Simply the best engineered transmitters

GPS1000

1 KW TOTALLY SOLID STATE DIFFERENTIAL GPS TRANSMITTER (282-326 kHz)

NAUTEL has developed the GPS1000 as an extremely efficient and highly reliable transmitter especially suited for use at remote unattended indoor installations. The 1 kW output is fed via a 50 ohm coaxial feeder directly to a separate automatic antenna tuning unit Type NX4000TUB to a suitable customer supplied antenna.

- Overall efficiency typically 78% (ac input to rf output)
- Totally solid state
- Either single or duplicated Main/Standby transmitters in one rack.
- Adjustable carrier 100W to 1kW
- Open and short circuit proof
- Over temperature and standby shutdown
- Ideal for unattended operation in remote areas
- Modular Construction
- Operation from Emergency Battery Supply with 85% efficiency

INTRODUCTION

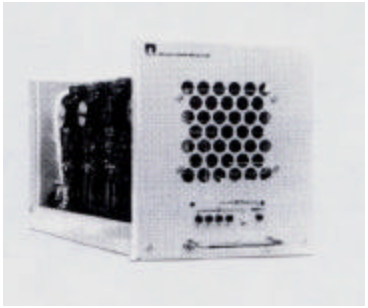
Nautel has been a pioneer and world leader in solid state high power radio transmitter technology for over 28 years. The power levels of Nautel's product line include Radiobeacons up to 4kW's, DGPS transmitters up to 6kW's, MF Telegraph and Navtex transmitters up to 5kW's, AM Broadcast transmitters up to 300kW's, FM Broadcast transmitters up to 20kW's and MF Antenna systems and Automatic Antenna Tuning Units.

This extensive experience has been utilized to develop a rugged, reliable, and easily maintained 1 kW transmitter specifically intended to transmit DGPS correction data.

SYSTEM CONFIGURATION

The GPS1000 can be supplied as a single transmitter or in a dual, main/standby configuration, with automatic transfer. Both configurations are housed in a single, 19 inch rack featuring removable Modulator/Power Amplifiers, Exciters and Power Supplies.

The following describes the layout of the dual system (the single system is similar except the duplicate sub-system is replaced by blank panels). At the top of the rack, the Control/ Monitor Panel contains metering, LED indicators and system master controls. This panel is hinged at the left providing access to monitoring circuits and the Harmonic Filter. The remaining modules and sub assemblies are divided into completely separate A and B sub-systems providing automatic main/standby operation. Either A or B may be locally or remotely selected as the main system which is connected to the antenna. The standby system is normally off, but is automatically connected to the antenna if the main system fails. Under local control, the standby sub-system may be run for maintenance purposes into an open circuit. The readily removable Modulator/Power Amplifiers utilize class D switching power amplifiers and associated pulse width modulators for high efficiency. Each contains its own cooling fan and high temperature protection.

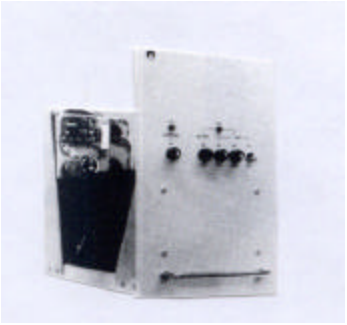


Modulator/Power Amplifier

Immediately below are the two Exciter systems. Each contains a pulse width generator, an RF buffer and an RF driver, built on a printed wiring board. Everything is readily accessible for servicing or replacement by partially withdrawing the exciter chassis from the front of the cabinet.

A main Power ON/OFF switch which controls the complete transmitter is located beneath the Exciters.

The two Power Supply Systems are located at the bottom of the cabinet. These may be withdrawn from the front for servicing, after a connector at the rear has been disconnected.



Power Supply

OPERATING PRINCIPLES

The system design utilizes switching techniques for all high power stages including supply regulation, RF power level control (Modulator) and the RF Amplifiers to achieve high overall efficiency. This high efficiency is maintained at any operating power level. The resulting low power consumption and heat dissipation are important factors in achieving a high degree of operational reliability.

Class D Power Amplifier

Power MOSFETS are used in a class D (switching) mode to achieve very high efficiency. The simple class D principle is illustrated in Figure 1.

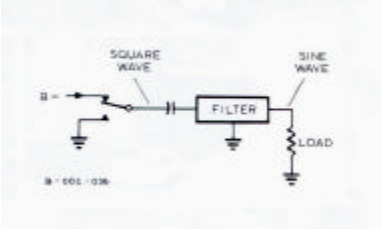


Figure 1
Class D Operation

If the switch is opened and closed with a 50% duty cycle at the rf carrier frequency, a square wave signal results at the filter input. The filter is designed to pass the carrier frequency but to

reject the harmonics of the square wave, hence a sinusoidal current flows in the load to produce a rf signal at the output.

In Nautel transmitters, this simple switch is replaced by bridge configuration of power MOSFET devices coupled to the harmonic filter through an RF transformer. This provides a push-pull, DC to RF converter with an efficiency of approximately 91%. With this arrangement, the RF output level is directly related to the level of the B- supply and can be varied by varying the Power Amplifier supply voltage.

Pulse Width Modulator

The Pulse Width Modulator provides this power control function by varying the power amplifier supply voltage. Operating principles are illustrated in Figure 2.

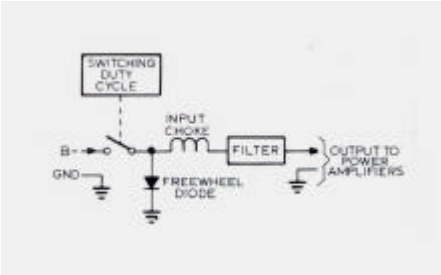


Figure 2
Modulator

A negative DC supply (B-) is applied through an rf switch which is opened/closed by the PWM control signal at a constant repetition frequency of approximately 70 kHz. This produces a rectangular waveform to a choke-input, low pass filter. A freewheel diode provides a path for the current in the choke when the switch is open. The filter is designed to reject the switching frequency, passing only the lower frequency components of the input waveform. With a 50% switching duty cycle, the dc output would be equal to the average input level ie. half of the B- supply voltage. Variations in the duty cycle of the switch cause the level of the dc output voltage to be linearly controlled. If the duty cycle is varied at an audio rate, this audio frequency is superimposed on the output voltage level. The overall efficiency for this linear dc to dc conversion process is approximately 96%. Although amplitude modulation is not required in this application, a Nautel patented circuit uses this technique to control and stabilize the transmitter's output power level and to cancel hum and ripple appearing on the B- supply voltage.

PWM Control Signal

Figure 3 illustrates the method used to generate the PWM (pulse width modulation) control signal.

A 70 kHz square wave signal is integrated to provide a triangular waveform which is applied as one input to a switching comparator. Variation of the level of a dc control signal applied to its second input causes the width of the pulses at the comparator output to vary while the pulse repetition rate remains constant. If the control voltage is varied at an audio rate, the audio signal is encoded into the width of the output pulses. The resulting PWM control signal is used to control the switching duty cycle of the Pulse Width Modulator.

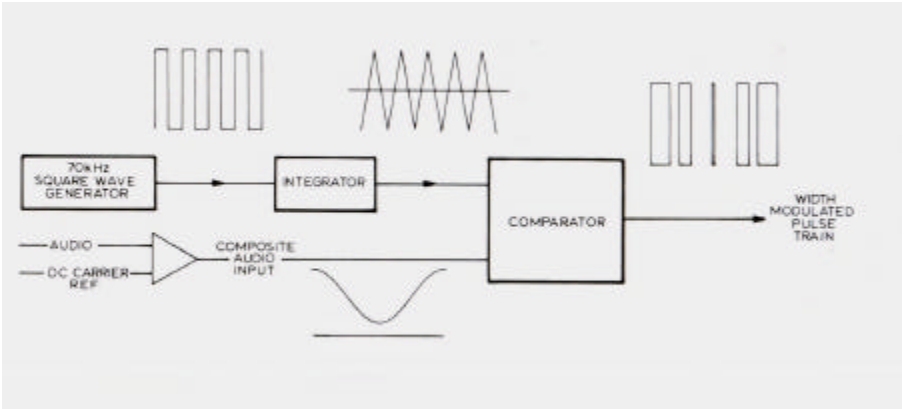
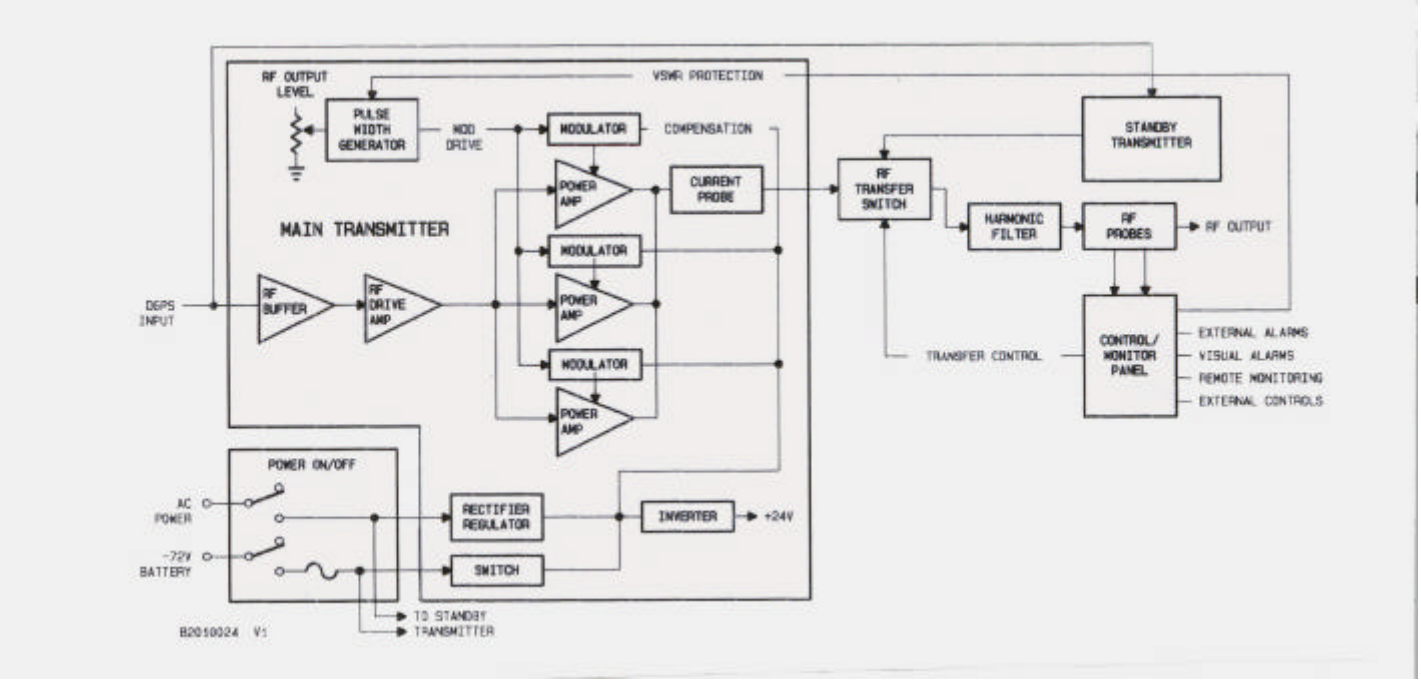


Figure 3
Pulse Width Generator



BLOCK DIAGRAM

Figure 4 is an overall block diagram of the GPS1000D transmitter. Only details of the main transmitter are shown for simplicity.

Exciter

The MSK modulated, rf DGPS correction data is fed to a buffer circuit which stabilizes any input signal amplitude variations. It is then applied via an RF Drive Amplifier as the RF drive to the Power Amplifier Module.

The Pulse Width Generator controlled by signals from the RF Output Level Control, a sample of the -72 volt supply and a VSWR protection signal from the Monitor, produces a pulse width modulated (PWM) control signal for the Modulator. The Modulator uses this digital information to produce a ripple free Power Amplifier supply that will give the desired output power level.

Modulator/Power Amplifier

The Modulator/Power Amplifier contains separate class D power amplifiers and modulators which are removable for servicing. The amplifiers are driven by the common rf drive signal. Their outputs are serially connected via an rf transformer to provide the final 1000 watt output. Similarly the three modulators are fed from a common PWM control signal.

Harmonic Filter

The rf output is then fed, via an rf current probe and RF Transfer Unit, to an impedance transformer and passive harmonic filter. These are common to both transmitters. This filter may be set at any operating frequency within the range of the transmitter. The filtered output signal is then fed via an RF Power Probe to provide the transmitter final output.

Monitoring and Control

Both transmitters are monitored and controlled by common metering and control circuits. Metered functions include forward and reflected power on the operating transmitter, all supply voltages and the dc current consumption on AC and battery supply. LED's and external alarms provide additional indications as shown on the block diagram. The monitor checks the output of the transmitter and initiates transfer to standby when it falls below an adjustable threshold level (Normally set to -3dB).

Either transmitter can be locally or remotely selected as Main, and the Standby transmitter can be operated into an open circuit while the main transmitter is operated into the antenna.

VSWR Protection

A sophisticated VSWR protection system keeps the signal on-air when load impedance changes. The GPS1000 transmitter is a low impedance voltage source which is capable of operation with VSWR's up to 1.7:1 without level reduction.

If the VSWR exceeds 1.7:1 but is less than 2:1 when operating at full power, a reflected power sensing circuit reduces the output by one or more of sixteen nearly equal power steps to keep the reflected power at a safe level. The power subsequently steps back toward normal at the rate of 60 ms per step as the VSWR improves. No interruption of transmission occurs during this process. As the power reduction is controlled by reflected power, the transmitter is proportionally more tolerant of VSWR when adjusted for operation at power levels below 1000 watts.

If the reflected power exceeds that which would occur at full power with a VSWR of 2:1, the output is instantly cut-back to zero, then returns at a level that is one step lower. This process is repeated until a safe operating level is achieved. As before, the power continuously attempts to return to normal at a rate of 60 ms per step.

This feature not only provides transmitter protection but is useful for quenching arcs in the antenna system which result from lightning activity and allows the ATU to attempt to achieve a tuned condition.

Power Supply

The Power Supply for each transmitter contains its own AC line transformer, rectifier/ regulator and filter. Battery back-up supply in the event of an ac power failure is a standard option. The required battery supply is a nominal -72 volts at 16 amps for full power operation. An optional wall mount 72 volt battery charger, model NAB8, capable of up to 7.0 amps is also available.

ANTENNA SYSTEM

The GPS1000 is designed to operate in conjunction with Automatic Antenna Tuning Unit Model NX4000TUB and a suitable customer supplied antenna.

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GPS1000

SPECIFICATIONS

The GPS1000 transmitter, whilst comprising just a single equipment cabinet, has all the features of a fully duplicated main/standby pair of transmitters. A single is designated GPS1000S and a dual, GPS1000D.

Continuous carrier power

1000W max.
(adjustable from 10% to 100%)

Frequency Range

282 to 326 kHz

Emission Mode

G1D, (MSK)

Modulation Rates

25 to 200 bits/sec.

External Drive Level

-3 to +10 dBm into 50 ohms

Harmonic Levels

Not exceeding -80dB relative to carrier when used in conjunction with an NX4000TUB ATU into a standard antenna load.

Monitor Failure Thresholds

Adjustable threshold normally set so that changeover will occur if Carrier Power reduces more than 3dB

External or Remote Control Interface

ON/OFF
Select A or B as Main
Battery Reset

External or Remote Alarms

Changeover
Shutdown
High VSWR
Battery Operation
MSK Input (A or B)
Exciter (A or B)

Power Requirements

AC Single phase 190 to 260 Vac, 50/60 Hz, 1.4 kW max.
Optional 95 to 130 VAC operation

Environmental Limits

-10°C to +55°C
0 to 95% relative humidity

Altitude

Up to 3000 meters (10,000 ft.)

Dimensions

166 x 57 x 61 cm,
(65 x 22.5 x 24 inches)

Weight (Unpacked)

Not exceeding 211 Kg. (465 lbs.)

Cooling and Heat Flushing

Forced air at approximately 90 cu. ft./min
2,200 BTU/hr. max.

Optional extras:

Standby Battery Operation

72 Volt Battery Charger @ 7 amps, Model NAB8

AATU type NX4000TUB

Remote Control Unit for use with a compatible PC

FOR FURTHER DETAILS CONTACT

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