MACHINE TO MACHINE | WEB TO WIRELESS

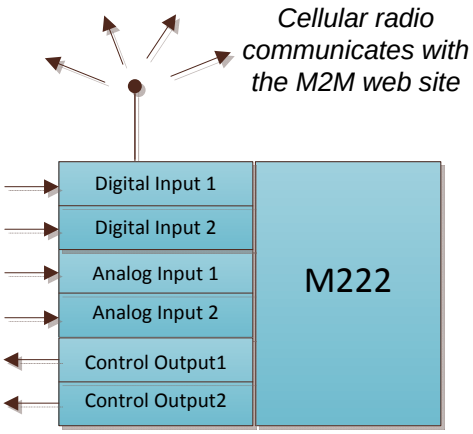
M2M communications

M222 RIO

M222 with RIO (Remote Inputs & Outputs)

The M222 is a web-to-wireless remote monitor and control system. An internal cellular modem provides two-way communications to the automated www.m2mcomm.com web site. A choice of cellular or satellite based communications provides coverage anywhere in the world.

- ✓ CDMA/1X Cellular
- ✓ GSM/GPRS Cellular
- ✓ Iridium Satellite



The on-board inputs and outputs of the M222 are suitable for a wide range of direct connect monitoring and control applications. The standard M222 monitors two digital inputs, which can be either dry contact or voltage sensing inputs. It can also monitor two analog inputs. An on-board DIP switch selects either 0-10 VDC or 0-20 mA inputs. Monitored inputs are reported to the web site upon request, upon change, or on a time scheduled basis.

Two relay outputs can be remotely controlled (turned on or off) from the web site.

Remote Inputs & Outputs

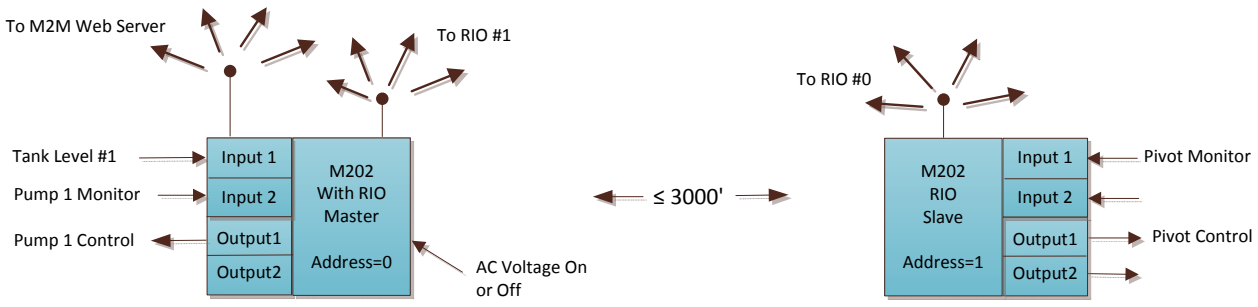
The M222 can be ordered with a built-in Digi Maxstream RF radio module. This radio allows you to expand the system by also monitoring inputs and controlling outputs that are located a distance from the main (Master) M222 unit. This is useful when the points to be monitored and/or controlled are not all located together.

The slave unit also contains a Maxstream RF radio, but does not need a cellular or satellite modem (or an airtime account).

In a RIO installation, the Master unit polls the slave(s) to read the status of the remote inputs and to control the remote outputs. The Master then reports the status of all system inputs and outputs to the M2M web server.

The maximum I/O configuration is 8 digital inputs, 8 analog inputs and 8 control outputs.

In the following diagram, one master unit and one slave unit combine to provide a total capacity of 4 digital inputs and 4 control outputs



One Master M222 with one remote (slave) M222

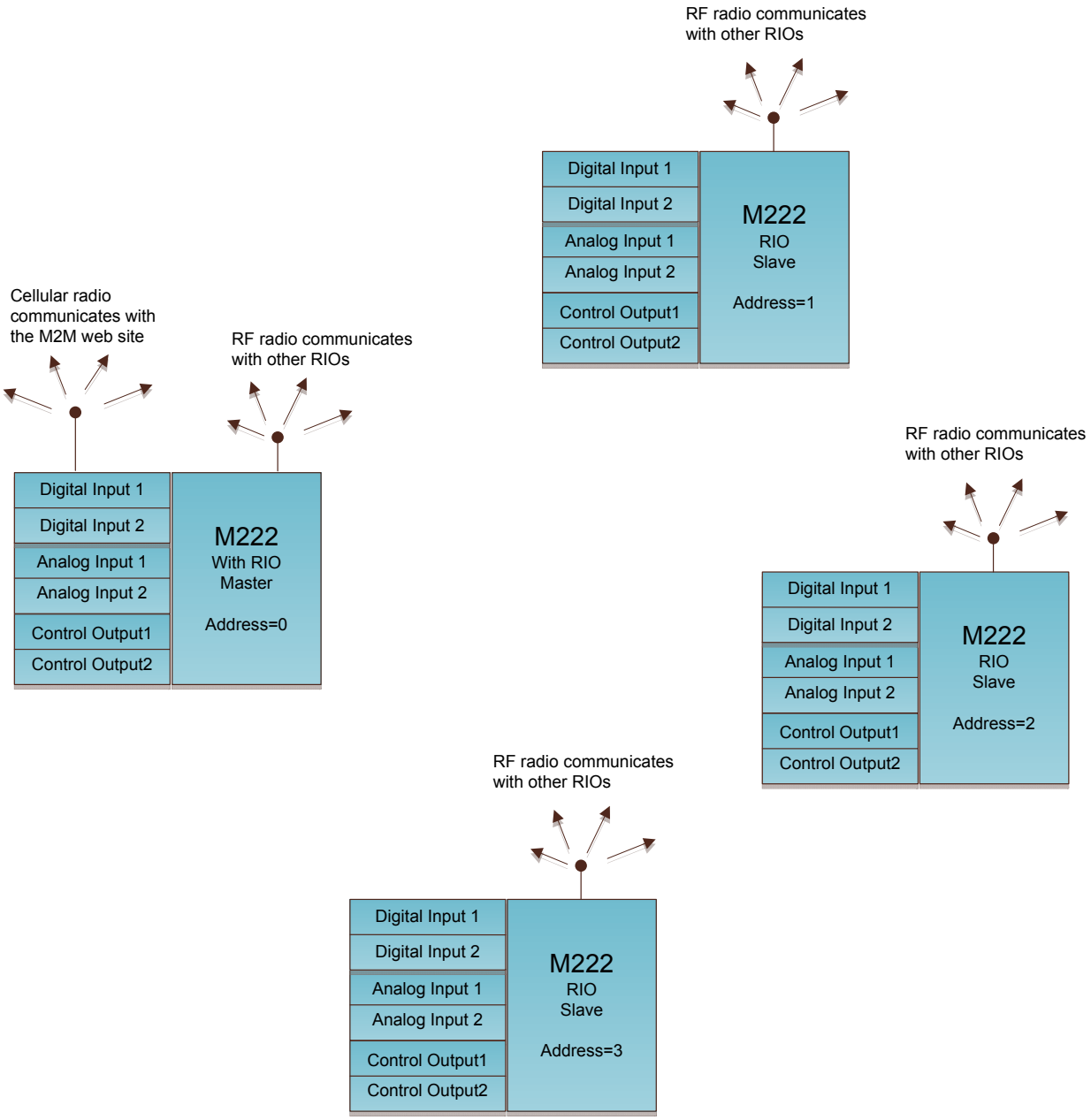
Master to Slave RF Range

The M222 will accommodate one of three different types of Maxstream RF radio modems. The published “Ideal” ranges for the three models as shown in the table below are under ideal conditions with a high gain antenna. The “Standard” ranges are realistic estimates when using the standard internal 2.1 db d gain antenna. An external high gain antenna can be used to extend the standard ranges.

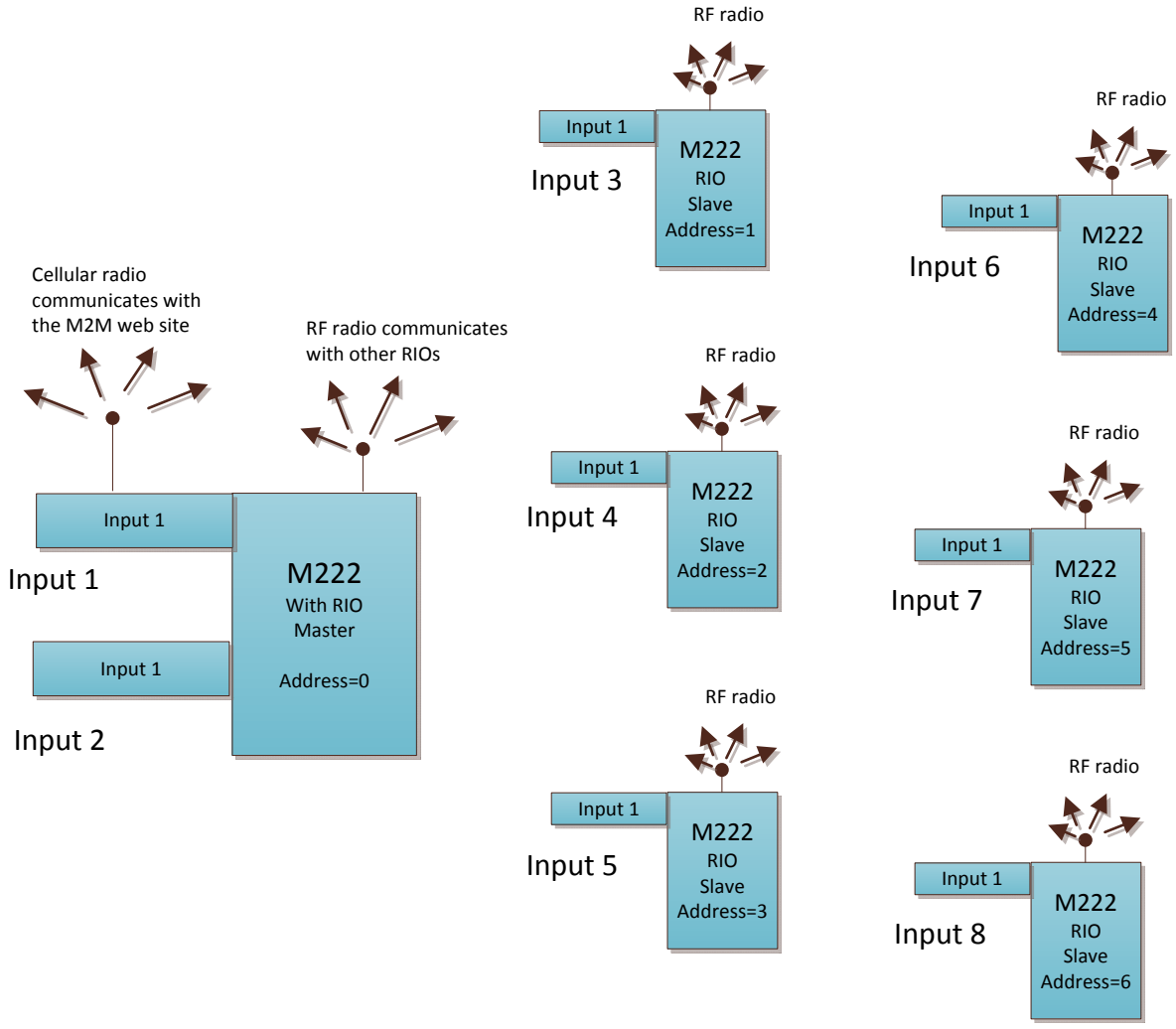
Radio	Ideal Range	Standard Range
XBEE	300’	Up to 300’
XBEE PRO	1 mile	Up to 900’
9XSTREAM	7 miles	Up to 3000’

Multiple Slave Units

One Master M222 can support up to six slave units. The maximum I/O configuration is 8 digital inputs, 8 analog inputs and 8 control outputs.



This example shows 1 Master and 3 Slaves. The “system” inputs and outputs can be mapped among the devices in many combinations. In this example, 8 digital inputs are spread among the master and 6 slaves.



M2xx I/O Configurations & Options

For applications that don’t require the full set of I/O options, the product can be ordered with reduced I/O.

M200	Two digital Inputs
M202	Two digital Inputs and two control outputs
M202HV	Two high voltage digital Inputs and two control outputs
M222	Two digital Inputs, two analog inputs, and two control outputs

Digital inputs can monitor and report the open/closed state of dry contacts or the presence or absence of 120VAC or 240 VAC.

High Voltage digital inputs can directly monitor and report the presence or absence of 120VAC, 240 VAC, or 480 VAC. No external step-down transformers are required.

Power Outage Reporting - The standard unit will report a 'Power Outage' when the unit's primary power supply voltage is lost for more than 1 minute. A battery is required for this feature. If power outage reporting is not needed, then the unit can be ordered without a battery.

DC Powered Option - The standard unit can be powered by 120, 240, or 480 VAC.
As an option, the unit can be powered by 15 VDC or by 12 VDC if there is no battery.

RIO System Setup Overview

The master & slave units can have different I/O configurations. For example, the master might be a M200 while slave #1 is a M222 and slave #2 is a M202.

A Configuration program is used to define the overall system setup. As a first step, the entire system is assigned a unique System ID number to prevent interference with other systems.

I/O points 1 & 2 are always defined as local (the inputs and outputs are connected to the master unit's terminal strip).

I/O points 3-8, if used, are remote, which means that the input or output is monitored or controlled by a slave unit thru the Maxstream modems. For each remote point, the configuration program will prompt for the remote slave's unique address and the corresponding slave I/O point (#1 or 2) to be used.

As an example, a typical set of questions and answers for a remote digital input #3 is:

```
Digital Input 3:
  Enable (1) or Disable (0)?  1
  Report on Change? Yes (1), No (0)   1
  Remote Unit# 1-6?  2
  Remote Input 1 or 2? 1
```

During ongoing operation, the master will poll slave #2 to read the status of its input #1. This on/off value will be reported to the M2M web site as Digital Input #3. At the web site, all inputs and outputs can be defined with descriptive labels. System input #3 might be labeled something like "Low Tank Level (yes or no)".

All RIO communications are initiated by the master. The master RIO device will poll the designated remote units at a customer specified frequency to retrieve the status of inputs or to set the outputs to on or off.

On the remote (slave) boards, all of the inputs are monitored and reported via the Maxstream radio to the master unit and the outputs are only controlled by the master thru the Maxstream

radio. Slaves never initiate a conversation. They only respond when they hear a poll containing their address. Slaves do not talk to slaves

Automatic Local Controls = “Wireless Wire” Mode

All (eight) outputs can be configured as:

(1) Remotely controlled from the M2M web site or
(2) Automatic

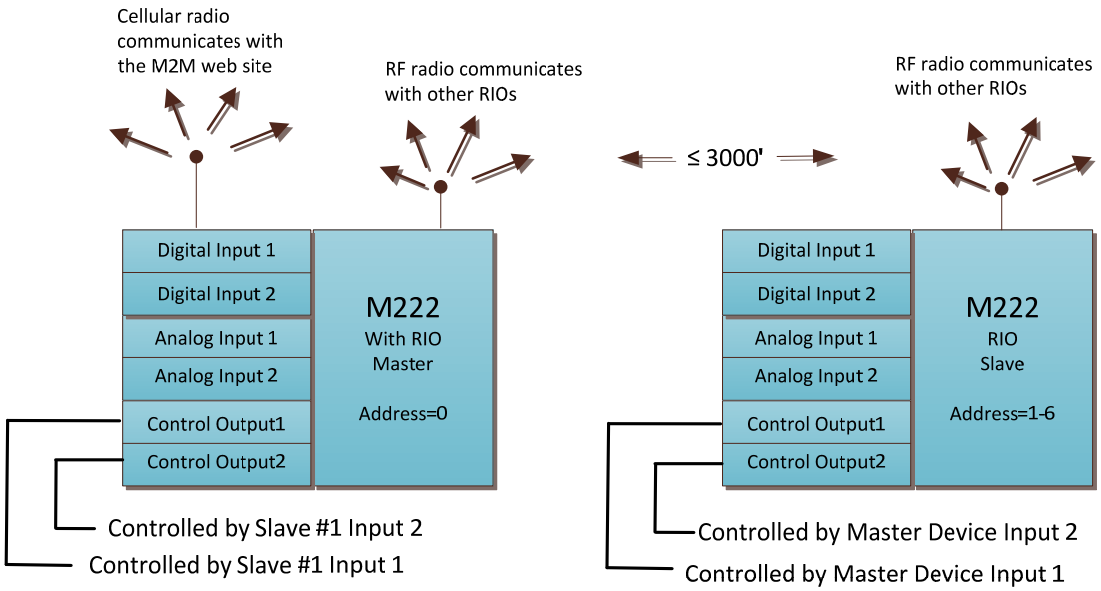
In the remote control configuration, any output relay can be closed (turned on) or opened (turned off), either permanently or for a specified period of time, from 1-9999 minutes.

In the automatic mode, each output relay can be locally controlled based on the state of remotely monitored switches and/or sensors. More specifically, the outputs can be configured to “follow” a remote analog or digital input.

This control option can be changed from the web site at any time. For example, any output may normally be controlled based on local conditions, but can be individually overridden at any time by a command from the web site

Mapping the Inputs and Outputs

Each output can be locally controlled based on a user-assigned analog or digital input. The following diagram is one example:



Each output relay has a common terminal point plus two other contacts - a normally open and a normally closed relay connection.

Following a digital input:

- If the corresponding input is closed (on), then the control relay will be energized. The normally open (NO) point will be closed and the normally closed (NC) point will be open.

- If the corresponding input is open (off), then the control relay will be de-energized. (The normally open point will be open and the normally closed point will be closed).

To set up the output so that its state complements the state of the input, simply wire to the common and NC terminal points, so that closing an input will open the control relay.

Following an analog input:

At the local board level, each analog input is measured as a value from 0-1023.

Ranges:

Two setpoints can be entered for each analog input. These setpoints are used to categorize the measured value into one of three ranges: 0, 1, or 2.

If the measured value is ≤ the low set point, the range = 0
If the measured value is > the low setpoint and ≤ the high set point, the range = 1
If the measured value is > the high set point, the range = 2

For example if the setpoints are 500 and 600, then a measured value

≤ 500	is in Range 0
> 500 and ≤ 600	is in Range1
> 600	is in Range 2

When a measured analog value crosses a setpoint and stays there for longer than the specified trigger time, then the range will change.

Range 1 provides serves as a dead band and changes into range 1 will be ignored.

Outputs can be controlled when a measured value changes to range 0 or 2.

- The relay will be energized when the analog range = 2. (The normally open point will be closed and the normally closed point will be open).

- The relay will be de-energized when the analog range = 0. (The normally open point will be open and the normally closed point will be closed).

Note that a load can be turned on or off based on the analog value being in either range 0 or 2.

- Connect to the Normally Open contact point to close the relay (turn a load on) when the analog range = 2 and open the relay (turn the load off) when the range = 0.

- Connect to the Normally Closed contact point to open the relay (turn a load off) when the analog range = 2 and close the relay (turn the load on) when the range = 0.

Application Examples:

A greenhouse temperature is being monitored.

Assume that:
- a temperature of 70 degrees F = an analog reading of 500
- a temperature of 80 degrees F = an analog reading of 600

Assume that the setpoints are set to 500 and 600 (= 70 & 80 degrees)

If the temperature exceeds 80 degrees, a fan can be turned on.
If the temperature drops below 70 degrees, a fan can be turned off.

A water tank level (or pressure) is being monitored.

Assume that:
- a high level = an analog reading of 800
- a low level = an analog reading of 350

Assume that the setpoints are set to 350 and 800 (= low and high levels)

When the water level becomes low, the pump can be turned on.
When the water level becomes high, the pump can be turned off.

The local programming utility - will configure the I/O mapping by asking the following questions for each enabled output:

1. Is automatic control to be enabled?
2. What is the controlling input # (1-8).

The location assignments of Inputs 1-8 and Outputs 1-8 are predefined in earlier setup menus.

Application Notes:

There are several great ways to use the M222 RIO products

#1 - A "Standard" Web-to-Wireless M200, M202, or M222 with no Remote I/O

- ✓ To remotely monitor up to 2 digital inputs and/or 2 analog inputs
- ✓ To remotely control up to 2 on/off outputs
- ✓ When all I/O points are close enough together to connect into one unit

#2 - Web-to-Wireless M222 with a built-in RIO

- ✓ To remotely monitor up to 8 digital inputs and/or 8 analog inputs
- ✓ To remotely control up to 8 on/off outputs
- ✓ When all I/O points are *not* close enough together to connect into one unit

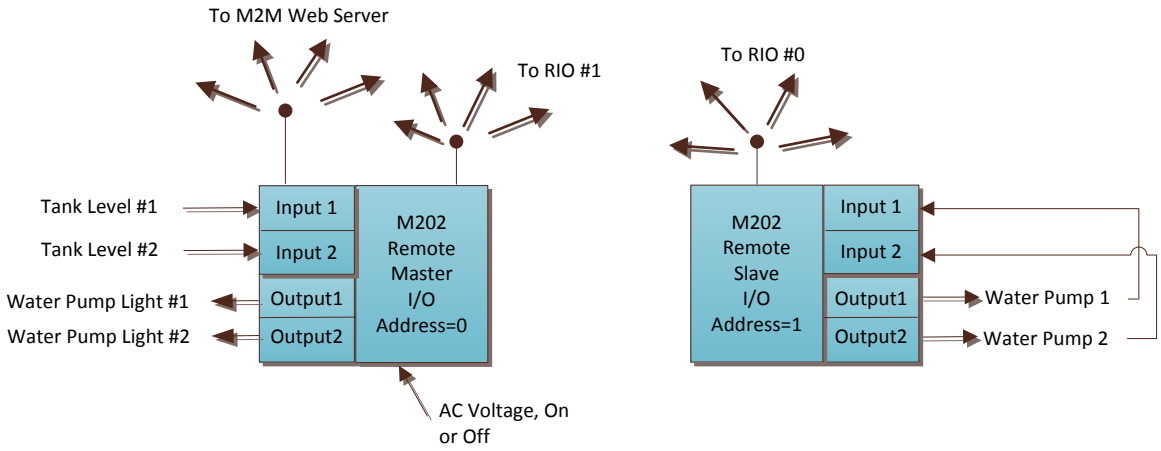
#3 - Standalone M202 RIO slaves - To create "wireless wires"

- ✓ As multi channel wireless switches
- ✓ If any system input changes, the corresponding relay on another unit will change
- ✓ Wirelessly control a remote load (on or off) based on a local switch (on or off)
- ✓ Limited to the range of the selected RF radio and antenna combination
- ✓ No web site is required = no remote monitor = no ongoing airtime cost

#4 - Combine #2 & 3 Above! - Automatic with remote overrides

- ✓ Remotely monitor the equipment status even when operating in the automatic mode
- ✓ Adds the ability to remotely set outputs, overriding the automatic mode

The following example demonstrates applications 2, 3, and 4 above.



Two remote water pumps are used to fill a tank located ¼ mile away. If the tank level drops to low level #1, float switch 1 will close and remote pump #1 will turn on. If the tank continues to drop to level #2, the second float switch will close and pump # 2 will join the fun.

- The two water tank level float switches are monitored with the Master unit's local digital inputs.
- The remote slave outputs control the pumps. These outputs are configured to automatically follow the master's inputs in the automatic mode.
- The pumps are also wired into the slave's inputs to provide a positive feedback mechanism.
- The master's outputs provide power to "Pump On" indicator lights and are configured to automatically follow the slave's inputs.

When a tank level switch closes, the corresponding remote pump will turn on. When the pump turns on, the slave's input will sense the pump voltage and report a "pump on" status. The indicator lights wired to the master's output will then light up, completing the loop.

The status of both the tank levels and the pumps can be reported to the M2M web site.

There are several easy variations with this system design:

1. The same setup can be accomplished by two Standalone RIO units without a cellular modem if no remote monitoring is needed. This design has no ongoing airtime cost.

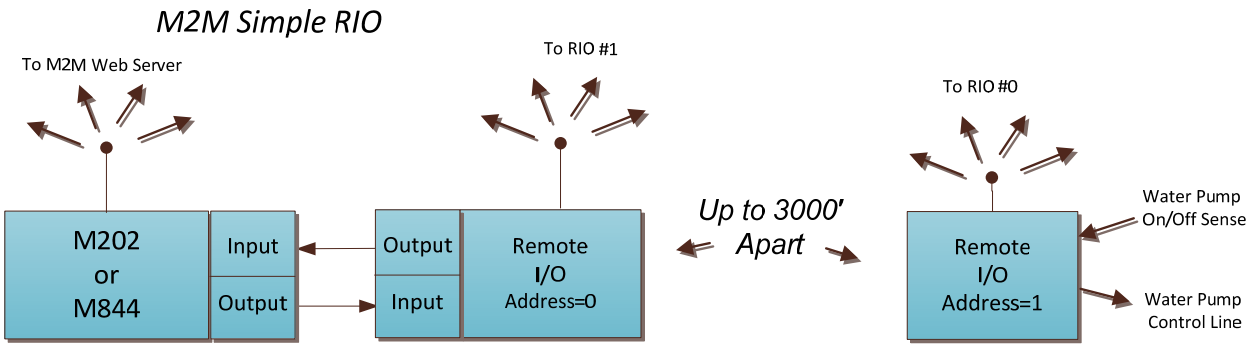
2. When human supervision is desirable, web based monitoring and control can be added. In this setup, the tank level sensors can be reported to the M2M web site and control commands can be remotely sent by the human operator to turn on both the pumps and the indicator lights.

3. Rather than using "digital" float switches, adjustable analog level sensors can be used.

4. If the monitored and controlled points are too far apart for direct RF communication, assign one unit to report input changes to the M2M NOC. Then set up the NOC to notify a second unit of the monitored input change. This works over any distance.

#5 - Use two M202 RIO slave units with an existing M2M product to monitor or control remote I/O points

One RIO unit is connected to the inputs and/or outputs of a M2M product such as the M844.



For example, one RIO's output relay can connect to the M844's digital input and a digital input can connect to the M844's relay output.

- If the remote unit's input closes, the local device's relay will close, and the M844 will detect and report the change.
- If the M844 receives a web-based command to close an output, the local RIO will see this as an input change, and will cause the remote RIO to close its corresponding Output Relay.

RF Reliability

- Controlled outputs have a normal position (normally open or closed). All command communications are repeated every N seconds. If a controlled output does not hear from the master for N minutes, the output will return to the normal (safe) position.

- RF communication failures, after N retries, are reported by the master device to the M2M web site

  Test programs are included to verify and evaluate all master-to slave RF communications. Each connection can be locally monitored and displayed during installation to assist in correct antenna setup.