Siemens
Energy & Automation

CONFIGURATION GUIDE

CGiLL-1
Rev: 2
September 2005
Supersedes Rev 1

Ladder Logic

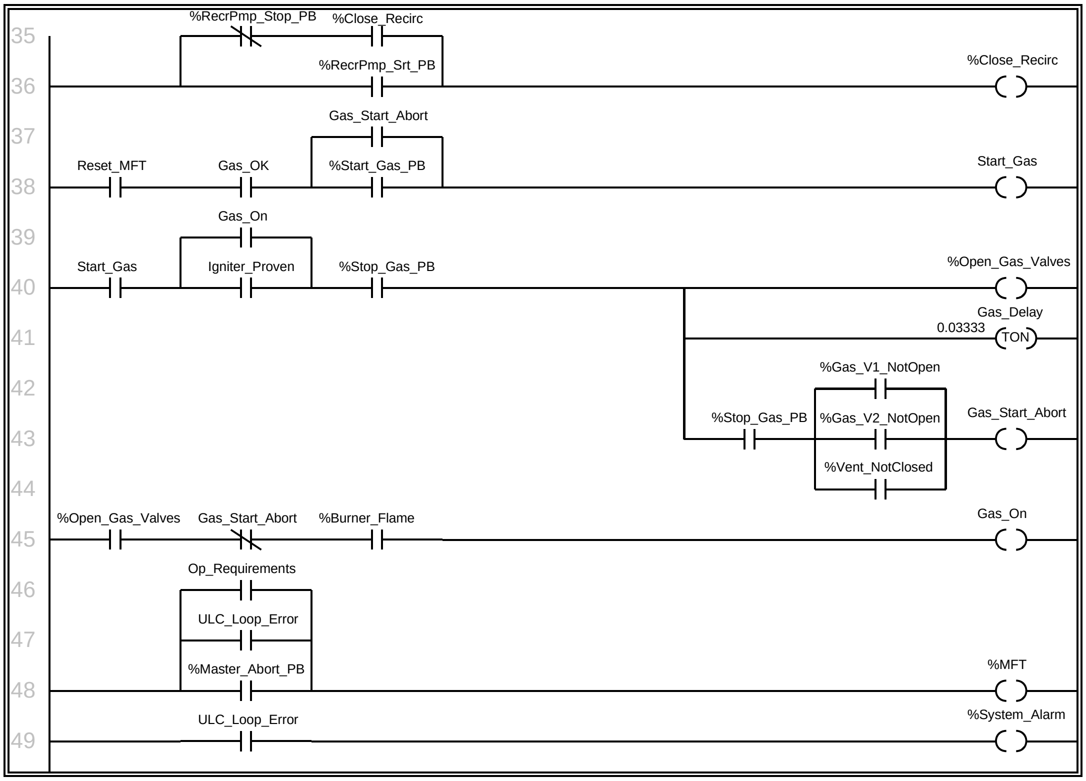


TABLE OF CONTENTS

SECTION AND TITLE **PAGE**

Changes for Rev 2, September 2005

- There were no technical changes.
- References to Moore Products, Co. were replaced with Siemens Energy & Automation, Inc.
- Disclaimer text updated.
- Add Product Support section.

Procidia, i|config, and i|station are trademarks of Siemens Energy & Automation, Inc. Other trademarks are the property of their respective owners. All product designations may be trademarks or product names of Siemens Energy & Automation, Inc. or other supplier companies whose use by third parties for their own purposes could violate the rights of the owners.

Siemens Energy & Automation, Inc. assumes no liability for errors or omissions in this document or for the application and use of information in this document. The information herein is subject to change without notice.

Procedures in this document have been reviewed for compliance with applicable approval agency requirements and are considered sound practice. Neither Siemens Energy & Automation, Inc. nor these agencies are responsible for repairs made by the user.

1.0 INTRODUCTION

This Configuration Guide provides detailed descriptions of Procidia™ ladder logic elements and their implementation.

The Procidia Internet Control System (ICS), the Model 353 Process Automation Controller, and the Model 354N Universal Loop Controller represent the next generation in controller technology. Designed to satisfy the needs of both continuous and discrete control applications, these controllers have access to a large library of reusable function blocks that can be applied to a configuration to manage a vast array of process control applications. Depending upon controller model, either a Universal Serial Bus or a LonWorks® fieldbus interface extends the analog and digital I/O of these controllers over a low cost, easy to install twisted pair cable. As a result, applications traditionally requiring a single-loop controller and a PLC can now be accomplished in a single controller.

Ladder logic configurations are built using the i|config™ Graphical Configuration Software. Install the software on a Windows®-based personal computer or on an i|station™ Industrial PC. When completed, the configuration is then downloaded to the target controller.

Related Literature

This manual can be used with:

- i|config Graphical Configuration Utility Software Guide SG15939-64 - This manual describes use of the software to create and download a configuration.
- Procidia Function Blocks and FCOs Configuration Guide CGiFB-1 - This manual contains a description of each function block and factory configured option provided in controller firmware.
- Procidia i|pac™ User's Manual UMiPAC-1 (and -2) - This manual describes installation of the i|pac and i|o™ hardware and UMiPAC-1 contains CGiFB-1.
- Controller User's Manuals UM353-1 and UM354N-1 - Each manual describes installation of the named controller and it contains the function block and factory configured option details for that controller.

Product Support

NORTH AMERICA	Telephone	+1 800 569 2132, option 2 for Siemens-Moore brand instruments
	Fax	+1 215 646 3547
	E-mail	PITechSupp@sea.siemens.com
	Hours of Operation	8 a.m. to 4:45 p.m. eastern time Monday – Friday (except holidays)
	Public Internet Site	www.sea.siemens.com/ia/
	Repair Service	+1 215 646 7400 extension 3187

For contact information outside North America, visit the Siemens public Internet site (see the above table for the URL), locate "Customer Support Process Instrumentation," and click on the Contact Tech Support link to access the Global Support link.

2.0 CONFIGURATION OVERVIEW

Controller configuration is the selecting and interconnecting of function blocks from an available list and the entering of appropriate block parameters to implement a specific control strategy. Although configuration affects the entire controller, the controller partitions related control implementations into LOOPS.

Each LOOP can contain the function blocks listed in the above manuals. Signals can be connected between function blocks within the LOOP as well as between loops. Also, there are several STATION function blocks that are fixed and available in the STATION menu for setting station related values, such as security. Ladder logic status can be displayed using the Operator Display for Discrete Indications and Control (ODD) function block and a logic sequence can be initiated from an Operator Display for PushButtons (ODP) function block. Refer to CGiFB-1 or the controller's User's Manual for the list of function blocks and their definitions.

Each controller must be configured to perform the desired control strategy. The arrangement of functions and the numerical data required for a particular control circuit are referred to as the controller configuration.

A configuration is designed by first arranging the needed function blocks in a fashion similar to that of a P & ID drawing. Parameter and calibration values are determined next and then entered on a Configuration Documentation Form (e.g., CG353-2) and finally into the Graphical Configuration software.

2.1 CONFIGURATION

This section provides tips for use while configuring a controller. Most references to controller displays are to those seen on either i|station or a Local Faceplate, Display Assembly faceplate, or Faceplate Display, depending upon controller model.

Loop Tags

Begin a configuration by laying down all of the loops and assigning loop tag names. A loop tag should be a meaningful name of 6 to 8 characters, although a tag name can be up to 12 characters. The controller will display 8 characters: the last 6 characters in the tag name, a period, and a variable (P, S, V, X, Y, T or " "). The entire tag name, when more than 6 characters, can be viewed by pressing the TAG key. For example, a tag of "Primary" is displayed as "rimary.P". The ".P" indicates that the process variable is shown in the digital display. When the Tag key is pressed, the full tag would scroll "Primary".

To avoid scrolling and show the tag name and variable, condense the tag name. For example, condensing "Primary" to "Prim" would cause the display to read "Prim.P".

A ladder logic loop tag name should be up to 8 characters. While in configuration mode, a maximum of 8 characters can be displayed.

The controller distinguishes between analog and digital signals. If you need to convert a digital signal to analog, use the Transfer Switch block (TSW). The inputs do not need to be configured. If you need to convert an analog signal into digital, use a Comparator block (CMP)[1].

When creating a large loop configuration, first go into Page view and then lay down all the blocks. This will permit you to quickly organize the blocks in a logical order.

Ladder Logic Pages

Up to four pages of ladder logic rungs are permitted in the ladder logic loops. In practice, it is best to use only two pages of ladder logic per loop. After the second page, you typically will run out of loop resources. For this reason, it is best to switch to a new loop after two pages of ladder.

When configuring ladder logic, it is useful to skip a rung between each rung of ladder created. While debugging the ladder logic, you will probably need to add more contacts or rungs of logic. Having unused rungs makes it easy to add needed rungs.

2.2 LADDER LOGIC CONFIGURATION

A summary of the steps involved in assigning names to Ladder Logic elements follows. Each step is then further divided into steps is subsequent paragraphs.

1. Create the loops necessary for the ladder.
2. Enter the discrete inputs to the ladder in the Reference list.

[1] *For function block details, refer to CGiFB-1, UMiPAC-1, UM353-1, or UM354N-1.*

3. Draw the ladder.
4. Name the contacts in the ladder.
5. Name the coils in the ladder.
6. Connect the coils to the discrete outputs.

Create the loops necessary for the ladder

1. Create a function block loop called “Disc I/O”.
2. In this loop, place all of the I/O blocks that will be used by the ladder, such as DIN's, DID's, DOUT's and DOD blocks.
3. Create a ladder logic loop to construct the ladder.

Create the Reference List for the discrete inputs to the ladder

1. Select **Reference** from the Edit>References menu to get the Edit/Reference dialog box.
2. Left click on the Create button to get the Create/Modify References dialog box.
3. Type in the reference name of the discrete inputs to the ladder, such as “*FAN RUNNING*” or “*FLAME ON*”.
4. Now click on the check mark in the box next to ‘Unconfigured’ to configure the input. (Alternatively, click on the name of the loop containing the Discrete I/O in the ladder.) It is now possible to select the loop, block, and output that will be connected to the discrete input.

A % symbol will appear in front of the reference name. This indicates that the reference is connected from the ladder to a signal outside the station. A > symbol indicates a connection from the ladder to another loop within the station. No symbol in front of the reference name indicates that it is connected within the ladder only.

Draw the ladder

1. Draw the ladder by selecting the New Ladder Logic Element button from the Line Connection Toolbar and selecting the appropriate contacts and coils.
2. Next, select the Line Connection Mode button on the Line Connection Toolbar. The cursor will change to a wire spool that is used to interconnect or "wire" the elements in the ladder.
3. Wire all the elements into the desired ladder logic configuration.

Name the contacts on the ladder

1. Name the contacts in the ladder using the wire spool cursor. Right click on the contact name. The set reference dialog box will pop up.
2. For external inputs, select the proper discrete input from the list created earlier.
3. Add to the reference list any contact that comes from a loop within the station. Select the Edit/References button and click on the Create button. The Create/Modify References dialog box will pop up. Name the contact reference and then specify the loop block and output used to provide this discrete input to the ladder.
4. If a contact comes from a coil on the ladder, leave it unconfigured until the coils are named in the next step.

Name the coils on the ladder

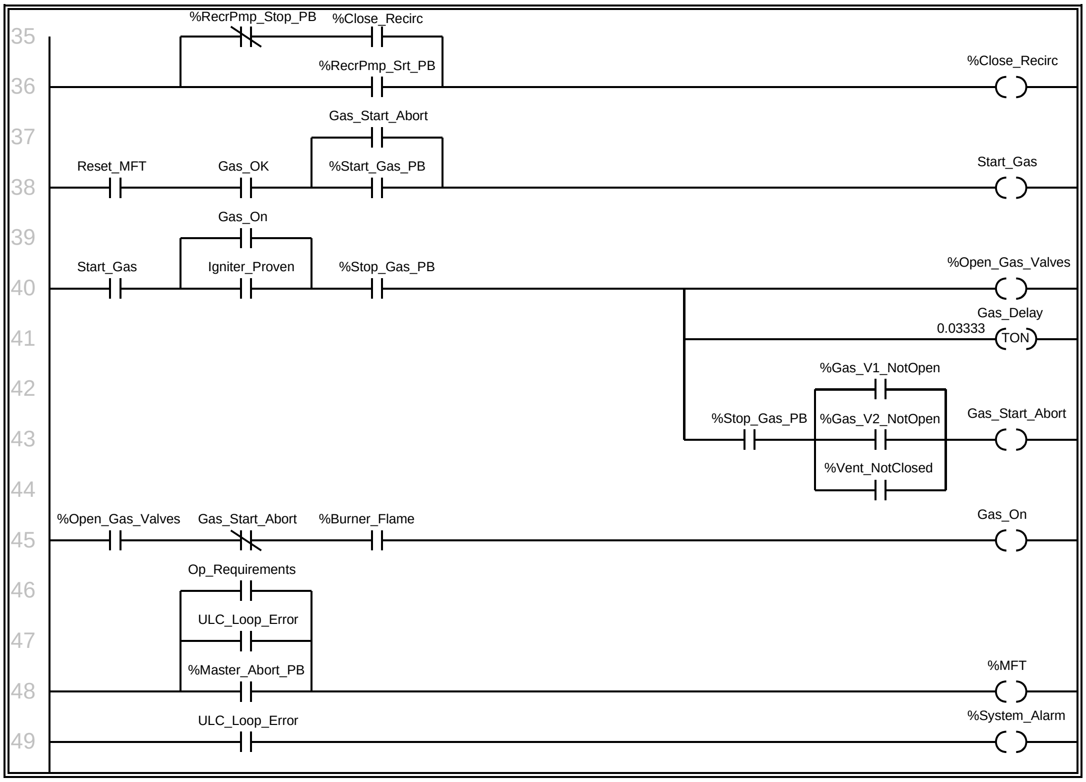
1. To name coils, continue to use the wire spool. Right click on the coil name; usually it will be in the form of DefCoilTagn.
2. The Create/Modify Reference dialog box will pop up with the coil name highlighted.
3. Change the reference name to the appropriate name and click on OK.
4. Go to the next coil and repeat this procedure until all the coils are named.
5. Go back through the ladder and name the unconfigured contacts that come from the coils that were just named. This is done by using the wire spool and right clicking ‘Unconfigured’ above the contact. As before, the Set Reference dialog box pops up and the appropriate coil name may be selected from the references listed by highlighting the appropriate name and clicking on OK.

Connect coils to discrete outputs

1. Connect each coil that drives a discrete output, such as START FAN, OPEN GAS SSV's, to a discrete output block. This is accomplished by opening the "Discrete I/O" function block loop with the Line Connection Selected Mode cursor button that is next the wire spool button.
2. Double click on the appropriate discrete block. The Item Attributes dialog box will pop up.
3. Click on the tab for the block selected.
4. Then click on the appropriate input to highlight it.
5. Next, highlight the word Reference in the Connect to box.
6. Then click on the Edit Input button in that box. The Set Reference list will pop up with all the coil names listed.
7. Click on the proper coil name that corresponds to the discrete output channel desired and then click OK. This connects the coil to that discrete output channel. When the coil goes high, the discrete output will go high.

3.0 LADDER LOGIC ELEMENTS

Logic functions are implemented in a controller using function blocks (Boolean functions). Many users, however, prefer ladder diagrams for developing logic configurations. The graphical configuration utility can be used to configure logic using ladder techniques. This section provides a list of ladder diagram elements, contacts, coils, and timers available for use within the graphical configuration utility. It also describes how they correspond to controller function blocks. A sample ladder logic page with a variety of elements is shown below.



3.1 LADDER ELEMENTS

Power Rail (PR) |

This element is on the left of the ladder diagram and is always conducting.

Horizontal Shunt (HS) -----

This element conducts when the element on the left is conducting and transfers this state to the element on the right.

Vertical Shunt (VS) |

This element is the inclusive OR of the states of the elements to its left.

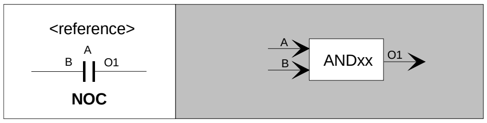
Connections By Reference <reference>

The <reference> is the connection element to other elements within the ladder diagram and to inputs and outputs of function blocks within the loop.

3.2 CONTACTS

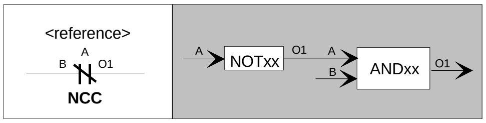
A contact is a ladder element that copies a state to the element on its right equal to the logical AND of the state of the element on its left with the state of the reference.

Normally Open Contact --| |-- NOC



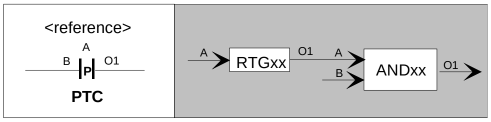
The NOC copies the state of the left horizontal shunt to the right horizontal shunt, if the state of the contact reference is TRUE. Otherwise the state of the right horizontal shunt will be non-conducting. *{The NOC is equivalent to a two input AND function block having inputs A <reference> & B and output O1. If the B input is connected to the Power Rail the contact output will equal the <reference> and an actual AND function block is not required.}*

Normally Closed Contact --|\|-- NCC



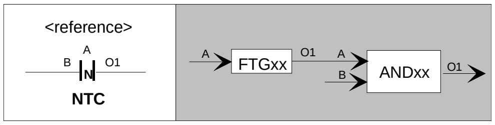
The NCC copies the state of the left horizontal shunt to the right horizontal shunt, if the state of the contact reference is FALSE. Otherwise the state of the right horizontal shunt will be non-conducting. *{The NCC is equivalent to a two input AND function block having inputs A <reference> & B and output O1 and a NOT function connected to the A input of the AND block.. If the B input is connected to the Power Rail the contact output will equal the output of the NOT function block and an AND function block is not required. }*

Positive Transition Sensing Contact --|P|-- PTC



The PTC copies the state of the left horizontal shunt to the right horizontal shunt for one scan cycle, when the state of the contact reference changes from FALSE to TRUE. Otherwise the state of the right horizontal shunt will be non-conducting. *{The PTC function is equivalent to a two input AND function block having inputs A <reference> & B and output O1 and a RTG rising edge trigger function connected to the A input. If the B input is connected to the Power Rail the contact output will equal the output of the RTG function block and an AND function block is not required.}*

Negative Transition Sensing Contact --|N|-- NTC

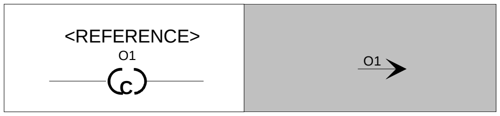


The NTC copies the state of the left horizontal shunt to the right horizontal shunt for one scan cycle, when the state of the contact reference changes from TRUE to FALSE. Otherwise the state of the right horizontal shunt will be non-conducting. *{The NTC function is equivalent to a two input AND function block having inputs A <reference> & B and output O1 and a FTG falling edge trigger function connected to the A input. If the B input is connected to the Power Rail the contact output will equal the output of the FTG function block and an AND function block is not required.}*

3.3 COILS

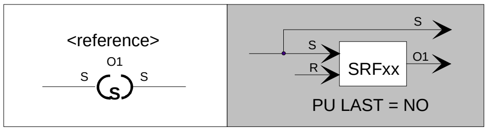
Coils copy the state of the left horizontal shunt to the right horizontal shunt without modification and store the state of the left horizontal shunt into a Boolean variable, having a unique user assigned name for use within the graphical ladder diagram.

Coil --(C)--



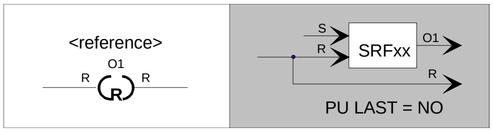
The C coil sets the state of the reference to TRUE when the left horizontal shunt is conducting and to FALSE when not conducting. *{The coil function is associated with the output state of another function block and assigns a unique reference name within the ladder diagram to this state.}*

Set (Latch) Coil --(S)--



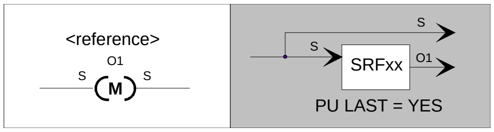
The S coil sets the state of the coil reference TRUE when the left horizontal shunt changes from not conducting to conducting. It will remain TRUE, after the left horizontal shunt returns to a not conducting state, until the reference is reset using an R coil assigned to the same reference. During a warm or cold start the reference will be set to FALSE. *{The set coil function is equivalent to a SRF function block having input S connected to the left horizontal shunt, the block output O1 associated with the coil reference, and PU LAST set to NO. The left horizontal shunt of the corresponding R coil is connected to the R input. Set is paired with the complementary Reset function. }*

Reset (Unlatch) Coil --(R)--



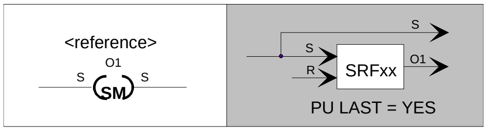
The R coil resets the state of the coil reference to FALSE when the left horizontal shunt changes from not conducting to conducting. It will remain FALSE after the left horizontal shunt returns to a not conducting state, until the reference is set using an S coil assigned to the same reference. During a warm or cold start the reference will be set to FALSE. *{The reset coil function is equivalent to a SRF function block having input R connected to the left horizontal shunt, the block output O1 associated with the coil reference, and PU LAST set to NO. The left horizontal shunt of the corresponding S coil is connected to the S input. Reset is paired with the complementary Set function. }*

Retentive (Memory) Coil --(M)--



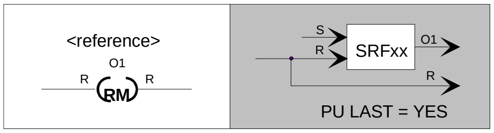
The M coil sets the state of the coil reference to TRUE when the left horizontal shunt is conducting and will set it to FALSE when the shunt is not conducting. It will retain the state of the reference during a warm start until the coil is executed on the first scan cycle. *{The retentive coil function is equivalent to a SRF function block having input S connected to the left horizontal shunt, the R input is not connected (defaulting to TRUE), the block output O1 associated with the coil reference, and PU LAST set to YES. }*

Set Retentive (Memory) Coil --(SM)--



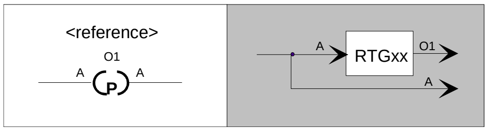
The SM coil sets the state of the coil reference TRUE when the left horizontal shunt changes from not conducting to conducting. It will remain TRUE, after the left horizontal shunt returns to a not conducting state, until the reference is reset using a RM coil assigned to the same reference. During a warm start the reference will be retained at the previous value and during a cold start it will be set to FALSE. *{The set retentive coil function is equivalent to a SRF function block having input S connected to the left horizontal shunt, the block output O1 associated with the coil reference, and PU LAST set to YES. The left horizontal shunt of the corresponding RM coil is connected to the R input. Set is paired with the complementary Reset function below. }*

Reset Retentive (Memory) Coil --(RM)--



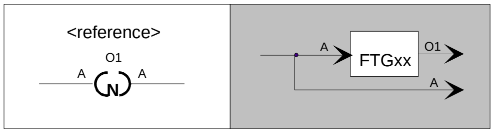
The RM coil resets the state of the coil reference to FALSE when the left horizontal shunt changes from not conducting to conducting. It will remain FALSE after the left horizontal shunt returns to a not conducting state, until the reference is set using a SM coil assigned to the same reference. During a warm start the reference will be retained at the previous value and during a cold start it will be set to FALSE. *{The reset retentive coil function is equivalent to a SRF function block having input R connected to the left horizontal shunt, the block output O1 associated with the coil reference, and PU LAST set to YES. The left horizontal shunt of the corresponding SM coil is connected to the S input. Reset is paired with the complementary Set function above. }*

Positive Transition-Sensing Coil --(P)--



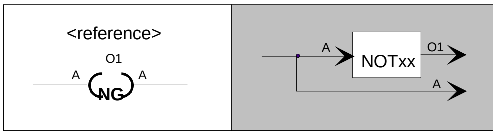
The P coil changes the state of the coil reference from FALSE to TRUE for one scan cycle, when the left horizontal shunt changes from not conducting to conducting. *{The positive transition-sensing coil function is equivalent to a RTG function block having input A connected to the left horizontal shunt and the block output O1 associated with the coil reference. }*

Negative Transition-Sensing Coil --(N)--



The N coil changes the state of the coil reference from FALSE to TRUE for one scan cycle, when the left horizontal shunt changes from conducting to not conducting. *{The negative transition-sensing coil function is equivalent to a FTG function block having input A connected to the left horizontal shunt and the block output O1 associated with the coil reference. }*

Negated Coil --(NG)--

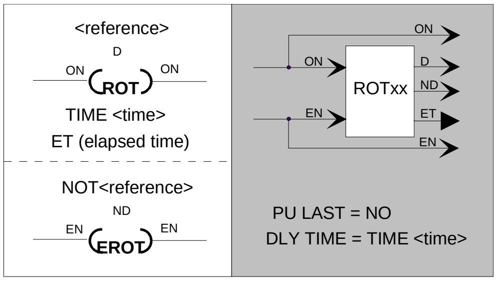


The NG coil sets the state of the coil reference TRUE when the left horizontal shunt not conducting and to FALSE when conducting. *{The negated coil function is equivalent to a NOT function block having input A connected to the left horizontal shunt and the block output O1 associated with the coil reference. }*

3.4 TIMERS

Timers are similar to coils. They copy the state of the left horizontal shunt to the right horizontal shunt without modification and store a state into a Boolean reference based on the state of the left horizontal shunt and the operation of the specific timer function.

Retentive On Timer --(ROT)--

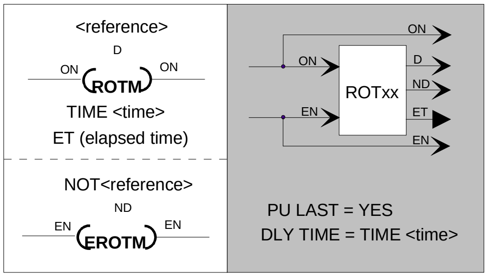


The ROT changes its coil reference from FALSE to TRUE after the left horizontal shunt has been conducting for a time equal to or greater than the time setting, provided its associated EROT is conducting. Once the timer has been started, the elapsed time will be retained even if the left horizontal shunt returns to a not conducting state. The elapsed timer will continue when the state returns to conducting. The ROT must be used with an EROT (enable retentive on timer) having the same reference as the ROT but preceded by NOT (e.g. ROT is TIMER1 and EROT is NOTTIMER1). During a warm or cold start the reference will be initialized to FALSE and the elapsed timer will be initialized to 0. *{This function and its associated EROT corresponds to a ROT function block with the PU LAST set to NO, the left horizontal shunt connected to the ON input, and the D output corresponding to the reference. The left horizontal shunt of the corresponding EROT coil is connected to the EN input. }*

Enable Retentive On Timer --(EROT)--

The EROT changes its coil reference from FALSE to TRUE when the left horizontal shunt is conducting and its associated ROT is NOT TRUE. *{This function and its associated ROT corresponds to a ROT function block with the PU LAST set to NO, the left horizontal shunt connected to the EN input, and the DN output corresponding to the reference. The left horizontal shunt of the corresponding ROT coil is connected to the ON input. }*

Retentive On Timer (Memory) --(ROTM)--

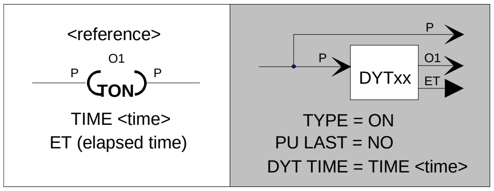


The ROTM changes its coil reference from FALSE to TRUE after the left horizontal shunt has been conducting for a time equal to or greater than the time setting, provided its associated EROTM is conducting. Once the timer has been started, the elapsed time will be retained even if the left horizontal shunt returns to a not conducting state. The elapsed timer will continue when the state returns to conducting. The ROTM must be used with an EROTM (enable retentive on timer) having the same reference as the ROTM but preceded by NOT (e.g. ROTM is TIMER2 and EROTM is NOTTIMER2). During a warm start the references and elapsed timer will be initialized to their previous values. *{This function and the matching EROTM corresponds to a ROT function block with the PU LAST set to YES, the left horizontal shunt connected to the ON input, and the D output corresponding to the reference. The left horizontal shunt of the associated EROTM coil is connected to the EN input. }*

Enable Retentive On Timer (Memory) --(EROTM)--

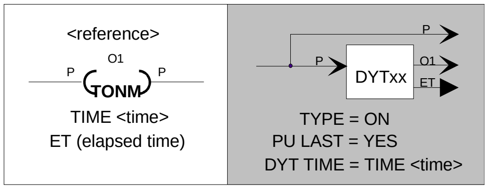
The EROTM changes its coil reference from FALSE to TRUE when the left horizontal shunt is conducting and its associated ROTM is NOT TRUE. *{This function and its associated ROTM corresponds to a ROT function block with the PU LAST set to YES, the left horizontal shunt connected to the EN input, and the DN output corresponding to the reference. The left horizontal shunt of the associated ROTM coil is connected to the ON input. }*

On-Delay Timer --(TON)--



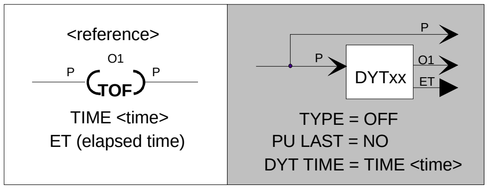
The TON changes the coil reference from FALSE to TRUE after the left horizontal shunt changes from not conducting to conducting and has been conducting for a time equal to or greater than the time setting. The reference will remain TRUE until the left horizontal shunt returns to a not conducting state. During a warm start the reference will be set FALSE, any elapsed time will reset to 0.0, and the timer will act on state of the left horizontal shunt during the first scan. *{The TON function is equivalent to the DYT function block with the TYPE set to ON, PU LAST set to NO, and the DLY TIME set to the time.}*

On-Delay Retentive (Memory) Timer --(TONM)--



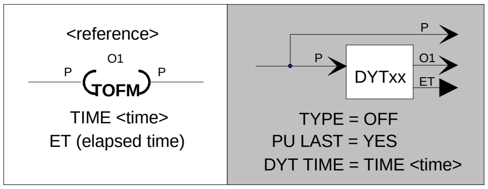
The TONM changes the coil reference from FALSE to TRUE after the left horizontal shunt changes from not conducting to conducting and has been conducting for a time equal to or greater than the time setting. It will remain TRUE until the left horizontal shunt returns to a not conducting state. During a warm start the reference will be set to the last state, any elapsed time will be retained including that time accumulated during a power out condition. The timer will act on the state of the left horizontal shunt during the first scan based on the state of the last scan prior to power out. *{The TONM function is equivalent to the DYT function block with the TYPE set to ON, PU LAST set to YES, and the DLY TIME set to the time.}*

Off-Delay Timer --(TOF)--



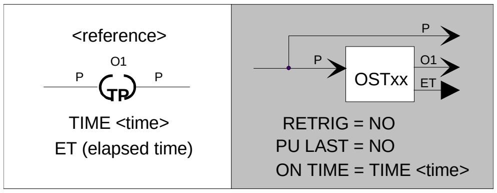
The TOF changes the coil reference from TRUE to FALSE after the left horizontal shunt changes from conducting to not conducting and has been in a not conducting state for a time equal to or greater than the time setting. It will remain FALSE until the left horizontal shunt returns to a conducting state. During a warm start the reference will be set FALSE, any elapsed time will reset to 0.0, and the timer will act on state of the left horizontal shunt during the first scan. *{The TOF function is equivalent to the DYT function block with the TYPE set to OFF, PU LAST set to NO, and the DLY TIME set to the time.}*

Off-Delay Retentive (Memory) Timer --(TOFM)--



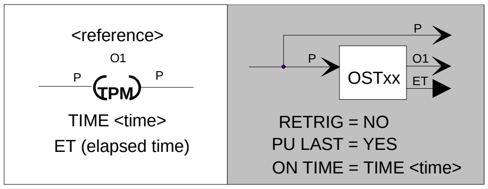
The TOFM changes the coil reference from TRUE to FALSE after the left horizontal shunt changes from conducting to not conducting and has been in a not conducting state for a time equal to or greater than the time setting. It will remain FALSE until the left horizontal shunt returns to a conducting state. During a warm start the reference will be set to the last value, the elapsed time will be retained, including any time accumulated during a power out condition, and the timer will act on the state of the left horizontal shunt during the first scan based on the state on the last scan prior to power out. *{The TOF function is equivalent to the DYT function block with the TYPE set to OFF, PU LAST set to YES, and the DLY TIME set to the time.}*

Timed Pulse Timer --(TP)--



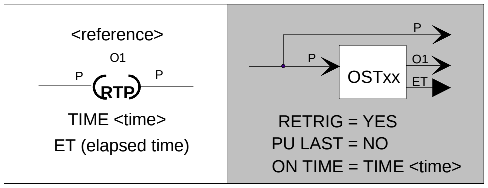
The TP changes the coil reference from FALSE to TRUE when the left horizontal shunt changes from a not conducting to a conducting state and will remain TRUE for a period equal to the time setting regardless of the state of the left horizontal shunt. The timed pulse can not be retriggered until after the time expires. During a warm start the reference will be set FALSE, any elapsed time will reset to 0.0, and the timer will act on state of the left horizontal shunt during the first scan. *{The TP function is equivalent to the OST function block with RETRIG set to NO, PU LAST set to NO, and the ON TIME set to the time.}*

Timed Pulse Retentive (Memory) Timer --(TPM)--



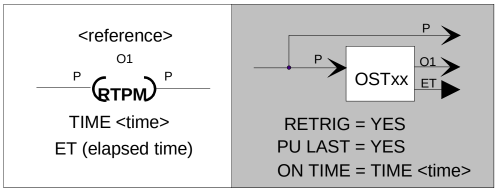
The TPM changes the coil reference from FALSE to TRUE when the left horizontal shunt changes from a not conducting to a conducting state and will remain TRUE for a period equal to the time setting regardless of the state of the left horizontal shunt. The timed pulse can not be retriggered until after the time expires. During a warm start the reference will be set to the last state, any elapsed time will be retained including that time accumulated during a power out condition, the timer will continue timing, if time has not elapsed, and if elapsed will act on state of the left horizontal shunt during the first scan based on the state during the last scan prior to power out. *{The TP function is equivalent to the OST function block with RETRIG set to NO, PU LAST set to YES, and the ON TIME set to the time.}*

Retriggerable Timed Pulse Timer --(RTP)--



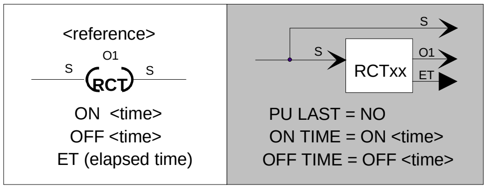
The RTP changes the coil reference from FALSE to TRUE when the left horizontal shunt changes from a not conducting to a conducting state and will remain TRUE for a period equal to the time setting regardless of the state of the left horizontal shunt. The timed pulse can be retriggered if the left horizontal shunt changes from a not conducting to a conducting state during the timing period. During a warm start the reference will be set FALSE, any elapsed time will reset to 0.0, and the timer will act on the state of the left horizontal shunt during the first scan. *{The TP function is equivalent to the OST function block with RETRIG set to YES, PU LAST set to NO, and the ON TIME set to the time.}*

Retriggerable Timed Pulse Retentive (Memory) Timer --(RTPM)--



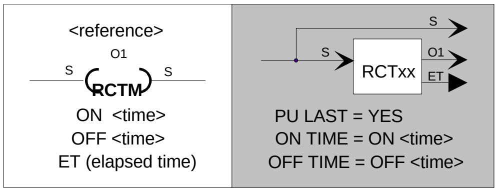
The RTPM changes the coil reference from FALSE to TRUE when the left horizontal shunt changes from a not conducting to a conducting state and will remain TRUE for a period equal to the time setting regardless of the state of the left horizontal shunt. The timed pulse can be retriggered if the left horizontal shunt changes from a not conducting to a conducting state during the timing period. During a warm start the reference will be set to the last state, any elapsed time will retained including that time accumulated during a power out condition, the timer will continue timing if time has not elapsed, and if elapsed will act on state of the left horizontal shunt during the first scan based on the state during the last scan prior to power out. *{The TP function is equivalent to the OST function block with RETRIG set to NO, PU LAST set to YES, and the ON TIME set to the time.}*

Repeat Cycle Timer --(RCT)--



The RCT changes the coil reference from FALSE to TRUE when the left horizontal shunt changes from a not conducting to a conducting state and will remain TRUE for a period equal to the on time. At the end of the on time the reference will go FALSE and remain FALSE until the off time expires. It will continue to repeat this cycle as long as the left horizontal shunt is conducting. The reference will always be FALSE when the left horizontal shunt is not conducting. During a warm start the reference will be set FALSE, any elapsed time will reset to 0.0, and the timer will act on state of the left horizontal shunt during the first scan. *{The RCT function is equivalent to the RCT function block with INPUT AT unconfigured, PU LAST set to NO, the ON TIME set to the on time, and the OFF TIME set to the off time.}*

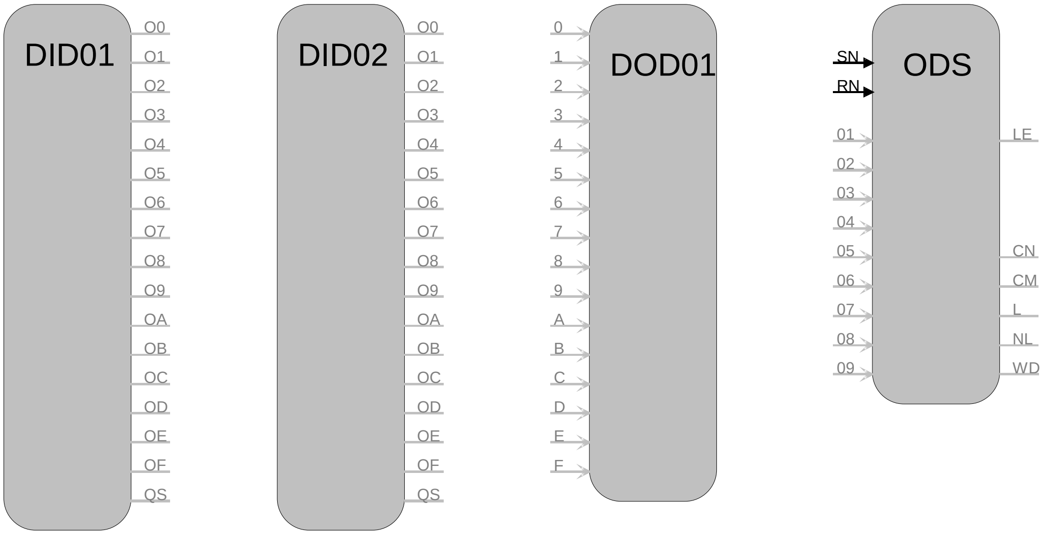
Repeat Cycle Retentive (Memory) Timer --(RCTM)--



The repeat cycle retentive timer RCTM changes the coil reference from FALSE to TRUE when the left horizontal shunt changes from a not conducting to a conducting state and will remain TRUE for a period equal to the on time. At the end of the on time the reference will go FALSE and remain FALSE until the off time expires. It will continue to repeat this cycle as long as the left horizontal shunt is conducting. The reference will always be FALSE when the left horizontal shunt is not conducting. During a warm start the reference will be set to the last value, any elapsed time will retained including that time accumulated during a power out condition, and the timer will act on state of the left horizontal shunt during the first scan. *{The RCT function is equivalent to the RCT function block with INPUT AT unconfigured, PU LAST set to YES, the ON TIME set to the on time, and the OFF TIME set to the off time.}*

4.0 LADDER LOGIC DESIGN EXAMPLE

This section illustrates a typical controller ladder logic configuration using the graphical configuration utility. The configuration consists of a function block loop and a ladder logic loop. The function block loop contains the discrete I/O function blocks required to process the physical inputs and outputs to the station. The ladder logic loop contains the ladder logic diagrams.



Reference connections for function block DID01:

Output O0:	%FDF_Start_PB	Output O8:	%Gas_Press_Lo
Output O1:	%FDF_Stop_PB	Output O9:	%Gas_Press_Hi
Output O2:	%FD_Fan_Running	Output OA:	%Gas_V1_Closed
Output O3:	%Air_Flow_LoLo	Output OB:	%Gas_V2_Closed
Output O4:	%Drum_Level_LoLo	Output OC:	%Oil_V1_Closed
Output O5:	%Oil_Temp_Lo	Output OD:	%Oil_V2_Closed
Output O6:	%Oil_HdrPress_Lo	Output OE:	%Start_Purge_PB
Output O7:	%Atom_Med_Hi	Output OF:	%Reset_MFT_PB

Reference connections for function block DID02:

Output O0:	%Start_Ignitr_PB	Output O8:	%Start_Gas_PB
Output O1:	%Burner_Flame	Output O9:	%Stop_Gas_PB
Output O2:	%Start_Oil_PB	Output OA:	%Gas_V1_NotOpen
Output O3:	%Stop_Oil_PB	Output OB:	%Gas_V2_NotOpen
Output O4:	%Oil_V1_NotOpen	Output OC:	%Vent_NotClosed
Output O5:	%Oil_V2_NotOpen	Output OD:	%Master_Abort_PB
Output O6:	%RecircPmp_Stop_PB	Output OE:	%
Output O7:	%RecircPmp_Strt_PB	Output OF:	%

Reference connections for function block DOD01:

Input 0:	%FDF_Start	Input 8:	%MFT
Input 1:	%Start_Purge	Input 9:	%System_Alarm
Input 2:	%Purge_InProgress	Input A:	%
Input 3:	%Purge_Complete	Input B:	%
Input 4:	%Opn_Ig_Gas_Vlvs	Input C:	%
Input 5:	%Open_Oil_Valves	Input D:	%
Input 6:	%Close_Recirc	Input E:	%
Input 7:	%Open_Gas_Valves	Input F:	%

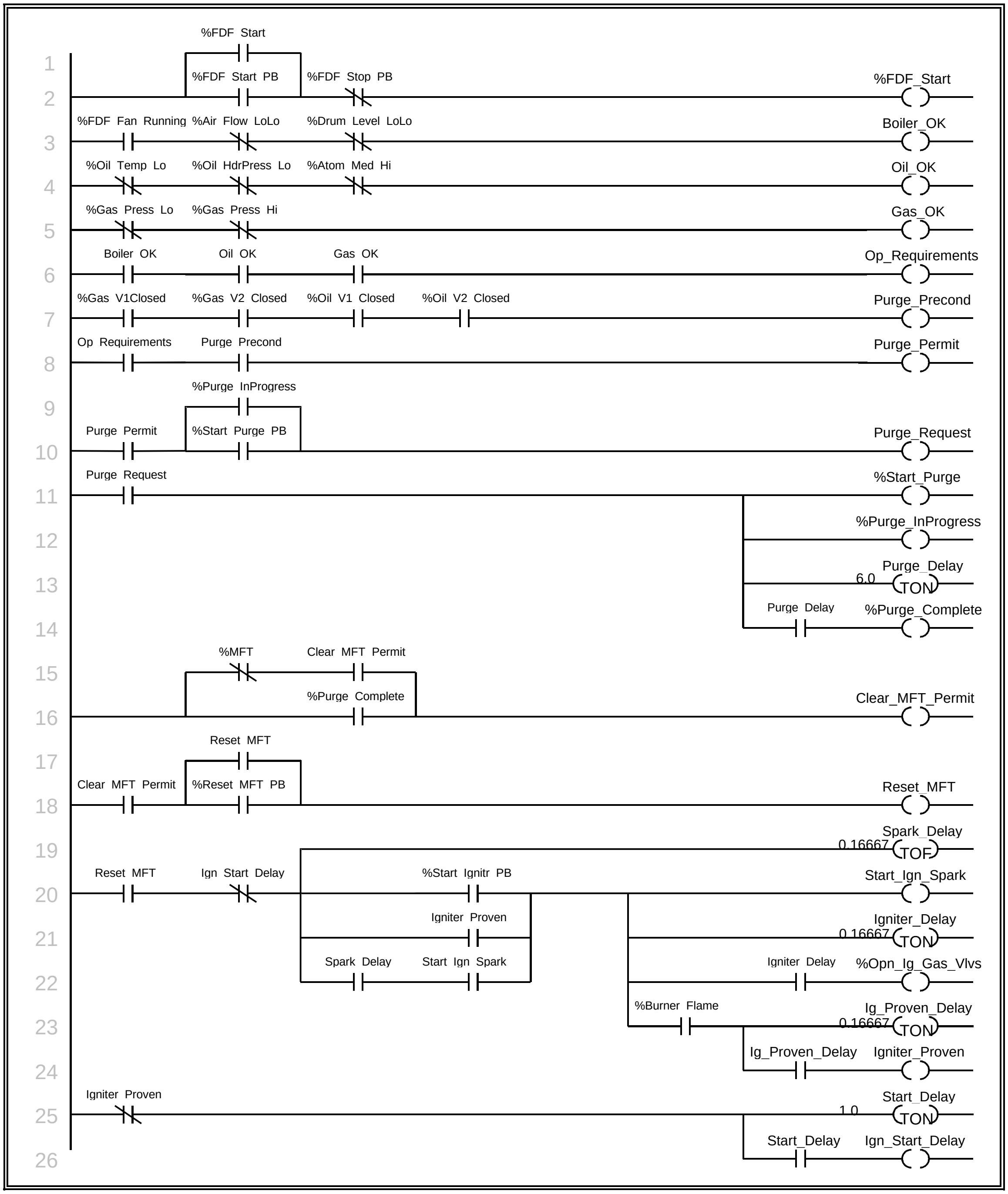
Reference connections for function block ODS:

Output LE:	Model 353_Loop_Error

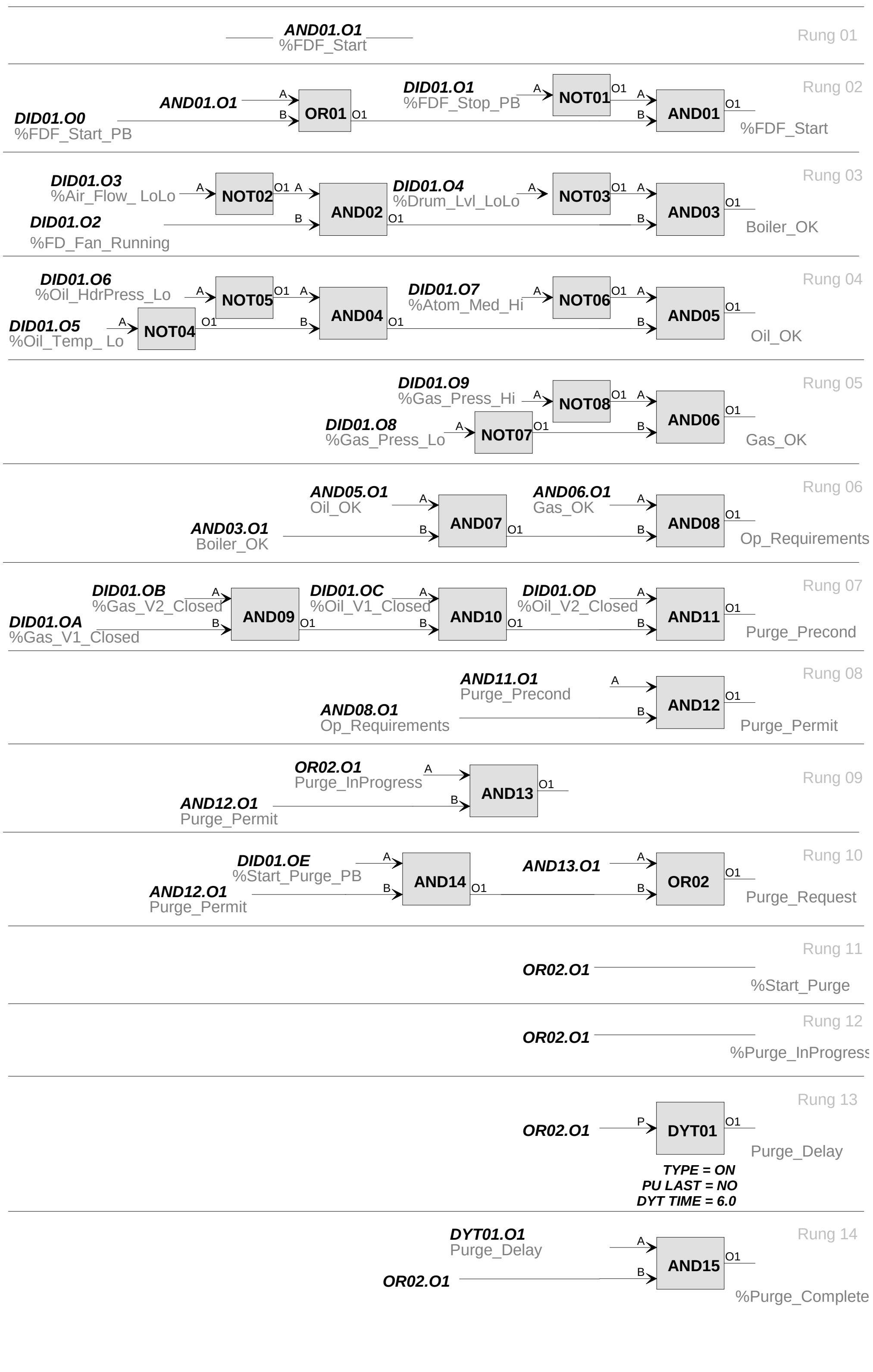
The ODS can be used for displaying various operations within the ladder logic loops. The Universal display provides more capability for this type of loop in that it will be able to display various messages. See the description of the ODS function block for additional information. When a basic display is used it will normally display the loop tag.S and indicate the step number of the sequencer, if used. If message inputs are configured and a basic display is used they can be viewed by pressing the D button to advance through the list of active messages.

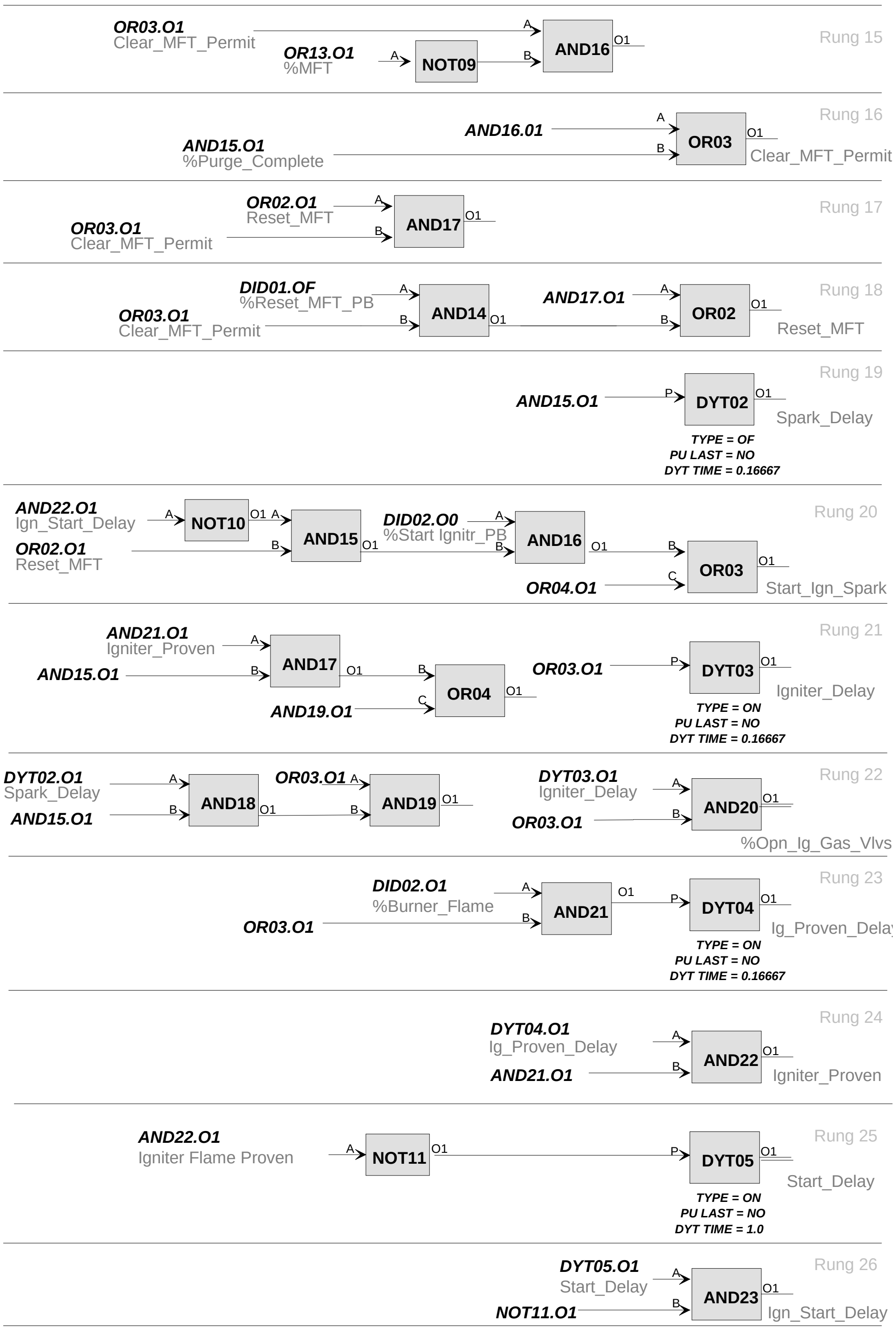
Other function blocks can also be used to provide boolean inputs or outputs to the ladder logic elements. For example, a pushbutton function block could be used to start or stop a logic operation. The connections between these elements on the primary page are made by creating a reference for the inputs and outputs of these function blocks, similar to that above for the discrete I/O.

The graphical configuration of the first secondary page:

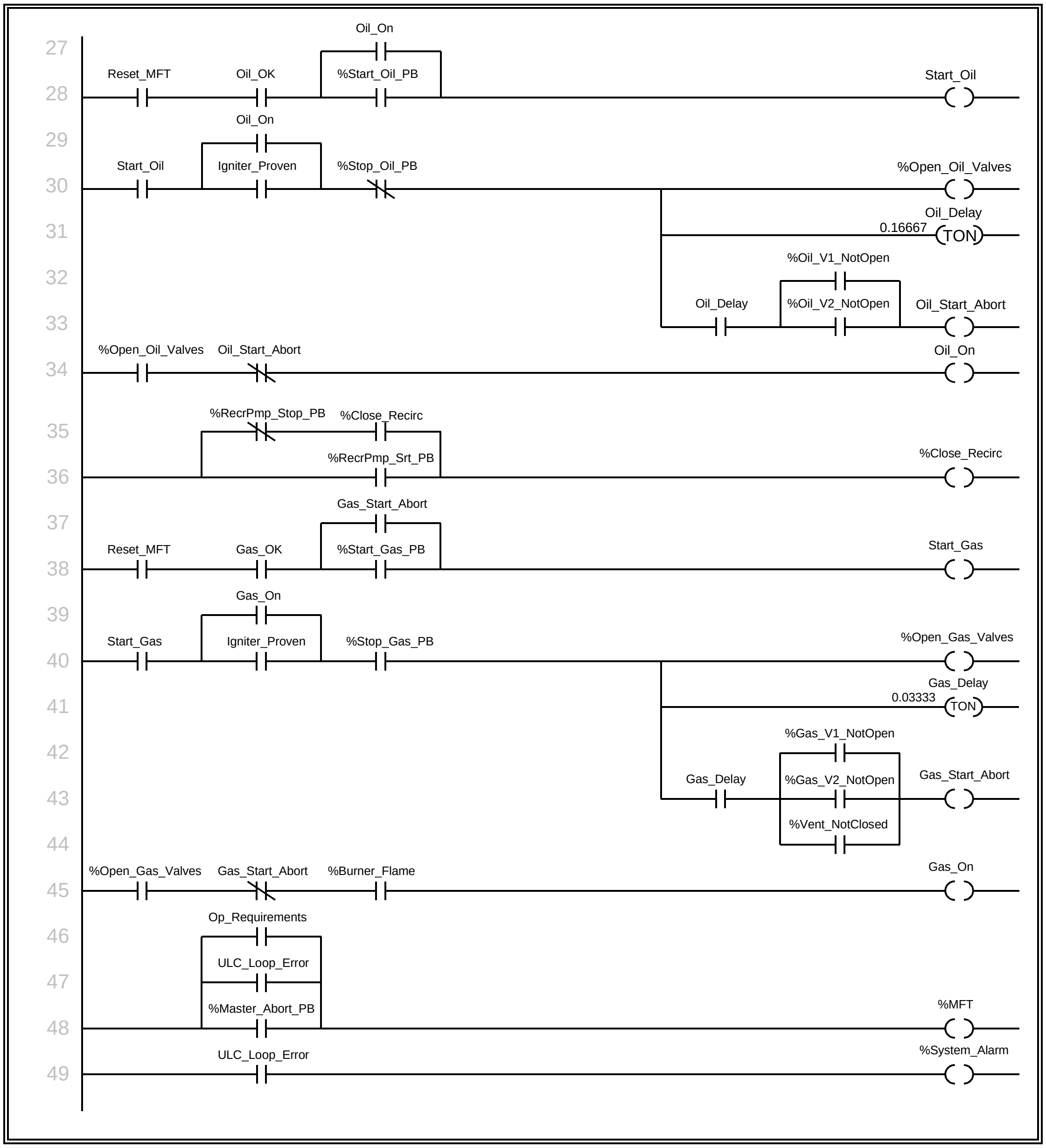


Ladder to function block conversion for the previous ladder diagram:

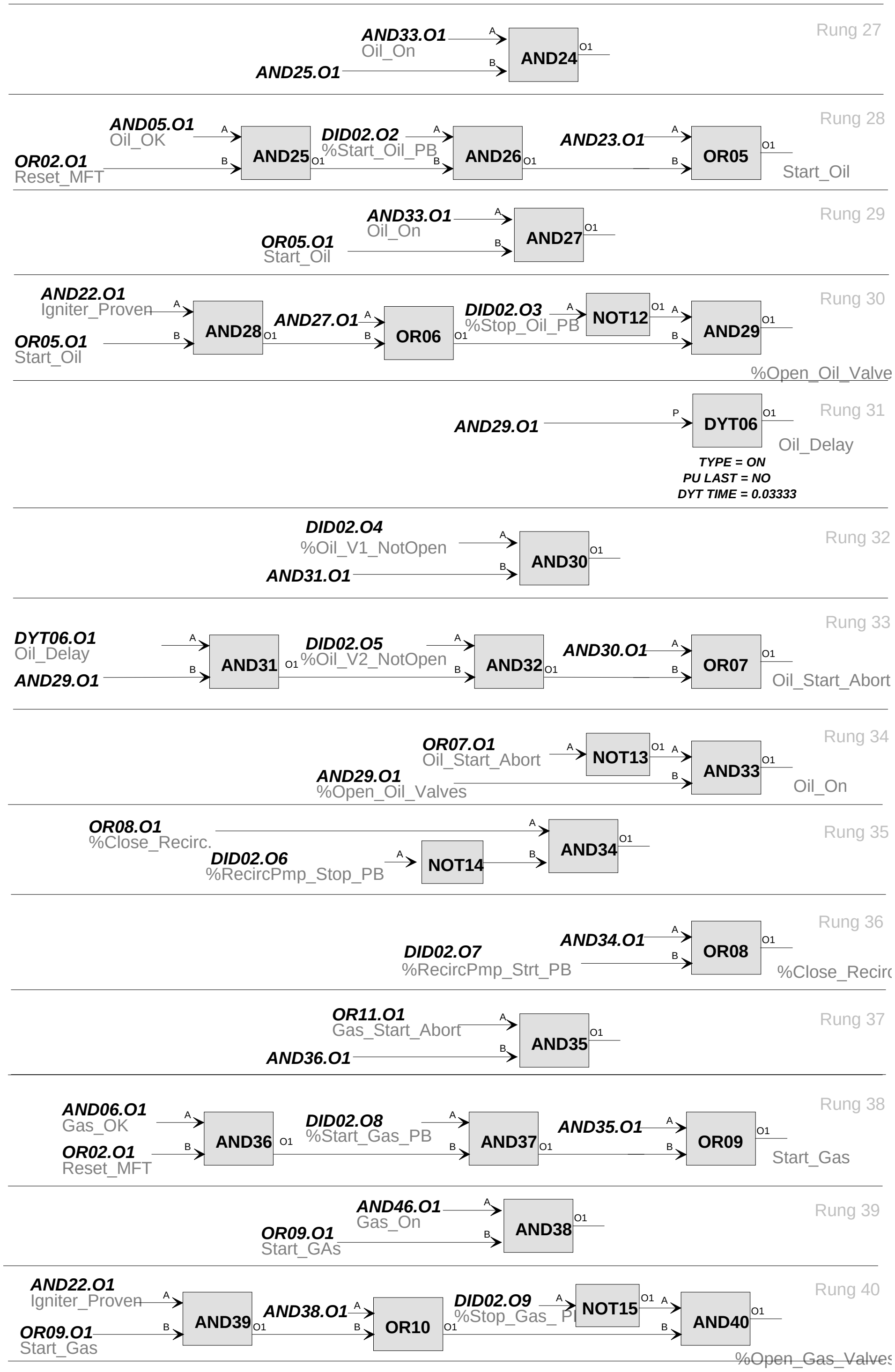


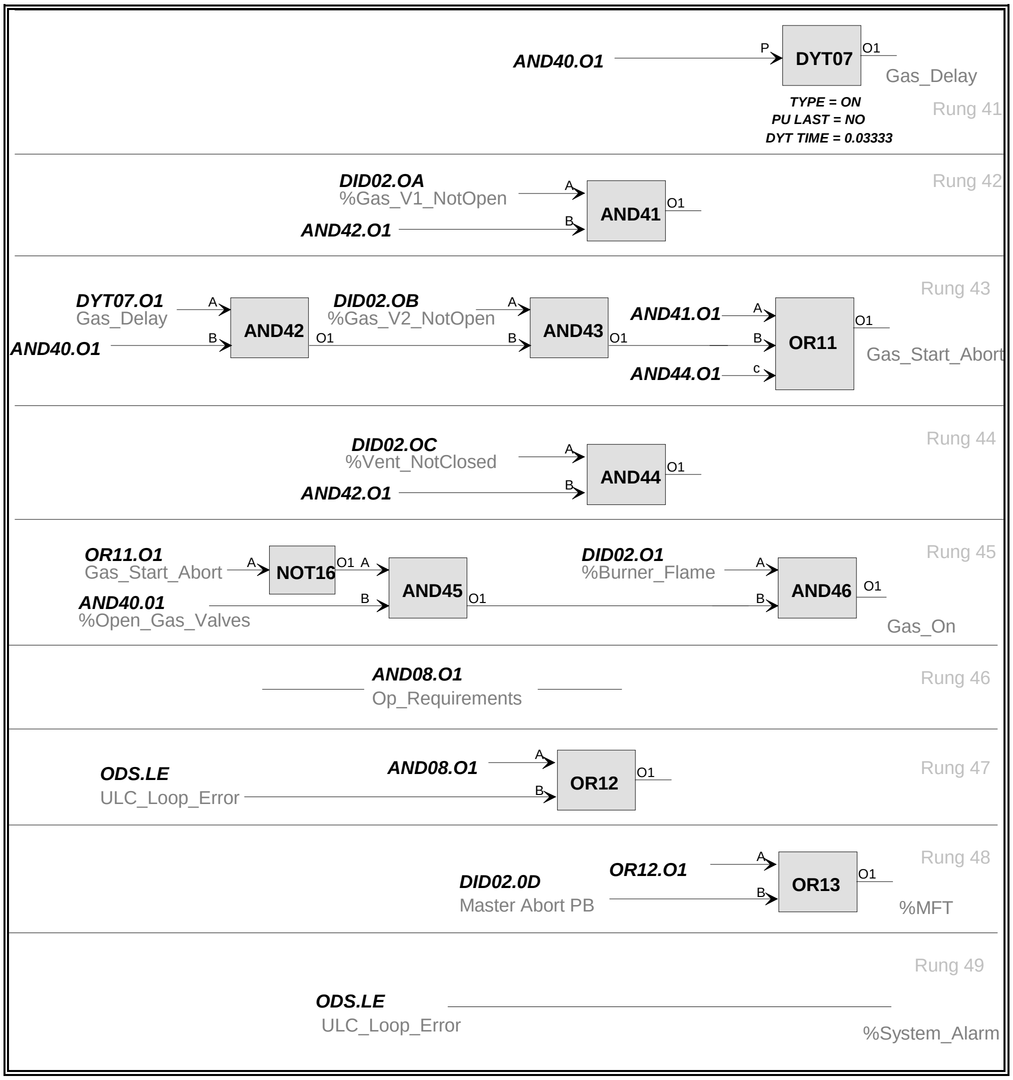

Rung 15
OR03.O1
Clear_MFT_Permit
OR13.O1
%MFT
A
NOT09
B
AND16
O1
Rung 16
AND16.01
A
AND15.O1
%Purge_Complete
B
OR03
O1
Clear_MFT_Permit
Rung 17
OR02.O1
Reset_MFT
A
OR03.O1
Clear_MFT_Permit
B
AND17
O1
Rung 18
DID01.OF
%Reset_MFT_PB
A
OR03.O1
Clear_MFT_Permit
B
AND14
O1
AND17.O1
A
B
OR02
O1
Reset_MFT
Rung 19
AND15.O1
P
DYT02
O1
Spark_Delay
TYPE = OF
PU LAST = NO
DYT TIME = 0.16667
Rung 20
AND22.O1
Ign_Start_Delay
A
NOT10
O1
A
OR02.O1
Reset_MFT
B
AND15
O1
DID02.O0
%Start Ignitr_PB
A
B
AND16
O1
B
OR04.O1
C
OR03
O1
Start_Ign_Spark
Rung 21
AND21.O1
Igniter_Proven
A
AND15.O1
B
AND17
O1
B
AND19.O1
C
OR04
O1
OR03.O1
P
DYT03
O1
Igniter_Delay
TYPE = ON
PU LAST = NO
DYT TIME = 0.16667
Rung 22
DYT02.O1
Spark_Delay
A
AND15.O1
B
AND18
O1
OR03.O1
A
B
AND19
O1
DYT03.O1
Igniter_Delay
A
OR03.O1
B
AND20
O1
%Opn_Ig_Gas_Vlvs
Rung 23
DID02.O1
%Burner_Flame
A
OR03.O1
B
AND21
O1
P
DYT04
O1
Ig_Proven_Delay
TYPE = ON
PU LAST = NO
DYT TIME = 0.16667
Rung 24
DYT04.O1
Ig_Proven_Delay
A
AND21.O1
B
AND22
O1
Igniter_Proven
Rung 25
AND22.O1
Igniter Flame Proven
A
NOT11
O1
P
DYT05
O1
Start_Delay
TYPE = ON
PU LAST = NO
DYT TIME = 1.0
Rung 26
DYT05.O1
Start_Delay
A
NOT11.O1
B
AND23
O1
Ign_Start_Delay

The graphical configuration of the second secondary page:



Ladder to function block conversion for previous ladder diagram:




AND40.O1
P
DYT07
O1
Gas_Delay
TYPE = ON
PU LAST = NO
DYT TIME = 0.03333
Rung 41
DID02.OA
%Gas_V1_NotOpen
A
AND42.O1
B
AND41
O1
Rung 42
DYT07.O1
Gas_Delay
A
AND40.O1
B
AND42
O1
DID02.OB
%Gas_V2_NotOpen
A
B
AND43
O1
AND41.O1
A
B
AND44.O1
c
OR11
O1
Gas_Start_Abort
Rung 43
DID02.OC
%Vent_NotClosed
A
AND42.O1
B
AND44
O1
Rung 44
OR11.O1
Gas_Start_Abort
A
NOT16
O1
A
AND40.01
%Open_Gas_Valves
B
AND45
O1
DID02.O1
%Burner_Flame
A
B
AND46
O1
Gas_On
Rung 45
AND08.O1
Op_Requirements
Rung 46
ODS.LE
ULC_Loop_Error
AND08.O1
A
B
OR12
O1
Rung 47
DID02.0D
Master Abort PB
OR12.O1
A
B
OR13
O1
%MFT
Rung 48
Rung 49
ODS.LE
ULC_Loop_Error
%System_Alarm