

Telemetry Instrumentation Systems



GOVERNMENT AIRCRAFT FACTORIES

General Information

The Government Aircraft Factories has for many years been involved in the development of guided weapons, target aircraft and manned aircraft. An essential part of these projects has been the development and application of airborne and ground instrumentation systems for monitoring the performance of prototype missiles and aircraft during flight trials.

With this expertise, GAF has a proven compatibility for providing a full range of services covering complete system design, installation and operation and analysis as well as the supply of telemetry and signal conditioning hardware.

The users' viewpoint and practical experience acquired during years of flight trials carried out on behalf of the armed services are reflected in the company's services and product line.

Design and Development

GAF has established an experienced and highly qualified group of personnel covering a wide range of expertise. This expertise includes:

- Electronics design
- Structural design
- Aerodynamics design
- Control systems design
- Mathematical modelling and simulation
- Materials and structure bonding
- NATA approved laboratories.

On-going development of concepts, techniques and hardware is carried out in modern well equipped laboratories

where particular attention is paid to reliability, maintainability and performance under stringent environmental conditions.

Capability

In addition to the supply of airborne and ground hardware, GAF will undertake to carry out complete system tasks utilising its own or other existing hardware, and will develop special-to-type hardware if required. These services include:

- Feasibility and project studies
- System analysis
- Systems detail design
- Prototype manufacture and testing
- Production manufacture and testing
- Installation design and commissioning
- Trials participation and data acquisition
- Data reduction and analysis.

Previous tasks carried out cover both military and commercial systems and include:

- Instrumentation system for the Ikara missile (Royal Australian Navy, Royal Navy, Brazilian Navy)
- Instrumentation system for Jindivik target aircraft development
- Airborne data logger for Nomad (STOL aircraft) development
- Airborne instrumentation and ground data acquisition and reduction systems for RAAF Trainer aircraft development
- Concept study for water and sewerage monitoring and control system (MMBW).



Transmitters

Telemetry Transmitter – Mk 2

Description

The transmitter utilises a TDM/FM/AM system and can be configured to meet IMIC 4650 Variant 1 or IRIG 106-80 Telemetry standards.

The unit provides a basic 48 channels (analog) capability expandable using sub commutation techniques. A sub-carrier in the range 130-180 kHz is generated from the TDM output and is used to amplitude modulate a 1 watt transmitter operating in the 430-490 MHz band. The unit is powered by a re-chargeable nickel-cadmium battery pack which plugs into the transmitter.

External interfaces allow remote charging of the battery pack in situ and ON/OFF control of the transmitter.

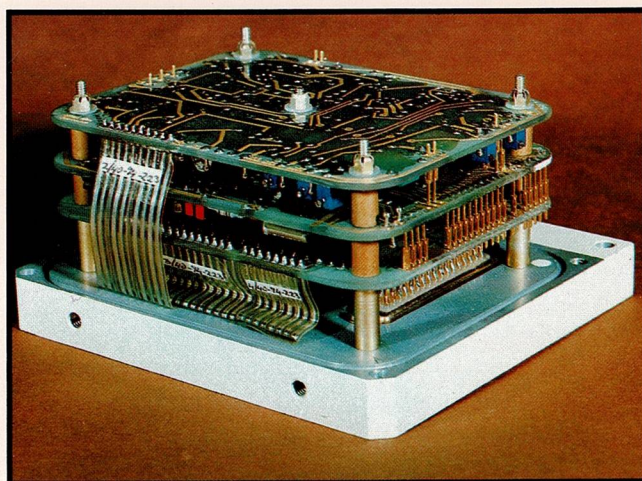
Features

- Rugged compact construction suitable for missile applications
- Meets MIL-STD-810C
- Internally generated calibration level
- Over voltage protection on all analog inputs
- O ring seals on all mechanical interfaces

- Easily disassembled for maintenance or repair
- Internal voltage scaling provided for all data channels
- Proven reliability in GW and RPV field use.

Specification (Short)

Frequency Range : 430-490 MHz (adjustable)
 Frequency Stability : ± 2.5 MHz over full environmental range
 Power Output : 1 watt nominal
 Channels : 48 plus sub commutation
 Input : Voltage internally scaled to ± 3 volts FSR
 Multiplexer : Break before make
 Sample Rate : 2 kHz
 Mechanical : 137 mm X 120 mm X 127 mm
 Weight : 2.4 kg (including battery pack)
 Environmental : MIL-STD-810C.
 Contact factory for a more detailed specification.



Telemetry Transmitter – Mk 4

Description

The transmitter is a PCM/FM type configured to meet IRIG 106-80 PCM telemetry standards. For versatility the transmitter is constructed in three compact and compatible modules:

- Encoder
- Modulator
- Power Amplifier.

The Encoder Module provides a nominal 48 primary channels capability, expandable with sub-commutation to meet future requirements and is software configurable for variables such as bits per word, words per frame, PN Code and bit rates.

The PCM bit stream may be configured with a choice of codes such as NRZ and Manchester.

The Modulator Module provides:

- Crystal controlled frequency source
- RF output generated directly at operating frequency in the band 1435-1535 MHz
- FM modulation of the carrier using a phase lock loop technique.

This unit will accept serial PCM bit streams of up to 3 Megabits per second and provides an FM modulated carrier with adjustable deviation.

An RF output of 100 milliwatts allows this unit to operate as the system transmitter.

Configurations with additional power output can be provided. The third module, the Power Amplifier Module, houses a power amplifier which when driven by the Modulator, produces a minimum of 10 watts at the operating frequency.

Features

- Rugged compact, compatible modules which can be mounted together or separate
- Software configurable Encoder formats
- Up to 12 bit resolution
- Accepts analog and digital inputs
- Crystal stabilised carrier
- Easily disassembled for maintenance and repair
- Proven reliability in GW and RPV field use.

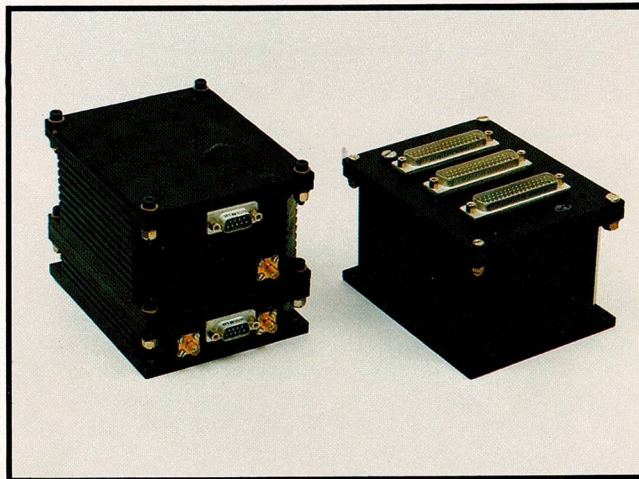
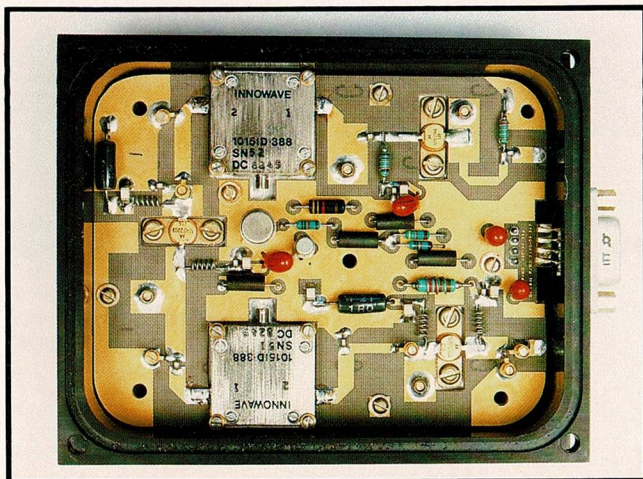
Specification (Short)

Encoder

Channels : 48 nominal, expandable by sub-commutation
 Resolution : up to 12 bits
 Bit Rate : 500K bits/sec. max.
 Format : Software configurable for bit rate, bits per word, words per frame, PN synchronising code All IRIG 106-80 codes
 Size : 127 mm X 102 mm X 86 mm
 Weight : 130 g

Modulator

Frequency : Adjustable in range 1435-1535 MHz
 Stability : $\pm .003\%$ of centre frequency
 Bit Rates : Up to 3M bits/sec.
 Spurious Emissions: Conforms to IRIG 106-80 with Filter Module (optional)



Deviation : Adjustable to ± 1.5 MHz peak
 Output : 100 milliwatts typical, SMA jack
 Size : 127 mm $\times$ 102 mm $\times$ 71 mm
 Weight : 134 g

Size : 127 mm $\times$ 102 mm $\times$ 34 mm
 Weight : 77 g

Environment

MIL-STD-810C

Power Amplifier

Input : 100 milliwatts nominal, SMA jack
 Output : 10 watts minimum, SMA jack

Power Supplies

± 15 V, + 28V DC
 Contact factory for more detailed specifications.

Decoders

PCM Telemetry Ground Decoder MK 3

Description

The MK3 Ground Decoder has been designed to process the demodulated PCM signals from the MK4 or similar transmitter. It allows signals to be recovered and displayed in real time and sets flags to indicate data integrity via a number of status indicators. The decoder generates its own bit and frame synchronisation timing from the incoming data.

The unit is designed to directly interface with mini computer systems via a PDP-11/DR11B parallel digital interface, as well as other computer storage devices. Since these systems are generally not equipped to handle the continuous throughput of data, a system of elastic memories has been built into the ground decoder to ensure that the data transfer is not impaired.

A 16-bit microprocessor is utilised to achieve the flexibility necessary to adapt to the wide range of input data formats as well as a fluctuating input signal-to-noise ratio, whilst a second microprocessor is used to control the various outputting modes available to the user.

In addition to providing an interface to peripheral computer systems, up to 16 channels can be converted into their equivalent analog voltages for subsequent display or measurement on a pen recorder, DVM, etc.

Although the system's operation is virtually automatic the user has at his disposal the means of altering the processing of any data word. This operation can take place at any time (pre, post, and during data transmission) since the microprocessor involved will complete all higher priority tasks before servicing the front panel (user interface).

An elaborate self-test sequence enables quick self-check analyses.

Features

- Compact rack mounting PCM decoding system complementing the PCM/FM MK4 Transmitter
- Capable of deriving data from a wide variety of NRZ or Manchester PCM Telemetry Transmitters



- Programmable bit rates, bits per channel, and channel formats
- Compatible with all IRIG 106-80 codes
- Automatic operation after presetting
- Maintains efficient operation through the ability to adapt to varying bit rates
- Near optimum digital 'MAP' bit sync technique utilised
- Output data format suitable for display in analog or digital form
- Minimum calibration and set up requirements
- Modular construction.

Specification (Short)

BIT FORM – Direct Input: NRZ-L
 – Tape Relay : NRZ-L or BIØ-M (selectable)
 (250K bits/sec. not clocked)

INPUT LEVEL – Direct : 1Vpp nominal
 – Replay : TTL compatible

INPUT BIT RATE : Initialised to 500K bits/sec. NRZ

WORD LENGTH : Variable 4 to 16 bits

WORDS PER PRIMARY FRAME : Variable up to 64

PRIMARY FRAME LENGTH : Variable 100 to 1024 bits

No. OF PRIMARY WORDS SUB FRAMES : Up to 3

No. OF CHANNELS PER SUB FRAME – Primary Channel : Up to 64

FRAME SYNC. CODE LENGTH : 12 to 32 bits

ELASTIC MEMORY STORAGE CAPACITY : 4095 $\times$ 16 bits per silo

NUMBER OF SILOS : 2

OUTPUT DATA RATE : Up to 500K bits/sec. of 16 bit words/sec.

ANALOG OUTPUTS : 16

D/A CONVERSION –
 Resolution : 10 bits
 Linearity : $\pm 0.2\%$ FS
 Output Voltage : ± 5 V
 Max. Load Capacity : 10,000 pF

PARALLEL DIGITAL INTERFACE : Compatible for transfer to a PDP-11/DR11B Interface

SIZE : 584 mm (D) $\times$ 483 mm (W) $\times$ 178 mm (H) (approx).

WEIGHT : 16.4 kg (approx).

POWER SUPPLY : ± 15 volts, +5 volts or 240V mains.

PCM Telemetry Ground Decoder MK 4

Description

The MK4 Decoder complements the MK3 Decoder by providing the same basic functions but with increased performance and wider choice of options.

The system is a versatile, expandable system allowing customers to tailor to their needs with various configurations available.

The basic system consists of two compatible modules, the Synchroniser Module and the Real-Time Conditioner Module, controlled by an RS232 interface port. This basic system allows PCM signals from the MK4 or similar transmitter to be demodulated and a digital output provided as well as analog outputs to be outputted to displays. In addition, a re-constituted bit stream is available for recording on an instrumentation tape recorder. By the use of a suitable controller (VDU terminal) a number of pre-set variables can be altered to allow rapid transmitter reconfiguration compatibility.

With the addition of a small mini-computer system and a data display system, the ground decoder can be expanded to allow for engineering units display, both in analog and digital form via one or more displays. In addition, hard copy storage devices such as disc and mag tape can also be connected.

All IRIG 106-80 Formats are accepted by the synchroniser module.

Features

Synchroniser Module

- Compatible with all IRIG 106-80 codes
- Bit and frame synchronisation
- Stand alone operation via RS 232 interface
- Modular, easily operated and maintained
- Data rates to 5 Mbit/sec.
- Bit sync near optimum due to 'MAP' bit sync loop
- NRZ output for Frame Sync Bi-phase and NRZ for tape recording
- Selectable loop bandwidths, noise filter, bit shape, code type, windowing, data source and acquisition/tracking scheme via RS 232 bus
- Status indications.

Real-Time Conditioner (RTC)

- This unit takes parallel data and word identification information from the frame synchroniser output and provides real-time analog outputs suitable for display and/or further processing
- Other channels of information such as timing (IRIG) and voice information can also be recovered in real-time
- A full programmable PCM Frame Simulator is also included to allow exercising of the Sync Module as well as the RTC data recovery via an RS 232 bus.

D/A Converters

- Resolution up to 12 bits
- Conversion rate 100,000 updates/sec. min
- Interpolation filtering up to 5 poles to match airborne anti-aliasing filters
- Histogram output for 'quick look' facility
- 24 channels nominally, with expansion capability.

Display System

- Up to three monochrome displays can be provided for the display of engineering data
- The display system will take the parallel data and word identification information from the frame synchroniser, convert the required channels to engineering units and display it
- First or second order curve fits are used for the conversions giving accuracy compatible with the resolution of the displays
- A data recall facility is provided, allowing the previous 10 mins. of data to be displayed and compared to the current data
- Simple keyboard controls are provided to the operator to allow reconfiguration of the displays at any time.

Specification (Short)

WORDS PER MINOR FRAME	: 12 to 256
No. SUBMULTIPLE FRAMES	: 2 to 32
WORDS PER SUBMULTIPLE FRAME	: 2 to 96 using subframe sync method (a) 2 to 64 using subframe sync method (b)
SUBMULTIPLE FRAME SYNCHRONISATION	: Method (a) sub frame Identification (SFID) Method (b) Complementary Frame Sync Code (CFSC)
FRAME LENGTH (Nf)	: 100 to 256 × 16 bits
FRAME SYNC CODE LENGTH (Np)	: Less than 12, to 64
FRAME FORMAT	: Frame sync code at start of minor frames will accept IRIG 106-80 compatible formats
DATA OUTPUT	: Decoded parallel data output : 16 bits data : 12 bits identification (minor frame/subframe number and word number) : Data valid flag
DATA OUTPUT	: Write pulse : Minor and major frame pulses : Status bits
16-BIT MICROPROCESSOR USED TO	: Set up data formats : Initialise self-testing : Communicate with other computing systems : Provide an adaptive frame synchroniser strategy based on stored optimum search, verify and lock parameters for fluctuating bit error rates from 3×10^{-1} to 10^{-5}

Mobile Telemetry Receiving Stations

GAF maintains and operates two Mobile Telemetry Receiving Stations which provide facilities for acquiring and displaying telemetry data.

The first van provides acquisition of telemetry data in the 1435-1535 MHz band together with modest data reduction facilities enabling the display of up to 24 channels of analog data in real time. Changes to the displayed channels can be

made readily prior to or during flight trials.

All data including communications is recorded in real time on a 7 track IRIG compatible instrumentation recorder.

The total hardware is housed in standard racks and mounted inside an air-conditioned 20' × 8' × 8' mobile van.

The second van provides similar telemetry acquisition equipment but provides more sophisticated data reduction and



display equipment. A 16 bit mini computer system provides facilities for substantial data reduction calibration and storage together with inputs to the display system.

The display system provides both analog trace and alpha numeric display of data which can be selected by the operator.

The system is housed in a 40' X 8' X 8' air-conditioned mobile van.

Features – (Both Vans)

- Mobile
- Most systems are duplicated to enhance reliability for single transmitter operation or can be configured to acquire data from two transmitters
- Spectrum surveillance
- Extensive self testing.

Acquisition Van –

- Small and manoeuvrable
- Economical to operate
- Analog displays (up to 24 channels)
- Interface to digital computer (data).

Acquisition and Data Reduction Van –

- Comprehensive data calibration and reduction facilities
- Software configurable display systems
- IRIG B timing decoders
- Internal and external communications system.

For further details on systems – contact the factory.

Instrumentation Systems

GAF has over many years evolved a number of total instrumentation packages to meet varying requirements. This total capability ensures optimum system reliability and accuracy. Design, manufacture and installation of systems can be undertaken to meet the most stringent requirements.

System packages include:

- Transducers
- Data acquisition stations, incorporating
 - Analog signal conditioning
 - Digital signal conditioning
 - Synchro-to-digital convertors
 - Frequency to digital convertors
- Data encoding
- Data storage
 - Instrumentation recorder
 - Crash recorder

– Pen recorders

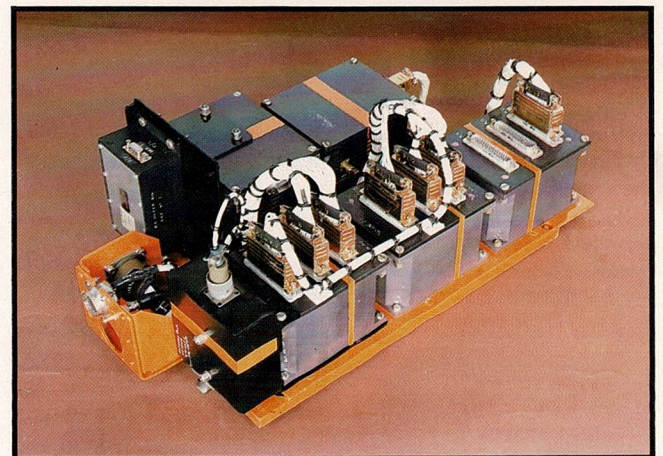
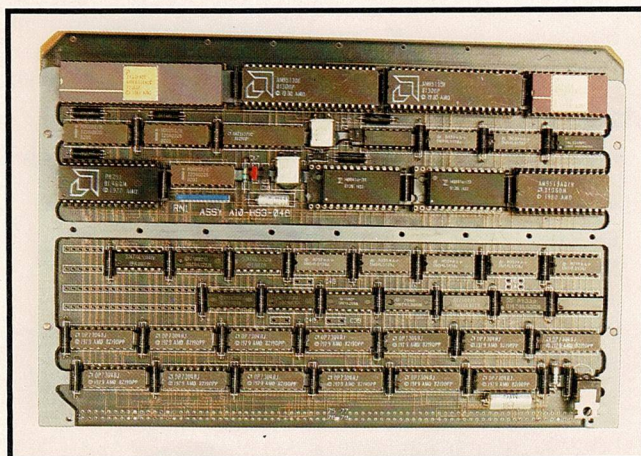
- Aircrew Displays (including CRT)
- Timing
- RF Transmissions (telemetry)

Typical systems utilise distributed data acquisition via remote and master stations to optimise installations and minimise problems associated with RFI, earth loops, etc.

Reconfiguration of systems to suit changing test requirements can be carried out simply on-site by inputting new software from an external test unit.

Systems are designed to meet stringent airborne environmental requirements such as MIL-E-5400 and MIL-STD-810C. Both printed circuit and multiwire boards are used with integral heatsinks to minimise thermal stresses.

For further details on airborne or ground systems – contact the factory.



ENQUIRIES:

CHIEF DESIGNER
GOVERNMENT AIRCRAFT FACTORIES
226 LORIMER STREET
PORT MELBOURNE AUSTRALIA
TELEX AA30252
PHONE (03) 647 3513

