

## RUG3 Ladder Logic

Ladder logic is one method of programming a RUG3 RTU using a graphical diagram based on circuit diagrams of relay-based logic hardware. The RUG3 can be programmed with ladder logic alone or with a combination of ladder logic and the provided pre-compiled program modules.

The purpose of this document is to illustrate the various ways that ladder logic contacts and coils may be used in a RUG3 program. Please reference the program “R3\_Ladder\_Logic.rgd” for the implementation of the ladder logic that is examined in this document.

### Defining Ladder Logic

Ladder logic is defined in the Ladder Editor of the RUG3 Support Software. The Ladder Editor is opened by clicking the ‘Ladder’ tab in the ‘R3 Module Library’, see figure 1 below. Note that the order the R3 Module Library tabs are displayed will rearrange as different tabs are selected. Once open, the Ladder Editor will provide a schematic onto which the ladder diagram is configured, see figure 2.

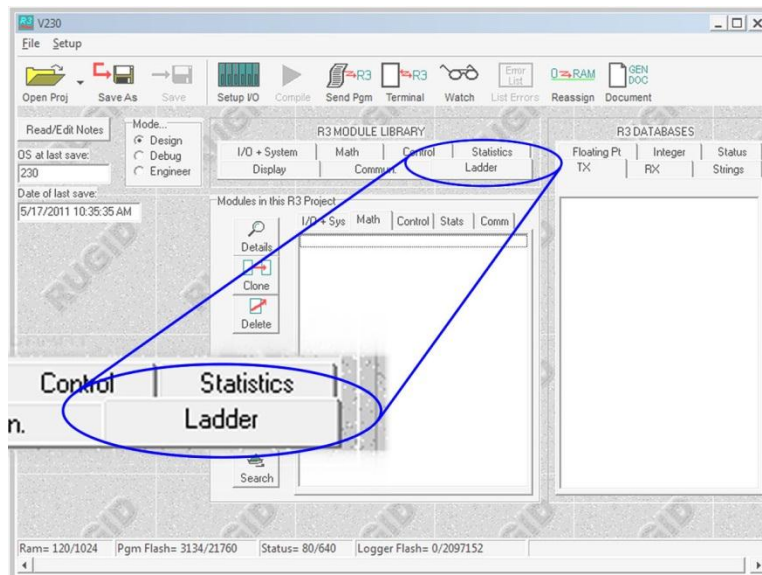


Figure 1 – Open the Ladder Editor by clicking the ‘Ladder’ Tab

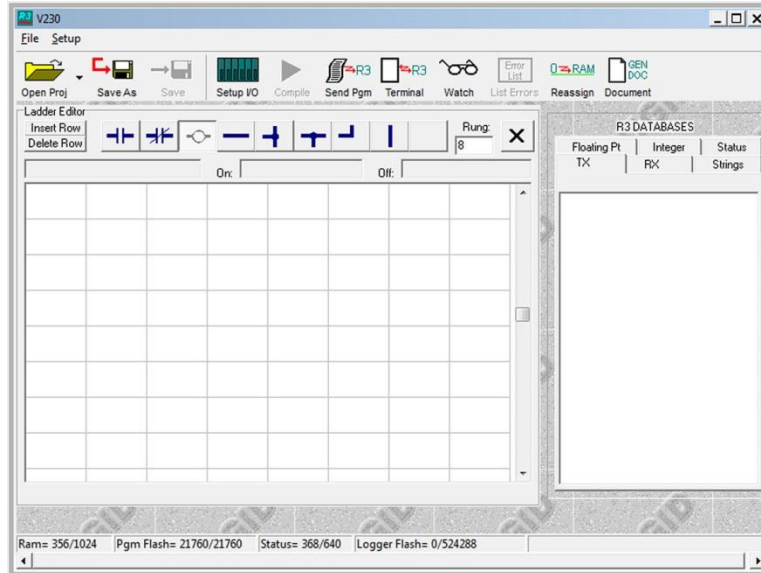


Figure 2 – Ladder Editor

The Ladder Editor toolbar above the schematic grid provides nine buttons with schematic icons. Referring to Figure 3, from left to right the schematic icons are as follows:

- Normally open contact
- Normally closed contact
- Coil (selected)
- Horizontal connection
- Vertical junction
- Horizontal junction
- Elbow
- Vertical connection
- Blank



Figure 3 – Ladder schematic items

Clicking any of the ladder toolbar buttons makes it the active schematic item. Thereafter, wherever you click in the schematic page, the selected item will appear (note that coils can only be placed in the far-right grid box, no other schematic items may be placed in the far-right grid box). Each row or 'rung' of the ladder can have eight entries. The rightmost entry must either be blank or have a coil in it. Coils can only be placed one per row and must be the rightmost entry.

Contacts on the same row constitute a logical AND; contacts connected vertically constitute a logical OR. For each normally open or normally closed contact, a status variable from the status database must be dragged and dropped onto the contact. In figure 4 a single contact is present but has no status assigned. Once a status from the status database is dragged and dropped on the contact, the contact will display the name of the status assigned, figure 5.

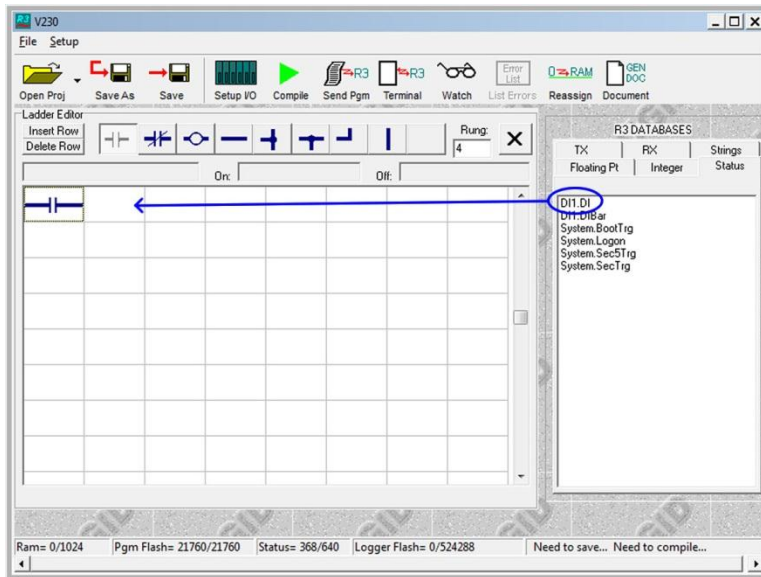


Figure 4 – Ladder schematic with unnamed contact

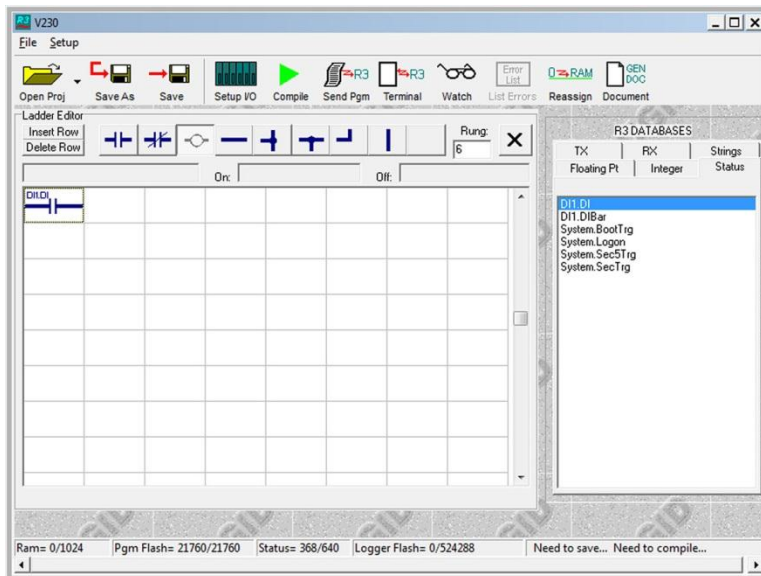


Figure 5 – Ladder schematic with contact named from status database

In this example “DI1.DI”, digital input 1, is assigned to the contact.

When a coil is placed on the schematic, a dialog box automatically pops up, see figure 6. In this dialog box a unique name must be entered for the coil; this will be the status that appears in the status database for the coil so it should be given a unique descriptive name that makes it easily identifiable. Also in the dialog box are two more entries, an ON delay and an OFF delay, both in seconds. The ON delay defines the number of seconds from when the ladder logic evaluates from false to true before the coil is energized (ON); the OFF delay defines the number of seconds from when the ladder logic evaluates from true to false before the coil is de-energized (OFF). Note that if the logic changes state during this delay, the coil does not; the logic state must be present throughout the entire delay. The delays may be left at the

default of 0, a numerical constant may be entered, or a database variable can be dragged and dropped to either field.

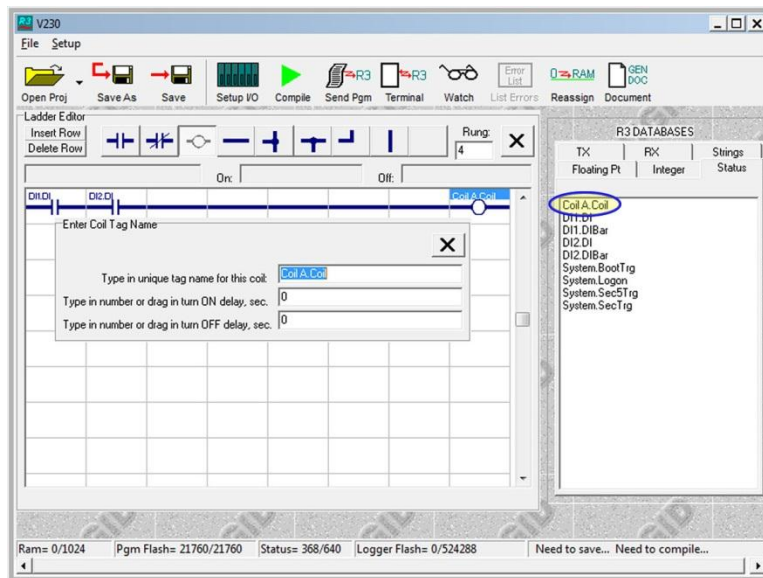


Figure 6 – Defining a coil

When a coil is defined in the schematic, it now appears in the status database, reference the circled and highlighted variable in figure 6. The coil variable that is now present in the status database is now available for use throughout your program, including different rungs in your ladder logic, the same as any other database variable.

## Ladder Logic Example Explanation

The reference program “R3\_Ladder\_Logic.rgd” illustrates various features of incorporating ladder logic into your RUG3 program in conjunction with the pre-compiled program modules. Three coils are defined and an explanation of the logic behind energizing each coil will be analyzed. The ladder logic defined in the reference program is illustrated in figure 7.

The following additional program modules were used to help illustrate features:

- Setpoints (default values loaded each power-on/reset):
  - “CoilBOffDelay” – Setpoint to define and adjust Coil B off delay, 1-5 seconds, default set to 2
  - “CoilBOnDelay” – Setpoint to define and adjust Coil B on delay, 1-10 seconds, default set to 5
  - “InputA” – Setpoint to provide a variable for comparison, 1-100, defaulted to 50
  - “InputB” – Setpoint to provide a variable for comparison, 1-100, defaulted to 25
- Digital Inputs:
  - “Dix” – x denotes the digital input channel 1-4 used, contact closure
- Digital Outputs:

- “DOx” – x denotes the digital output channel 1-2 used, digital output standard
- TriggerOnKeyMany:
  - “TriggerOnKey” – Issues an individual trigger for each key when pressed, defined for display 0 on port 0.
- FlipFlop:
  - “LatchKeyxPress” – x denotes the key press that is latched, keys 1 and 2 (from display 0, port 0) latched individually. Key 3 press (from display 0, port 0) clears the latch.
- ValueTest:
  - “ValueTest” – Compares “InputA” and “InputB” setpoint entries. Module outputs used: A = B and A > B.
- Display “MAIN” (Local):
  - State of coils A, B, and C.
  - Remind user of key press functionality

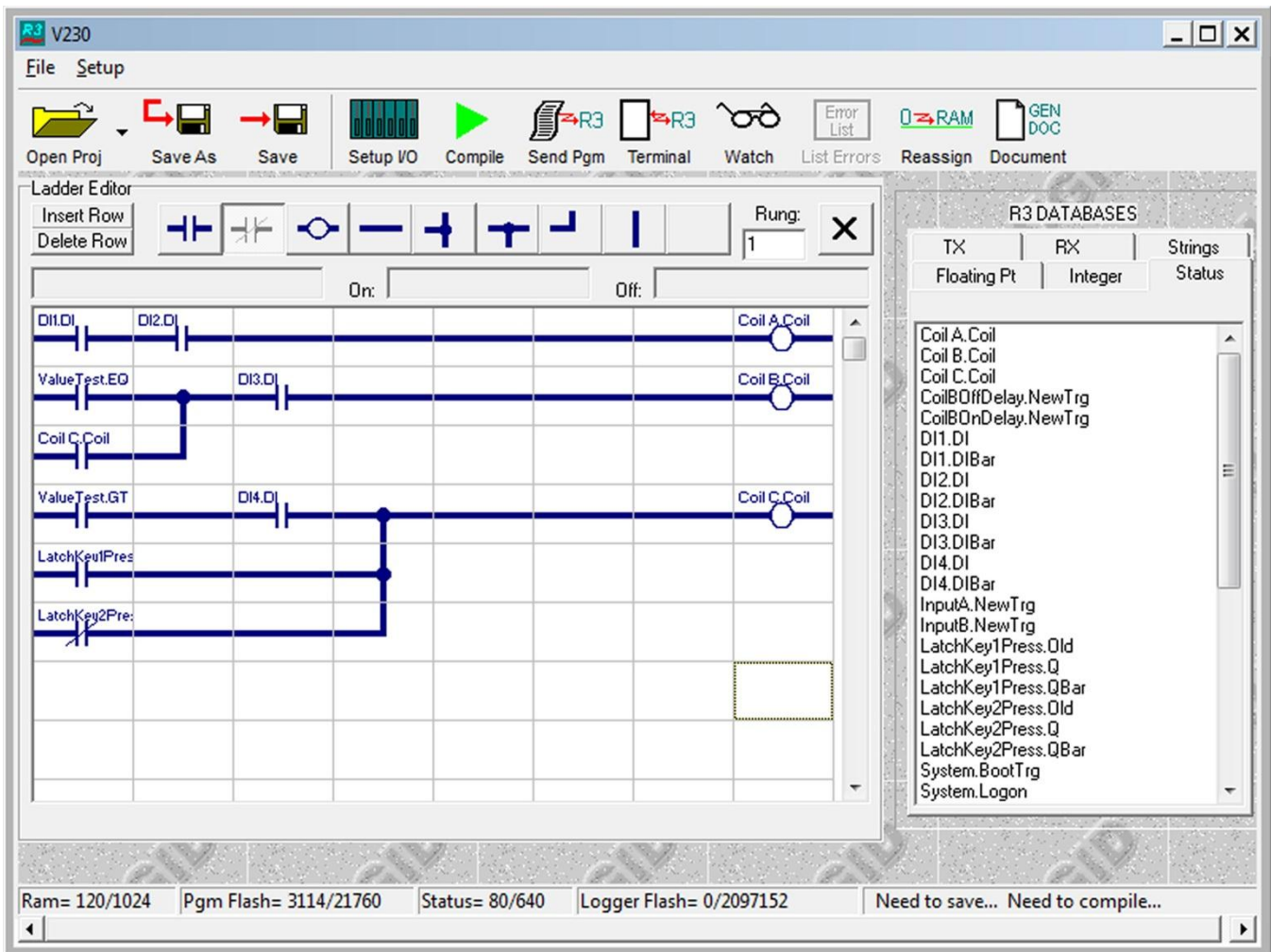


Figure 7 – Example program ladder logic



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### **COIL A:**

Coil A = DI1 AND DI2

### **User Actions (Also See 'Example User Actions and Results' below):**

-Assert DI1 and DI2 by grounding.

### **Coil:**

Coil A status used as 'Input status that controls' input into DO1. ON and OFF delay for Coil A are set to 0. Status displayed on the "MAIN" display.

### **Features demonstrated:**

Logical AND (2 conditions), digital inputs assigned to contacts, coil controlling digital output.

### **Example User Actions and Results:**

- Action:
  1. Connect DI1 to ground.
  2. Connect DI2 to ground.
- Result:
  - Coil A energized.
  - DO1 closed.

### **COIL B:**

Coil B = ((InputA must equal InputB) OR Coil C) AND DI3

### **User Actions (Also See 'Example User Actions and Results' below):**

-InputA and InputB may be adjusted through the Setpoint Menu to control the evaluation of InputA = InputB. To change setpoints, from the home RUG3 display, press key '2' for setpoints, navigate to the desired setpoint using the UP and DOWN keypad arrow keys, clear the current value by pressing the 'CLR' key, enter in a new value and press the 'ENTER' key. To navigate out of any menu/display back to the home RUG3 display, including the Setpoint Menu, press the '-' (minus) key.

-Assert DI3 by grounding the input.

-See Coil C User Actions.

### **Coil:**

Coil B status used as 'Input status that controls' input into DO2. Coil B ON and OFF delays controlled by "CoilBOnDelay.SP" and "CoilBOffDelay.SP" respectively. Default values are 5 and 2 seconds. These values can be user changed by navigating to the Setpoint Menu, clearing the current setpoint value and entering in a new value. Status displayed on the "MAIN" display.

Note that Coil C is one logical path to Coil B so the turn-on/off delays defined in Coil C will effect in time when Coil B is energized from when the true condition exists.

### **Features demonstrated:**



Logical AND (2 conditions), logical OR (2 paths), digital input assigned to contact, module output status assigned to contact, ladder coil assigned to contact, coil turn on/off delay entered from a setpoint, coil controlling digital output.

### **Example User Actions and Results:**

- Action:
  1. From the Setpoint Menu (changing setpoint instructions available under Coil B 'User Actions' section) set 'Value A' to 50.
  2. From the Setpoint Menu set 'Value B' to 50.
  3. Connect DI3 to ground.
- Result:
  - Coil B energized.
  - DO2 closed.

### **COIL C:**

Coil C = ((InputA greater than InputB) AND DI4) OR Key1 OR (not)Key2

### **User Actions (Also See 'Example User Actions and Results' below):**

-InputA and InputB may be adjusted through the Setpoint Menu to control the valuation of InputA > InputB.

-Assert DI4 by grounding the input.

-InputA = InputB and grounding DI4 is a logical control path that will energize Coil C.

-Key '3' press from the "MAIN" display (from the home RUG3 display, hitting key '1' will display the list of user defined displays, the "MAIN" display is the only defined display, hit key '0' to select this display) will clear out the latched values for key strokes '1' and '2'. Clearing the latched values will result in Coil C being energized (if during the ON delay the conditions don't change) because 'LatchKey2Press' is assigned to a normally closed contact.

-Key '1' press from the "MAIN" display is a logical control path that will energize Coil C.

-Key '2' press from the "MAIN" display is a logical control path that will de-energize Coil C (assuming no other logical paths are true) because 'LatchKey2Press' is assigned to a normally closed contact.

### **Coil:**

Coil C status is not used as an entry into another module. Coil C ON and OFF delays defined in the program as constants of 5 and 10 respectively. To adjust these values they must be changed in the program and the program reloaded into the RUG3. Coil C is used in Coil B logic and the status is displayed on the "MAIN" display.

### **Features demonstrated:**

Logical AND (2 conditions), logical OR (3 paths), digital input assigned to contact, module output statuses assigned to contact, coil turn on/off delay from numerical constant.

### Example User Actions and Results:

- Action A:
  1. From the “MAIN” display hit key ‘3’.
- Result A:
  - Coil C energized.
  
- Action B:
  1. From the “MAIN” display hit key ‘2’.
- Result B:
  - Coil C de-energized.
  
- Action C:
  1. From the “MAIN display hit key ‘1’.
- Result C:
  - Coil C energized.
  
- Action D:
  1. From the Setpoint Menu (changing setpoint instructions available under Coil B ‘User Actions’ section) set ‘Value A’ to 50.
  2. From the Setpoint Menu set ‘Value B’ to 25.
  3. Connect DI4 to ground.
- Result D:
  - Coil C energized.





## Contact Information

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