Temat: Gra Reversi

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Semestr 6

1. Opis teoretyczny zadania
   Celem zadania jest implementacja gry Reversi na sterowniku S7-1200 zgodnie z przyjętymi zasadami. Gra powinna być możliwa do zagrania przez dwóch graczy na urządzeniu HMI a sterownik powinien przechowywać i zapamiętywać wyniki pięciu ostatnich gier oraz tworzyć tabelę pięciu najlepszych wyników wraz z imionami graczy.
2. Podział pracy:
   a. Maciej Dworzański:
   - Wybór HMI z dostępnych na stronie Siemens
   - Stworzenie interfejsu graficznego wraz z przypisaniem tagów
   - Dodanie do algorytmu szukania prawidłowego ruchu systemu wskazówek
   - Implementacja pętli systemu wskazówek wraz ze zliczaniem ilości możliwych ruchów

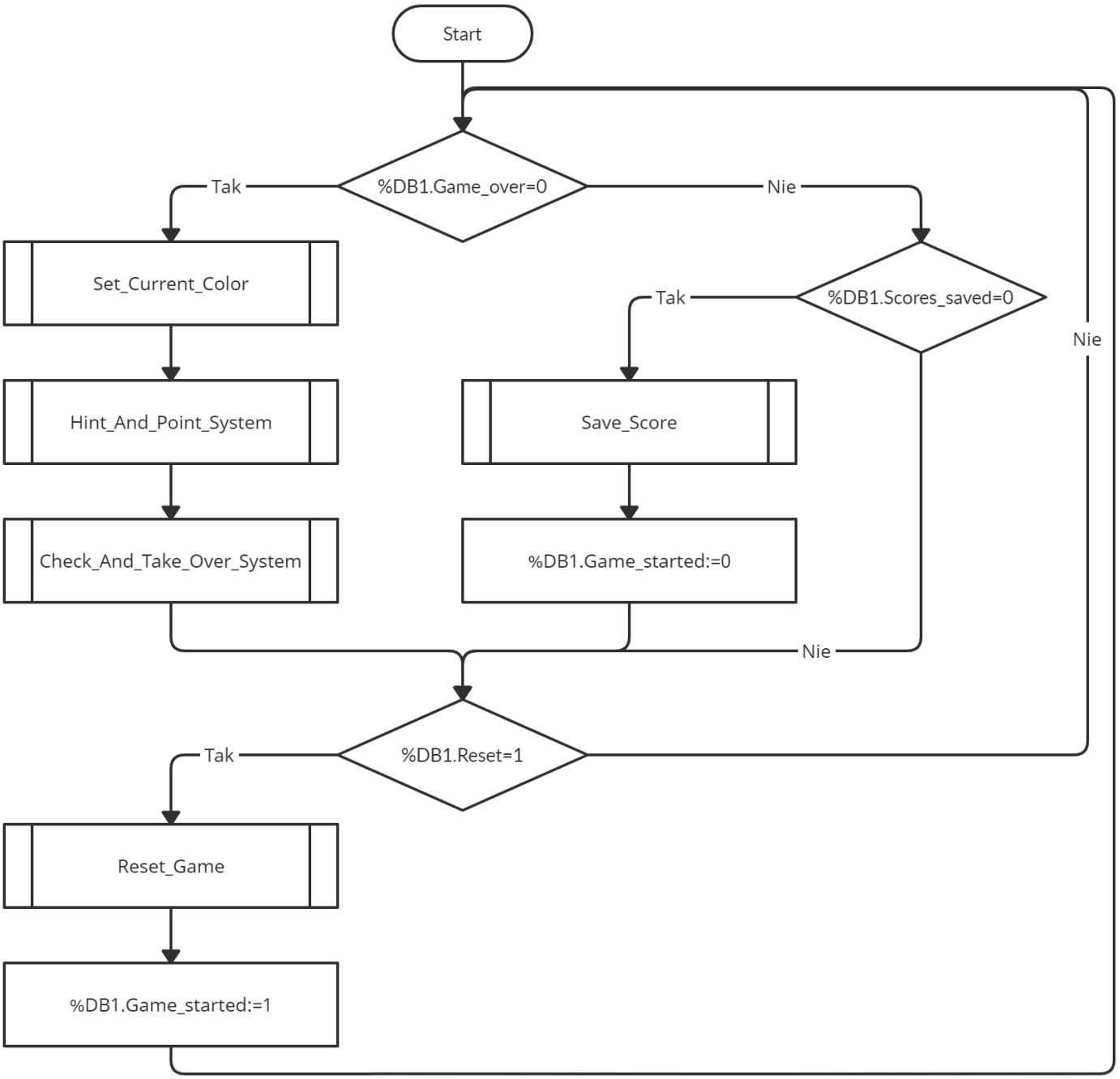
   b. Szymon Feliński:
   - Opracowanie i implementacja algorytmu szukania prawidłowego ruchu (obliczanie możliwych indeksów w ośmiu kierunkach)
   - Implementacja algorytmu przejmowania pól po wykonaniu ruchu
   - Opracowanie i implementacja algorytmu zapisywania wyników do tabeli
   - Opracowanie algorytmu resetowania gry, wykrywania zwycięstwa, zmiany gracza w przypadku braku możliwych ruchów i końca gry
   - Implementacja systemu zliczania punktów
3. Opis istniejących rozwiązań
   W grę “Reversi” możemy zagrać na wielu różnych urządzeniach. Możemy ją znaleźć m.in. na Sklepie Play[1] i pobrać wersję na Androida. W Microsoft Store znajduje się wersja na Windowsa. Istnieje też dużo wersji przeglądarkowych (np. na stronie topster.pl[2] albo kurnik.pl[3]).

4. Algorytm (schematy blokowe)
   Przyjęto konwencję nazw:

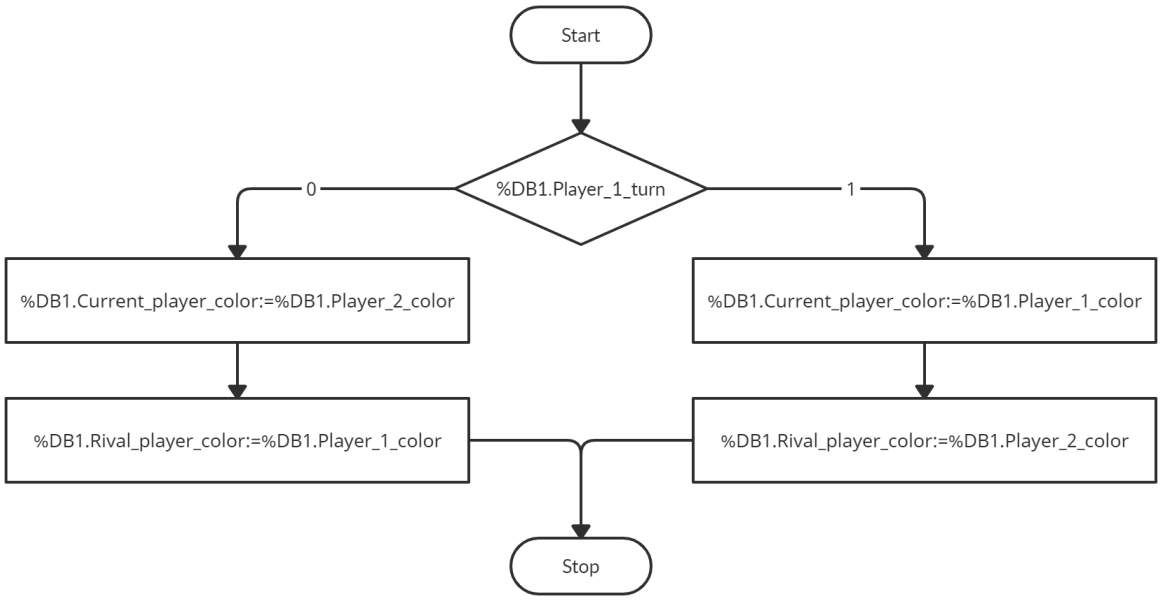
- Zmienne lokalne i wejścia/wyjścia rozpoczynają się od #
- Tylko pierwsze słowo w nazwie zmiennej jest kapitalizowane
- Zmienne zapisane w Data Bloku rozpoczynają się od %DB1.
- Każde słowo w nazwie bloków funkcyjnych jest kapitalizowane
- Nazwy bloków funkcyjnych w opisach są uzupełnione odpowiadającymi im adresami w sterowniku (FB1..14)
- Zapis #Nazwa(1:3) oznacza zmienne lokalne w kolejności: #Nazwa1, #Nazwa2, #Nazwa3
- Zapis #Nazwa(#i-2) gdy #i=5 oznacza zmienną lokalną #Nazwa3

[1] https://play.google.com/store/apps/details?id=uk.co.aifactory.rrfree&hl=pl&gl=US
[2] https://www.topster.pl/reversi/
[3] https://www.kurnik.pl/reversi/

- Main (OB1):

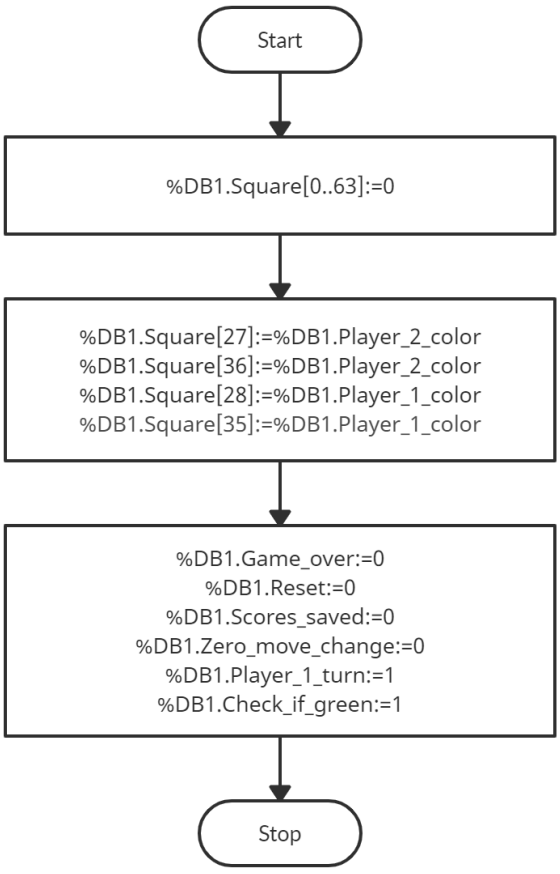

Start
%DB1.Game_over=0
Tak
Nie
Set_Current_Color
Hint_And_Point_System
Check_And_Take_Over_System
%DB1.Scores_saved=0
Tak
Nie
Save_Score
%DB1.Game_started:=0
Nie
%DB1.Reset=1
Tak
Reset_Game
%DB1.Game_started:=1
Nie

- Set_Current_Color (FB8):



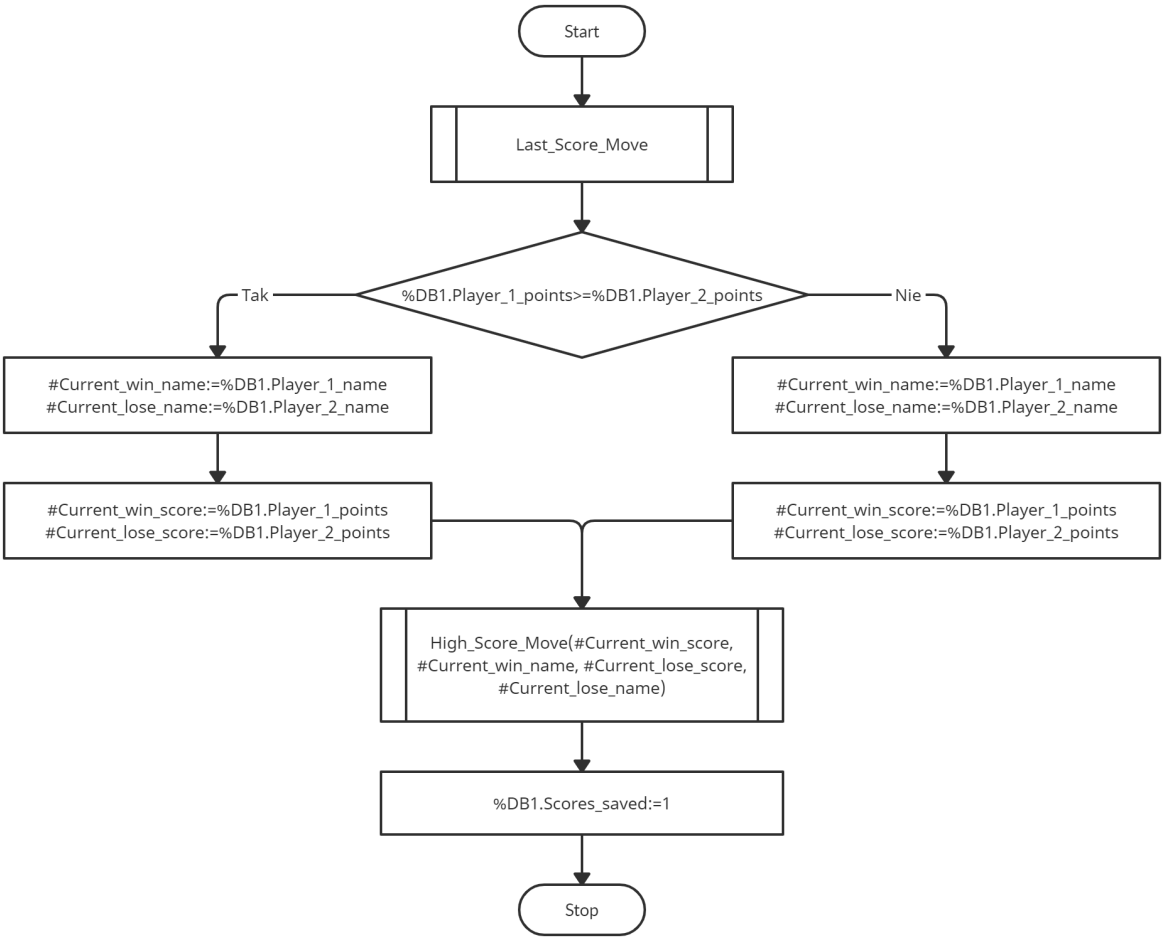
Ten blok funkcyjny ustala odpowiednie kolory obecnego gracza i przeciwnika na podstawie zmiennej Player_1_turn.

- Reset_Game (FB13):



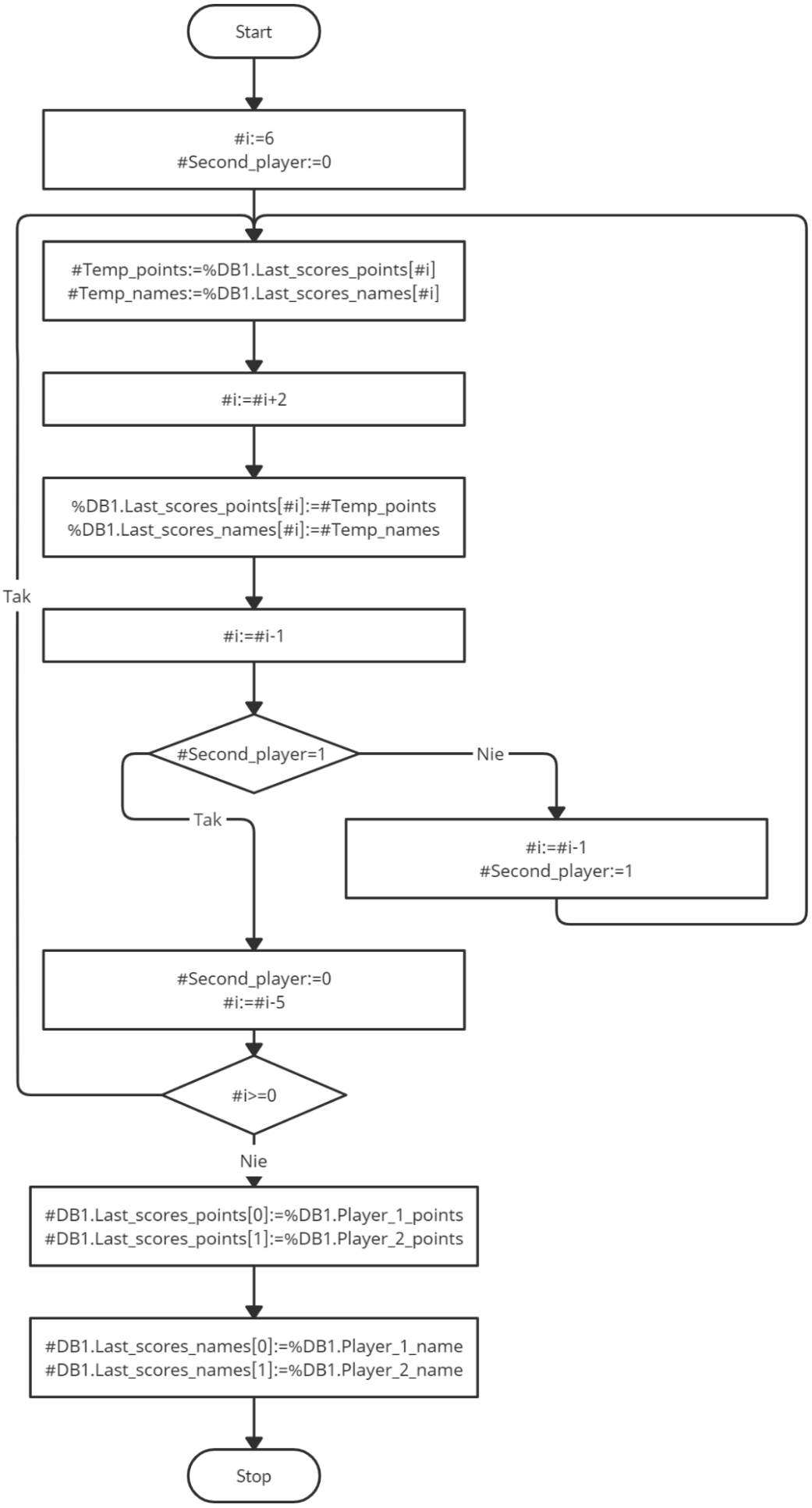
Ten blok funkcyjny zeruje tablicę z planszą, wpisuje kolory graczy (początkowe piony) i ustala zmienne logiczne tak, aby rozpocząć od nowa grę.

- Save_Score (FB11):



Warto zauważyć, że w przypadku remisu gracz 1. będzie uznany za zwycięzcę.

- Last_Score_Move (FB12):



Blok funkcyjny Last_Score_Move (FB12) zapisuje wyniki ostatniej gry na początek tablic Last_scores_points oraz Last_scores_names bez względu na to, kto wygrał mecz, jednocześnie przesuwając poprzednie cztery gry o jedno miejsce w dół w tabeli (ostatni jest odrzucany).

Gra	Player 1	Player 2
1	0	1
2	2	3
3	4	5
4	6	7
5	8	9

Przed:

Gra	Player 1	Player 2
1	5	7
2	32	32
3	60	4
4	15	40
5	33	31

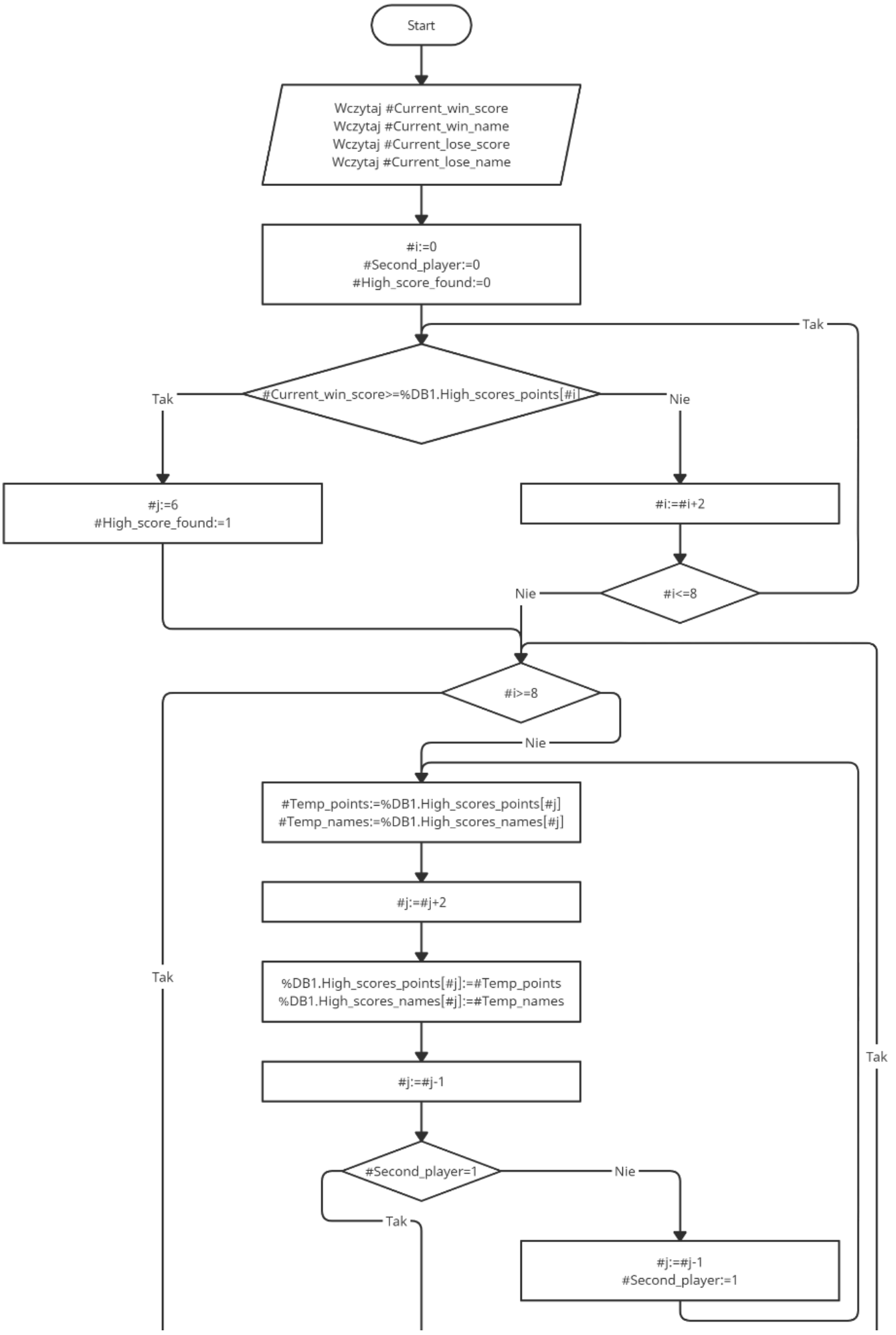
Po: Obecna gra: 16-30

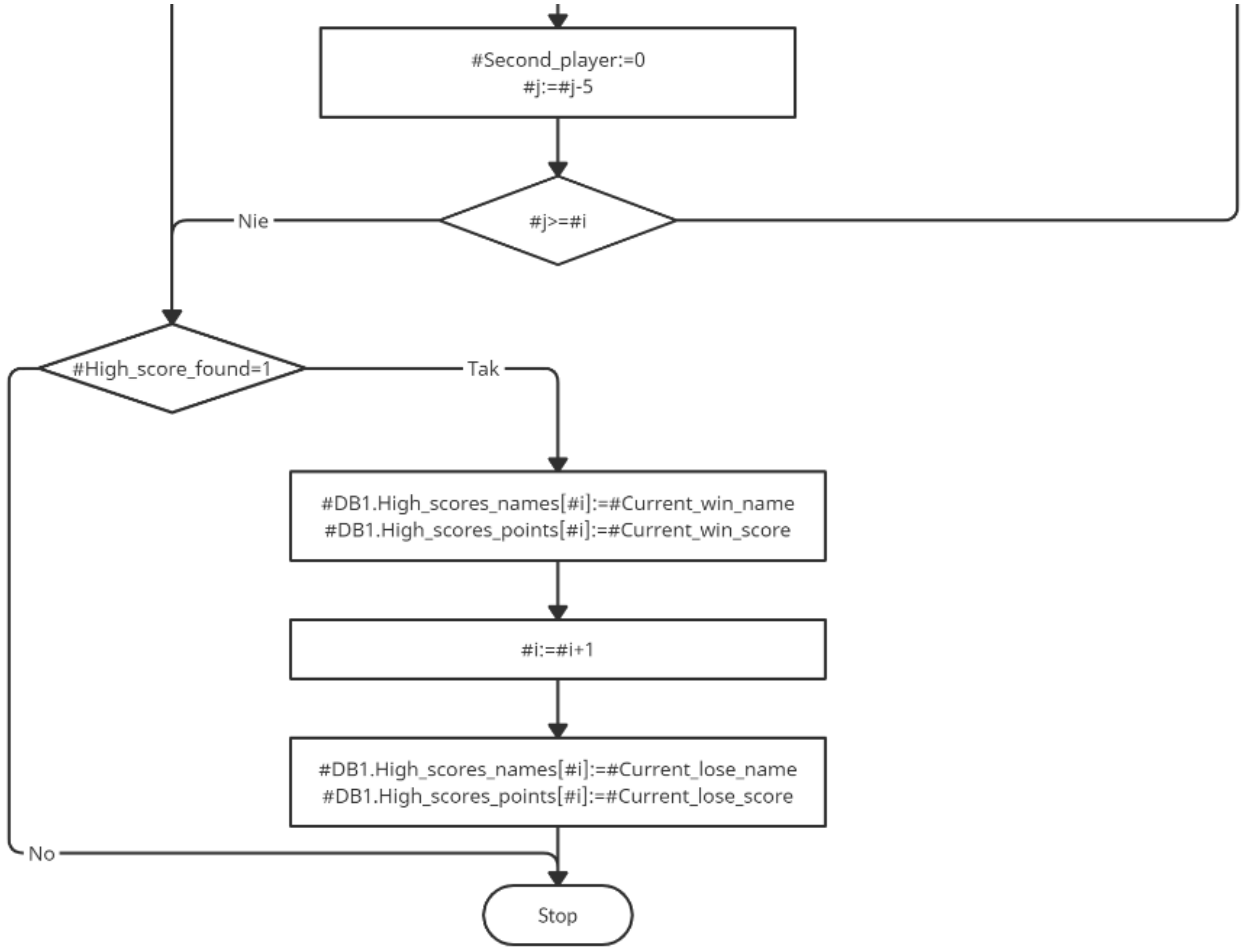
Gra	Player 1	Player 2
1	16	30
2	5	7
3	32	32
4	60	4
5	15	40

W komórkach tabeli zapisano indeksy tablic.

Na grafice pokazano przykładowy efekt działania algorytmu. Indeksy tablic z punktami i nazwami są tożsame.

- High_Score_Move (FB14):





Przykładowy efekt działania algorytmu został przedstawiony na grafice:

Gra	Player 1	Player 2
1	0	1
2	2	3
3	4	5
4	6	7
5	8	9

Przed:

Gra	Player 1	Player 2
1	60	4
2	40	15
3	33	31
4	32	32
5	7	5

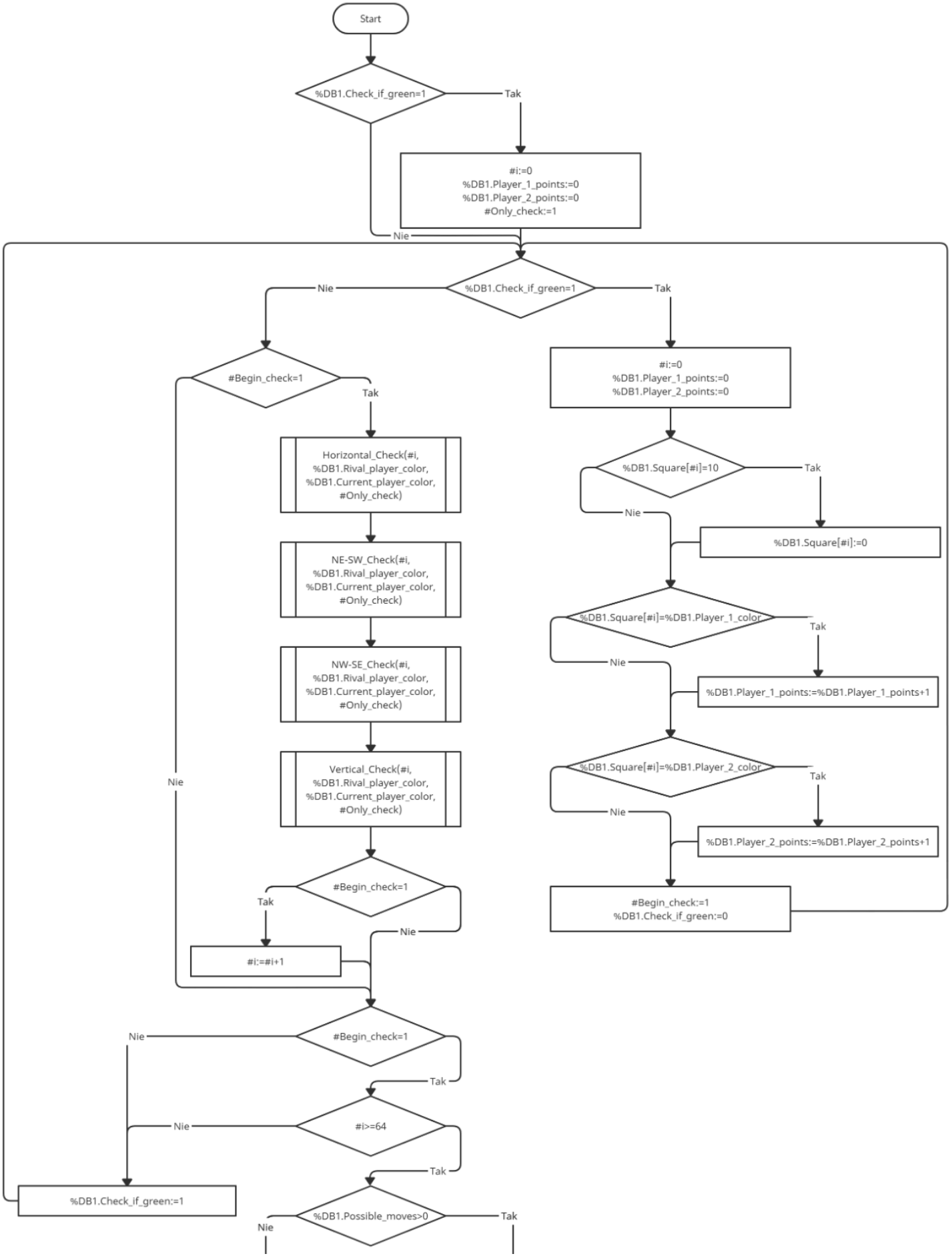
Po: Obecna gra: 16-36

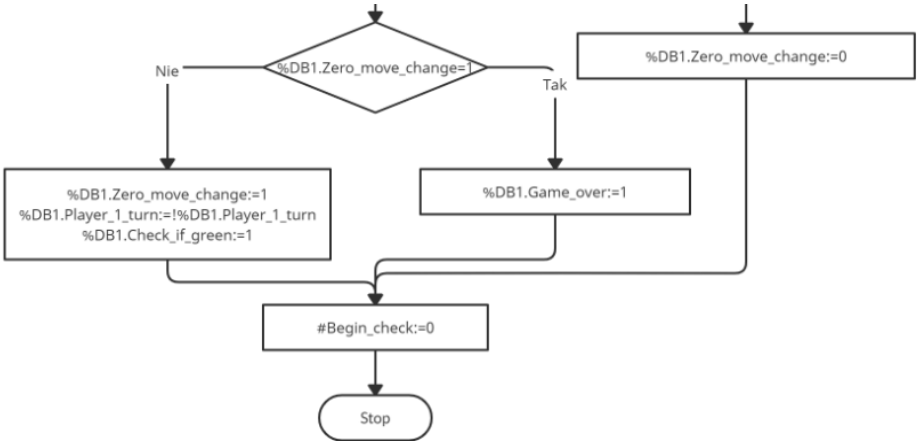
Gra	Player 1	Player 2
1	60	4
2	40	15
3	36	16
4	33	31
5	32	32

W komórkach tabeli zapisano indeksy tablic.

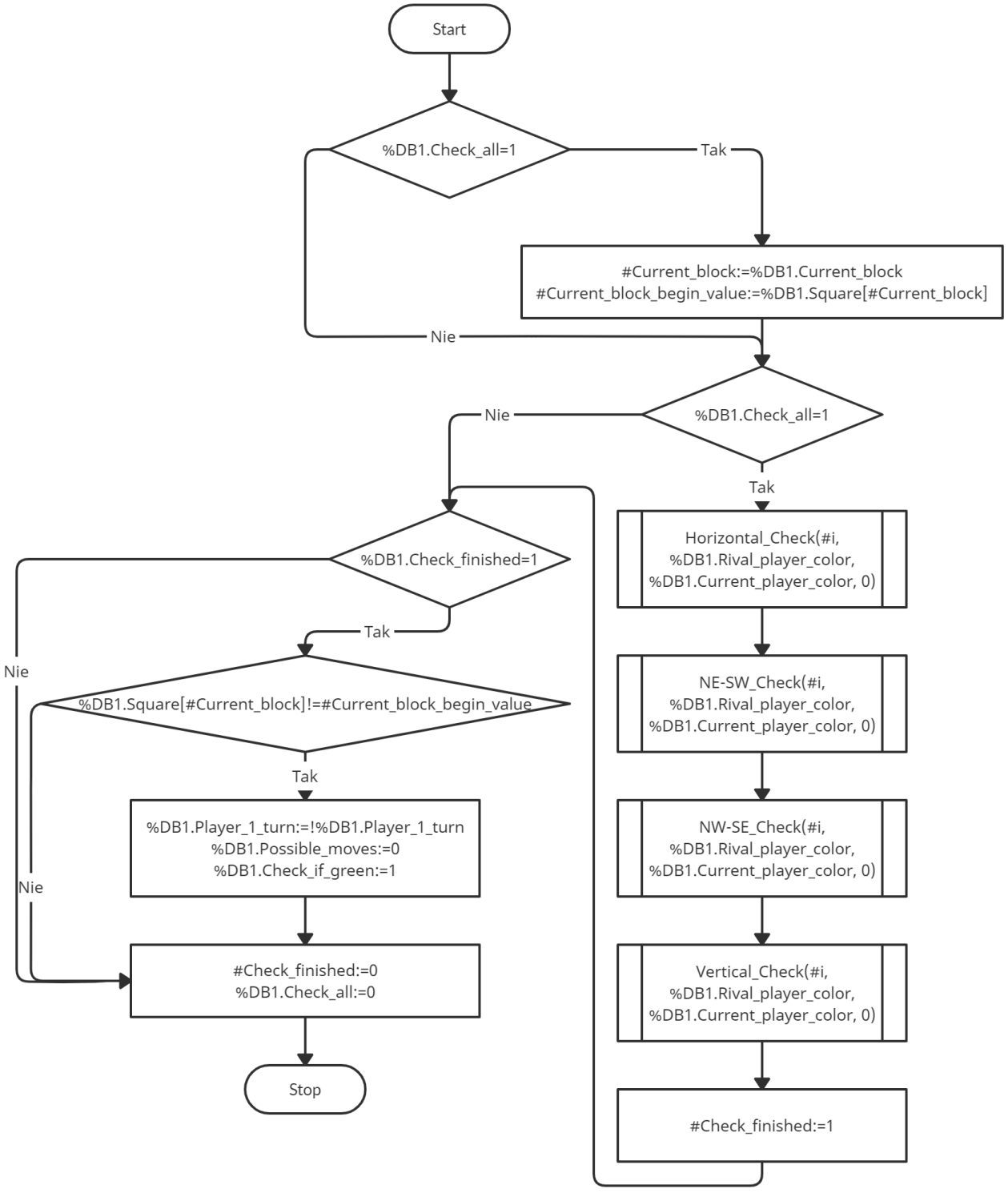
Blok funkcyjny High_Score_Move (FB13) zapisuje wyniki ostatniej gry do odpowiedniego miejsca w sortowanej po wartości w indeksach parzystych, mając na wzgląd to, kto wygrał mecz. Jeśli ilość punktów z ostatniej gry jest wyższa niż którykolwiek wynik z pierwszej kolumny, to wynik ten jest wstawiany pod ostatni wynik wyższy od obecnego, jednocześnie przesuwając wyniki niższe o jedno miejsce w dół (ostatni jest odrzucany).

- Hint_And_Point_System (FB9):

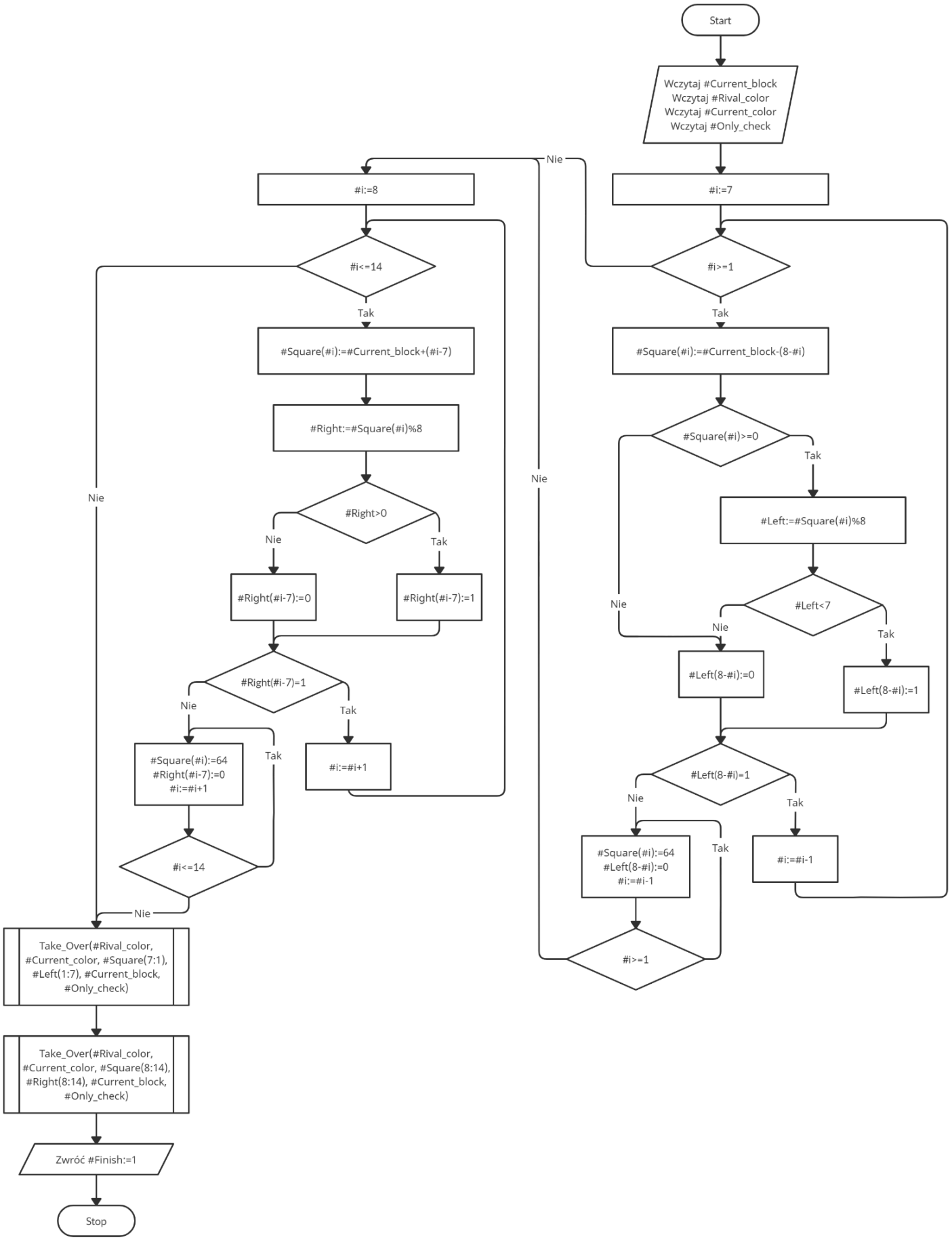




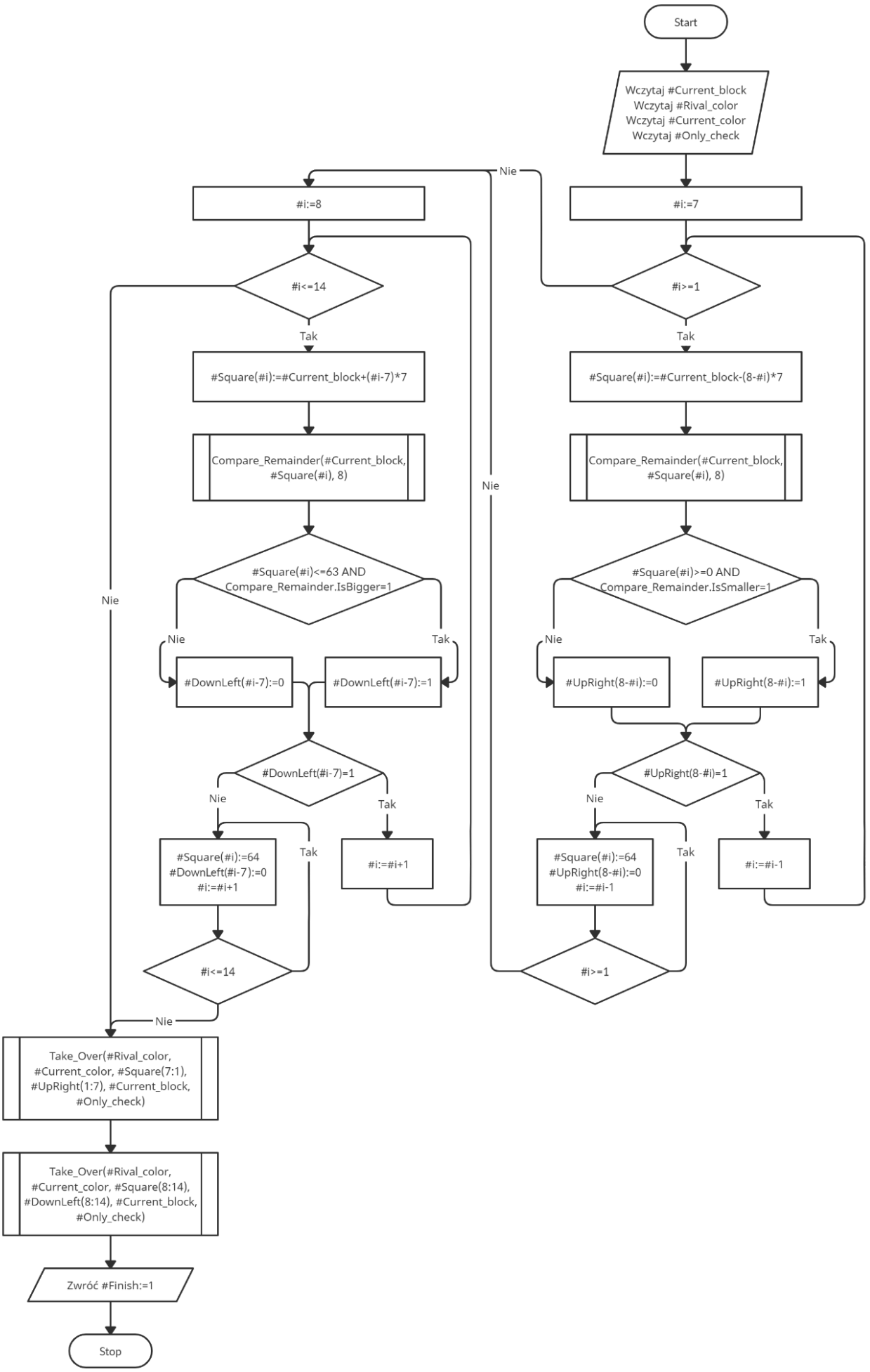
- Check_And_Take_Over_System (FB10):



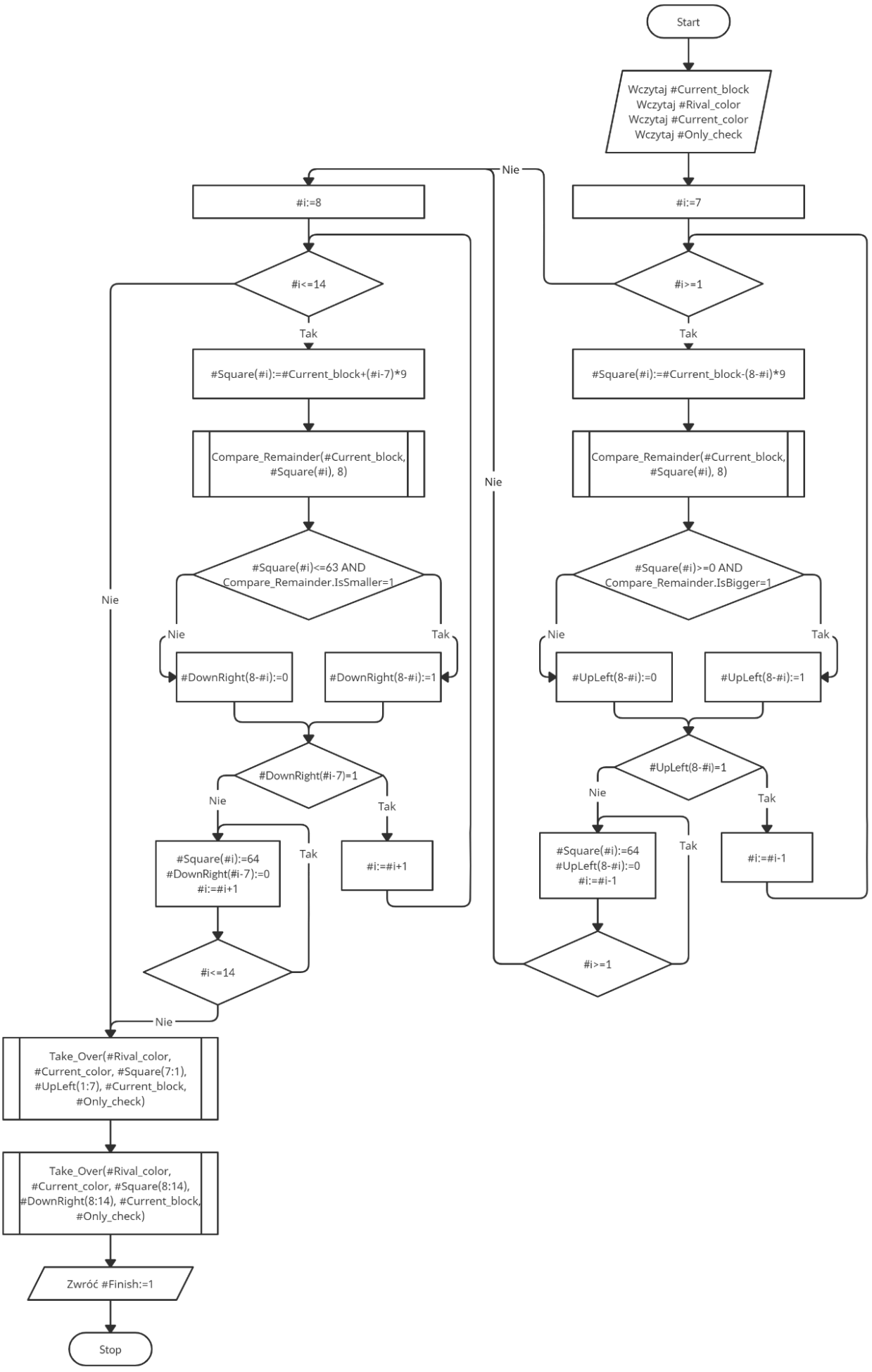
- Horizontal_Check (FB3):



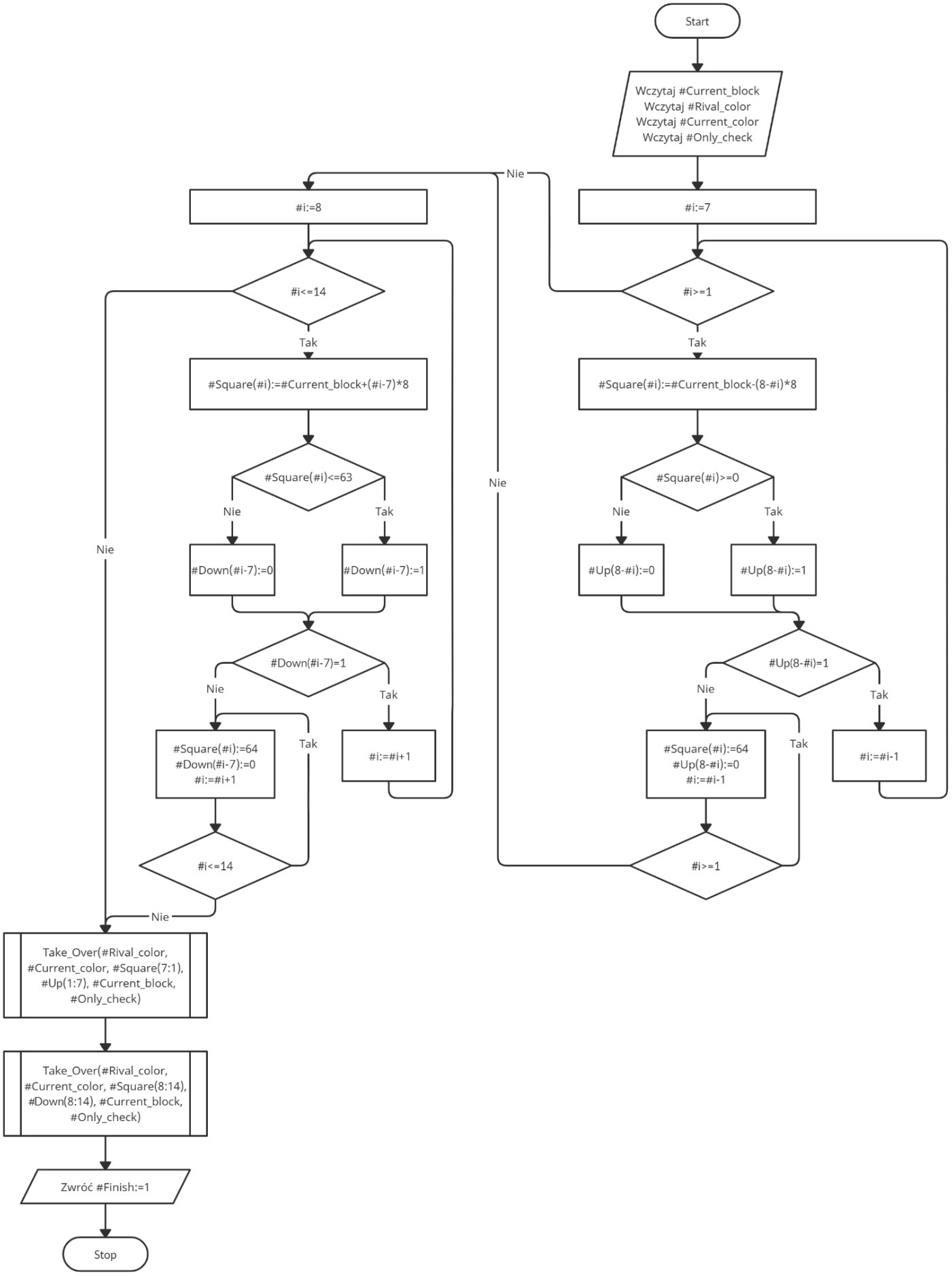
- NE-SW_Check (FB5):



- NW-SE_Check (FB4):



- Vertical_Check (FB1):



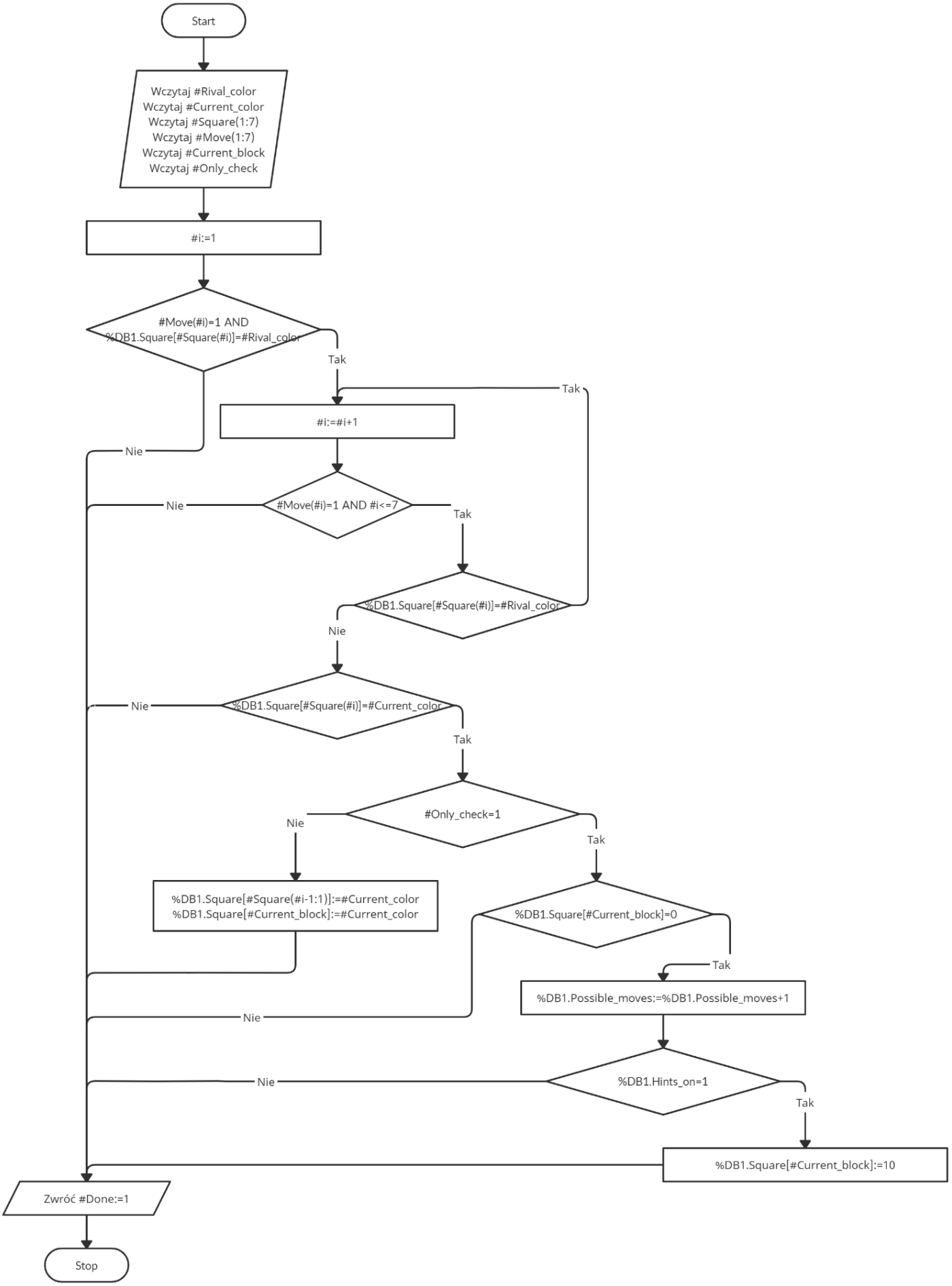
Graficzne przedstawienie tablicy Square[] i możliwych wyliczeń indeksów w blokach _Check:

Square[0..63]

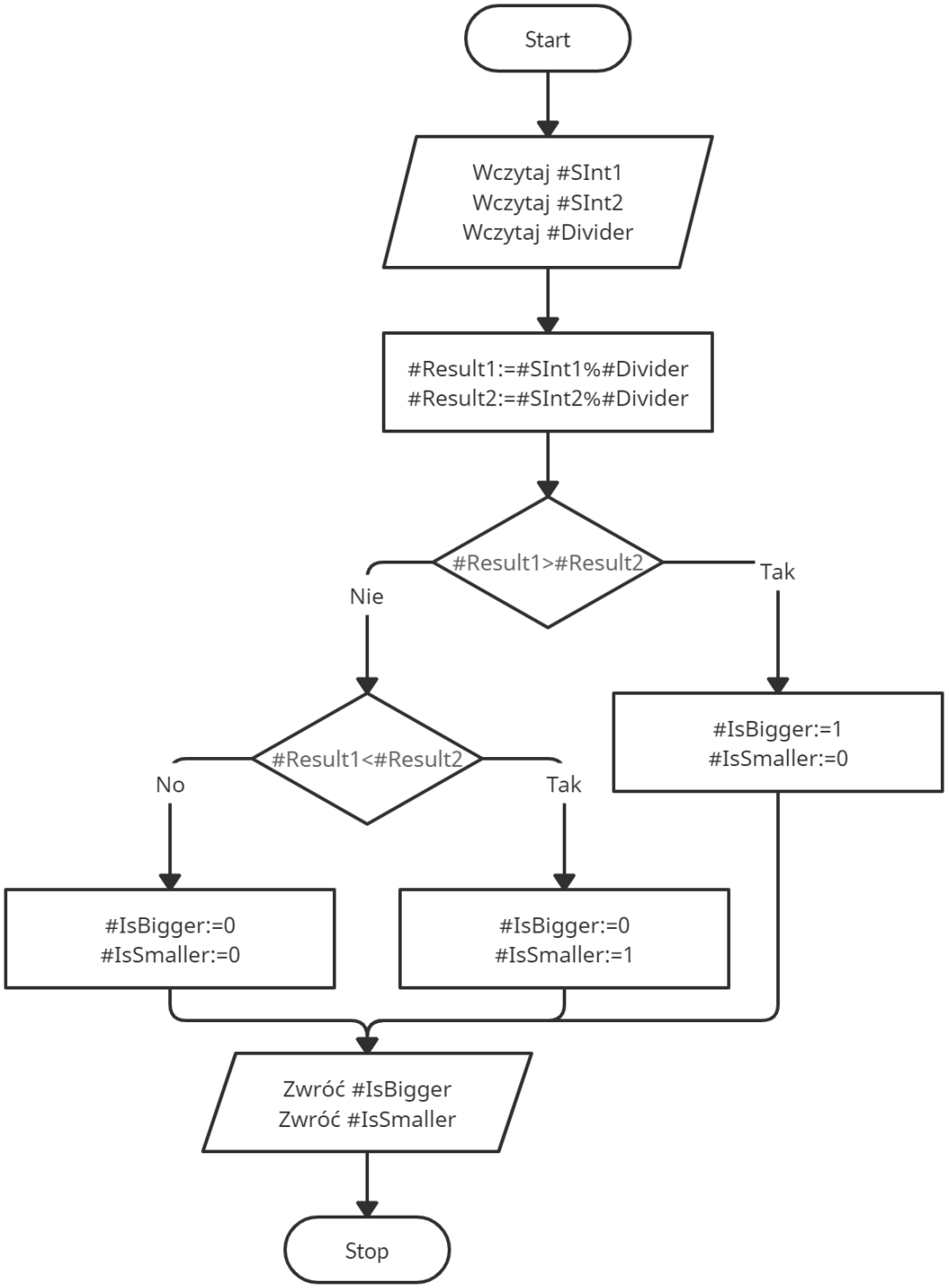
0	1	2	3	4	5	6	7
8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31
32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55
56	57	58	59	60	61	62	63

-63							-56							-49
	-54						-48						-42	
		-45					-40					-35		
			-36				-32				-28			
				-27			-24			-21				
					-18		-16		-14					
						-9	-8	-7						
-7	-6	-5	-4	-3	-2	-1	i	1	2	3	4	5	6	7
						7	8	9						
					14		16		18					
				21			24			27				
			28				32				36			
		35					40					45		
	42						48						54	
49							56							63

- Take_Over (FB2):



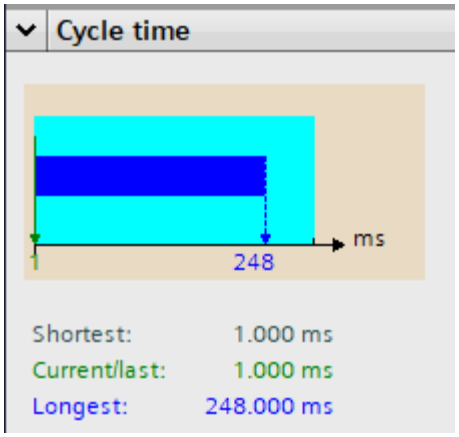
- Compare_Remainder (FB7):

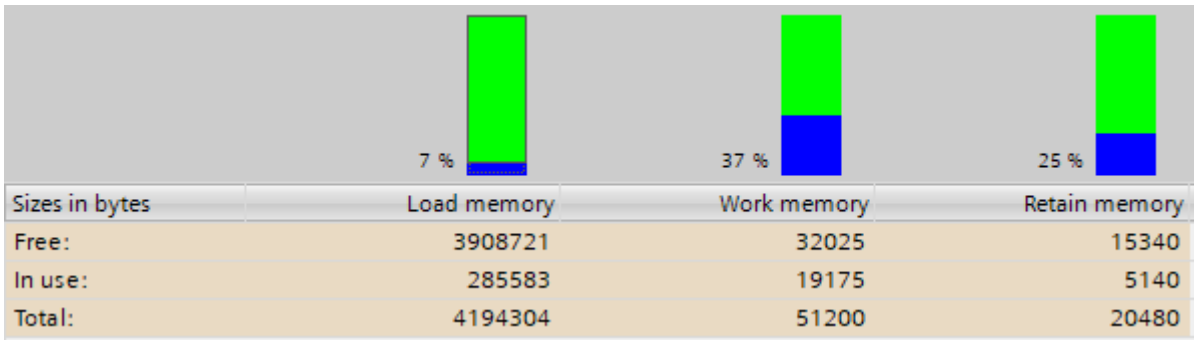


Do zaprogramowania urządzeń, implementacji algorytmów i symulacji wykorzystano oprogramowanie TIA Portal V16, WinCC Advanced V16, PLCSIM V16.

Name	Version	Release
Automation License Manager	V6.0 + SP5 + Upd1	06.00.05.01_02.01.00.05
S7-PCT	V3.5 + SP1	K3.5.1.0_1.19.0.1
S7-PLCSIM	V5.4 + SP8	V05.04.08.01_01.24.00.01
SIMATIC ProSave	V16.0	V16.00.00.00_31.02.00.01
SIMATIC S7-PLCSIM	V16.0	V16.00.00.00_31.00.13.01
SIMATIC STEP 7 Prof - STEP 7 Safety - WinCC Adv	V16.0	V16.00.00.00_31.02.00.01
SIMATIC WinCC Runtime Advanced Simulation	V16.0	V16.00.00.00_31.02.00.01
TIA Administrator	V1.0	01.00.02.00_01.10.00.01
TIA Portal Project Server	V16.0	V16.00.00.00_31.02.00.01
User Management Component	V2.7	V02.07.00.00_00.00.00.00

5. Spis pamięci sterownika





Sizes in bytes	Load memory	Work memory	Retain memory
Free:	3908721	32025	15340
In use:	285583	19175	5140
Total:	4194304	51200	20480

6. Wnioski

- Projektowanie HMI w programie TIA Portal jest bardzo intuicyjne, połączenie zmiennych używanych w sterowniku z tymi używanymi w panelu jest łatwe.
- Robienie prostych animacji w panelu operatorskim nie wymaga dużej wiedzy, ponieważ program ma do tego wbudowane funkcje.
- Przez cały cykl tworzenia programu zwracaliśmy uwagę na czas pojedynczego cyklu. Program był na bieżąco optymalizowany, aby nie wymagał dużej ilości obliczeń (które mogły mieć miejsce ze względu na dużą ilość pętli “for”). Najdłuższy cykl występuje przy uruchamianiu samego sterownika, potem długość cyklu nie przekracza 4ms.
- Gra została rozbudowana o wybór koloru na początku, w oryginalnej wersji występują jedynie piony czarne i białe.
- Tworząc program tego typu należy uważać na tworzenie tablic danych, próba odwołania się do elementu tablicy, który nie istnieje spowoduje błąd w PLC (miganie czerwonej diody ERROR).
- Wielojęzyczność jest wbudowana w program TIA Portal, więc tworzenie programu w kilku językach jest łatwe.
- Dzielenie programu na podprogramy i umieszczanie ich w osobnych blokach (szczególnie fragmentów programu używanych wielokrotnie) pomaga w organizacji pracy i w debugowaniu.

7. Listing programu i spis tagów:

Program blocks

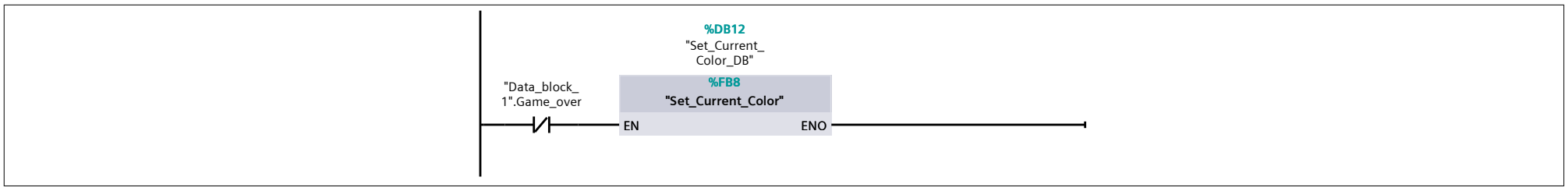
Main [OB1]

Main Properties							
General							
Name	Main	**Number**	1	**Type**	OB	**Language**	LAD
Numbering	Automatic						
Information							
Title	"Main Program Sweep (Cycle)"	**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Comment
▼ Input			
Initial_Call	Bool		Initial call of this OB
Remanence	Bool		=True, if remanent data are available
Temp			
Constant			

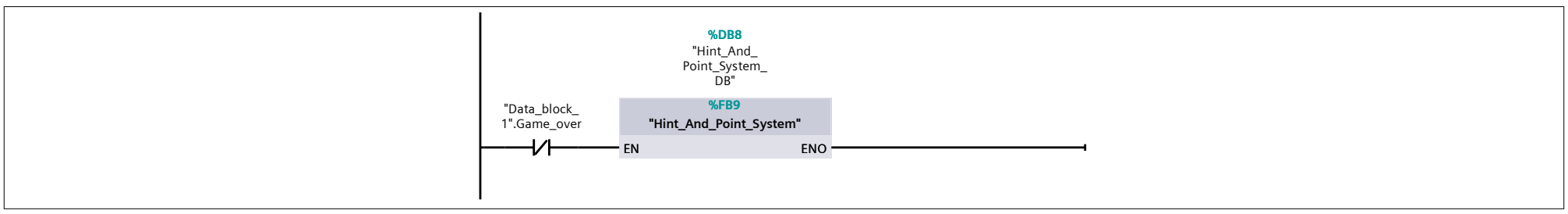
Network 1:

Sets current player colors (important when current player changes)



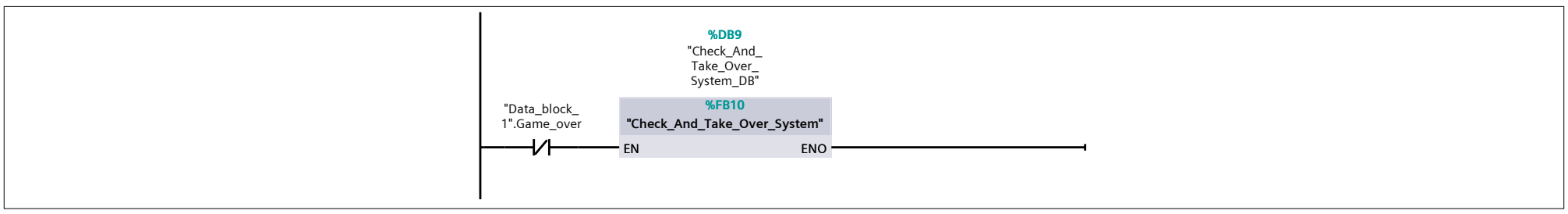
Network 2:

Calculates points and possible moves, sets hints



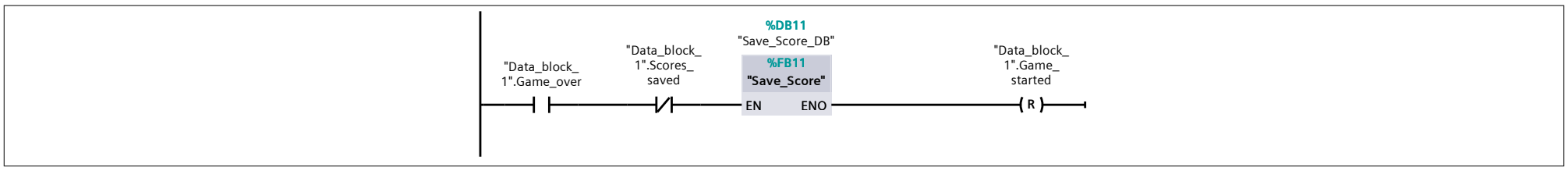
Network 3:

System for taking over squares after a move has happened



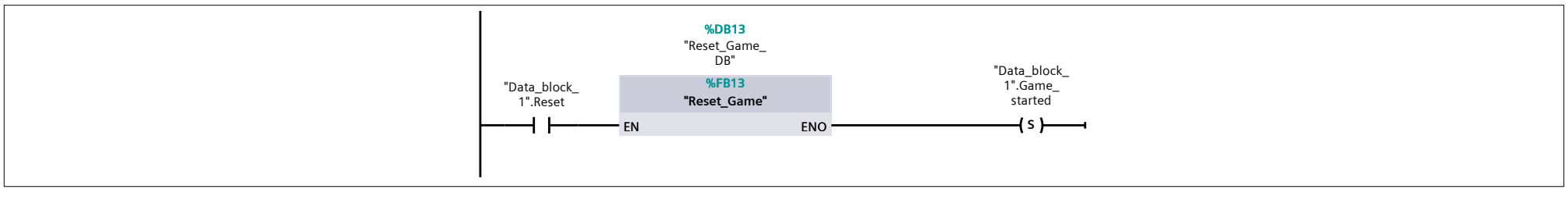
Network 4: Default false; tells the PLC that a game is in progress

If game has ended save current scores in respectable arrays. Tell the PLC that a game is not in progress



Network 5: Default false; tells the PLC that a game is in progress

Reset game if the button in HMI is pressed. Tell the PLC that no game is in progress



Program blocks

Data_block_1 [DB1]

Data_block_1 Properties							
General							
Name	Data_block_1	**Number**	1	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
▼ Static									
▼ Last_scores_names	Array[0..9] of String		True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[0]	String	''	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[1]	String	''	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[2]	String	''	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[3]	String	''	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[4]	String	''	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[5]	String	''	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[6]	String	''	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[7]	String	''	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[8]	String	''	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[9]	String	''	True	True	True	True	False		Array of up to 5 last game player names
▼ Last_scores_points	Array[0..9] of SInt		True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[0]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[1]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[2]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[3]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[4]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[5]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[6]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[7]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[8]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[9]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
▼ High_scores_names	Array[0..9] of String		True	True	True	True	False		Array of up to 5 highest scores player names
High_scores_names[0]	String	''	True	True	True	True	False		Array of up to 5 highest scores player names
High_scores_names[1]	String	''	True	True	True	True	False		Array of up to 5 highest scores player names
High_scores_names[2]	String	''	True	True	True	True	False		Array of up to 5 highest scores player names
High_scores_names[3]	String	''	True	True	True	True	False		Array of up to 5 highest scores player names
High_scores_names[4]	String	''	True	True	True	True	False		Array of up to 5 highest scores player names
High_scores_names[5]	String	''	True	True	True	True	False		Array of up to 5 highest scores player names
High_scores_names[6]	String	''	True	True	True	True	False		Array of up to 5 highest scores player names
High_scores_names[7]	String	''	True	True	True	True	False		Array of up to 5 highest scores player names
High_scores_names[8]	String	''	True	True	True	True	False		Array of up to 5 highest scores player names
High_scores_names[9]	String	''	True	True	True	True	False		Array of up to 5 highest scores player names
▼ High_scores_points	Array[0..9] of SInt		True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[0]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[1]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[2]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[3]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[4]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[5]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[6]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[7]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
High_scores_points[8]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[9]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores
Scores_saved	Bool	false	False	True	True	True	False		Default false; Tells the program whether the Save_Score subroutine has been executed
Player_1_turn	Bool	true	False	True	True	True	False		Default true; tells the program which player's turn it is
Possible_moves	SInt	0	False	True	True	True	False		Default 0; number of possible moves in current turn
Zero_move_change	Bool	false	False	True	True	True	False		Default false; tells the program whether last turn was invalid and current player has been toggled
Reset	Bool	false	False	True	True	True	False		Default false; tells the PLC to reset the board and set default values
Game_over	Bool	false	False	True	True	True	False		Default false; tells the PLC if a game has finished
Game_started	Bool	false	False	True	True	True	False		Default false; tells the PLC that a game is in progress
Player_1_name	String	'Maciej'	False	True	True	True	False		Default "Maciej"; name of Player 1
Player_1_color	SInt	1	False	True	True	True	False		Default 1; color of Player 1
Player_1_points	SInt	0	False	True	True	True	False		Default 0; points of Player 1
Player_2_color	SInt	2	False	True	True	True	False		Default "Szymon"; name of Player 2
Player_2_name	String	'Szymon'	False	True	True	True	False		Default 1; color of Player 2
Player_2_points	SInt	0	False	True	True	True	False		Default 0; points of Player 2
▼ Square	Array[0..64] of SInt		False	True	True	True	False		Array of elements that define the current state of the board
Square[0]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[1]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[2]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[3]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[4]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[5]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[6]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[7]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[8]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[9]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[10]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[11]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[12]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[13]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[14]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[15]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[16]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[17]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[18]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[19]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[20]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[21]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[22]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[23]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[24]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[25]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[26]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[27]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Square[28]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[29]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[30]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[31]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[32]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[33]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[34]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[35]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[36]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[37]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[38]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[39]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[40]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[41]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[42]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[43]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[44]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[45]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[46]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[47]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[48]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[49]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[50]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[51]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[52]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[53]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[54]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[55]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[56]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[57]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[58]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[59]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[60]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[61]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[62]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[63]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[64]	SInt	20	False	True	True	True	False		An arbitrary index to set if no valid move is calculated.
Current_player_color	SInt	0	False	True	True	True	False		Color of currently playing player
Rival_player_color	SInt	0	False	True	True	True	False		Color of currently not playing player
Current_block	SInt	0	False	True	True	True	False		Default 0; index of currently clicked place on the board
Check_all	Bool	false	False	True	True	True	False		Default false; check the board whether current move is valid and take over places if it is
Hints_on	Bool	1	False	True	True	True	False		Default 1; turns on hints in game
Player_2_color_memory	SInt	1	False	True	True	True	False		Default 1; for memorizing player 2 color while in menu

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Player_1_color_memory	SInt	0	False	True	True	True	False		Default 0; for memorizing player 1 color while in menu
Check_if_green	Bool	false	False	True	True	True	False		Default false; check the board for green places (possible moves)

Program blocks

Vertical_Check [FB1]

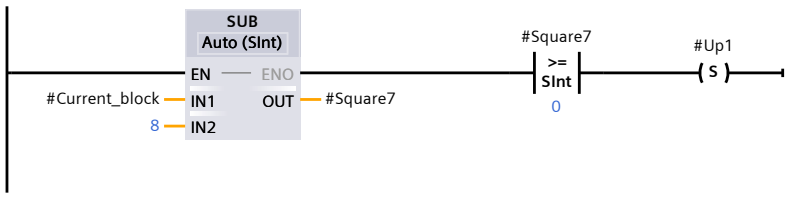
Vertical_Check Properties							
General							
Name	Vertical_Check	**Number**	1	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Current_block	SInt	0	Non-retain	True	True	True	False		
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Finish	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Take_Over_Up	"Take_Over"			True	True	True	True		
Input									
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Square1	SInt	0	Non-retain	True	True	True	False		
Square2	SInt	0	Non-retain	True	True	True	False		
Square3	SInt	0	Non-retain	True	True	True	False		
Square4	SInt	0	Non-retain	True	True	True	False		
Square5	SInt	0	Non-retain	True	True	True	False		
Square6	SInt	0	Non-retain	True	True	True	False		
Square7	SInt	0	Non-retain	True	True	True	False		
Move1	Bool	false	Non-retain	True	True	True	False		
Move2	Bool	false	Non-retain	True	True	True	False		
Move3	Bool	false	Non-retain	True	True	True	False		
Move4	Bool	false	Non-retain	True	True	True	False		
Move5	Bool	false	Non-retain	True	True	True	False		
Move6	Bool	false	Non-retain	True	True	True	False		
Move7	Bool	false	Non-retain	True	True	True	False		
Current_block	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Done	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Take_Over_Down	"Take_Over"			True	True	True	True		
Input									
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Square1	SInt	0	Non-retain	True	True	True	False		
Square2	SInt	0	Non-retain	True	True	True	False		
Square3	SInt	0	Non-retain	True	True	True	False		
Square4	SInt	0	Non-retain	True	True	True	False		
Square5	SInt	0	Non-retain	True	True	True	False		
Square6	SInt	0	Non-retain	True	True	True	False		
Square7	SInt	0	Non-retain	True	True	True	False		
Move1	Bool	false	Non-retain	True	True	True	False		
Move2	Bool	false	Non-retain	True	True	True	False		
Move3	Bool	false	Non-retain	True	True	True	False		
Move4	Bool	false	Non-retain	True	True	True	False		
Move5	Bool	false	Non-retain	True	True	True	False		
Move6	Bool	false	Non-retain	True	True	True	False		
Move7	Bool	false	Non-retain	True	True	True	False		
Current_block	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Done	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Temp									

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Square1	SInt								Up 7
Square2	SInt								Up 6
Square3	SInt								Up 5
Square4	SInt								Up 4
Square5	SInt								Up 3
Square6	SInt								Up 2
Square7	SInt								Up 1
Square8	SInt								Down 1
Square9	SInt								Down 2
Square10	SInt								Down 3
Square11	SInt								Down 4
Square12	SInt								Down 5
Square13	SInt								Down 6
Square14	SInt								Down 7
Up1	Bool								
Up2	Bool								
Up3	Bool								
Up4	Bool								
Up5	Bool								
Up6	Bool								
Up7	Bool								
Down1	Bool								
Down2	Bool								
Down3	Bool								
Down4	Bool								
Down5	Bool								
Down6	Bool								
Down7	Bool								
Constant									

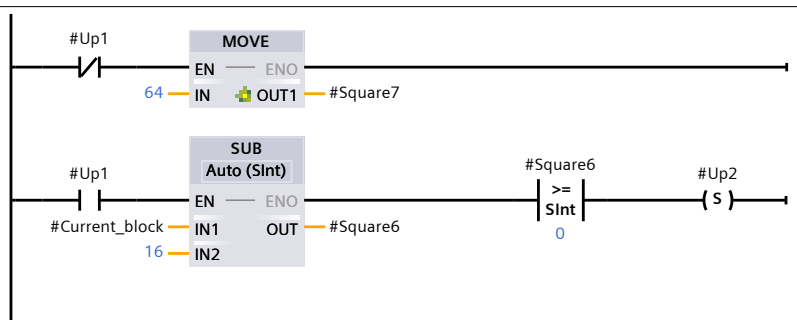
Network 1:

Calculate possible index in the up direction and set truth value Up1



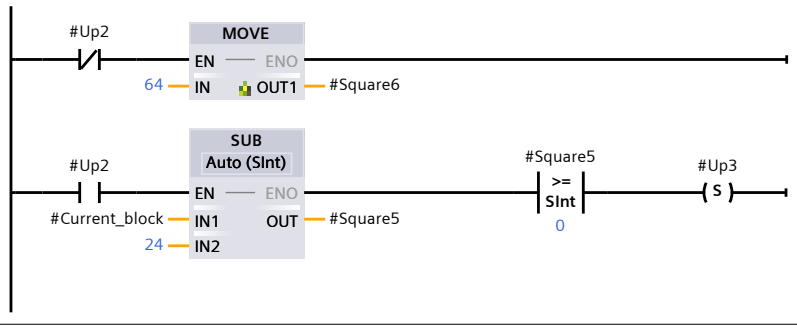
Network 2:

Calculate possible index in the up direction and set truth value Up2



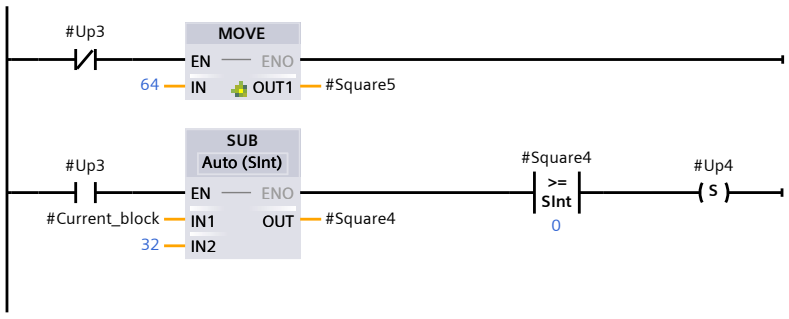
Network 3:

Calculate possible index in the up direction and set truth value Up3



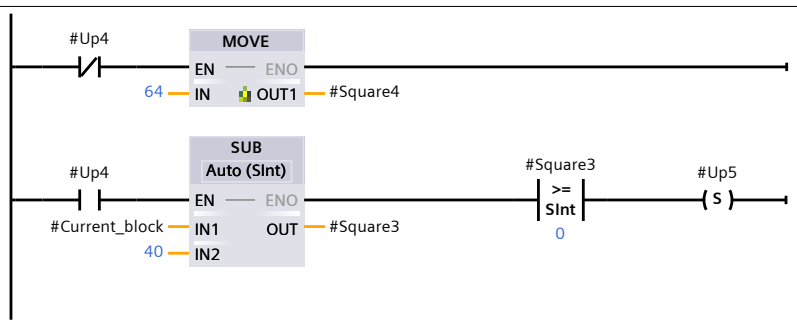
Network 4:

Calculate possible index in the up direction and set truth value Up4



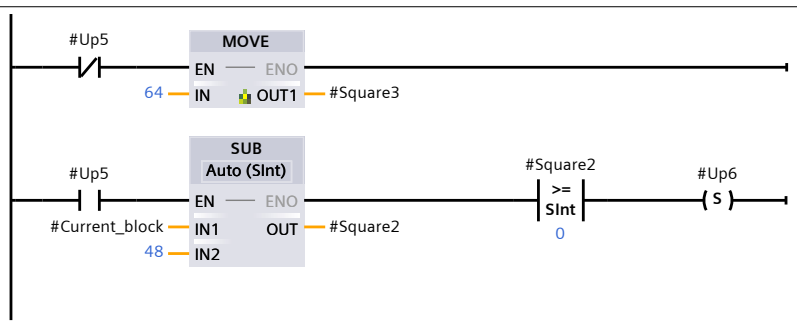
Network 5:

Calculate possible index in the up direction and set truth value Up5



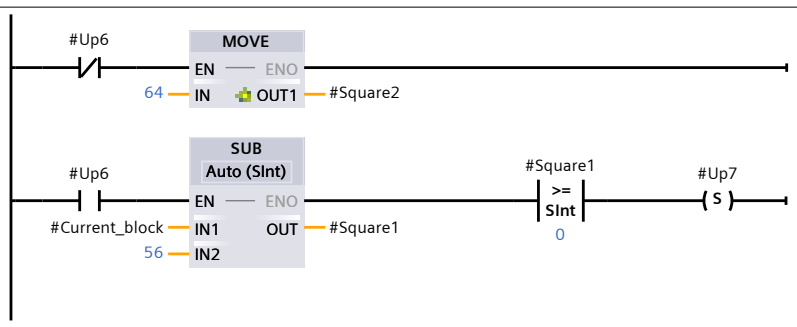
Network 6:

Calculate possible index in the up direction and set truth value Up6



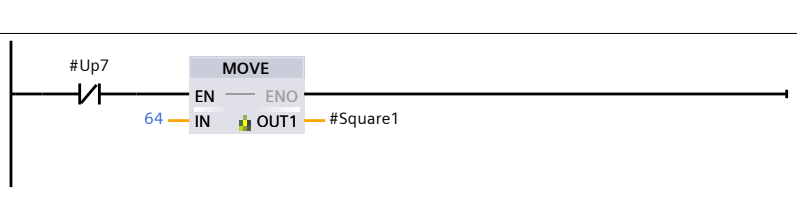
Network 7:

Calculate possible index in the up direction and set truth value Up7



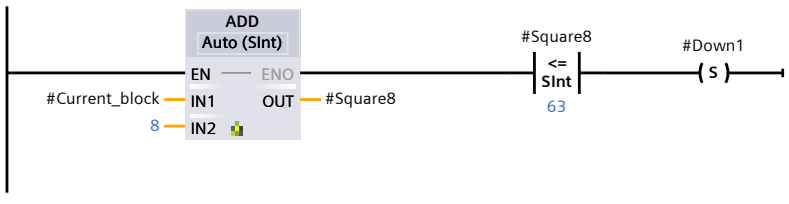
Network 8:

Reset value if no move set



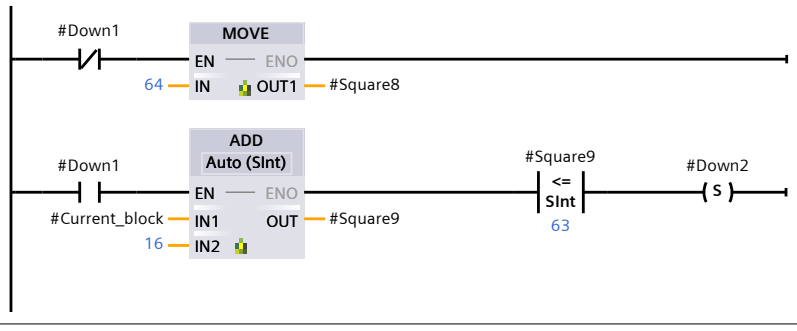
Network 9:

Calculate possible index in the down direction and set truth value Down1



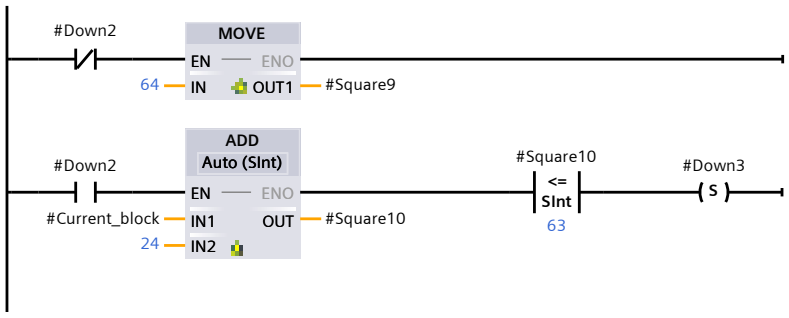
Network 10:

Calculate possible index in the down direction and set truth value Down2



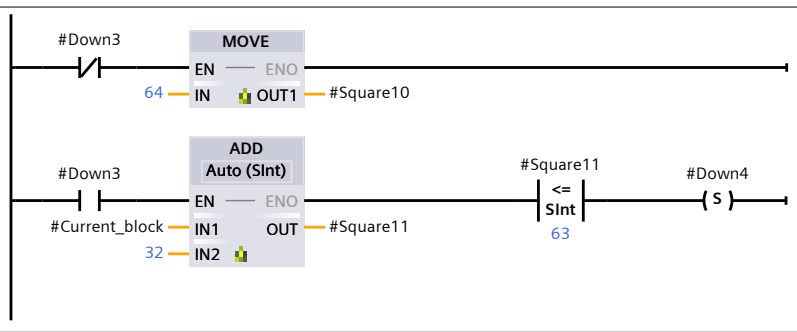
Network 11:

Calculate possible index in the down direction and set truth value Down3



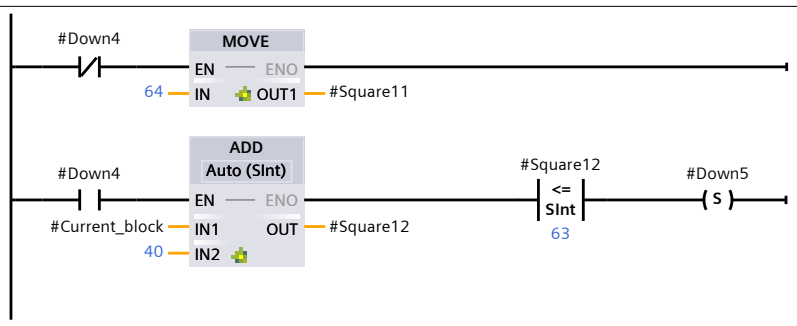
Network 12:

Calculate possible index in the down direction and set truth value Down4



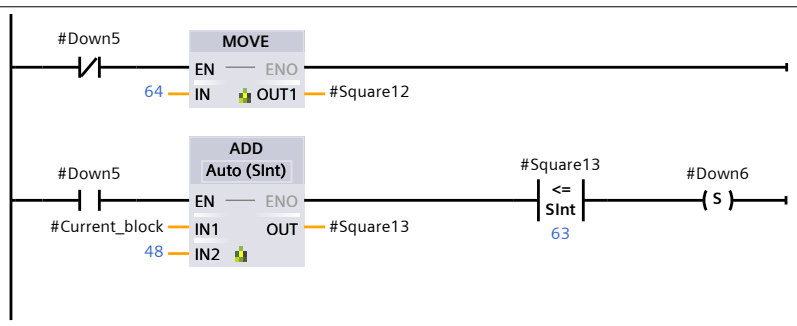
Network 13:

Calculate possible index in the down direction and set truth value Down5



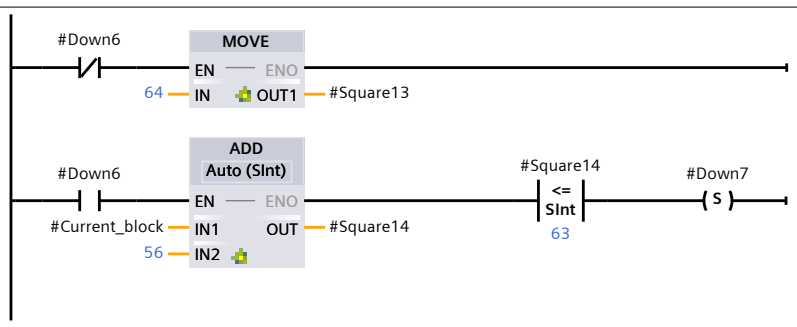
Network 14:

Calculate possible index in the down direction and set truth value Down6



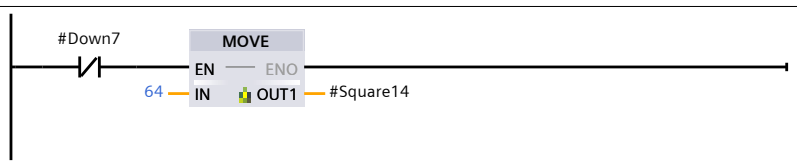
Network 15:

Calculate possible index in the down direction and set truth value Down7



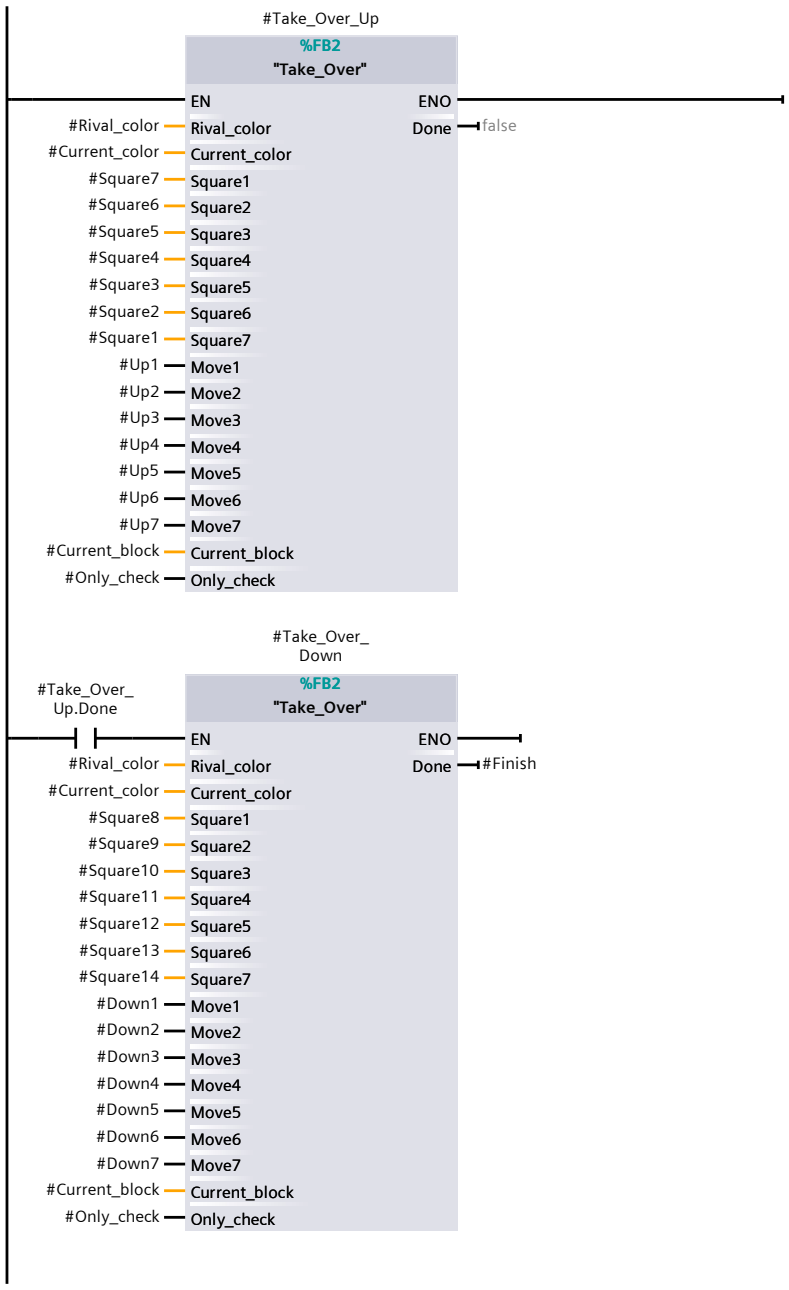
Network 16:

Reset value if no move set



Network 17:

Check squares for conditions of takeover and take over squares if #Only_check is set to 0.


#Take_Over_Up
%FB2
"Take_Over"
EN
ENO
#Rival_color
Rival_color
Done
false
#Current_color
Current_color
#Square7
Square1
#Square6
Square2
#Square5
Square3
#Square4
Square4
#Square3
Square5
#Square2
Square6
#Square1
Square7
#Up1
Move1
#Up2
Move2
#Up3
Move3
#Up4
Move4
#Up5
Move5
#Up6
Move6
#Up7
Move7
#Current_block
Current_block
#Only_check
Only_check
#Take_Over_
Down
#Take_Over_
Up.Done
%FB2
"Take_Over"
EN
ENO
#Rival_color
Rival_color
Done
#Finish
#Current_color
Current_color
#Square8
Square1
#Square9
Square2
#Square10
Square3
#Square11
Square4
#Square12
Square5
#Square13
Square6
#Square14
Square7
#Down1
Move1
#Down2
Move2
#Down3
Move3
#Down4
Move4
#Down5
Move5
#Down6
Move6
#Down7
Move7
#Current_block
Current_block
#Only_check
Only_check

Program blocks

Horizontal_Check [FB3]

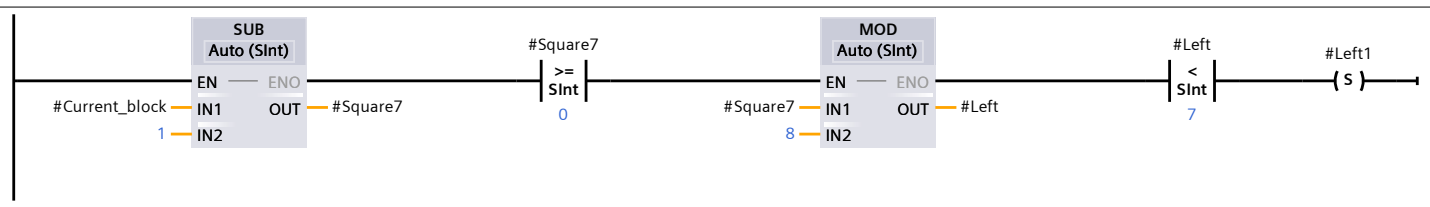
Horizontal_Check Properties							
General							
Name	Horizontal_Check	**Number**	3	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Current_block	SInt	0	Non-retain	True	True	True	False		
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Finish	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Take_Over_Left	"Take_Over"			True	True	True	True		
Input									
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Square1	SInt	0	Non-retain	True	True	True	False		
Square2	SInt	0	Non-retain	True	True	True	False		
Square3	SInt	0	Non-retain	True	True	True	False		
Square4	SInt	0	Non-retain	True	True	True	False		
Square5	SInt	0	Non-retain	True	True	True	False		
Square6	SInt	0	Non-retain	True	True	True	False		
Square7	SInt	0	Non-retain	True	True	True	False		
Move1	Bool	false	Non-retain	True	True	True	False		
Move2	Bool	false	Non-retain	True	True	True	False		
Move3	Bool	false	Non-retain	True	True	True	False		
Move4	Bool	false	Non-retain	True	True	True	False		
Move5	Bool	false	Non-retain	True	True	True	False		
Move6	Bool	false	Non-retain	True	True	True	False		
Move7	Bool	false	Non-retain	True	True	True	False		
Current_block	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Done	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Take_Over_Right	"Take_Over"			True	True	True	True		
Input									
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Square1	SInt	0	Non-retain	True	True	True	False		
Square2	SInt	0	Non-retain	True	True	True	False		
Square3	SInt	0	Non-retain	True	True	True	False		
Square4	SInt	0	Non-retain	True	True	True	False		
Square5	SInt	0	Non-retain	True	True	True	False		
Square6	SInt	0	Non-retain	True	True	True	False		
Square7	SInt	0	Non-retain	True	True	True	False		
Move1	Bool	false	Non-retain	True	True	True	False		
Move2	Bool	false	Non-retain	True	True	True	False		
Move3	Bool	false	Non-retain	True	True	True	False		
Move4	Bool	false	Non-retain	True	True	True	False		
Move5	Bool	false	Non-retain	True	True	True	False		
Move6	Bool	false	Non-retain	True	True	True	False		
Move7	Bool	false	Non-retain	True	True	True	False		
Current_block	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Done	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Temp									

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Square1	SInt								Left 7
Square2	SInt								Left 6
Square3	SInt								Left 5
Square4	SInt								Left 4
Square5	SInt								Left 3
Square6	SInt								Left 2
Square7	SInt								Left 1
Square8	SInt								Right 1
Square9	SInt								Right 2
Square10	SInt								Right 3
Square11	SInt								Right 4
Square12	SInt								Right 5
Square13	SInt								Right 6
Square14	SInt								Right 7
Left	SInt								
Left1	Bool								
Left2	Bool								
Left3	Bool								
Left4	Bool								
Left5	Bool								
Left6	Bool								
Left7	Bool								
Right	SInt								
Right1	Bool								
Right2	Bool								
Right3	Bool								
Right4	Bool								
Right5	Bool								
Right6	Bool								
Right7	Bool								
Constant									

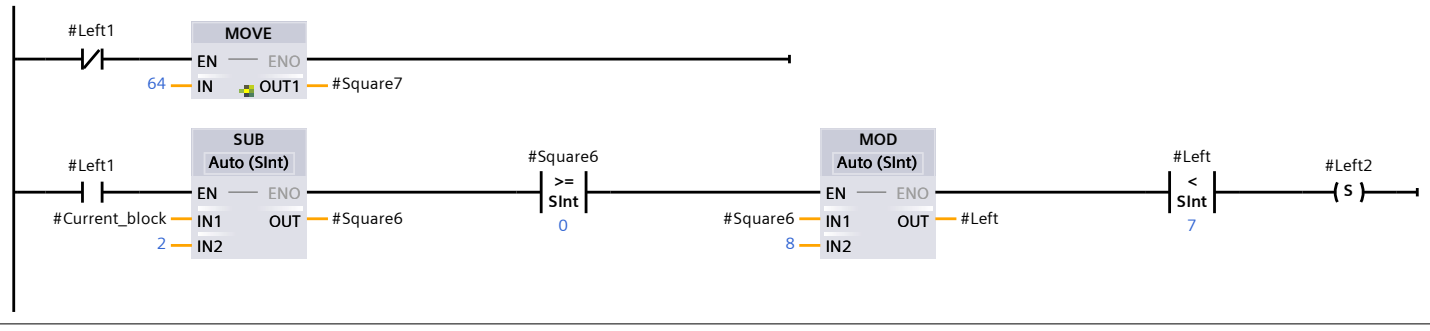
Network 1:

Calculate possible index in the left direction and set truth values Left1



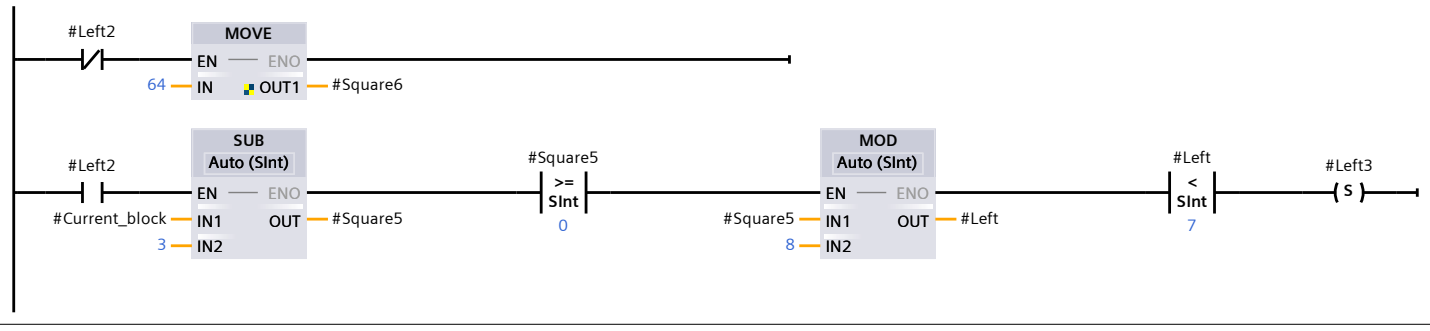
Network 2:

Calculate possible index in the left direction and set truth values Left2



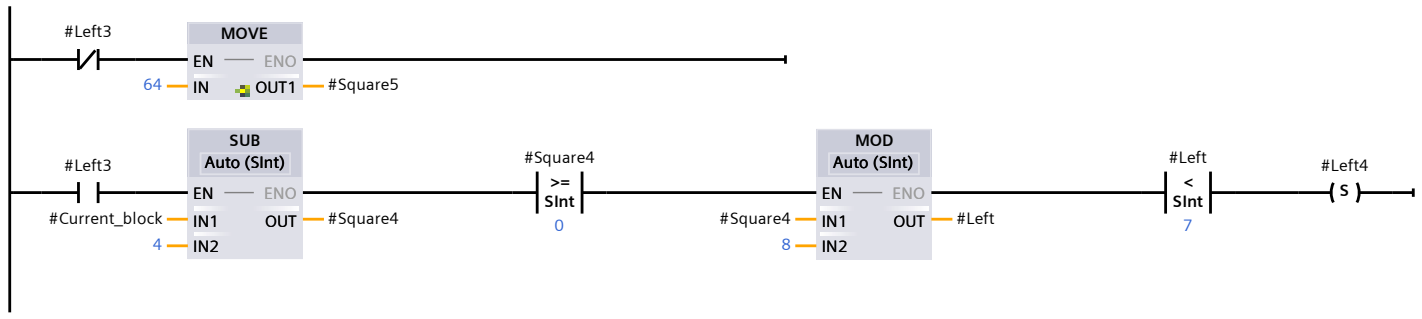
Network 3:

Calculate possible index in the left direction and set truth values Left3



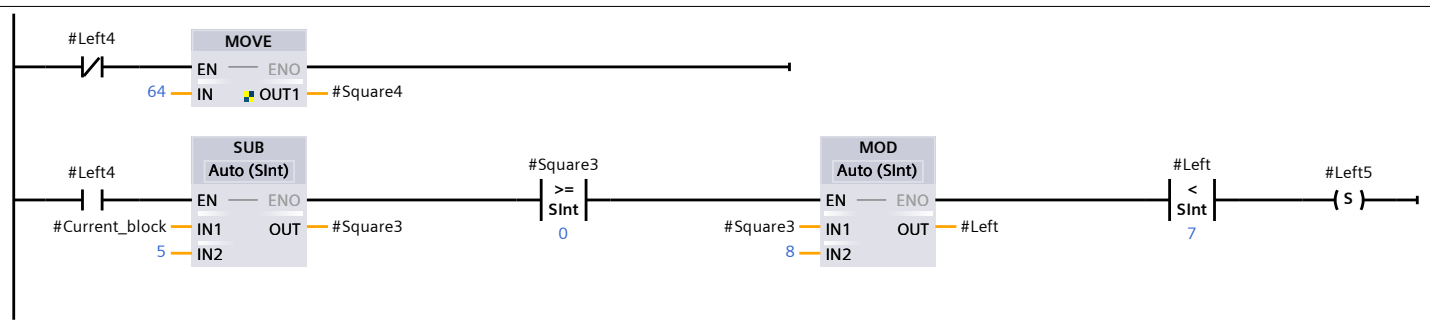
Network 4:

Calculate possible index in the left direction and set truth values Left4



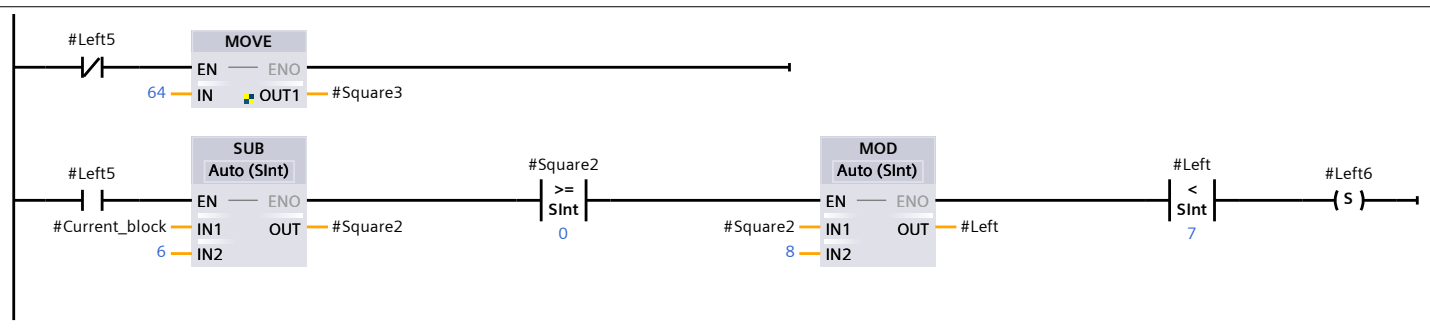
Network 5:

Calculate possible index in the left direction and set truth values Left5



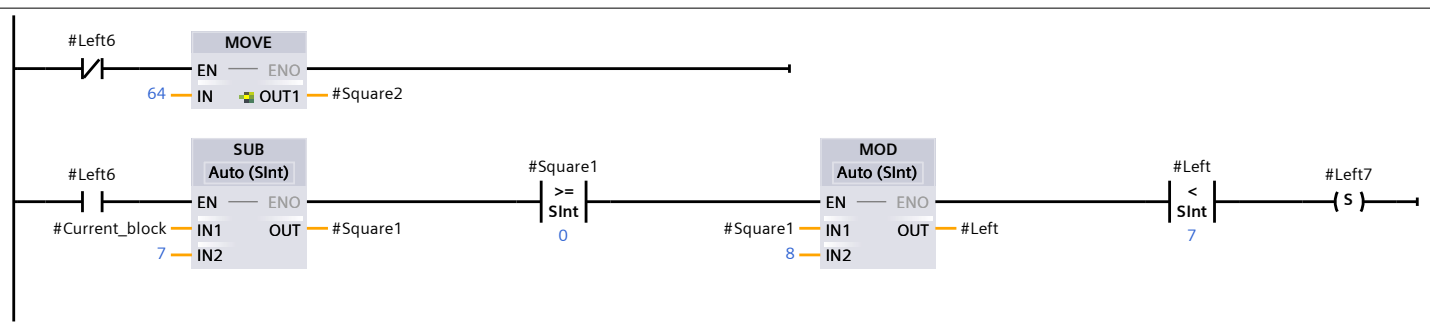
Network 6:

Calculate possible index in the left direction and set truth values Left6



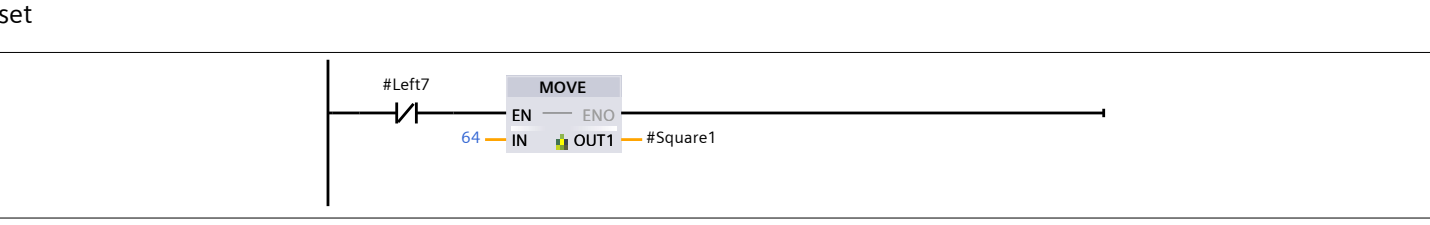
Network 7:

Calculate possible index in the left direction and set truth values Left7



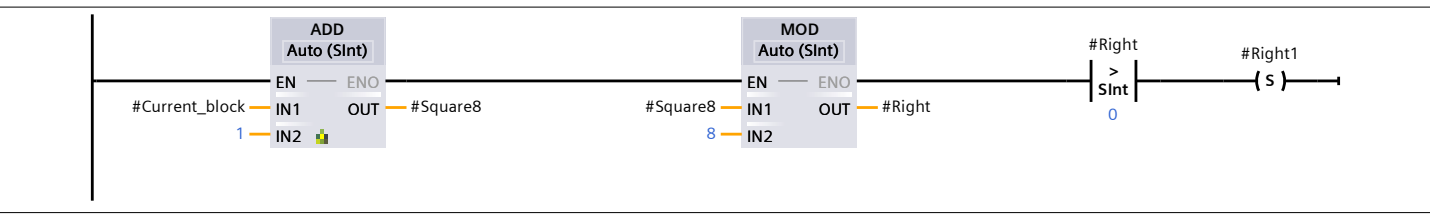
Network 8:

Reset value if move not set



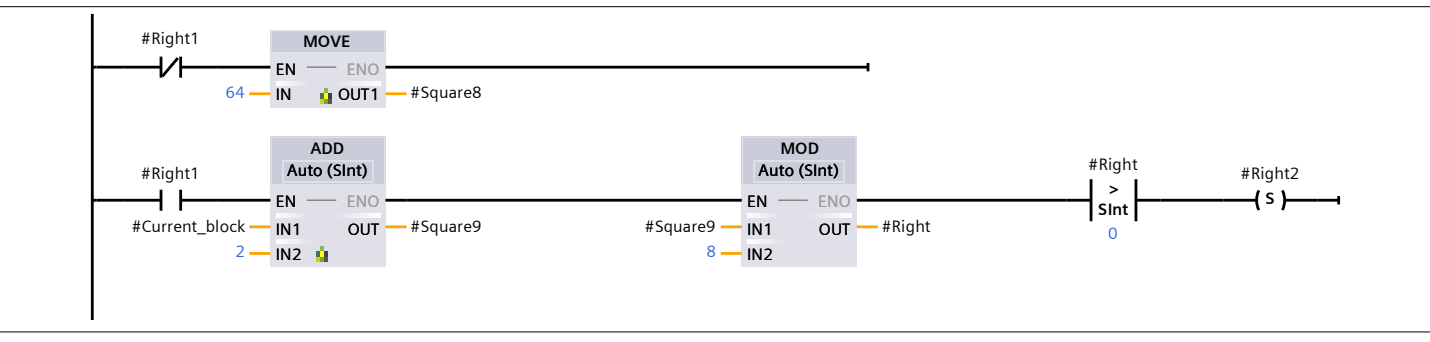
Network 9:

Calculate possible index in the right direction and set truth value Right1



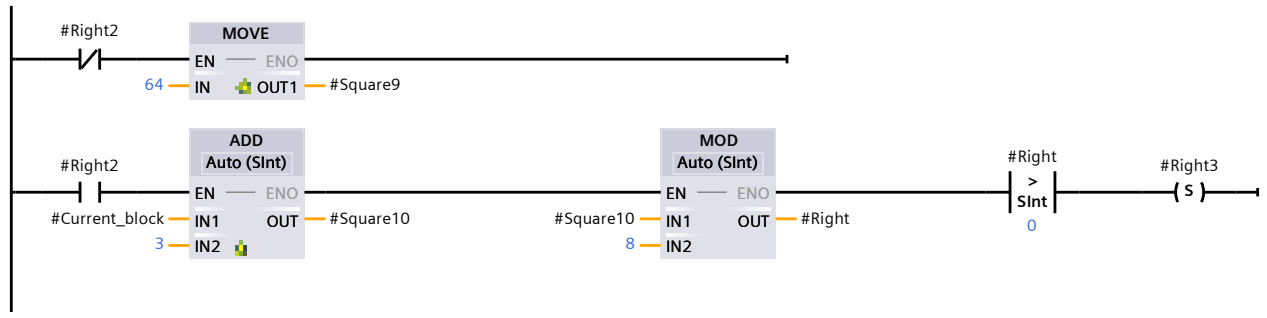
Network 10:

Calculate possible index in the right direction and set truth value Right2



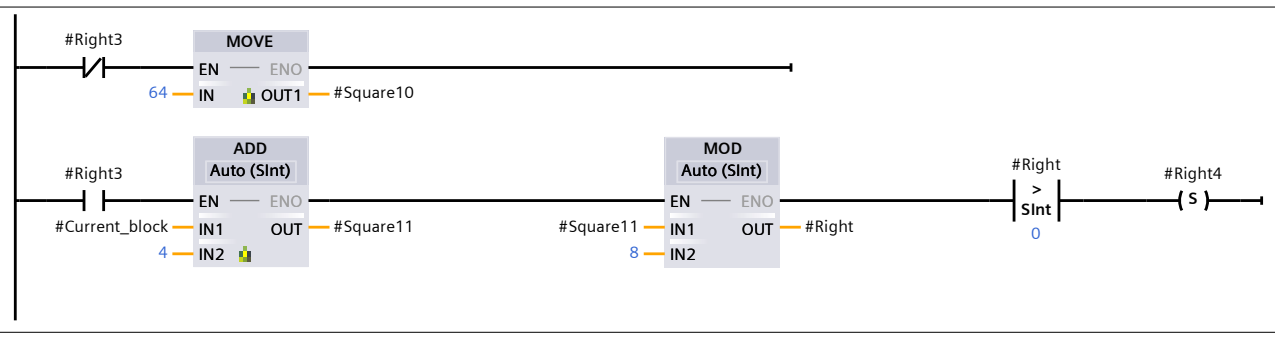
Network 11:

Calculate possible index in the right direction and set truth value Right3



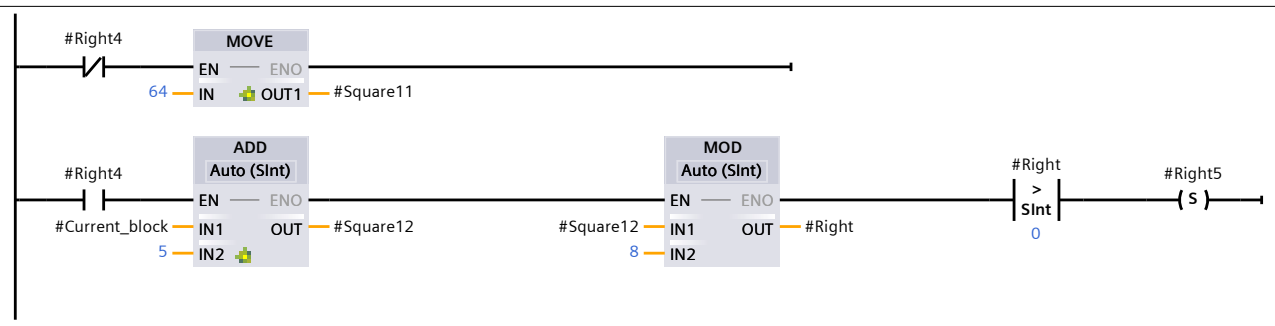
Network 12:

Calculate possible index in the right direction and set truth value Right4



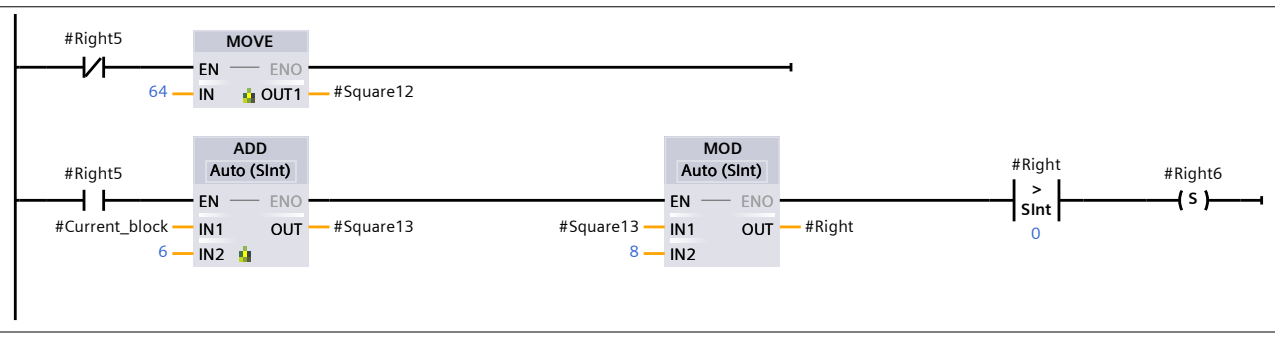
Network 13:

Calculate possible index in the right direction and set truth value Right5



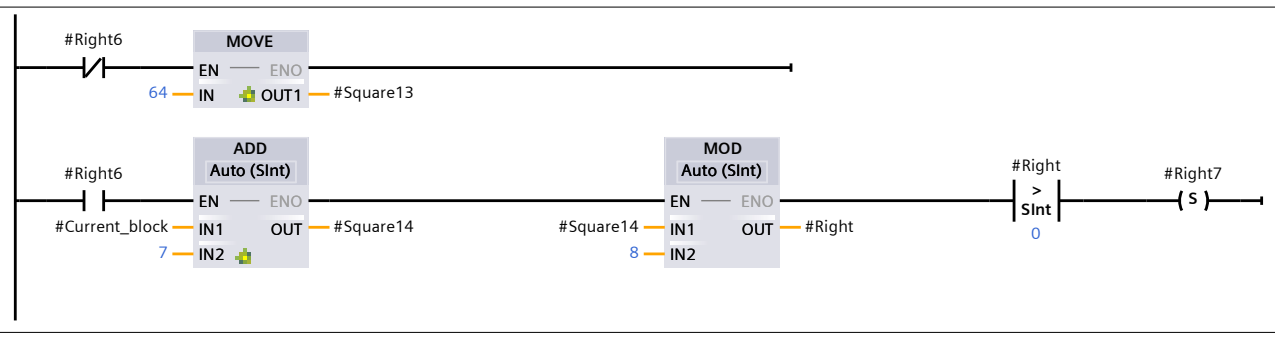
Network 14:

Calculate possible index in the right direction and set truth value Right6



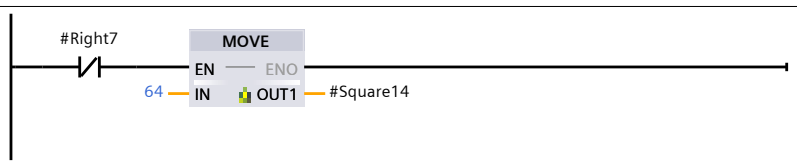
Network 15:

Calculate possible index in the right direction and set truth value Right7



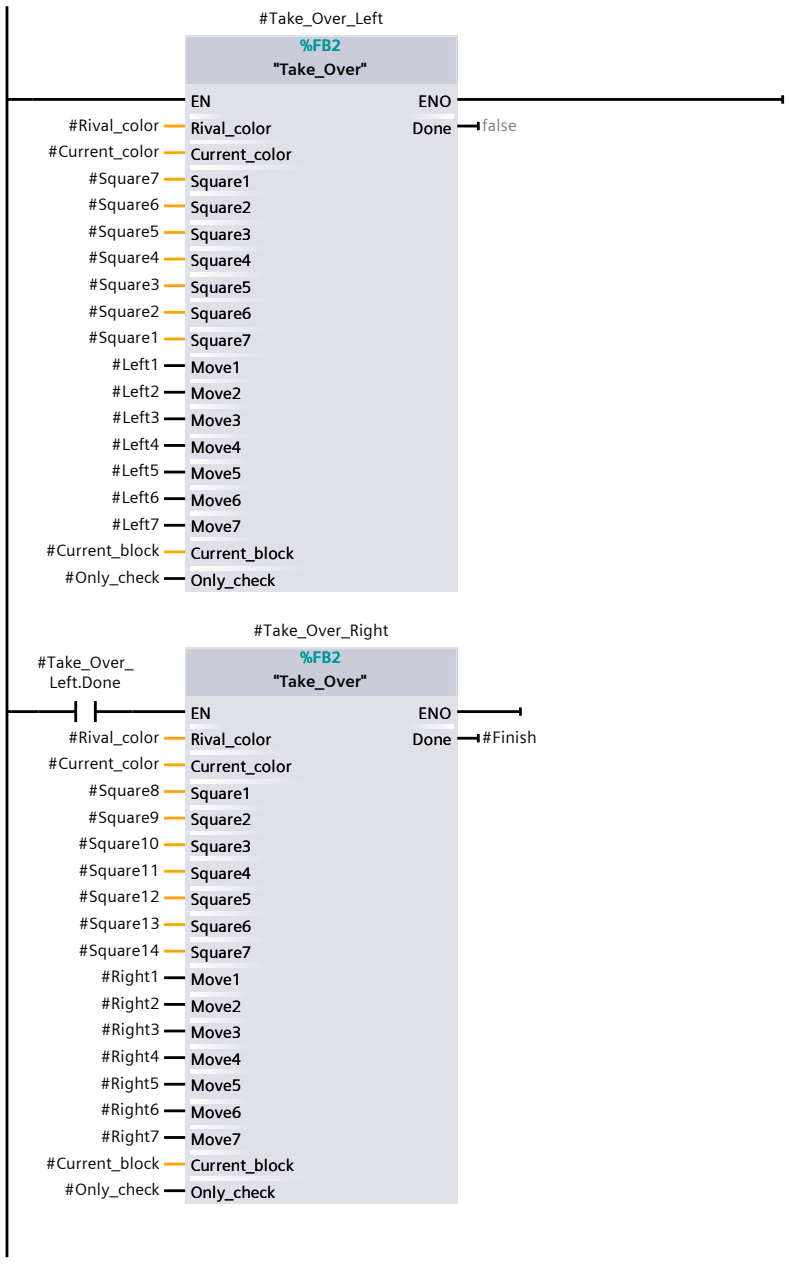
Network 16:

Reset variable if move not set



Network 17:

Check squares for conditions of takeover and take over squares if #Only_check is set to 0.


#Take_Over_Left
%FB2
"Take_Over"
EN
ENO
#Rival_color
Rival_color
Done
false
#Current_color
Current_color
#Square7
Square1
#Square6
Square2
#Square5
Square3
#Square4
Square4
#Square3
Square5
#Square2
Square6
#Square1
Square7
#Left1
Move1
#Left2
Move2
#Left3
Move3
#Left4
Move4
#Left5
Move5
#Left6
Move6
#Left7
Move7
#Current_block
Current_block
#Only_check
Only_check
#Take_Over_Right
#Take_Over_
Left.Done
%FB2
"Take_Over"
EN
ENO
#Rival_color
Rival_color
Done
#Finish
#Current_color
Current_color
#Square8
Square1
#Square9
Square2
#Square10
Square3
#Square11
Square4
#Square12
Square5
#Square13
Square6
#Square14
Square7
#Right1
Move1
#Right2
Move2
#Right3
Move3
#Right4
Move4
#Right5
Move5
#Right6
Move6
#Right7
Move7
#Current_block
Current_block
#Only_check
Only_check

Program blocks

NW-SE_Check [FB4]

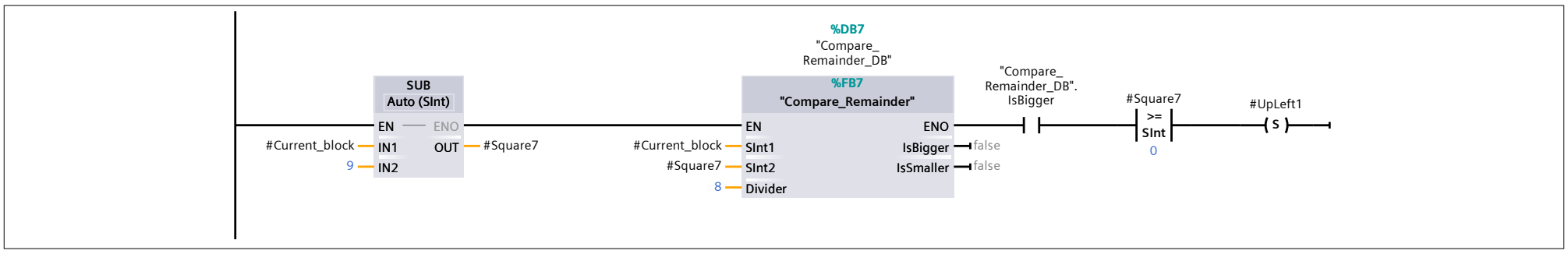
NW-SE_Check Properties							
General							
Name	NW-SE_Check	**Number**	4	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Current_block	SInt	0	Non-retain	True	True	True	False		
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Finish	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Take_Over_UpLeft	"Take_Over"			True	True	True	True		
Input									
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Square1	SInt	0	Non-retain	True	True	True	False		
Square2	SInt	0	Non-retain	True	True	True	False		
Square3	SInt	0	Non-retain	True	True	True	False		
Square4	SInt	0	Non-retain	True	True	True	False		
Square5	SInt	0	Non-retain	True	True	True	False		
Square6	SInt	0	Non-retain	True	True	True	False		
Square7	SInt	0	Non-retain	True	True	True	False		
Move1	Bool	false	Non-retain	True	True	True	False		
Move2	Bool	false	Non-retain	True	True	True	False		
Move3	Bool	false	Non-retain	True	True	True	False		
Move4	Bool	false	Non-retain	True	True	True	False		
Move5	Bool	false	Non-retain	True	True	True	False		
Move6	Bool	false	Non-retain	True	True	True	False		
Move7	Bool	false	Non-retain	True	True	True	False		
Current_block	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Done	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Take_Over_DownRight	"Take_Over"			True	True	True	True		
Input									
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Square1	SInt	0	Non-retain	True	True	True	False		
Square2	SInt	0	Non-retain	True	True	True	False		
Square3	SInt	0	Non-retain	True	True	True	False		
Square4	SInt	0	Non-retain	True	True	True	False		
Square5	SInt	0	Non-retain	True	True	True	False		
Square6	SInt	0	Non-retain	True	True	True	False		
Square7	SInt	0	Non-retain	True	True	True	False		
Move1	Bool	false	Non-retain	True	True	True	False		
Move2	Bool	false	Non-retain	True	True	True	False		
Move3	Bool	false	Non-retain	True	True	True	False		
Move4	Bool	false	Non-retain	True	True	True	False		
Move5	Bool	false	Non-retain	True	True	True	False		
Move6	Bool	false	Non-retain	True	True	True	False		
Move7	Bool	false	Non-retain	True	True	True	False		
Current_block	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Done	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Temp									

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Square1	SInt								UpLeft 7
Square2	SInt								UpLeft 6
Square3	SInt								UpLeft 5
Square4	SInt								UpLeft 4
Square5	SInt								UpLeft 3
Square6	SInt								UpLeft 2
Square7	SInt								UpLeft 1
Square8	SInt								DownRight 1
Square9	SInt								DownRight 2
Square10	SInt								DownRight 3
Square11	SInt								DownRight 4
Square12	SInt								DownRight 5
Square13	SInt								DownRight 6
Square14	SInt								DownRight 7
UpLeft	SInt								
UpLeft1	Bool								
UpLeft2	Bool								
UpLeft3	Bool								
UpLeft4	Bool								
UpLeft5	Bool								
UpLeft6	Bool								
UpLeft7	Bool								
DownRight	SInt								
DownRight1	Bool								
DownRight2	Bool								
DownRight3	Bool								
DownRight4	Bool								
DownRight5	Bool								
DownRight6	Bool								
DownRight7	Bool								
Constant									

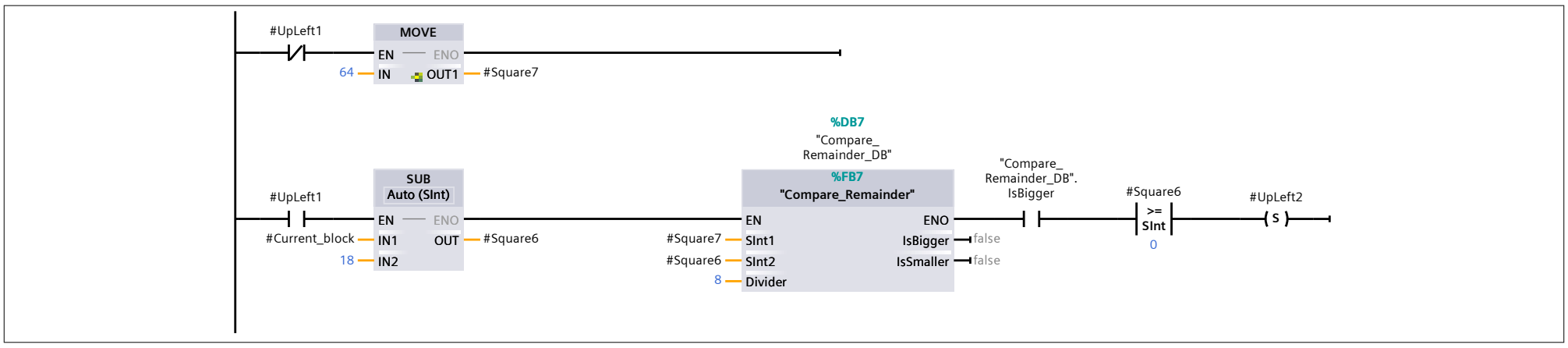
Network 1:

Calculate possible index in the Up-left direction and set truth value UpLeft1



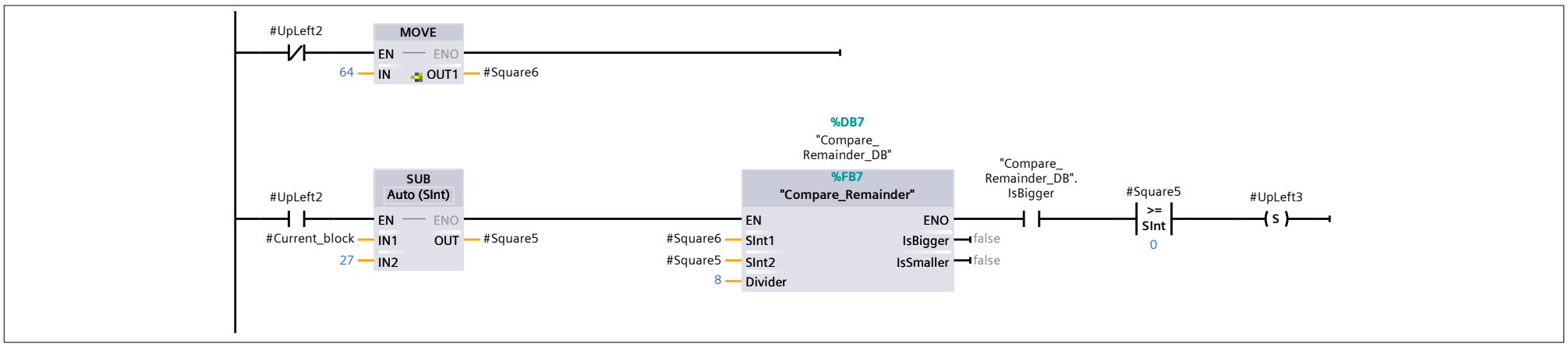
Network 2:

Calculate possible index in the Up-left direction and set truth value UpLeft2



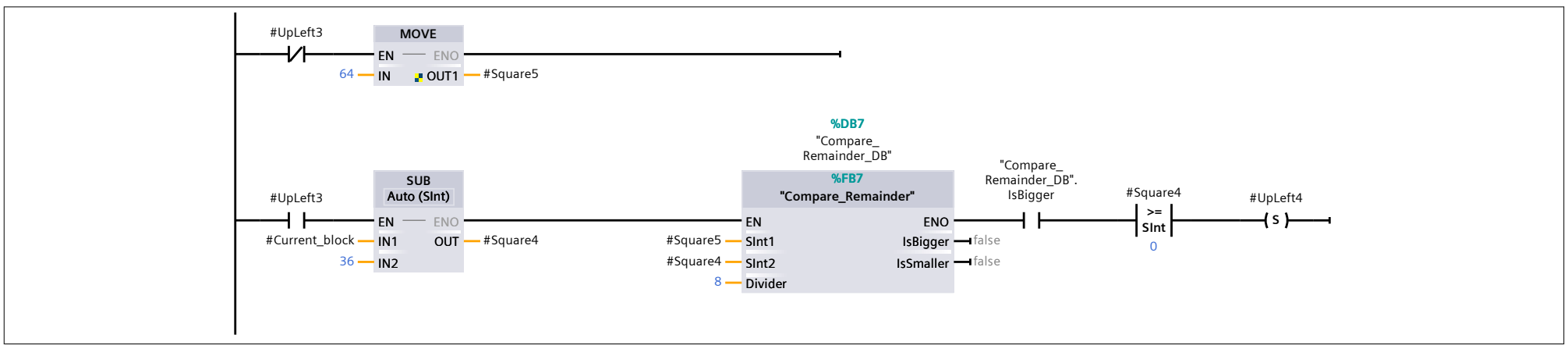
Network 3:

Calculate possible index in the Up-left direction and set truth value UpLeft3



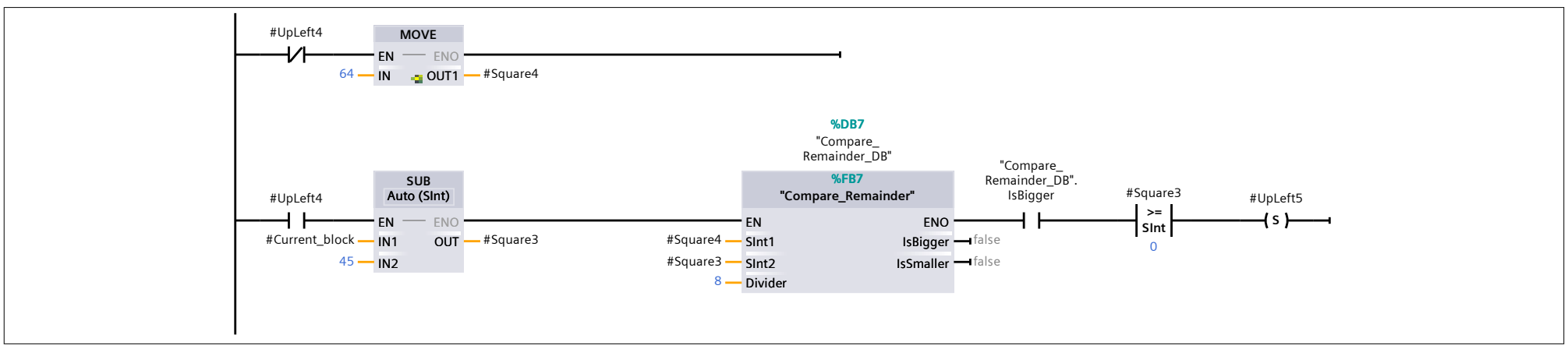
Network 4:

Calculate possible index in the Up-left direction and set truth value UpLeft4



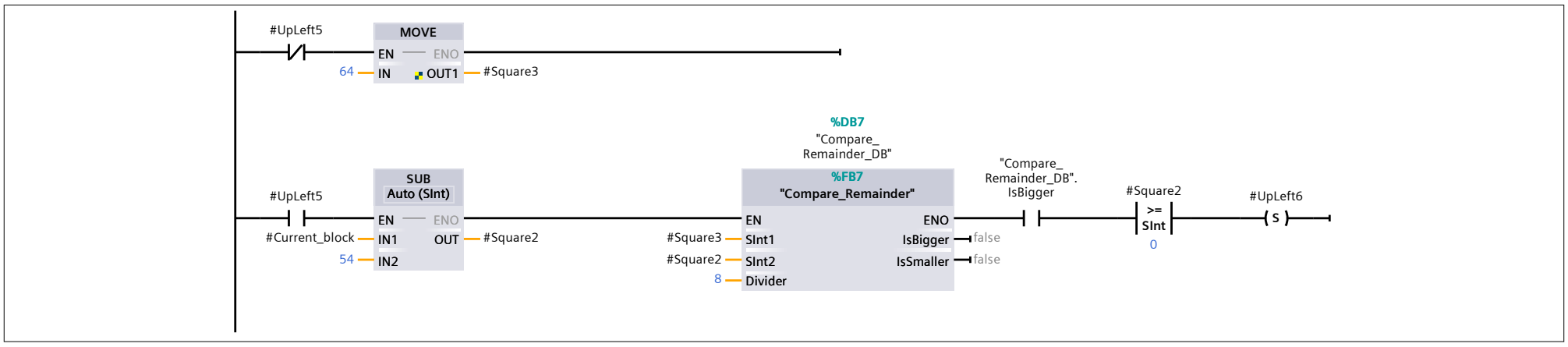
Network 5:

Calculate possible index in the Up-left direction and set truth value UpLeft5



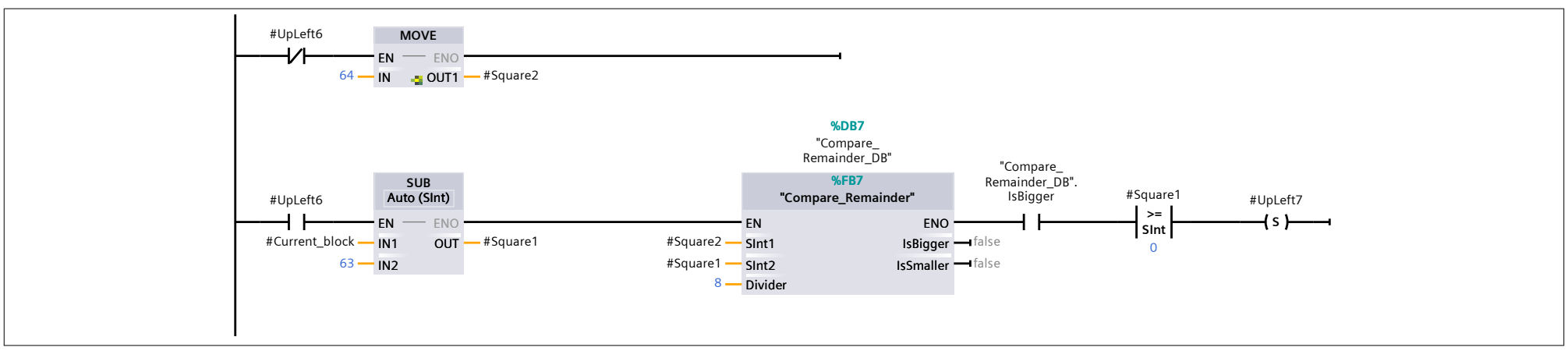
Network 6:

Calculate possible index in the Up-left direction and set truth value UpLeft6



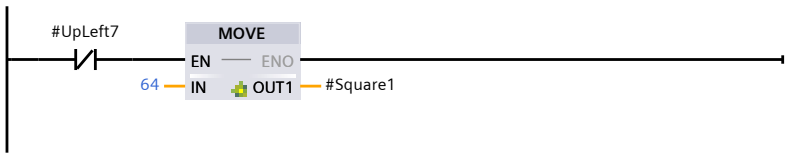
Network 7:

Calculate possible index in the Up-left direction and set truth value UpLeft7



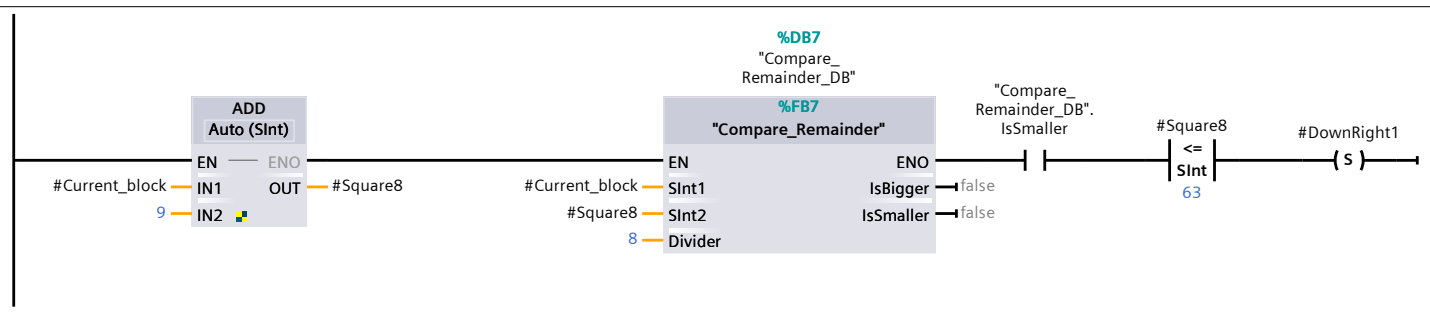
Network 8:

Reset value if no move set



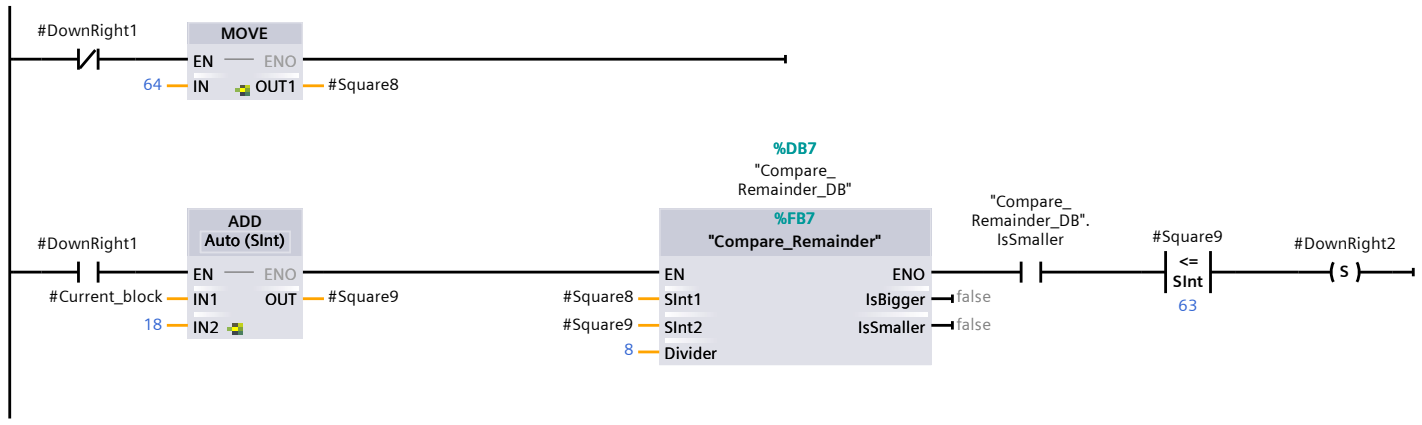
Network 9:

Calculate possible index in the Down-right direction and set truth value DownRight1



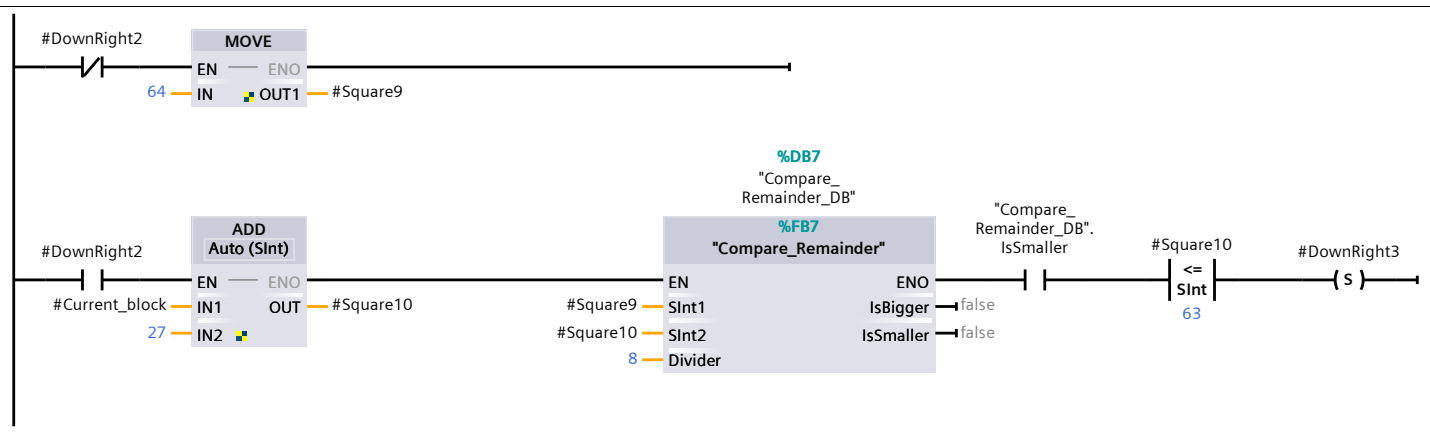
Network 10:

Calculate possible index in the Down-right direction and set truth value DownRight2



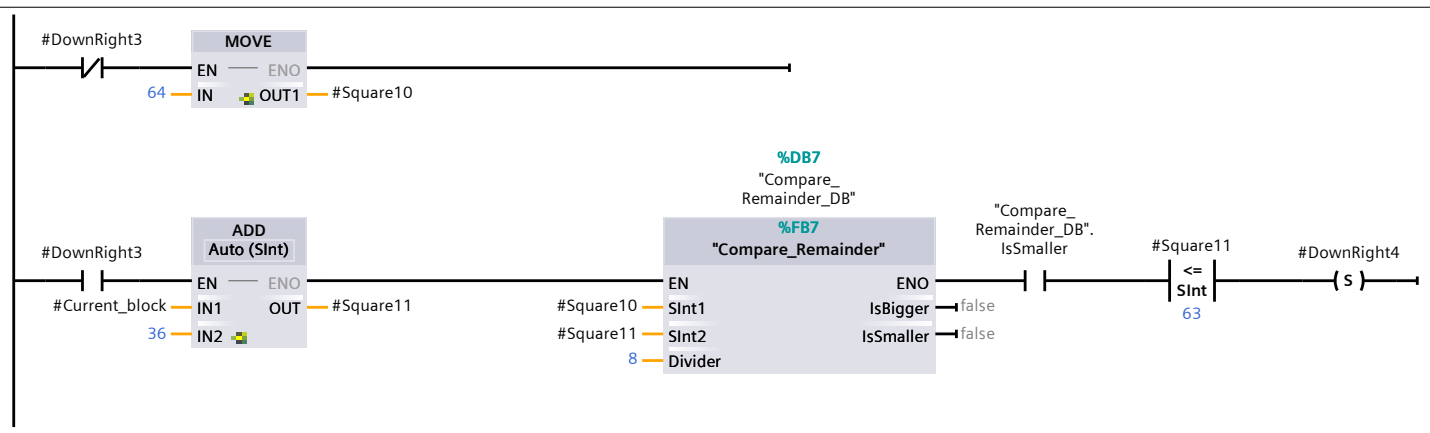
Network 11:

Calculate possible index in the Down-right direction and set truth value DownRight3



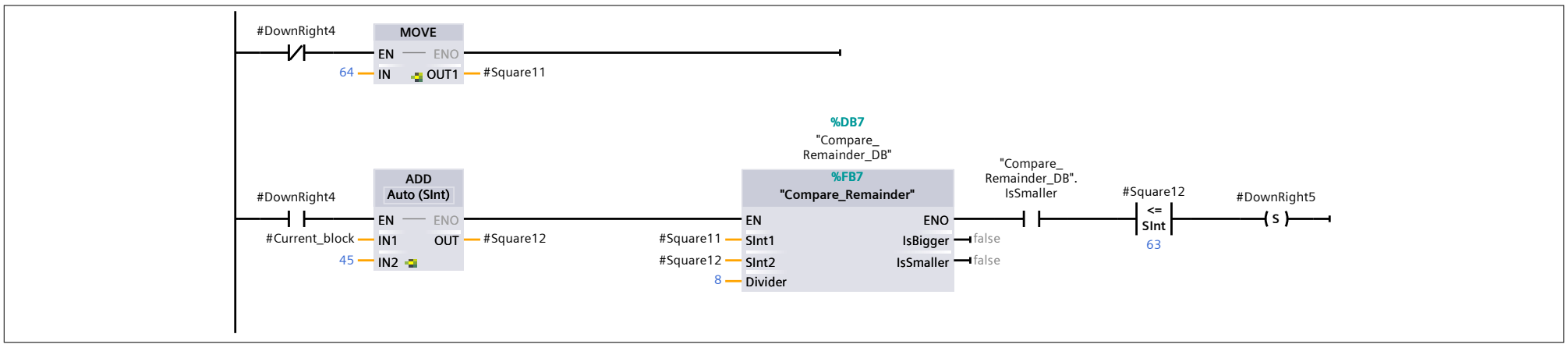
Network 12:

Calculate possible index in the Down-right direction and set truth value DownRight4



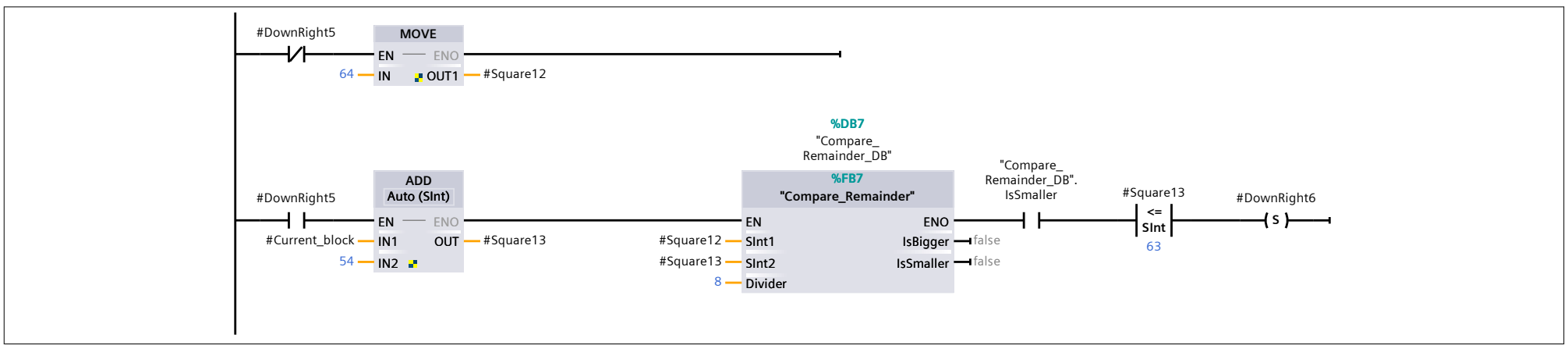
Network 13:

Calculate possible index in the Down-right direction and set truth value DownRight5



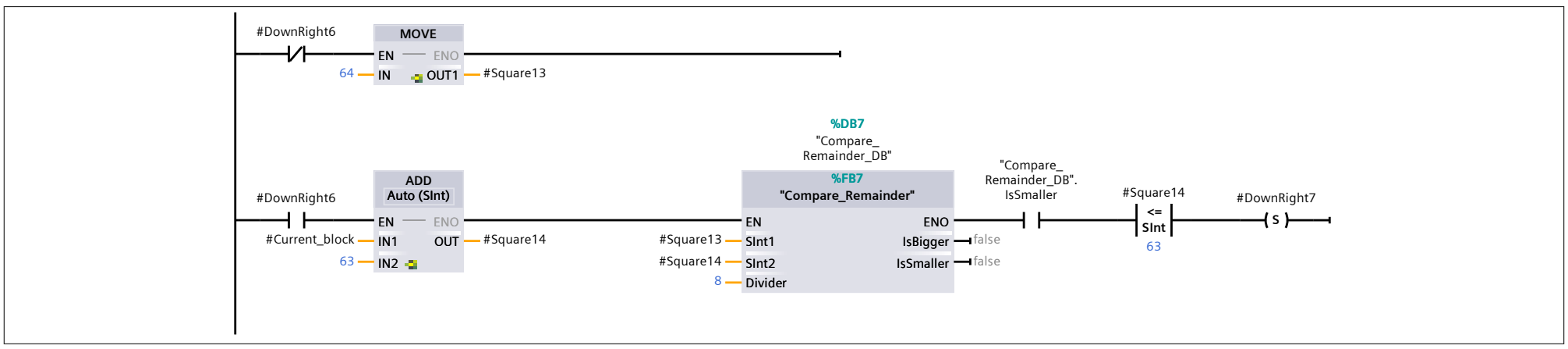
Network 14:

Calculate possible index in the Down-right direction and set truth value DownRight6



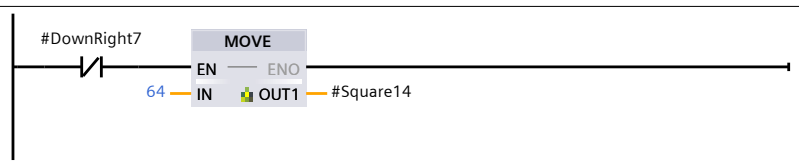
Network 15:

Calculate possible index in the Down-right direction and set truth value DownRight7



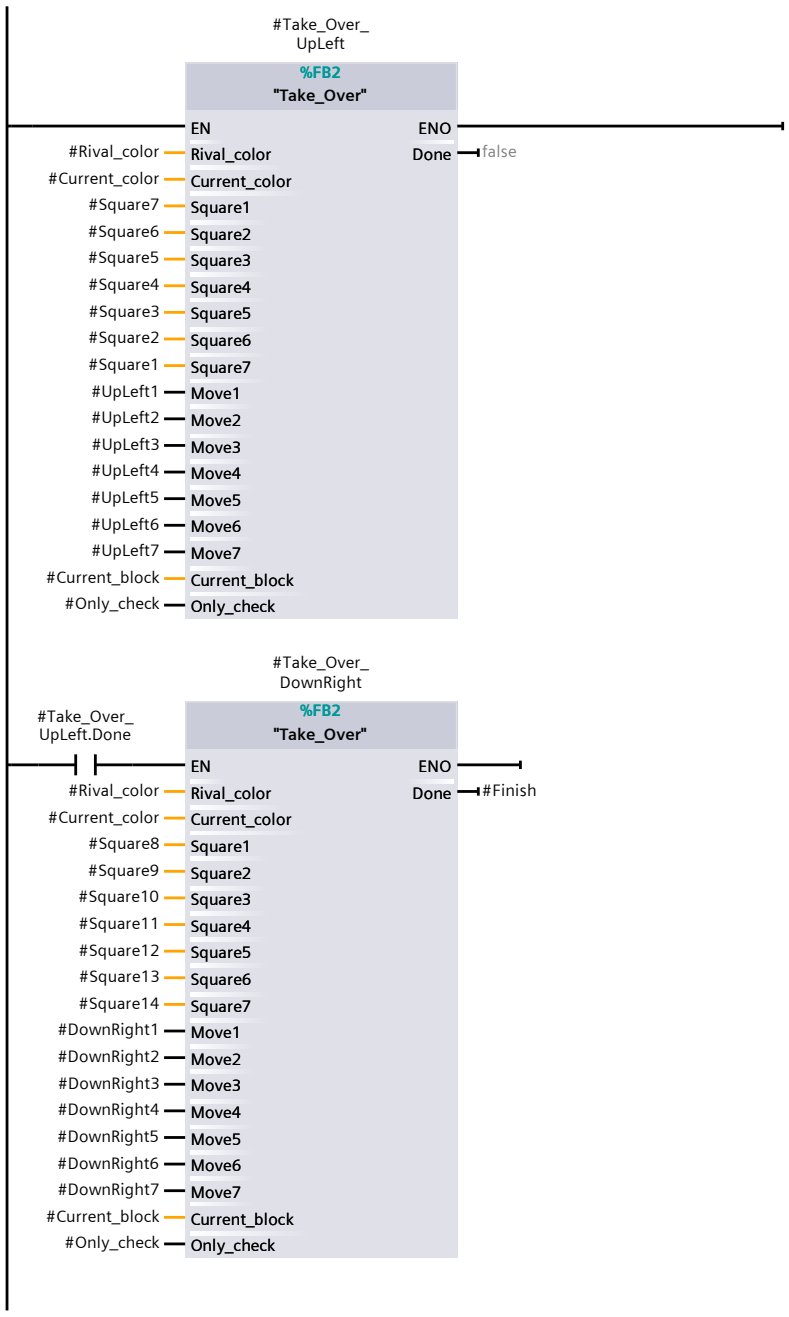
Network 16:

Reset value if no move set



Network 17:

Check squares for conditions of takeover and take over squares if #Only_check is set to 0.


#Take_Over_
UpLeft
%FB2
"Take_Over"
EN
ENO
#Rival_color
Rival_color
Done
false
#Current_color
Current_color
#Square7
Square1
#Square6
Square2
#Square5
Square3
#Square4
Square4
#Square3
Square5
#Square2
Square6
#Square1
Square7
#UpLeft1
Move1
#UpLeft2
Move2
#UpLeft3
Move3
#UpLeft4
Move4
#UpLeft5
Move5
#UpLeft6
Move6
#UpLeft7
Move7
#Current_block
Current_block
#Only_check
Only_check
#Take_Over_
DownRight
#Take_Over_
UpLeft.Done
%FB2
"Take_Over"
EN
ENO
#Rival_color
Rival_color
Done
#Finish
#Current_color
Current_color
#Square8
Square1
#Square9
Square2
#Square10
Square3
#Square11
Square4
#Square12
Square5
#Square13
Square6
#Square14
Square7
#DownRight1
Move1
#DownRight2
Move2
#DownRight3
Move3
#DownRight4
Move4
#DownRight5
Move5
#DownRight6
Move6
#DownRight7
Move7
#Current_block
Current_block
#Only_check
Only_check

Program blocks

NE-SW_Check [FB5]

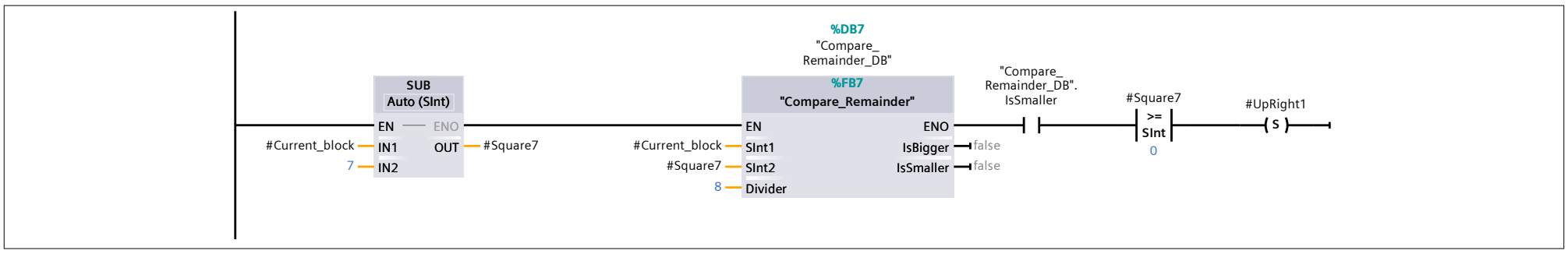
NE-SW_Check Properties							
General							
Name	NE-SW_Check	**Number**	5	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Current_block	SInt	0	Non-retain	True	True	True	False		
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Finish	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Take_Over_UpRight	"Take_Over"			True	True	True	True		
Input									
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Square1	SInt	0	Non-retain	True	True	True	False		
Square2	SInt	0	Non-retain	True	True	True	False		
Square3	SInt	0	Non-retain	True	True	True	False		
Square4	SInt	0	Non-retain	True	True	True	False		
Square5	SInt	0	Non-retain	True	True	True	False		
Square6	SInt	0	Non-retain	True	True	True	False		
Square7	SInt	0	Non-retain	True	True	True	False		
Move1	Bool	false	Non-retain	True	True	True	False		
Move2	Bool	false	Non-retain	True	True	True	False		
Move3	Bool	false	Non-retain	True	True	True	False		
Move4	Bool	false	Non-retain	True	True	True	False		
Move5	Bool	false	Non-retain	True	True	True	False		
Move6	Bool	false	Non-retain	True	True	True	False		
Move7	Bool	false	Non-retain	True	True	True	False		
Current_block	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Done	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Take_Over_DownLeft	"Take_Over"			True	True	True	True		
Input									
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Square1	SInt	0	Non-retain	True	True	True	False		
Square2	SInt	0	Non-retain	True	True	True	False		
Square3	SInt	0	Non-retain	True	True	True	False		
Square4	SInt	0	Non-retain	True	True	True	False		
Square5	SInt	0	Non-retain	True	True	True	False		
Square6	SInt	0	Non-retain	True	True	True	False		
Square7	SInt	0	Non-retain	True	True	True	False		
Move1	Bool	false	Non-retain	True	True	True	False		
Move2	Bool	false	Non-retain	True	True	True	False		
Move3	Bool	false	Non-retain	True	True	True	False		
Move4	Bool	false	Non-retain	True	True	True	False		
Move5	Bool	false	Non-retain	True	True	True	False		
Move6	Bool	false	Non-retain	True	True	True	False		
Move7	Bool	false	Non-retain	True	True	True	False		
Current_block	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Done	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Temp									

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Square1	SInt								UpRight 7
Square2	SInt								UpRight 6
Square3	SInt								UpRight 5
Square4	SInt								UpRight 4
Square5	SInt								UpRight 3
Square6	SInt								UpRight 2
Square7	SInt								UpRight 1
Square8	SInt								DownLeft 1
Square9	SInt								DownLeft 2
Square10	SInt								DownLeft 3
Square11	SInt								DownLeft 4
Square12	SInt								DownLeft 5
Square13	SInt								DownLeft 6
Square14	SInt								DownLeft 7
UpRight1	Bool								
UpRight2	Bool								
UpRight3	Bool								
UpRight4	Bool								
UpRight5	Bool								
UpRight6	Bool								
UpRight7	Bool								
DownLeft1	Bool								
DownLeft2	Bool								
DownLeft3	Bool								
DownLeft4	Bool								
DownLeft5	Bool								
DownLeft6	Bool								
DownLeft7	Bool								
Constant									

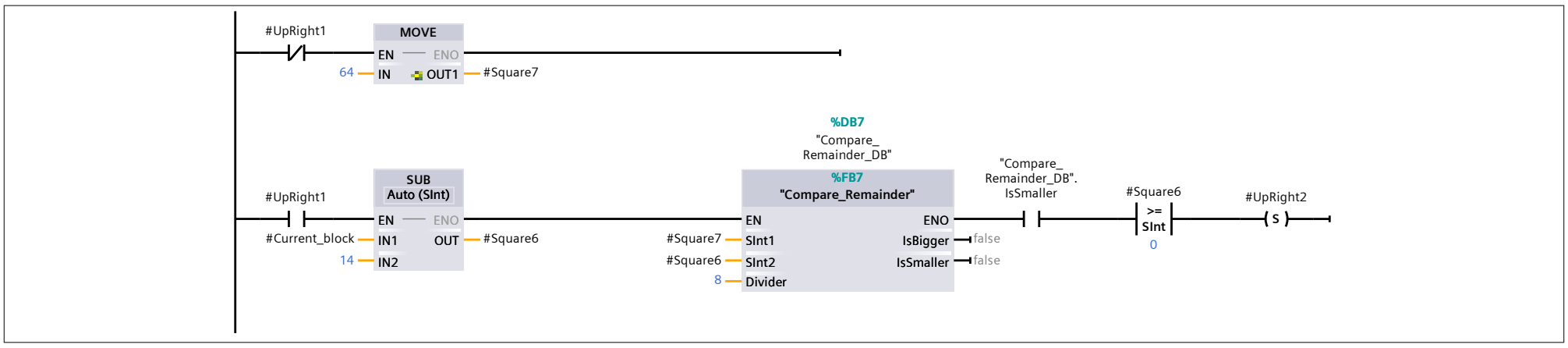
Network 1:

Calculate possible index in the Up-right direction and set truth value UpRight1



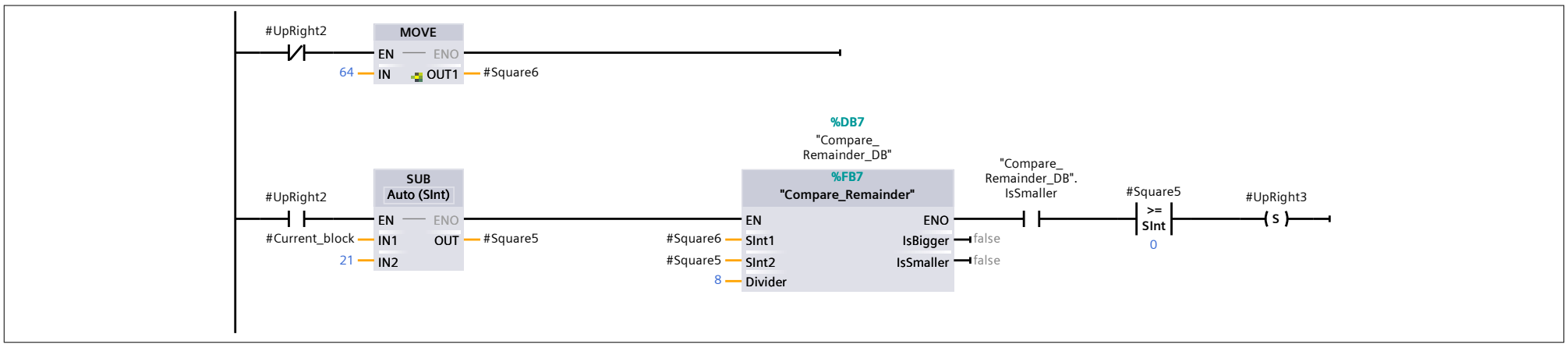
Network 2:

Calculate possible index in the Up-right direction and set truth value UpRight2



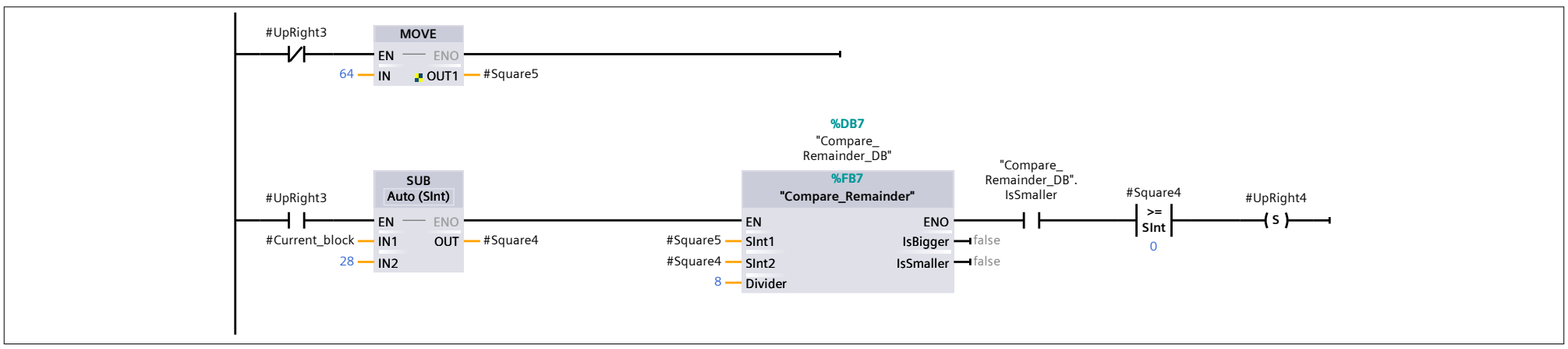
Network 3:

Calculate possible index in the Up-right direction and set truth value UpRight3



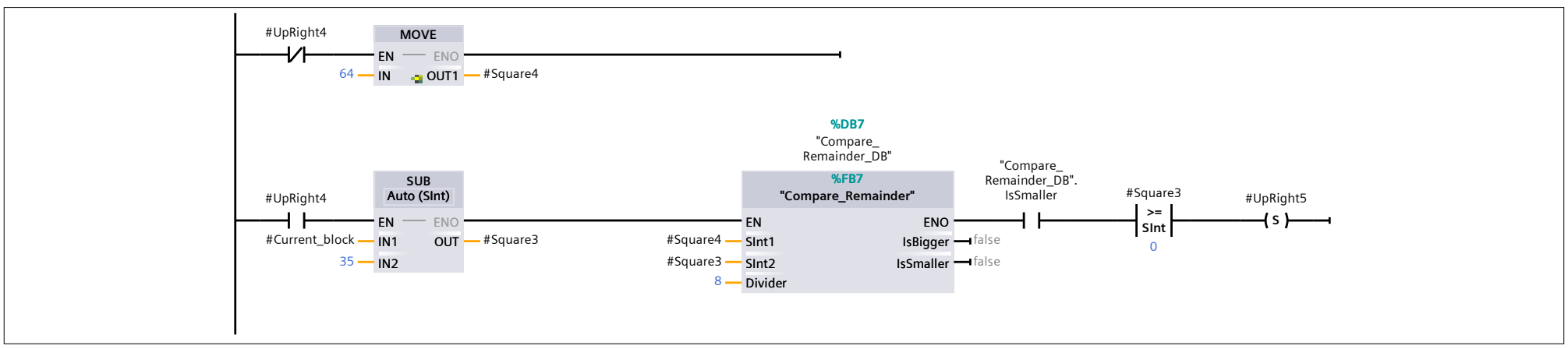
Network 4:

Calculate possible index in the Up-right direction and set truth value UpRight4



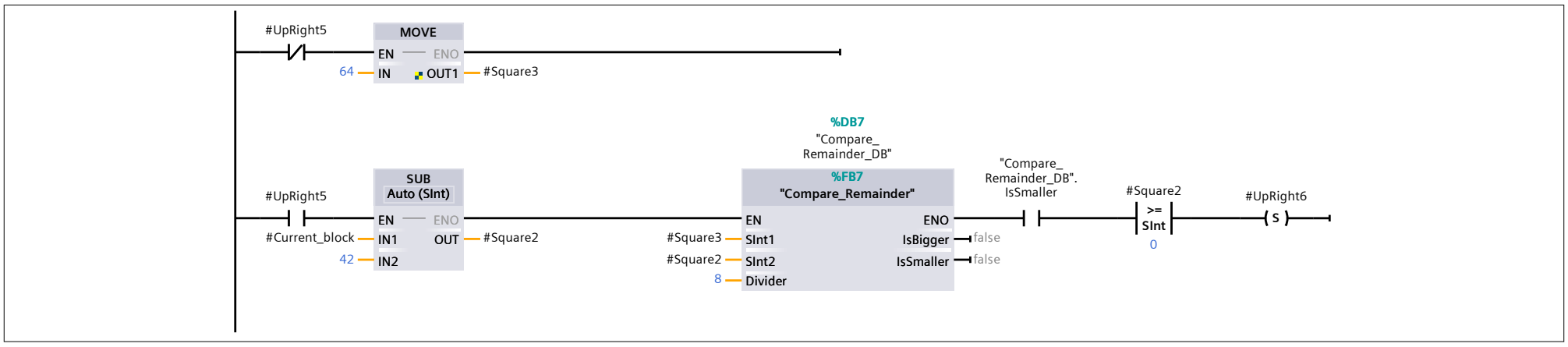
Network 5:

Calculate possible index in the Up-right direction and set truth value UpRight5



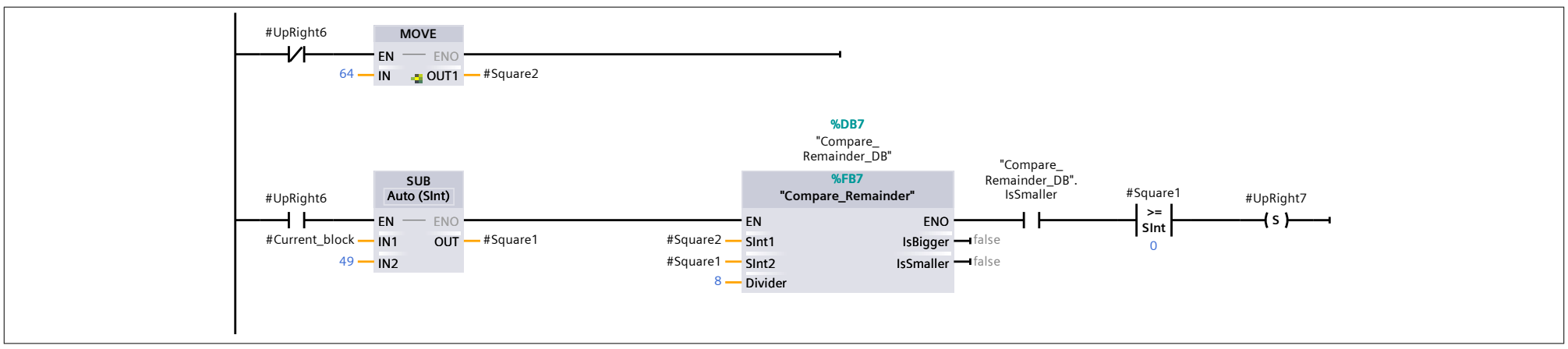
Network 6:

Calculate possible index in the Up-right direction and set truth value UpRight6



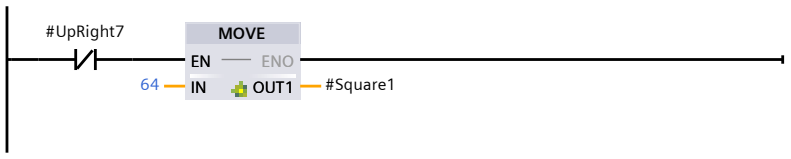
Network 7:

Calculate possible index in the Up-right direction and set truth value UpRight7



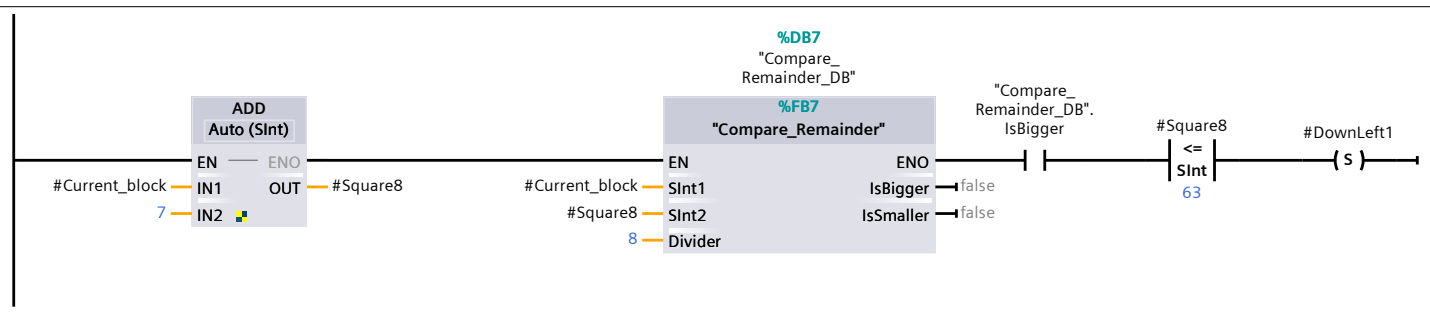
Network 8:

Reset value if no move set



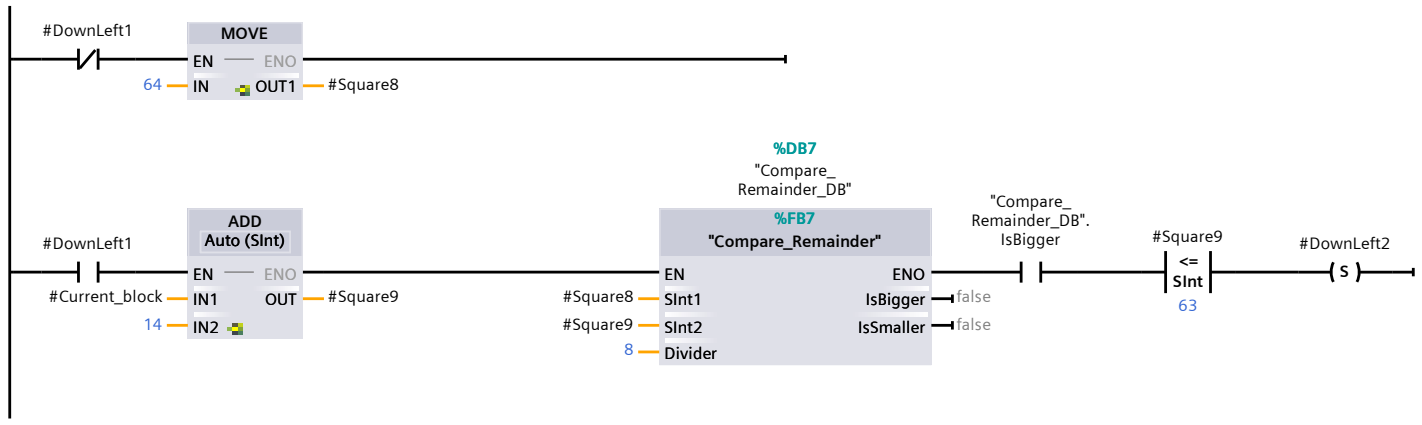
Network 9:

Calculate possible index in the Down-left direction and set truth value DownLeft1



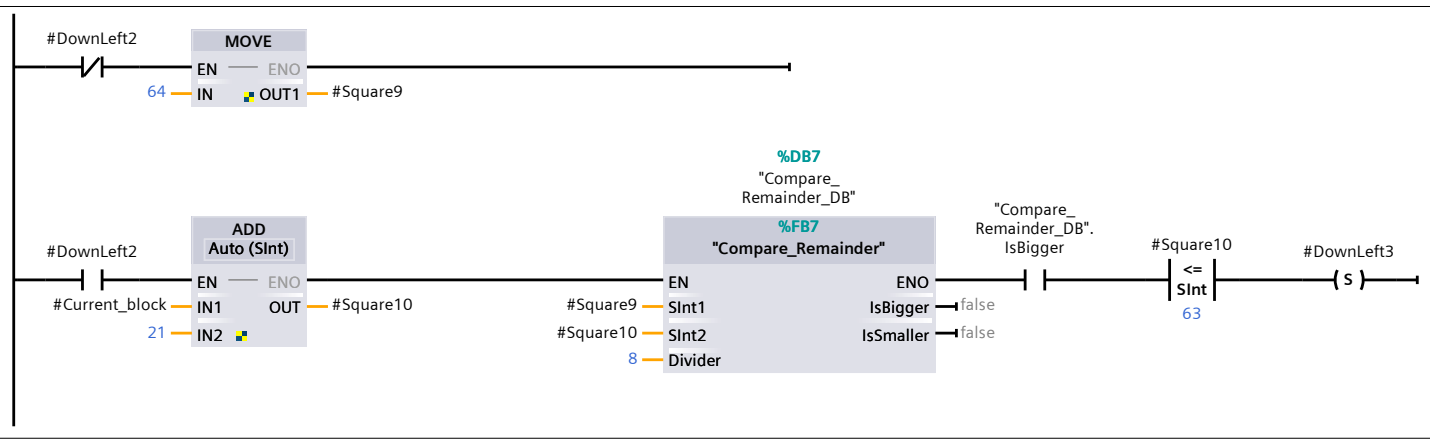
Network 10:

Calculate possible index in the Down-left direction and set truth value DownLeft2



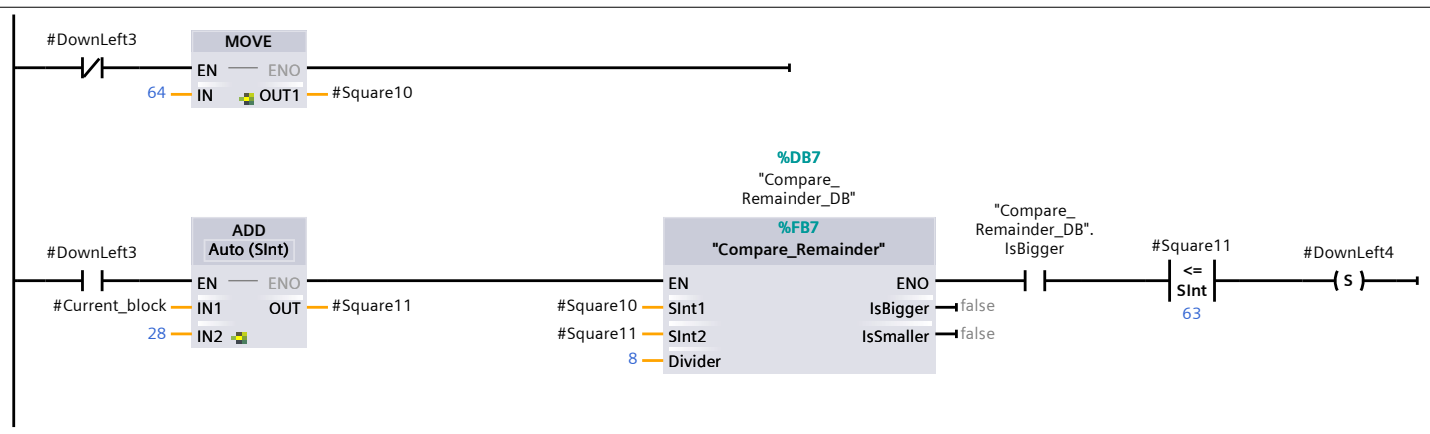
Network 11:

Calculate possible index in the Down-left direction and set truth value DownLeft3



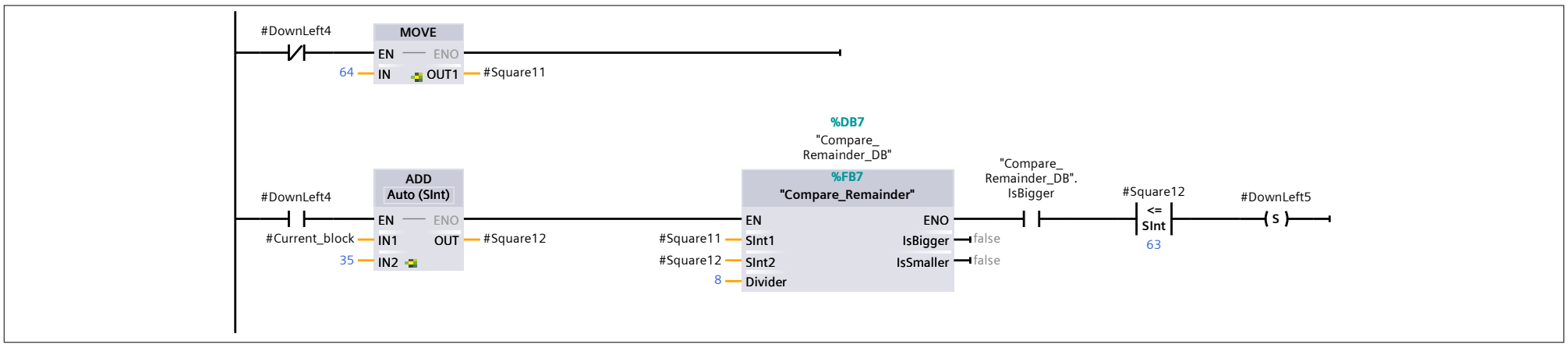
Network 12:

Calculate possible index in the Down-left direction and set truth value DownLeft4



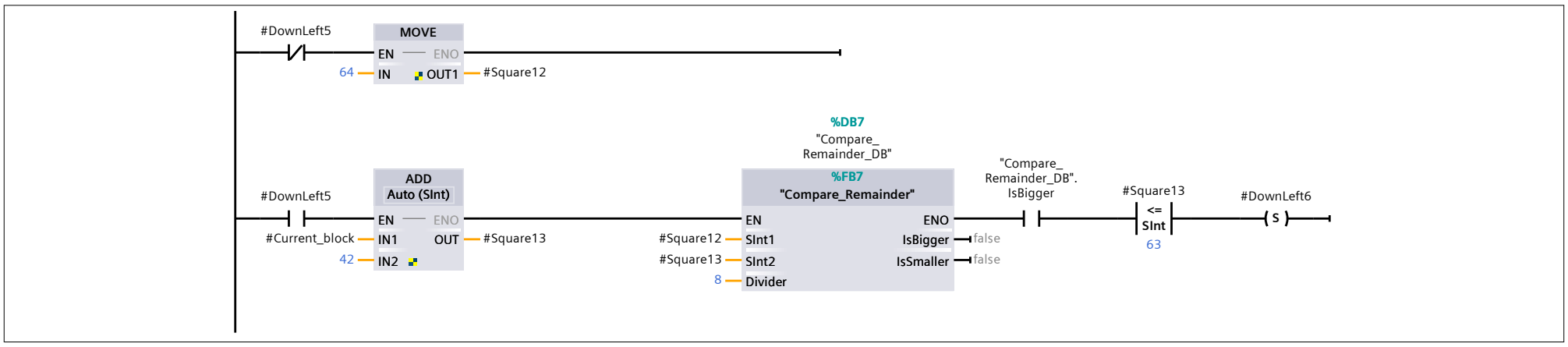
Network 13:

Calculate possible index in the Down-left direction and set truth value DownLeft5



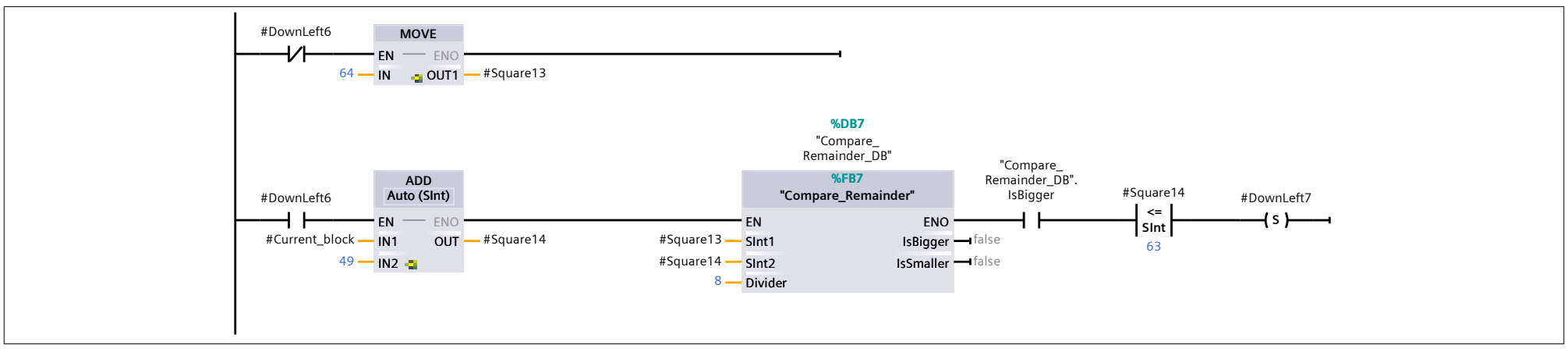
Network 14:

Calculate possible index in the Down-left direction and set truth value DownLeft6



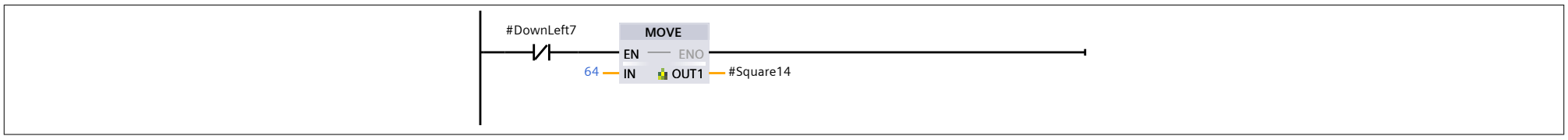
Network 15:

Calculate possible index in the Down-left direction and set truth value DownLeft7



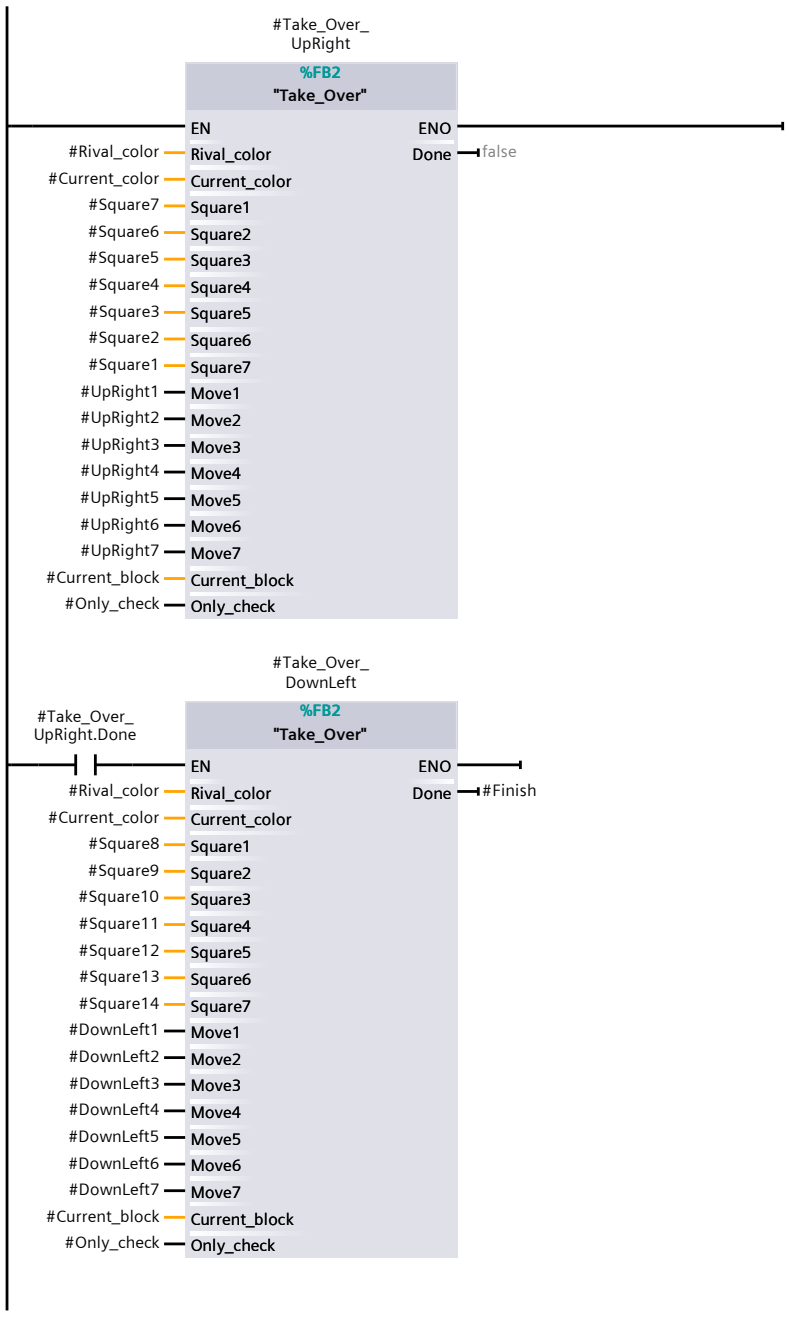
Network 16:

Reset value if no move set



Network 17:

Check squares for conditions of takeover and take over squares if #Only_check is set to 0.


#Take_Over_
UpRight
%FB2
"Take_Over"
EN
ENO
#Rival_color
Rival_color
Done
false
#Current_color
Current_color
#Square7
Square1
#Square6
Square2
#Square5
Square3
#Square4
Square4
#Square3
Square5
#Square2
Square6
#Square1
Square7
#UpRight1
Move1
#UpRight2
Move2
#UpRight3
Move3
#UpRight4
Move4
#UpRight5
Move5
#UpRight6
Move6
#UpRight7
Move7
#Current_block
Current_block
#Only_check
Only_check
#Take_Over_
DownLeft
#Take_Over_
UpRight.Done
%FB2
"Take_Over"
EN
ENO
#Rival_color
Rival_color
Done
#Finish
#Current_color
Current_color
#Square8
Square1
#Square9
Square2
#Square10
Square3
#Square11
Square4
#Square12
Square5
#Square13
Square6
#Square14
Square7
#DownLeft1
Move1
#DownLeft2
Move2
#DownLeft3
Move3
#DownLeft4
Move4
#DownLeft5
Move5
#DownLeft6
Move6
#DownLeft7
Move7
#Current_block
Current_block
#Only_check
Only_check

Program blocks

Take_Over [FB2]

Take_Over Properties							
General							
Name	Take_Over	**Number**	2	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Rival_color	SInt	0	Non-retain	True	True	True	False		
Current_color	SInt	0	Non-retain	True	True	True	False		
Square1	SInt	0	Non-retain	True	True	True	False		
Square2	SInt	0	Non-retain	True	True	True	False		
Square3	SInt	0	Non-retain	True	True	True	False		
Square4	SInt	0	Non-retain	True	True	True	False		
Square5	SInt	0	Non-retain	True	True	True	False		
Square6	SInt	0	Non-retain	True	True	True	False		
Square7	SInt	0	Non-retain	True	True	True	False		
Move1	Bool	false	Non-retain	True	True	True	False		
Move2	Bool	false	Non-retain	True	True	True	False		
Move3	Bool	false	Non-retain	True	True	True	False		
Move4	Bool	false	Non-retain	True	True	True	False		
Move5	Bool	false	Non-retain	True	True	True	False		
Move6	Bool	false	Non-retain	True	True	True	False		
Move7	Bool	false	Non-retain	True	True	True	False		
Current_block	SInt	0	Non-retain	True	True	True	False		
Only_check	Bool	false	Non-retain	True	True	True	False		
Output									
Done	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Temp									
Temp1	Bool								Used to end checking if a valid move is found.
Temp2	Bool								Used to end checking if a valid move is found.
Temp3	Bool								Used to end checking if a valid move is found.
Temp4	Bool								Used to end checking if a valid move is found.
Temp5	Bool								Used to end checking if a valid move is found.
Constant									

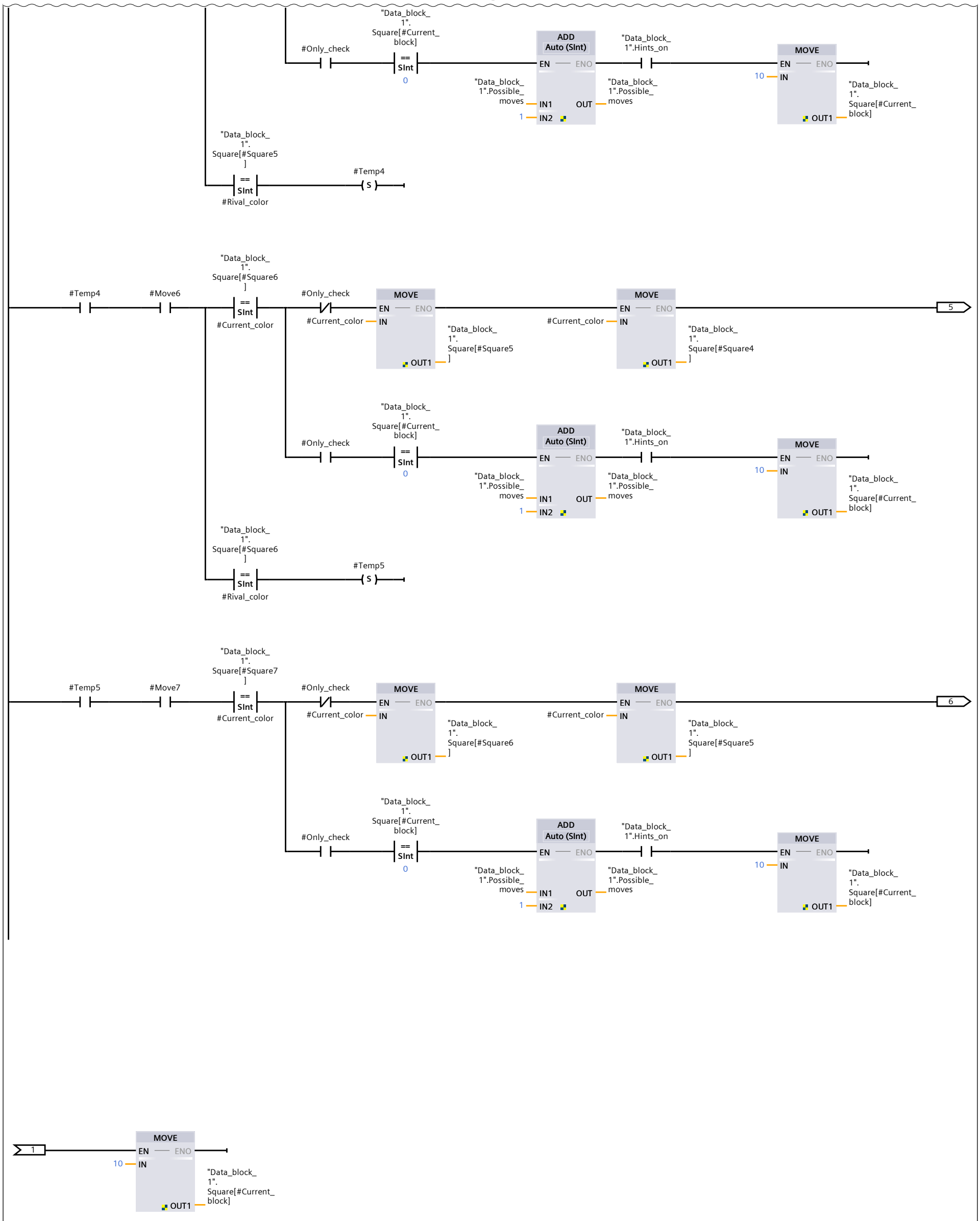
Network 1: Used to end checking if a valid move is found.

Check and take over or mark squares if conditions for takeover met

Network 1: Used to end checking if a valid move is found. (1.1 / 5.1)

Network 1: Used to end checking if a valid move is found. (2.1 / 5.1)

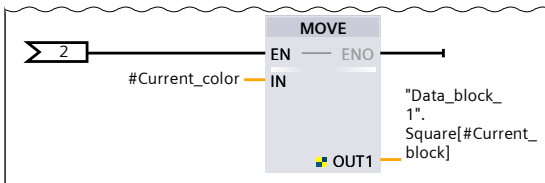
1.1 (Page7 - 2)

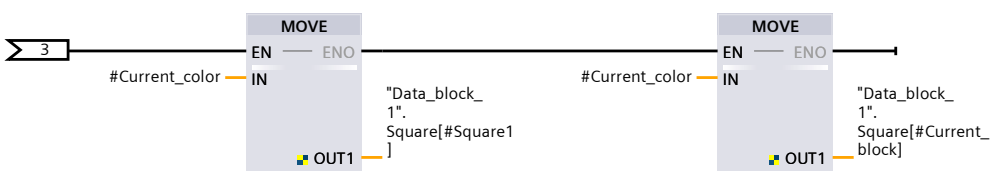


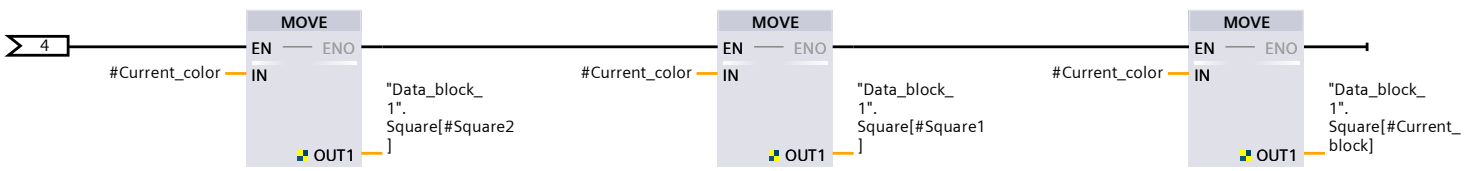
3.1 (Page7 - 4)

Network 1: Used to end checking if a valid move is found. (3.1 / 5.1)

2.1 (Page7 - 3)



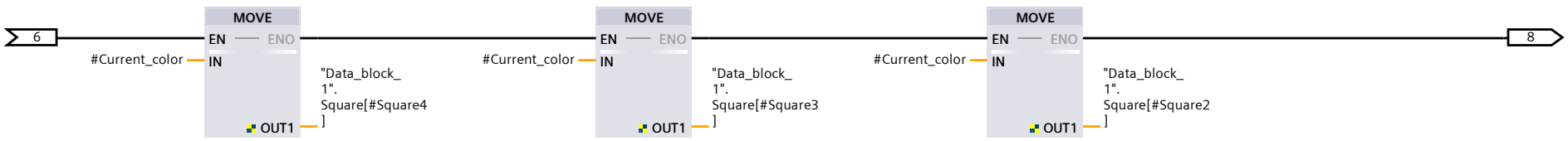




4.1 (Page7 - 5)

Network 1: Used to end checking if a valid move is found. (4.1 / 5.1)

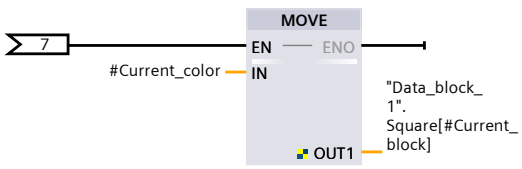
3.1 (Page7 - 4)

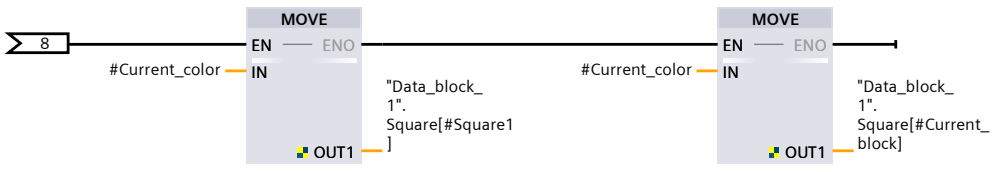


5.1 (Page7 - 6)

Network 1: Used to end checking if a valid move is found. (5.1 / 5.1)

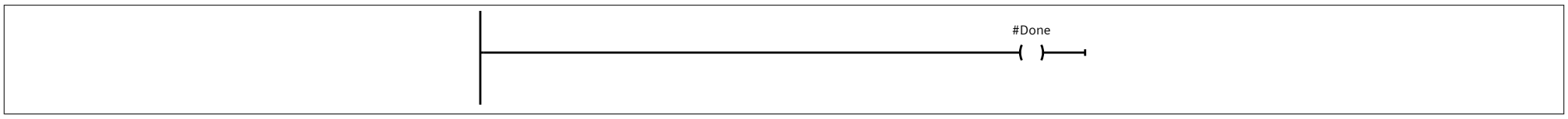
4.1 (Page7 - 5)





Network 2:

Finish the program and setell higher subroutine that it's finished



Program blocks

Horizontal_Check_DB [DB2]

Horizontal_Check_DB Properties							
General							
Name	Horizontal_Check_DB	**Number**	2	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writ-able from HMI/ OPC UA/ Web API	Visible in HMI engi-neering	Setpoint	Supervi-sion	Comment
Input									
Current_block	SInt	0	False	True	True	True	False		
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Finish	Bool	false	False	True	True	True	False		
InOut									
Static									
Take_Over_Left	"Take_Over"		False	True	True	True	True		
Input									
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Square1	SInt	0	False	True	True	True	False		
Square2	SInt	0	False	True	True	True	False		
Square3	SInt	0	False	True	True	True	False		
Square4	SInt	0	False	True	True	True	False		
Square5	SInt	0	False	True	True	True	False		
Square6	SInt	0	False	True	True	True	False		
Square7	SInt	0	False	True	True	True	False		
Move1	Bool	false	False	True	True	True	False		
Move2	Bool	false	False	True	True	True	False		
Move3	Bool	false	False	True	True	True	False		
Move4	Bool	false	False	True	True	True	False		
Move5	Bool	false	False	True	True	True	False		
Move6	Bool	false	False	True	True	True	False		
Move7	Bool	false	False	True	True	True	False		
Current_block	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Done	Bool	false	False	True	True	True	False		
InOut									
Static									
Take_Over_Right	"Take_Over"		False	True	True	True	True		
Input									
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Square1	SInt	0	False	True	True	True	False		
Square2	SInt	0	False	True	True	True	False		
Square3	SInt	0	False	True	True	True	False		
Square4	SInt	0	False	True	True	True	False		
Square5	SInt	0	False	True	True	True	False		
Square6	SInt	0	False	True	True	True	False		
Square7	SInt	0	False	True	True	True	False		
Move1	Bool	false	False	True	True	True	False		
Move2	Bool	false	False	True	True	True	False		
Move3	Bool	false	False	True	True	True	False		
Move4	Bool	false	False	True	True	True	False		
Move5	Bool	false	False	True	True	True	False		
Move6	Bool	false	False	True	True	True	False		
Move7	Bool	false	False	True	True	True	False		
Current_block	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Done	Bool	false	False	True	True	True	False		
InOut									
Static									

Program blocks

NE-SW_Check_DB [DB3]

NE-SW_Check_DB Properties							
General							
Name	NE-SW_Check_DB	**Number**	3	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Current_block	SInt	0	False	True	True	True	False		
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Finish	Bool	false	False	True	True	True	False		
InOut									
Static									
Take_Over_UpRight	"Take_Over"		False	True	True	True	True		
Input									
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Square1	SInt	0	False	True	True	True	False		
Square2	SInt	0	False	True	True	True	False		
Square3	SInt	0	False	True	True	True	False		
Square4	SInt	0	False	True	True	True	False		
Square5	SInt	0	False	True	True	True	False		
Square6	SInt	0	False	True	True	True	False		
Square7	SInt	0	False	True	True	True	False		
Move1	Bool	false	False	True	True	True	False		
Move2	Bool	false	False	True	True	True	False		
Move3	Bool	false	False	True	True	True	False		
Move4	Bool	false	False	True	True	True	False		
Move5	Bool	false	False	True	True	True	False		
Move6	Bool	false	False	True	True	True	False		
Move7	Bool	false	False	True	True	True	False		
Current_block	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Done	Bool	false	False	True	True	True	False		
InOut									
Static									
Take_Over_DownLeft	"Take_Over"		False	True	True	True	True		
Input									
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Square1	SInt	0	False	True	True	True	False		
Square2	SInt	0	False	True	True	True	False		
Square3	SInt	0	False	True	True	True	False		
Square4	SInt	0	False	True	True	True	False		
Square5	SInt	0	False	True	True	True	False		
Square6	SInt	0	False	True	True	True	False		
Square7	SInt	0	False	True	True	True	False		
Move1	Bool	false	False	True	True	True	False		
Move2	Bool	false	False	True	True	True	False		
Move3	Bool	false	False	True	True	True	False		
Move4	Bool	false	False	True	True	True	False		
Move5	Bool	false	False	True	True	True	False		
Move6	Bool	false	False	True	True	True	False		
Move7	Bool	false	False	True	True	True	False		
Current_block	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Done	Bool	false	False	True	True	True	False		
InOut									
Static									

Program blocks

NW-SE_Check_DB [DB4]

NW-SE_Check_DB Properties							
General							
Name	NW-SE_Check_DB	**Number**	4	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Current_block	SInt	0	False	True	True	True	False		
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Finish	Bool	false	False	True	True	True	False		
InOut									
Static									
Take_Over_UpLeft	"Take_Over"		False	True	True	True	True		
Input									
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Square1	SInt	0	False	True	True	True	False		
Square2	SInt	0	False	True	True	True	False		
Square3	SInt	0	False	True	True	True	False		
Square4	SInt	0	False	True	True	True	False		
Square5	SInt	0	False	True	True	True	False		
Square6	SInt	0	False	True	True	True	False		
Square7	SInt	0	False	True	True	True	False		
Move1	Bool	false	False	True	True	True	False		
Move2	Bool	false	False	True	True	True	False		
Move3	Bool	false	False	True	True	True	False		
Move4	Bool	false	False	True	True	True	False		
Move5	Bool	false	False	True	True	True	False		
Move6	Bool	false	False	True	True	True	False		
Move7	Bool	false	False	True	True	True	False		
Current_block	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Done	Bool	false	False	True	True	True	False		
InOut									
Static									
Take_Over_DownRight	"Take_Over"		False	True	True	True	True		
Input									
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Square1	SInt	0	False	True	True	True	False		
Square2	SInt	0	False	True	True	True	False		
Square3	SInt	0	False	True	True	True	False		
Square4	SInt	0	False	True	True	True	False		
Square5	SInt	0	False	True	True	True	False		
Square6	SInt	0	False	True	True	True	False		
Square7	SInt	0	False	True	True	True	False		
Move1	Bool	false	False	True	True	True	False		
Move2	Bool	false	False	True	True	True	False		
Move3	Bool	false	False	True	True	True	False		
Move4	Bool	false	False	True	True	True	False		
Move5	Bool	false	False	True	True	True	False		
Move6	Bool	false	False	True	True	True	False		
Move7	Bool	false	False	True	True	True	False		
Current_block	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Done	Bool	false	False	True	True	True	False		
InOut									
Static									

Program blocks

Vertical_Check_DB [DB5]

Vertical_Check_DB Properties							
General							
Name	Vertical_Check_DB	**Number**	5	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writ-able from HMI/ OPC UA/ Web API	Visible in HMI engi-neering	Setpoint	Supervi-sion	Comment
Input									
Current_block	SInt	0	False	True	True	True	False		
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Finish	Bool	false	False	True	True	True	False		
InOut									
Static									
Take_Over_Up	"Take_Over"		False	True	True	True	True		
Input									
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Square1	SInt	0	False	True	True	True	False		
Square2	SInt	0	False	True	True	True	False		
Square3	SInt	0	False	True	True	True	False		
Square4	SInt	0	False	True	True	True	False		
Square5	SInt	0	False	True	True	True	False		
Square6	SInt	0	False	True	True	True	False		
Square7	SInt	0	False	True	True	True	False		
Move1	Bool	false	False	True	True	True	False		
Move2	Bool	false	False	True	True	True	False		
Move3	Bool	false	False	True	True	True	False		
Move4	Bool	false	False	True	True	True	False		
Move5	Bool	false	False	True	True	True	False		
Move6	Bool	false	False	True	True	True	False		
Move7	Bool	false	False	True	True	True	False		
Current_block	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Done	Bool	false	False	True	True	True	False		
InOut									
Static									
Take_Over_Down	"Take_Over"		False	True	True	True	True		
Input									
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False	True	True	True	False		
Square1	SInt	0	False	True	True	True	False		
Square2	SInt	0	False	True	True	True	False		
Square3	SInt	0	False	True	True	True	False		
Square4	SInt	0	False	True	True	True	False		
Square5	SInt	0	False	True	True	True	False		
Square6	SInt	0	False	True	True	True	False		
Square7	SInt	0	False	True	True	True	False		
Move1	Bool	false	False	True	True	True	False		
Move2	Bool	false	False	True	True	True	False		
Move3	Bool	false	False	True	True	True	False		
Move4	Bool	false	False	True	True	True	False		
Move5	Bool	false	False	True	True	True	False		
Move6	Bool	false	False	True	True	True	False		
Move7	Bool	false	False	True	True	True	False		
Current_block	SInt	0	False	True	True	True	False		
Only_check	Bool	false	False	True	True	True	False		
Output									
Done	Bool	false	False	True	True	True	False		
InOut									
Static									

Program blocks

Toggle_bit [FB6]

Toggle_bit Properties							
General							
Name	Toggle_bit	**Number**	6	**Type**	FB	**Language**	SCL
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writ-able from HMI/ OPC UA/ Web API	Visible in HMI engi-neering	Setpoint	Supervi-sion	Comment
Input									
Output									
▼ InOut									
Bit	Bool	false	Non-retain	True	True	True	False		
Static									
Temp									
Constant									

```
0001 #Bit := NOT #Bit;
```

Symbol	Address	Type	Comment
#Bit		Bool	

Program blocks

Toggle_bit_DB [DB6]

Toggle_bit_DB Properties							
General							
Name	Toggle_bit_DB	**Number**	6	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writ-able from HMI/ OPC UA/ Web API	Visible in HMI engi-neering	Setpoint	Supervi-sion	Comment
Input									
Output									
▼ InOut									
Bit	Bool	false	False	True	True	True	False		
Static									

Program blocks

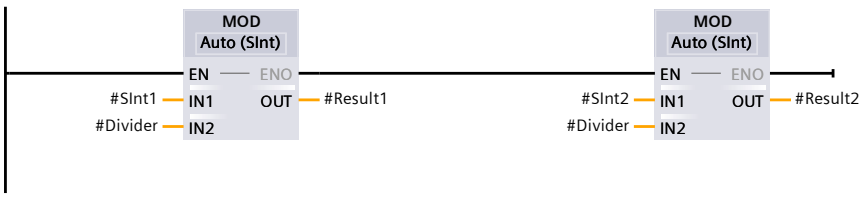
Compare_Remainder [FB7]

Compare_Remainder Properties							
General							
Name	Compare_Remainder	**Number**	7	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
SInt1	SInt	0	Non-retain	True	True	True	False		
SInt2	SInt	0	Non-retain	True	True	True	False		
Divider	SInt	0	Non-retain	True	True	True	False		
Output									
IsBigger	Bool	false	Non-retain	True	True	True	False		
IsSmaller	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
Temp									
Result1	SInt								
Result2	SInt								
Constant									

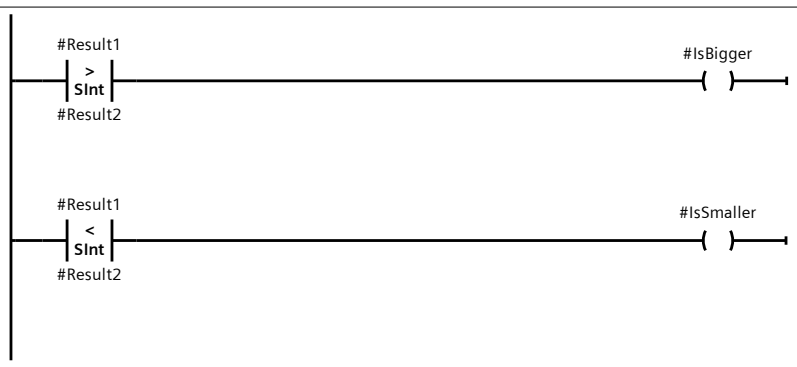
Network 1:

Calculate division remainders for 2 SInt numbers



Network 2:

Compare the remainders and give feedback on their relation.



Program blocks

Compare_Remainder_DB [DB7]

Compare_Remainder_DB Properties							
General							
Name	Compare_Remainder_DB	**Number**	7	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
SInt1	SInt	0	False	True	True	True	False		
SInt2	SInt	0	False	True	True	True	False		
Divider	SInt	0	False	True	True	True	False		
Output									
IsBigger	Bool	false	False	True	True	True	False		
IsSmaller	Bool	false	False	True	True	True	False		
InOut									
Static									

Program blocks

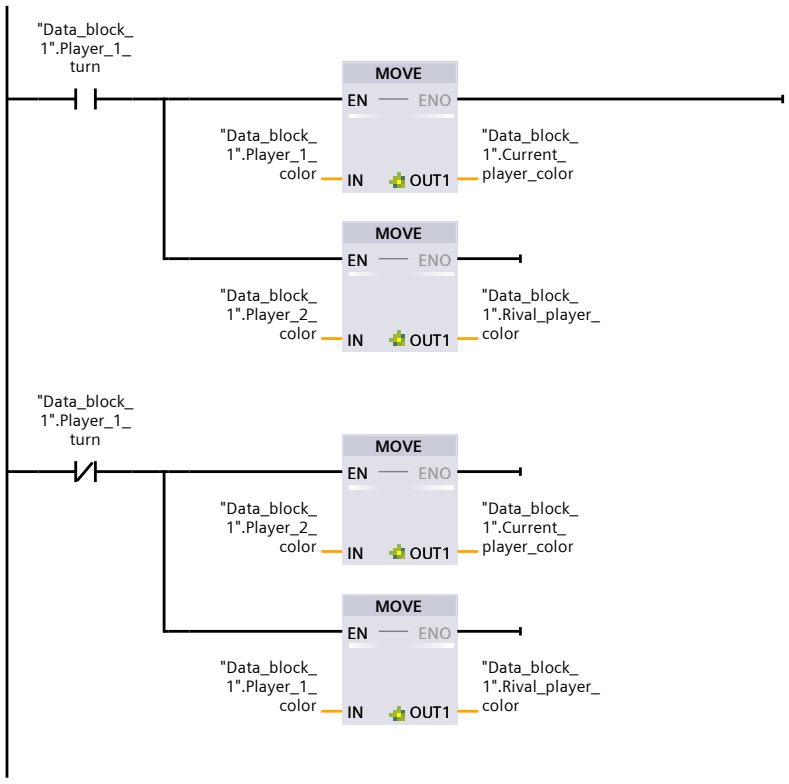
Set_Current_Color [FB8]

Set_Current_Color Properties							
General							
Name	Set_Current_Color	**Number**	8	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Output									
InOut									
Static									
Temp									
Constant									

Network 1:

Set current color according to data in Data_block_1



Program blocks

Set_Current_Color_DB [DB12]

Set_Current_Color_DB Properties							
General							
Name	Set_Current_Color_DB	**Number**	12	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writ-able from HMI/ OPC UA/ Web API	Visible in HMI engi-neering	Setpoint	Supervi-sion	Comment
Input									
Output									
InOut									
Static									

Program blocks

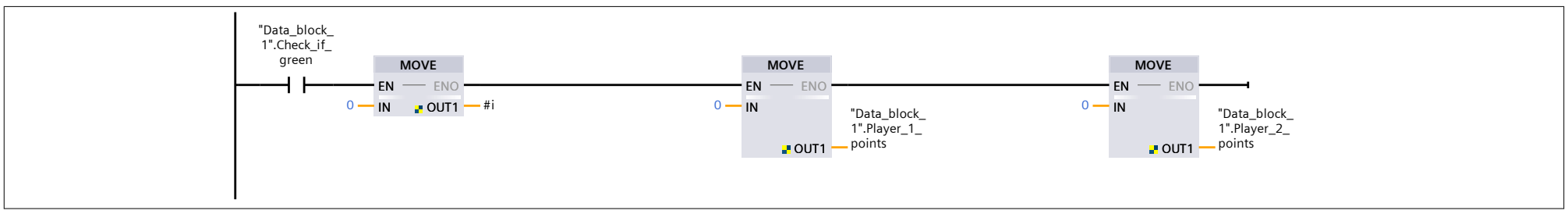
Hint_And_Point_System [FB9]

Hint_And_Point_System Properties							
General							
Name	Hint_And_Point_System	**Number**	9	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Output									
InOut									
Static									
▼ Temp									
i	SInt								
Current_block	SInt								
Current_block_begin_value	SInt								
Begin_check	Bool								
▼ Constant									
Only_check	Bool	true							

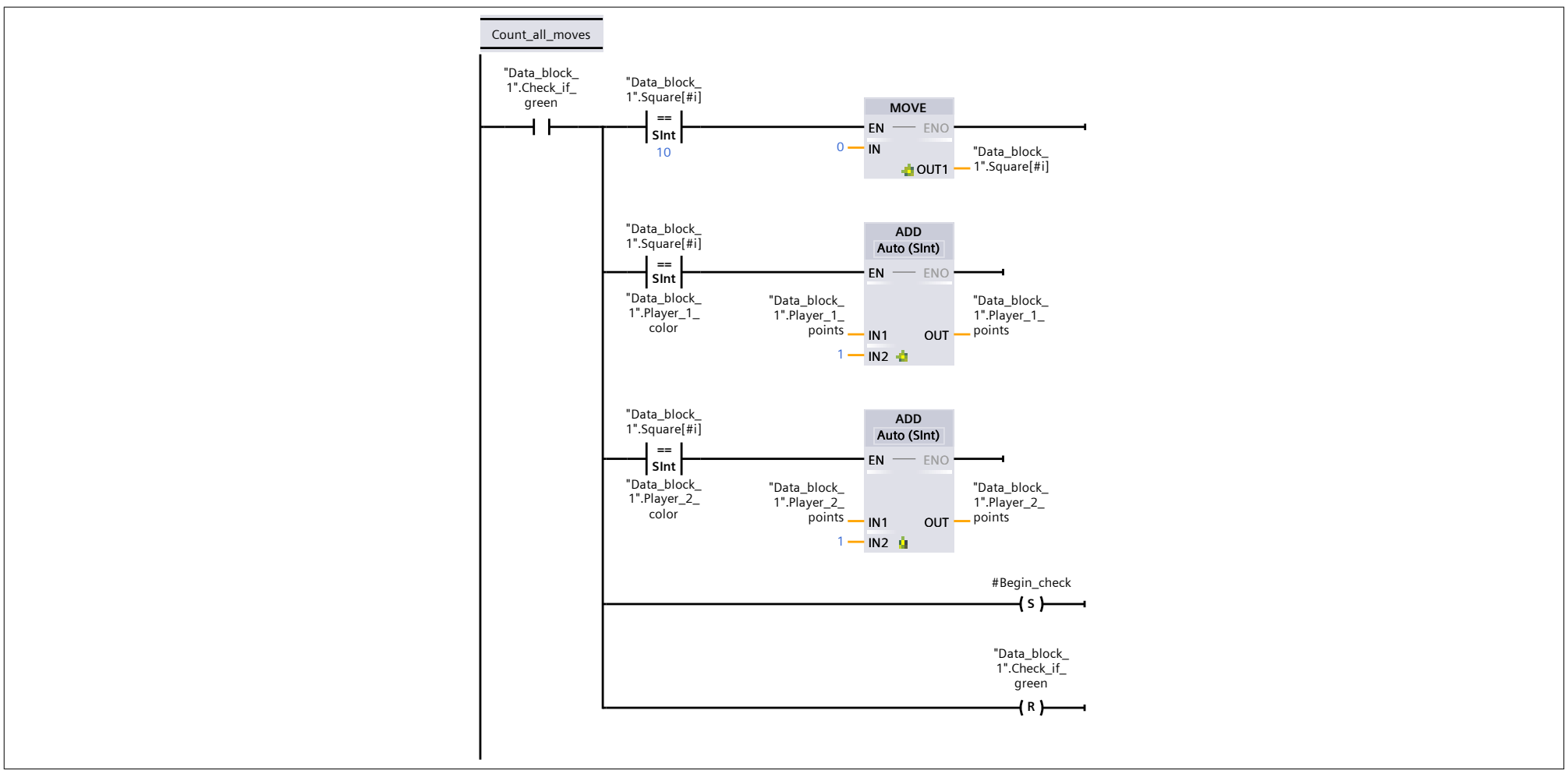
Network 1:

Init variables used for hint and point calculation



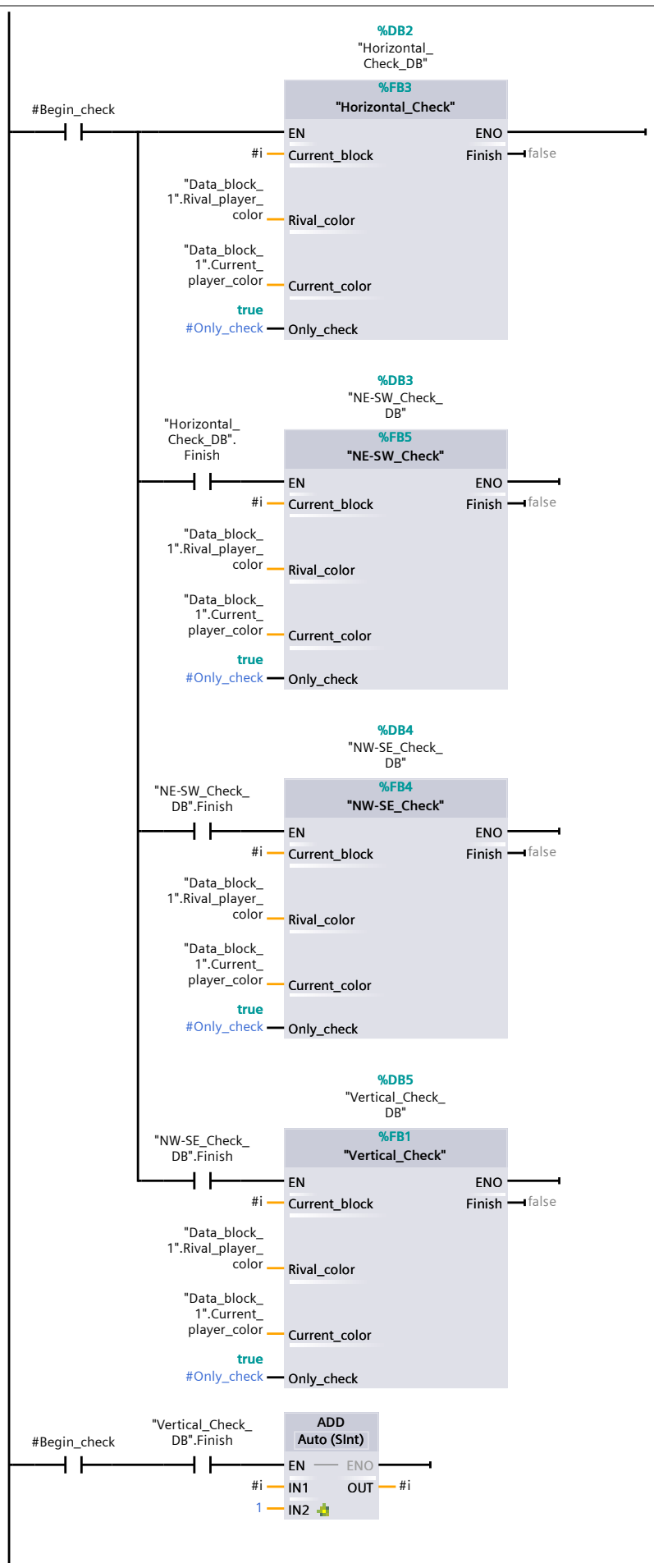
Network 2:

Check if current block is green (possible move) and calculate points based on current contents of Square[] array



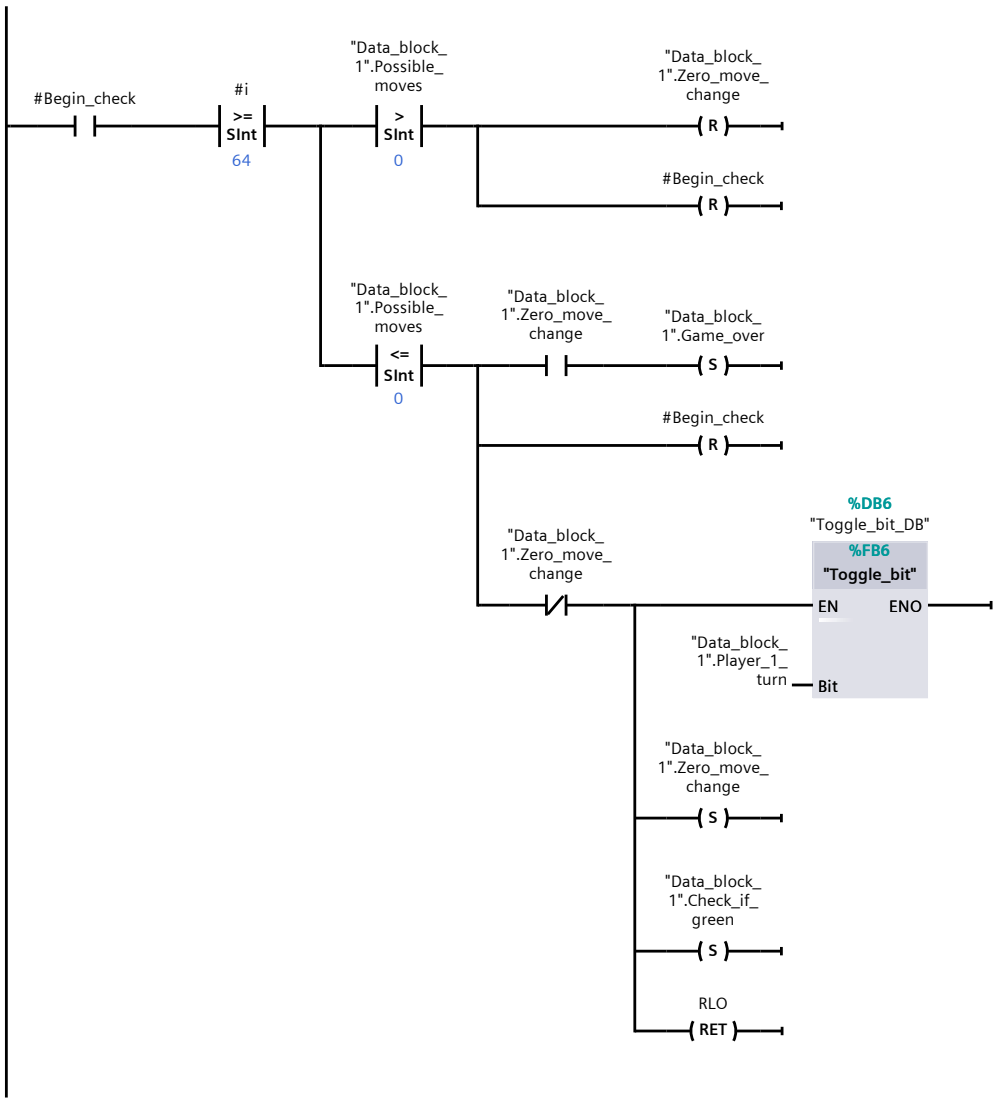
Network 3:

The same blocks that are used for taking over, except they are set to mark possible moves with the value of 10 in Square[] array (only checking)



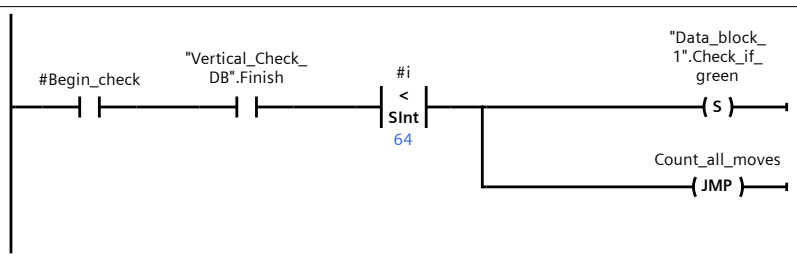
Network 4: Default false; tells the program whether last turn was invalid and current player has been toggled

Changes current player if there are no possible moves. Condition for ending the loop. If current player has been changed two times in a row there are no more possible moves and the game has to end.



Network 5: Default false; check the board for green places (possible moves)

Continues loop if current loop variable is less than the size of Square[] array



Program blocks

Hint_And_Point_System_DB [DB8]

Hint_And_Point_System_DB Properties							
General							
Name	Hint_And_Point_System_DB	**Number**	8	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writ-able from HMI/ OPC UA/ Web API	Visible in HMI engi-neering	Setpoint	Supervi-sion	Comment
Input									
Output									
InOut									
Static									

Program blocks

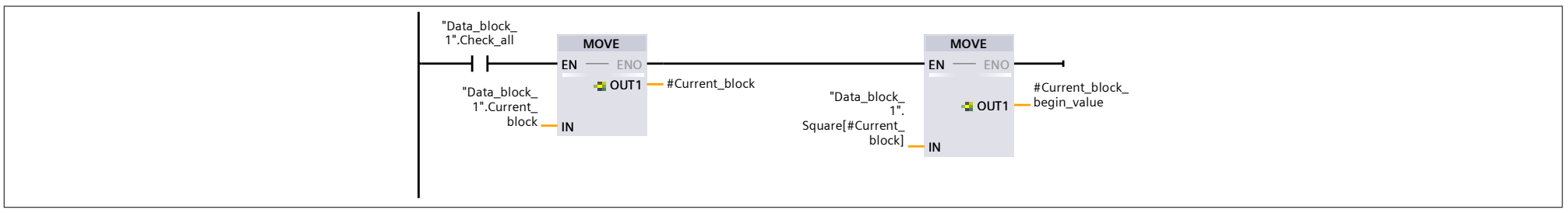
Check_And_Take_Over_System [FB10]

Check_And_Take_Over_System Properties							
General							
Name	Check_And_Take_Over_System	**Number**	10	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Output									
InOut									
Static									
▼ Temp									
Current_block	SInt								
Current_block_begin_value	SInt								
Check_4	Bool								
Check_3	Bool								
Check_2	Bool								
Check_1	Bool								
Check_finished	Bool								
Constant									

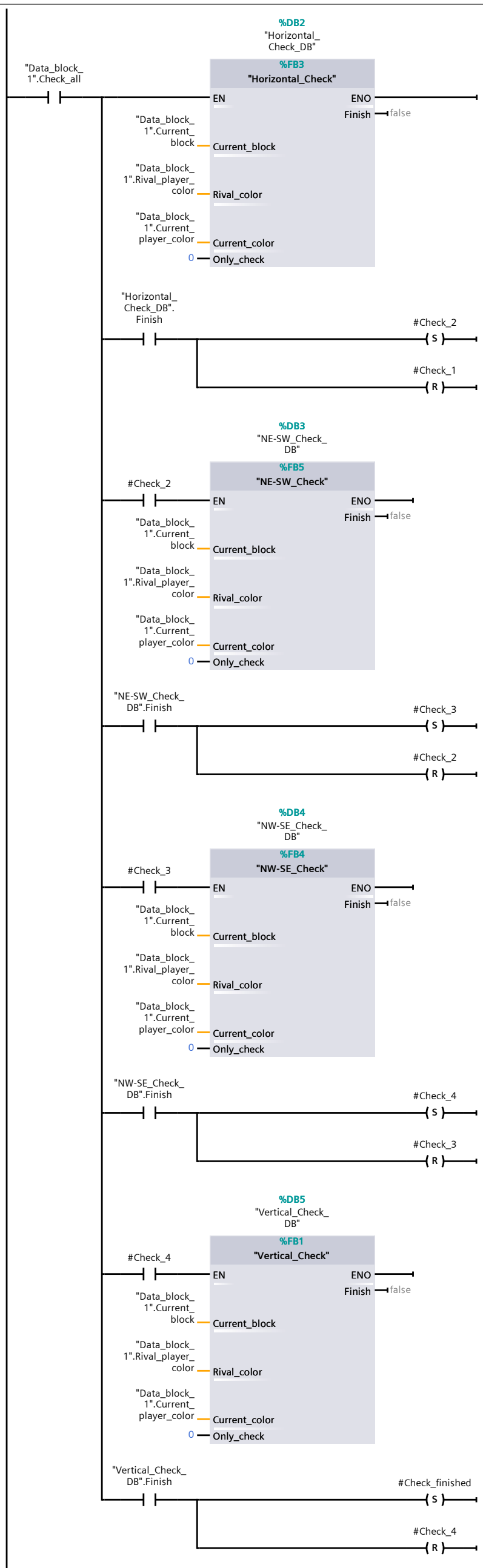
Network 1:

Save current index and value of clicked square



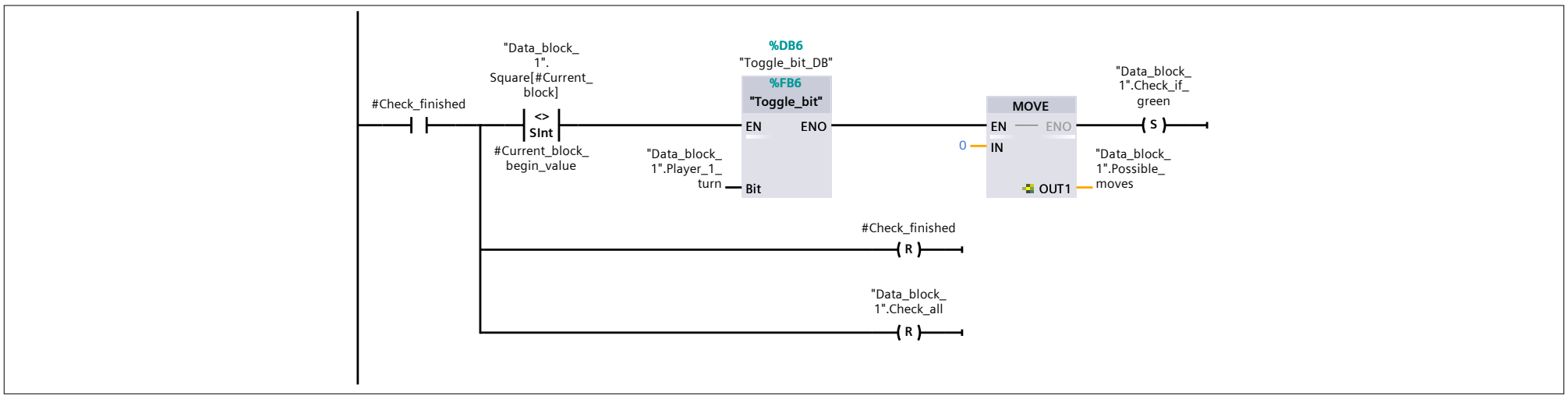
Network 2:

Perform checking in all directions and take over squares if conditions met. Checks are performed sequentially in order to reduce possible collisions of interest between functions.



Network 3: Default false; check the board for green places (possible moves)

If checking in all directions has been finished check if a valid move was made, toggle current player, reset possible moves count and set Check_if_green in order to activate the hint system.


"Data_block_
1".
Square[#Current_
block]
#Check_finished
<>
SInt
#Current_block_
begin_value
%DB6
"Toggle_bit_DB"
%FB6
"Toggle_bit"
EN
ENO
"Data_block_
1".Player_1_
turn
Bit
MOVE
EN
ENO
0
IN
OUT1
"Data_block_
1".Check_if_
green
S
"Data_block_
1".Possible_
moves
#Check_finished
R
"Data_block_
1".Check_all
R

Program blocks

Check_And_Take_Over_System_DB [DB9]

Check_And_Take_Over_System_DB Properties							
General							
Name	Check_And_Take_Over_System_DB	**Number**	9	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Output									
InOut									
Static									

Program blocks

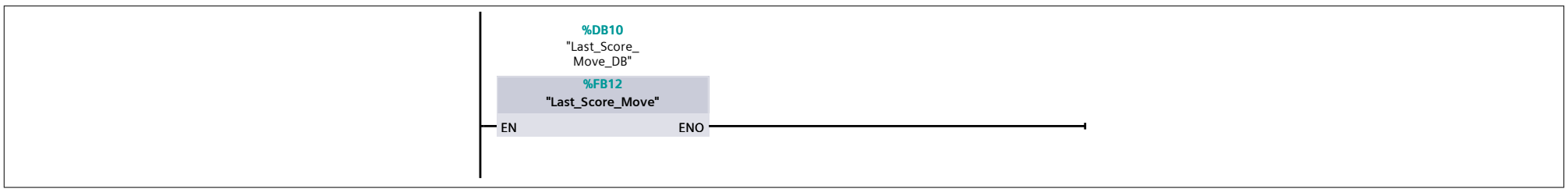
Save_Score [FB11]

Save_Score Properties							
General							
Name	Save_Score	**Number**	11	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Output									
InOut									
Static									
Temp									
Current_win_score	SInt								
Current_win_name	String								
Current_lose_name	String								
Current_lose_score	SInt								
Constant									

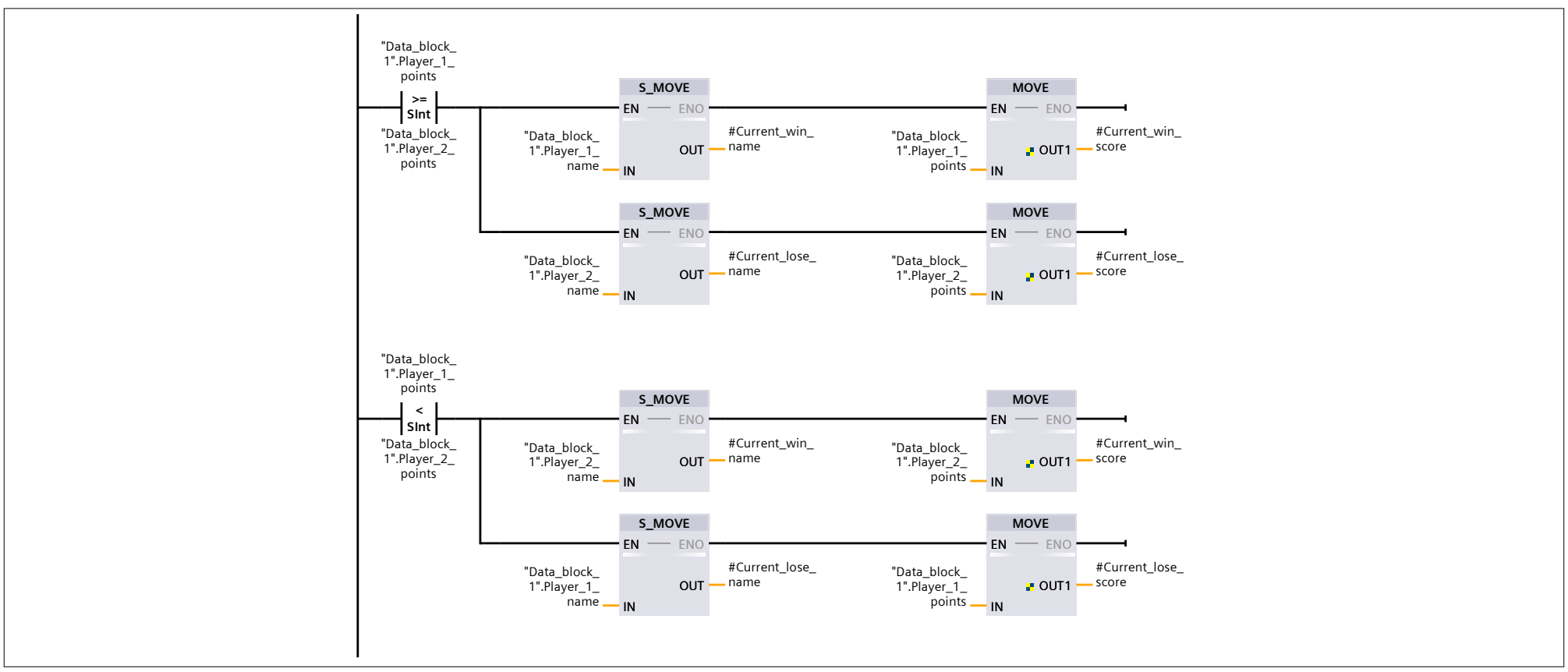
Network 1:

Save current scores to Last scores array



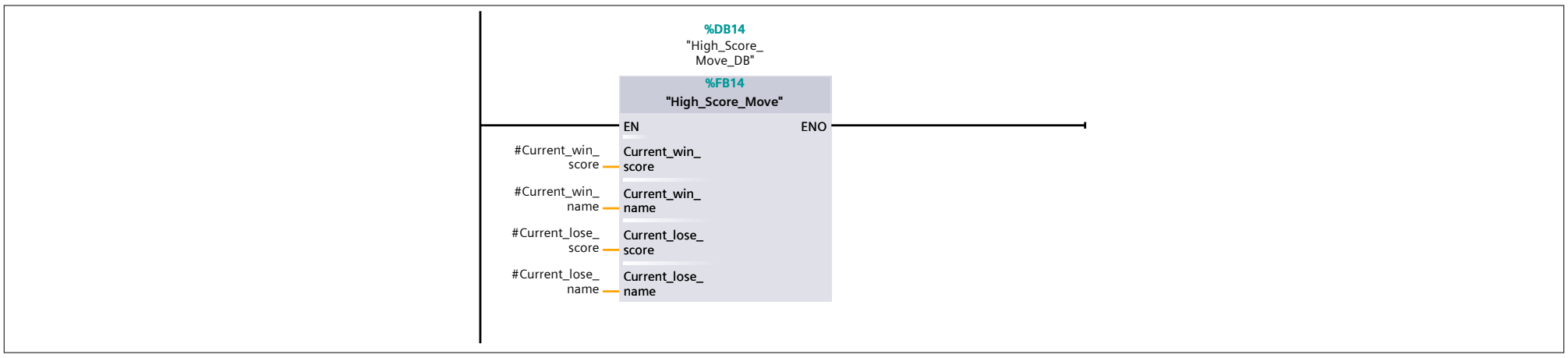
Network 2:

Check which player has won



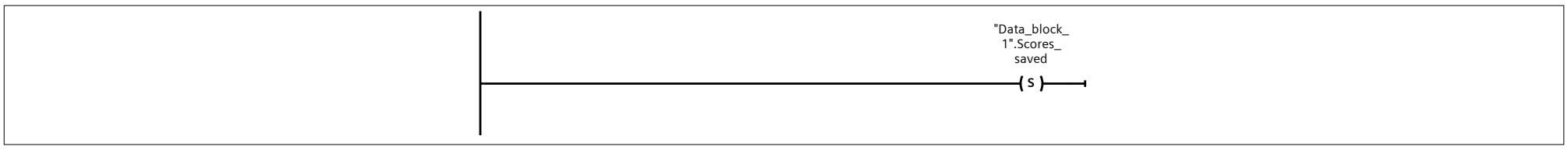
Network 3:

Save High scores according to results from Network 2



Network 4:

Set Scores_saved to true



Program blocks

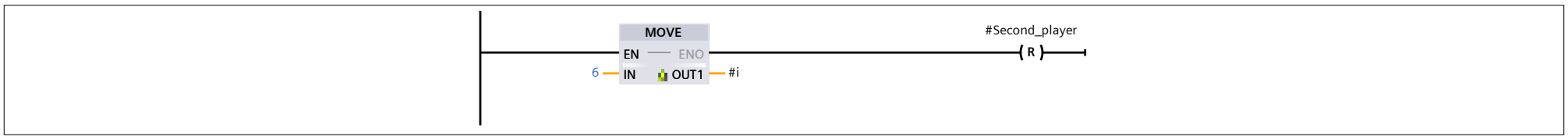
Last_Score_Move [FB12]

Last_Score_Move Properties							
General							
Name	Last_Score_Move	**Number**	12	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Output									
InOut									
Static									
Temp									
i	SInt								
Temp_points	SInt								
Temp_names	String								
Second_player	Bool								
Constant									

Network 1:

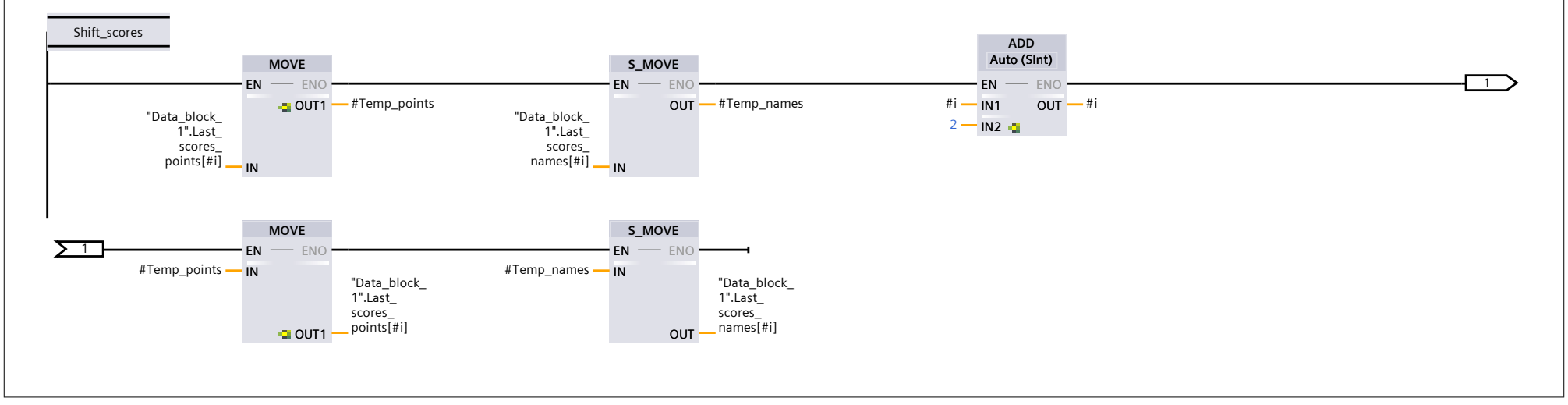
Start with player 1's score 4 matches ago



Network 2:

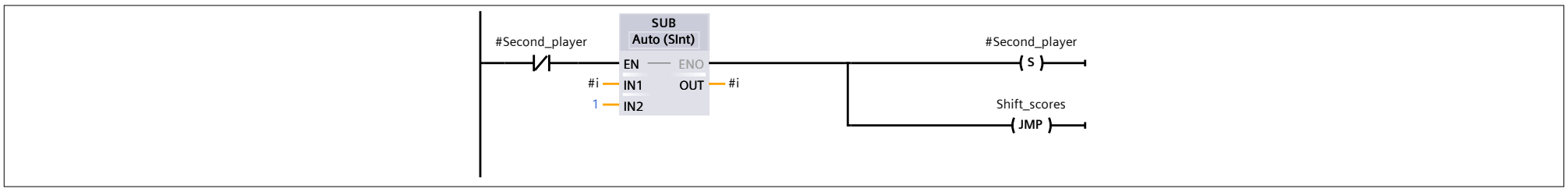
Shift all scores and names by 2 places (Player 1's scores and names)

Network 2:



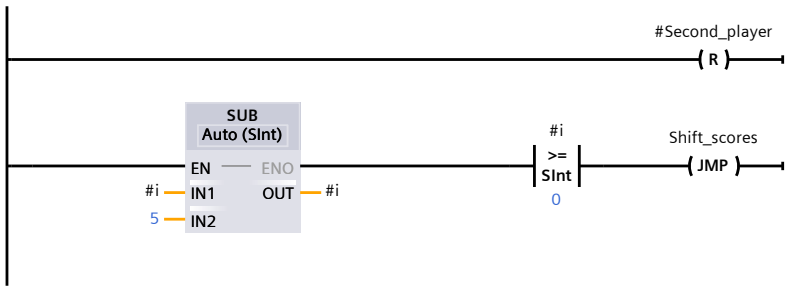
Network 3:

Player 2's scores and names



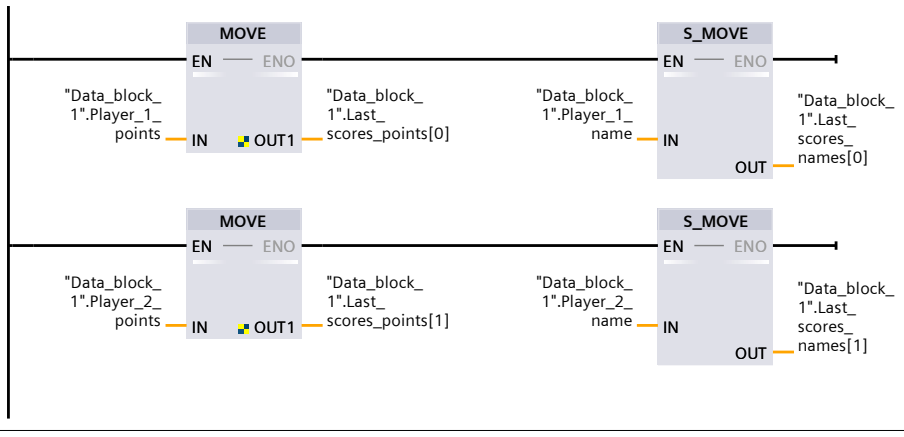
Network 4:

Go back to Player 1's more recent match score and name



Network 5:

Save data from the current match in Last Scores array (points and names)



Program blocks

Last_Score_Move_DB [DB10]

Last_Score_Move_DB Properties							
General							
Name	Last_Score_Move_DB	**Number**	10	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writ-able from HMI/ OPC UA/ Web API	Visible in HMI engi-neering	Setpoint	Supervi-sion	Comment
Input									
Output									
InOut									
Static									

Program blocks

Save_Score_DB [DB11]

Save_Score_DB Properties							
General							
Name	Save_Score_DB	**Number**	11	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Output									
InOut									
Static									

Program blocks

Reset_Game [FB13]

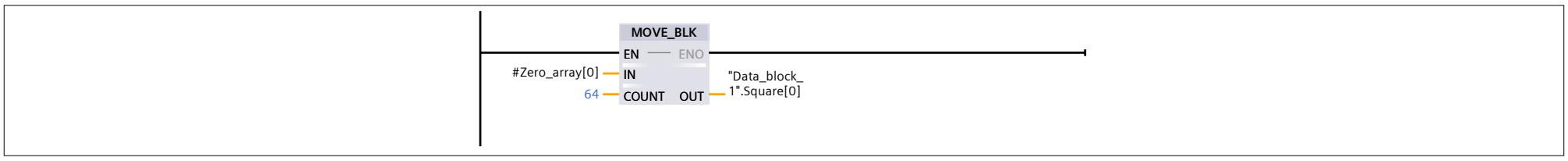
Reset_Game Properties							
General							
Name	Reset_Game	**Number**	13	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Output									
InOut									
▼ Static									
▼ Zero_array	Array[0..63] of SInt		Non-retain	False	False	False	False		
Zero_array[0]	SInt	0	Non-retain	False	False	False	False		
Zero_array[1]	SInt	0	Non-retain	False	False	False	False		
Zero_array[2]	SInt	0	Non-retain	False	False	False	False		
Zero_array[3]	SInt	0	Non-retain	False	False	False	False		
Zero_array[4]	SInt	0	Non-retain	False	False	False	False		
Zero_array[5]	SInt	0	Non-retain	False	False	False	False		
Zero_array[6]	SInt	0	Non-retain	False	False	False	False		
Zero_array[7]	SInt	0	Non-retain	False	False	False	False		
Zero_array[8]	SInt	0	Non-retain	False	False	False	False		
Zero_array[9]	SInt	0	Non-retain	False	False	False	False		
Zero_array[10]	SInt	0	Non-retain	False	False	False	False		
Zero_array[11]	SInt	0	Non-retain	False	False	False	False		
Zero_array[12]	SInt	0	Non-retain	False	False	False	False		
Zero_array[13]	SInt	0	Non-retain	False	False	False	False		
Zero_array[14]	SInt	0	Non-retain	False	False	False	False		
Zero_array[15]	SInt	0	Non-retain	False	False	False	False		
Zero_array[16]	SInt	0	Non-retain	False	False	False	False		
Zero_array[17]	SInt	0	Non-retain	False	False	False	False		
Zero_array[18]	SInt	0	Non-retain	False	False	False	False		
Zero_array[19]	SInt	0	Non-retain	False	False	False	False		
Zero_array[20]	SInt	0	Non-retain	False	False	False	False		
Zero_array[21]	SInt	0	Non-retain	False	False	False	False		
Zero_array[22]	SInt	0	Non-retain	False	False	False	False		
Zero_array[23]	SInt	0	Non-retain	False	False	False	False		
Zero_array[24]	SInt	0	Non-retain	False	False	False	False		
Zero_array[25]	SInt	0	Non-retain	False	False	False	False		
Zero_array[26]	SInt	0	Non-retain	False	False	False	False		
Zero_array[27]	SInt	0	Non-retain	False	False	False	False		
Zero_array[28]	SInt	0	Non-retain	False	False	False	False		
Zero_array[29]	SInt	0	Non-retain	False	False	False	False		
Zero_array[30]	SInt	0	Non-retain	False	False	False	False		
Zero_array[31]	SInt	0	Non-retain	False	False	False	False		
Zero_array[32]	SInt	0	Non-retain	False	False	False	False		
Zero_array[33]	SInt	0	Non-retain	False	False	False	False		
Zero_array[34]	SInt	0	Non-retain	False	False	False	False		
Zero_array[35]	SInt	0	Non-retain	False	False	False	False		
Zero_array[36]	SInt	0	Non-retain	False	False	False	False		
Zero_array[37]	SInt	0	Non-retain	False	False	False	False		
Zero_array[38]	SInt	0	Non-retain	False	False	False	False		
Zero_array[39]	SInt	0	Non-retain	False	False	False	False		
Zero_array[40]	SInt	0	Non-retain	False	False	False	False		
Zero_array[41]	SInt	0	Non-retain	False	False	False	False		
Zero_array[42]	SInt	0	Non-retain	False	False	False	False		
Zero_array[43]	SInt	0	Non-retain	False	False	False	False		
Zero_array[44]	SInt	0	Non-retain	False	False	False	False		
Zero_array[45]	SInt	0	Non-retain	False	False	False	False		
Zero_array[46]	SInt	0	Non-retain	False	False	False	False		
Zero_array[47]	SInt	0	Non-retain	False	False	False	False		
Zero_array[48]	SInt	0	Non-retain	False	False	False	False		
Zero_array[49]	SInt	0	Non-retain	False	False	False	False		
Zero_array[50]	SInt	0	Non-retain	False	False	False	False		
Zero_array[51]	SInt	0	Non-retain	False	False	False	False		
Zero_array[52]	SInt	0	Non-retain	False	False	False	False		
Zero_array[53]	SInt	0	Non-retain	False	False	False	False		
Zero_array[54]	SInt	0	Non-retain	False	False	False	False		

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Zero_array[55]	SInt	0	Non-retain	False	False	False	False		
Zero_array[56]	SInt	0	Non-retain	False	False	False	False		
Zero_array[57]	SInt	0	Non-retain	False	False	False	False		
Zero_array[58]	SInt	0	Non-retain	False	False	False	False		
Zero_array[59]	SInt	0	Non-retain	False	False	False	False		
Zero_array[60]	SInt	0	Non-retain	False	False	False	False		
Zero_array[61]	SInt	0	Non-retain	False	False	False	False		
Zero_array[62]	SInt	0	Non-retain	False	False	False	False		
Zero_array[63]	SInt	0	Non-retain	False	False	False	False		
▼ Temp									
i	SInt								
Constant									

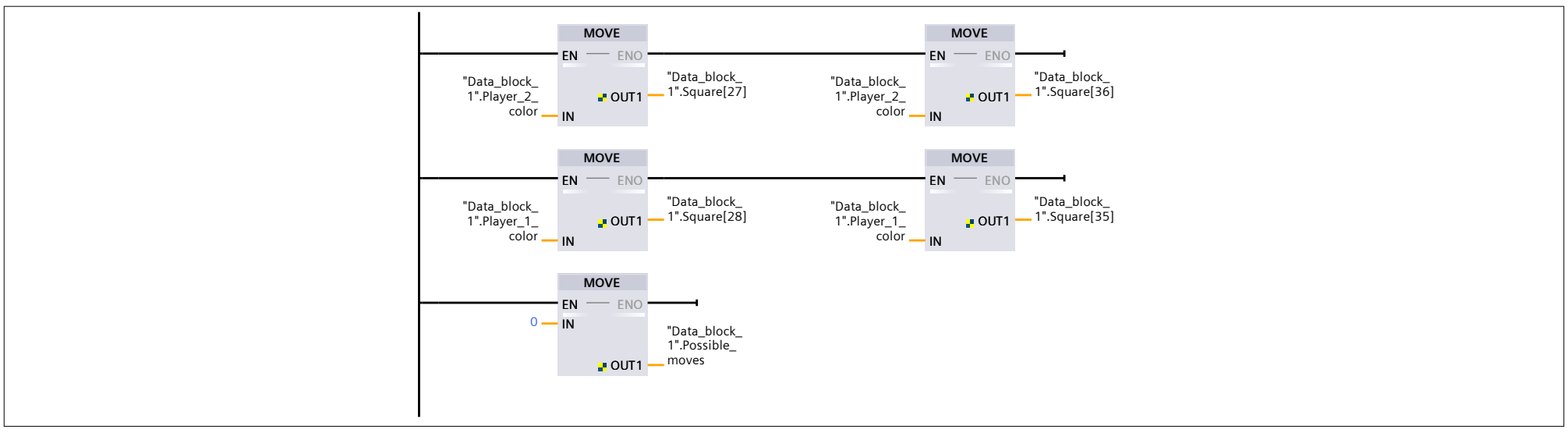
Network 1:

Fill the Square[] array with zeros



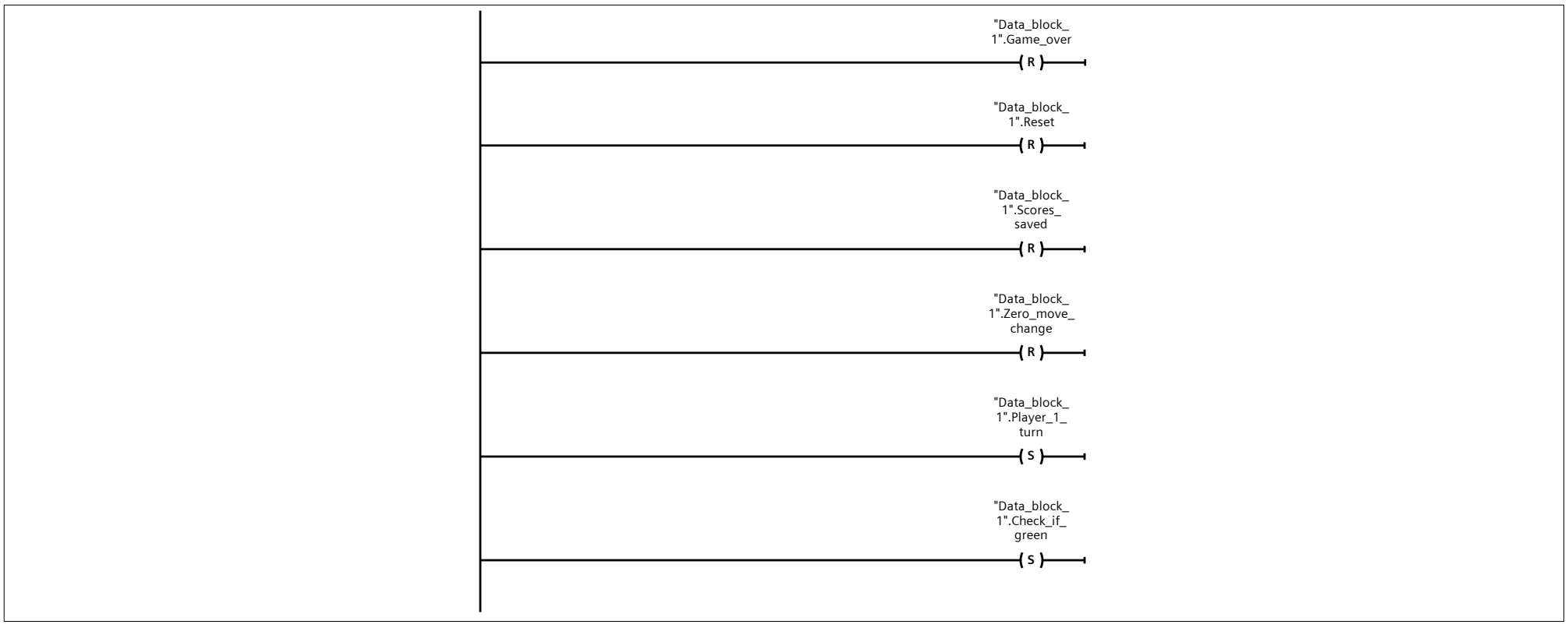
Network 2:

Fill in beginning, default squares with corresponding player color values



Network 3: Default false; tells the PLC if a game has finished

Set default variables for a new game



Program blocks

Reset_Game_DB [DB13]

Reset_Game_DB Properties							
General							
Name	Reset_Game_DB	**Number**	13	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Output									
InOut									
▼ Static									
▼ Zero_array	Array[0..63] of SInt		False	False	False	False	False		
Zero_array[0]	SInt	0	False	False	False	False	False		
Zero_array[1]	SInt	0	False	False	False	False	False		
Zero_array[2]	SInt	0	False	False	False	False	False		
Zero_array[3]	SInt	0	False	False	False	False	False		
Zero_array[4]	SInt	0	False	False	False	False	False		
Zero_array[5]	SInt	0	False	False	False	False	False		
Zero_array[6]	SInt	0	False	False	False	False	False		
Zero_array[7]	SInt	0	False	False	False	False	False		
Zero_array[8]	SInt	0	False	False	False	False	False		
Zero_array[9]	SInt	0	False	False	False	False	False		
Zero_array[10]	SInt	0	False	False	False	False	False		
Zero_array[11]	SInt	0	False	False	False	False	False		
Zero_array[12]	SInt	0	False	False	False	False	False		
Zero_array[13]	SInt	0	False	False	False	False	False		
Zero_array[14]	SInt	0	False	False	False	False	False		
Zero_array[15]	SInt	0	False	False	False	False	False		
Zero_array[16]	SInt	0	False	False	False	False	False		
Zero_array[17]	SInt	0	False	False	False	False	False		
Zero_array[18]	SInt	0	False	False	False	False	False		
Zero_array[19]	SInt	0	False	False	False	False	False		
Zero_array[20]	SInt	0	False	False	False	False	False		
Zero_array[21]	SInt	0	False	False	False	False	False		
Zero_array[22]	SInt	0	False	False	False	False	False		
Zero_array[23]	SInt	0	False	False	False	False	False		
Zero_array[24]	SInt	0	False	False	False	False	False		
Zero_array[25]	SInt	0	False	False	False	False	False		
Zero_array[26]	SInt	0	False	False	False	False	False		
Zero_array[27]	SInt	0	False	False	False	False	False		
Zero_array[28]	SInt	0	False	False	False	False	False		
Zero_array[29]	SInt	0	False	False	False	False	False		
Zero_array[30]	SInt	0	False	False	False	False	False		
Zero_array[31]	SInt	0	False	False	False	False	False		
Zero_array[32]	SInt	0	False	False	False	False	False		
Zero_array[33]	SInt	0	False	False	False	False	False		
Zero_array[34]	SInt	0	False	False	False	False	False		
Zero_array[35]	SInt	0	False	False	False	False	False		
Zero_array[36]	SInt	0	False	False	False	False	False		
Zero_array[37]	SInt	0	False	False	False	False	False		
Zero_array[38]	SInt	0	False	False	False	False	False		
Zero_array[39]	SInt	0	False	False	False	False	False		
Zero_array[40]	SInt	0	False	False	False	False	False		
Zero_array[41]	SInt	0	False	False	False	False	False		
Zero_array[42]	SInt	0	False	False	False	False	False		
Zero_array[43]	SInt	0	False	False	False	False	False		
Zero_array[44]	SInt	0	False	False	False	False	False		
Zero_array[45]	SInt	0	False	False	False	False	False		
Zero_array[46]	SInt	0	False	False	False	False	False		
Zero_array[47]	SInt	0	False	False	False	False	False		
Zero_array[48]	SInt	0	False	False	False	False	False		
Zero_array[49]	SInt	0	False	False	False	False	False		
Zero_array[50]	SInt	0	False	False	False	False	False		
Zero_array[51]	SInt	0	False	False	False	False	False		
Zero_array[52]	SInt	0	False	False	False	False	False		
Zero_array[53]	SInt	0	False	False	False	False	False		
Zero_array[54]	SInt	0	False	False	False	False	False		

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Zero_array[55]	SInt	0	False	False	False	False	False		
Zero_array[56]	SInt	0	False	False	False	False	False		
Zero_array[57]	SInt	0	False	False	False	False	False		
Zero_array[58]	SInt	0	False	False	False	False	False		
Zero_array[59]	SInt	0	False	False	False	False	False		
Zero_array[60]	SInt	0	False	False	False	False	False		
Zero_array[61]	SInt	0	False	False	False	False	False		
Zero_array[62]	SInt	0	False	False	False	False	False		
Zero_array[63]	SInt	0	False	False	False	False	False		

Program blocks

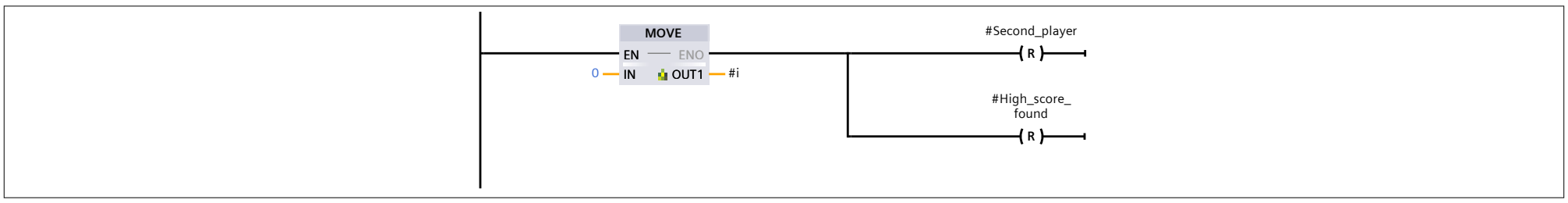
High_Score_Move [FB14]

High_Score_Move Properties							
General							
Name	High_Score_Move	**Number**	14	**Type**	FB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Current_win_score	SInt	0	Non-retain	True	True	True	False		
Current_win_name	String	''	Non-retain	True	True	True	False		
Current_lose_score	SInt	0	Non-retain	True	True	True	False		
Current_lose_name	String	''	Non-retain	False	False	False	False		
Output									
InOut									
Static									
Temp									
i	SInt								
j	SInt								
Temp_points	SInt								
Temp_names	String								
Second_player	Bool								
High_score_found	Bool								
Constant									

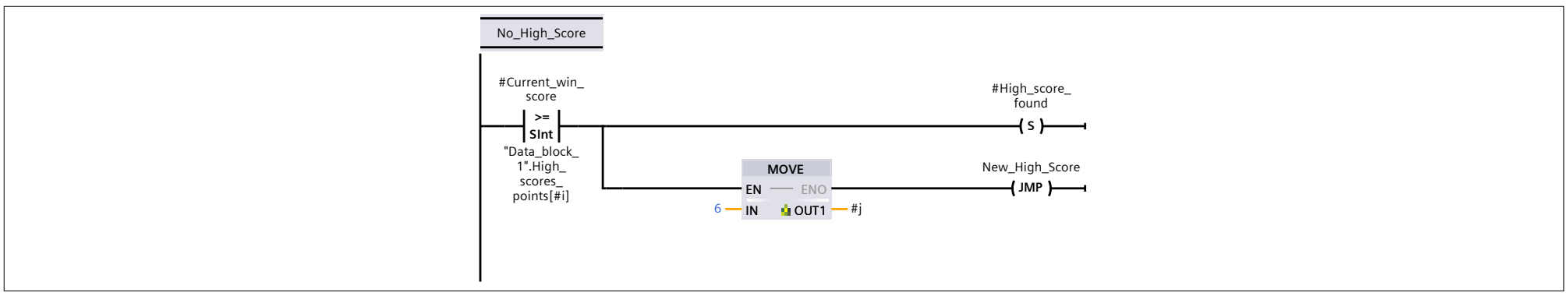
Network 1:

Initialize first loop variable



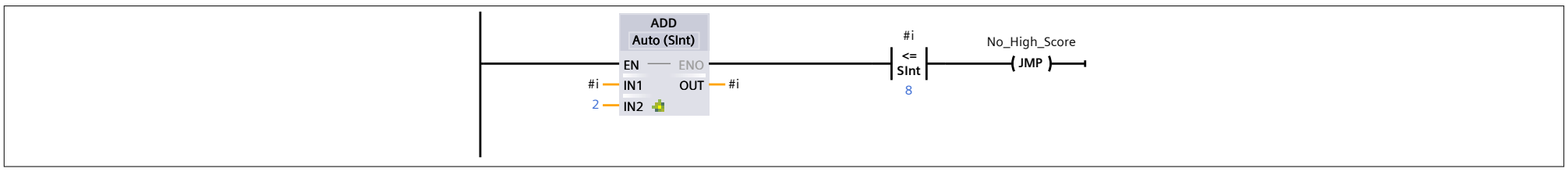
Network 2:

If a new high score is found initialize second loop variable



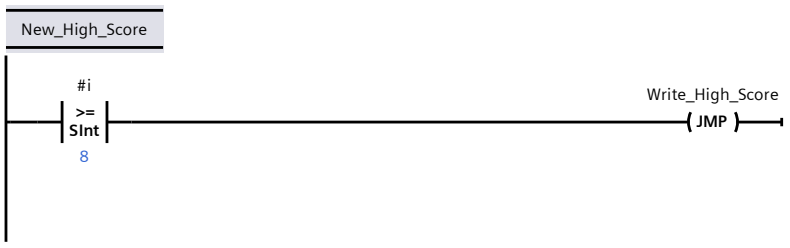
Network 3:

if no new high score is found move on to next record



Network 4:

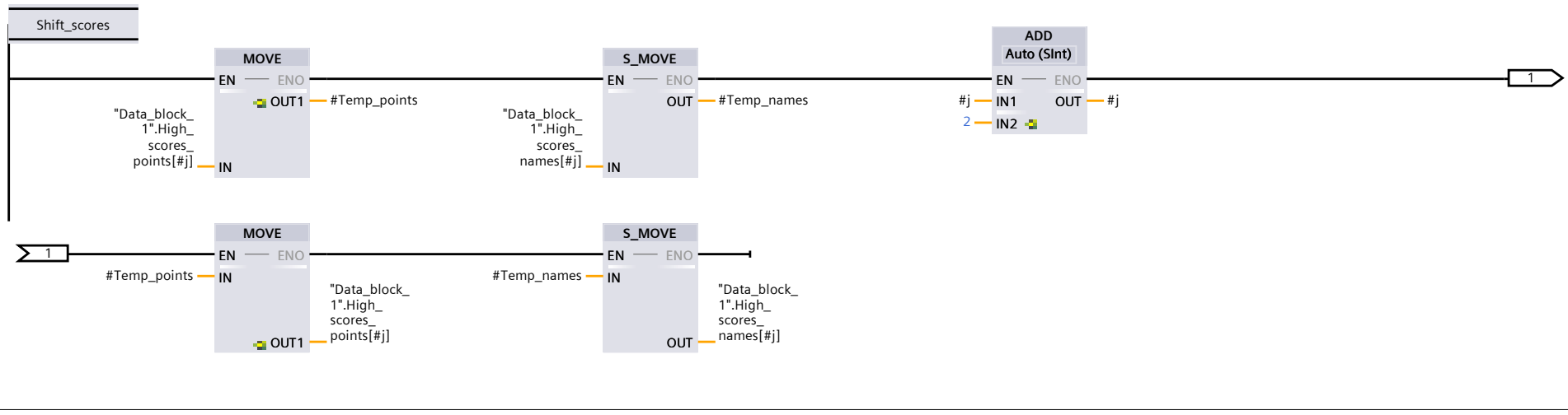
If current high score will only replace the last record of array skip the loop



Network 5:

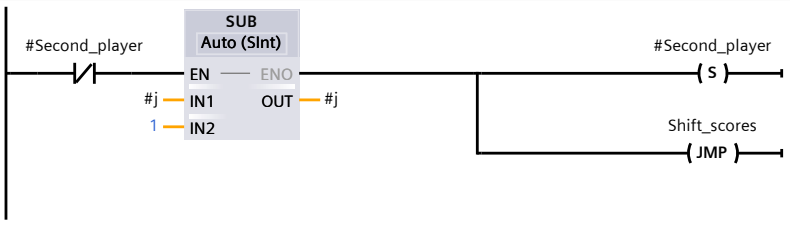
Shift all scores lower than current high score and names by 2 places (Player 1's scores and names)

Network 5:



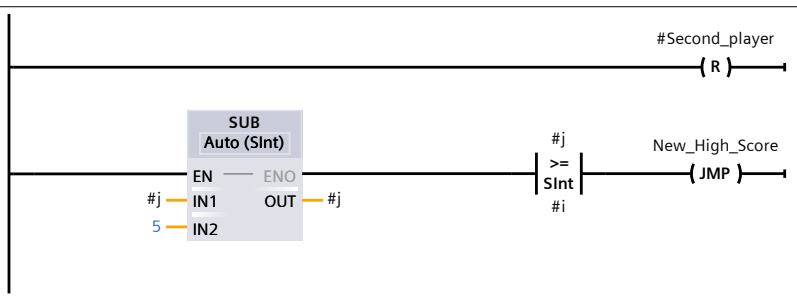
Network 6:

Player 2's scores and names



Network 7:

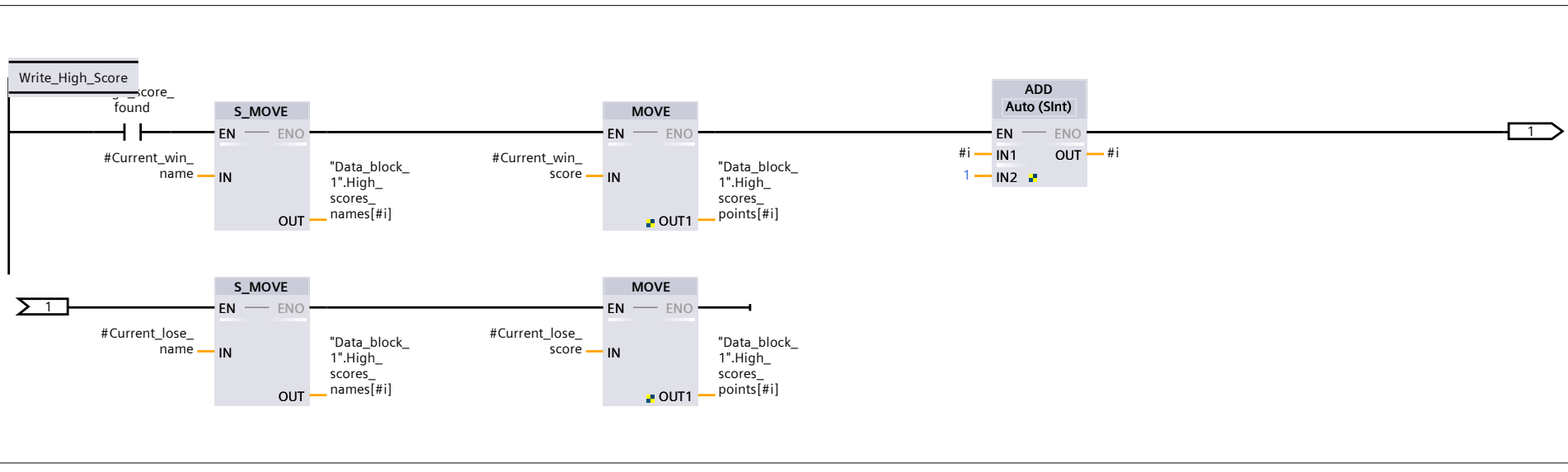
Go back to Player 1's more recent match score and name (move up a row). if calculated second loop variable is greater or equal than first loop variable, continue loop



Network 8:

Move current high score to corresponding place in high scores array

Network 8:



Program blocks

High_Score_Move_DB [DB14]

High_Score_Move_DB Properties							
General							
Name	High_Score_Move_DB	**Number**	14	**Type**	DB	**Language**	DB
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Setpoint	Supervision	Comment
▼ Input									
Current_win_score	SInt	0	False	True	True	True	False		
Current_win_name	String	''	False	True	True	True	False		
Current_lose_score	SInt	0	False	True	True	True	False		
Current_lose_name	String	''	False	False	False	False	False		
Output									
InOut									
Static									