Design and Development of Graphical HMI panel with Modbus Communication for interfacing with various AC Drives

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Abstract— AC drive widely used to control the speed of AC motor. For demanding applications like crane (hoist), conveyor, stacker, centrifuge, etc. In certain cases where AC drive regenerates energy due to this DC link capacitor voltage exceed to the specified level very rapidly because of small capacitor value. A researcher shows the Supervisory Control on drives is implemented using a Programmable Logic Controller (PLC) to monitor and control drive performance. This Project focus on Design of Graphical Human Machine Interface (HMI) FOR Real Time Monitoring and Controlling Operation of AC Drive especially for Graphic Analysis of drive parameter such as frequency, torque, speed, temperature, etc. The design is basically divided in two section which one is HMI controller section and second is AC Drive controller section which communication using Modbus protocol. HMI section includes 128x64 Dot Matrix LCD and dsPIC33EP512MC206/506 Series controller. AC Drives controller section includes TMS320F28069 DSP controller to control switching frequency of IGBT. The control of the DC link capacitor voltage during regeneration that can be done by DSP. This AC Drives also includes Built-in PLC control that can be programmed by HMI. The whole Development will be carried on Embedded System.

Key words: AC Drives all parameter test, DSP PIC controller use, AC Drives all parameter are testing and monitoring

I. INTRODUCTION

A. Background

To control the speed of an electrical motor, an induction motor then used AC drives. AC drives are also known by various other names such as adjustable frequency drives (AFD) or adjustable speed drives (ASD) or variable speed drives (VSD) or frequency converters (FC) or variable frequency drives (VFD).

Electrical motors main functionality are electric energy into mechanical energy by electromagnetic induction. These motors are characterized by: fixed speed, determined by the frequency of the power supply fixed torque.

A fixed speed is not suitable for all processes in the need for adjusting the speed according to need. AC drives are used in a wide variety of industrial applications. AC drives are often used with fans to provide adjustable airflow in large heating and air conditioning systems. Industrial machinery is often driven by electrical motors that have provisions for speed adjustment. If speed control is required that controller is called an AC drive. The water and chemicals in industrial processes is often controlled by adjusting the speed of pumps (ASP). AC drives used in water and waste water processing, paper mills, tunnel boring, oil drilling platforms or mining.

B. Motivation

New trend in industry is going towards to provide Graphical LCD display as a feature Because customer requirement is AC Drive in the used GLCD. Development Micro controller based graphical LCD and interface with our product.

C. AC Drives

An AC drive is a device that is used to control the speed of an electrical motor, either an induction motor or a synchronous motor. Electrical motors convert electric energy into mechanical energy by electromagnetic induction. These motors are characterized by fixed speed, determined by the frequency of the power supply fixed torque Obviously, a fixed speed is not suitable for all processes in all thus, the need for adjusting the speed according to need. Industrial machinery is often driven by electrical motors that have provisions for speed adjustment. Such motors are simply larger, more powerful versions of those driving familiar appliances or electric drills.

D. Block Diagram

Fig. 1: The main components of an AC drive: rectifier, DC circuit and inverter

E. Rectifier Circuit

The AC drive is supplied by the electrical network via a rectifier. It is two types uni and bidirectional. Rectifier convert AC voltage to DC voltage.

F. DC circuit

The DC circuit will store the electrical energy from the rectifier for the inverter to use. In this part used the energy is stored in high-power capacitors.

G. Inverter circuit

The inverter unit takes the electrical energy from the DC circuit and supplies it to the motor. The inverter uses modulation techniques to create the needed 3-phase AC voltage output for the motor. Inverter is convert DC voltage to AC voltage. The higher the frequency of the output voltage then the higher the speed of the motor so the output of the process.
H. Introduction for GLCD Display

A liquid-crystal display (LCD) are a flat panel display, electronic visual display, and video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. GLCDs are available to display arbitrary images or fixed images which can be displayed or hidden, such as pre set words, digits, and 7-segment displays as in a clock. GLCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. They are used devices such as DVD players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. GLCDs are however, susceptible to image persistence.

The GLCD screen is more energy efficient and can be disposed of more safely than a CRT. Its low electrical power to be used in battery-powered electronic equipment. It is an electronically modulated optical device made up of any number of segments filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in colour or monochrome.

I. Requirements of GLCD

The requirements of this project are as follows:

Thoroughly research and understand the operation of the graphical LCD and write a primer so that others can benefit from my research.

Select and purchase a readily available, low-cost 128 x 64 graphical LCD which could be obtained by course instructors.

Write an image library that replicates the functions of an alphanumeric LCD by storing images of each character which can be placed on the display.

Write a driver that has the ability to place images on the screen.

II. SYSTEM OVERVIEW

A. Block Diagram for Graphical LCD

![Block Diagram for Graphical LCD](Image)

This Block diagram is a 128 X 64 Graphical LCD Display Card used for the user interface (Digital Operation Panel) with 8-key keypad. It has 128 x 64 dot-matrix LCD with back-light and interfaced with 8-key keypad. It can be used for multiple power electronics products like Inverter, Front-end converter, PWM DC Drive, Electronics Soft starter etc…

It uses 16-bit High-Performance PIC controller dsPIC33EP512MC506. It uses RS-485 link to communicate to the main control unit. This board is powered up through the 4-core cable from the main control board.

B. Power Supply

This block diagram is uses +3.3V power supply for its operation. The input power supply to this board is +24V from the control board at J3. This +24V is input to the buck switching regulator U5 (MC33063A) used to get 3.3V.

C. Keypad & LCD module

This block diagram can be interfaced to 8-key keypad for parameter setting, monitoring and navigation. The 8-keys are NORM, MODE, GROUP, UP, DOWN, ENTER, RUN & STOP. The parameters and values are displayed using 128 X 64 dot-matrix graphical LCD display.

D. Communication to the main control board

This board communicates with the main control board using two wires RS-485 serial communication. It uses MODBUS-RTU protocol. The terminal resistance is 120Ω between RX and TX.

E. Communication to the EEPROM

This block diagram has internal facility to communicate to EEPROM & RTC through I2C Bus. EEPROM can be used to store different parameters. RTC can be used to provide timing to control circuitry.

F. dsPIC33EP512MC506 Controller

At their highest level of functionality. DsPIC33EP512MC506 Devices integrate several features that affect the entire device as a whole. They add convenience and flexibility of design for the user. And allow the devices to be incorporated into a wide range of design. These include: flexible configuration options- allowing users to select a wide range of basic microcontroller operating options and changing them if needed during run time Device identification – allowing electronic confirmation of a device part number and revision level in the target application.

DsPIC33EP512MC506 is 16-Bit microcontroller. It is DSP based microcontroller, dsPIC33EP512MC506 in 64 pin and 8-port.
III. HARDWARE SETUP

A. Hardware Setup for GLCD and A.C Drives control Card

![Hardware Setup Diagram]

As shown figure in the include are power supply, A.C Drives control card, normal LCD and Graphical LCD.

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D. A.C Drives control card

DSPTMS320F28069 is the heart of the control card, which performs all the control action for control drive. It comprises of inbuilt ADC, General purpose input output port, Timer etc. The control card compromises Firing circuit, programmable terminals, interfacing circuit, serial communication circuit, QEP circuit and DSP controller. This card has deferent blocks for the voltage and current measurements. The main function function of the control card is to generate firing pulses, which are used to drive line side IGBT converter as well as motor side IGBT inverter.

E. Display parameter

1) Display for normal condition parameter in GLCD

![Normal Condition Display]

Fig. 4: Normal condition for Display in 8-parameter

As shown figure in the display normal condition parameter. In this condition display are 8-parameter. Then show the 8-parameter and give the value of parameter.

![Company Logo Display]

Fig. 5: Display the company logo

![Fault Parameter Display]

Fig. 6: Display fault parameter

![GLCD AC Drive Testing]

Fig. 7: GLCD testing with AC Drive

As shown figure is the GLCD testing with AC Drives. 128x64 GLCD connected to the AC Drives so
GLCD are monitoring and controlling the AC Drives all parameter. Frequency, Input voltage, Output voltage, Resister load, Local Set Torque(%L), DC Bus Voltage, etc parameter Graph are Display in the GLCD.

As we are using both cores, CPU and CLA (Control Law Accelerator), for Inverter and Converter respectively, we need to communicate between two by MSGRAMs and DATARAMs.

B. Initialize the DSP Sections

DSP section in many peripherals such as UART, Timer, Serial Peripheral Interface PWM, Serial Communication Peripherals. These pins of a DSP have a multiples functionality. DSP can be used as a PWM or as a GPIO, Serial Communication. So, pin mode function select pin either as a GPIO or Special purpose. Initialize Variables Specifies the range of values for each variables. Define a structure for its default, minimum and maximum values.

If pin used as GPIO then also set its data direction either input or output. Each functionality the reference of datasheet of DSP TMS320F28069.

IV. Simulation for GLCD and Control Card

A. Serial communication wave from

This wave from is expanded view in Serial TX channel A and GND; RX channel B and GND.

V SOFTWARE FLOW CHART

A. A.C Drives Control Card flow Chart

Software in to use DSP TMS320F28069. DSP includes two processing core, CLA (Control Law Accelerator) and Main CPU core which executes code independently of the Main CPU. The peripherals shared between Main CPU and CLA of DSP. For the Main CPU and CLA for accessing these peripherals refer the technical reference manuals of DSP TMS320F28069.
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D. Interrupt Service Routine (ISR)

Interrupt service Routine are the functions related to CPU and CLA algorithm or Communication interrupt. ISR routine is timer based so Timer 0 used for CPU and Timer 1 for CLA. CPU routine and CLA routine are takes 200us and takes 100us. PSI and ADC scanning used Timer 0 interrupt. Serial Communication through Display and Control Card through serial communication interface, communication interrupt side service by ISR.

E. GLCD Background Routines

Background routines are a continues loop. Background routines checks locking parameter such as start key status, faults status and pre charge complete status. If found ok then only start gate pulse otherwise toggle fault LED and it has a different routine using Timer. such as 2 ms, 10 ms, 100 ms, 500 ms, 600 ms, 2 second, 6 second, 12 second and 18 second, check GLCD status.
V. CONCLUSION

We conclude that GLCD are high resolution, highly accurate and large memory storage compared to normal LCD.

Graphical Liquid Crystal Displays can enhance the usability of almost any project. They often require more initial time and effort to get them running than do alphanumeric LCDs but they do not have the character limits of such displays. Documentation is often not readily available for graphic LCDs and fewer microcontrollers have built-in drivers for their operation. This discourages their use even further.

In the proposed GLCD design a user friendly, attractive, simple, portable and multifunctional timekeeping system has been developed and implemented.

The same timekeeping system can be implemented on different type of display systems like seven segment display modules, led matrix modules, led displays, numeric displays.

This embedded system can be used to analyze high frequency signal and amplitude voltage. It helps customer use to develop new system.

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