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Development of Time Code Generator Translator using Microcontroller Based user Interface

T. Jaswanth Kumar, M. Vijaya Kumar, A. Venugopal, Ch. Jayalakshmi

Abstract*— the paper deals with development of time code generator and translator using microcontroller based user interface. TCG/T is used in order to provide time stamping and event synchronization in satellite stations. TCG (Time Code Generator) is a precision timing system that generates a GPS (Global positioning system) Synchronized serial time code with DS1307-RTC (Real time Clock) where the process takes place and gives a serial time output using the IRIG-A (Inter Range Instrumentation Group) time code.TCT (Time Code Translator) is capable of accepting the control signals from TCG and translate the serial time to parallel time using a CPLD (Complex Programmable Logic Device). TCG/T can be programmed to even translate and provide parallel time code to front end hardware for time stamping the satellite raw data ingested by real time data acquisition systems up to microsecond level.

Keywords: Time Code, CPLD, TCG, TCT, Microcontroller, GPS, DS1307-RTC, IRIG-A.

I. INTRODUCTION

Many centuries have been spent by man for determination and measurement of time. Earliest references were the sun and the moon. (E.g.: Sundial). Invention of the Clock helped to process the methods of measuring and regulating time. The invention of the Time Code [3] was a major step towards this direction. Time Codes which are in serial form are used to transport time information from one point to another. Different time code formats have been developed over the years, by both commercial as well as military agencies. All the Time Codes however diverse they are tend to follow a set of basic characteristics such as time information within the format is pulse width coded. The time information is coded in either Binary Coded decimal (BCD) or binary fashion. The Frame length is fixed (Example: 0.1 sec for IRIG –A). Timing Systems are one of the important constituents of Data Reception Station. At nearly all facilities where data is collected, the need exists to time tag data for the purpose of its correlation and indexing. The Global Positioning System (GPS) [1] [2] has evolved as a popular and accurate source for precision time. A standard Timing System comprises of a GPS Receiver, Time code generator, time code translators and remote time display units.

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The Time Code Generator clocked by a DS1307-RTC and with a provision for synchronization with GPS is the master source of serial IRIG-A time code. At the receiving system, the serial time code needs to be processed to extract the time information and provide a Binary Coded Decimal (BCD) output as well as a Display of the time being translated, the Time Code Translators are designed to provide these functions. The remote time display units convert the received serial IRIG Time Code and provide display of the translated time. The paper discusses the design details of a precision time instrument, which performs the dual functions of Time Code Generation & Translation (TCG/T).

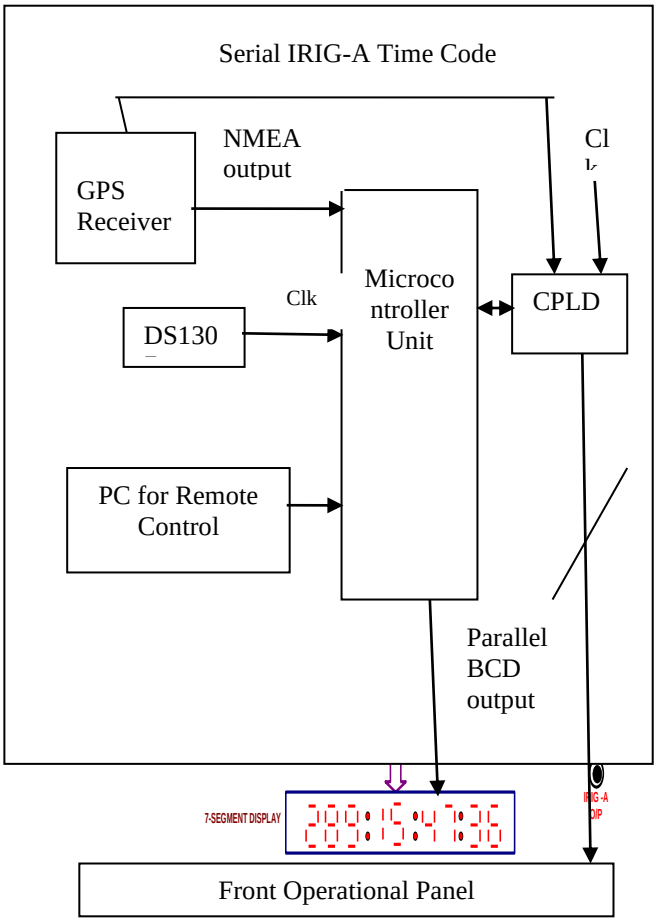

Fig. 1 Overall Block Diagram

The Fig.1 depicts TCG/T unit is designed to perform the dual functions of Time Code Generator or Translator as per the user choice. This Time Code Generator unit provides the GPS synchronized IRIG-A Serial time code, which is the reference time for the Station for tracking and data archival. It also has provision for user preset able time.

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In the Translator Mode the unit provides the BCD Time for the AFEH Unit to time tag the RAW data in real-time. It also provides a serial interface for system time setting for scheduling the DAQLB activities. Designed around Xilinx XC95288 CPLD it features a LCD/Keypad Interface and RS-232 Serial interface for control/configuration of the unit. The Fig. 1 depicts the system block diagram. The Time Base Generator, microcontroller, front operational panel, display unit, CPLD Block and a PC for remote control.

II. TIME CODE GENERATOR

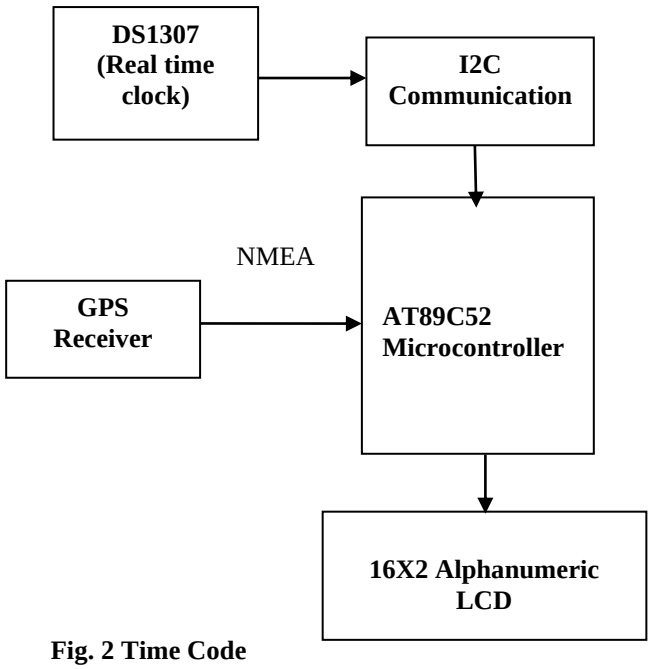

Fig. 2 Time Code Generator

The Fig.2 shows Time Code Generator whose basic function is twofold, first it must operate as a digital clock to maintain real or preset time and second to format and process the time information providing a serial time code output in a specified format generally IRIG. Additional features include ability to auto Synchronize to an external reference such as GPS time, control and configuration through computer via RS-232 Interface. The outputs include Serial IRIG time code, parallel BCD, Pulse Rate Output and RS-232 Outputs. For precision time keeping accuracy the ability of absolute synchronization to an external standard reference such as GPS is a critical feature a TCG has to provide. The TCG derives its clock from the internal frequency standard, which is a 32.768 KHz DS1307 Real Time Clock (RTC) [6]. The output from the RTC is passed to a microcontroller AT89C52. The communication between the microcontroller and RTC is done through I2C Protocol or I2C bus. It consists of two signal to operate they are SDA (Serial Data) and SCL (Serial Clock) as shown in Fig.3 based on the signals the I2C protocol works on four major conditions such as

a) Start Condition
b) Stop Condition
c) Data Validity
d) Acknowledgement

Start Condition

When SCL is high and SDA falls from High to Low the start condition is valid.

Stop Condition

When SCL is high and SDA rises from Low to High the stop condition is valid.

Data Validity

When SCL is high there should be no change in SDA line only then the data is valid or data is proper, the data change be made only when SCL is Low.

Acknowledgement

After sending one byte of data the receiver has to acknowledge the sender for the successful reception

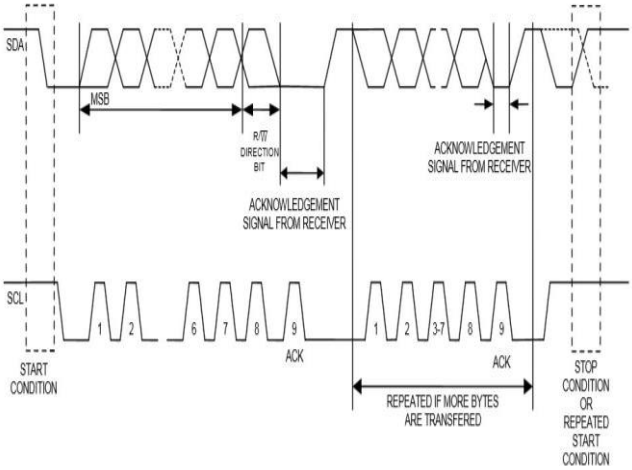

Fig. 3 DS1307 Data Transfer Diagram

III. TIME CODE TRANSLATOR

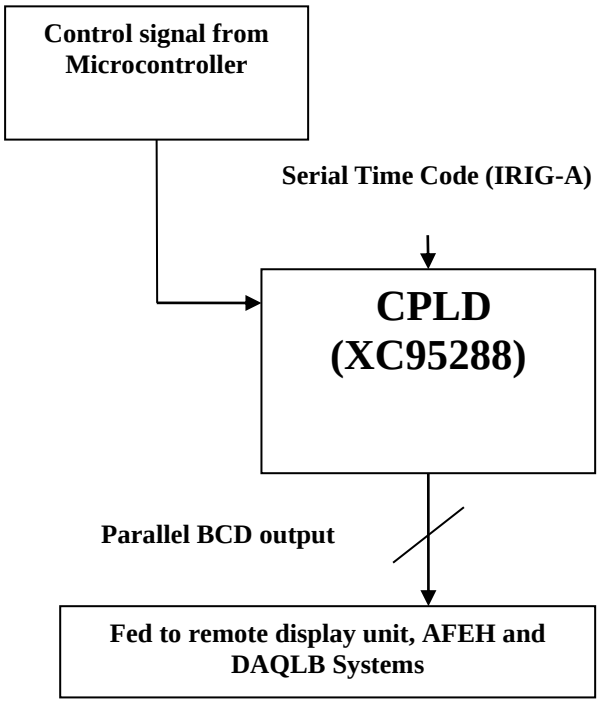

Fig. 4 Time Code Translator

The above Fig.4 depicts the working model of TCT in which the control signals from the microcontroller are taken and programmed in HDL Language in order to translate the so called serial time o parallel BCD out using the CPLD.

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Time Code Translator performs the task of providing the parallel BCD data to the Advanced Front End Hardware unit for time tagging the Real-time Raw Data (Satellite Image Data) for cross reference. It also has a front panel seven segment display of the time being translated in DAYS: HOURS: MINUTES: SECONDS from IRIG format. The unit supports serial IRIG-A time from any standard time code source such as a Time Code Generator. The Fig. 8 shows the TCT configuration in the DAQLB system. The Time Code Translator is connected to the Advanced Front End Hardware through the 50 Core FRC cable, the TCT is connected to the DAQLB System through the 9-core D-type cable.

IV. WORKING OF THE MODULE

5.1 Description

The design module is basically divided into two segments namely TCG (Time Code generator) and TCT (Time Code Translator).

5.5.1 Design Description of TCG

The main blocks in the TCG include the GPS receiver, DS1307 (RTC), AT89C52 microcontroller [7] and a 16X2 alphanumeric LCD.

GPS Receiver

The GPS receiver is the most popular and accurate source for precision time which gives NMEA output. $GPGGA NMEA sentence gives the time information. The below line shows the NMEA time output

“
$GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,*47
”

The time extracted from the above sentence i.e. the first argument after the first comma and auto synchronizes with the RTC time output in order to maintain accuracy where mere drift is allowed.

DS1307 (Real Time Clock)

The DS107 is an 8 pin IC which has two specific lines for data transfer like SDA (Serial Data) and SCL (Serial Clock) [10] .In order to communicate with the microcontroller this chip uses I2C protocol which is having few conditions which are discussed above. It also contains some time keeping registers from which we acquire the required time.

(TCG block diagram and explain

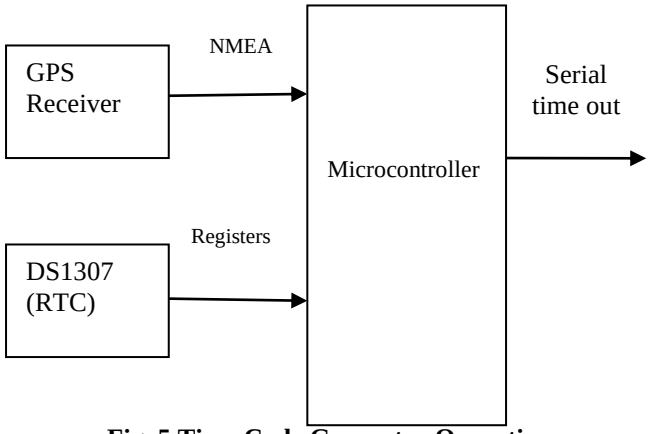

Fig. 5 Time Code Generator Operation

The Fig. 5 show the operation of the time code generator operation in which the microcontroller is fed with both the GPS receiver and the DS1307- RTC inputs. There is a comparison in between the time generated by the GPS receiver and DS1307-RTC and the drift is calculated between the times generated by the inputs. As GPS time is the accurate source of time the drift so obtained is corrected to the GPS time.

5.5.2 Design Description of TCT

The Time Code translation process involves the extraction of code from the Serial IRIG-A modulated input. The Carrier clock generated forms the reference clock for the subsequent logics.

- The Core logics implemented in CPLDs perform the task of generation of the parallel time and the required control signals. The logic realized inside the CPLD performs the functions of providing the parallel BCD data for time stamping the Satellite Image data, which forms the reference for further processing.
- The front operational panel seven-segment displays provide the visual indication of the time being translated from the IRIG-A format.
- The BCD data which is byte aligned from the CPLD is passed on to the RS-232 Interface logic, which does the conversion of the BCD data to ASCII and finally interfaced to the computer for system time synchronization and scheduling of DAQLB Scheduler events.

Time Code Translator (TCT) accepts a serial time code and translates the information within the code to functional data, generally converted into visual form and parallel BCD for use by Data processing Systems. The Main blocks of the Time Code Translator logic are control signals from microcontroller, Serial IRIG-A input, CPLD Block (XC95288) [14] and the parallel BCD output.

V. RESULT ANALYSIS

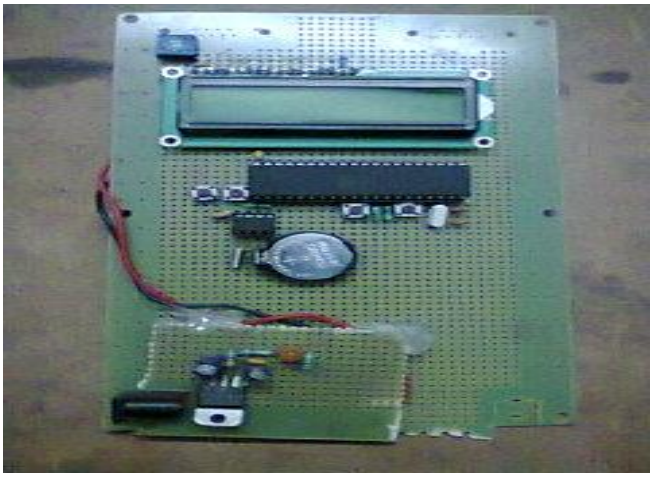

Fig. 5 Time Code Generator with DS1307 (RTC)

The Fig. 5 shows the time code generator circuit which is developed using GPS, DS1307-RTC and gives a serial time output.

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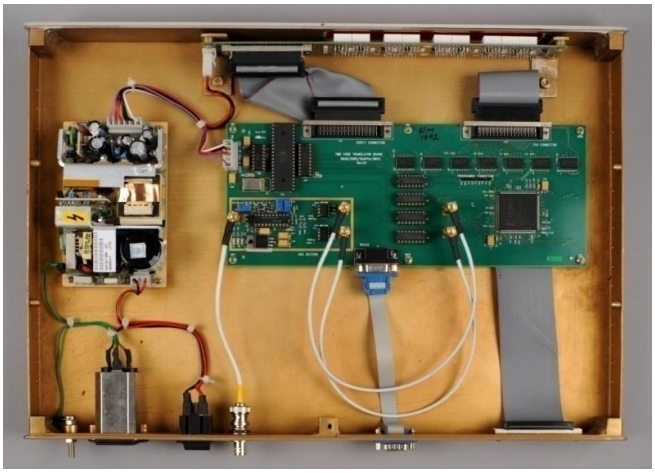

Fig. 6 Circuit Diagram of TCT Unit

The Fig. 6 shows the time code translator blocks which contain CPLD in order to translate the serial time to parallel time.

Fig. 7 Final result of TCT for DAQLB System

The Fig. 9 shows the final result of the TCT which is used by the DAQLB (Data Archival and Quick Look Browse) system.

Fig. 8 Final result of TCT for Remote Display Unit

The Fig. 8 shows the final time output for the remote display unit.

VI. CONCLUSION

In this paper a time code generator/ translator is developed with a microcontroller based user interface and with the help of CPLD. Purely speaking the serial time has been converted into parallel time and in future all this can be developed using the touch pad interface for manual operation and the entire logic can realized using FPGA.

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