 1 06 <unkey> or *
- 4) Now Kelvin temperature inputs will be converted into fahrenheit temperature.

Voice response:

"One 'is' Six"

Example: I need to monitor my 12 battery voltage on analog #2

- 1) Make sure resistor R35 is in-circuit (default)
- 2) Turn off Switch #4 on the 4-position dip switch. This removes power from the analog input
- 3) Execute Command 13 to assign a faceplate
#13 2 01 <unkey> or *
- 4) Now 0.00-16.0 volts input is converted into a readable number.

Voice response:

"Two 'is' One"

Errors when programming:

- Error 1 - Invalid analog input line
- Error 2 - Invalid analog faceplate

14 : Recall an Analog Conversion Faceplate

This command allows the user to recall what conversion faceplate is assigned to a specific analog input line. If a conversion result is not converting as expected, then first check the conversion faceplate to make sure it is correct.

Refer to the table on Command 13 for conversion faceplates.

Format:

<DTMF Name>14 \$\$

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <14> is the command number associated with this command

Where '\$\$' is the requested analog conversion faceplate

Default:

All analog inputs default to faceplate 00: 0.00-5.00 volts conversion

Errors when programming:

Error 1 - Invalid analog line

15 : Calibrate an Analog Input

This command allows the user to calibrate an analog input. This feature is required to make an input translate the input voltage to a voice number correctly.

To determine if an input needs to be calibrated:

- 1) Assign the appropriate conversion face
- 2) Read the analog input using Command 18

If the number read differs from the number at the analog input, you need to calibrate

Format:

<DTMF Name>15 # \$ &&

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <15> is the command number associated with this command

Where '#' is the requested analog line

Where '\$' is to either add or subtract the calibration number

1 - Add the calibration number from the analog input

Adding the calibration increases the analog number read

0 - Subtract the calibration number from the analog input

Subtracting the calibration decreases the analog number read

Where '\$\$' is the calibration number

Default:

All analog calibration is plus 00

Example: I have an LM335 temperature sensor on analog input #1 and it says the temperature is 85 degrees when in fact the temperature is 73 degrees.

- 1) The converted analog input is higher than the actual analog input
Subtract calibration is needed
- 2) LM335 sensors in fahrenheit mode has a conversion resolution of 3 degrees
The input vs. output difference is 12 degrees, or 04 calibration numbers
- 3) Execute Command 15
#15 1 0 04 <unkey> or *
#15 is the command name and number
1 is the analog line needing calibration
0 indicates subtraction calibration needed
04 is the number of calibration units needed

Errors when programming:

Error 1 - Too many or too few digits entered

Error 2 - Invalid analog line

16 : Recall Analog Calibration Variables

This command allows the user to recall the calibration variables. These variables are explained in Command 15.

If an analog input reads incorrectly, and you have checked the conversion faceplate, then check the calibration variables to see if they are correct.

Format:

<DTMF Name>16 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <16> is the command number associated with this command

Where '#' is the requested analog line

Default:

All analog calibration is plus 00

Errors when programming:

Error 1 - Invalid analog line

17 : Reset the Analog High-Low Extremes

This command allows the user to reset the analog input high-low variations to the current reading. This feature must be used when monitoring the maximum-minimum extremes that your analog inputs take. Once a high level is reached, any lower readings will not be stored for the high reading. The same procedure is true for the lower extremes.

See Command 19 to recall the analog high readings.

Speak custom words 241..248 for high readings inserted into voice messages

See Command 20 to recall the analog low readings.

Speak custom words 233..240 for low readings inserted into voice messages

Format:

<DTMF Name>17 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <17> is the command number associated with this command

Where '#' is the analog channel needed to reset high\low variations

Default:

All analog high and low extremes reset at RLC-ANG power reset

Errors when programming:

Error 1 - Too many or too few digits entered

Error 2 - Invalid analog line

18 : Read and Analog Input

This command allows the user to read a selected analog input. The user would normally not use this command for day-to-day operation. Because of the analog reading special words (Words 225..232), the user would normally include these words for message readback. This command is mainly used for setting up the RLC-ANG analog system. The readings obtained from this command include the calibration data (Command 15) and the conversion faceplates (Command 13).

Format:

<DTMF Name>18 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <18> is the command number associated with this command

Where '#' is the requested analog input

The voice response will only readback the analog converted number and not the number delimiter (Volts, Degrees, Amps etc...)

Errors when programming:

Error 1 - Invalid analog line

19 and 20: Recall Analog High and Low Extremes

These commands allow the user to recall the analog high and low extreme readings. The user would normally not use this command for day-to-day operation. Because of the analog high reading special words (Words 233..240) and the analog low reading special words (Words 241..248), the user would normally include these words for message readback. This command is mainly used for setting up the RLC-ANG analog system.

To reset the analog high and low readings to current levels, refer to Command 17.

Format:

<DTMF Name>19 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <19> is the command number associated with this command

Where '#' is the requested analog inputs high extreme reading

and

<DTMF Name>20 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <20> is the command number associated with this command

Where '#' is the requested analog inputs low extreme reading

The voice response will only readback the analog converted number and not the number delimiter (Volts, Degrees, Amps etc...)

Errors when programming:

Error 1 - Invalid analog line

21 : Analog Alarm Program

This command allows the user to assign both high and low alarm points to the analog inputs. The applications for this command are for monitoring high and low points like temperature, voltage, door alarms, contact closures, and any analog or contact closure condition.

The analog alarm system on the RLC-ANG is checked every 1 second. These alarms are spoken when either a high alarm occurs, a low alarm occurs, or the alarm is cleared. When an alarm is present, and the alarm is enabled (See Command 24 and 25) the controller will beacon the alarm condition

Format:

<DTMF Name>21 # % &&&

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <21> is the command number associated with this command

Where '#' is the requested analog input to be alarmed

Where % is the high or low alarm point

1 - high alarm point

0 - low alarm point

Where &&& is the analog alarm point

This number ranges from 000..255 (See table on next page)

Default:

All alarms are disabled. See Commands 24 and 25 for enable\disable control of the high and low analog alarms.

Example: I want my battery monitor that is on analog #2 to give me a high alarm beacon and announcement if the battery voltage rises above 14.7 volts and give me a low alarm beacon and announcement if the battery voltage drops below 11.6 volts.

- 1) We take into account that analog input #2 is assigned a faceplate of 01 and properly calibrated for correct readings.
- 2) Look-up in the table under faceplate type 01 the number that corresponds to 14.7
- that number is 235; this is your high alarm point
- 3) Look-up in the table under faceplate type 01 the number that corresponds to 11.6
- that number is 185; this is your low alarm point
- 4) Execute Command 21 to program the high alarm point then your low alarm point
- #21 2 1 235 ; this sets your high alarm at 235 (14.7 volts)
- #21 2 0 185 ; this sets your low alarm at 185 (11.6 volts)
- 5) Execute Command 24 and 25 to enable your high and low alarms points
- #24 2 1 ; this enables analog line #2 low alarm
- #25 2 1 ; this enables analog line #2 high alarm

Example: I want to add a door alarm to my site using an existing switch that is closed when the door is closed and opens when the door is open

Example: I want to monitor the site AC voltage using a relay that is closed when the power is ON and opens when the AC fails causing the relay to open.

Errors when programming:

Error 1 - Invalid analog line

Error 2 - Invalid analog alarm value

Input Number and Analog Alarm Conversion Tables

Number	FC00	FC01	FC02	FC03	FC04	FC05	FC06	FC07	FC08
255	4.00	16.0	32.0	64.0	128.0	255	264	129	100
245	3.84	15.4	30.7	61.5	123.0	245	235	113	096
235	3.69	14.7	29.5	59.0	118.0	235	206	097	092
225	3.53	14.1	28.2	56.5	112.9	225	178	081	088
215	3.37	13.5	27.0	54.0	107.9	215	149	065	084
205	3.22	12.9	25.7	51.5	102.9	205	121	049	080
195	3.06	12.2	24.5	48.9	097.9	195	092	033	077
185	2.90	11.6	23.2	46.4	092.9	185	064	018	073
175	2.75	11.0	22.0	43.9	087.8	175	035	002	069
165	2.59	10.4	20.7	41.4	082.8	165	006	-014	065
155	2.43	09.7	19.5	38.9	077.8	155	-022	-030	061
145	2.27	09.1	18.2	36.4	072.8	145	-051	-046	057
135	2.12	08.5	16.9	33.9	067.8	135	-079	-062	053
125	1.96	07.8	15.7	31.4	062.7	125	....	....	049
115	1.80	07.2	14.4	28.9	057.7	115	....	....	045
105	1.65	06.6	13.2	26.4	052.7	105	....	....	041
095	1.49	06.0	11.9	23.8	047.7	095	....	....	037
085	1.33	05.3	10.7	21.3	042.7	085	....	....	033
075	1.18	04.7	09.4	18.8	037.6	075	....	....	029
065	1.02	04.1	08.2	16.3	032.6	065	....	....	026
055	0.86	03.5	06.9	13.8	027.6	055	....	....	022
045	0.71	02.8	05.6	11.3	022.6	045	....	....	018
035	0.55	02.2	04.4	08.8	017.6	035	....	....	014
025	0.39	01.6	03.1	06.3	012.5	025	....	....	010
015	0.24	00.9	01.9	03.8	007.5	015	....	....	006
005	0.08	00.3	00.6	01.3	002.5	005	....	....	002
000	0.00	00.0	00.0	00.03	000.0	000	....	....	000

Input Number and Analog Alarm Conversion Tables

Number	FC09	FC10	FC11	FC12	FC13	FC14	FC15	FC16	FC17	FC18
255	360	S9+60	CLOSE	OPEN	LOW	HIGH	OFF	ON	19.3	20.0
245	346	S9+60	CLOSE	OPEN	LOW	HIGH	OFF	ON	18.6	19.4
235	332	S9+50	CLOSE	OPEN	LOW	HIGH	OFF	ON	17.8	18.8
225	317	S9+50	CLOSE	OPEN	LOW	HIGH	OFF	ON	17.1	18.2
215	304	S9+40	CLOSE	OPEN	LOW	HIGH	OFF	ON	16.3	17.5
205	289	S9+30	CLOSE	OPEN	LOW	HIGH	OFF	ON	15.6	16.9
195	275	S9+30	CLOSE	OPEN	LOW	HIGH	OFF	ON	14.9	16.3
185	261	S9+20	CLOSE	OPEN	LOW	HIGH	OFF	ON	14.1	15.7
175	247	S9+20	CLOSE	OPEN	LOW	HIGH	OFF	ON	13.4	15.0
165	233	S9+10	CLOSE	OPEN	LOW	HIGH	OFF	ON	12.6	14.5
155	219	S9	CLOSE	OPEN	LOW	HIGH	OFF	ON	11.9	13.9
145	205	S9	CLOSE	OPEN	LOW	HIGH	OFF	ON	11.1	13.2
135	191	S8	CLOSE	OPEN	LOW	HIGH	OFF	ON	10.4	12.6
125	177	S7	OPEN	CLOSE	HIGH	LOW	ON	OFF	9.7	12.0
115	162	S7	OPEN	CLOSE	HIGH	LOW	ON	OFF	8.9	11.4
105	148	S6	OPEN	CLOSE	HIGH	LOW	ON	OFF	8.2	10.8
95	134	S5	OPEN	CLOSE	HIGH	LOW	ON	OFF	7.4	10.1
85	120	S5	OPEN	CLOSE	HIGH	LOW	ON	OFF	6.7	9.5
75	106	S4	OPEN	CLOSE	HIGH	LOW	ON	OFF	5.9	8.9
65	92	S4	OPEN	CLOSE	HIGH	LOW	ON	OFF	5.2	8.3
55	78	S3	OPEN	CLOSE	HIGH	LOW	ON	OFF	4.5	7.7
45	64	S2	OPEN	CLOSE	HIGH	LOW	ON	OFF	3.7	7.1
35	49	S2	OPEN	CLOSE	HIGH	LOW	ON	OFF	3.0	6.5
25	35	S1	OPEN	CLOSE	HIGH	LOW	ON	OFF	2.3	5.8
15	21	S0	OPEN	CLOSE	HIGH	LOW	ON	OFF	1.5	5.2
5	7	S0	OPEN	CLOSE	HIGH	LOW	ON	OFF	0.7	4.6
0	0	S0	OPEN	CLOSE	HIGH	LOW	ON	OFF	0.0	4.0

22 : Recall an Analog Alarms Alarm Point

This command allows the user to recall the settings of an analog alarm point for each analog line. The settings are programmed using Command 21. The alarm point will be spoken in the actual alarm level, not in the 3 digit alarm table settings as listed in the previous command. From the actual number the user can extrapolate the actual 3 digit number that represents what the analog lines alarm is programmed for.

Format:

<DTMF Name>22 # \$

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <22> is the command number associated with this command

Where '#' is the requested analog input to be alarmed

Where '\$' is the high\low alarm select

1 - High alarm

0 - Low alarm

Default:

All alarms are disabled. See Commands 24 and 25 for enable\disable control of the high and low analog alarms.

Errors when programming:

Error 1 - Invalid analog line

23 : Check what state an Analog Lines Alarm is in

This command allows the user to check what state an analog lines alarm is in. The analog alarms will either be in 'High', 'Low' or 'Not in Alarm'. The user can not change the interrogation voice message.

This command is not affected by the system enable\disable analog alarm commands (See Commands 24 and 25). If a user want to take an analog line out of alarm without disabling the actual alarm they can bump up or down the alarm point using Command 21, and check what state the alarm is in with Command 23 before enabling the alarm on the system.

Format:

<DTMF Name>23 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <23> is the command number associated with this command

Where '#' is the requested analog input to be alarmed

Default:

All alarms are disabled. See Commands 24 and 25 for enable\disable control of the high and low analog alarms.

Errors when programming:

Error 1 - Invalid analog line

24 : Enable or Disable an Analog lines Low Alarm

This command allows the user to enable or disable an analog lines low alarm activation. Use this command to control if an analog line is allowed to go into a system wide alarm condition. If an analog line is enabled for system wide alarming and the line goes into a low alarm then the beacon message will be enabled for timed beaconing (See message slot #35 for beacon message) and (See Command 35 for beacon mode) and (See Command 39 to program the beacon timer).

Format:

<DTMF Name>24 # \$

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <24> is the command number associated with this command

Where '#' is the requested analog input to be alarmed

Where '\$' is the enable\disable control

1 - Enables the low alarm

0 - Disables the low alarm

Default:

All alarms are disabled. See Commands 24 and 25 for enable\disable control of the high and low analog alarms.

Errors when programming:

Error 1 - Invalid analog line

25 : Enable or Disable an Analog lines High Alarm

This command allows the user to enable or disable an analog lines high alarm activation. Use this command to control if an analog line is allowed to go into a system wide alarm condition. If an analog line is enabled for system wide alarming and the line goes into a high alarm then the beacon message will be enabled for timed beaconing (See message slot #35 for beacon message) and (See Command 35 for beacon mode) and (See Command 39 to program the beacon timer).

Format:

<DTMF Name>25 # \$

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <25> is the command number associated with this command

Where '#' is the requested analog input to be alarmed

Where '\$' is the enable\disable control

1 - Enables the high alarm

0 - Disables the high alarm

Default:

All alarms are disabled. See Commands 24 and 25 for enable\disable control of the high and low analog alarms.

Errors when programming:

Error 1 - Invalid analog line

26 : Check what Analog Line Alarms is Enabled\Disabled

This command checks the settings that Commands 24,25 set. Using this command the user can check if a high and low alarm is enabled or disabled. If the line is disabled, then system wide alarming is also disabled.

Format:

<DTMF Name>26 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <26> is the command number associated with this command

Where '#' is the requested analog input to be alarmed

Default:

All alarms are disabled. See Commands 24 and 25 for enable\disable control of the high and low analog alarms.

Errors when programming:

Error 1 - Invalid analog line

27 : Lock or Unlock a Command

This command allows the user to assign an unlock code first be entered before commands can be entered. The unlock command is a normal command with user entered password. The password is user programmed to add uniqueness to each controller. All commands default to unlocked. High security commands like Command 45 Re-initialization of the controllers variables should be locked once the controller is properly programmed.

Format:

<DTMF Name>27 ## \$

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <27> is the command number associated with this command

Where '##' is the requested command number

Where '\$' is the control variable

1 - Lock '##' command (Forces that the unlock code be entered first)

0 - unlock this command (Allows execution without unlock code

entered)

Default:

- All commands are unlocked

- Command 30 can never be locked because it is the unlock command.

Example: I want my Re-Initialization command to be locked

1) Locate the command number for the re-initialization command

Command 45 is the re-initialization command

2) Execute Command 27 to assign a lock required

#27 45 1 <unkey> or *

3) Now the command requires the unlock command be executed first

Errors when programming:

Error 1 - Invalid command name

Error 2 - Bad control variable

28 : Check if a Command Needs the Unlock Code

This command allows the user to check if a command needs to be unlocked in order to be executed. Actual unlock control is programmed using Command 27.

Format:

<DTMF Name>28 ##

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <28> is the command number associated with this command

Where '##' is the requested command number

Default:

All commands are unlocked

Example: I want to check if my re-initialization command requires an unlock before execution.

1) Locate the command number for the re-initialization command

Command 45 is the re-initialization command

2) Execute Command 28 to check a lock required

#28 45 <unkey> or *

3) The response will indicate if the lock is on or off

Errors when programming:

Error 1 - Invalid command name

29 : Assign an Unlock Code

This command allows the assignment of a 6 digit unlock code. The code must be 6 digits for the security of your controller. It is a good idea to assign codes that are normally not used in the every day operation of your controller. If your radios can support 4th column tones (A,B,C,D DTMF digits) to assign these codes in part to your unlock sequence.

Once a command is locked the user must not forget what the unlock code is. If you do misplace the code then the serial terminal is the only way to change the unlock code to a new one. The serial port does not require the use of an unlock code in order to execute commands.

Format:

<DTMF Name>29 #####

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <29> is the command number associated with this command

Where '#####' is the unlock code

- The code must be 6 digits in length

Default:

- All commands are unlocked
- The unlock code defaults to '123456'

Example: I want to assign my unlock code to be 'A12B#C'

1) Execute Command 29 to assign the code

- #29 A12B#C <unkey> or *

2) Now all commands that require the unlock sequence must enter the new access name

No errors are provided for this command

30 : Unlock and Re-lock the Controller

This command unlocks the controller and allows execution of commands that required the unlock sequence to be entered first. Refer to Commands 27,28,29 for unlock controls. Once the unlock code is entered the unlock timer is started and is only reset when a command is executed correctly. Try to keep this timer in the 1-2 minute range. See Command 39 to program your system timers.

Format:

<DTMF Name>30 #####

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <30> is the command number associated with this command

Where '#####' is the unlock code

- The code must be 6 digits in length

- Unlocks the controller

or

<DTMF Name>30

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <30> is the command number associated with this command

- Re-Lock the controller

Default:

- All commands are unlocked

- The unlock code defaults to '123456'

Example: I want to execute commands that require the unlock sequence be entered

- 1) Locate your unlock code (6 digits in length)
- 2) Execute Command 30 followed by your unlock code to enable access
#30 123456 <unkey> or *
- 3) Start executing commands before your unlock timer expires

Example: I have finished programming and need to re-lock the controller

- 1) Execute Command 30 without and lock code
#30 <unkey> or *
- 2) You must unlock the controller before any locked commands can be executed

No errors are provided for this command

31 : Change the Ports Access Mode

This command allow the user to change how a receiver accesses the RLC-ANG. In repeater mode there are 4 types of access into the controller. COR only, PL only, COR and PL or COR or PL required. These signals must be present in order for the controller to recognize that a receiver is active. Normally the controller operates in the COR only mode.

To change the polarity of the COR and PL inputs see Command 32.

Format:

<DTMF Name>31 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <31> is the command number associated with this command

Where '#' is the operating mode

Default:

COR access

Access Mode	Definition
0	No Access: Receiver can not access the transmitter
1	COR Access: Only activity on the COR input needed
2	PL Access: Only activity on the PL input needed
3	COR and PL Access: Activity on both COR and PL needed for access
4	COR or PL Access: Activity on either COR or PL needed for access

Example: I want to change my access mode to COR and PL in order to access the repeater

1) Execute Command 31

#31 3 <unkey> or *

Errors when programming:

Error 1 - Invalid access mode

32 : *Change the Ports COR and PL polarity*

This command allows the user to customize the COR and PL levels into the RLC-ANG. In repeater mode every radio differs in how the COR and PL levels are present when the receiver is active. This command allows either active high or active low COR and PL signals to be accepted.

When the user does not use the COR or PL lines for access, and uses timed command execution, the lines need to be set for active low (default). A valid COR and/or PL is needed for executing commands. Timed execution does not use these lines but they still need to be active.

Format:

<DTMF Name>32 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <32> is the command number associated with this command

Where '#' is the COR/PL polarity modes

Default:

COR and PL set for active low

Mode	COR and PL levels
0	Both COR and PL active Low
1	COR Active High, PL active Low
2	COR Active Low, PL active High
3	COR and PL active High

Example: I want to execute by timed access

1) Execute Command 32 to change polarity to active low

#32 0 <unkey> or *

2) Disconnect both COR and PL lines from the RLC-ANG

Errors when programming:

Error 1 - Invalid polarity selected

33 : DTMF Keypad Test

this command allows the user to check the functioning of their DTMF keypad. Up to 30 DTMF digits can be entered and the voice will speak them back in voice. Only the forced execution digit (Default to *) will not be spoken.

Format:

<DTMF Name>33 #.#

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <33> is the command number associated with this command

Where '#.#' are the DTMF digits to be tested

Example: I want to test my DTMF pad

1) Execute Command 33

#33 1 2 3 4 5 6 7 8 9 A B C D # 0 <unkey> or *

2) Voice will speak the keys pushed

Errors when programming:

Error 1 - Too many digits entered

34 : *Change the Ports Operation Mode*

This command configures the operation of the radio port on the RLC-ANG. The radio port can operate in 3 modes that range from a link radio port to repeater port. The repeater port adds full repeater functions with voice ID's hang and time-out timers and a courtesy message slot. The link mode is what you would use when operating from a half-duplex radio (Transceiver) and the link-thru mode is used when placing the RLC-ANG in series with the repeater receiver (Passes all inputs to the output when COR\PL lines active).

Format:

<DTMF Name>34 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <34> is the command number associated with this command

Where '#' is the operating mode of the interface

(See Table Below)

Default:

Configured as a link with no pass audio (Mode 0)

Mode	Description
0	Link mode with no pass through audio. Use with no COR\PL input (Default)
1	Link mode with pass through audio. Use when in series with existing repeater
2	Repeater mode with ID, hang timer, time-out timer and courtesy beep slot
3	Telephone interface mode with ring counter, dial out number, hook timer (Future)

Example: I want the RLC-ANG to be my repeater controller.

- 1) Make sure you have a full duplex radio connected to the radio port
- 2) Make sure your COR and/or PL inputs are connected
- 3) Execute Command 34
#34 2 <unkey> or *
- 4) Program your repeater Initial ID and Pending ID slots (See Command 09)
- 5) Program your hang, time-out, and courtesy beep timers (See Command 39)

Errors when programming:

Error 1 - Invalid mode selected

35 : Configure specific Operation Modes

This command allows the user to set-up specific operating modes in the RLC-ANG. These modes configure how the different functions of the controller operate. See the below table for mode configurations.

Format:

<DTMF Name>35 # \$

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <35> is the command number associated with this command

Where '#' is the operating mode requested

(See Table Below)

Where '\$' is the control variable

(See Table Below)

Default:

(See Table Below)

Mode Number	Mode Description	1	0
1	Output Line Definition Default (0)	Summed Alarm Output Indicates active alarm by a contact closure.	User controlled Output Line. See Command 37,38
2	Alarm Beacon Mode Default (0)	Enables active beaconing when an active alarm is present	Disables active beaconing when an active alarm is present
3	DTMF Execution Mode Default (1)	Enables Timed DTMF Command Execution	Disables Timed DTMF Command Execution
4	RS-232 Serial Baud Rate Default (0)	0 - 9600 Baud Rate N81 1 - 4800 Baud Rate N81 2 - 2400 Baud Rate N81	3 - 1200 Baud Rate N81 4 - 600 Baud Rate N81 5 - 300 Baud Rate N81
5	Serial Execution causes a voice response on the radio port Default (0)	Enables serial port voice response over the radio port	Disables serial voice response over the radio port
6	Voice Polite - Impolite control Default (0)	Voice will wait on receiver activity before speaking	Voice will speak regardless of receiver activity
7	Mute DTMF digits when in repeater mode or Link pass mode	Enables DTMF mute	Disables DTMF mute
8	RS-232 Serial Echo Control (1)	Enables serial echo for command entries	Disables serial echo for command entries

Output Line Control

This command mode allows the controller to either be a user output line that the user can control manually using Command 37 and 38, or a summed alarm indication. The summed alarm indication is used to signal the user, or external equipment that a valid alarm condition is present on the controller. Only system enabled alarms will be indicated on this output line.

Alarm Beacon Mode

This command mode controls the automatic alarm beacon mode that will cycle when a system wide alarm is present. This mode is used when alarms are present and the user needs to be contacted by the controller to indicate the alarm condition. Once the user acknowledges the alarm condition with Command 41, only changes in the system alarm conditions will re-enable the beacon mode. The beacon mode timer is programmed with Command 39.

DTMF Execution Mode

This command mode controls how DTMF commands are executed. In timed execution mode the DTMF execution timer (See Command 39) is reset at the end of each DTMF digit. After this timer has expired the command is executed. In non-timed execution mode the controller requires a loss of receiver activity (See Command 31) in order to execute the command.

In all cases the 'Forced Execution Digit (Default to a '*')' can force the execution of a DTMF sequence entered.

RS-232 Serial Baud Rate

This command mode set the baud rate the RS-232 serial port operates at. The default rate is set to 9600 baud N-8-1. See serial programming section for mode information.

Serial Voice Response

This command mode controls where voice responses will be sent when programming from the serial port. When serial voice response is enabled, all commands executed from the serial port will cause a response over the serial terminal along with a voice response over the radio port. In some cases it may be nice to cancel serial port responses to allow programming of sensitive information without the voice broadcasting that information over the radio port.

Voice Polite Switch

This command mode allows the voice to be polite when speaking a voice message. If the interface is used on a common used channel, you would not want the voice to speak when the channel is in use. When the voice is polite the RLC-ANG requires the receiver to be inactive before it starts a voice message. If the receiver is active, and a voice message is needed, it will wait on speaking that message until the receiver goes inactive.

DTMF mute Enable\Disable

This mode allows the user to control the repeating of the entered DTMF tones when in repeater mode. When this mode is enabled, the controller will mute received DTMF digits to keep them from passing out the repeaters transmitter port. The length of the mute is programmed with Command 39. When disabled, all DTMF tones received will be allowed to pass to transmitter port.

RS-232 Serial Echo Control Enable\Disable

This mode allows the user to control whether serial information that is received on the serial port is re-transmitted (echoed) back to the user. This control is needed to keep some external modem from locking the controller up by echoing data it receives back to the controller and back and forth until the controller resets. Command responses will still be sent when controlled from the serial port. Error messages will only be sent if the error is part of a command. Command names not found, command is locked, and command extra data lengths will not be sent when echo control is turned off (disabled).

Errors when programming:

Error 1 - Invalid mode selected

36 : Recall specific Operation Modes

This command allows the user to recall specific operation mode information that was programmed in Command 35. Refer to Command 35 for mode specific information.

Format:

<DTMF Name>36 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <36> is the command number associated with this command

Where '#' is the operating mode requested

(See Command 35)

Errors when programming:

Error 1 - Invalid mode selected

37 and 38 : Turn the User Output Line ON\OFF

These commands allows the user to turn on and off the output line. This output line can be connected to community panels to allow repeater operation. In order for these commands to function, the user must set the output line mode in Command 35 to be a user output line.

Format:

<DTMF Name>37

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <37> is the command number associated with this command

Turn Output Line On

and

<DTMF Name>38

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <38> is the command number associated with this command

Turn Output Line Off

No Errors are provided for this command

39 : Program a selected User Timer

This command allows the user to program several of the timers used in the RLC-ANG interface. These timers are broken into 2 groups. Group 1 program in 10mS increments and Group 2 program in 10 sec. increments. The maximum a timer can be programmed is (999 * 10mS) or (999 * 10sec.). Do not program a timer to 000 unless you the maximum time for that timer.

Format:

<DTMF Name>39 # \$\$\$

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <39> is the command number associated with this command

Where # is the timer number (See Below)

Where \$\$\$ is the timer amount

From 000 to 999 (See Below for timer resolution)

Timer Number	Resolution	Default Time	Timer Name
0	10mS	050 (500mS)	Voice Delay
1	10mS	200 (2 Seconds)	Hang Time
2	10mS	100 (1 Second)	Courtesy Beeps Start
3	10mS	200 (2 Seconds)	DTMF Mute
4	10 Sec.	300 (3 Seconds)	DTMF Execution
5	10 Sec.	018 (3 Minutes)	Time-Out
6	10 Sec.	060 (10 Minutes)	Initial ID
7	10 Sec.	059 (9.90 Minutes)	Pending ID
8	10 Sec.	003 (30 Seconds)	ID'ing Wait
9	10 Sec.	018 (3 Minutes)	Alarm Beacon

Timer Definitions:

See Command 40 for timer definitions

Errors when programming:

Error 1 - Invalid timer slot

40 : Recall a selected User Timer

This command allows the user to recall specific timer slots. The slots contain system wide timing variables used for controller operation. See Command 39 for timer programming.

Format:

<DTMF Name>40 #

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <40> is the command number associated with this command

Where # is the timer number (See Command 39 for timer numbers)

Voice Delay Timer 0

This timer controls how long the voice delays before it starts to speak. This timer is usually set to less than 1 second.

Transmitter Hang Timer 1

This timer control the transmitter hang timer. When it is time for the transmitter to unkey the hang timer is started to hold the transmitter active for a little longer. This minimizes fast transmitter cycling when in repeater mode.

Courtesy Beep Timer 2

This timer control the time between receiver unkey and the time the courtesy message will be sent. This timer is only used when the RLC-ANG is set in the repeater controller configuration.

DTMF Mute Timer 3

This timer controls the time that the receiver audio is muted when DTMF tones are entered. This timer is only used when the RLC-ANG is in repeater mode.

DTMF Execution Timer 4

This timer controls the time the controller waits from the last DTMF digit received before it executes the command requested. This timer is only used when the RLC-ANG is set for timed DTMF execution.

Repeater Time-Out Timer 5

This timer controls the time-out timer when in repeater mode. This timer is started when the receiver goes active and is canceled when the receiver goes inactive. If the timer expires while the receiver is active the repeater transmitter will unkey until the receiver unkey.

Repeater Initial ID Timer 6

This timer controls the initial ID timer when in repeater mode. When this timer expires it enables the initial ID voice message to be sent when the repeater receiver becomes active. This timer is reset on receiver activity.

Repeater Pending ID Timer 7

This timer controls the pending ID timer when in repeater mode. When this timer expires it enables the pending ID voice message to be sent when the repeater receiver becomes active. This timer is only reset when the initial ID is sent. This timer continually runs during repeater activity.

Repeater ID Wait Timer 8

This timer controls the forced ID timer when in repeater mode. This timer is only used when an ID is requested, but the repeater receiver is still active. If this timer expires while the receiver is still active, the appropriate ID will be sent or (Forced). This timer is usually kept under 1 minute.

Alarm Beacon Timer 9

This timer controls the active alarm beacon timer when a system wide alarm is necessary. If the alarm beacon is enabled (See Command 35) and an analog alarm is enabled, and an analog alarm is present then this timer is used. When this timer expires the alarm beacon message (See Command 09) is sent and the timer is re-started. Once the beacon message is acknowledge, this timer is bypassed. This timer should be set to 3-5 minutes so alarms won't be missed.

Errors when programming:

Error 1 - Incorrect timer slot number

41 : Acknowledge a System wide Beacon Alarm

This command acknowledges a system wide alarm. When an alarm is present, and the beacon timer has expired (See Command 39) the alarm beacon message is sent. Once the beacon message has been sent, the beacon timer is restarted and this cycle continues. If the user acknowledges the alarm condition with Command 41, the cycle is broken until a change occurs in the system alarms.

Format:

<DTMF Name>41

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <41> is the command number associated with this command

Default:

Beacon message bypassed until an alarm occurs

Example: I hear a high temperature beacon message out my repeater and I know the alarm is present, how do I cancel the beacon message from cycling.

1) Execute Command 41 cancels the beacon cycle

#41 <unkey> or *

No Errors are provided for this command

42 : Recall all Analog Lines that are in Alarm

This command recalls all analog lines that are in alarm. If you have a beacon message running and want to locate the alarm causing line, simply execute Command 42. This will readback all lines that are in an alarm state. Once you have located the line in alarm you can take the appropriate action to clear the alarm condition. If no lines are in alarm the controller will respond 'Not In Alarm'.

Format:

<DTMF Name>42

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <42> is the command number associated with this command

Default:

All alarms disabled

Example: I hear a beacon message out my repeater and I know an alarm is present, but I do not know what alarm is present. How do I locate the line in alarm??

- 1) Execute Command 42 and all active analog alarms will be spoken
#42 <unkey> or *
- 2) If a line is in alarm the controller will speak it.

No Errors are provided for this command

43 : *Speak a Voice Message*

This command allows the user to speak a voice message before it is entered into the controller.

Format:

<DTMF Name>43 ###.###

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <43> is the command number associated with this command

Where '###.###' is a voice word from the voice table in Appendix C

A total of 20 words may be spoken in a voice message. This command is the same structure as Command 09 except the message slot number is not used.

Example: I want to see how a message will sound before I program it into a message slot.

My test message is:

'This_is The K F 7 F W Repeater <Pause> The Temperature Is XX Degrees'

1) Look-up your words to be spoken

This_is(171), The(170), K(040), F(035), 7(007), F(035), W(052), Repeater(147), Pause(189), The(170), Temperature(164), Is(110), Analog#1(225), Degrees(086)

2) Execute Command 43 and build a test message

#43 171 170 040 035 007 035 052 147 189 170 164 110 225 086 <unkey> or *

3) The controller will speak:

'This_is The KF7FW Repeater The Temperature Is 73 Degrees'

Errors when programming:

Error 1 - Too many or too few digits entered

Error 2 - Invalid word number

44 : Re-Initialize the Controller

This command needs only to be executed when returning your RLC-ANG back to factory defaults. If this command is executed all your programming, ID's messages and timers will be erased and the controller must be totally re-programmed. The user must enter a special code following Command 44 to tell the controller that you are serious about re-initialization of the controller.

Format:

<DTMF Name>44 123543

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <44> is the command number associated with this command

Where '123543' is the special access data to re-initialize the controller

The special data '123543' must be entered in for order for execution

Voice Response:

When the user remotely initializes the controller the voice message

"System Program Start" is spoken

Example: I want to clear everything out of my RLC-ANG and start over

- 1) Be sure you want to do the re-initialization
- 2) Again ask yourself 'Do I really want to do this'
- 3) Execute Command 44
 #44 123543 <unkey> or *
- 4) Now your controller is reset to factory defaults

Errors when programming:

Error 1 - Invalid special access code. The code must be '123543'

45 : Remote Reset the Controller

This command allows the user to remotely reset the RLC-ANG. This will not affect any of your programmed data. It will only reset your high\low readings to current readings. This is the same function as cycling your power off\on. Again, no information will be lost with this command.

Format:

<DTMF Name>45

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <45> is the command number associated with this command

Voice Response:

When the user remotely resets the controller the voice message

"Controller Ready" is spoken

Example: I want to re-start the controller remotely

1) Execute Command 45

#45 <unkey> or *

2) You will hear the reset message on start-up

46 : Set-up RTU Modbus Address, Baud, and Timers

This command allows the user set-up the controllers RTU mode features. This command will only affect the controllers baud rate, address and timer numbers when the RLC-ANG is programmed into RTU mode with Command 47.

Format:

<DTMF Name>46 aaa b ttt

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <46> is the command number associated with this command

Where AAA is the RTU's address ranging from 001..255 (0x01..0xff)

Where B is the RTU's baud rate

RS-232 Serial Baud Rate Default (0)	0 - 9600 Baud Rate N81	3 - 1200 Baud Rate N81
	1 - 4800 Baud Rate N81	4 - 600 Baud Rate N81
	2 - 2400 Baud Rate N81	5 - 300 Baud Rate N81

Where TTT is the execution timer. This timer sets the time between the last serial byte received and the time the RTU will wait before executing the received serial packet. This timer should be at least 3x baud rate character to keep the RTU from executing the serial stream too early. This timer programs in 10mS increments.

Default:

RTU address = 001

Baud rate = 9600 N-8-1

Execution timer = 50mS

Voice Response:

Number is <AAA> and Rate is and the timer is <TTT>

Example: I want to set-up RTU mode

1) RTU address = 080 (0x50 hex)

2) Baud rate = 1200 baud

3) Execution timer = 40mS

You will enter from the radio port: #46 080 3 004 <unkey>

Voice response: Number is <080> and Rate is <3> and the timer is <004>

You will enter from the RS-232 port: 46 080 3 004 <Enter>

Serial response: Number is 0 8 0 and Rate is 3 and the timer is 0 0 4

47 : Enable / Disable RTU Modbus Control Mode

This command allows the user turn on/off the RTU modbus control mode. When in this mode the serial port will be configured for modbus address hex operation mode. RTU parameters are set-up using Command 46.

Format:

<DTMF Name>47 c

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <47> is the command number associated with this command

Where C is the control variable

0 = Terminate RTU mode and return to ASCII terminal mode

1 = RTU modbus mode. (See description at front of the manual)

Default:

ASCII terminal Mode

Note:

When in RTU mode there may be a need to terminate RTU mode and return to normal ASCII mode on the RLC-ANG controller. If this need arises simply write a register using Modbus command <13> at address location X00001 with the value 0xabcd. When you execute this command the RTU will return back to ASCII mode. It is important not to place this command in your masters polling routine. If this command were to be executed the remote RTU will go from the operation mode to the programming mode.

- X0001 0xabcd cancel RTU mode

Voice Response:

Remote Programming Condition <ON/OFF>

48 : Enable / Disable 4mA to 20mA Analog Inputs

This command allows the user turn on/off the controllers conversion changes when a 4mA-20mA input is connected. If the user does not tell the controller a 4mA-20mA input is connected, the analog readings will be off slightly. When the controller is told a 4mA-20mA input is connected, it offsets the 4mA reading to read as 0, and offsets the 20mA reading to read as full scale. Any analog faceplate can be assigned to a 4mA-20mA input. The slope change occurs before any faceplate is assigned.

Format:

<DTMF Name>48 l c

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <48> is the command number associated with this command

Where L is the analog input line. This number is between 1 and 8

Where C is the control variable

0 = Normal analog input signal

1 = 4mA-20mA analog input connected

Default:

All analog inputs selected for normal mode (0).

49 : Recall the 4mA to 20mA Analog Input Controls

This command recalls the 4mA-20mA conversion changes set-up in Command 48.

Format:

<DTMF Name>49 L

Where <DTMF Name> is the 1..6 digits needed for DTMF access

See Command 11,12 for DTMF name programming

Where <49> is the command number associated with this command

Where L is the analog input line. This number is between 1 and 8

Default:

All analog inputs selected for normal mode (0).

Appendix A - Voice Word List

ZERO	000	P	045	DOWN	090	PHONE	135
ONE	001	Q	046	EMERGENCY	091	PLEASE	136
TWO	002	R	047	ENGINE	092	PLUS	137
THREE	003	S	048	ERROR	093	POINT	138
FOUR	004	T	049	EXIT	094	POWER	139
FIVE	005	U	050	FAIL	095	PRESSURE	140
SIX	006	V	051	FAILURE	096	PROBE	141
SEVEN	007	W	052	FARENHEIT	097	PRGRMING	142
EIGHT	008	X	053	FIRE	098	RADIO	143
NINE	009	Y	054	FLOW	099	RATE	144
TEN	010	Z	055	FROM	100	READY	145
ELEVEN	011	ABOVE	056	GET	101	REMOTE	146
TWELVE	012	AIR	057	GO	102	REPEATER	147
THIRTEEN	013	ALERT	058	GROUND	103	RIGHT	148
FOURTEEN	014	ALL	059	HALF	104	ROAD	149
FIFTEEN	015	AMPS	060	HAVE	105	SAFE	150
SIXTEEN	016	AND	061	HIGH	106	SECONDS	151
SEVENTEEN	017	AS	062	IN	107	SENCE	152
EIGHTEEN	018	AT	063	INCREASE	108	SERVICE	153
NINETEEN	019	AUTOMATIC	064	INTRUDER	109	SET	154
TWENTY	020	BASE	065	IS	110	SHUT	155
THIRTY	021	BATTERY	066	IT	111	SIDE	156
FORTY	022	BELOW	067	LINE	112	SMOKE	157
FIFTY	023	BUSY	068	LOCK	113	START	158
SIXTY	024	BY	069	LONG	114	STOP	159
SEVENTY	025	CALIBRATE	070	LOOK	115	SWITCH	160
EIGHTY	026	CALL	071	LOW	116	SYSTEM	161
NINETY	027	CANCEL	072	MACHINE	117	TANK	162
HUNDRED	028	CAUTION	073	MEASURE	118	TELEPHONE	163
THOUSAND	029	CELSIUS	074	METER	119	TEMPERTR	164
A	030	CHANGE	075	MICRO	120	TEST	165
B	031	CHECK	076	MINUS	121	THANKYO	166
C	032	CIRCUIT	077	MOTOR	122	THAT	167
D	033	CLEAR	078	NEGATIVE	123	THE(LNGE)	168
E	034	CLOSED	079	NO	124	THE(SRTE)	169
F	035	CONDITION	080	NOT	125	THE	170
G	036	CONNECT	081	NUMBER	126	THIS-IS	171
H	037	CONTACT	082	OF	127	TIMER	172
I	038	CURRENT	083	OFF	128	UNDER	173
J	039	CYCLE	084	OIL	129	UNIT	174
K	040	DANGER	085	ON	130	UP	175
L	041	DEGREES	086	OPEN	131	USE(NOUN)	176
M	042	DEVICE	087	OPERATION	132	USE(VERB)	177
N	043	DIAL	088	PATCH	133	VARIABLE	178
O	044	DOOR	089	PERCENT	134	VOLTS	179

WAIT	180	ANG1 LOW	233
WARNING	181	ANG 2 LOW	234
WATCH	182	ANG 3 LOW	235
WATTS	183	ANG 4 LOW	236
WELCOME	184	ANG 5 LOW	237
WITH	185	ANG 6 LOW	238
YOU	186	ANG 7 LOW	239
YOUR	187	ANG 8 LOW	240
ZONE	188	ANG1 HIGH	241
PAUSE	189	ANG2 HIGH	242
LASER	190	ANG3 HIGH	243
WHISTLE	191	ANG4 HIGH	244
PHASER	192	ANG5 HIGH	245
TRAIN	193	ANG6 HIGH	246
EXP	194	ANG7 HIGH	247
CROWD	195	ANG8 HIGH	248
HILOTONE	196	Output ON	249
LOHITONE	197	Output OFF	250
HITONE	198		
ALARM	199		
ANALOG	200		
AUTOPATH	201		
CHARGING	202		
COMNICTNS	203		
CONTROLLER	204		
DIGITAL	205		
INPUT	206		
INSIDE	207		
LINK	208		
MEDIUM	209		
MONITOR	210		
OUTSIDE	211		
PEAK	212		
POUND	213		
PUMP	214		
STAR	215		
VALUE	216		
VOLTAGE	217		
WATER	218		
ANG1READ	225		
ANG2READ	226		
ANG3READ	227		
ANG4READ	228		
ANG5READ	229		
ANG6READ	230		
ANG7READ	231		
ANG8READ	232		

Appendix B - Initializing and Resetting the RLC-ANG

Re-Initialization of the RLC-ANG

When the RLC-ANG powers up or the reset button is pressed, a warm reset is processed. This reset will load the most recently programmed variables into the controller. The variables are stored in the nonvolatile EEPROM cell located inside the microprocessor. If the variables in the EEPROM get scrambled somehow, a cold boot will be needed. This cold boot resets all of the RLC-ANG's variables to the factory settings - anything you have programmed will be lost. This cold boot is accomplished by executing Command 44 followed by the special access word. The initialization process will be complete when the RLC-ANG sends out the initialization Copyright and Version message.

After re-initialization the voice message "System Program Start" will be spoken.

Resetting the RLC-ANG

There are several ways to reset the RLC-ANG controller.

- 1) Remove and re-apply the system power
- 2) Press and release the switch marker 'Reset' on the controller
- 3) Access Controller Set-Up Command 09

Resetting the controller will not change any of the system variables, just reset the controller to square 1. Resetting will clear the analog input lines High/Low values.

After reset the voice message "Controller Ready" will be spoken.

Appendix C - Troubleshooting

No Audio at Test Bus:

- Check for main system power (+12 Volts plugged in).
- Is there a valid COR signal present if in full-duplex mode?
- Check the Mute switch.
- Is the Access mode COR correct for the attached radio?
- If access mode is PL is PL present
- Check COR and PL polarities

Have audio at the test bus, but not on the transmitter:

- Are the output audio pots turned up (clockwise)?
- Is the transmitter connected to the audio output (high)?

The Voice Volume seems Low, or not at all:

- Turn up the pot marked "Voice" and/or "Audio Out"
- Is the COR active therefore causing a polite voice hold
- Check Command 35 for polite voice mode

When I connect my COR and/or PL, the RLC-ANG will not accept it:

- Does the COR/PL go to ground when active?
- If so is the COR/PL polarity selected correctly in Command 32?
- Does the COR/PL go above 4 volts when active?
- Can the COR/PL sink 2mA when active?
- Does the 5V pull-up resistor conflict with your radio?
- Motorola R-100 Repeaters are susceptible to this
- Solution: open collector the driver on R-100 repeaters

When I connect my serial terminal, I do not get any data:

- Is your terminal baud rate set to 9600,N,8,1?
- The RLC-ANG defaults to 9600 Baud upon re-initialization
- Is your serial terminal plugged into P4 serial connector?
- Are all the RS-232 TX and RX and ground wires connected?
- You should use a straight-through (not null-modem) cable in most cases.
- Are you in RTU mode?? (See Command 47)
- Is your address Correct (See Command 46)
- Is your master RTU's baud rate correct (See Command 46)

DTMF Valid LED flashes, but nothing happens:

- Are you entering the correct DTMF command name?
- Default name begins with '#'
- Command numbers are listed with each command
- Is your transmitter hooked up?
- Is there valid PTT present from the RLC-ANG?
- Are the Voice and TX pots adjusted?

Number converted is not what it should be:

- Have you selected the correct faceplate?
- Is the voltage divider in the circuit (Temperatures and 0-4 Volt Range)?
- Is the external voltage divided to the correct input voltage?
- See pages Commands 13 for conversion faceplates.

Appendix D: Modem to Serial Port Interfacing for RLC Series Controllers

The RLC controllers support a full duplex serial port for interfacing to a computer or serial terminal. This connection can be made with just a cable, a telephone modem, a packet TNC, or any other method that will send the serial characters back and forth (some have even used Telnet over the Internet).

Using a Telephone Modem

There are two ways to control the RLC controllers over the phone line. If the RLC-controller has an autopatch, you can control it using the reverse autopatch and entering commands with the telephone's DTMF pad. This works well for small changes, but if you want to do a lot of programming remotely, it is nice to do it with a computer. You can do this by putting an external modem on the controller and calling it from a modem attached to your computer (either internal or external). The modem should be connected to the controller's serial port - it has nothing to do with the autopatch. You can either run separate phone lines to the autopatch and the modem, or you can split the phone line and use it for both (one at a time, of course).

Sharing 1 phone line with your autopatch

You can either have your computer call the modem and have it answer or you can have the controller call your computer. If you want to call the controller and have the modem answer and you plan to use the reverse autopatch, you will have to have a way of determining which one answers the phone. The most common way is to set the modem to answer on three rings, then to change the reverse patch setup to make it answer on either 1 or 5 rings (you can do that with a couple of macros). Whichever one answers first will make the connection. It is also possible to use a call routing interface (similar to a fax switch) to detect whether you are calling with a modem or not or to make you press DTMF digits to get to the modem.

Controller calls your computer

The other option is to make the controller call your computer (If this function is supported on your controller). This is usually done by sending a DTMF command to the controller to tell it to call you, which means you can't connect with the modem if there is a problem with your receiver. The DTMF command usually calls a macro that sends "ATDT <phone number>" to the modem. The advantage of having the controller call you is that it doesn't conflict with the reverse patch and since the phone number is hard coded in the macro, you can be sure that no one else will call the controller with their modem and get control (since the modem can be set not to answer). If you plan to use this method, you may have to turn off line feed sending, since most modems will abort the dialing process if they receive any more serial characters after "ATDT<phone number><carriage return character \$0D hex or 014 decimal>" and the controller usually sends both a carriage return and line feed at the end of each line.

Before connecting the external modem to the controller, you should connect it to your computer or serial terminal and enter some setup commands. Even if you already have a modem in your computer, you need to hook up the modem that will go on the controller to set it up. You can use a standard modem cable for this, or build one according to the chart below. Note that this cable is different than the one that you will use between the controller and the modem, even if the connectors are the same (pins 2 and 3 are swapped).

Computer to Modem Cable

Computer DB-9	Computer DB-25	Description	Modem DB-9	Modem DB-25
3	2	Data Out of Computer	3	2
2	3	Data Into Computer	2	3
.....	.....	Hand Shaking Line	.....	4 to 5
.....	.....	Hand Shaking Line	.....	6 to 8
.....	.....	Hand Shaking Line	.....	8 to 20
5	7	Ground	5	7

You will not need to connect the modem to the phone line to enter these setup commands. Load your communications program and set the communications port to talk to the external modem (it will probably be set for the internal modem when you start). Enter "ATZ" (without the quotes) and press enter. You will see an "OK" response if everything is hooked up right. Then enter (without the quotes, pressing enter after each command):

- "AT&F" to set everything to factory defaults.
- "ATS0=3" to make the modem answer after 3 rings or "ATS0" to keep the modem from answering at all.
- "AT&K0" to disable local flow control (the controller doesn't support it).
- "ATE0" to disable local echo.
- "ATQ1" to keep the modem from sending result codes.
- "AT&W"** to store the settings to the modem's non-volatile memory.
- "AT&W1"** to store the settings to the modem's non-volatile memory.

RS-232 Signals and Interfacing

The RLC-controllers input and output is the RS-232 standard, $\pm 12V$. The pin-out is standard for a 9-pin serial connector (Except for the RLC-2/2a controller). To connect to a terminal or computer's 9-pin serial connector, use a straight-through cable (not a null modem) with at least pins 2, 3, and 5 connected. To connect to a computer with a 25-pin serial connector, you can use a standard 9 to 25-pin converter or wire your own cable. To wire your own, connect the RLC-controllers pins 2, 3, and 5 to the computer's 3, 2, and 7 respectively.

If you are connecting the controller to a modem, you will need to swap pins 2 and 3 relative to how you would connect it to a computer or run your cable through a null-modem adaptor. This is because master and slave devices (DTE and DCE devices) are wired differently. When hooking the controller and a modem (both slave devices) together, you have to adjust accordingly. The following chart summarizes the four different types of cables you may need.

Controller to Computer or Modem Cable

Controller DB-9	Description	Computer DB-9	Computer DB-25	Modem DB-9	Modem DB-25
2	Data Out of Controller	2	3	3	2
3	Data Into Controller	3	2	2	3
5	Ground	5	7	5	7

Communications Parameters

After connecting your terminal, computer, or modem (either packet or telephone) to the RLC-controllers, you need to make sure that the communications parameters match on both ends. The default settings for the RLC-controllers are 9600 N-8-1:

Baud Rate	9600
Parity	None (N)
Word Length	8
Stop bits	1

If you are using a modem, you may be able to set the baud rate that the modem uses to communicate with the controller to be different than the speed at which it connects to the other modem. In other words, a 2400 baud modem may be able to connect to the controller at 9600 baud and to the other modem at 2400 baud.

Troubleshooting

- If you can't get the connection between your computer or serial terminal and the controller to work, there are several things you can check. Make sure that the serial cable is properly connected between a serial port on your computer and the serial port on the controller and that the controller is powered up. Load your communications software (Procomm, Telix, the Windows terminal program, etc) and make sure it is set for the right communications port and baud rate. Whenever you reset the controller (or cycle the power) it will output a serial message you should see on the screen. Pressing enter should get you a "DTMF>" prompt that indicates that it is ready to accept the same commands you might enter from a radio's DTMF pad. If neither the reset message or pressing enter gets any response, double check that you have the communications port set right on your computer. Then disconnect the serial cable from the controller and short pins 2 and 3 on that end of that cable together (those are the data in and out pins). Then type on the keyboard and see if what you type shows up on the screen - it should (even with echo turned off). If you quit shorting those pins, the data should not show up on the screen. If you cannot get the data to show up on the screen by shorting those two pins, the problem is either in the computer or the cable (the controller isn't even hooked up). The most common problem is having the communications port set wrong - try all the settings. Then check your cable again. If you still can't get it to echo, unhook the cable from the computer and try shorting pins 2 and 3 together on the serial port right at the computer, eliminating the cable as a possible problem. Again, you should see whatever you type appear on the screen. If you don't, the problem is in the computer or how you have the communications program set up. Once you get it to echo with the jumper wire at the computer, hook up the cable to the computer and try the jumper wire at the other end of the cable. If that doesn't work, the problem is in the cable. Finally hook the cable back up to the controller and try again. If the characters echo but don't work, you may be in 7 bit mode rather than 8 bit mode. If all else fails, feel free to contact Link Communications, Inc. for help on our Technical Support Number: 1-406-482-7515.

Glossary:

Active Low - Indicates the when active, the input is at ground potential

Active High - Indicates the when active, the input is at a voltage above ground

COR - Receiver Activity Signal other wise known as COS

Dry Contact Input - A input that is commonly used with a typical on/off switch for detecting such things as open doors.

Kerchunk - Quickly keying up and unkeying a receiver.

PTT - Transmitter Push to Talk

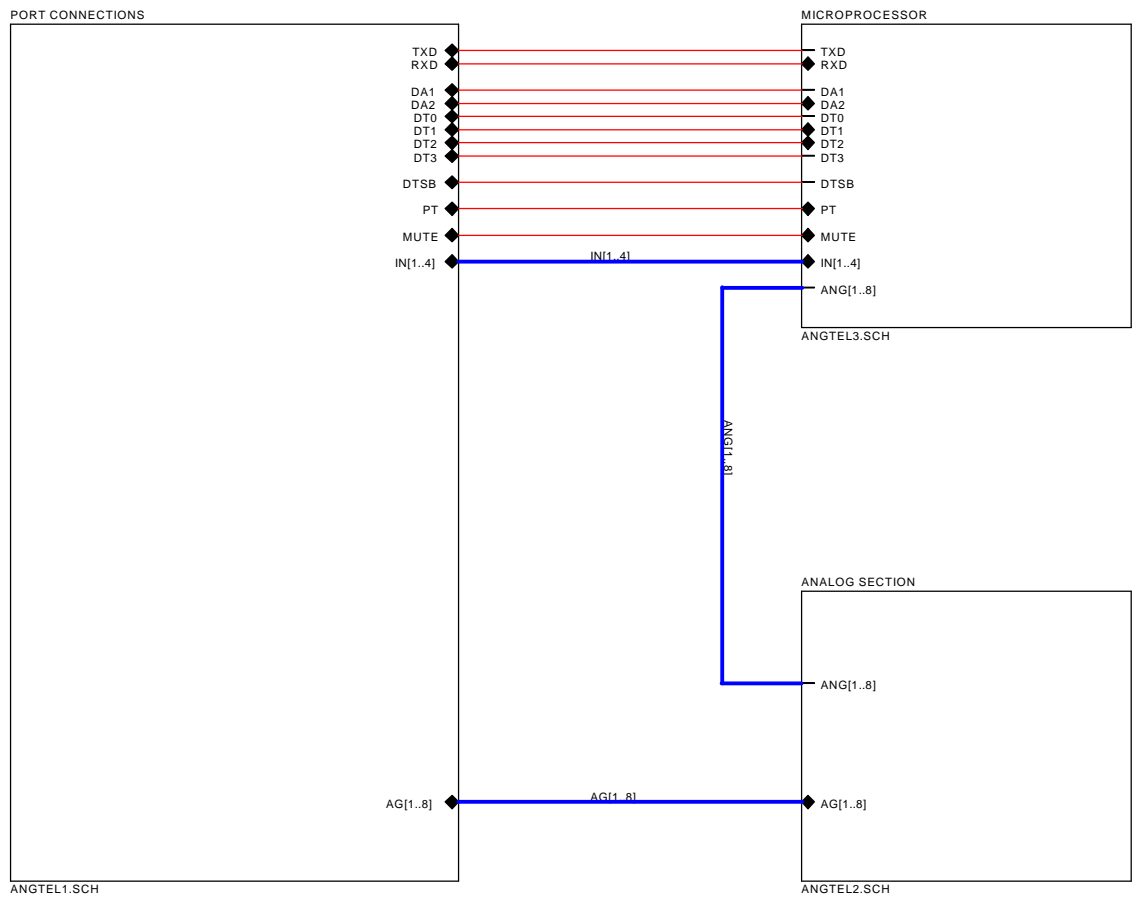
RX - Receiver

TX - Transmitter

RTU - Remote Telemetry Unit

CRC - Cyclical Redunancy Check (RTU Error Checking mode 16 bits)

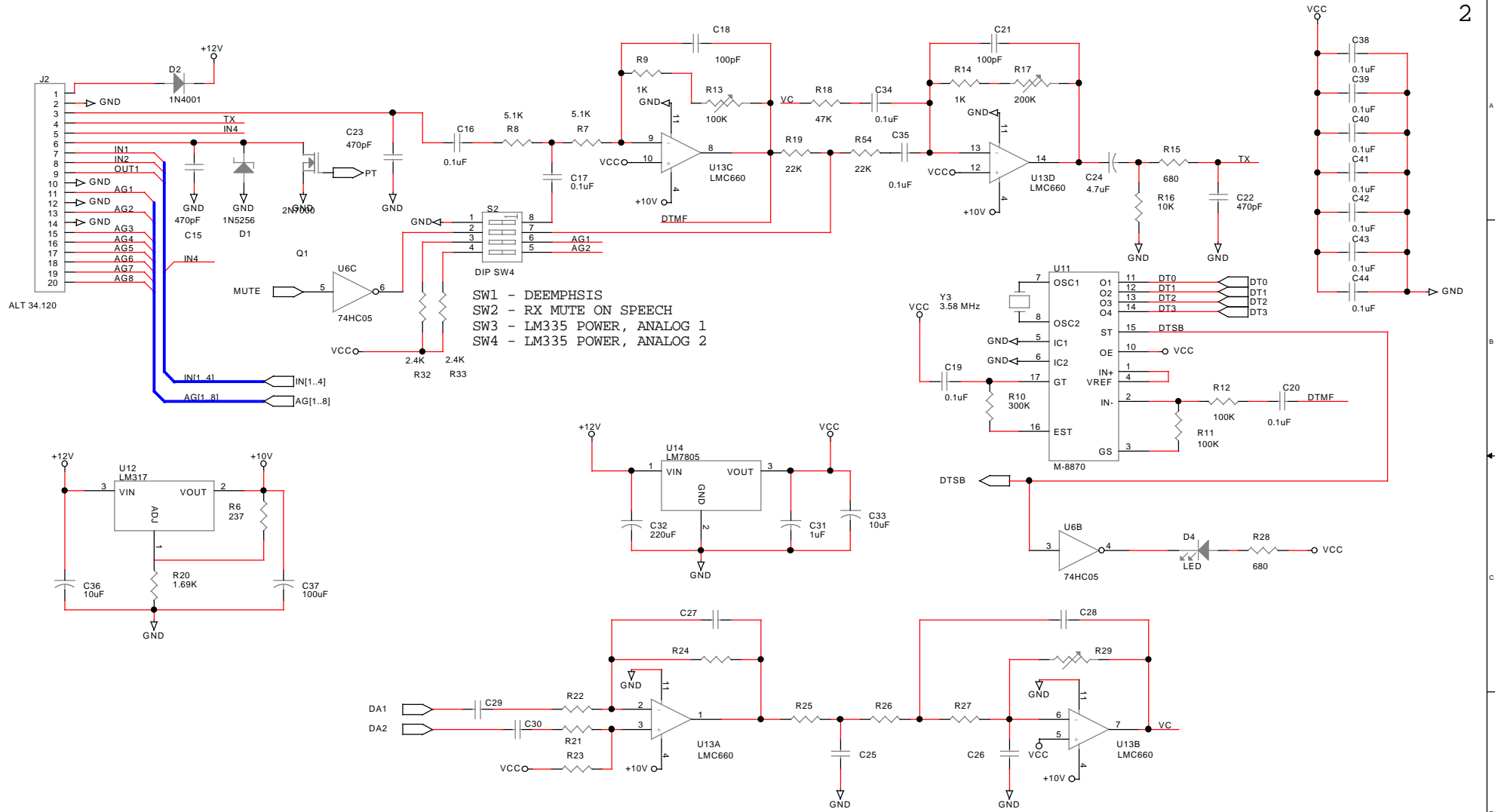
Schematic Diagrams:



LINK COMMUNICATIONS ANALOG/VOICE TELEMETRY UNIT

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Date: Friday, August 16, 1996	Sheet 1	of 4

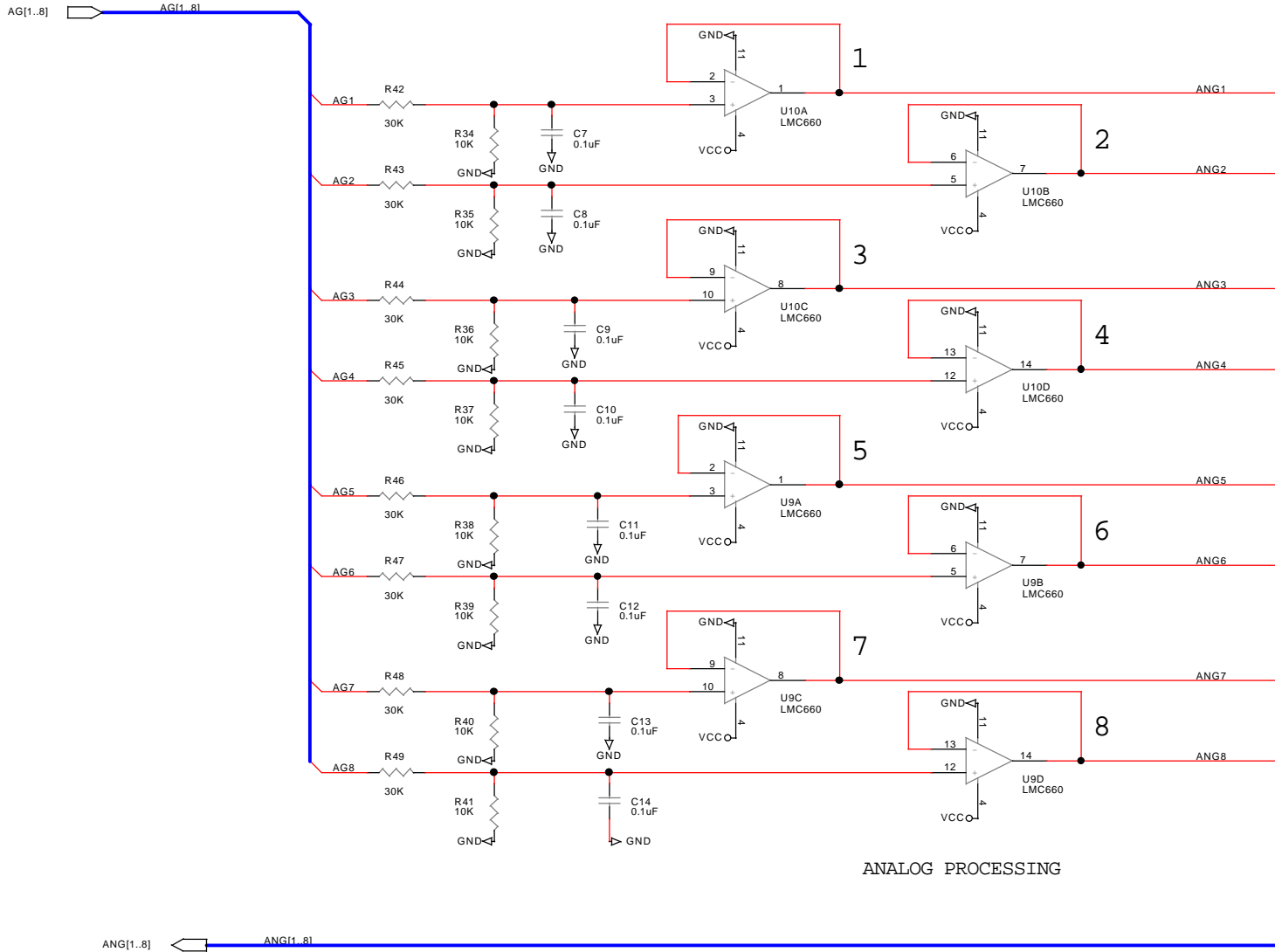
ALT 34.120



- SW1 - DEEMPHSIS
- SW2 - RX MUTE ON SPEECH
- SW3 - LM335 POWER, ANALOG 1
- SW4 - LM335 POWER, ANALOG 2

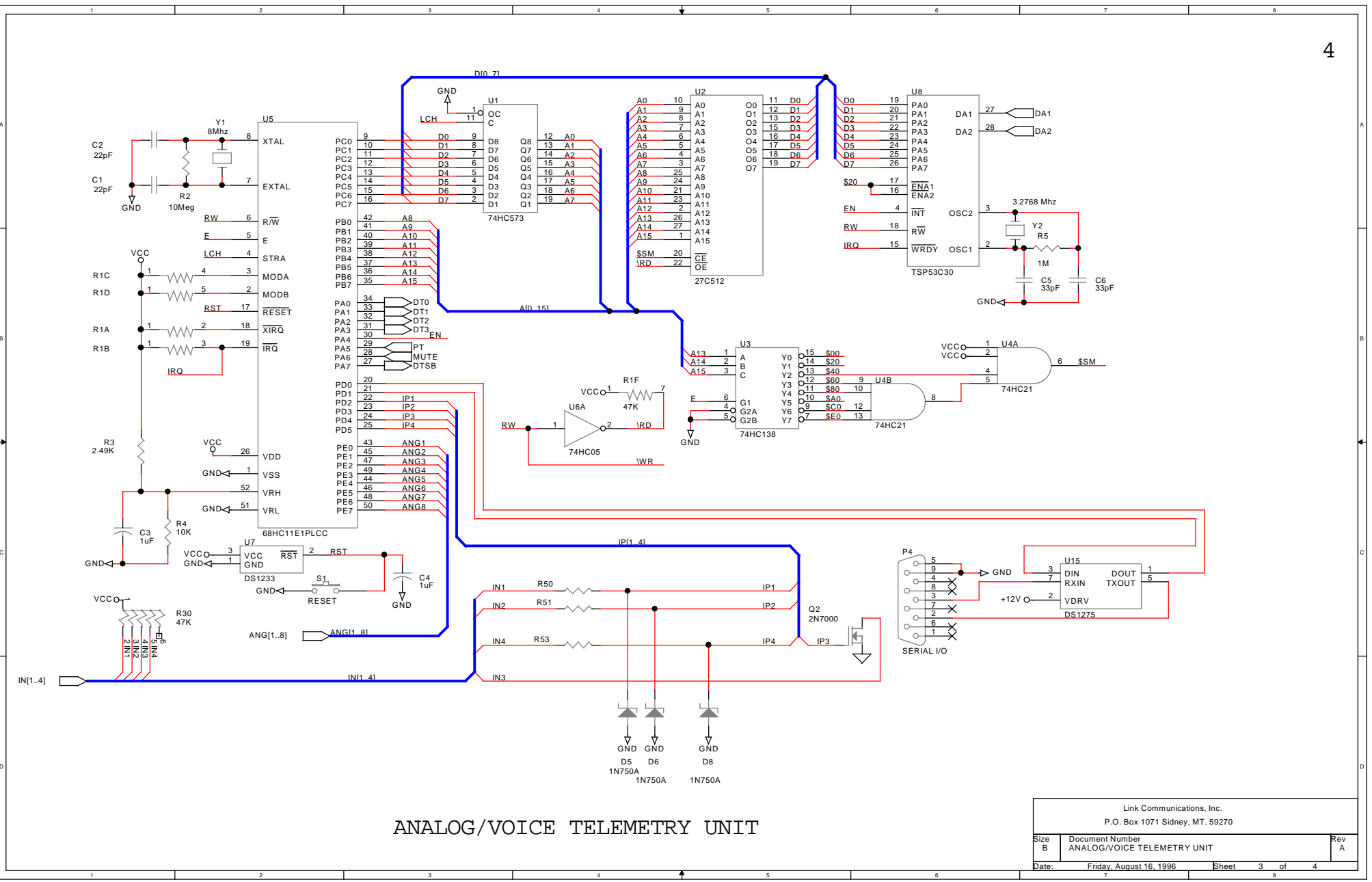
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Board Layout

ANALOG/VOICE TELEMETRY UNIT Revision: A

Bill Of Materials

Item	Quantity	Reference	Part
1	2	C1,C2	22pF
2	3	C3,C4,C31	1uF
3	2	C5,C6	33pF
4	23	C7,C8,C9,C10,C11,C12,C13, C14,C16,C17,C19,C20,C29, C30,C34,C35,C38,C39,C40, C41,C42,C43,C44	0.1uF
5	3	C15,C22,C23	470pF
6	3	C18,C21,C27	100pF
7	1	C24	4.7uF
8	1	C25	2000pF
9	1	C26	68pF
10	1	C28	0.01uF
11	1	C32	220uF
12	2	C33,C36	10uF
13	1	C37	100uF
14	2	D1,D7	1N5256
15	1	D2	1N4001
16	1	D4	LED
17	3	D5,D6,D8	1N750A
18	1	J2	20 Pin Phoenix

Bill of Materials Cont...

Item	Quantity	Reference	Part
19	1	P4	DB9RA/F
20	1	Q1,Q2	2N7000
21	1	R1	47K SIP/10
21a	1	R30	47K SIP/6
21b	4	R18,R24,R25,R26	47K
22	1	R2	10Meg
23	1	R3	2.49K
24	12	R4,R16,R23,R27,R34,R35, R36,R37,R38,R39,R40,R41	10K
25	1	R5	1M
26	1	R6	237
27	2	R7,R8	5.1K
28	5	R9,R14,R50,R51,R53	1K
29	1	R10	300K
30	1	R11,R12	100K
30a	1	R13	100K Variable
31	2	R15,R28	680
32	2	R17,R29	200K Variable
33	2	R19,R54	22K
34	1	R20	1.69K
35	2	R21,R22	24.9K

Bill of Materials Cont...

Item	Quantity	Reference	Part
36	2	R32,R33	2.4K
37	8	R42,R43,R44,R45,R46,R47, R48,R49	30K
38	1	S1	Button Switch
39	1	S2	DIP SW4
40	1	U1	74HC573
40a	1	U1s	20 Pin Socket
41	1	U2	27C512
41a	1	U2s	28 Pin Socket
42	1	U3	74HC138
42a	1	U3s	16 Pin Socket
43	1	U4	74HC21
43a	5	U4s,U6s,U9s,U10s,U13s	14 Pin Socket
44	1	U5	68HC11E1FN
44a	1	U5s	52 Pin PLCC
45	1	U6	74HC05
46	1	U7	DS1233
47	1	U8	TSP53C30
47a	1	U8s	28 Pin S-Socket
48	3	U9,U10,U13	LMC660
49	1	U11	M-8870

Bill of Materials Cont...

Item	Quantity	Reference	Part
49a	1	U11s	18 Pin Socket
50	1	U12	LM317-T
51	1	U14	LM7805-T
51a	2	U12,U14 Mounting	6-32/0.25 Screw
52	1	U15	DS1275
52a	1	U15s	8 Pin Socket
53	1	Y1	8Mhz Xtl
54	1	Y2	3.2768 Mhz Xtl
55	1	Y3	3.58 MHz Xtl