MICROCONTROLLERS (MCU's)

APPLICATION NOTE

ABSTRACTS

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1 AN392: MICROCONTROLLER AND TRIACS ON THE 110/240V MAINS

P. Rabier, L. Perier

Microcontrollers are in common use in most areas of electronics. They now penetrate the very cost sensitive arena of home appliance applications. The demonstration board described in this Application Note shows that enhanced appliances can be designed with fast prototyping time using microcontrollers such as the ST6210.

The circuit presented is an enhanced light dimmer operating from the 110/240V mains. It drives incandescent and halogen lamps supplied either directly from the mains or through a low voltage transformer.

The same circuit can also drive a universal motor. It includes soft start and protection features. Different user interfaces can be chosen: touch sensor, push button or potentiometer.

All this is achieved with only few components: a microcontroller ST6210, a Logic Level or a snubberless triac and some passive components.

Additional features like presence detection, IR remote control, homebus interface and motor speed control can be implemented from the existing solution.

2 AN411: SYMBOLS.INC, ST9 REGISTER ADDRESS AND CONTENT NAMES

P. Guillemin

For efficient communication, to speak the same language seems to be obvious.

This is also true in the world of programming.

A a matter of standardization, a specific name has been given for each of the ST9 registers and bits.

This Application Note gives the list of the predefined names for register, bit, page, peripheral register and mask and gives examples for the usage of these names.

3 AN412: DIGITAL POWER FACTOR CORECTION WITH NON-SINEWAVE CURRENT

P. Guillemin, J.M. Charreton, B. Maurice

Following the emergence of European and International standards concerning Power Factor and giving them limits to current harmonics content, electronic designers have to face the Power Factor Correction (P.F.C.) problem.

This paper gives an example of a pre-regulator on 230V mains in which the harmonic correction function is made by software using a standard microcontroller. This application, well-suited in the power range below one thousand Watts, allows flexible adaptation to specific application features and avoids the use of P.F.C. dedicated ICs.

Showing that such an incomplete harmonic compensation is a realistic solution in this power range, the author describes principle and method to generate the adequate current wave form to be drawn from the mains.

The closed loop voltage regulation made by software is also described.

It can be easily adapted to different types of loads. Practical results are given.

4 AN413: INITIALIZATION OF THE ST9

P. Guillemin

The ST9 family offers the microprocessor designer a wide variety of architectural features and peripheral units fully configurable to the user's specific application requirements.

Configuration is typically implemented by simple software routines included in the power-on- or system-reset routines. The sole difficulty which the user may initially encounter stems, in fact, from the power and versatility of this approach to system design. The large number of available options means that the user must specify a large number of system parameters by initializing control register contents for the specific peripheral units.

The objective of this Application Note is to suggest to the user a programming structure and philosophy to aid in the initial configuration of the system. The approach is illustrated by a number of specific examples selected from the wide range available.

5 AN414: CONTROLLING A BRUSH DC MOTOR WITH AN ST6265 MCU

J. Nicolai, T Castagnet

Microcontrollers are used more and more in motor drives, most commonly to turn on and off the motor, or to control the triggering angle of a triac, associated with a universal motor. In this paper, the universal motor is replaced by a permanent magnet DC motor, which offers the advantage of yielding a high power in a small volume. The variable speed drive is supplied from the rectified mains voltage, and consists of a chopper driven by a PWM signal generated by the ST6265 microcontroller (MCU).

The ST6265 MCU measures the DC supply voltage and adjusts the PWM duty cycle accordingly. So the motor voltage is regulated in case of mains and load variations, the motor speed is adjusted and the motor current ripple is reduced, thus reducing acoustic noise and losses in the motor. This drive also implements a software power limitation, which avoids motor overheating in case of excessive loading. Software flexibility allows to easily modify drive parameters such as maximum power, time constants, etc... The drive principle and practical results are given.

6 AN415: USING THE I2C-BUS PROTOCOL

M. Chabaud, A. Dunworth

The Serial Peripheral Interface (SPI) included in all ST9 family members has been designed to handle a wide variety of serial bus protocols, including SBUS, IMBUS, and I2C-bus.

Certain features of the popular I2C-bus serial communication standard have not been directly implemented in hardware, but may be realized with simple software routines, based on the SPI contained in the standard ST9 core.

This Application note gives an example of such routines, suitable for interfacing the ST9 with a serial memory device.

7 AN416: SENSORLESS MOTOR DRIVE WITH THE ST62 MCU + TRIAC

Thierry Castagnet

Home appliance applications require more and more electronic control in order to meet the new requests and constraints of the consumers.

Microcontrollers have been typically limited to high end applications because their performance appear to be overrated when related to the functions of the application. In reality, home appliances require microcontrollers which trade closely on the compromise between cost and performance.

This Application Note describes how a low cost speed drive is designed with a microcontroller, a triac and an a.c. universal motor. The control of the motor operates with sensorless speed control, based only on a motor current feedback. The example shown is adapted to food processor and to drill applications.

8 AN417: FROM NICD TO NIMH FAST BATTERY CHARGING

J.Nicolai, L.Wuidart

Rechargeable batteries are quickly becoming a major benefit to current lifestyles. They allow such utilities as portable telephones, camcorders, cordless power tools, portable appliances and audio equipments.

The charging of Rechargeable batteries often requires to take place in one hour and less for user convenience in applications which discharge rapidly, for example cordless power drills. The optimum fast charging techniques for Nickel Cadmium batteries are well known (please refer to AN433, Fast NiCd Battery Charging using ST6210 MCU), however these techniques are not suitable for the charging of batteries using the more environmently friendly Nickel Hydride (NiMH) technology.

This Application Note shows the differences in the charging of the two technologies and how a Fast Battery Charger compatible with both NiCd and NiMH can be made with the ST6210 MCU. The MCU control shown is able to provide three level charge termination methods for safe charging.

9 AN418: DMA THROUGH I/O PORT

P. Guillemin

Data communication links between a microcontroller and an external peripheral using an Input/Output (I/O) port is not always powerful enough and can dramatically overload the CPU when transmitting a great numbers of data.

The ST9 offers a powerful feature allowing continuous high speed data transfer between the ST9 memory and an 8-bit I/O port. This transfer is handled in a bidirectional way by a Direct Memory Access (DMA) mode using the Compare or Capture channel of the ST9 Multifunction Timer. Swap mode and handshake control signal are also implemented.

This DMA capability on I/O port can be used for PWM generation, stepper motor command generation and peripheral communication.

This Application Note gives a technical explanation of programming the DMA and gives practical examples for each of the DMA channels.

10 AN419: AN APPROACH TO MOTOR CONTROL WITH FUZZY LOGIC

P. Guillemin

Introduced in 1965, Fuzzy Logic now takes more and more importance in Industrial, Home Appliance and Consumer applications such as camcorders, washing machines, vacuum cleaners and microwave ovens. In a wide range of applications, from complex (chemical process regulation, automotive features like ABS) to very simple applications (temperature or voltage control), Fuzzy Logic concepts associated with Fuzzy Logic Development tools bring beneficial advantages to system design.

This Application Note describes the design of a Fuzzy Logic motor controller using the ST62 Microcontroller and a Fuzzy Logic design tool. The "*fuzzy*TECH ST6 Explorer Edition" covers all the steps of a Fuzzy Logic Design, from the initial concept definition, up to the generation of executable code for the ST62.

All the necessary characteristics of the motor, the way they are used with the development tool and the practical utilization of the tool are described in this Application Note.

*fuzzy*TECH ST6 Explorer Edition is a trademark of Inform Software Corporation.

11 AN420: EXPANDING A/D RESOLUTION OF THE ST6 A/D CONVERTER

P. Malusardi

Many members of the ST6 Microcontroller Family support an integrated Analog to Digital Converter. This converter allows the analog values produced by external sensors to be converted into digital form to take part in further digital control algorithms.

The standard resolution of the ST6 A/D Converter is 8-bit. Occasionally the analog signals provided require a higher resolution to extract the full dynamic range of the input.

The solution described in this Application Note provides this higher voltage resolution using only an additional Operational Amplifier and a few resistors. The tradeoff in the approach shown is the total conversion time to reach the required resolution.

The technique implemented is that of the Algebraic Adder. A full discussion of the principle of operation is given, with full ST6 source code.

12 AN421: STACK OVERFLOW DETECTION USING THE ST9 TIMER WATCHDOG

P. Guillemin

In real time applications, the implementation of software protection is not always easy, but allows reaching a high security level for the software against malfunction. This is particulary true for in-board applications in disturbed environments, such as automotive, power meter or industrial applications.

To help avoid non-controlled functionality and damage to real time system due to possible perturbations on the ST9 µC core and I/O port, a special peripheral able to act as a watchdog is available on all the ST9 family members: the Timer Watchdog.

A periodic restarting of the Timer Watchdog by program, associated with the automatic detection of possible stack overflow, add to the protection of real time application software.

This application note shows how to detect stack overflow by using the Timer Watchdog in watchdog mode.

13 AN422: IMPROVES UNIVERSAL MOTOR DRIVE

JM. Bourgeois/JM. Charreton/P. Rault

Universal motors are traditionally used in AC current mode of control with a Triac-based control circuit. This provides a low-cost circuit, but has potential drawbacks in high peak to peak current giving poor motor efficiency and high brush temperature leading to a limited motor lifetime.

Operation in DC current mode provides a solution to these problems and also the increased efficiency allows a reduction in the size of the motor. Motor noise is also reduced.

This Application Note presents three solutions for control of a Universal Motor, in AC and DC current modes with a comparison of the efficiency of each. The modes covered are:

- AC drive with Triac,
- DC drive with Triac and rectifier bridge
- DC drive with an IGBT and rectifier bridge.

In all cases the control of the drive is made by a microcontroller, the ST6, with an illustration of the circuit and additional functionality possible.

14 AN423: ISO SMART CARD INTERFACE

P. Guillemin

Smart Cards, with very popular applications take now a great place in today's life. Telephone cards, banking payment cards, PAY TV and health cards are many practical means for payment or for preserving confidential information.

Smart Cards provide also a high security level against access to the enclosed data. This high security level is partly given by a particular protocol of transmission described by the International Standard Organisation (ISO).

This Application Note describes how to use the ST9 SCI peripheral in order to interface to a Smart Card and gives a complete example of "answer to reset", writing data to a Smart Card and reading data from a Smart Card in the both direct or inverse convention.

Please note the goal of this application note is to explain how to manage the Smart Card I/O line protocol and not to realize a complete card Reader/Writer.

15 AN424: VERSATILE AND COST EFFECTIVE INDUCTION MOTOR DRIVE WITH DIGITAL THREE PHASE GENERATION

B. Maurice, JM. Bourgeois, B. Saby

Induction motor control normally requires complex control circuitry for the generation of well balanced three phase sine waves. The introduction of variable speed induction motor into large volume appliances (100W-1kW) requires the design of cost effective solutions. Usually, the generation of three phase PWM signals is controlled by a dedicated IC which is driven by a microcontroller. This solution is optimum while performance prevails over cost.

The solution proposed in this Application Note is a simplified solution using a standard ST9 microcontroller which includes an internal Direct Memory Access (DMA) capability. This solution spares the use of dedicated ICs (hardware being replaced by software), and saves over 50% of CPU time to perform control and supervision tasks.

A practical solution to quantize three phase sinewaves, and to create the corresponding DMA table is presented. The motor voltage and motor frequency can be chosen independently. A dead time avoiding cross conduction through the bridge is also created by software.

16 AN426: FREQUENCY DOUBLER DEMONSTRATION SYSTEM

M. Chabaud, A. Dunworth

This Application Note is intended to provide the interested designer of ST9 system applications with a further insight into methods of exploiting the powerful capabilities offered by the ST9 chip. For this purpose we present full software and broad hardware details of a complete system application.

An analogue signal (speech signal) is sampled at a fixed rate and digitized sample values are stored in internal RAM. After a delay period, equal to the period of the lowest frequency component in the input signal, the samples are read from RAM at twice the input sampling frequency and converted to analogue form by using Pulse Width modulation techniques coupled with external filtering.

The demonstration application makes use of the following basic ST9 system resources:

* A/D Convertor
* Multifunction Timer/Counter
* Internal RAM (Register File)
* Input/Output Ports.

17 AN427: DIGITAL 3-PHASE GENERATION ST9 DEMONSTRATION SOFTWARE

P. Guillemin

A new concept for Analog Induction Motor drive systems is based on an ST9 microcontroller. This MCU offers a powerful and continuous data transfer capability, allow the driving of, through a simple hardware interface, a three-phase half bridge with generated digital waveforms.

Demonstration software associated with a demonstration board has been developed to illustrate this new concept and to provide the user with a fast evaluation tool and a fast design time by using this software as a basis. Furthermore this evaluation tool can be easily customized for specific applications.

Fixed rotation speed with predefined voltage, positive or negative ramp, direct and reverse rotation direction and waveforms (sine and trapeze waves) can be easily generated by updating the tables. The frequency and the voltage applied to the motor can be chosen independently.

This Application Note describes several examples of generated waveforms and explains modification and adaption to different motors. Waveforms are selectable by keyboard.

18 AN428: 3 PHASE MOTOR CONTROL WITH MFT

B. Saby, P. Guillemin

3-phase induction motors are growing in popularity. Nevertheless, their maximum efficiency is achieved with a variable voltage and variable frequency drive through a bridge inverter.

The 6 power switches of the inverter require complex command sequences in order to approximate the 3 sine waves with a good accuracy. This is generally achieved by using a dedicated analog or digital IC, supervised by a standard microcontroller.

This Application Note presents an innovative single-chip solution taking advantage of the on-chip DMA of the ST9 family of microcontrollers. The DMA channel of the ST9 multi-function timers can be diverted to a 8-bit I/O port. This allows the ST9 to perform as pattern generator.

Different patterns are used to drive the 6 power switches in order to generate various voltages and frequencies.

19 AN430: SYNCHRONOUS POWER LINE MODEM COMMUNICATION WITH ST9 MULTIFUNCTION TIMER

O.Garreau

Home Automation Communications is proving to a popular way to control the electrical appliances in personal homes and appartments remotely from other rooms in the home.

Designed to provide a simple, reliable and low-cost implementation of the Home Automation Interface, the combination of the ST7537 with the ST9 8/16-bit Microcontroller provides synchronous communication with the "Home Service" Protocol at a Baud Rate of 1200.

This Application Note shows the implementation and test of this system.

A novel use of the Multifunction Timer of the ST9 is shown for frequency detection and data synchronization and transmission/reception.

Full source code listing and an example of the simplest interconnection between the two devices are provided.

20 AN431: USING ST6 ANALOG INPUTS FOR MULTIPLE KEY DECODING

J. Stockinger

The ST6 on-chip Analog to Digital Converter (ADC) is a useful peripheral integrated into the silicon of the ST6 family members. The flexibility of the I/O port structure allows the multiplexing of up to 13/8 Analog Inputs into the converter in a 28/20 pin device for the ST6210/15 2k ROM and ST6220/25 4k ROM families, enabling full freedom in circuit layout. Many other members of the ST6 family also offer the Analog to Digital converter.

One of the more novel and practical applications of this converter, is to decode a number of keys. The technique is to connect the keys by resistive voltage dividers to the converter inputs. An example of key detection using 10 keys is illustrated in this note.

Using the Analog to Digital converter in this fashion does not require a static current and avoids false key detection.

21 AN432: USING ST62XX I/O PORTS SAFELY

J. Stockinger

All members of the ST62 Series of Microcontrollers feature I/O ports with configurable bit functions. In addition many I/O bits may be set as inputs to the on-chip Analog to Digital Converter. This port bit function is in addition to the normal I/O functions of input (with or without internal pull-up resistor), output (open drain or push-pull) or edge/level selectable interrupt input (with pull-up). This flexibility makes the ST62 series suitable for many industrial control applications (and for many other uses).

This Application Note explains the architecture of the I/O bit associated with these port functions and provides some indications on the correct use of these features for functions such as keyboard scanning and analog inputs. The correct manner to switch between these function is also demonstrated in order to prevent potential malfunctions in operation.

22 AN433: ULTRA FAST BATTERY CHARGER USING ST6210 MICROCONTROLLER

L. Wuidart, P. Richter

Cordless and portable battery supplied equipments are proliferating thanks to the increasing capacity of rechargeable NiCd batteries.

A useful feature in applications where the battery is rapidly discharged, such as power tools, is ultra fast charging in less than half an hour.

The use of non-adapted monitoring charge methods may lead to a reduction of the battery life time and, in the worst case, to the explosion of the battery.

The solution described in this Application Note is an efficient 100 kHz converter charging an NiCd battery in less than 15 minutes. The battery charge is monitored by a low cost microcontroller ST6210 enabling battery voltages identification, temperature monitoring and charge control.

Overall performances and practical results are given. The program developped to control the battery charge is briefly described.

23 AN434: MOVEMENT DETECTOR CONCEPTS FOR NOISY ENVIRONMENTS

H. Sax

The sales of movement detectors, which react to human-body temperature, are increasing at a fantastic rate.

No Do-it-Yourself shop proposes less than 4 models for sale if it is serious about its image, however the majority of clients are novices who wish to install the system themselves. This installation often causes frustration, partly caused by a lack of knowledge of the operation of the system, but also by the weakness of the products. This weakness can be improved by the use of microcontrollers.

Most movement detectors available, whether using discrete components or integrated circuits, have a similar circuit concept. This Application Note shows concepts on how a microcontroller with analog inputs (the ST6210) can replace discrete components and add additional functionality.

Cost is not an essential factor, but carries a high prejudice against this concept. As shown, the decision to use a Microcontroller with analog inputs carries a series of advantages, together with its logical functionality.

24 AN435: DESIGNING WITH MICROCONTROLLERS IN NOISY ENVIRONMENTS

various

Microcontrollers (MCU) make possible the design of integrated and flexible controls for a constantly decreasing cost. As a result, they are spreading rapidly among most electronic applications and especially noise sensitive equipments such as for power control or automotive use.

An MCU operates with sequential logic, so the control of an application can be lost during a disturbance, as with analog control, but also after a power glitch in the system. In addition, a modern MCU includes several tens of thousands of transistors switching in the MHz range, potentially radiating interference of high magnitude in a large frequency spectrum. Consequently, noise sensitivity and generation have to be considered as early as possible in MCU based designs.

This Application note presents numerous methods to effectively reduce noise problems. The first part presents a short overview on noise and proposes hardware solutions to increase the equipment immunity to noise. The second part concerns the writing of software more immune to disturbances. The behaviour versus disturbances of MCUs designed for noisy environments, the ST62 family, is presented. Practical examples and results are shown.

25 AN438: SAFETY PRECAUTIONS FOR DEVELOPMENT TOOL TRIAC + MICROCONTROLLER

P. Rabier

The goal of this document is to analyse the different ways to configure a microcontroller and a development tool during the debbugging phase. The major problem is due to the direct connection of the computer I/O lines with the main power. Some precautions have to be taken during the emulation in order to avoid destruction.

26 AN490: PROGRAMMING FLASH MEMORY OF THE ST10F166

various

The ST10F166 high end microcontroller with on-chip Flash Memory fulfills the requirements of applications requiring an update to a part or all the program code. The block erase capability is also of use during the application development stage or for program updating. For data acquisition, the ST10F166 allows the programming of 16- or 32-bit data independently.

Operations on the Flash Memory are under software control. Erasure or programming is a simple procedure, however precautions must be taken to prevent damage to the ST10F166.

This Application Note describes the basic characteristics of the Flash Memory cell, and the different algorithms used for erasure and programming.

27 AN590: PWM GENERATION WITH ST62 AUTO-RELOAD TIMER

J.Nicolai

This note presents how to use the ST62 8-bit Auto-reload Timer (ARTimer) for the generation of a Pulse Width Modulated (PWM) signal tunable in frequency and duty cycle.

Two examples of this are shown, the first with a specific frequency and duty cycle, and the second with the generation of a 30kHz PWM signal with the duty cycle proportional to an analog voltage converted through the on-chip Analog to Digital Converter.

An introduction to the generation of PWM using the timer, and the software for the examples are provided.

28 AN591: INPUT CAPTURE WITH ST62 AUTO-RELOAD TIMER

J.Nicolai

This note presents how to use the 8-bit Auto-reload Timer (ARTimer) of the ST62 to measure time duration or frequency of an input signal.

The Capture Mode with reset is used to measure the time elapsed between two edges of an input signal: two rising edges, two falling edges, or one rising edge and one falling edge if the configuration of the AR-Timer is modified after the first edge is detected.

The minimum duration of one signal to measure depends on the microcontroller clock and on the required precision. With an 8MHz quartz crystal, a signal of 8µs duration can be measured with a resolution of 1/64.

A software example is provided.

29 AN592: PLL GENERATION USING THE ST62 AUTO-RELOAD TIMER

J.Nicolai

This note describes how to generate a digital signal locked in phase and frequency (PLL) with a calibrated delay starting from an active edge on the 8-bit Auto-reload timer (AR Timer) input pin.

An example is given for a digital input signal of 15kHz presented to the ARTimer input pin. A phase-locked signal at 15kHz with a falling edge delayed 19µs from the input rising edge, and a duty cycle of 75%, is generated.

An explanation of the function and software for the function are provided.

30 AN593: ST62 IN-CIRCUIT PROGRAMMING

This note provides information on the steps required in order to perform in-circuit programming of ST62Exx EPROM or OTP devices for both on-chip EPROM and EEPROM (where available).

In-circuit programming is possible if the relevant pins of the programming socket located on the ST62 EPROM Programming tool (either an ST6 Starter Kit, Remote Programming board, or Gang Programmer) are connected to a 16-pin connector (8x2 header), which must be provided on the application by the user.

Note: In-circuit programming embedded in program test is not possible. If the EPROM programmer cable is connected to the application, the RESET signal for example is tied to Ground before and after programming.

Connections are shown for the ST62E1x/2x, ST62E4x and ST62E6x/E9x and the corresponding OTP devices.

31 AN594: DIRECT SOFTWARE LCD DRIVE WITH ST621X AND ST626X

T.Castagnet, J.Nicolai, N.Michel

This note describes a technique for driving a Liquid Crystal Display (LCD) with a standard ST62 microcontroller, without any dedicated LCD driver. This technique offers a display capability for applications which require a small display at low cost together with the versatile capabilities of the standard ST62xx MCU. Higher display requirements are easily handled by dedicated members of the ST62xx MCU family, for example the ST6240.

The first part of this note describes the typical waveforms required to drive an LCD correctly with a multiplexing rate of 1 or 2 (duplex). The following parts present two solutions based on standard ST62 MCUs driving directly the LCD. The first is based on an ST6215 without using software interrupts and the second on an ST6265 where the LCD is controlled by timer interrupts.

In both examples the program size, the CPU time occupation due to the LCD drive and the number of surrounding components are minimized. Consequently many additional tasks can be added to the MCU program.

32 AN595: FUZZY VACUUM CLEANER USING ST6220 AND FUZZYTECH™ ST6 EXPLORER

Central Application Laboratory, Singapore

For the past 20 years, the home environment has changed drastically and with the rise of living standards, the consumers' need for home cleaning has switched from a simple mop or scrub to a more sophisticated mode. A vacuum cleaner that is able to do the cleaning based on different characteristics of floor surfaces will be very desired for today's market.

This new requirement actually represents the first and most visible group of the next generation of consumer products based on a new control-fuzzy logic. Fuzzy logic is a relatively new technology that enables machines and products to operate more efficiently and independently by processing information similar to the way people do.

This note describes a universal motor power control implemented on a standard microcontroller running software using the fuzzy logic concept. The different stages of development of the motor power control for a vacuum cleaner are described with the ST6220 microcontroller and a fuzzy logic development tool, the "*fuzzy*TECH™ ST6 Explorer Edition".

33 AN597: TEMPERATURE CONTROL WITH FUZZY LOGIC

Lionel Picandet

Fuzzy logic may be considered as an assortment of decision making techniques. In many applications like process control, the algorithm's outcome is ruled by a number of key decisions which are made in the algorithm. Defining the best decision requires extensive knowledge of the system. When experience or understanding of the problem is not available, optimizing the algorithm becomes very difficult. This is the reason why fuzzy logic is so useful.

We can split the problem into a discrete number of possible decisions by associating fuzzy logic membership functions with each input and output. The accuracy of the output depends on how many membership functions we define and how many rules we implement. The outcome is that a user without know-how or an extensive understanding can solve the problem.

This Application note describes the use of fuzzy logic to create a temperature controller suitable for home appliance needs. The example shown uses the ST6225 microcontroller with the ST6 fuzzyTECH Explorer Edition fuzzy logic development program. Practical steps are shown.

34 AN598: CASCADING FUZZY MODULES WITH ST6 FUZZYTECH

Lionel Picandet/Lim King Soon

Sometimes an application using fuzzy logic may require two fuzzy modules to operate with the desired conditions.

The ST6 fuzzyTECH Explorer Edition is capable of generating only one fuzzy module at a time. However this note explains a technique for linking two fuzzy modules into one application at the same time, without extensive modifications to the ST6 source code files created by ST6 fuzzyTECH Explorer Edition.

It should be noted that these two modules cannot work at the same time, but they can operate sequentially or in a different time period.

Application of this note requires knowledge of the ST6 fuzzyTECH Explorer Edition fuzzy logic development tool and the ST6 software development tools.

35 AN669: SIMPLE RESET CIRCUITS FOR THE ST62

T.Castagnet, J.Nicolai, L Perier

The circuit schematics shown in this Application Note provide examples of reset circuits for the ST62xx microcontrollers. These circuits range from a very simple solution, which is only efficient at power up, to a circuit providing power up and power down monitoring with a delay at power on.

When used with the watchdog and a software implementation, an efficient and reliable reset of the ST62 can be made.

36 AN670: OSCILLATOR SELECTION FOR ST62

C.Pilon, L.Perier

The purpose of this note is to give indications on how to choose a resonator or a quartz crystal in order to achieve reliable oscillation with the ST62 Microcontroller. This document provides first the major resonator parameters useful for a design. It then proposes measurement methods to ensure a safe oscillation.

37 AN671: PREVENTION OF DATA CORRUPTION IN ST6 ON-CHIP EEPROM

C Pilon

The ST6 Microcontroller has been designed to avoid any potential corruption of data programmed into its on-chip EEPROM (when available). Data integrity can be ensured as long as the application designer follows the guidelines provided in this note.

In general, EEPROM data corruption occurs whenever the reset signal is not controlled when the power supply goes up or down. This is particularly true with a slow ramp-up and/or slow fall time of the power supply, since the device may be in a supply voltage area when the device functionality is not guaranteed for a long time.

If no special care is taken during the power up sequence regarding the reset signal then the microcontroller may start writing into the EEPROM. The same behaviour can be present upon a power down.

This note proposes two complementary solutions to prevent these unwanted actions, a software solution and a hardware solution.

38 AN672: OPTIMIZING THE ST6 A/D CONVERTER ACCURACY

J.Nicolai

When using the internal Analog to Digital Converter of the ST62 family and maximum A/D converter accuracy is required, it is desirable to filter out any noise present on the analog input. This includes also noise present on the ground and Vcc supply lines of the MCU as Vcc is also the voltage reference of the A/D converter.

While good supply decoupling with capacitors is always recommended, and placing the ST6 into its WAIT state reduces potential noise induced by the digital switching within the MCU, digital filtering by averaging several successive A/D conversions can improve the accuracy of the conversion.

This is the most effective way to get the most accuracy out of the ST6 family A/D converter.

The code fragment included with this note demonstrates this digital filtering which gives the best results with a trade-off against the total time for conversion.

39 AN673: REDUCING CURRENT CONSUMPTION AT 32KHZ WITH ST62

C.Pilon, L.Perier

In many cases a 32kHz crystal is chosen for the oscillator of the ST62 microcontroller in order to achieve the minimum current consumption in the application.

This note provides a technique for minimising the current consumption when using a crystal oscillator at this frequency.

This short note should be read in conjunction with Application Note AN670, "Oscillator Selection for the ST62".

40 AN674: MICROCONTROLLERS IN HOME APPLIANCES: A SOFT REVOLUTION

L. Perier

The industrial world is now an arena where many manufacturers produce low cost, high quality products. Cost cutting and outsourcing are no longer sufficient to ensure competitiveness. Creativity and time to market become a must to survive. As a result, traditional electromechanical solutions do not fit many new home appliance requirements.

Now microcontrollers (MCUs) offer a strategic advantage for the design of cheap, attractive and environmentally safe products. For example, new MCUs can operate directly from the mains and drive power loads with only few external components. They can reduce the energy consumption, motor size and the cost of the appliance.

In the first chapter, this article analyses the forces driving new appliance concepts. In a second part, it describes state of the art solutions. The third chapter presents MCUs well adapted to home appliances and tools for increasing a designer's productivity.

41 AN675: A RAPID CHARGER FOR BATTERIES WITH FUZZY LOGIC

BOSCH Corporation

The advantages of Nickle-Cadmium (NiCd) batteries for portable appliances are well known (high peak current, low cost, and wide range of packaging). However NiCd batteries also have disadvantages for efficient and fast charging.

To correctly charge a NiCd battery a good estimation of the charge level of the battery needs to be made. This is dependent on a number of unknown variables such as age, charge and discharge state and temperature, which cannot be forecast.

While several techniques for charging are well known (refer to AN417 and AN433), this Application Note provides further extensions into the control domain by the application of fuzzy logic.

An overview of a practical and current application of fuzzy logic is shown with the Membership Functions and Rules chosen.

Application of this note requires prior knowledge of the ST6 fuzzyTECH Explorer Edition fuzzy logic development tool.

42 AN676: BATTERY CHARGER USING THE ST6-REALIZER ®

Lionel picandet

Because competition becomes greater and greater it is important to reduce time to market. The ST6 Realizer helps to fullfill this duty. The time needed to realize a design is dramatically reduced. Design of an application takes a few days instead of a few weeks.

Users who develop ST6 applications are systems electronics engineers; Often they do not know the assembler well and there are reluctant to use it. The ST6 Realizer allows users to design their applications using symbols known by hardware designers such as comparators, counters, multiplexers. Once the design is over, the ST6 Realizer generates assembly code or executable code for the different ST6 target hardware.

43 AN677: PAINLESS "MCU" CODE BY GRAPHICAL APPLICATION DESCRIPTION

Olivier Rouy

Some electromechanics and automatics engineers hesitate to use microcontroller (MCU) solutions despite their recognised advantages: High integration and flexibility for enhanced features. Their main worry is the unpleasant aspect of MCU application development: Learning, code writing, debugging through quite unconvivial tools.

Fortunately, it is possible today to use these tools (and to keep the genuine integrity of the code issued) through a graphic interface. This new complete toolbox, the ST6-Realizer ®, allows a graphical description of the system, automatic code generation, simulation and debugging.

44 AN678: LCD DRIVING WITH ST6240

Olivier Rouy

This application note describes the basic guidelines to achieve a fast and efficient LCD drive application development.

The allphanumeric LCD panel of the ST624x Starter-Kit is used as exemple and more general concerns are highlighted.

Hardware and software issues are described to demonstrate the benefits brought about while using a ST62 LCD driver.

45 AN839: ANALOG MULTIPLE KEY DECODING USING THE ST6-REALIZER

Olivier Rouy

Design of a multiple key decoder using the A/D converter present on the ST62 MCU. This note describes how the A/D convertor can be used to reduce the number of I/O lines required for key decoding. Software development is carried out using the ST6-REALIZER, and therefore does not involve writing code in assembly language.

46 AN840: CODED LOCK USING THE ST6-REALIZER

Olivier Rouy

Design of a coded security lock. This application uses the EEPROM on the ST62 MCU to store the secret code. Code entry and recognition is performed under software control. Software development is carried out using the ST6-REALIZER, and therefore does not involve writing code in assembly language.

47 AN841: A CLOCK DESIGN USING THE ST6-REALIZER

Olivier Rouy

Design of a clock system. This note provides an example of time management using the Timer embedded in the ST62 MCU. Current time setting and alarm time setting are carried out under software control. Software development is carried out using the ST6-REALIZER, and therefore does not involve writing code in assembly language.

48 AN842: 7 SEGMENT DISPLAY DRIVE USING THE ST6-REALIZER

Olivier Rouy

Design of 7-segment driver functions. This note provides an example of the use of lookup tables for conversion or coding purposes. Single digit and multiple digit display applications are described. Software development is carried out using the ST6-REALIZER, and therefore does not involve writing code in assembly language.

49 AN843: BANKSWITCH AND GNU C EXAMPLE

Thierry Crespo - Marc Liochon

An in-depth account of the bankswitching feature offered by several ST9 devices, which allows accessing up to 2x8 Mbytes of external memory. Examples are given showing how the port used to address memory banks may be used in full 8-bit mode or in "nibble" mode. Particular emphasis is paid to how bankswitching may be automated using the GNU C Toolchain and on how it is handled using the WGDB9 Windows GNU Debugger. Full software listings of sample code are provided.

50 AN859: AN INTELLIGENT ONE HOUR MULTICHARGER FOR Li-Ion, NiMH and NiCd BATTERIES

J-M. Ravon and L. Wuidart

A new intelligent multicharger concept, fully compatible with Li-Ion, NiCd and NiMH battery technology, illustrating the power and flexibility offered by a low-cost industry standard Microcontroller and the ease with which existing designs may be adapted to cater for emerging technologies. A low-cost, high resolution, voltage measurement technique using capacitor charge time is also described.

51 AN860: REAL-TIME KERNELS ON THE ST20

Julian Wilson

High-volume deeply embedded systems such as found in portable telephones or television set-top boxes require the same computing facilities as more familiar environments. Costs in these systems are such, however, that royalty fees for real-time kernels would be prohibitive. This article describes the implementation of a lightweight real-time kernel using the ST20 which delivers very fast context switching and is provided free in source form.

The ST20 hardware microkernel implements a cooperative model of scheduling in which application tasks share the available CPU resource on a first come first served basis. The model is very effective because context switching on an ST20 is very fast and systems can be designed so that a process is never very far from the front of the queue. The model does not guarantee a maximum scheduling time and in certain circumstances this is undesirable. Additionally, systems are in place which rely on multiple priorities. To address these issues the ST20 has hooks into the microcoded scheduler which allow a richer sheduling regime to be implemented. This article describes two such implementations (referred to as OS/20 and OS/20-Lite).

The kernels described can be used to provide a basis by which proprietary real-time kernel developers can port their kernels to the ST20 or can be used as a kernel directly. When used as the scheduling regime, OS/20-Lite delivers context switch times when a user task is pre-empting another user task of less than 5 microseconds on a 40MHz ST20-TP1.

The article describes in detail the OS/20 software, written in C, and shows how this takes advantage of the ST20 architecture to deliver the desired features. In conclusion the article shows how a combination of queue management in microcode and process selection in software delivers a fast, cost-effective and simple solution to real-time scheduling issues on the ST20.

52 AN861: PLUG & PLAY DEMONSTRATOR OF THE EUR. HOME SYSTEMS NETWORK: EHSNODE

R. Girard

This note describes a home automation application. The first part is a summary of the European Home Systems network for home and building trade. The specification of this network is issued from the ESPRIT project of the European Commission. This part presents a communication model used by EHS. It also introduces the requirements leading to the Plug and Play capability. The second part relates more to the application itself: a remote light dimmer. The EHS remote light dimmer demonstration is based on two boxes. Each box has its hardware split into two boards. One of them, the physical layer board carries the power supply and the modem. The other one, the application layer, carries the ST9 microcontroller and the components for the application. Finally, after the description of the hardware based on SGS-THOMSON's components, this document provides the software structure.

53 AN862: ST9058 MICROCONTROLLER, PLL CLOCK APPLICATION NOTE AND DEMOBOARD

Olivier Garreau

The objective of this Application Note is to present the technical features of the ST9058 clock generator based on a Phase Locked Loop (PLL) circuit.

Included is also the presentation of a simple application that features the PLL clock and illustrates the programming of this clock generator.

The hardware of this application note is the ST9058 PLL Demoboard that demonstrates the capabilities of the ST9058 running in low power mode and at low frequency.

54 AN863: IMPROVED SENSORLESS CONTROL WITH THE ST62 MCU FOR UNIVERSAL MOTOR

J. Nicolai, A. Bailly, T. Castagnet

The universal motor is today the most widely used motor in home appliances (vacuum cleaner, washer, hand tool, food processor...). This note describes a speed regulator without sensor: the speed sensing is per-formed indirectly by the ST6220, low-cost 8-bit microcontroller, measuring the motor current. Perform-ance results are given, which are in line with the need of many home appliances.

55 AN883: A MINI GUIDE TO THE APPLICATION NOTE INDEX IN THE 8-BIT MCUs BULLETIN BOARD SYSTEM

Ian Blythe

The Application Engineers of SGS-THOMSON provide their experience to you in the form of Application Notes, including system analysis for efficient design and Tips and Hints for optimal product operation. Sometimes it may not be evident which SGS-THOMSON Application Note answers your questions. This Index contains abstracts for all Applications Notes and these can be searched interactively by Device Type, Author (if known in advance) or Keywords.

This guide shows how to use the Application Note Index program from SGS-THOMSON. This program is available on-line through the SGS-THOMSON Bulletin Board Systems (BBSs -telephone numbers are listed in this document), and also can be downloaded from the BBSs to run on your personal PC.

56 AN884: ST62xx APPLICATION NOTE ABSTRACTS BY TOPIC

This document contains abstracts for all Applications Notes relating to ST6, general purpose 8-Bit MCU. These are classified by topic based on System Design, namely motor control, battery management, fuzzy logic, home applicance and graphical design, and System Optimization such as cost reduction, design im-provements and peripheral operations.

57 AN885: ST62 MICROCONTROLLERS DRIVE HOME APPLIANCE MOTOR TECHNOLOGY

Bruno Maurice

Most domestic appliances are driven by an electric motor; for the most part, these motors are controlled in a simple and rudimentary fashion, and electronics is only now beginning to be ap-plied. This article de-scribes the three main motor families – Universal, Induction and Electron-ically Commutated – as well as the relevant electronic control techniques, now possible thanks to the intrinsic characteristics of SGS-THOMSON's ST62 Family of microcontrollers.

ST62 MCUs, with their wide range of on-chip peripherals, their wide supply voltage range, their built-in ruggedness and their legendary noise immunity allow truly low total system cost, thus favouring the tech-nological advancement of electrical motor design.

Basic electrical topologies are described, together with their associated power and signal electronics. The relative strengths and weaknesses are explored, using practical examples, in order to illustrate the advan-tages of electronic control using ST62 MCUs.

58 AN886: SELECTING BETWEEN ROM AND OTP FOR A MICROCONTROLLER

A customer who develops an MCU based application needs different levels of flexibility in the ability to perform code modifications (these levels are explained on the next page). To satisfy these requirements, SGS-THOMSON supports several device types: Windowed EPROM, OTP and ROM.

Costs are highly depending on the flexibility given to the device (ability to be easily erased or pro-grammed). ROM is the cheapest technology but provides little flexibility whereas OTP and EPROM are more flexible but their manufacturing cost is higher. The high cost of EPROM MCU devices is due to the price of ceramic packages.

This application note gives some guidelines on how to select between ROM and OTP.

59 AN887: MAKING IT EASY WITH MICROCONTROLLERS

A few years ago, system control functions were implemented using logic components and were usually large, heavy boxes. Later on, microprocessors were used and the entire controller could fit onto a small circuit board. As the process of miniaturization continued, all of the components needed for a controller were built right onto one chip. By only including the features specific to the task, cost is relatively low.

This note makes a good description of the general features of a microcontroller (CPU, memory and peripherals) and shows its typical applications. It also tackles some power supplies issues.

60 AN898: EMC GENERAL INFORMATION

Because many electronic circuits are in proximity to each other, it is essential that their design is not affected by external noise sources and that the circuit itself is not a noise source affecting other circuits. This relationship is known as electromagnetic compatibility or EMC. Sources of electromagnetic noise are numerous and have both natural and man-made origins. This note describes some EMC general information such as Elelectromagnetic Interference (EMI) & Susceptibility (EMS) and give some precision about EMC regulations.

For detailed information regarding EMC guidelines for microcontroller - based applications, please refer to AN901.

61 AN899: SOLDERING RECOMMENDATIONS and PACKAGING INFORMATION

SGS-THOMSON supports various package types to adapt MCUs to customer requirements. Beside the available mounting technology (SMD or Throughhole), the choice is often driven by technical and economical concerns. This application note describes the various package types used for MCUs, introduces the various mounting technologies and gives soldering recommendations.

62 AN900: INTRODUCTION TO SEMICONDUCTOR TECHNOLOGY

An integrated circuit is a small but sophisticated device implementing several electronic functions. It is made up of two major parts: a tiny and very fragile silicon chip (die) and a package which is intended to protect the internal silicon chip and to provide users with a practical way of handling the component. This note describes the various “front-end” and “back-end” manufacturing processes and takes the Transistor as an example, because it uses the MOS technology. Actually, this technology is used for the majority of the ICs manufactured at SGS-THOMSON.

63 AN901: EMC GUIDE-LINES FOR MICROCONTROLLER - BASED APPLICATIONS

Edouard PRESSON and David JACQUINOD

EMC must be taken into account at the very beginning of a project; the cost of correcting an EMC problem of an application encountered at the start of the production can be far greater that the cost of detailed EMC study during the development phase.

This note aims to provide guide-lines to the designer of microcontroller-based applications in such a way that the optimum level of EMC performance can be achieved.

For more general information about EMC, please refer to AN898.

64 AN902: QUALITY AND RELIABILITY INFORMATION

We think that maintaining an optimal quality level is very important but we also believe that our customers contribute to the quality chain when they handle or program our MCU devices Quality is involved at each step but it is important to notice that the customer also has a major role in quality assurance. This application note describes all the stages an SGS-THOMSON’s product need to get over to be qualified, passing the various reliability tests.

65 AN910: ST7 AND ST9 PERFORMANCE BENCHMARKING

A. Albella, G. Bouvier and J. Pauvert

SGS-THOMSON has developed a set of test routines related to 8-bit and low-end 16-bit microcontroller applications to evaluate computing performance and interrupt processing performance of microcontroller cores. These routines have been implemented on ST7 and ST9 Microcontroller Units (MCUs) as well as several MCUs available on the market.

The routines have been written in assembler language to optimize their implementation and focus on core performance, without being dependent upon compiler code transformation.

For each test, the two parameters of interest are execution time and code size. Timings have been either measured whenever possible, or theoretically calculated when there was no other alternative. In most cases, programs have really run and execution times have actually been measured, so that assembly sources should not contain implementation errors and results can be considered as correct and reliable.

The results of this study point out the capability of the ST9+ to compete with 16-bit MCUs on 8-bit and low-end 16-bit applications and confirms its position of high-end 8/16-bit MCU. It also confirms the ST7 as an outstanding 8-bit MCU.

66 AN911: ST6 MICRO IS EMC CHAMPION

Since January 1996, Electro-Magnetic Compliance is required by international law for any electrical equipment that is manufactured including a printed circuit board. As early as 1991, SGS-THOMSON took this change in the law into account when planning the design and manufacture of the ST62 microcontroller family. An EMC environment was installed in the Design, Quality and Engineering center and ST quality standards were enlarged to include EMC performance criteria, with the result that the ST62 microcontrollers meet the EMC standards five years ahead of most 8-bit microcontrollers.

This short article describes the characteristics of the ST6 microcontroller in the EMC context and how this benefits the customer.

67 AN912: A SIMPLE GUIDE TO DEVELOPMENT TOOLS

K. Bigue

MCU Development Tools serve to program and evaluate one or several microcontrollers. This application note describes the types of tools that exist and the tasks for which they are used. With the aid of diagrams and illustrations, this application note provides easily-understandable answers to questions like “What are Development Tools?”, “What are the characteristics of High Level and Low level languages?” or “What is a Debugger?”. A general description of hardware tools allows the purpose of various tool packages such as emulators and starter kits to be compared.

68 AN913: PWM GENERATION WITH ST62 16-BIT AUTO-RELOAD TIMER

Microcontroller Division Application Team

The 16-bit Autoreload timer (ARTimer) is a 16-bit downcounter timer with prescaler. It includes auto-reload PWM, capture and compare capability with two input and two output pins. This note presents how to use the ST62 16-bit Auto-Reload Timer (ARTimer) for generating a DTMF signal (Dual-Tone Multiple Frequency) with the PWM. In the example shown, the PWM output pin generates a DTMF to dial a telephone number.

69 AN914: USING ST626X SPI AS UART

Microcontroller Division Application Team

This note shows how to use the ST626x SPI to perform UART serial communication. The operating principles and limitations are described. An example is developed for reception and transmission at 9600 baud, however, baud rates up to 19200 can be obtained. The assembly source code of the example is provided.

70 AN969: ST7 SCI COMMUNICATION BETWEEN THE ST7 AND A PC

Microcontroller Division Application Team

This application note shows how to implement standard RS232 protocol serial communications between an ST7 microcontroller and a PC. The various sections of the document describe the RS232 protocol, the ST7 SCI interface, how to configure the SCI, setting up hardware and writing the driver routines for initializing the communication parameters and performing data exchange. A source assembly listing is provided at the end of the document.

71 AN970: ST7 SPI COMMUNICATION BETWEEN THE ST7 AND E²PROM

Microcontroller Division Application Team

This application note gives a useful example of communication using the ST7 SPI peripheral. Simple communication between an ST7 microcontroller and a SPI E²PROM is implemented by performing, through SPI, a write in the memory, followed by a read of the written data. The hardware interfacing, software initialization and communication protocols are described and illustrated with schematics and flowcharts. A section describes how to address several E²PROM devices from the ST7. An assembly listing is provided at the end of the document.

72 AN971: ST7 I²C COMMUNICATION BETWEEN THE ST7 AND E²PROM

Microcontroller Division Application Team

This application note presents a practical example of a communication using the I²C peripheral of the ST7. It describes a basic single master communication between an ST7 microcontroller and an I²C bus E²PROM. The purpose is to execute, from the ST7 through the on-chip I²C interface, a write and a read in the external E²PROM without error management. The ST7 I²C peripheral allows multi master and slave communication with bus error management. In this application, only single master mode is used without error management. As polling mode is more difficult to implement, the application is based on this mode, but it can be easily adapted to interrupt mode. An assembly source listing is provided.

73 AN972: ST7 SOFTWARE SPI MASTER COMMUNICATION

Microcontroller Division Application Team

This application note presents a basic software driver for emulating SPI full duplex communication in master mode using the ST7 standard I/O ports. The principles of the SPI (Serial Peripheral Interface) are briefly introduced and an algorithm for 8-bit full duplex communication is described. A source assembly listing is provided at the end of the document.

74 AN973: SCI SOFTWARE COMMUNICATION WITH A PC USING THE ST72251 16-BIT TIMER

Microcontroller Division Application Team

The Serial Communication Interface (SCI) offers a flexible means of full-duplex data exchange with external equipment requiring an industry standard NRZ asynchronous serial data format. This document shows how to emulate SCI communication by software, using the ST7 timer. The application presented is for RS232 communication between an ST7 microcontroller and a PC. Initialization, interrupts and receive and transmit routines are described with the aid of diagrams and flowcharts. A source assembly listing is provided at the end of the document.

75 AN974: REAL TIME CLOCK WITH THE ST7 TIMER OUTPUT COMPARE

Microcontroller Division Application Team

This note explains how to use the ST7 Timer output compare function. The application example presents a real time clock with second, minute and hour counters based on a fixed time base. Flowcharts describe hardware configuration, initialization and register updating procedures. A source assembly code listing is given at the end of the document.

76 AN976: DRIVING A BUZZER USING THE ST7 PWM FUNCTION

Microcontroller Division Application Team

This "musical" application describes how to use the ST7 PWM to generate synthesized music using a buzzer. The document covers musical score, note duration and tone generation and volume control. A source assembly listing is provided at the end of the document.

77 AN979: DRIVING AN ANALOG KEYBOARD WITH THE ST7285 ADC

Microcontroller Division Application Team

This application note presents a standard example of the use of the Analog to Digital Converter (ADC) of the ST7. The ST7 on-chip ADC is used to emulate a 16-key analog keyboard. The hardware interfacing techniques are outlined in the first part of the document and the software is described by means of flowcharts. An assembler source listing is given at the end of the document.

78 AN985: EXECUTING CODE IN ST7 RAM

Microcontroller Division Application Team

Using the ST72251 as an example, this application note describes how to execute programs in the on-chip RAM area of the ST7. The code to be executed can be copied from the ROM area or loaded from an external device such as a host system or serial device such as E^2PROM. With the aid of flowcharts and an example source in assembly language, this document explains the essential steps required: linking, copying the code and calling the program.

79 AN986: USING THE ST7 INDIRECT ADDRESSING MODE

Microcontroller Division Application Team

The ST7 assembly language instruction set includes the indirect addressing mode (indexed or not indexed) for short and long variables. This document shows using examples how using the indirect addressing mode allows the programmer to write more compact code in both Assembly and C language programs.

80 AN988: STARTING WITH ST7 ASSEMBLY TOOL CHAIN

Microcontroller Division Application Team

This document gives guidelines on how to start an ST7 application design based on the SGS-THOMSON Assembly tool chain. The ST7 tool chain is a DOS or UNIX hosted cross development system for ST7 microcontroller based applications. The application note describes the use of the tool chain the DOS environment. An overview of the tool chain is given and the Assembler options are described.

81 AN987: ST7 IN-CIRCUIT PROGRAMMING

Microcontroller Division Application Team

This application note describes:

The advantages of In-Circuit Programming vs. programming on an EPROM programming board.

How to implement In-Circuit Programming targeting most of the ST7 general purpose micro-controller. These devices are all the parts supported by the ST7 starter kits and ST7 EPBs in the MDT1, MDT3 and MDT4 tool families.

82 AN989: STARTING WITH ST7 HIWARE C

Microcontroller Division Application Team

This document gives guidelines on how to start an ST7 application design based on the HIWARE C Compiler chain. A description is given of how to set up a project using the Hi-Cross C Compiler combined with the WINEDIT editor/project management tool integrated in the Hi-Cross package. The ST7 Hi-Cross/Hi-Light tool chain is a cross development system for ST7 microcontroller applications from HIWARE A.G.

83 AN990: ST7 BENEFITS VERSUS INDUSTRY STANDARD

Microcontroller Division Application Team

This note presents, from the application developer's point of view, the main advantages of the ST7 core over the corresponding industry standard architecture in terms of application cost, speed and flexibility. The ST7 enhancements discussed include the Y Index register, Indirect memory access mode, Stack pointer access, PUSH/POP instructions, SWAP instruction and interrupt vectors.

84 AN1014: HOW TO MINIMIZE THE ST7 POWER CONSUMPTION

Microcontroller Division Application Team

This document presents a way of minimising the ST7 power consumption for low power applications. This note is based on the ST72311, but is applicable to all ST7 general purpose devices. Use of ST7 Slow mode, Wait Mode and Halt mode is discussed and tables with examples of power consumption measurements are given.

85 AN1015: ST6 SOFTWARE TECHNIQUES FOR IMPROVING EMC PERFORMANCE

A. Niaussat

A major contributor to improved EMC performance in microcontroller-based electronics systems is the design of hardened software. To achieve this goal, EMC considerations must be included as early as possible in the design phase of the project. A quality approach to software increases the security and the reliability of the application. EMC-hardened software is inexpensive to implement, it improves the MCU's immunity performance and saves hardware costs. This application note describes how to implement preventive tricks and active detection in the application software.

86 AN1016: ST6 USING THE ST623XB/ST628XB UART

Microcontroller Division Application Team

This brief note describes the problem/solution for managing potential spurious UART interrupts during reset. A short descriptive paragraph outlines the problem. This is followed by a table of values for inserting in the application program covering a range of baud rates. A short assembly code example is provided.

87 AN1017: USING THE ST7 USB MICROCONTROLLER

Microcontroller Division Application Team

The ST7277 USB interface is a Universal Serial Bus peripheral that provides a means of connecting a PC peripheral serving as a function to a PC host. It supports low speed data transfers. This application note describes an example firmware for interaction with the USB interface hardware and support interactions between a USB device and a host system. The associated source code of the firmware is available.

88 AN1041: USING ST7 PWM SIGNAL TO GENERATE ANALOG OUTPUT (SINUSOID)

Microcontroller Division Application Team

The purpose of this note is to present how to use the ST7 PWM/BRM for the generation of a 50Hz sinusoïd tunable in average and amplitude. Our application has been done with a ST72511R4.

89 AN1042: ST7 ROUTINE FOR I²C SLAVE MODE MANAGEMENT

Microcontroller Division Application Team

The goal of this application note is to present a useful example of communication using the I²C peripheral of the ST7. The ST7 microcontroller is used as a slave and can communicate with any master. This slave, through the I²C interface, receives words from the master implementing error management and returns them. This application has been realized with a ST72E251 and a 7-bit addressing mode.

90 AN1044: MULTIPLE INTERRUPT SOURCES MANAGEMENT FOR ST7 MCUS

Microcontroller Division Application Team

The goal of this application note is to present a technique for managing several external I/O interrupts with a member of the ST7 series of MCUs (here a ST72251).

91 AN1045: ST7 S/W IMPLEMENTATION OF I2C BUS MASTER

Microcontroller Division Application Team

This application note implements an I^2C communications software interface that can be used in any general-purpose ST7 device without specific I^2C on-chip peripheral hardware. The program is written in C language. It implements the I^2C master transmitter and master receiver functions. The ST7 acts as the bus master and communicates via the I^2C bus to a slave EEPROM device.

92 AN1047: MANAGING RECEPTION ERRORS WITH THE ST7 SCI PERIPHERAL

Microcontroller Division Application Team

This application note provides guidelines for managing communication errors with the ST7 Serial Communications Peripheral (SCI) in reception mode. It describes how the ST7 SCI peripheral works when errors occur. A explanation is given of how to interpret the various error flags and to determine if the received byte is corrupted or not. An example interrupt service routine written in assembly language is provided at the end of the document.

93 AN1048: ST7 SOFTWARE LCD DRIVER

Microcontroller Division Application Team

This note describes a technique for driving a Liquid Crystal Display (LCD) with any standard ST72 Microcontroller i.e without any specific on-chip LCD driver hardware. This technique offers a solution for applications which require a small display at low cost together with the versatile capabilities of the ST72 MCU. The first solution uses the ST7 timer output compare feature to generate the LCD timing. The second solution targets low power applications, switching the ST7 into Halt mode between two I/O refreshes. An external RC circuit is used to wake up the ST7 using an external interrupt.

94 AN1050: ST6 INPUT CAPTURE WITH ST62 16-BIT AUTO-RELOAD TIMER

Microcontroller Division Application Team

This note presents how to use the ST62 16-bit Auto-Reload Timer (ARTimer) to measure durations or frequencies of an input signal. An example shows how to capture an input signal to make an output signal with the same frequency as input signal but with a duty cycle equal to 50%. The ARTimer has a 16-bit downcounter timer with prescaler. It includes auto-reload PWM, capture and compare capability with two input and two output pins.

95 AN1063: ST9 SERIAL COMMUNICATION INTERFACE IN SYNCHRONOUS SLAVE MODE

Microcontroller Division Application Team

This note shows how to use the ST9+ SCI Serial Communication Interface in synchronous mode. The SCI runs as a SPI Serial Peripheral Interface in slave mode only. This means that the external communication device provides the clock for both transmitter and receiver operation. The device used is the ST90158 PLCC84. The program is in C language and has been compiled, assembled and linked with the GNU C Toolchain release 4.21.

96 AN1064: WRITING OPTIMIZED HIWARE C LANGUAGE FOR ST7

Microcontroller Division Application Team

The purpose of this note is to present how to write an optimized C software application for ST7 embedded system programming. The main topics focus on how to write C source code that generates the smallest code and data size. To reach this goal some specific C language extensions have to be used like compiler options and pragmas.

97 AN1070: ST7 CHECKSUM SELFCHECKING CAPABILITY

Microcontroller Division Application Team

The goal of this application note is to present a software technique for determining if data and program in EPROM have been corrupted and if so not to run the user's program.

The program described in this application note has been written for the ST7GP family (ST72101G1 and G2, ST72121J2, ST72212G2, ST72213G1, ST72251G1 and G2, ST72311N2 and ST72331N2).

You have to choose your device at the beginning of the program (several "#define" statements are provided for this purpose). In this application, we chose to use a ST72251G2.

98 AN1075: USAGE OF THE ST9+ MEMORY MANAGEMENT UNIT (EXAMPLES FOR ST92195 & ST92R195)

Microcontroller Division Application Team

This application note describes techniques for creating software applications using the Memory Management Unit (MMU) of the ST9+. In addition, it provides useful hints on using the ST9+ C Compiler. A description of the main characteristics of the ST9+ MMU is given. Then, the C compiler is briefly described, emphasizing the Memory Management Unit aspects. Finally, the subject matter is developed using examples for a ROMless and a ROM microcontroller, the ST92R195 and the ST92195 respectively.

99 AN1078: ST7 TIMER PWM DUTY CYCLE SWITCH FOR TRUE 0% or 100% DUTY CYCLE

Microcontroller Division Application Team

This application note presents a program that uses the 16-bit timer of the ST7 in PWM output mode. The program can be used to perform a hot switch from one duty cycle to another and obtain a true fixed period and true duty cycle percentage values between 0% and 100%.

The example program in this application note has been developed for the ST7GP family (ST72251G1 and G2).

You have to choose your ST7 device at the beginning of the program using one of the several "#define" statements provided. In this application, we chose to use a ST72251G2.

100 AN1087: ST9+ INTERRUPT RESPONSE TIME

Microcontroller Division Application Team

This application note presents the ST9+ interrupt response time calculation for each kind of interrupt in the best and the worst cases. The interrupt response time is the time between the interrupt event occurrence and the start of the corresponding interrupt service routine. The different phases of interrupt processing are described in detail.

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