*Project: RMC75E FPGA TEST BENCH*

*Module: module.vhd*

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# High Level

**Description:** The "ExpSigRoute" module is responsible for routing various signals within the expansion modules. It acts as a central signal routing unit that connects different logic modules in the system based on the configuration set by "ExpMux" and other control signals.

Here's a summary of what the module does:

Input Signal Routing:

The module receives signals from various expansion modules, including analog inputs (from an external memory), DIO (Digital Input/Output) signals, and other control signals.

Signal Multiplexing (ExpMux):

The "ExpMux" input determines which logic module's signals need to be routed to the output "ExpData."

The module can direct signals from three different logic modules: Q1 (unknown), Ax (Analog Input), and D8 (DIO input).

Output Signal Routing:

The module routes the appropriate signals from the selected logic module to the "ExpData" output.

The "ExpData" output is a 6-bit signal that carries various information, including clock signals, data signals, latch signals, enable signals, etc., depending on the selected logic module.

Handling Invalid Modules:

If there is no valid module connected or selected (indicated by "ExpMux"), the output signals are tied to specific values (e.g., '1', '0', or 'Z' for high, low, or high-impedance state, respectively), ensuring proper behavior even when no valid module is present.

Control Signals:

The module also handles control signals such as "ExpSerialSelect" and "ExpLEDSelect," which determine whether the serial memory or LED module is active for routing.

The "ExpSigRoute" module acts as a flexible and efficient signal router, enabling different expansion modules to interact and share data within the system. Its flexibility allows for easy integration of additional modules in the future without significant changes to the overall system architecture.

# Low level

**Design Details:** The ExpSigRoute module is a signal routing module that takes multiple inputs and routes them to various output signals based on the values of control signals like ExpMux, ExpSerialSelect, and ExpLEDSelect. It acts as a multiplexer and logically connects the inputs to different parts of the RMC75E modular motion controller based on the configuration settings.

**Inputs:**

* ExpMux: A 2-bit signal that determines which module is currently selected for signal routing.
* ExpSerialSelect: A control signal that selects whether the serial interface is active or not.
* ExpLEDSelect: A control signal that selects whether the LED module is active or not.
* ExpLEDData: The data input signal containing LED data.
* ExpData: A 6-bit inout signal used for data routing between different modules.
* ExpA\_CS\_L: The chip select signal for the analog input logic module.
* ExpA\_CLK: The clock signal for the analog input logic module.
* ExpD8\_Clk: The clock signal for the DIO input logic module.
* ExpD8\_DataOut: The data output signal from the DIO input logic module.
* ExpD8\_OE: The output enable signal for the DIO input logic module.
* ExpD8\_Load: The load signal for the DIO input logic module.
* ExpD8\_Latch: The latch signal for the DIO input logic module.

**Outputs:**

* ExpQ1\_A, ExpQ1\_B, ExpQ1\_Reg, ExpQ1\_FaultA, ExpQ1\_FaultB: These are output signals that connect to the Q1 logic module based on the ExpMux value.
* SerialMemoryDataIn: The data input signal for the serial memory module.
* ExpA\_DATA: The data output signal for the analog input logic module.
* ExpData(0): The output signal for the clk connection to different modules.
* ExpData(1): The output signal for the data connection to different modules.
* ExpData(2): The output signal for the latch connection to different modules.
* ExpData(3): The output signal for the output enable connection to different modules.
* ExpData(4): The output signal for the chip select connection to different modules.
* ExpData(5): The output signal for the load connection to different modules.

**Architecture:** The architecture of the ExpSigRoute module, named ExpSigRoute\_arch, consists of a process block that performs the signal routing based on the configuration signals (ExpMux, ExpSerialSelect, and ExpLEDSelect).

The process block logically routes the signals based on the current values of ExpMux, ExpSerialSelect, and ExpLEDSelect, directing them to different parts of the RMC75E modular motion controller. The connections are made as follows:

* For the Q1 logic module, the ExpData(0:4) signals are routed based on the value of ExpMux.
* For the Analog input logic module (Ax), ExpA\_DATA(0) and ExpA\_DATA(1) are selected based on ExpMux, while SerialMemoryDataIn is also selected if ExpSerialSelect is '1'.
* For the DIO input logic module (D8), ExpD8\_DataIn is selected based on ExpMux, while ExpData(0:5) are used for clk, data, latch, output enable, load, and data connections respectively.
* For the LED module, ExpData(1) and ExpData(5) are used for data and data connection respectively if ExpLEDSelect is '1'.

## Simulation

To simulate the ExpSigRoute module, a testbench can be created with appropriate stimulus to change the values of ExpMux, ExpSerialSelect, and ExpLEDSelect and observe the corresponding output signal behavior. Different scenarios can be tested to ensure correct signal routing based on these control signals. Additionally, the stimulus should include changing values of ExpLEDData, ExpData, ExpA\_CS\_L, ExpA\_CLK, ExpD8\_Clk, ExpD8\_DataOut, ExpD8\_OE, ExpD8\_Load, and ExpD8\_Latch to observe the impact on the output signals.