

# THE DEVELOPMENT OF FPGA-BASED CONTROLLER

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## ABSTRACT

THE ARCHITECTURE OF FPGA-BASED CONTROLLER SYSTEM ADOPTS FPGA COMPONENT AS THE FOUNDATION OF THE PROGRAMMABLE HARDWARE OF THE CONTROLLER SYSTEM. IT CREATES AN INTEGRATED-DEVELOPMENTAL -ENVIRONMENT(SETTING) TO IMPLEMENT THE FOLLOWING FIVE STAGES : THE FUNCTION DESIGN OF CONTROLLER SYSTEM, THE BEHAVIOR VERIFYING OF SYSTEM, THE SIGNAL ANALYSIS OF FAULT DIAGNOSIS, THE IMPLEMENT OF SYSTEM, AND THE ACTUAL OPERATION. THE ARCHITECTURE OF FPGA-BASED CONTROLLER SYSTEM CONSISTS OF TWO SUBSYSTEMS-- THE INTEGRATED-DEVELOPMENTAL- ENVIRONMENT AND THE RECONFIGURABLE HARDWARE MODULE. THE CONTROL FUNCTION EDITOR, LADDER-DIAGRAM-TO-PETRI-NET TRANSLATOR, SYSTEM BEHAVIOR VERIFIER, FAULT DIAGNOSIS ANALYZER, PETRI-NET-TO-VHDL TRANSLATOR, HARDWARE SYNTHESIZER AND DOWNLOADER, AND REAL TIME OPERATION MONITOR ARE THE SOFTWARE TOOLS OF THIS INTEGRATED-DEVELOPMENTAL-ENVIRONMENT. IT PERFORMS SYSTEMATIC MODELING, ANALYSIS, SIMULATION, ACTUAL OPERATION MONITOR AS WELL AS VERIFYING WITH EFFICIENCY. THUS, THE ARCHITECTURE OF FPGA-BASED CONTROLLER SYSTEM CAN SERVE AS A OPENING INDUSIAL CONTROLLER. THE RECONFIGURABLE HARDWARE MODULE OF CPLD OR FPGA IS THE FUNCTION EXECUTION HARDWARE OF THE WHOLE CONTROLLER. IT CONTAINS THREE SECTIONS: THE INPUT/OUTPUT SECTION, THE FUNCTION CORE SECTION, AND THE CONTROL SECTION. THE RECONFIGURABLE HARDWARE MODULE OF CPLD OR FPGA IS NOT JUST AN ON-LINE RECONFIGURABLE OPENING ARCHITECTURE BUT ALSO A STRETCHABLE CONTROLLER WITH HIGH RELIABILITY AND ELASTICITY. THE FUNCTION ESTABLISHMENT OF THE CONTROL SYSTEM USES THE STANDARD IEC1131-3 LANGUAGE TO INTEGRATE EACH MODULE OF THE SYSTEM IN ORDER TO DEVELOP A CONCURRENT AND INTEGRATED WHOLE. THE VERIFYING MODULE OF CONTROL SYSTEM EMPLOYS THE CONCEPT OF MACRO- TRANSITION IN THE PETRI-NET TO MAKE THE SYSTEM DESCRIPTION MORE ABSTRACT, MORE GRADATIONAL, AND SIMPLER. AT THE SYSTEM VERIFYING STAGE, THE TRANSITION FIRING SEQUENCE OF PETRI-NET MODULE IS INFERRED USING THE FSDA. THE TRANSITION FIRING SEQUENCE CAN SERVE AS THE BASE FOR THE BEHAVIOR ANALYSIS. IN ADDITION, THE REAL-TIME FAILURE DIAGNOSIS, SIGNAL ANALYSIS, AND FAILURE-TRACING MODULE ARE ADDED IN ORDER TO BE MORE EFFICIENT IN FAULT DETECTING. THE CONTROL SYSTEM HARDWARE IS IMPLEMENTED THROUGH THE VHDL DESCRIPTION LANGUAGE. VHDL IS COMPATIBLE WITH MANY OTHER LANGUAGES. IT CAN USE IN DESIGNING THE ASIC COMPONENT. VHDL CAN MITIGATE AND SIMPLIFY THE TRANSLATION OF THE SYSTEM MODULE TO THE HARDWARE STRUCTURE. SINCE THE COMPONENT HAS THE CHARACTERS OF ENVELOPMENT, REUSE, AND EXPANSION, TRANSLATING SYSTEM MODULE INTO VHDL USING THE COMPONENT-BASED TECHNIQUE, THE EFFICIENCY OF THE TRANSLATION WOULD BE ENHANCED. THE TRANSLATION MODULE IS MORE INCLUSIVE IN NATURE AND, THUS, THE ARCHITECTURE OF FPGA-BASED CONTROLLER SYSTEM CAN ALSO BE PROMOTED WITH EFFICIENCY.

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