Chapter 12: I/O System

About the I/O System

The RLC-Club supports eight open collector outputs (Requires the RLC-Club Deluxe Module) and 5 analog input lines (which can also be used as digital inputs). Each type is handled totally separately in software; each command applies to only one of the three types of lines. Each type will be described below.

Note that you can control how often the RLC-Club checks the analog/digital input lines and analog alarms by using Command 020 to change the duration of timer 11. The default is to check the alarms once per second.

Open Collector Output Lines

The open collector outputs are supported only with the RLC-Club Deluxe module. When turned on, an open collector output gets connected to ground; when turned off it is an open circuit. The open collector output lines never output any voltage. The way they are commonly used is to connect one lead of the coil of a relay (or whatever else you want to control) to 12 volts and the other lead to an open collector output line. When the open collector output is turned on and applies a ground, the coil of the relay will be energized and will turn the relay on. The open collector output line can "sink" (apply a ground of) about 150 milliamps. Connecting an open collector output line directly to a power supply and turning it on will destroy the output driver. Make sure that whatever you are turning on and off draws less than 150mA.

The open collector output lines can be turned on and off with Commands 093 and 094. You can recall whether a line is currently on or off with Command 095. If you want to speak a custom message when you turn an open collector output on or off, program one of the user macros to speak the message you want, execute Command 038 (to suppress the rest of the voice responses), and then turn the open collector output line on or off.

Analog/Digital Input Lines

The input lines on the RLC-Club are designed to handle input voltages ranging from 0 to 5 volts. The voltage on these lines can be read and processed as an analog voltage (so the controller can tell the difference between 0V, 1V, 2V...5V) or the same inputs can be treated as digital inputs (so they simply read high or low).

Inputs 1, 2 and 3 have internal pullup resistors which allow them to be used with LM335 temperature sensors or to be connected directly to an open collector or relay output that connects

to ground when turned on. Input #4 is wired internally to the power supply voltage. Input #5 (on pin 4 of the DB-9) has no pullup resistor, which makes it suited for reading receiver signal strength indications or other voltage sources that would be adversely affected by a pullup resistor.

Digital Input Lines

Digital inputs lines can only distinguish between two levels, high and low. If the voltage on the input is below 0.5V, it will consistently read low. If it is above 3.5V, it will consistently read high. If it is between 0.5 and 3.5V, it may read inconsistently. If the connected device does not keep the voltage high enough or low enough to read consistently, you may need to buffer it with a relay or transistor. Do not apply negative voltage to an input line.

If the digital input line has a pullup resistor, it can be directly interfaced with an open collector output or a switch with one lead connected to ground. When open collector output or switch does not pull the line low, the pullup resistor will make sure it reads high.

Digital input lines can be used in three ways.

- Command 090 can read an input line and tell you whether it is high or low.
- A custom voice message can be assigned to each state of an input line, such as "door open" and "door shut" (instead if high and low). To do this, program the voice messages you want to be spoken for the high and low states into the input line macros (see automatic macros in Chapter 8). You can then cause the appropriate message to be spoken by executing Command 091.
- If you want a message to be spoken whenever an input line changes from high to low or low to high, you can cause the macros you programmed in the step above to automatically be executed at those times by enabling an "input line alarm" with Command 092. You could use this feature along with a door switch to tell you when someone opens or closes a door.

Analog Input Lines

When an input line is used as an analog line, the way the voltage is interpreted can be customized, so rather than telling you the voltage directly, the controller can convert the voltage to a temperature, percentage, wind speed, etc. The information needed to set up a variety of common conversions is provided in a chart (see command 102). If you have an unusual application, it is possible to set up a custom conversion scale.

If you need to set up a custom conversion scale, you will need to deal with the following issues:

"**Resolution**" refers to how many digits after the decimal place you want to know about.

Temperature is usually read to the nearest degree, zero digits after the decimal. When reading a battery or power supply's voltage, you probably want to hear more than "thirteen volts" or "fourteen volts", something like "thirteen point six volts". To obtain this kind of reading, you would specify one digit after the decimal point.

The "**conversion ratio**" specifies how the controller interprets the voltage it detects. It could also be called the "scale" or "meter faceplate". If you are measuring wind speed, you may want a reading that varies from zero to 100 MPH. If wind direction, zero to 360 degrees. If pH, zero to 14. If temperature, way below zero to a hundred degrees or more. No matter what scale you want the reading to use, the voltage going into the analog line must be between 0 volts and 5 volts. If you have a sensor to measure something in the physical world that can provide a voltage that varies between 0 volts and 5 volts, you can set up the conversion ratio to handle it. The point of this discussion is to make it clear that the controller does not care what the real-world quantity is, it just needs a variable voltage and the proper conversion ratio. You tell the RLC-Club what the conversion ratio is by specifying two points:

> The first is what real world quantity would cause the sensor to output 0 volts. In many cases this is zero. For example, if you are using a small motor with a propeller to detect wind speed and the wind is not blowing, you will get 0 volts. But what about temperature? If our sensor outputs 0 volts for zero degrees, how would we get negative temperature readings? The analog lines can only accept positive voltages. The answer is that we use a temperature sensor that outputs about 2.5 volts at zero degrees, less than that when below zero and more than that when above zero. So our first conversion point for temperature says that it would have to be 460 degrees below zero to get 0 volts out of the sensor.
>
> The second point we set specifies what real world quantity would cause the sensor to output 5 volts. If your wind speed detector outputs 5 volts when the wind is blowing 150 MPH, this point would be 150. For the temperature sensor we use (the LM335), it would have to be 440 degrees out to get 5 volts out of the sensor.

"Calibration" refers to correcting for small errors in a reading. If the controller tells you it is 85 degrees when it is 88, you can calibrate it to correct for the small error. If it is way off, you probably have the conversion set wrong.

You can also set "analog alarms". These will cause a macro to be executed whenever the value read on one of the analog lines goes above or below a preset value. See Commands 104..107 for more information.

Inputs Connector Pin-Out

Analog/Digital Input Lines (on main RLC-Club board)

Function	Pin Number	Typical Use	Other
Input 1	1	Temperature or Contact Closure	With internal pullup resistor
Input 2	2	Temperature or Contact Closure	With internal pullup resistor
Input 3	3	Temperature or Contact Closure	With internal pullup resistor
Input 4	Internal	Power Supply Voltage	Connected to power supply voltage with divider
Input 5	4	S-Meter	No Pullup Resistor
Ground	5,6,7,8,9	...	...

Open Collector Output Connector on Deluxe

(This pinout is the same as the outputs connector on the RLC-2)

Function	Pin Number	.	Function	Pin Number
Output 1	9	.	Output 6	3
Output 2	5	.	Output 7	6
Output 3	8	.	Output 8	2
Output 4	4	.	Ground	1
Output 5	7	.	...	...

090: Read Whether Digital Input Line is High or Low

This command allows you to read the digital input lines. The controller will speak a message that indicates whether the line is high or low. Some lines have internal pullup resistors; see the inputs connector pinout for more information.

<090> L	Read single digital input line
<090> L..L	Read multiple digital input lines

Parameters:

- 090 is the default command name.
- L is the digital input line number (1..4)

Notes:

To provide customized messages for the digital input lines, see Command 091.

091: Execute Digital Input Line High or Low Macro

This command is similar to Command 090. The difference is that instead of speaking the word "high" or "low", the high or low internal macro for that digital input line will be executed. This allows you to program custom messages such as "door open" and "door shut". See Chapter 8 to find the macro numbers for each digital input line.

<091> l	Execute macro for one digital input line
<091> l..l	Execute macros for multiple digital input lines

Parameters:

- 091 is the default command name.
- L is the digital input line number (1..4)

Notes:

Multiple digital input lines can be read with one call to this command by entering more than one port number here.

092: Enable/Disable Digital Input Line Alarm

This command allows you to turn on digital input line alarms that will occur whenever an digital input line goes high or low. When the alarm occurs, it will execute the digital input line high or low macro. Note that these are the same macros that get executed by Command 091 whenever the digital input line is read. The high and low alarms can be enabled or disabled separately.

<092> l a c

Parameters:

- 092 is the default command name.
- L is the digital input line number (1..4)
- A is 1 for the high alarm, 0 for the low alarm
- C is 1 to enable the alarm, 0 to disable it

Note:

There is currently no command to recall whether the digital input line alarm is turned on or off.

093: Turn Open Collector Output Line On

This command allows you to turn an open collector output line on. The outputs are active low open collector drivers, so on means that they apply a ground to that open collector output. Off means that the open collector output is open, or not hooked to anything. The outputs are only supported on the RLC-Club Deluxe interface.

<093> l	Turn a single open collector output line on
<093> l..l	Turn multiple open collector output lines on

Parameters:

- 093 is the default command name.
- L is the open collector output line number (1..8)

Notes:

To provide customized messages when turning open collector output lines on or off, use a macro that both executes this command and the speak voice message command (036).

094: Turn Open Collector Output Line Off

This command allows you to turn an open collector output line off. The outputs are active low open collector drivers, so on means that they apply a ground to that open collector output. Off means that the open collector output is open, or not hooked to anything. The outputs are only supported on the RLC-Club Deluxe interface.

<094> l	Turn a single open collector output line off
<094> l..l	Turn multiple open collector output lines off

Parameters:

- 094 is the default command name.
- L is the open collector output line number (1..8)

Notes:

To provide customized messages when turning open collector output lines on or off, use a macro that both executes this command and the speak voice message command (036).

095: Recall Whether Open Collector Output Line is On or Off

This command allows you to recall whether the open collector output lines are turned on or off. The outputs are only supported on the RLC-Club Deluxe interface.

<095> l	Check a single open collector output line
<095> l..l	Check multiple open collector output lines

Parameters:

- 095 is the default command name.
- L is the open collector output line number (1..8)

Notes:

To provide a customized message when an open collector output line is turned on or off, call Commands 093 or 094 from a macro that also speaks a voice message. There is no easy way to get a customized message to recall whether a line is on or off at the current time without turning it on or off again. If you really need custom recall messages and you are very familiar with macro programming, read the following, otherwise don't bother. The idea is to use a macro to call the open collector output line on and off commands. Also in that on/off macro, call the program-single-command-macro command and program another macro (we will call it the recall macro) to speak the appropriate recall message. That recall macro could then be executed to find out whether the open collector output line was turned on or off last. In other words, we would use the on and off macros to program the recall macro. Whichever on/off macro was executed last would have programmed the recall macro last, making it contain the appropriate message. If you didn't understand all of this, don't worry about it, use this command, and wait for a later software version that will make all of this easier.

100: Read Analog Input Line

This command allows you to read the analog input lines on the RLC-Club. The number that is read back will depend on three other things: the precision used (set with Command 101), the conversion scale (set with Command 102), and the calibration (set with Command 103). When you want to read the analog lines as part of a custom message such as "The temperature is ??? degrees Fahrenheit" you should use the read-analog-input special words (see words numbered 800 and higher in Appendix B). They will allow you to read the analog input without all of the extra " Line ?" words that you won't want in your messages.

<100> l	Read a single analog line
<100> l..l	Read multiple analog lines

Parameters:

- 100 is the default command name.
- L is the analog input line number (1..5)

Notes:

Multiple analog input lines can be read with one call to this command by entering more than one port number here.

Example:

Command 100 works fine, but I want a nicer message when reading wind speed. 053 erases then starts programming a macro. 400 is the macro number. 036 is the command to speak a voice message. The following numbers come from Appendix B and specify the words for the message. Word 853 is a special word number that the controller automatically replaces with the current reading for analog line 3.

; Speak "The wind speed is (analog 3) miles per hour"
053 400 036 476 531 452 270 853 317 375 249

101: Set Resolution For Analog Input

This command allows you to specify how many digits after the decimal point will be used when reading each analog input line. If you want to read voltage to 1/10 of a volt, you specify one digit after the decimal point. This decimal point is assumed in the other analog commands since there is no good way to enter a decimal point on a DTMF pad. If you specify one decimal place with this command, the other analog commands will assume that the numbers you enter have an assumed decimal point one digit from the end. In other words, if you want to specify a value of 12 volts and you are using one digit after the decimal point, you must enter 120. The descriptions of those commands will explain this in more detail.

<101> l r

Parameters:

- 101 is the default command name.
- L is the analog input line number (1..5)
- R is the number of digits after the decimal point (0..3)

Explanation:
This command may allow you to read an analog input with more decimal places than the controller can accurately measure. That doesn't hurt anything, but may be misleading (such as indicating that the temperature is 75.251 degrees when you really only know it is within about one degree of 75). The analog to digital converter (ADC) in the controller accepts a voltage between 0 and 5 volts (higher voltages may be reduced to that range with the internal voltage divider on the power supply or external voltage dividers on the other lines) and can differentiate 1024 levels within that range, about 5mV per level. LM335 temperature sensors output a voltage of 10mV per degree Kelvin (Celsius - 273). This corresponds to about 5mV (10mV * 5/9) per degree Fahrenheit, about one-half degree resolution. There is no reason to try to read temperature with two decimal places when conversion itself doesn't have that much resolution. Even one digit after the decimal point is pushing it - it would sound like you were getting 1/10 degree resolution even though you would really only be getting about ½ degree resolution. We recommend reading temperature to the nearest degree (0 digits after the decimal point).

Another example: reading battery voltage. Since the controller requires 12 or so volts to run, the processor's analog to digital converter cannot handle reading the power supply voltage directly. So analog input line #4 is connected to the controller's power input through a voltage divider. This divider uses a 40.2K and a 10K resistor, which divides the input voltage down to 10/(10+40.2) = 20% of its original value. So with a 12 volt input, the converter actually sees 2.4 volts. To make the controller read the power supply voltage, we need to set it to convert the

value read on a scale of 0..25 volts (5 volts * (10+40.2)/10). This can be done by entering

102 4 0 0000 0 0025 ;	read analog input 4 on 0 to 25 volt scale
101 4 0 ;	read analog input 4 with no decimal places

If we want to read the battery voltage to the nearest 1/10 volt, we need to detect 10 times as many levels, 250 and use one decimal place:

102 4 0 0000 0 0250 ;	read analog input 4 on 0.0 to 25.0 volt scale
101 4 1 ;	read analog input 4 with 1 decimal place

Since the divider increases the voltage range that can be read on analog input 4 by 5 times, it also reduces the precision to 1/5 of what it is without the divider (from 5mV to 25mV). You can therefore read your battery voltage with one digit after the decimal point (100mV resolution) and waste a little resolution, or use two digits after the decimal point (10mV) and exceed the resolution of the converter. You can put an external voltage divider on analog input 5 to read external voltages in a similar way. To use inputs 1..3 with a voltage divider, you would need to disconnect the built-in pullup resistor.

Let us suppose that we using analog input #5 to read the voltage supplied by a 3 volt battery pack with 3 digits after the decimal point (1mV resolution). Remember that the converter has only 5mV resolution (let us suppose it is exactly 5mV for this example). If the battery voltage is 3.002 volts, the converter will round it to 3.000. If the voltage is 3.003 volts, the converter will round it to 3.005. No matter what you do, the last digit read will always be 0 or 5. The number read back by the controller will sound like it has 1mV resolution, but the reading will only have 5mV resolution.

102: Set Conversion Ratio For Analog Input

This command allows you to select what scale the analog inputs are read on. This allows you to use the analog inputs to read temperature on a scale from hundreds of degrees below zero to hundreds above, battery voltage on a scale from 0 to 25 volts or wind direction from 0 to 360 degrees. Anything that can generate an analog voltage can be read on a scale appropriate to the measurement. Unfortunately, this flexibility brings with it a little complexity. To make it easy, we provide a chart of the common conversions you might use. If you want to use a conversion that is not listed, read the explanations after the chart and study the examples on the chart. Once you see the pattern, the calculations are not difficult.

Command Parameters	Description	Resolution
<102> x n wwww m zzzz	General conversion form	....
<102> x 0 0000 0 1023	Default Setting	1 analog to digital converter count
<102> 4 0 0000 0 0250	Internal Battery Voltage	0.1 volts, enter "101 4 1"
<102> x 1 0460 0 0440	Fahrenheit temperature	1 degree, enter "101 x 0"
<102> x 1 0273 0 0227	Celsius temperature	1 degree, enter "101 x 0"
<102> x 0 0000 0 0005	0..5 volts	1 volt, enter "101 x 0"
<102> x 0 0000 0 0050	0..5 volts	0.1 volt, enter "101 x 1"
<102> x 0 0000 0 0500	0..5 volts	0.01 volt, enter "101 x 2"
<102> x 0 0000 0 0025	0..25 volts	1 volt, enter "101 x 0"
<102> x 0 0000 0 0250	0..25 volts	0.1 volt, enter "101 x 1"
<102> x 0 0000 0 2500	0..25 volts	0.01 volt, enter "101 x 2"
<102> x 0 0000 0 0100	0 to 100%	1 percent, enter "101 x 0"
<102> x 0 0000 0 0360	0 to 360 degrees	1 degree, enter "101 x 0"

Notes:

- Please note that regardless of the conversion used, the voltage entering the analog inputs must be between 0 and 5 volts.
- For more information about hooking up a LM335Z temperature sensor, see Appendix H.

Parameters:
- 102 is the default command name.
- x is the analog input line number (1..5)
- n is 1 for negative, 0 for positive for the following number
- wwww is the reading with a 0 volt input with leading 0s if necessary
- m is 1 for negative, 0 for positive for the following number
- zzzz is the reading with a 5 volt input to the processor with leading 0s if necessary.

Custom Analog Conversion Ratios:

If the conversions provided in the chart are what you need, don't bother reading this section. It describes how to come up with your own conversions.

The conversion is simply a linear ratio. You provide a reading that corresponds with 0 volts at the processor and another number that corresponds with 5 volts at the processor, and the controller just does a linear interpolation.

First we will describe some of the conversions in the table, then illustrate how to come up with your own:

0 to 5 volt, 1 volt resolution, no voltage dividers:
This is about as straightforward as it can get. When it reads 0, it converts it to zero. When the processor reads 5 volts, it converts it to 5 volts.

0 to 5 volt, 1/10 volt resolution, no voltage dividers:
When it reads 0, it converts it to zero. To get 1/10 volt resolution, we need to use one digit after the decimal point. Because of this we have to assume one decimal point when we enter the conversion points. When the processor reads 5 volts, we need to convert to 50, which with one assumed decimal place, is 5.0 volts.

0 to 5 volt, 1/100 volt resolution, no voltage dividers:
When it reads 0, it converts it to zero. To get 1/100 volt resolution, we need to use two digits after the decimal point. When the processor reads 5 volts, we tell it to convert it to 500, which with one assumed decimal place, is 5.00 volts.

Temperature in Celsius, 1 degree resolution, no voltage dividers:
The key to figuring this one out is knowing how the LM335 temperature sensor works. It provides an output voltage of 10mV per degree Kelvin. It should therefore output zero volts at zero degrees Kelvin. Zero degrees Kelvin is minus 273 degrees Celsius, so that is our first conversion point, -273. The 5 volt conversion point would be reached at 5V/10mV per degree = 500 degrees Kelvin, or 227 degrees Celsius (above zero). This is our other conversion point.

Temperature in Fahrenheit, 1 degree resolution, no voltage dividers:

This conversion is very similar to the one for Celsius temperature. 0 degrees Kelvin is -460 degrees Fahrenheit. 500 degrees Kelvin is 440 degrees Fahrenheit.

0 to 25 volt, 1 volt resolution, with the voltage divider. (analog input line 4):

The difference between this and the 5 volt conversion is the voltage divider. The divider cuts the received voltage to 1/5 before passing it on to the processor. In other words, the zero point does not change, but the full-scale reading is now 25 rather than 5 volts. Since we want it to read 25 volts when we give it 25 volts, the zero point is 0 and the full scale point is 25. Seems too easy, doesn't it?

The other resolutions of the 0 to 25 volt conversions are left to a comparison with the 5 volt conversions.

One more example will illustrate how to develop a conversion that is not listed in the chart. Let us assume that we want to read the wind speed at our site and that we have an anemometer (wind speed detector) that reads 10 volts at 100 MPH. Since the maximum voltage is above 5 volts we will need to use a voltage divider. To avoid having to disconnect the pullup resistors on inputs 1..3 (which is necessary to use a voltage divider with them), we will use analog input #5 and make our own external voltage divider. The divider will have the input voltage coming through a 40.2K resistor in series with a 10K resistor. The other end of the 10K should be hooked to ground. Analog input #5 should be connected to the point where the two resistors are joined, where the voltage should be about 1/5 what it is at the input of the voltage divider. We will assume that 0 volts are produced when the wind is not blowing and that it increases linearly from there. That sets our zero point to be zero. We must calculate our full scale reading as if it will occur at 25 volts, even though the sensor will never put out that much voltage, because that is the 5 volt full scale reading at the processor times the 5:1 voltage divider ratio. What we need to know is how fast the wind would have to blow to give us a 25 volt signal. A simple ratio will give us the answer:

$$\frac{100 \text{ MPH}}{10 \text{ volts}} = \frac{X \text{ MPH}}{25 \text{ volts}}$$

Cross Multiplying: $100 * 25 = 10 * X$, $2500 = 10 * X$, $X = 250$ MPH

We now know that the low point is 0, the high point is 250, and that we need to use the voltage divider.

103: Calibrate an Analog Input

This command allows you to correct for small amounts of error in reading analog sources. It should not be used until the resolution and conversion ratios are set (with Commands 101 and 102). It is not intended to fix readings that are way off (more that 20 percent or so). If you are getting a reading that is a long way off, go back to Command 102 and correct the conversion ratio. This command accepts as input the correct value for an analog input line and adds or subtracts the right amount from the reading it is receiving to make it equal what you say it is. To get rid of this correction factor, execute the reset calibration form of this command shown in the table below.

<103> l n wwww	Calibrate an analog input
<103> l 2	Reset calibration

Parameters:

- 103 is the default command name.
- L is the analog input line number (1..5)
- N is 1 for negative, 0 for positive for the following number
- WWWW is the actual value that should be read by the sensor.

Notes:

The value you enter will have as many assumed decimal places as you set with Command 101.

104: Set an Analog Alarm

This command allows you to set an alarm that will occur when an analog reading goes below a low alarm point or above a high alarm point. When the alarm occurs, it will execute an internal macro (see Chapter 8 for internal macro definitions). You can program this internal macro to do anything, turn open collector output lines on or off, speak a voice message, change your courtesy beep, etc. The alarm point will be checked at intervals determined by the duration of the input alarm timer (see Command 020). When the analog reading comes out of alarm by the "Hysteresis" amount (set with Command 105), the analog alarm clear macro will be executed. You might want to program this macro to change an open collector output line and/or speak an alarm clear message.

<104> l a n wwww	Set an Analog Alarm

Parameters:

- 104 is the default command name.
- L is the analog input line number (1..5)
- A is 0 for a low alarm, 1 for a high alarm
- N is 1 for negative, 0 for positive for the following number
- WWWW is the alarm point with leading 0s if necessary

Notes:

The value you enter will have as many assumed decimal places as you set with Command 101.

105: Set Analog Alarm Hysteresis

Hysteresis is a concept not everyone is familiar with, so let me illustrate it before I try to explain how to use it. Let us suppose that you are using one of the analog lines to read the temperature inside of your radio shack. In the winter, you want the controller to automatically turn the heater on and off to keep the temperature above 40 degrees. To do this you decide to control the heater with a relay that you can switch with one of the open collector output lines. Next you set a low alarm at 40 degrees and program the low alarm macro for that analog line to turn the heater on and speak the message "low alarm". Now you need a way to turn the heater back off. To do this you use the analog alarm to normal macro to turn the heater off and speak the message "low alarm clear". This is where Hysteresis comes in. Do you want the heater to turn off at 41 degrees? This would probably make the heater turn on and off really often. It might be better if it warmed up to 45 degrees before the heater turned off, so it would turn on and off less often. The amount that it has to warm up past where the low alarm point was is the amount of Hysteresis, in this case 5 degrees. In the case of a high alarm (such as would be used to run an air conditioner, the amount of Hysteresis is how much the temperature would have to drop below the high alarm point before the alarm to normal macro would be executed. The amount of Hysteresis is the same for the high and low alarms (if this is not acceptable for your application, let us know). This command lets you set how much Hysteresis each analog line uses when determining whether the alarm is clear yet.

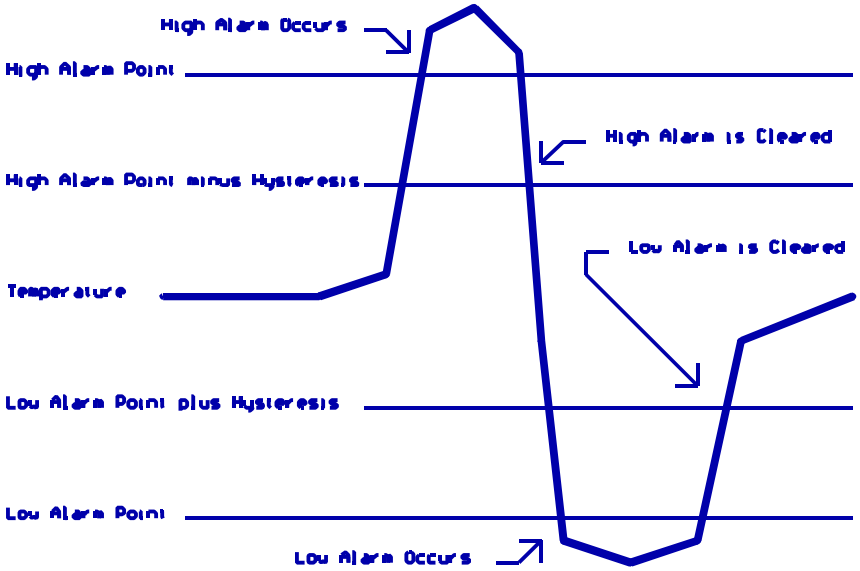
<105> l wwww

Parameters:

- 105 is the default command name.
- L is the analog input line number (1..5)
- WWWW is the alarm point with leading 0s if necessary

Notes:

The value you enter must be a positive number and will have as many assumed decimal places as you set with Command 101.



106: Enable/Disable an Analog Alarm

This command allows you to control whether or not the analog alarms will occur without having to mess with the alarm points. This might be used to turn off a low temperature alarm while you are working at a site and have the door open or to disable turning a heater on when you are running on battery power. If an alarm is disabled, Command 107 will still tell you whether or not the line is in alarm, but the alarm macro will never execute.

<106> l a n

Parameters:

- 106 is the default command name.
- L is the analog input line number (1..5)
- A is 0 for a low alarm, 1 for a high alarm
- N is 1 to enable the alarm, 0 to disable it

107: Recall Analog Lines in Alarm

This command lists all of the ports in high alarm, then all of the ports in low alarm. It is helpful when trying to find out whether you have set the alarm points correctly.

<107>

Parameters:

- 107 is the default command name.

108: Recall Analog Line Configuration

This command recalls all kinds of information about an analog line's conversion, resolution, calibration, alarm points, Hysteresis, alarm enabled/disabled status, etc. It is intended to aid in setting up the analog subsystem, not as a user command.

<108> l

Parameters:

- 108 is the default command name.
- L is the analog input line number (1..5)

Description of the voice response:

"analog ?" - which analog input on the I/O board we are referring to (1..5)
"0 volts is ?" - the lower calibration point
"5 volts is ?" - the upper calibration point
"calibrate ?" - how many units the calibration changes the reading
"low alarm ?" - the low alarm point
"high alarm ?" - the high alarm point
"h ?" - the amount of Hysteresis
"low alarm ?" - whether alarm is on or off
"high alarm ?" - whether alarm is on or off

160: Clear Analog High/Lows

This command allows you to reset the analog high/low values. They are reset to whatever the current value is. The readings can be read by speaking the appropriate word numbers (see Appendix B).

<160> a l..l

Parameters:

- 160 is the default command name
- A is 0 for the low value, 1 for the high value, 2 to clear both the low and high values
- L..L are the analog input lines (1..5)

161: Set Analog Smoothing Factor

This command allows you to smooth the analog readings to "average out" noise and sudden changes.

<161> l ss

Parameters:

- 161 is the default command name
- L is the analog input line (1..5)
- SS is the smoothing factor

Smooth Factor	Average Smooth Time
50	about 9 seconds
60	about 13 seconds
70	about 18 seconds
80	about 30 seconds
90	about 50 seconds
95	about 120 seconds
97	about 220 seconds
98	about 325 seconds
99	about 11 minutes

109: Configure Wind Speed Reading

This command can be used to tell the controller to count the pulses coming from an anemometer (those whirly things with three cups that spin in the wind) to determine the wind speed. It counts the number of pulses in a default of 2.26 seconds and treats that number like a voltage that could be read by an analog line. All of the normal analog commands will work with the resulting number: command 102 will control the scaling, command 100 will provide the current reading, the analog alarms can be used to notify you if the wind exceeds a certain speed, etc.

<109> 0	Don't calculate wind speed
<109> X	Use input line 'X' for wind speed

Parameters:

X - the contact closure input line to use for wind speed.

Note:

The "conversion ratio" (see command 102) for the analog line corresponding to the input number used for wind speed needs to be set up for the default ratio (0 to 1023, enter "102 X 0 0000 0 1023" where X is the input line number).

Details:

To read wind speed, hook up the anemometer so that the reed switch that closes as it rotates connects the input line on the controller to ground. Using a voltmeter or logic probe, make sure that the line pulses every time the anemometer goes around. The line can be connected directly to inputs 1..3, or to input 5 (on pin 4) if you use a 10K pullup resistor to 5 volts. Then use command 109 to tell the controller which input line it is connected to. From that point on, reading the analog line of that number will give you a number related to the wind speed.

To make the controller read the wind speed in miles per hour, you will need to find out how fast your anemometer pulses relative to the wind speed. One common anemometer (Davis) is rated at 26.6 pulses per minute per mile per hour. 60/26.6 = 2.2556 seconds to get one pulse per mile per hour. The wind speed timer is set to count the pulses in 2.26 seconds. If the analog conversion ratio is left at the default 1:1 (it can be changed with command 102), the analog line will read the speed in miles per hour. The wind speed measurement can be adjusted by changing the timer or by changing the conversion ratio with command 102. Using the calibrate command for wind speed is not recommended, as any calibration offset will keep it from reading zero when it is calm. You can use command 100 or the analog special words to make the controller speak the wind speed.

096: Control or Recall Extended Output Lines

"Extended" output lines provide a way to control more external devices or signals than the number of open collector output lines built into the controller (or option boards). By connecting external shift registers such as are used on many BCD boards to three of the controller's open collector output lines, you can control up to 64 "extended" output lines. Whenever command 096 is executed to set or recall the state of an extended output line, the controller shifts out 64 bits of information representing the state of each of the outputs. Extended output line 64 is shifted out first, line 1 last. The data is also shifted out when the controller is reset and the extended outputs are enabled (you should not enable the extended output lines if you are not using them, or output lines 5, 6 and 7 will get messed up every time the controller resets).

<096> 0	Disable the extended output lines (the default)
<096> 1	Enable the extended output lines
<096> xx	Recall the state of extended output line "xx"
<096> xx 1	Turn extended output line "xx" on
<096> xx 0	Turn extended output line "xx" off

Parameters:

XX - the extended output line number (two digits, 01..64)

Details:
Most standard shift registers should be compatible with this command. Up to eight 8-bit shift registers can be chained together, each one providing eight more extended outputs. If the shift registers have separate output registers (like the 74HC595 or 4094), the latch line can be used to keep the outputs from rippling each time new data is shifted in.

Open Collector Output Line Number	Description
5	Latch - Optional, but will prevent the lines from “rippling” as data is shifted if used
6	Clock - pulses 64 times to shift data out
7	Data - goes high or low for each clock pulse. If using the RBI-1 or RLC-ICM, this line will be shared. Both should work normally.

Chapter 19: The Beaconing System

The beaconing system was designed to alert you when something at the site needs your attention. It can be set up to announce a message over the radio and/or call you using the autopatch. It can beacon a limited number of times, or indefinitely until you cancel the beacon.

Note:

If you have two beacons in a row set up to go to the autopatch, and the patch never hangs up between them, you may need to shorten the hang timer for the autopatch port to less than a second.

045: Setup Beacon Table

This command allows you to set up the beacon table. It is this table that controls what happens when a beacon is started. The different slots in the table can be used to alert you of different things, or they can be used together (when N is set to 01..50) to alert you in several different ways, such as by radio and by telephone.

<045> SS	Recall slot SS
<045> SS MMM XX TTTT NN T D..D	Set slot SS

Parameters:

045 is the default command name.

SS = beaconing table slot number to set up/recall: 01..50. If this is the last parameter entered, will recall the current settings of the slot in the table.

MMM = macro/command number to do

XX = number of times to do it

TTTT = time to wait between in seconds between calls to MMM. If the message spoken in command/macro MMM uses the controller's synthesized voice or DVR and it takes longer than this timer is set for, the controller will wait until the message is done. This timer should be set fairly short (less than 5 seconds) when T=1 (autopatch), so when you answer the phone you won't have to wait a long time before you hear the message.

NN = next beaconing table slot to do (01..50), or

00 = stop after done with this slot

T = type of beacon to do

0 = beacon out radio port(s)

D..D = list of radio ports, audio routing

1 = beacon out of autopatch

D..D = phone number to dial

046: Start Beacon

This command starts a beacon using the table you set up with command 045. You can start with any of the beacon table slots, so different conditions can start different messages.

<046> SS

Parameters:

046 is the default command name.
SS = beaconing table slot number to start with (01..50)

047: Cancel Beacon

This command allows you cancel a beacon after it has been started. Since only one beacon can be active at a time, you don't have to specify which one you want to cancel.

<047>

Parameters:

047 is the default command name.

048: Start Beacon Using English Words

This command allows you to start a beacon from the serial port that will speak the message you specify using English words. It automatically programs macro 297 (and possibly 298) to speak the message you specify (see command 066 for more details) and starts beaconing using the beacon table slot you specify (which should be set up ahead of time to call macro 297). This command is most useful for alerting you of errors that occur in another system that can output a serial error message and execute this command. Any word that is not in the controller's voice library (see Appendix B) will be spelled out.

<048> SS Error_message_in_English_words

Parameters:

048 is the default command name.
SS is the beacon slot number to use (often is 01)
Error_message_in_English_words is the message to be spoken, with the words separated by underscore digits.

Example:

048 01 This_is_a_test_error_message

Appendix B: Voice Word Table

Romeo's words (words 000..543):

These words make up the main vocabulary of the controller. They are arranged with the numbers first, then the alphabet, then alphabetically.

Prefixes and Suffixes (words 544..552):

These are really parts of words. They can be used in combination with other words to make some new words. For example, you can use words 311 and 549 together to form the word "meetings".

Juliet's words (words 553..586):

These are used primarily for time and date. They are not intended to allow you to run the whole controller with the female voice.

Pause (word 587):

Word 587 is listed as "pause". It causes the voice to pause for a moment, such as between sentences. It does not speak the word "pause". It can be used in combination with any of the other words.

Sound Effects (words 588..598):

Try them!!!

Junior's words (599..685):

Romeo quit the recording business, so we had to get Junior to record some other words for us. Some words were recorded by both Romeo and Junior, so you might want to check both places in the word list. It usually sounds best if you don't mix words from the two lists in one message, but sometimes that is the only way to get the words you want.

Variable words (810..919):

Most of these words allow you to insert a message that is not always the same into a voice message, such as the current time. If you want to include the time in one of your IDs, for example, you could just include word 810 in the ID message. "At <the time>, this-is the XXXXX repeater" would be word numbers 086, 810, 480, 475, 054, 054, 054, 054, 054, 411.

These words make it easy to write custom messages that read the time, date, I/O lines, etc.

Word List:

Romeo's Words

000 ZERO
001 ONE
002 TWO
003 THREE
004 FOUR
005 FIVE
006 SIX
007 SEVEN
008 EIGHT
009 NINE
010 TEN
011 ELEVEN
012 TWELVE
013 THIRTEEN
014 FOURTEEN
015 FIFTEEN
016 SIXTEEN
017 SEVENTEEN
018 EIGHTEEN
019 NINETEEN
020 TWENTY
021 THIRTY
022 FORTY
023 FIFTY
024 SIXTY
025 SEVENTY
026 EIGHTY
027 NINETY
028 HUNDRED
029 THOUSAND
030 MILLION
031 A
032 B
033 C
034 D
035 E
036 F
037 G
038 H
039 I
040 J
041 K
042 L
043 M
044 N
045 O
046 P
047 Q
048 R
049 S
050 T
051 U
052 V
053 W
054 X
055 Y
056 Z
057 ABORT
058 ABOUT
059 ABOVE
060 ACKNOWLEDGE
061 ACTION
062 ADJUST
063 ADVANCED
064 ADVISE
065 AERIAL
066 AFFIRMATIVE
067 AIR
068 AIRPORT
069 AKRON
070 ALERT
071 ALL
072 ALOFT
073 ALPHA
074 ALTERNATE
075 ALTITUDE
076 AMATEUR
077 AMPS
078 AND
079 ANSWER
080 APPROACH
081 APRIL
082 AREA
083 ARRIVAL
084 AS
085 ASSOCIATION
086 AT
087 AUGUST
088 AUTO
089 AUTOMATIC
090 AUTOPILOT
091 AUXILIARY
092 AVON
093 AVON MOUNTAIN
094 A.M.
095 BAND
096 BANK
097 BASE
098 BATTERY
099 BELOW
100 BETWEEN
101 BLOWING
102 BLUE KNOB
103 BOARD
104 BOOST
105 BOZO

106 BRAKE
107 BRAVO
108 BREAK
109 BROKEN
110 BUSY
111 BUTTON
112 BY
113 CABIN
114 CALIBRATE
115 CALL
116 CALLING
117 CALM
118 CANCEL
119 CAUTION
120 CEILING
121 CELSIUS
122 CENTER
123 CHANGE
124 CHARLIE
125 CHECK
126 CIRCUIT
127 CLEAR
128 CLIMB
129 CLOCK
130 CLOSED
131 CLUB
132 CODE
133 COLUMBUS
134 COME
135 COMPLETE
136 COMPUTER
137 CONDITION
138 CONGRATULATIONS
139 CONNECT
140 CONNECTICUT
141 CONTACT
142 CONTROL
143 CONVERGING
144 COSHOCTON
145 COUNT
146 COURSE
147 CRANE
148 CROSSWIND
149 CURRENT
150 CUYAHOGA FALLS
151 CYCLE
152 DALLAS
153 DANGER
154 DATE
155 DAY
156 DAYS
157 DAYTON
158 DECEMBER
159 DECREASE
160 DECREASING
161 DEGREES
162 DELTA
163 DEPARTURE
164 DEVICE
165 DIAL
166 DINNER
167 DIRECTION
168 DISPLAY
169 DIVIDED
170 DOOR
171 DOWN
172 DOWNWIND
173 DRIVE
174 DRIZZLE
175 DUST
176 EAST
177 ECHO
178 ELECTRICIAN
179 ELEVATION
180 EMERGENCY
181 ENGINE
182 ENTER
183 EQUAL
184 EQUALS
185 ERROR
186 ESTIMATED
187 EVACUATE
188 EVACUATION
189 EXIT
190 EXPECT
191 FAIL
192 FAILURE
193 FARAD
194 FAHRENHEIT
195 FARMINGTON
196 FAST
197 FEBRUARY
198 FEET
199 FILED
200 FINAL
201 FINDLAY
202 FIRE
203 FIRST
204 FLAPS
205 FLIGHT
206 FLOW
207 FOG
208 FOR
209 FOURTH
210 FOXTROT
211 FREEDOM
212 FREEZING
213 FREQUENCY
214 FRIDAY
215 FROM
216 FRONT
217 FULL
218 GALLONS
219 GATE
220 GAUGE
221 GEAR
222 GET
223 GLIDE
224 GO
225 GOLF
226 GOODBYE
227 GREEN
228 GREENWICH
229 GROUND
230 GURNEE
231 GUSTINGTO

232 HAIL
233 HALF
234 HAM
235 HAMFEST
236 HAMVENTION
237 HAVE
238 HAZARDOUS
239 HAZE
240 HEAVY
241 HELLO
242 HELP
243 HENRY
244 HERTZ
245 HIGH
246 HOLD
247 HOME
248 HOTEL
249 HOUR
250 HOURS
251 ICE
252 ICING
253 IDENTIFY
254 IGNITE
255 IGNITION
256 IMMEDIATELY
257 IN
258 INBOUND
259 INCH
260 INCREASE
261 INCREASING
262 INCREASINGTO
263 INDIA
264 INDICATED
265 INFLIGHT
266 INFORMATION
267 INNER
268 INSPECTOR
269 INTRUDER
270 IS
271 IT
272 JANUARY
273 JULIET
274 JULY
275 JUNE
276 KENTUCKY
277 KEY
278 KILO
279 KNOTS
280 LAND
281 LANDING
282 LATE
283 LAUNCH
284 LEAN
285 LEFT
286 LEG
287 LESS THAN
288 LEVEL
289 LIGHT
290 LIMA
291 LINE
292 LINK
293 LIST
294 LITTON
295 LOCK
296 LONG
297 LOOK
298 LOW
299 LOWER
300 LUNCH
301 MACHINE
302 MAINTAIN
303 MANUAL
304 MARCH
305 MARKER
306 MAY
307 MAYDAY
308 ME
309 MEAN
310 MEASURE
311 MEETING
312 MEGA
313 MESSAGES
314 METER
315 MICRO
316 MIKE
317 MILES
318 MILL
319 MILLI
320 MINUS
321 MINUTES
322 MIST
323 MOBILE
324 MODERATE
325 MONDAY
326 MONTH
327 MORETHAN
328 MOTOR
329 MOUNT HAMILTON
330 MOUNT TAMALPAIS
331 MOVE
332 MOVING
333 MUCH
334 NEAR
335 NEGATIVE
336 NET
337 NEW
338 NEWINGTON
339 NEW HAVEN
340 NEXT
341 NIGHT
342 NO
343 NORTH
344 NORTHEAST
345 NORTHWEST
346 NOT
347 NOVEMBER
348 NUMBER
349 OAKS
350 OBSCURED
351 O'CLOCK
352 OCTOBER
353 OF
354 OFF
355 OHIO
356 OHMS
357 OIL

358 ON
359 OPEN
360 OPERATION
361 OPERATOR
362 OSCAR
363 OTHER
364 OUT
365 OUTER
366 OVER
367 OVERCAST
368 PAPA
369 PARTIALLY
370 PASS
371 PASSED
372 PATCH
373 PATH
374 PELLETS
375 PER
376 PERCENT
377 PHONE
378 PICO
379 PLEASE
380 PLUS
381 POINT
382 POLICE
383 POSITION
384 POWER
385 PRACTICE
386 PRESS
387 PRESSURE
388 PRIVATE
389 PROBE
390 PROGRAMMING
391 PULL
392 PUSH
393 P.M.
394 QUEBEC
395 RADAR
396 RADIO
397 RAIN
398 RAISE
399 RANGE
400 RATE
401 RATTLESNAKE MOUNTAIN
402 READY
403 REAR
404 RECEIVE
405 RED
406 RELEASE
407 REMARK
408 REMOTE
409 REPAIR
410 REPEAT
411 REPEATER
412 RICH
413 RICHMOND
414 RIG
415 RIGHT
416 ROAD
417 ROGER
418 ROMEO
419 ROUTE
420 RUNWAY
421 SAFE
422 SAINT PETERSBURG
423 SAND
424 SANTA CLARA
425 SAN LEANDRO
426 SATURDAY
427 SCATTERED
428 SECOND
429 SECONDS
430 SECURITY
431 SELECT
432 SEPTEMBER
433 SEQUENCE
434 SERVICE
435 SET
436 SEVERE
437 SEXY
438 SHORT
439 SHOWERS
440 SHUT
441 SIDE
442 SIERRA
443 SIGHT
444 SLEET
445 SLOPE
446 SLOW
447 SMOKE
448 SNOW
449 SOUTH
450 SOUTHEAST
451 SOUTHWEST
452 SPEED
453 SPRAY
454 SQUAWK
455 STALL
456 START
457 STOP
458 STORM
459 SUNDAY
460 SWITCH
461 SYSTEM
462 TANGO
463 TANK
464 TARGET
465 TARPON SPRINGS
466 TAXI
467 TEEN
468 TELEPHONE
469 TEMPERATURE
470 TERMINAL
471 TEST
472 THANK YOU
473 THAT
474 THE (LONG E)
475 THE (SHORT E)
476 THE
477 THIN
478 THINLY
479 THIRD
480 THIS IS
481 THIS
482 THUNDERSTORMS

483 THURSDAY
484 TIME
485 TIMER
486 TIMES
487 TO
488 TODAY
489 TOMORROW
490 TONIGHT
491 TOOL
492 TORNADO
493 TORONTO
494 TOUCHDOWN
495 TOWER
496 TRAFFIC
497 TRANSMIT
498 TRIM
499 TUESDAY
500 TURBULANCE
501 TURN
502 UNDER
503 UNIFORM
504 UNIT
505 UNLIMITED
506 UNTIL
507 UP
508 USE (NOUN)
509 USE (VERB)
510 VALLEY
511 VALVE
512 VARIABLE
513 VERIFY
514 VICTOR
515 VISIBILITY
516 VOLTS
517 WAIT
518 WAKE
519 WAKEUP
520 WARNING
521 WATCH
522 WATTS
523 WAY
524 WEATHER
525 WEDNESDAY
526 WELCOME
527 WEST
528 WEST HARTFORD
529 WHISKEY
530 WILL
531 WIND
532 WISKEY
533 WITH
534 WRONG
535 X-RAY
536 YANKEE
537 YELLOW
538 YESTERDAY
539 YOU
540 YOUR
541 ZED
542 ZONE
543 ZULU

Prefixes and Suffixes

544 FIF-
545 THIR-
546 -ED
547 -ER
548 -ING
549 -S
550 -TEEN
551 -TH
552 -TY

Juliet's Words

553 OH
554 ONE
555 TWO
556 THREE
557 FOUR
558 FIVE
559 SIX
560 SEVEN
561 EIGHT
562 NINE
563 TEN
564 ELEVEN
565 TWELVE
566 THIRTEEN
567 FOURTEEN
568 FIFTEEN
569 SIXTEEN
570 SEVENTEEN
571 EIGHTEEN
572 NINETEEN
573 TWENTY
574 THIRTY
575 FORTY
576 FIFTY
577 GOOD
578 MORNING
579 AFTERNOON
580 EVENING
581 THE
582 TIME
583 IS
584 A.M.
585 P.M.
586 O'CLOCK

Pause

587 PAUSE

Sound Effects

588 LASER
589 WHISTLE
590 PHASER
591 TRAIN
592 EXP
593 CROWD
594 TIC
595 TOC
596 HIGH-LOW TONE

597 LOW-HIGH TONE
598 HIGH TONE

Junior's Words

599 ALARM
600 AMATEUR
601 ANALOG
602 ARIZONA
603 AUTOPATCH
604 BACHELOR
605 BAD
606 BASE
607 BATTERY
608 BAY
609 BILLINGS
610 BOZEMAN
611 CANOE
612 CAPROCK
613 CENTRAL
614 CHARGING
615 CLOUDS
616 CLUB
617 COMMUNICATIONS
618 CONTROLLER
619 DIGITAL
620 EMPIRE
621 EVENT
622 FIELD
623 FLASH
624 FLOOD
625 FRIENDLY
626 GOLDEN
627 GREYCLIFF
628 HAM
629 HAMFEST
630 HARRISON
631 HOLLEY
632 HOME
633 INFORMATION
634 INLAND
635 INPUT
636 INSIDE
637 KOOTENAI
638 LINK
639 LITTLEROCK
640 MEDIUM
641 MEETING
642 MICA
643 MONITOR
644 MOUNTAIN
645 NET
646 OBED
647 OREGON
648 OUTSIDE
649 PEAK
650 POUND
651 PUMP
652 PYRAMID
653 RACES
654 RADIO
655 RATTLESNAKE
656 REMOTE
657 REPEATER
658 RIDGE
659 SANDRA
660 SCAN
661 SIDNEY
662 SKYWARN
663 SOCIETY
664 SPOKANE
665 STAR
666 STATE
667 SUNDANCE
668 SYSTEM
669 TACOMA
670 THIS
671 TIGER
672 TODAY
673 TOMORROW
674 TONIGHT
675 VALUE
676 VOLTAGE
677 WASHINGTON
678 WATCH
679 WATER
680 WELCOME
681 WITH
682 YAKIMA
683 YELLOWHEAD
684 YELLOWKNIFE
685 ZED

Internal Variable Words (don't use these)

800 UNUSED
801 START POLITE
802 END POLITE
803 END POLITE DO CMD
804 DO DELAYED DIAL
805 START DVR TIMER

User Variable Words

810 TIME
811 HOUR (12 hr)
812 HOUR (24 hr)
813 MINUTE OF HOUR
814 AM/PM
815 DATE
816 MONTH OF YEAR
817 DAY OF MONTH
818 YEAR
819 DAY OF WEEK
830 TIME (FEMALE)
831 HOUR,F (12 hr)
832 HOUR,F (24 hr)
833 MINUTE,F
834 AM/PM (FEMALE)
835 MRN/AFT/EVE, F
836 ANALOG 1
837 ANALOG 2
838 ANALOG 3
839 ANALOG 4
840 ANALOG 5
841 ANALOG 1 HIGH
842 ANALOG 2 HIGH

843 ANALOG 3 HIGH
844 ANALOG 4 HIGH
845 ANALOG 5 HIGH
846 ANG 1 HIGH TIME
847 ANG 2 HIGH TIME
848 ANG 3 HIGH TIME
849 ANG 4 HIGH TIME
850 ANG 5 HIGH TIME
851 ANALOG 1 LOW
852 ANALOG 2 LOW
853 ANALOG 3 LOW
854 ANALOG 4 LOW
855 ANALOG 5 LOW
856 ANG 1 LOW TIME
857 ANG 2 LOW TIME
858 ANG 3 LOW TIME
859 ANG 4 LOW TIME
860 ANG 5 LOW TIME

Special Word *Pairs*:

Most of the following words need to be followed by another word number that specifies which one to do: which analog line to read, which command to execute, which time zone to use, etc. For example, to read analog 5 as an S-meter, you would want to speak word 861 followed by word 005.

861 xxx - read analog 1..5 as S-Meter. To obtain a current reading, must use an event trigger to clear the high value each time the COR goes active. For example “157 000 500" followed by “053 500 038" and “056 500 160 15" will reset the high value for analog line 1 whenever the COR for port 1 goes active.

862 xxx - read analog line as a Direction: N, NE, E, SE, S, etc.

863 xxx - execute command xxx (up to command 900 or so, may not go all the way to 999). Will not happen until this word is actually spoken.

864 xxx - speak 24 hour time in male voice adding xxx hours. Can use to speak the time for any time zone.

865 xxx - same as above in female voice

866 xxx - callsign of user xxx (as set with cmd 191)

867 xxx - callsign of user logged onto port xxx

868 xxx - callsign of user being paged with command 132

