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"Cycle Time Reduction of Transmitting Output Power Measurement of URRF Radio"

[1] Prof.Suhas A R, [2] 2Pratiksha R Matlawar , [3] Rashmi R
[1] Assistant Professor, [2][3]Student of 8th semester
[1][2][3] Department of Electronics and Communication Engineering, R R Institute of Technology, Chikkabanavara, Bengaluru-560090

***Abstract*— Radio Station RRF(UG) is extensively used by the Indian Military for communication related purposes. In this radio, measurement of output power at different frequencies is one of the most important factors to be considered for the purpose of secured communications. In this paper, we develop a method based on automation to measure output power at different frequencies using LABVIEW software. This reduces the time required for output power measurement.**

I. INTRODUCTION

The Radio Station RRF (UG) is UHF communication equipment designed to provide fast, reliable and secure telecommunication medium for Military applications. It is fully digital and is operated at a range of (1350-1850) Mhz. It can operate in both Frequency Hopping (FH) and Fixed Frequency (FF) modes. The equipment transmits digital data in multiple transmission channels. The radio power output can be set in one of the 4 modes: LOW, HIGH, AUTO, MANUAL modes. Antennas with high side lobes and back lobes are used to reduce the risk of signal detection thereby increasing the communication security.

The modulation technique used is QPSK (Quadrature Phase Shift Keying)

Measurement of output power is one of the most important factors to be considered for secured communication. A strong need was felt to develop a method which can measure output powers at different frequencies in a short time span and which would be efficient. One such method is the Automation method which is developed using LABVIEW (Laboratory Virtual Instrumentation Engineering Workbench) software.

LABVIEW is a system design platform and development environment for a virtual performing language. It was developed by NATIONAL INSTRUMENTATIONS in 1986.It is commonly used for data acquisition, instrument control and industrial automation on a variety of Operating Systems. Its open architecture enables integration of any hardware devices and any software approaches. It is based on Graphical User Interface (GUI).

II. LITERATURE REVIEW

The URRF is UHF communication equipment which is designed to provide fast, reliable and secured communication for military applications. It was originally designed in 1988 and operated at a rate of 2Mbps.However to meet certain requirements of military communication; the RRF was upgraded to 8Mbps version. This offered certain advantages over the 2Mbps version such as higher data rates, higher transmission security, encryption of data and enhanced ant jamming capacity.

III. AUTOMATIC TEST EQUIPMENT

It becomes increasingly difficult to correlate all information regarding many measurements, that modern test equipment is capable of taking, and in many instances is even impossible. There by test functions still remain humanly possible and test procedures often take so long as to be uneconomic . This brings us to AUTOMATIC TEST EQUIPMENT [ATE] which is capable of performing all the , measurements and tests we require and then presenting the test results in a requested format quickly and economically.

A. ADVANTAGES OF ATE SYSTEMS

1. MORE MEASUREMENTS: All measurements in an ATE are performed automatically, with a consequent increase of speed, so it is possible to increase the number of measurements made.

2. GREATER ACCURACY: Many errors may be introduced in mutual test equipment systems often, because measurements are taken once, at a single time. ATE systems may offer solution by taking multiple readings and averaging results, errors are reduced and may even be eliminated.

Faster procedures: Where measurements entail complicated setup, triggering, result interrogation and evaluation procedure, manual measurement systems are inevitably slow. Human involvement means these process must be under taken at human speed, automatic systems on the other hand, can perform the same procedures much faster.

3. ELIMINATION OF HUMAN INVOLVEMENT: Automation procedures avoid human interpolation of results, subjective result interrogation, subjective evaluation and erroneous of measurements.

IV. GENERAL INFORMATION ON RRF

The RL432A radio relay equipment is designed for the transmission of digital data in multiple transmission channels. The multiple-transmission channel facility is achieved by inter-spacing the different channels in a time division multiplex(TDM) system. The TDM mode allows selected data rate of 2048kbps. The equipment operates in the frequencies range of 1350 to1850 Mhz and the transmission is full duplex. The radio relay is designed to operate in two different modes:-
Fixed frequency mode (FF mode)
Frequency hopping mode also called as ECCM mode.

FIX MODE: When the radio relay operates in fix mode the transmission for each direction take place on a pair of fixed frequencies.

FREQUENCY HOPPING MODE (FH MODE): In this mode transmission does not occur at a fixed pair of frequencies rather it hops between different pairs of frequencies randomly, this makes impossible for tracking the frequency illegally. The radio relay can be powered from 110-220v AC or 24v DC power supply. If both supplies are connected, the power will be taken from the mains voltage. In case the mains voltage fails, the equipment switches to the 24v DC input without interrupting the transmission . The radio relay is built from number of sub-units, mounted on the front sub-unit the units are interconnected via a motherboard mounted on the front sub-unit. The power sub-unit is the only unit not mounted on the front sub-unit. The sub-unit are: Front sub-unit, Transmitter sub-unit,Modulator sub-unit,Frequency hopping (FH) generator sub-unit,Receiver sub-unit,Duplex filter sub-unit,Processor sub-unit,Fix frequency sub-unit,ECCM sub-unit,Interface sub-unit,Power sub-unit,Cover.

A. FUNCTIONAL DESCRIPTION OF FIXED FREQUENCY MODE

In this mode fixed frequencies are used for the transmission. The transmission is fully duplex mode and the channel spacing is 125khz. The transmission and receiver frequencies can be set in three ways:

1. By setting a pre-declared radio channel number
2. By setting user-defined radio channels
3. By setting individual transmitter and receiver frequencies.

B. AUTO POWER MODE _The Auto power mode is used to reduce the output power to a minimum, but still have a good transmission quality. This takes place by making an average measurement of the bit error rate on the transmission.

C. FUNCTIONAL DESCRIPTION OF THE ECCM MODE- In ECCM mode the transmission takes place on frequencies determined by the frequencies selected for the fixed frequency mode and the programmed FH key. If no frequencies are blocked, the radio relay use all of the 24Mhz around the center frequency of the filter in the duplex filter for the transmission path

The control of the filters is performed in one way: If a spacing of more than 74Mhz is set, the center frequencies of the filters will be tuned at the set frequencies.

Note: If the spacing between the center frequencies is set to a value less than 74mhz, frequency hopping will not be accepted. The display for the TX and RX frequency starts flashing.

It is possible to block frequencies within the frequency band from the keyboard. This is used when there are other transmission equipment that are using frequencies within the Radio Relays frequency bandwidth. When the functions is used, the local and the remote radio relays must have the same frequencies blocked.

The selection of frequency to be used for a frequency hop is controlled by the active FH key that has been programmed by the operator. It is possible to store 20 different FH keys. The frequency to be used is generated by a pseudo random that is loaded with an internal key calculated from the FH key.

The TX and RX paths are asynchronous , which means that they can have different states and the frequency changes do not have to take place simultaneously.

The radio relay can work in two different modes :
Conventional FH mode
Adaptive FH mode .
In conventional FH mode the radio relay is using only active FH key to select the frequencies to be used for

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transmission. In adaptive FH mode the radio relay works in the same way as in conventional FH mode, but avoids frequencies that have been detected as disturbed

V. HARDWARE INTRODUCTION

A. URRF-RADIO-Frequency range of this radio set is 1350MHz to 1850Mz

The radio set is a single unit this consisting of front panel (aluminum casting).The front panel house mother board, display board, EMP/EMC board, MOV filter board and buzzer. The mother board has connector /receptor on which various modules are fixed these modules are fixed together with binding screws and fixed to front panel casting by means of fixing screws .The casting has a groove for sealing gasket. The cabinet is made up of stainless steel.

Fig.URRF Radio

B. POWER SUPPLY SUB UNITt-The Power Supply sub-unit is used to generate all the voltages necessary for the operation of the radio relay unit, from the incoming mains power supply or from 24 V battery. This is done by three primary switch mode power supply units and the voltages generated are +28 V, +12 V, +5.1 V and -7 V. When both mains and battery supply are connected to the radio, the radio works on the mains voltage automatically, switching over to battery operation when the mains voltage falls below the specified limit.

Fig. Power Supply

C. ENGINEERS ORDER WIRE (EOW)-The EOW is meant to be used for speech transmission between the operators of the radio relay and the units connected to the auxiliary connector and the TDM connector. The data rate for the transmission is 8 Kbit/s and the signals are Delta modulated.The EOW is omnibus. There are four signal paths for the EOW; radio, handset, digital 4-wire and digital 2-wire path. The EOW block is used as a switch for these paths. If a signal is present at one of the input, it is to be output to all the outputs, except for the output that corresponds to the input where the signal is present. The switching is controlled by the processor subunit. Due to this omni bus function, the operator has to use push to talk button on the handset like in simplex transmission.

D. GENERAL PURPOSE INTERFACE BUS-The general purpose interface bus (GPIB), also known as HEWLETT PACKARD interface bus and the IEEE 488 bus is not intended for the use as a computer network. It was developed by HP to interface smart test instruments with a computer. The main features of GPIB are:-

• An IEEE standard digital interface for programmable instrumentation.

• This standard applies to interface systems used to interconnect both programmable and non- programmable electronic measuring apparatus with others.

• The term system denotes the byte serial bit parallel interface system that in general includes all circuits cables, connectors, message repeaters and control protocols to effect unambiguous data transfer between devices. Devices here is any programmable measurement devices as other product connected to the interface system that communicates information.

• This standard is intended to define a general purpose system for use in limited distance applications. To define a system that permits asynchronous communication over a wide range of data rate.

The device clear and device trigger: functions provide a device with the ability to be initialized or triggered, on command from the controller, this may occur simultaneously with other selected or all devices in a system.

Fig. GPIB

E. RS-232-***RS-232*** stands for Recommend Standard number 232 and C is the latest revision of the standard

An RS-232 serial port was once a standard feature of a personal computer, used for connections to modems, printers, mice, data storage, uninterruptible power supplies, and other peripheral devices. However, RS-232 is hampered by low transmission speed, large voltage swing, and large standard connectors.

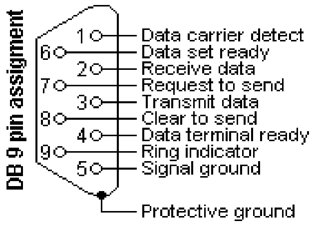

Fig.RS-232

F. POWER METER-The Keysight 437B power meter is a low-cost, high-performance, single-channel, programmable, average power meter compatible with the 8480 family of power sensors. Depending on which power sensor is used, the 437B can measure from -70 dBm (100pW) to +44 dBm (25W) at frequencies from 100 kHz to 110 GHz.

Fig.Power meter

D. SENSOR

• Excellent SWR for reducing mismatch uncertainty

• Accurate calibration and traceability to US National Institute of Standards and Technology (NIST)

• Compatible with EPM, EPM-P and P-series power meters, plus the E1416A VXI and discontinued 70100A and 43X power meter

• Accurate average power measurements over -30 to +20 dBm

• Frequency range 10 MHz to 18 GHz

• Thermocouple power sensing element

Fig. Sensor

VI. METHODS

There are two methods used to measure the output power of RRF
1. Manual method
2. Automation method

A. MANUAL METHOD-In this method, Output power measurement of Radio is done manually by proper adjustments of required radio parameters. In fixed frequency mode, the transmitted and received frequency is set such that there is a difference of 50MHz between them. The output power is measured using the power meter and the values are recorded. This is repeated for different frequencies between 1350-1850MHz.The above steps are similar for Frequency hopping(FH) mode also by setting the radio manually in FH mode and the difference between the transmitted and received frequency is 100MHz.
DISADVANTAGES OF MANUAL METHOD:
1. Time consuming
2. Inefficient
3. No data storage

B. AUTOMATION METHOD-In this method, the output power of radio is measured using Automation technique with the help of LABVIEW software. For output power measurement, a block diagram is designed. Then it is executed after which output power at different frequency between 1350-1850MHz is calculated using power meter (HP 437B) and stored in an array. The values are then displayed on an excel sheet.
ADVANTAGES OF AUTOMATION METHOD:
1. Reduced cycle time for output power measurement.
2. More efficient compared to manual method.
3. Data is stored

VII. ALGORITHM

• Initially a message is displayed using the prompt user block as "connect to power meter". Press "ok" to connect the power meter to the radio.

• Next we enter the serial no of the radio. We set the range for the serial number from 1 to 10000.If the serial number lies within the range ,execution proceeds further else it displays a message " set number is not valid" and

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prompt use to enter the serial number again till it's within the range .

• We configure the URRF radio using "VISA serial port" for some required setting and for connect with the pc.

• Next we set certain radio parameters such a data rate, output power mode, transmission control mode, frequency hop.

• Then we set transmission control mode, receiver frequency.

• Next we set the starting transmission frequency as 1350Mhz and the frequency spacing 10Mhz.Hence the transmitter power increases in the steps of 10Mhz,the frequency value is stored in array block and displayed on the excel sheet.

• At the same time the output power for the frequency value is measured using power meter stored in array and displayed on the excel sheet ,corresponding to the frequency.

• There is a small delay in displayed the corresponding frequency and it's corresponding output power.

• Once transmitted frequency reaches 1600Mhz value a message is displayed as "SPEC NOT MEETING ,DO YOU WANT TO CONTINUE?", This is just for check whether the frequency has crossed the specified range or not.

• On pressing "YES" the execution proceeds further else it terminates.

• The process continues till the transmitter frequency reaches the maximum frequency (1850Mhz) and corresponding output power are displayed.

• Finally on reaching 1850Mhz .The message is displayed as "SWITCH OFF THE TRANSMITTER POWER", on pressing " ok", the execution completes and the radio is switched off.

CONCLUSION

To conclude we would like to state that this way a truly enlightening and informative experience. Besides having diverse practical exposure, it has provided us with an excellent opportunity to learn and apply ourselves to the rigorous demands of the industry. The automatic test equipment system has been unsuccessfully implemented in MCE testing department of BHARAT ELECTRONICS LIMITED (BEL). ATE is specially designed to test the processor card of radio. The existing procedure for measuring output power was to tedious process and requires high time. It nearly requires 2 hours for the measurement of output power. In the use of lab view software we can reduce the time consumption where it takes only 20 minutes for the measurement of transmitter output power.

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