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Implementation of IRIG-B Output for Time Synchronization

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***Abstract* – IRIG time codes are used for time synchronization for industrial equipments as all types of IRIG time codes are accepted as international standard. IRIG-B is one of the available IRIG time codes which is widely accepted as time synchronization protocol. This paper highlights the brief description of various time codes of IRIG standard and mentions the methods used for generation of IRIG-B time code format.**

***Keywords* – IRIG, RCC, G.P.S., RCC, 1PPS, B.C.D., U.T.C., P.W.M..**

I. INTRODUCTION

In current automation industrial technology requirements, time synchronization of industrial products have become a key factor for improving the efficiency of industries performance and productivity by indentifying and overcoming the losses which can be accurately traced depending on the logging of any periodic or asynchronous event or any fault with accurate timestamp with milliseconds accuracy. This application demand can be achieved by using one of various available IRIG (Inter Range Instrumentation Group) time codes in which IRIG-B time code is widely accepted in industry for time synchronization purpose. IRIG (Inter-Range Instrumentation Group) is a subordinate body of U.S. RCC (United States Range command Committee) [2].

Devices which provide IRIG time code output are generally stand along IRIG based generation equipments or widely used G.P.S. (Global Position System) Clock device which provide very good IRIG time code output depending on the G.P.S. receiver module available in G.P.S. Clock device.

II. IRIG TIME CODES

IRIG Protocol comes in different coding and timing variants and may be propagated via different media (i.e. coax cable, symmetrical twisted pair or fibre optic) [3]. IRIG DC (Digital Current) signal can be transmitted over coaxial cable or RS485 (Recommended Standard) or Fibre optic output whereas IRIG-AM (Amplitude Modulation) can be provided on coaxial cable. There are multiple IRIG time codes available which are Time Code A, Time Code B, Time Code D, Time Code E, Time Code G and Time Code H] These time codes have different time frame and index count. IRIG time code is transmitted in form of pulse which is identified as single "bit". The repetition rate is identified as bit rate [4]. The time interval between the leading edge of two consecutive bits is the index count interval [4]. The time frame is duration in which complete IRIG frame is transmitted.

IRIG-A signal have time frame of 0.1 seconds with index count of 1 millisecond, contains time information of year in B.C.D. (Binary Code Decimal) format and seconds of day information in SBS (Straight Binary Seconds) format. IRIG-B signal have time frame of 1 second and index count of 10 milliseconds with time information in B.C.D. format and seconds of day in SBS format. IRIG-D have time frame of 1 hour and index count of 1 minute and contains only time information in B.C.D. format. IRIG-E have time frame of 10 seconds with index count of 100 milliseconds. IRIG-G have time frame of 0.01 seconds with index count of 0.1 milliseconds. IRIG-H have time frame of 1 minute with index count of 1 second.

Generally, all IRIG time code contains time of year information in B.C.D. format. The Starting point of Standard time of the symbol is the leading edge of its pulses, and the reference frame is made up by a location identification mark and a adjacent reference code [1]. The number of pulse transmitted in time frame is different for all IRIG time codes. Apart from time of year information, there are control functions available in the time frame code which can be used for specific applications as per requirement. All time frame begins with reference position market bit P0 and then with reference identifier bit Pr. IRIG frame content three type of pulse format first is the reference or position identifier having duration of 80% of index count interval, bit 1 having duration of 50% of index count interval and bit 0 data having duration of 20% of index count interval as shown in Fig. 1.

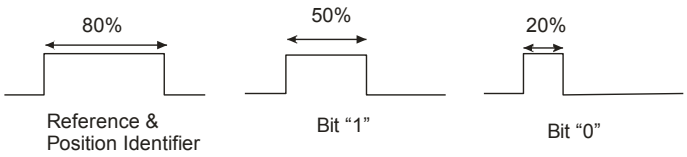

Fig 1. IRIG Bit Format

IRIG time frame data consist of Index Markers which occur at specific index count position, which are not assigned as reference code or control function bit. Each index market bit has duration equal to 20% of index count interval of respective time code format. IRIG signal output is provided in the form of pulse width code or can be in sine wave form with amplitude modulation with carrier signal.

III. IRIG-B Time Code

IRIG-B frame consist of 100 pps (pulse per second) having time information in B.C.D. format and seconds of day information in SBS format. Each pulse is of 10ms duration. The reference and position identifier is of 8ms duration, Bit 1 is of 5 ms duration and Bit 0 is of 2ms duration of index count interval as shown in Fig. 2.

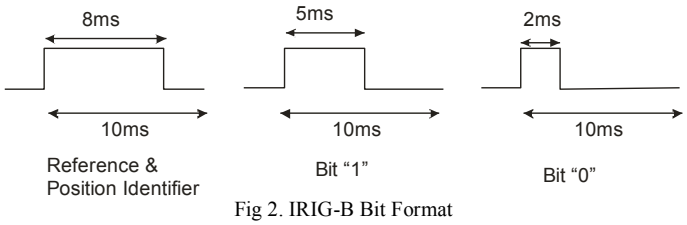

Fig 2. IRIG-B Bit Format

IRIG-B frame further have multiple format in which IRIG-B120 which is pulse width format and IRIG-B122 which is amplitude modulated signal. This both the formats have time of year information in B.C.D. format.

IRIG-B120/122 frame begins with position identifier and reference identifier bits. Thereafter, 30 bits transmitted consists of time of year information including seconds, minutes, hours and days of year. IRIG-B122 signal is amplitude modulated signal with carrier frequency of 1KHz signal. The mark to space ratio is 3: 1 Vpp (voltage peak to peak) and the rising edge of signal starts with 1PPS(One Pulse Per second) signal at each second.

IV. Generation of IRIG-B120/122 Signal

IRIG-B12x signal can be generated using microcontroller using 1PPS signal, port pins of microcontroller with P.W.M. (Pulse Width Modulation) capability and timers as per Fig. 3. Microcontroller uses timer of 1ms which is calibrated at every 1PPS signal such that 1PPS is equal to 1000ms counts of timer. This calibration is done continuously to ensure that 100pps of IRIG-B signal is transmitted at every rising edge of 1PPS signal. After the timer of 1ms is calibrated, the other timer is started which can provide P.W.M. output of total period 1ms pulse with minimum duty cycle of 20% and maximum duty cycle of 80%. This P.W.M. based internal time is also calibrated at every 1PPS signal. Now, after both the timers are calibrated, time information is decoded in microcontroller and provided in the IRIG-B frame depending on bit 1 or bit 0 information at specific location of seconds, minutes, hours, days in IRIG-B120 frame. Data of time is shifted bit by bit intp RIG-B frame at every 1ms interval. This data is transmitted at every 1 ms P.W.M. timer based on 1PPS signal. The time information in IRIG-B signal may be of U.T.C. (Universal Time Coordinate) format or local time depending on the time zone offset provided with respect to U.T.C. time.

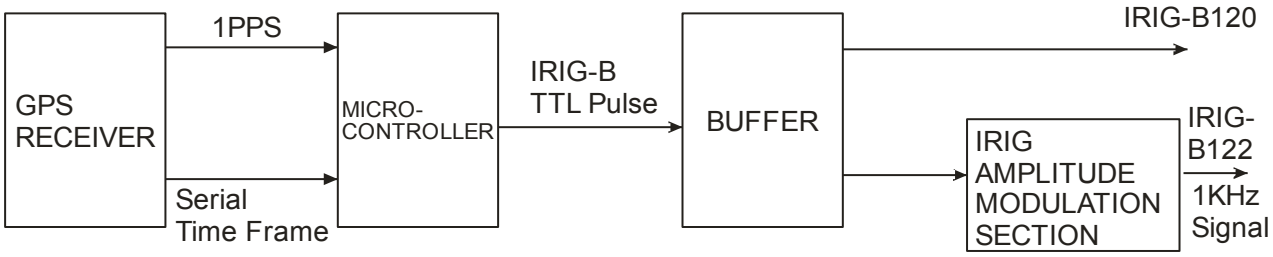

Fig. 3. IRIG-B120/122 Frame Generation

V. Test Results of IRIG-B

Below figures are the test results of IRIG-B120 (Fig. 4) and IRIG-B122 (Fig. 5 and Fig. 6) signal captured on test equipment.

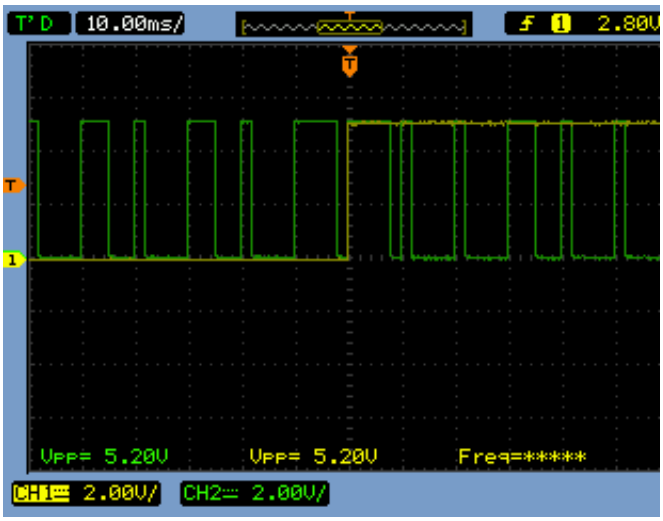

Fig. 4. IRIG-B120 Output w.r.t. 1PPS signal

Fig. 5. IRIG-B122 Output w.r.t. 1PPS signal

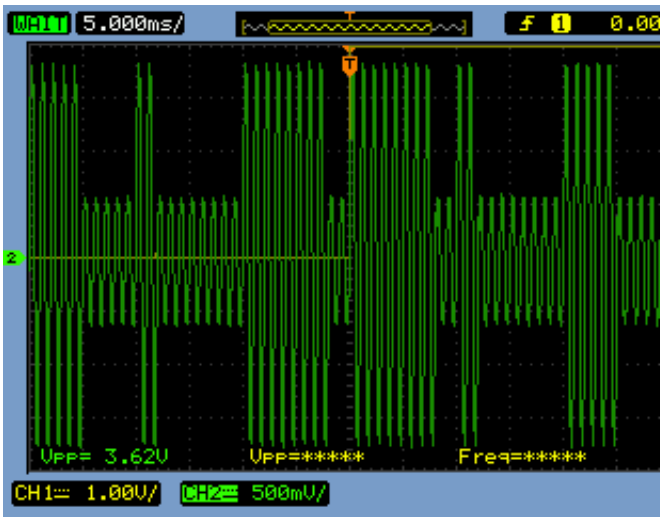

Fig. 6. IRIG-B122 Output w.r.t. 1PPS signal

VI. CONCLUSIONS

The test results of IRIG-B120 and IRIG-B122 frame shows full compliance with IRIG-B standards and were used to time synchronization up to resolution of 1 millisecond for various event recorders. This paper successfully represents the generation and testing of IRIG-B signal. IRIG-B122 signal is widely used in industrial equipments for time synchronization purpose which can be transmitted over a considerable length of few hundred meters. The number of equipments which can be synchronized with a single IRIG-B122 signal depends on current output capability of IRIG-B122 output.

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