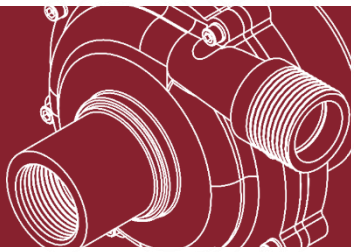
Moog RM30 Pump System: Specification for Modbus Communications between RM30 Pump Unit and RMC051-0003 Drive



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Purpose

This document details the Modbus RTU asynchronous serial communications between Moog's RM30 Pump unit and RMC051 Drive.

General Communications

All serial communications between the pump unit (Master) and the drive (Slave) are initiated by the Master and conform to the Modbus RTU protocol. For detailed Modbus information refer to the "Modicon Modbus Protocol Reference Guide, PI-MBUS-300 Rev. J".

1.1 Physical Layer – Differential RS-485 multipoint half-duplex.

1.2 Protocol: Asynchronous serial Modbus RTU – selectable19200/9600 baud, 8 data bits, even parity, 1 stop bit.

1.3 Addressing: Valid addresses are 1-6. Address 0 is used for the broadcast address which all slave devices recognize.

1.4 Connector – there are 2 connectors associated with communications.

1.4.1 Address Connector J5 – Female DB-9 connector.

2.4.1.1 Pin 1 - GND: signal ground
2.4.1.2 Pin 2 - ADDRESS1: connect to ground at power-on to select #1 address
2.4.1.3 Pin 3 - ADDRESS2: connect to ground at power-on to select #2 address
2.4.1.4 Pin 4 - ADDRESS3: connect to ground at power-on to select #3 address
2.4.1.5 Pin 5 - ADDRESS4: connect to ground at power-on to select #4 address
2.4.1.6 Pin 6 - ADDRESS5: connect to ground at power-on to select #5 address
2.4.1.7 Pin 7 - ADDRESS6: connect to ground at power-on to select #6 address
2.4.1.8 Pin 8 - BOOTLOAD: connect to ground at power-on to enable reprogramming
2.4.1.9 Pin 9 - CHASSIS GND: chassis connection

1.4.2 Communications Connector J3 – Molex 22-12-4052 5-pin header. Mating connector – Molex 22-01-3057 with 08- 55-0102 pins for 22-30AWG wire.

2.4.2.1 Pin 1 - RS485+
2.4.2.2 Pin 2 - RS485-
2.4.2.3 Pin 3 - GND: signal ground
2.4.2.4 Pin 4 - BAUD_SELECT: connect to GND for 9600 baud, leave open for 19200 baud
2.4.2.5 Pin 5 - GND: signal ground

1.4.3 Slave addressing – set by jumpering any one of J5's address lines to GND. The pump address is normally captured only on power-on. If more than 1 address line is read as GND, or 0 volt level, or if no lines are detected as 0, then the pump will by default respond to only the 0, or broadcast, address. A special command can be broadcast by the master controller to request that all pumps repeat their read address routine – see function code 25.

1.4.4 Line termination – RS-485 line termination, if needed, is implemented by connecting a resistor between pins 1 and 2 of the J3 mating connector.

1.4.5 IAP (In-Application Programming) – if BOOTLOAD is jumpered to GND, or 0 volt level, at power-on, the drive will enter the software reprogramming mode. Reprogramming is accomplished through the use of a serial terminal program that is capable of communicating through the binary YMODEM protocol. See the separate "Serial Reprogramming Instructions" document for further information. If a drive is being reprogrammed, it must be the only "live" drive connected to the RS-485 bus.

1.5 Modbus RTU Framing – a typical message frame is shown below.

START	ADDRESS	FUNCTION	DATA	CRC Check	END
T1-T2-T3-T4	8 bits	8 bits	n x 8 bits	16 bits	T1-T2-T3-T4

1) START/END (T1-T2-T3-T4) – Silent interval of at least 3.5 character times before and after transmission.
2) ADDRESS – pump addresses 1-6 and broadcast address 0 supported.
3) FUNCTION – function code.
4) DATA – unless otherwise specified, all data is unsigned 16-bit, transmitted hi-byte first followed by lo-byte.
5) CRC Check – calculated CRC value for the complete message is appended to the end and transmitted lo-byte first followed by hi-byte.

1.6 Modbus function codes - the following Modbus function codes are supported. All data is transmitted as a 16-bit word, hi- byte first followed by the lo-byte. Reading or writing Coils is not supported. Note that the same data are available in both holding registers and input registers, meaning that either function (0x03 or 0x04) can be used for reading data.

1) Hex 0x03 (decimal 3) – Read holding registers.
2) Hex 0x04 (decimal 4) – Read input registers.
3) Hex 0x06 (decimal 6) – Write single register.
4) Hex 0x10 (decimal 16) – Write multiple registers.
5) Hex 0x19 (decimal 25) - Force pumps to reacquire addresses (see section 2.8 Address Reacquisition).

1.7 Register blocks

START ADDRESS	REGISTER BLOCK	PERMISSIONS	DESCRIPTION
0001	Drive Model/Serial/ Version data	R	Drive model and serial numbers and software version information
0101	Pump control	R/W	Registers for control of the pump
0201	Pump status	R	Registers for reading run/fault status of the pump
0301	Pump data	R	Registers for reading data values

1.7.1 Pump model/serial/version register block – Read-only registers containing drive model number, serial number, and software version information with Start address 0001. All registers can be read with either function code 0x03 or 0x04.

1.7.1.1 **Drive Series** – Register address 0001 (0x01 hex, addressed as 0x00 in message). Read-only data register that contains the numeric portion of the first part of the drive model number – for instance, the "051" of RMC051-0003. The data received from this register should be interpreted as Binary-Coded Decimal (BCD) values rather than hexadecimal.

1.7.1.2 **Drive Version** – Register address 0002 (0x02 hex, addressed as 0x01 in message). Read-only data register that contains the second part of the drive model number – for instance, the "0003" of RMC051-0003. The data received from this register should be interpreted as BCD values rather than hexadecimal.

1.7.1.3 **Software Version** – Register address 0003 (0x03 hex, addressed as 0x02 in message). Read-only data register that contains the drive's software version. The data received from this register should be interpreted as BCD values with an implied "." between the 1st major byte and 2nd minor byte of the version number. An example would be version 03.00.

1.7.1.4 **Serial Number High** – Register address 0004 (0x04 hex, addressed as 0x03 in message). Read-only data register that contains the high 16-bit word of the drive's 8 digit serial number. The high word contains the "year" and "week" of manufacture. This data should be read as BCD values. For instance, a drive's serial number might be 19320001. This word contains the year byte of "19" for 2019, and the week byte of "32" for week 32.

1.7.2 **Serial Number Low** – Register address 0005 (0x05 hex, addressed as 0x04 in message). Read-only data register that contains the low 16-bit word of the drive's 8 digit serial number. The low word contains the "item" number of manufacture. This data should be read as BCD values. For instance, a drive's serial number might be 19320001. The low word indicates that that drive was the first unit manufactured in week 32 of year 19.Pump control register block – Read/Write registers with Start address 00101. These registers can be read with either function code 0x03 or 0x04, and written as holding registers with function codes 0x06 and 0x10. These registers control pump operation.

1.7.2.1 **RequestOnOff** – Register address 0101 (0x65 hex, addressed as 0x64 in message).

1) Bit 0 OnOffReq – Control bit that switches pump on or off: 0 = Off (stop): 1 = On (start).
2) Bit 1 ResetFault – Control bit that resets the global fault bit once the existing fault has cleared: 0 = no resetting: 1 = resetting fault. Since this is an edge detection bit, it should be set in a transmission and then reset in subsequent transmissions.

1.7.2.2 **SpeedSetpoint** – Register address 0102 (0x66 hex, addressed as 0x65 in message). Control register that sets the speed setpoint, a valid command is from 10% to 100%. If a setpoint of < 10% is commanded, the command will be adjusted to the minimum command of 10%. The scale is 0.01%, so the actual transmitted value should be from 1000 (10%) to 10000 (100%).

1.7.2.3 **Serial10SecIgnore** – Register address 0103 (0x67 hex, addressed as 0x66 in message). Setting this control register to a non-zero value will disable the Serial 10 second timeout warning. Setting it to 0 again will enable the timeout warning. This capability is provided as a diagnostic tool.

1.7.2.4 **ResetDefault** – Register address 0104 (0x68 hex, addressed as 0x67 in message). Writing the hex value 0xAA55 to this register using function code 0x06 will reset the accumulating run data registers Runtime, Ontime, and Starts, to 0. This register will always be read as 0.

1.7.2.5 **CurrentLimit** – Register Address 0105 (0x69 hex, addressed as 0x68 in message). This register sets a maximum current limit value for the motor phase current. The default value for current limit is the maximum setting of 1800, which corresponds to an average motor phase current of approximately 13.7 amps. This value can be reduced to a minimum of 1200, which corresponds roughly to 9.3 amps. This register is backed up in the onboard EEPROM, and any changes from the default are stored and reloaded at power-on.

1.7.2.6 **AccelDecel** – Register Address 0106 (0x6A hex, addressed as 0x69 in message). The value in this register determines the time required to accelerate or decelerate from one commanded speed to another, and is defined as the change in commanded RPM in a 40 millisecond time period. The default value is 40. Therefore, if the AccelDecel value is set to the default, and the pump is commanded to accelerate from 1000 RPM to 2000 RPM, the time required to ramp the command 1000 RPM would be 1000/40/25 = 1 second. The 40 in the equation is the AccelDecel value and the 25 represents Hz or 1 / 40 milliseconds. The maximum value that the AccelDecel register can be set is 80, and the minimum is 5. Therefore, with a value of 80, only 0.5 seconds would be required to ramp 1000 RPM, and with a value of 5, 8 seconds would be required. This register is backed up in the onboard EEPROM, and any changes from the default are stored and reloaded at power-on.

1.7.3 Pump status register block – Read-only registers with Start address 00201. These registers are read-only and can be read with either function code 0x03 or 0x04. These registers reflect pump run, fault, and warning status.

1.7.3.1 **RunStatus** – Register address 00201 (0xC9 hex, addressed as 0xC8 in message).

1) Bit 0 Rotation – Indicates if the pump is enabled to run: 0 = not enabled: 1 = enabled
2) Bit 1 Starting – Indicates the pump is going through the alignment and starting phase - once the pump is running normally, this bit is reset: 0 = not starting: 1 = starting
3) Bit 2-7 RESERVED – not used, read as 0
4) Bit 8 GlobalFault – Indicates if there is a system fault: 0 = no fault: 1 = fault
5) Bit 9 Warning – Indicates if there is a system warning: 0 = no warning: 1 = warning
6) Bit 10-15 RESERVED – not used, read as 0

1.7.3.2 **SpeedFeedback** – Register address 0202 (0xCA hex, addressed as 0xC9 in message). Indicates the actual speed of the pump in % of maximum. The scale is 0.01%, so the valid range is from 0 to 10000. This value can be compared with the setpoint value.

1.7.3.3 **FaultStatus** – Register address 0203 (0xCB hex, addressed as 0xCA in message).

1) Bit 0 Overcurrent – If the motor/bus current exceeds the overcurrent trippoint, the Overcurrent fault bit along with the Global Fault bit will be set and the pump disabled. This is a fatal error and the power must be cycled in order to clear the fault. If the fault occurs a second time, the pump should be powered off and taken out of service.

2) Bit 1 Stall – If the pump fails to start within a 5 second period or stops running, the Stall fault bit along with the Global Fault will be set and the pump disabled. The ResetFault control bit must then be toggled to clear the Stall bit and Global Fault bit, at which point the pump can be restarted.

3) Bit 2 Motor Overtemperature – If a motor temperature > 125 deg. C (398 K) is sensed, the Motor Overtemperature fault bit along with the Global Fault bit will be set and the pump disabled. When the motor temperature drops to < 105 degrees C. (378 K), the Overtemperature fault bit will be reset and the pump can be restarted. If the microcomputer fails to act on the overtemperature and the temperature eventually exceeds 140 degrees C. (413 K), the fault will be latched in hardware, a motor/drive overtemperature signaled, and the power stage's gate drive inputs disabled. Power must be cycled in order to clear the latched fault.

4) Bit 3 Motor Thermistor – If the motor thermistor circuit becomes an open circuit, the Motor Thermistor fault bit along with the Global Fault bit will be set and the pump disabled. When the open circuit has been corrected, the Motor Thermistor bit will be cleared. The Global Fault bit can be cleared and the pump restarted by toggling the ResetFault control bit. While an open thermistor circuit is sensed, the motor temperature will be reported as 0 degrees K when the Motor Temperature data register is read.

5) Bit 4 Drive Overtemperature – If a drive heatsink temperature > 90 deg. C (363 K) is sensed, the Drive Overtemperature fault bit along with the Global Fault bit will be set and the pump disabled. When the drive heatsink temperature drops to < 75 degrees C. (348 K), the Overtemperature fault bit will be reset and the pump can be restarted. If the microcomputer fails to act on the overtemperature and the temperature eventually exceeds 105 degrees C. (378 K), the fault will be latched in hardware, a motor/drive overtemperature signaled, and the power stage's gate drive inputs disabled. Power must be cycled in order to clear the latched fault.

6) Bit 5 Drive Thermistor – If the drive thermistor circuit becomes an open circuit, the Drive Thermistor fault bit along with the Global Fault bit will be set and the pump disabled. When the open circuit has been corrected, the Drive Thermistor bit will be cleared. The Global Fault bit can be cleared and the pump restarted by toggling the ResetFault control bit. While an open thermistor circuit is sensed, the drive temperature will be reported as 0 degrees K when the Drive Temperature data register is read.

7) Bit 6 48V Bus Fault – If the 48VDC bus exceeds 55VDC or falls below 25VDC, this fault will be signaled, and the pump will be disabled. If the bus subsequently attains the nominal voltage range of 40-52VDC, the fault bit will be reset. The Global Fault bit can be cleared and the pump restarted by toggling the ResetFault control bit.

8) Bit 7 Power Supply – If the drive determines that the internal +12 supply is outside the range of 11.0-13.2 volts, the Power Supply fault bit along with the Global Fault bit will be set and the pump disabled. This is a fatal error and the power must be cycled in order to clear the fault.

9) Bit 8 Address Error – If no address line is selected in the ADDRESS connector, or multiple address lines are selected, this fault will be signaled and the pump will not run (the address is determined at power-on). Either DC power must be cycled or the Address Reacquisition command received from the user.

1.7.3.4 **WarningStatus** – Register address 0204 (0xCC hex, addressed as 0xCB in message).

1) Bit 0 Overload – If the pump, due to load, is unable to maintain the commanded speed within a tolerance of 3% for a time period of 10 seconds, this warning bit will be set. This is not a fault, but an indicator that the load is excessive. When the pump speed error drops below 2% and maintains it for 2 seconds, the warning bit will be reset.

2) Bit 1 Serial Timeout – If the drive fails to receive a transmission during a 10 second period, the Serial Timeout warning bit will be set. If running, the pump will continue to run. When communications resume, the warning bit will be reset. This warning can be disabled by setting the Serial10SecIgnore bit in the RequestOnOff control register.

1.7.4 Pump data register block – Read-only registers with Start address 00301. These registers are read-only and can be read with either function code 0x03 or 0x04. These registers contain operating data.

1.7.4.1 **Speed** – Register address 0301 (0x12D hex, addressed as 0x12C in message). Present pump speed in RPM with a resolution of 1 RPM.

1.7.4.2 **Motor Current** – Register address 0302 (0x12E hex, addressed as 0x12D in message). Motor current X 10 –resolution of 0.1 amps. 5 amps = 50.

1.7.4.3 **Bus Voltage** – Register address 0303 (0x12F hex, addressed as 0x12E in message). Bus voltage X 10 – resolution of 0.1 volts. 48 volts = 480.

1.7.4.4 **Drive Temperature** – Register address 0304 (0x130 hex, addressed as 0x12F in message). Present drive temperature in deg. K (deg C + 273) expressed with a resolution of 1 deg. K. Note that an open thermistor circuit will result in a 0 deg. K value.

1.7.4.5 **Motor Temperature** – Register address 0305 (0x131 hex, addressed as 0x130 in message). Present motor temperature in deg. K expressed with a resolution of 1 deg. K. Note that an open thermistor circuit fault will result in a 0 deg. K value.

1.7.4.6 **Pump Run Hours High** – Register address 0306 (0x132 hex, addressed as 0x131 in message). Register contains the upper 16-bit word of a 32-bit count of pump run hours.

1.7.4.7 **Pump Run Hours Low** – Register address 0307 (0x133 hex, addressed as 0x132 in message). Register contains the lower 16-bit word of a 32-bit count of pump run hours.

1.7.4.8 **Drive Powered Hours High** – Register address 0308 (0x134 hex, addressed as 0x133 in message). Register contains the upper 16-bit word of a 32-bit count of drive powered ON hours.

1.7.4.9 **Drive Powered Hours Low** – Register address 0309 (0x135 hex, addressed as 0x134 in message). Register contains the lower 16-bit word of a 32-bit count of drive powered ON hours.

1.7.4.10 **RunOn Minutes** – Register address 0310 (0x136 hex, addressed as 0x135 in message). This register contains the Run Minutes in the high byte and the powered ON minutes in the low byte of the 16-bit register.

1.7.4.11 **Starts High** – Register address 0311 (0x137 hex, addressed as 0x136 in message). Register contains the upper 16-bit word of a 32-bit count of pump starts.

1.7.4.12 **Starts Low** – Register address 0312 (0x138 hex, addressed as 0x137 in message). Register contains the lower 16-bit word of a 32-bit count of pump starts.

1.8 Address Reacquisition - This function is broadcast to all the pumps and forces them to reacquire their slave addresses. The command requires that 2 bytes consisting of 0xAA and 0x55 must follow the function code.

Example:	Slave address (broadcast)	0x00
	Function	0x19
	Data hi	0xAA
	Data lo	0x55
	CRC	------

Status LED

There is a single red/green bicolor status LED on the pump drive, which displays pump status information.

1.9 Green LED only – When a flashing green LED only is displayed, a state of normal, or normal with warning, operation, is being indicated.

1) 1 second ON, 1 second OFF – pump is powered but not running.
2) ½ second ON, ½ second OFF – pump is powered and running normally.
3) Brief 40 millisecond red flash at the end of the green ON time in 1) or 2) green LED modes – warning that pump has not received transmissions for a period of 10 seconds. The red flashes will disappear when communications resume.

1.10 Red LED only – When a flashing red LED only is displayed, a fault state is being indicated. The fault is specified by the number of flashes that occur between 3 second OFF periods. If there are multiple faults, the fault code for the highest priority fault will be flashed.

1) Overcurrent – 1 flash, 3 seconds OFF
2) Stall – 2 flashes, 3 seconds OFF
3) Motor Overtemperature – 3 flashes, 3 seconds OFF
4) Motor Thermistor – 4 flashes, 3 seconds OFF
5) Drive Overtemperature – 5 flashes, 3 seconds OFF
6) Drive Thermistor – 6 flashes, 3 seconds OFF
7) Bus – 7 flashes, 3 seconds OFF
8) Power Supply – 8 flashes, 3 seconds OFF
9) Address Error – 9 flashes, 3 seconds OFF

1.11 Green LED interspersed with Red LED – The overtemperature and thermistor faults, along with the 48V Bus fault, are resettable and do not require cycling drive power. Once these faults reset, the Red LED only fault code will cease blinking. In order to extend the time that might be needed to diagnose these faults, the Red LED fault code will be HELD and will continue to be flashed by interspersing it with the Green LED "normal" blinking pattern for 1 minute after the fault resets. The number of flashes for each fault code will remain the same as that observed during the Red LED only flashing.

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