4-phase reshufflings with 2 ports

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This document lists 2 port, 4-phase HSE reshufflings and their implementations in PRS. By symmetry, some reshufflings are redundant. Specifically, $[x_i \wedge y_i]$ is the same as $[y_i \wedge x_i]$, and $x_o \uparrow, y_o \uparrow$ is the same as $y_o \uparrow, x_o \uparrow$. In addition, when the ports are both active or both passive, their names are interchangeable, which makes other reshufflings redundant. Redundant reshufflings are not included. Some implementations require a state variable. We use u as our state variable.

1 Active X, Active Y

This combination has 30 orderings.

```
0) x_o \uparrow; [x_i]; x_o \downarrow; [\neg x_i]; y_o \uparrow; [y_i]; y_o \downarrow; [\neg y_i]
    1) x_o \uparrow; [x_i]; x_o \downarrow, y_o \uparrow; [\neg x_i \land y_i]; y_o \downarrow; [\neg y_i]
    2) x_o \uparrow; [x_i]; x_o \downarrow, y_o \uparrow; [y_i]; y_o \downarrow; [\neg x_i \land \neg y_i]
    3) x_o \uparrow; [x_i]; x_o \downarrow; y_o \uparrow; [\neg x_i \land y_i]; y_o \downarrow; [\neg y_i]
    4) x_o \uparrow; [x_i]; x_o \downarrow; y_o \uparrow; [y_i]; y_o \downarrow; [\neg x_i \land \neg y_i]
    5) x_o \uparrow; [x_i]; y_o \uparrow; x_o \downarrow; [\neg x_i \land y_i]; y_o \downarrow; [\neg y_i]
    6) x_o \uparrow; [x_i]; y_o \uparrow; x_o \downarrow; [y_i]; y_o \downarrow; [\neg x_i \land \neg y_i]
    7) x_o \uparrow; [x_i]; y_o \uparrow; [y_i]; x_o \downarrow; [\neg x_i]; y_o \downarrow; [\neg y_i]
                                                                                                                (X\uparrow; Y\uparrow; X\downarrow; Y\downarrow)
   8) x_o \uparrow; [x_i]; y_o \uparrow; [y_i]; x_o \downarrow, y_o \downarrow; [\neg x_i \land \neg y_i]
    9) x_o \uparrow; [x_i]; y_o \uparrow; [y_i]; x_o \downarrow; [\neg x_i \land \neg y_i]
10) x_o \uparrow; [x_i]; y_o \uparrow; [y_i]; y_o \downarrow; x_o \downarrow; [\neg x_i \land \neg y_i]
11) x_o \uparrow; [x_i]; y_o \uparrow; [y_i]; y_o \downarrow; [\neg y_i]; x_o \downarrow; [\neg x_i]
12) x_o \uparrow, y_o \uparrow; [x_i]; x_o \downarrow; [\neg x_i \land y_i]; y_o \downarrow; [\neg y_i]
13) x_o \uparrow, y_o \uparrow; [x_i]; x_o \downarrow; [y_i]; y_o \downarrow; [\neg x_i \land \neg y_i]
14) x_o \uparrow, y_o \uparrow; [x_i \land y_i]; x_o \downarrow; [\neg x_i]; y_o \downarrow; [\neg y_i]
15) x_o \uparrow, y_o \uparrow; [x_i \land y_i]; x_o \downarrow, y_o \downarrow; [\neg x_i \land \neg y_i] \quad (X \uparrow \parallel Y \uparrow; X \downarrow \parallel Y \downarrow)
16) x_o \uparrow, y_o \uparrow; [x_i \land y_i]; x_o \downarrow; y_o \downarrow; [\neg x_i \land \neg y_i]
17) x_o \uparrow, y_o \uparrow; [x_i \land y_i]; y_o \downarrow; x_o \downarrow; [\neg x_i \land \neg y_i]
18) x_o \uparrow, y_o \uparrow; [x_i \land y_i]; y_o \downarrow; [\neg y_i]; x_o \downarrow; [\neg x_i]
19) x_o \uparrow, y_o \uparrow; [y_i]; y_o \downarrow; [x_i]; x_o \downarrow; [\neg x_i \land \neg y_i]
20) x_o \uparrow, y_o \uparrow; [y_i]; y_o \downarrow; [x_i \land \neg y_i]; x_o \downarrow; [\neg x_i]
21) x_o \uparrow; y_o \uparrow; [x_i]; x_o \downarrow; [\neg x_i \land y_i]; y_o \downarrow; [\neg y_i]
22) x_o \uparrow; y_o \uparrow; [x_i]; x_o \downarrow; [y_i]; y_o \downarrow; [\neg x_i \land \neg y_i]
23) x_o \uparrow; y_o \uparrow; [x_i \land y_i]; x_o \downarrow; [\neg x_i]; y_o \downarrow; [\neg y_i]
24) x_o \uparrow ; y_o \uparrow ; [x_i \land y_i] ; x_o \downarrow , y_o \downarrow ; [\neg x_i \land \neg y_i]
25) x_o \uparrow; y_o \uparrow; [x_i \land y_i]; x_o \downarrow; y_o \downarrow; [\neg x_i \land \neg y_i]
26) x_o \uparrow; y_o \uparrow; [x_i \land y_i]; y_o \downarrow; x_o \downarrow; [\neg x_i \land \neg y_i]
27) x_o \uparrow; y_o \uparrow; [x_i \land y_i]; y_o \downarrow; [\neg y_i]; x_o \downarrow; [\neg x_i]
28) x_o \uparrow; y_o \uparrow; [y_i]; y_o \downarrow; [x_i]; x_o \downarrow; [\neg x_i \land \neg y_i]
29) x_o \uparrow; y_o \uparrow; [y_i]; y_o \downarrow; [x_i \land \neg y_i]; x_o \downarrow; [\neg x_i]
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7)
$$x_o \uparrow$$
; $[x_i]$; $y_o \uparrow$; $[y_i]$; $x_o \downarrow$; $[\neg x_i]$; $y_o \downarrow$; $[\neg y_i]$ $(X \uparrow; Y \uparrow; X \downarrow; Y \downarrow)$

$$\begin{array}{cccc}
\neg y_i \to x_o \uparrow & & x_o \to y_o \uparrow \\
y_o \to x_o \downarrow & & \neg x_i \to y_o \downarrow
\end{array}$$

15)
$$x_o \uparrow, y_o \uparrow; [x_i \land y_i]; x_o \downarrow, y_o \downarrow; [\neg x_i \land \neg y_i] \quad (X \uparrow || Y \uparrow; X \downarrow || Y \downarrow)$$

$$\begin{array}{ccc} u & \to & x_o \uparrow & & \neg x_i \land \neg y_i \to & u \uparrow \\ \neg u & \to & x_o \downarrow & & x_i \land y_i & \to & u \downarrow \end{array}$$

$$\begin{array}{ccc} u & \to & y_o \uparrow \\ \neg u & \to & y_o \downarrow \end{array}$$

2 Passive X, Passive Y

This combination has 28 orderings.

```
1) [x_i]; x_o \uparrow; [\neg x_i]; x_o \downarrow; [y_i]; y_o \uparrow; [\neg y_i]; y_o \downarrow
```

2)
$$[x_i]; x_o \uparrow; [\neg x_i \land y_i]; x_o \downarrow, y_o \uparrow; [\neg y_i]; y_o \downarrow$$

3)
$$[x_i]; x_o \uparrow; [\neg x_i \land y_i]; x_o \downarrow; y_o \uparrow; [\neg y_i]; y_o \downarrow$$

4)
$$[x_i]; x_o \uparrow; [\neg x_i \land y_i]; y_o \uparrow; x_o \downarrow; [\neg y_i]; y_o \downarrow$$

5)
$$[x_i]; x_o \uparrow; [\neg x_i \land y_i]; y_o \uparrow; [\neg y_i]; x_o \downarrow, y_o \downarrow$$

6)
$$[x_i]; x_o \uparrow; [\neg x_i \land y_i]; y_o \uparrow; [\neg y_i]; x_o \downarrow; y_o \downarrow$$

7)
$$[x_i]; x_o \uparrow; [\neg x_i \land y_i]; y_o \uparrow; [\neg y_i]; y_o \downarrow; x_o \downarrow$$

8)
$$[x_i]; x_o \uparrow; [y_i]; y_o \uparrow; [\neg x_i]; x_o \downarrow; [\neg y_i]; y_o \downarrow (X \uparrow; Y \uparrow; X \downarrow; Y \downarrow)$$

9)
$$[x_i]; x_o \uparrow; [y_i]; y_o \uparrow; [\neg x_i \land \neg y_i]; x_o \downarrow, y_o \downarrow$$

10)
$$[x_i]; x_o \uparrow; [y_i]; y_o \uparrow; [\neg x_i \land \neg y_i]; x_o \downarrow; y_o \downarrow$$

11)
$$[x_i]; x_o \uparrow; [y_i]; y_o \uparrow; [\neg x_i \land \neg y_i]; y_o \downarrow; x_o \downarrow$$

12)
$$[x_i]; x_o \uparrow; [y_i]; y_o \uparrow; [\neg y_i]; y_o \downarrow; [\neg x_i]; x_o \downarrow$$

13)
$$[x_i \wedge y_i]; x_o \uparrow; [\neg x_i]; x_o \downarrow, y_o \uparrow; [\neg y_i]; y_o \downarrow$$

14)
$$[x_i \wedge y_i]; x_o \uparrow; [\neg x_i]; x_o \downarrow; y_o \uparrow; [\neg y_i]; y_o \downarrow$$

15)
$$[x_i \wedge y_i]; x_o \uparrow; [\neg x_i]; y_o \uparrow; x_o \downarrow; [\neg y_i]; y_o \downarrow$$

16)
$$[x_i \wedge y_i]; x_o \uparrow; [\neg x_i]; y_o \uparrow; [\neg y_i]; x_o \downarrow, y_o \downarrow$$

17)
$$[x_i \wedge y_i]; x_o \uparrow; [\neg x_i]; y_o \uparrow; [\neg y_i]; x_o \downarrow; y_o \downarrow$$

18)
$$[x_i \wedge y_i]; x_o \uparrow; [\neg x_i]; y_o \uparrow; [\neg y_i]; y_o \downarrow; x_o \downarrow$$

19)
$$[x_i \wedge y_i]; x_o \uparrow, y_o \uparrow; [\neg x_i]; x_o \downarrow; [\neg y_i]; y_o \downarrow$$

20)
$$[x_i \wedge y_i]; x_o \uparrow, y_o \uparrow; [\neg x_i \wedge \neg y_i]; x_o \downarrow, y_o \downarrow (X \uparrow \star Y \uparrow; X \downarrow \star Y \downarrow)$$

21)
$$[x_i \wedge y_i]; x_o \uparrow, y_o \uparrow; [\neg x_i \wedge \neg y_i]; x_o \downarrow; y_o \downarrow$$

22)
$$[x_i \wedge y_i]; x_o \uparrow, y_o \uparrow; [\neg x_i \wedge \neg y_i]; y_o \downarrow; x_o \downarrow$$

23)
$$[x_i \wedge y_i]; x_o \uparrow, y_o \uparrow; [\neg y_i]; y_o \downarrow; [\neg x_i]; x_o \downarrow$$

24)
$$[x_i \wedge y_i]; x_o \uparrow; y_o \uparrow; [\neg x_i]; x_o \downarrow; [\neg y_i]; y_o \downarrow$$

25)
$$[x_i \wedge y_i]; x_o \uparrow; y_o \uparrow; [\neg x_i \wedge \neg y_i]; x_o \downarrow, y_o \downarrow$$

26)
$$[x_i \wedge y_i]; x_o \uparrow; y_o \uparrow; [\neg x_i \wedge \neg y_i]; x_o \downarrow; y_o \downarrow$$

27)
$$[x_i \wedge y_i]; x_o \uparrow; y_o \uparrow; [\neg x_i \wedge \neg y_i]; y_o \downarrow; x_o \downarrow$$

28)
$$[x_i \wedge y_i]; x_o \uparrow; y_o \uparrow; [\neg y_i]; y_o \downarrow; [\neg x_i]; x_o \downarrow$$

8)
$$[xi]; x_o \uparrow; [yi]; y_o \uparrow; [\neg xi]; x_o \downarrow; [\neg yi]; y_o \downarrow (X \uparrow; Y \uparrow; X \downarrow; Y \downarrow)$$

$$x_i \wedge \neg y_o \rightarrow x_o \uparrow$$
 $y_i \wedge x_o \rightarrow y_o \uparrow$ $\neg x_i \wedge y_o \rightarrow x_o \downarrow$ $\neg y_i \wedge \neg x_o \rightarrow y_o \downarrow$

20)
$$[xi \wedge yi]; x_o \uparrow, y_o \uparrow; [\neg xi \wedge \neg yi]; x_o \downarrow, y_o \downarrow (X \uparrow \star Y \uparrow; X \downarrow \star Y \downarrow)$$

$$\begin{array}{ccc}
\neg u \to y_o \uparrow & x_i \wedge y_i \to u \downarrow \\
u \to y_o \downarrow & \neg x_i \wedge \neg y_i \to u \uparrow
\end{array}$$

$$\begin{array}{ccc}
\neg u & \to & x_o \uparrow \\
u & \to & x_o \downarrow
\end{array}$$

3 Active A, Passive P

This combination has 60 orderings.

```
1) a_o \uparrow; [a_i]; a_o \downarrow; [\neg a_i \land p_i]; p_o \uparrow; [\neg p_i]; p_o \downarrow
           (A; P)
   2)
          a_o \uparrow; [a_i]; a_o \downarrow; [p_i]; p_o \uparrow; [\neg a_i \land \neg p_i]; p_o \downarrow
   3) a_o \uparrow; [a_i]; a_o \downarrow; [p_i]; p_o \uparrow; [\neg p_i]; p_o \downarrow; [\neg a_i]
   4) a_o \uparrow; [a_i \land p_i]; a_o \downarrow; [\neg a_i]; p_o \uparrow; [\neg p_i]; p_o \downarrow
   5) a_o \uparrow; [a_i \land p_i]; a_o \downarrow, p_o \uparrow; [\neg a_i \land \neg p_i]; p_o \downarrow
   6) a_o \uparrow; [a_i \land p_i]; a_o \downarrow, p_o \uparrow; [\neg p_i]; p_o \downarrow; [\neg a_i]
   7) a_o \uparrow; [a_i \land p_i]; a_o \downarrow; p_o \uparrow; [\neg a_i \land \neg p_i]; p_o \downarrow
   8) a_o \uparrow; [a_i \land p_i]; a_o \downarrow; p_o \uparrow; [\neg p_i]; p_o \downarrow; [\neg a_i]
   9) a_o \uparrow; [a_i \land p_i]; p_o \uparrow; a_o \downarrow; [\neg a_i \land \neg p_i]; p_o \downarrow
            (A\uparrow; P\uparrow; A\uparrow; P\uparrow)
10) a_o \uparrow; [a_i \land p_i]; p_o \uparrow; a_o \downarrow; [\neg p_i]; p_o \downarrow; [\neg a_i]
11) a_o \uparrow; [a_i \land p_i]; p_o \uparrow; [\neg p_i]; a_o \downarrow; [\neg a_i]; p_o \downarrow
12) a_o \uparrow; [a_i \land p_i]; p_o \uparrow; [\neg p_i]; a_o \downarrow, p_o \downarrow; [\neg a_i]
13) a_o \uparrow; [a_i \land p_i]; p_o \uparrow; [\neg p_i]; a_o \downarrow; p_o \downarrow; [\neg a_i]
14) a_o \uparrow; [a_i \land p_i]; p_o \uparrow; [\neg p_i]; p_o \downarrow; a_o \downarrow; [\neg a_i]
15) a_o \uparrow; [p_i]; p_o \uparrow; [a_i]; a_o \downarrow; [\neg a_i \land \neg p_i]; p_o \downarrow
16) a_o \uparrow; [p_i]; p_o \uparrow; [a_i]; a_o \downarrow; [\neg p_i]; p_o \downarrow; [\neg a_i]
           (A\uparrow \parallel P\uparrow; A\uparrow \parallel P\uparrow)
17) a_o \uparrow; [p_i]; p_o \uparrow; [a_i \land \neg p_i]; a_o \downarrow; [\neg a_i]; p_o \downarrow
18) a_o \uparrow; [p_i]; p_o \uparrow; [a_i \land \neg p_i]; a_o \downarrow, p_o \downarrow; [\neg a_i]
19) a_o \uparrow; [p_i]; p_o \uparrow; [a_i \land \neg p_i]; a_o \downarrow; p_o \downarrow; [\neg a_i]
20) a_o \uparrow; [p_i]; p_o \uparrow; [a_i \land \neg p_i]; p_o \downarrow; a_o \downarrow; [\neg a_i]
21) a_o \uparrow; [p_i]; p_o \uparrow; [\neg p_i]; p_o \downarrow; [a_i]; a_o \downarrow; [\neg a_i]
22) [p_i]; a_o \uparrow; [a_i]; a_o \downarrow; [\neg a_i]; p_o \uparrow; [\neg p_i]; p_o \downarrow
23) [p_i]; a_o \uparrow; [a_i]; a_o \downarrow, p_o \uparrow; [\neg a_i \land \neg p_i]; p_o \downarrow
24) [p_i]; a_o \uparrow; [a_i]; a_o \downarrow, p_o \uparrow; [\neg p_i]; p_o \downarrow; [\neg a_i]
25) [p_i]; a_o \uparrow; [a_i]; a_o \downarrow; p_o \uparrow; [\neg a_i \land \neg p_i]; p_o \downarrow
26) [p_i]; a_o \uparrow; [a_i]; a_o \downarrow; p_o \uparrow; [\neg p_i]; p_o \downarrow; [\neg a_i]
27) [p_i]; a_o \uparrow; [a_i]; p_o \uparrow; a_o \downarrow; [\neg a_i \land \neg p_i]; p_o \downarrow
28) [p_i]; a_o \uparrow; [a_i]; p_o \uparrow; a_o \downarrow; [\neg p_i]; p_o \downarrow; [\neg a_i]
29) [p_i]; a_o \uparrow; [a_i]; p_o \uparrow; [\neg p_i]; a_o \downarrow; [\neg a_i]; p_o \downarrow
            (P\uparrow \star A\uparrow; P\downarrow \star A\downarrow)
30) [p_i]; a_o \uparrow; [a_i]; p_o \uparrow; [\neg p_i]; a_o \downarrow, p_o \downarrow; [\neg a_i]
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32) $[p_i]; a_o \uparrow; [a_i]; p_o \uparrow; [\neg p_i]; p_o \downarrow; a_o \downarrow; [\neg a_i]$ 33) $[p_i]$; $a_o \uparrow$, $p_o \uparrow$; $[a_i]$; $a_o \downarrow$; $[\neg a_i \land \neg p_i]$; $p_o \downarrow$ 34) $[p_i]$; $a_o \uparrow$, $p_o \uparrow$; $[a_i]$; $a_o \downarrow$; $[\neg p_i]$; $p_o \downarrow$; $[\neg a_i]$ 35) $[p_i]$; $a_o \uparrow$, $p_o \uparrow$; $[a_i \land \neg p_i]$; $a_o \downarrow$; $[\neg a_i]$; $p_o \downarrow$ 36) $[p_i]$; $a_o \uparrow$, $p_o \uparrow$; $[a_i \land \neg p_i]$; $a_o \downarrow$, $p_o \downarrow$; $[\neg a_i]$ $(P\uparrow; A\uparrow; P\downarrow; A\downarrow)$ 37) $[p_i]; a_o \uparrow, p_o \uparrow; [a_i \land \neg p_i]; a_o \downarrow; p_o \downarrow; [\neg a_i]$ 38) $[p_i]; a_o \uparrow, p_o \uparrow; [a_i \land \neg p_i]; p_o \downarrow; a_o \downarrow; [\neg a_i]$ 39) $[p_i]; a_o \uparrow, p_o \uparrow; [\neg p_i]; p_o \downarrow; [a_i]; a_o \downarrow; [\neg a_i]$ 40) $[p_i]; a_o \uparrow; p_o \uparrow; [a_i]; a_o \downarrow; [\neg a_i \land \neg p_i]; p_o \downarrow$ 41) $[p_i]; a_o \uparrow; p_o \uparrow; [a_i]; a_o \downarrow; [\neg p_i]; p_o \downarrow; [\neg a_i]$ PCHB 42) $[p_i]; a_o \uparrow; p_o \uparrow; [a_i \land \neg p_i]; a_o \downarrow; [\neg a_i]; p_o \downarrow$ 43) $[p_i]$; $a_o \uparrow$; $p_o \uparrow$; $[a_i \land \neg p_i]$; $a_o \downarrow$, $p_o \downarrow$; $[\neg a_i]$ 44) $[p_i]; a_o \uparrow; p_o \uparrow; [a_i \land \neg p_i]; a_o \downarrow; p_o \downarrow; [\neg a_i]$ WCHB 45) $[p_i]; a_o \uparrow; p_o \uparrow; [a_i \land \neg p_i]; p_o \downarrow; a_o \downarrow; [\neg a_i]$ 46) $[p_i]$; $a_o\uparrow$; $p_o\uparrow$; $[\neg p_i]$; $p_o\downarrow$; $[a_i]$; $a_o\downarrow$; $[\neg a_i]$ 47) $[p_i]; p_o \uparrow; a_o \uparrow; [a_i]; a_o \downarrow; [\neg a_i \land \neg p_i]; p_o \downarrow$ 48) $[p_i]; p_o \uparrow; a_o \uparrow; [a_i]; a_o \downarrow; [\neg p_i]; p_o \downarrow; [\neg a_i]$ 49) $[p_i]; p_o \uparrow; a_o \uparrow; [a_i \land \neg p_i]; a_o \downarrow; [\neg a_i]; p_o \downarrow$ 50) $[p_i]; p_o \uparrow; a_o \uparrow; [a_i \land \neg p_i]; a_o \downarrow, p_o \downarrow; [\neg a_i]$ 51) $[p_i]; p_o \uparrow; a_o \uparrow; [a_i \land \neg p_i]; a_o \downarrow; p_o \downarrow; [\neg a_i]$ 52) $[p_i]; p_o \uparrow; a_o \uparrow; [a_i \land \neg p_i]; p_o \downarrow; a_o \downarrow; [\neg a_i]$ 53) $[p_i]; p_o \uparrow; a_o \uparrow; [\neg p_i]; p_o \downarrow; [a_i]; a_o \downarrow; [\neg a_i]$ 54) $[p_i]; p_o \uparrow; [\neg p_i]; a_o \uparrow; [a_i]; a_o \downarrow; [\neg a_i]; p_o \downarrow$ 55) $[p_i]; p_o \uparrow; [\neg p_i]; a_o \uparrow; [a_i]; a_o \downarrow, p_o \downarrow; [\neg a_i]$ 56) $[p_i]; p_o \uparrow; [\neg p_i]; a_o \uparrow; [a_i]; a_o \downarrow; p_o \downarrow; [\neg a_i]$ 57) $[p_i]; p_o \uparrow; [\neg p_i]; a_o \uparrow; [a_i]; p_o \downarrow; a_o \downarrow; [\neg a_i]$ 58) $[p_i]; p_o \uparrow; [\neg p_i]; a_o \uparrow, p_o \downarrow; [a_i]; a_o \downarrow; [\neg a_i]$ 59) $[p_i]; p_o \uparrow; [\neg p_i]; a_o \uparrow; p_o \downarrow; [a_i]; a_o \downarrow; [\neg a_i]$ 60) $[p_i]; p_o \uparrow; [\neg p_i]; p_o \downarrow; a_o \uparrow; [a_i]; a_o \downarrow; [\neg a_i]$

31) $[p_i]$; $a_o \uparrow$; $[a_i]$; $p_o \uparrow$; $[\neg p_i]$; $a_o \downarrow$; $p_o \downarrow$; $[\neg a_i]$

1) $a_o \uparrow$; [ai]; $a_o \downarrow$; $[\neg ai \land pi]$; $p_o \uparrow$; $[\neg pi]$; $p_o \downarrow$ (A; P)

9) $a_o \uparrow$; $[ai \land pi]$; $p_o \uparrow$; $a_o \downarrow$; $[\neg ai \land \neg pi]$; $p_o \downarrow (A \uparrow; P \uparrow; A \downarrow; P \downarrow)$

$$\begin{array}{cccc}
 \neg p_o \to a_o \uparrow & & a_i \wedge p_i & \to p_o \uparrow \\
 p_o \to a_o \downarrow & & \neg a_i \wedge \neg p_i \to p_o \downarrow
 \end{array}$$

16) $a_o \uparrow$; [pi]; $p_o \uparrow$; [ai]; $a_o \downarrow$; $[\neg pi]$; $p_o \downarrow$; $[\neg ai]$ $(A \uparrow || P \uparrow; A \downarrow || P \downarrow)$

29) $[pi]; a_o \uparrow; [ai]; p_o \uparrow; [\neg pi]; a_o \downarrow; [\neg ai]; p_o \downarrow (P \uparrow \star A \uparrow; P \downarrow \star A \downarrow)$

$$\begin{array}{ccc} p_i & \rightarrow & a_o \uparrow & & & a_i & \rightarrow & p_o \uparrow \\ \neg p_i & \rightarrow & a_o \downarrow & & & \neg a_i & \rightarrow & p_o \downarrow \end{array}$$

36) $[pi]; a_o \uparrow, p_o \uparrow; [ai \land \neg pi]; a_o \downarrow, p_o \downarrow; [\neg ai] \quad (P \uparrow; A \uparrow; P \downarrow; A \downarrow)$

$$\begin{array}{ccc}
u & \to & a_o \uparrow & & \neg a_i \wedge p_i \to u \uparrow \\
\neg u & \to & a_o \downarrow & & a_i \wedge \neg p_i \to u \downarrow
\end{array}$$

$$\begin{array}{cccc}
u & \to & p_o \uparrow \\
u & \to & p_o \downarrow
\end{array}$$

44) $[pi]; a_o \uparrow; p_o \uparrow; [ai \land \neg pi]; a_o \downarrow; p_o \downarrow; [\neg ai]$ (WCHB)

This is known as the weak-condition logic half buffer (WCHB).

41) $[pi]; a_o \uparrow; p_o \uparrow; [ai]; a_o \downarrow; [\neg pi]; p_o \downarrow; [\neg ai]$ (PCHB)

This is known as the pre-charge half buffer (PCHB).