



GPIO Open Collector/Drain Output

By John Sonnenberg

Raveon Technologies Corp

Summary

Raveon has products with various IO options, some of which include Open Drain (OD) or Open Collector (OC) outputs. This Application Note describes how these kinds of features can be used. These IOs are used to turn things on and off.

The RV-M21G and RV-M22G *Tech Series* radios with the GPIO interface can be configured to have an Open Collector output. Here is a picture of the RV-M21G. This document refers to these M21G and M22G radios.



The RV-M22 is smaller than the RV-M21 version, but with reduced RF output power.

Open Drain outputs are great for turning on lights, valves, relays, and many other devices. Open Drain (OD) connects the load to ground when it is turned on.

GPIO Interface on RV-M21G and RV-M22G Data Radios

The General Purpose IO (GPIO) front panel interface has many IO options on 3 pins to remotely control things or monitor things. Pins 3,4,5 are configurable.

- A:** Digital TTL Inputs,
- B:** Digital TTL Outputs
- C:** Open Drain MOSFET
- D:** DC Power switch outputs.
- E:** **Analog Voltage Inputs.**
- F:** **4-20mA current monitoring.**

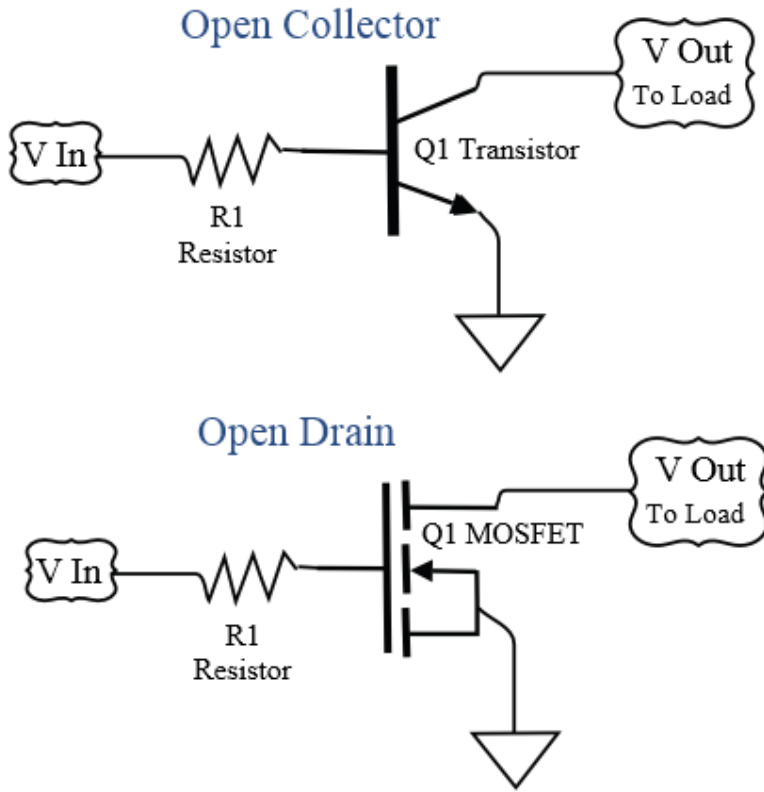


Uses the same IO connector as the RS-232, and has serial IO and general purpose IO functions that are software configurable. **Raveon Production** sets the IO mode the way You want, and configures these pin versions to: A,B,C,D,E,F. C,D,E are GPIO and can be turned in is software. A will be off if you want to use C,D,or E. If you want A&B digital io versions, then C&D are disabled in hardware.

Pin #	Name	Direction	Function	Level / Specification
1	RX	In	Serial data Input	RS232
2	TX	Out	Serial Data Output	RS232
3	IO0	I/O	I/O Pin 0	Configurable General Purpose IO
4	IO1	I/O	I/O Pin 1	Configurable General Purpose IO
5	IO2	I/O	I/O Pin 2	Configurable General Purpose IO
6	GND	-	Ground	Connect to earth ground.

C Open Drain vs Open Collector

Open Drain MOSFET means the semiconductor's output port is directly connected to the "drain" pin of a MOSFET. It is similar to "Open Collector", where the output port is on a collector of a TRANSISTOR. OC is a traditional way, but OD is more powerful and more reliable, so we provide Open Drain output to drive relays, lights, and other devices.

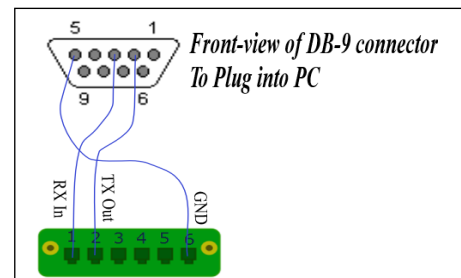


Enabling the GPIO Open Drain feature

Raveon's *Tech Series* Radios GPIO General Purpose IO interface pins can be configured in different ways.

Connect an RS232 serial port to the RX in and TX out pins of the GPIO interface to send commands and data into the product. See the user manual on how to enter the command mode. (+++ enters command mode)

To set the IO pin to Open Drain mode, have Raveon configure the radio before shipped to you, or use the **IOPIN** command to configure it.



IOPIN XX M is the command to set the GPIO bits on the Tech Series GPIO front panel to inputs or outputs. Enter **IOPIN <enter>** in command mode to read pin settings.

XX parameter are the Hexadecimal representation of the pins being configured. For example, to configure bits 0 and 1, **XX** should be set to 3. FYI: GPIO pin #4 is called IO1 and is designated as **XX** bit 1, which in hex is **XX=02**.

GPIO Connector Pin #	5	4	3
Index	2	1	0
IO Pin Name	IO2	IO1	IO0
<i>XX value to identify the pin. Add these up to identify multiple values.</i>	4	2	1

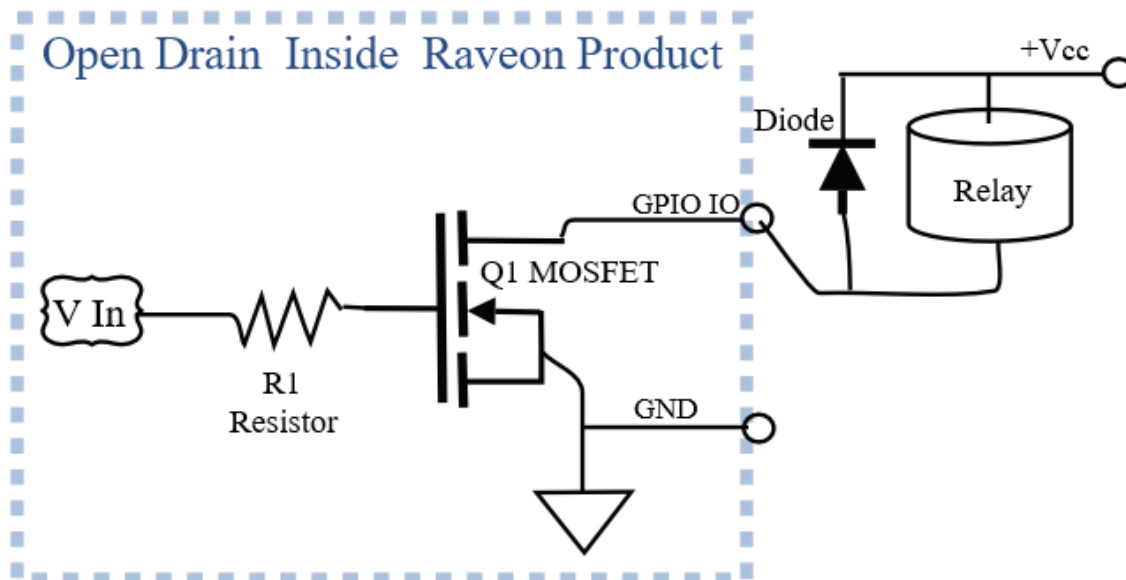
XX is Hexadecimal. To specify all 3 IO pins IO0-IO2, the **XX** value is 7. (4+2+1)

M is the IO Type code **A**: Digital TTL Inputs, **B**: Digital TTL Outputs, **C**: Open Drain MOSFET outputs, **D**: DC Power switch outputs, **E**: Analog Voltage Inputs. **F**: 4-20mA sensor inputs. Different products have different varieties of GPIO features. Check your product's data sheets to see what GPIO features it supports on which IO pins. **X** is Hexadecimal.

- IOPIN 1 C** command sets The IO pin 0 (first pin) to Open Drain mode.
- IOPIN 2 C** command sets The IO pin 1 (first pin) to Open Drain mode.
- IOPIN 4 C** command sets The IO pin 2 to Open Drain mode.
- IOPIN 7 C** command sets all 3 IO pins to Open Drain mode.

How Open Drain works show

Inside Raveon's products with GPIO and Open Collector (OD) features, there is an OD output pin connected to the collector of a MOSFET inside the product. The MOSFET is also connected to the ground of the product.



Use Open Drain for enabling: Lights, Relays, LEDs, Valves, AC power switches ...

When the GPIO pin is OD mode, and the output is SET, the MOSFET is turned on, and the IO pin is shored to ground (GND). The device connected to OD will normally be connected to a voltage power supply (Vcc) or a battery. When the OD pin shorts to ground the device will turn on. The device can be an LED, light, relay, valve, or many other devices. Devices with inductors, such as a relays, should have a diode connected to the device so that the voltage spike that is generated when its turns on and off gets limited.

Use a diode to protect the GPIO interface and keep the wires safe. There are many ways to reduce voltage spikes when switching a relay. Some add capacitors, some add extra diodes with resistors. Do the right thing for your system. The Tech Series GPIO interface uses a MOSFET like the NXP PMV130ENEA . Its specs are:

drain-source voltage : 40V
Max drain current: 2.1A
junction temperature -55 to 150C
electrostatic discharge voltage 1000V

Using the Open Drain (OD) feature

Power on default mode on OD IO pins is open. The OD output is not shorted to ground when the device powers on. When the device receives a command via the local serial port or over the air using the radio modem, a command can turn on the OD making the OD IO pin short to ground.

See the product's data sheet for information about resistance to ground and maximum current that should be drawn from the IO pin when the open drain is shored to ground.

There are a number of ways to enable on the Open Drain output.

- Local commands in the command mode.
- Remote Over The Air (OTA) commands sent to the products.
- Remote Over The Air (OTA) MODBUS messages sent to the product.

Local commands in the command mode

See the product's Technical Manual or User Manual for a list of commands that the product supports. Most products with GPIO support these local commands that can be typed into the product, or sent via software, when the product is in the Command Mode.

Raveon products can also utilize a serial port protocol called WMX. WMX enables a user to send commands into a data radio product when it is in operating mode, not command mode, and the WMX command will still be executed in operating mode.

Here are the commands the RV-M21 and RV-M22 Tech Series radios support.

Command	Command Description	Parameters	Default Settings
MODB	MODB x Enable or disable the MODBUS communication feature. 0=disable. 1=MODBUS RTU mode. 3=MODBUS TCP (if available on the product)	X: 1-3 0=No MODBUS	0
CBIT	CBIT XX Clears output bits, XX is hexadecimal format. Any bit in x set to 1 will cause the same output bit in the modem's output register to be cleared to 0. No bits get set. X=C3 to set bits 0, 1, 14, 15. To read the	0-FF	

	output bit register, enter CLRBIT with no parameter or better to use GETOUT command.		
SBIT	SBIT XX Sets output bits, XX is hexadecimal format of the bits being set. Any bit in x set to 1 will cause the same output bit in the modem's output register to be set. No bits get cleared. X=C3 to set bits 0, 1, 14, 15. To read the output bit register, enter SETBIT with no parameter or better to use GETOUT command.	0-FF	0
TBIT	TBIT XX MMM Sets output bits for a specific time, XX is hexadecimal format of the bits. Any bit in x set to 1 will cause the same output bit in the modem's output register to be set. MMM is in mS. 1000=one second, 60000=one minute,...To set bit #3 to 1 for 250mS: TBIT 4 250 After the time expires, the bits that was st in XX is cleared to 0.	0-FF 2 – 4000000000 (2mS – 1100hours)	


CBIT command is to clear a bit. It will disable the Open Drain, and the IO output will not connect to ground if the output is cleared with the CBIT command.

SBIT command is to set a bit. It will turn on the Open Drain, and the IO output will connect to ground with the SBIT command if the parameters of the SBIT are for the OD IO pin that is used and configured for OD.

TBIT command is to set a bit for some time. It will turn on the Open Drain for some time. The IO output will connect to ground with the SBIT command if the parameters of the SBIT are for the OD IO pin that is used and configured for OD. The specified OD IO pin will stay shored to ground for the number of mS specified in the TBIT command.

To enable MODBUS protocol reception on the device, execute the **MODB X** command. **MODB 1** to enable RTU MODBUS.

WMX commands

 All of the *Local Commands* specified above can be executed with the WMX message. WMX can be enabled on the product with the command WMX 1.

See the *WMX Technical Node .PDF* and the WMX user manual for more WMX information.

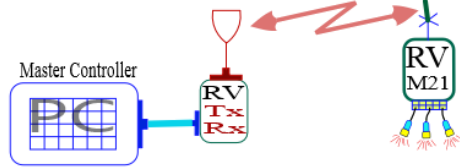
Your custom software can issue WMX messages into a data radio and the message will be processed. If you pass in a WMX message to a modem, that has the TOID set to the ID of a remote radio you want the message to be sent to, the radio will send the data in the WMX message to the remote radio. If you tagged the WMX message as a “Command” the remote radio will execute the command when it receives the transmission from the radio that you passed the WMX message into.

WMX can pass over two types of data: 1) Actual rad message data. 2) Commands to be executed. Because it has the command feature, you can pass those SBIT, CBIT, TBIT or any other command into a modem using WMX commands messages, and the get sent over-the-air to the remote radio or SCADA device and the command is executed remotely.

Over the air WMX command can set and clear the Open Drain IO pins. Most WMX users have incorporated the WMX protocol into their master controller software. One Raveon’s website is a free software tool called *Radio Manager*. Radio Manager is for communication to radios via serial ports or TCP/IP connects. It also has a WMX feature to send and receive WMX messages so you can experiment with WMX.

MODBUS commands

The RV-M21 and RV-M22 Tech Series radios have a communication feature option that is compatible with the MODBUS RTU protocol.



You Master Controller computer will pass a MODBUS message to a Data Radio modem. The Radio modem connected to your PC will transmit the message to the RV-M2x Tech Series radio that will process the MODBUS message, and send the

response.

For more information about MODBUS RTU messages, see

<https://www.raveon.com/modbus-information/> or read Raveon's app note **AN234** for SCADA info about Raveon's Tech Series SCADA products. In the RV-M21 data radio modem's software must be version D30 or larger to utilize MODBUS.

Raveon Application note **AN230** contains all information about using the MODBUS protocol [AN230 \(ModbusMx\)](#).

With Raveon's Products that have GPIO interfaces with Open Drain, such as the RV-M21 and RV-M2 data radio modems.

MODBUS RTU Commands

Modbus is a registered trademark of MODICON, Inc.

Messages sent from devices that utilize SCADA and Telemetry protocols such as MODBUS RTU are often called "Telegrams". The MODBUS function 5 (Force single coil) can be used to set or clear the Open Drain IO pins.

Modbus data is specified as big-endian, which means the most significant value is at the lowest address.

(05) Force single coil to turn on the Open Drain.

To set the state of output bits and Open Drain (OD) pins (MODBUS refers to them "coils"), function code 05 is used to send the set command to the remote device. To set a OD open (coil off) (0) send 0x0000 and to enable and Open Drain output (coil on) (1) send 0x00FF. The data per OD output are two bytes.

When broadcast, the same function forces the same data output in all attached slave devices.

Function code 05 (Force Coil Status) is the code used in MODBUS to send a message to control an Open Drain. The command structure is:

Byte 0:	Slave Address. The ID of the RTU device
Byte 1:	Function Code for this message. 05
Byte 2:	Coil Address MSB
Byte 3:	Coil Address LSB
Byte 4:	Data Force MSB
Byte 5:	Data Force LSB
Byte 6:	<i>Error Check Low Byte (LSB)</i>
Byte 7:	<i>Error Check High Byte (MSB)</i>

The structure of the 05 (Force Coil Status) response back is:

Byte 0:	Slave Address. The ID of the RTU device
Byte 1:	Function Code for this message. 02
Byte 2:	Byte Count (N)
Byte 2 and 4:	The response Data bytes containing the output bit status. 0x0000=0 0x00FF=1
2 CRC Bytes	<i>Error Check</i>

So for example, the telegram to set bit #2 (Coil address 2) on device 150(0x96) is:

Request: 96 05 00 02 FF 00 31 1D
Response: 96 05 00 02 FF 00 31 1D (it reported coil 2 is on)

The Register control coils in MODBUS is referred to as a “Coil Address” In Application note AN230, Raveon’s register list has the register number (Coil address) for all the IO pins and SCADA features that can be accessed with the MODBUS SCADA protocol.

IO0 is Register 1. **IO1** is Register 2, **IO2** is Register 3. Use these register numbers to execute MODBUS messages that set coils or read coil status.

For Example, to turn on the Open Drain output (Pin to Ground) for device 30 (0x1E) using a MODBUS “Force Single Coil” message which used function code 5, here are some example messages in hex bytes. Each are 8 bytes long.

	Device	Function	Register	Data	CRC
IO0 On:	1E	05	00 01	FF 00	DF 95
IO1 On:	1E	05	00 02	FF 00	2F 95
IO2 On:	1E	05	00 03	FF 00	7E 55

For additional information, contact:

Raveon Technologies Corporation

2320 Cousteau Court

Vista, CA 92081 - USA

Phone: 1-760-444-5995

Fax: 1-760-444-5997

Email: sales@raveon.com