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Application Note

Document Number	YEGA1008V1000-02		
Application	**All applications which need to detect unbalance e.g. washing machine**		
Industry	Miscellaneous		
Yaskawa Product	V1000 / A1000 in Open Loop Vector control with DWEZ		
Created by	Adrian Lischka		
Date	25-Aug-10	Pages	1 of 11

1 Overview

This software can be used in washing machine application to detect a possible load unbalance. The advantage of software unbalance detection is the reduction of additional hardware like unbalance detection switches, reduction of additional wiring and shortening of the drainage mode.

Basically the washing machine application is running in three different modes:

1. Washing Mode

   Alternating between “forward run” and “reverse run” at a low frequency

2. Drainage Mode

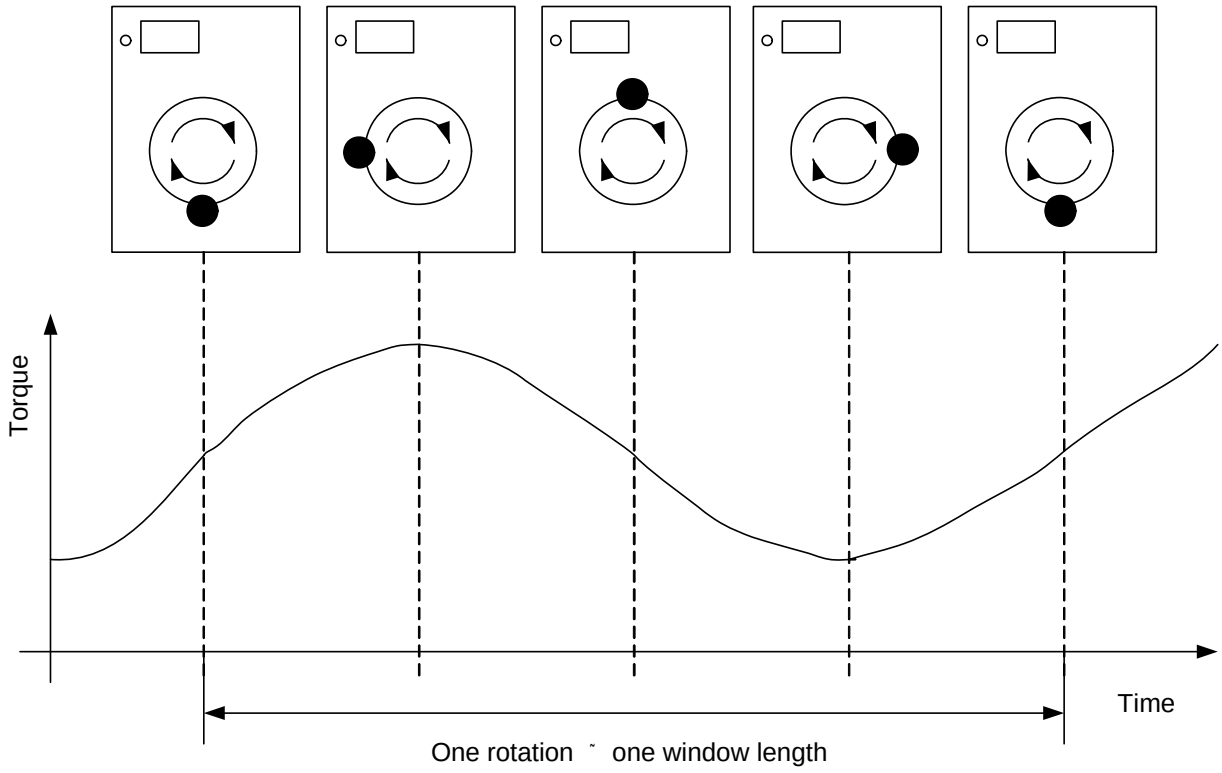
   Before the washing machine is going into the spinning mode, it stays for some while in the drainage mode. The drainage frequency is the lowest frequency, the laundry sticks already tightly to the washing machine barrel. This mode is very important for the unbalance detection, because of its steady state. In this mode, the washing machine is still slow enough that no damages occur through unbalance, but the conditions are al ready well suited for the unbalance detection.

3. Spinning Mode

   Dwells at a high frequency for a long time

2 Principle of unbalance detection

The following sketch gives a rough idea about the behaviour of the torque. Regarding this, the length of the unbalance window has to be at least ½ rotation to get a maximum and ½ rotation to get a minimum. So it is recommended to take a full or 1 ½ rotations as one unbalance detection window length.



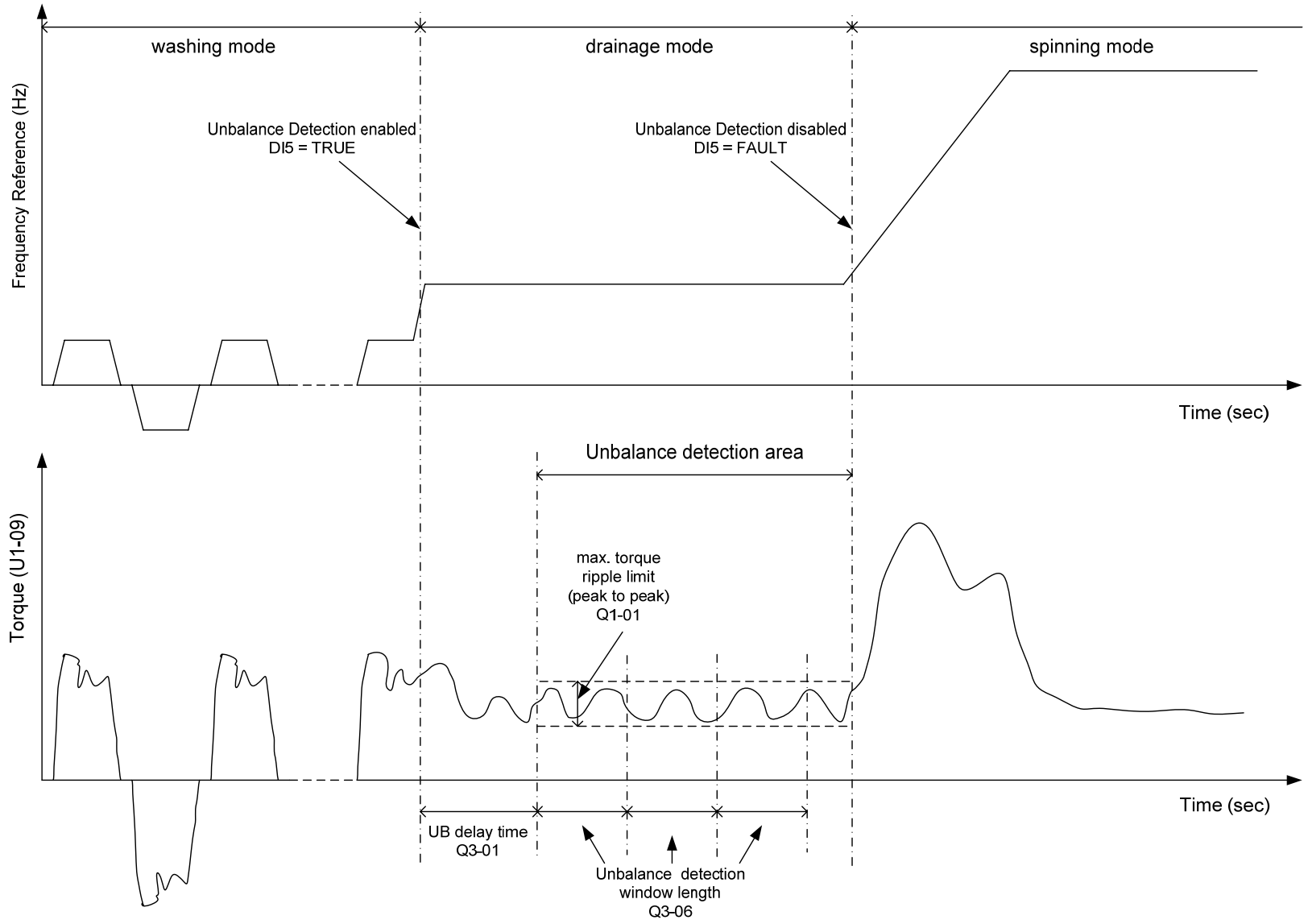
3 Main features of the Software

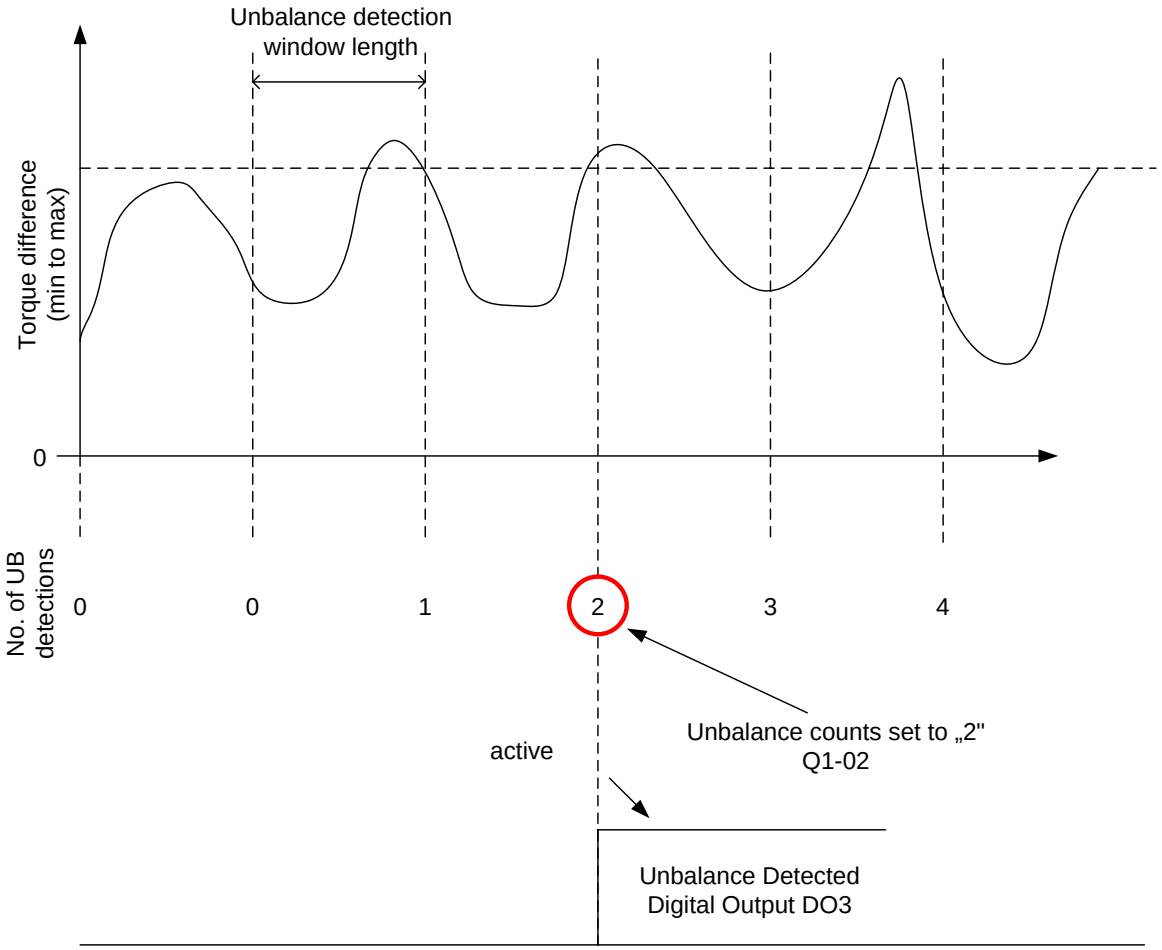
The following two sketches show the 3 washing modes and the function of the unbalance detection.

When the drainage frequency (well known by machine builder) is reached the unbalance detection should be enabled by digital input S5. The frequency reference for the drainage mode must be stabile during the unbalance detection.

When the unbalance detection is active the delay timer is starting at first. The unbalance detection is activated after delay time Q3-01 is over.

The software calculates a local minimum and a local maximum of the torque within a window of a length set in Q3-06. At the end of the window, the difference between these values is calculated and compared with the threshold set in Q1-01. If this threshold is crossed, a counter is incrementing. After the counter reaches the number of crossed torque ripples set in Q1-02, “Unbalance” is detected and digital output DO3 is set to TRUE.


washing mode
drainage mode
spinning mode
Frequency Reference (Hz)
Unbalance Detection enabled
DI5 = TRUE
Unbalance Detection disabled
DI5 = FAULT
Time (sec)
Unbalance detection area
Torque (U1-09)
max. torque
ripple limit
(peak to peak)
Q1-01
Time (sec)
UB delay time
Q3-01
Unbalance detection
window length
Q3-06



This example shows unbalance detection in the drainage mode. The first diagram shows the torque difference of the local minimum and maximum. Below that, the counter which increases its value at the end of a window if the difference crosses the threshold set in Q1-01. Here it is assumed that the number of threshold-crossings until unbalance is detected is 2.

4 Description of DWEZ program

The program consists of seven pages, described in the table below

Name	Description
Window Time	Sets the time for unbalance detection window length
Min_Max Detection	Stores the min/max torque of one window length
Start Window	Starts the unbalance window counting
Count Ripple	Counts the torque ripple
Unbalance detected	Sets the digital output when unbalance is detected

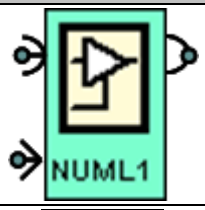
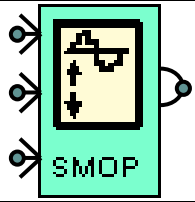
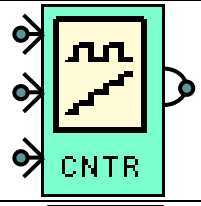
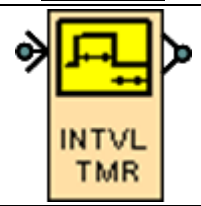
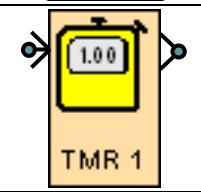
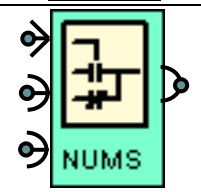
The DWEZ digital inputs are used like follows:

Terminal input number	Description
S5	Enable the unbalance detection
S6	Reset the unbalance detected condition

The DWEZ digital output is used like follows:

Terminal input number	Description
DO3	Unbalance is detected

The main DWEZ function blocks

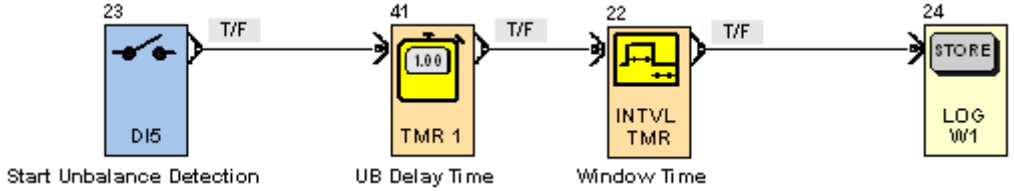
Objective	Function Block	Name	Function Descriptions
Store output		NumL1	If the hold input is TRUE, the numeric output keeps the value that was preset on the numeric input during Hold input became TREU
Step Motor Operated Poti Function		SMOP	This function block is used for counting of torque ripples. If the torque ripple threshold is crossed, a counter is incre-menting
Up and Down Counter		CNTR	Counts the quantities of measured win-dows.
Interval Timer		INTVL TMR	This timer is used to measure one win-dow length of the unbalance detection
Delay the process for a certain time		Timer 1	Output of Timer 1 will be TRUE, when the input signal is TRUE for a certain time.
Select one from two nu-meric input by using a logic input		Numeric Selector	Numeric Selector is used to switch be-tween two numeric inputs. This function operates as a two-channel analog selec-tor switch. When the Select input is TRUE, numeric input A is output. When the Select input is FALSE, numeric input B is output.

DWEZ parameter settings

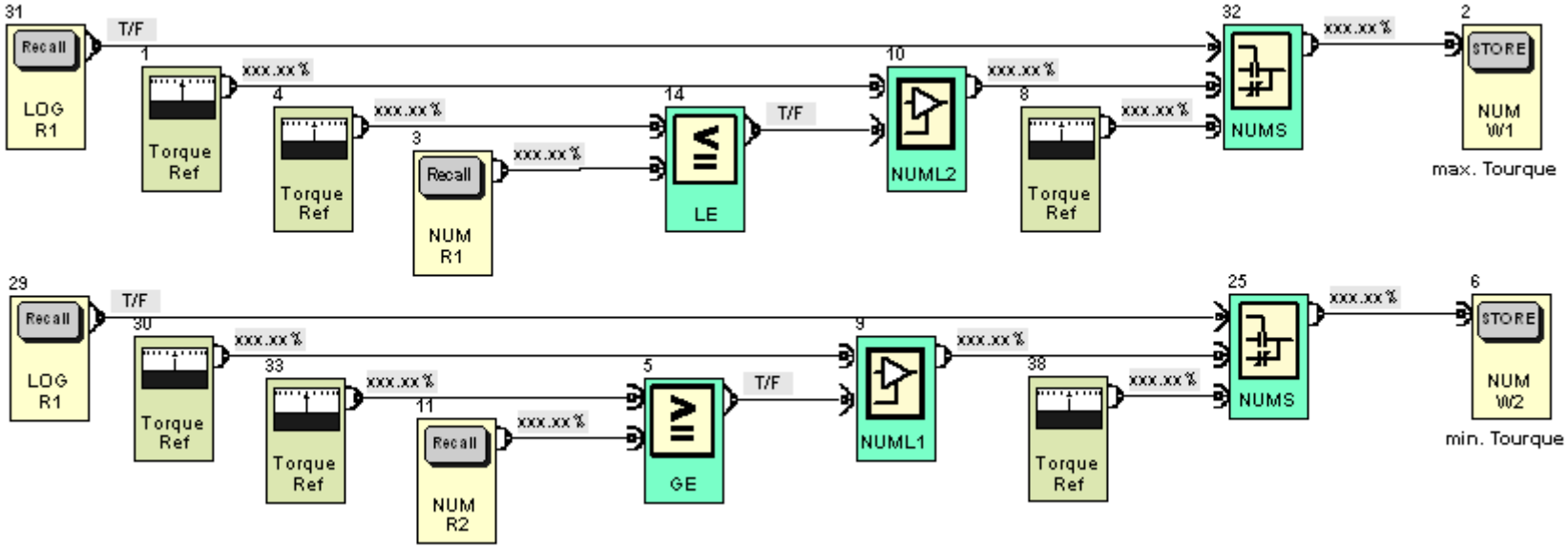
Parameter No.	MEMOBUS Address	Parameter Name	Description	Range / Unit	Default	Function Block	Preset
Q1-01	1600h	Max. Delta Torque	Sets max. torque ripple deviation to detect unbalance. This value is set in percentage or U1-09	0.00 to 655.35%	0.00%	Q1-01	20.00
Q1-02	1601h	No. of torque ripples	Sets the number of torque ripples to detect unbalance	0.00 to 655.35%	0.00%	Q1-02	03.00
Q1-03	1602h	No. of windows	Sets the total number of windows to detect unbalance. Keep in mind that the unbalance threshold can be reached only one time in one window length. To measure 3 windows set parameter to 0.03.	0.00 to 655.35%	0.00%	Q1-03	00.03
Q3-01	1680h	Delay timer	On-delay time for enable the unbalance detection function	0 to 600.0	0.0 sec	TRM 1	2.0
Q3-04	1683h	1 Shot	Enables the threshold is crossed counter	0 to 600.0	0.0 sec	1 Shot	0.1
Q3-05	1684h	Interval Timer Off Time	Delay time Window Time length	0 to 600.0	0.0 sec	INTVL TMR	0.1
Q3-06	1685h	Interval Timer On Time	Window Time length	0 to 600.0	0.0 sec	INTVL TMR	2.0
Q5-05	1704h	Step MOP Amount	Set the increment value of each step	0 to 999.9	0.0	SMOP	1.0
Q5-07	1706h	Step MOP Max. Output	Sets the maximum output value of the block	-999.9 to 999.9	0.0	SMOP	100.0

5 DWEZ Project

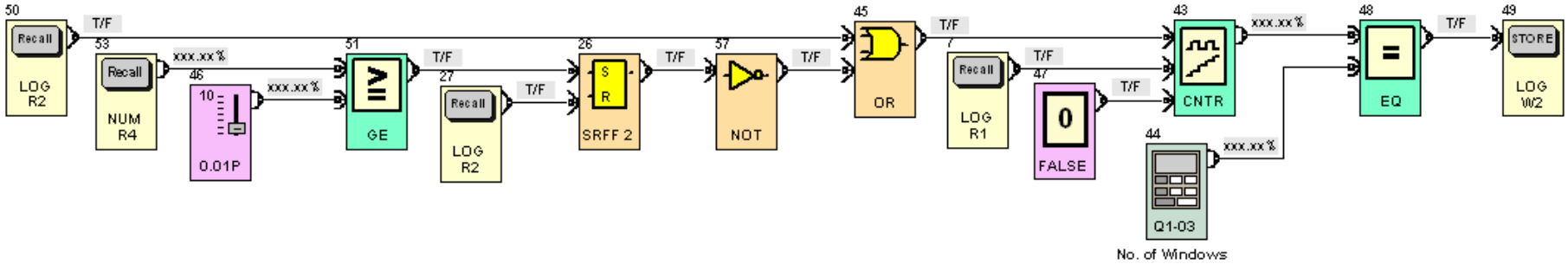
5.1 Page 1: Window Time



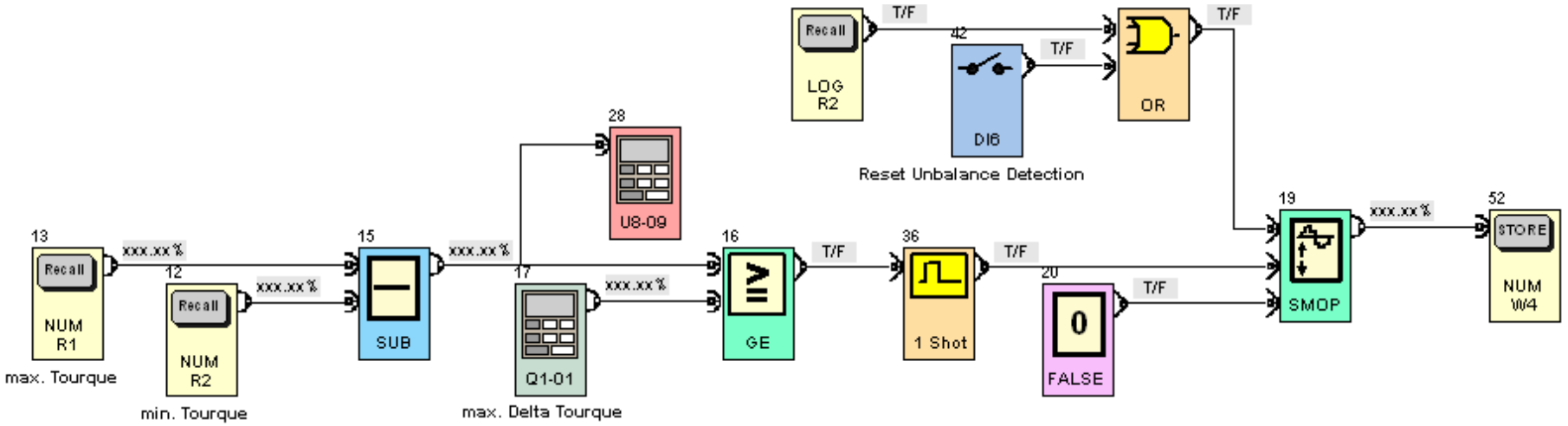
5.2 Page 2: Min_Max Detection



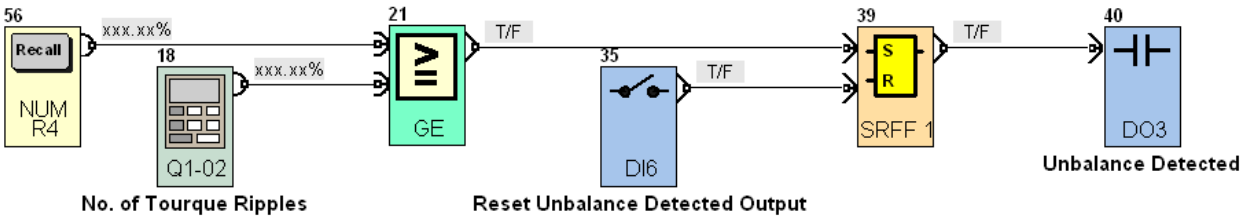
5.3 Page 3: Start Window



5.4 Page 4: Count Ripple



5.5 Page 5: Unbalance Detected



6 Additional Information

In case that inverter is running in V/f mode use the output current function block instead of torque reference function block to detect the unbalance.

Please keep in mind that the number of ripples should not be more then the number of windows to detect the unbalance.