Technical Brief:

Using the RMC Discrete I/O Parallel Position Mode

Abstract

The RMC-DI/O is capable of sophisticated motion control using small and inexpensive Programmable Controllers with simple discrete I/O. An RMC with a DI/O communication interface is capable of three discrete I/O interfaces: Command Mode, Input to Event Mode, and Parallel Position Mode. Of these three communication modes, Parallel Position mode is easiest to use for applications in which an axis must be able to move to numerous—perhaps calculated—positions.

This technical brief will compare the three discrete I/O interfaces of the RMC100 series product-line, describe implementing Parallel Position Mode, and finally provide a sample application using Parallel Position Mode.

DI/O Communication Mode Comparison

The following chart lists the advantages and disadvantages of each communication mode. Each word or phrase in bold print appears in RMCWin's online help index.

Interface Mode	Advantages	Disadvantages
Parallel Position Mode	• Any position can be moved to in a single PLC scan • Any open loop drive can be triggered in a single PLC scan • Multiple profiles can be selected for any move	• Requires a PLC • Returns only a **Halted Bit**—indicating an error has occurred—and an **In Position Bit** per axis • Issues only **Go** and **Open Loop** commands • Gives commands to only one axis per scan • Is limited in number of speed/acceleration profiles
Parallel Event Mode	• Up to four axes may be commanded at once • PLC or thumb-wheel switches may be used • Allows use of Event Control feature	• Requires parallel inputs • Returns only a **Halted Bit**—indicating an error has occurred—and an **In Position Bit** per axis • Sequence must be pre-programmed in Event Control
Command Mode	• Any RMC command can be issued • Any status information can be retrieved (including **Actual Position**, **Actual Speed**, **Drive**, **Error Bits**, and other **Status Bits**)	• Requires a PLC • Requires 2 PLC scans per command • Gives commands to only one axis per command cycle
Input to Event Mode	• Does not require a PLC • Multiple axes may be given commands from a single input • Allows use of Event Control feature	• Returns only a **Halted Bit**—indicating an error has occurred—and an **In Position Bit** per axis • Issues only **Start Event** commands

Implementation

The following diagram shows the electrical control connections of a single-axis hydraulic system using RMC-DI/O in Parallel Position Mode (the PC and its RS232 cable are needed only during setup):
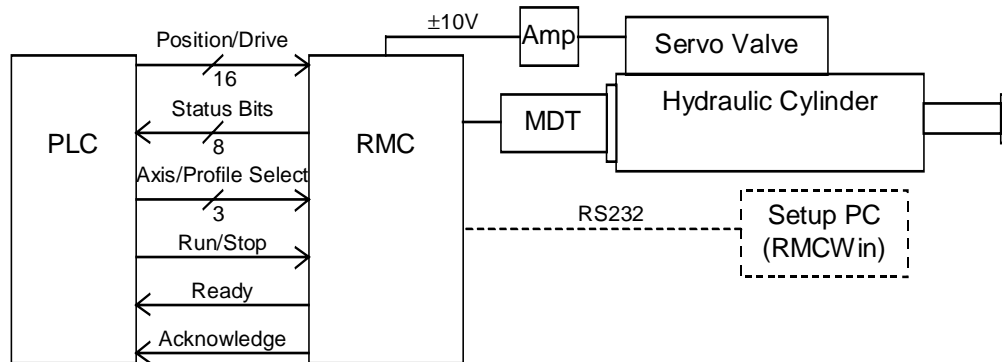
This document discusses only the connections between the Programmable Controller and the RMC. For details on the transducer and drive wiring, look up **Wiring Notes** in the RMCWin index.

The following points describe the operation of Parallel Position mode:

- Parameters and tables used by the RMC are configured using the RMCWin software and stored in the RMC **FLASH memory**.

- All axes are initialized by raising the **Run/Stop** (CPU input 0) line on the RMC, and all axes are immediately stopped by the falling of the **Run/Stop** line on the RMC. Therefore, an emergency-stop button often controls the **Run/Stop** input.

- The **Ready** (CPU output 0) line matches the **Run/Stop** input line to give feedback to the controlling system that the RMC is ready to take commands.

- When the **Run/Stop** line is set, the **Position/Drive** or **Axis/Profile Select** (described below) lines are monitored for changes. When any of these inputs change, and they remain stable for a user-configured duration (between 2 and 20 milliseconds), a new command is issued to the RMC.

- The **Axis/Profile Select** (CPU input 1 and DI/O inputs 16-17) lines select both the profile of the new command, and the axis the command is sent to.

The profile is selected from one of the first eight profile entries in the RMC's **Profile table**. The following chart indicates how the inputs are used to select the profile:

CPU Input 1	DI/O Input 17	DI/O Input 16	Profile #
0	0	0	**0**
0	0	1	**1**
0	1	0	**2**
0	1	1	**3**
1	0	0	**4**
1	0	1	**5**
1	1	0	**6**
1	1	1	**7**

The bits used to select the axis that receives the command change depending on the total number of axes in the module. The following charts indicate how the inputs are used to select the axis:

Two axes:

DI/O Input 16	Axis #
0	**0**
1	**1**

Three or four axes:

DI/O Input 17	DI/O Input 16	Axis #
0	0	**0**
0	1	**1**
1	0	**2**
1	1	**3**

Four or more axes:

CPU Input 1	DI/O Input 17	DI/O Input 16	Axis #
0	0	0	**0**
0	0	1	**1**
0	1	0	**2**
0	1	1	**3**
1	0	0	**4**
1	0	1	**5**
1	1	0	**6**
1	1	1	**7**

- The user may select from RMCWin whether profiles 4-7 are used as open or closed loop commands. Profiles 0-3 are always used as closed loop commands.

- When a closed loop profile is selected, the **Position/Drive** (DI/O inputs 0-15) lines give the 16-bit requested position. The move begins immediately after the inputs are stabilized (described above). The axis commanded and the profile used are selected by the **Axis/Profile Select** lines.

- When an open loop profile is selected, the **Position/Drive** (DI/O inputs 0-15) lines give the 16-bit drive in millivolts. The move begins immediately after the inputs are stabilized (described above). The axis commanded and the profile used are selected by the **Axis/Profile Select** lines.

- Each time the RMC executes a new command, it updates the **Status Bits** (described below) and toggles the **Acknowledge** (CPU output 0) line.

  It is important to wait for the **Acknowledge** line to toggle before using the **Status Bits**; otherwise, the bits may reflect the status of a previous move. For example, suppose the **In Position** bit is set from a previously completed move. If the **Acknowledge** line has not toggled before the PLC uses the **In Position** bit, the newly commanded move will look as though it completed immediately.

- The eight **Status** (DI/O outputs 0-7) outputs are used for the following:

DI/O Output #	2-4 Axis RMC's	5-8 Axis RMC's
0	Axis 0 In Position	Axis 0 In Position
1	Axis 1 In Position	Axis 1 In Position
2	Axis 2 In Position	Axis 2 In Position
3	Axis 3 In Position	Axis 3 In Position
4	Axis 0 Stop on Error	Axis 4 In Position
5	Axis 1 Stop on Error	Axis 5 In Position
6	Axis 2 Stop on Error	Axis 6 In Position
7	Axis 3 Stop on Error	Axis 7 In Position

The following general steps must be taken to set up a system using Parallel Position mode:

1. **Design the System**

   Designing the system begins with selecting the appropriate method of communication. First, decide whether one of the RMC's field bus solutions fits your application, and if you decide to use digital I/O, then decide which of the communication modes fits your application.

   If you decide to use digital I/O using Parallel Position mode, then you must design the wiring of the system and the event step table.

2. **Program the Profile Table**

   Programming the Profile table is described in the RMCWin online help. The profile table holds the speeds, accelerations, and decelerations used by the moves. Be sure to save your Profile table both in the RMC FLASH memory, and also on disk from RMCWin.

3. **Configure the RMC Communication**

    The following steps are required to configure the Communication DI/O from RMCWin:

    - Connect the serial port to the module being configured.

    - On the **Tools** menu, click **Module configuration**.

    - In the **Slots** list, select the **Communication DI/O** item, and then click **Slot options**.

    - In the **DI/O mode** list, select **Parallel Position** mode.

    - If you need to invert any inputs or outputs to match your hardware, select the appropriate check boxes in the **Invert inputs** and **Invert outputs** areas.

    - Check **Mode options**.

    - In the **Input Filter** box, enter the number of milliseconds you wish to have the RMC wait for the inputs to settle. You may need to change this more than once if you are not sure how long you should delay. If you don't need the speed, it may be wise to be conservative and select 20 ms.

    - If you wish to do open loop moves as well as closed, select the **Allow open loop select** check box.

    - Click **OK**.

    - Click **Update RMC**.

    - The **Update Module Configuration** dialog box will be displayed to indicate the progress. If the module could not be reset manually, you may be prompted to reset the module yourself.

4. **Wire, Test, and Tune the System**

    Wiring and testing should follow your design. Tuning the system is described in the RMCWin online help. Be sure to save your tuning parameters both in the RMC FLASH memory, and also on disk from RMCWin.

Sample Application

The customer needs a single axis to move between two positions. The first position is the retracted position for the cylinder and is fixed; this position is defined at 0 inches. The second position is calculated by the PLC and may be anywhere from 10 to 20 inches, depending on the measured size of the raw materials coming down a production line.

We will assume that the customer decided 5 inches per second was the maximum safe extension speed, and that 10 inches per second was the maximum safe retracting speed.
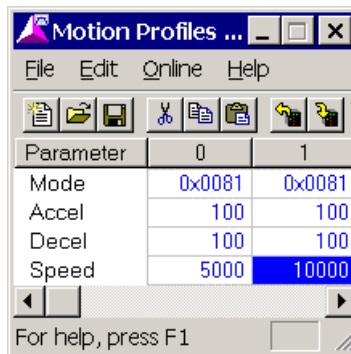
1. Design the System

The RMC controls based on the transducer or encoder counts received. However, counts rarely correspond to meaningful engineering units. Therefore, the RMC allows the user to convert counts into meaningful position units by using **Scale** and **Offset** parameters. Refer to RMCWin's online documentation for details. In this application, the position units used will be thousandths of an inch. Therefore, speeds will be given in thousandths of an inch per second.

Because only one axis of MDT feedback is used, the smallest RMC module available— an **RMC100-M1-DI/O** module—will be used.

2. Program the Profile Table

Because two speeds are required, two motion profiles will be used. As shown in the charts for selecting profiles and axes above, profiles 0, 2, 4, and 6 are available for axis 0. Therefore, profiles 0 and 2 will be used. The following profile table entries defines the speeds required by the customer for each move (remember that profile 1 is unused in this example):

Parameter	0	1
Mode	0x0081	0x0081
Accel	100	100
Decel	100	100
Speed	5000	10000

Once this **Profile table** and the desired configuration parameters are stored in the RMC **FLASH memory**, the following steps are used to make the moves.

3. Configure the RMC Communication

The steps required for this procedure are described in the **Implementation** section of this Technical Brief. You should not need to invert any inputs or outputs, nor should you need to allow open loop select. You may need to change the **Input Filter** setting depending on your I/O speed.

4. Wire, Test, and Tune the System

The system should be wired as described in the design above. Test the functionality of the final system, and finally tune the system as described in the RMCWin online help.

When the system is completed, the following steps can be taken to make the moves:

- **Initializing the axis:**

  1. Set the **Run/Stop** (CPU input 0) line high.

  2. Wait for the **Ready** (CPU output 0) line to be high.

- **Moving the axis to its home position:**

  1. When returning to the home position, the user wants to use profile 2 (which goes 10 inches per second). Therefore, CPU input 1 and DI/O input 16 will be reset, and DI/O input 17 will be set high. Notice that this step also selects axis 0.

  2. Place the value 1500 (for 1.5" or 1500 thousandths of an inch) in binary on DI/O inputs 0-15.

  3. Wait for the **Acknowledge** (CPU output 1) line to toggle, indicating the command has been received.

  4. Wait for the **In Position** bit of axis 0 (DI/O output 0) to be high, indicating the axis has reaches its commanded position.

- **Moving the axis to its calculated extension position:**

  1. When extending, the user wants to use profile 0 (which goes 5 inches per second). Therefore, CPU input 1, DI/O input 17, and DI/O input 16 will all be reset. Notice that this step also selects axis 0.

  2. Place the calculated requested position (in thousandths of inches) in binary on DI/O inputs 0-15.

  3. Wait for the **Acknowledge** (CPU output 1) line to toggle, indicating the command has been received.

  4. Wait for the **In Position** bit of axis 0 (DI/O output 0) to be high, indicating the axis has reaches its commanded position.

- **Stopping the axis in an emergency:**

  1. Lower the **Run/Stop** (CPU input 0) line.

Reference

Throughout this technical note, references are made to RMCWin online help index entries. To obtain the RMCWin software package, contact Delta Computer System's web site (www.deltacompsys.com).