LET'S MAKE LIFE EASIER FOR THE INSTRUMENTATION ENGINEERS

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ABSTRACT

As new products are developed for the telemetry market, network interfaces are being used for set-up and control. This paper describes the programmability of various telemetry components that are now available and discusses the internal status functions that can be returned to the user or telemetry system via the same interface that are good indicators of system health. Possible control interfaces are discussed that could be used to interface many different components. Also discussed is the need for the Range Commanders Council to address the total programmability protocol issues related to connecting multiple components into a common setup and control bus.

Keywords: Telemetry, Control Bus, Programming Protocol

INTRODUCTION

Commonality is a concept whose time has come in many areas of the telemetry field. Common Airborne Instrumentation hardware led the way 20 years ago. Today, Chapter 10 recorders are available from several vendors. Tunable telemetry transmitters have been available for several years. The Enhanced Flight Termination Receiver (EFTR) CTEIP development led to the first digitally tunable flight termination receiver. Digitally tunable telemetry receivers, radar transponders, and transmitters are now available. The Range Commanders Counsel, Inter-Range Instrumentation Group (IRIG) has published Appendix N to IRIG 106[2], which defines the protocol for telemetry transmitter programming. However, other than telemetry transmitters and the EFTR receiver, a set of common programming protocols does not currently exist.

TELEMETRY TRANSMITTERS

Digitally programmable telemetry transmitter control is now defined by IRIG-106 appendix N[1]. The following tables were extracted from appendix N and define the basic command set and the extended command set. The commands are typically linked from a computer in a hyper-terminal mode to the transmitter using a full-duplex digital interface with one start bit, one stop bit, no parity, LSB first, at a default rate of 9600 baud. The appendix N abbreviated commands are shown in Table 1.

Table 1 IRIG 106 Appendix N

BASIC COMMAND SET		EXTENDED COMMAND SET	
Command	**Function**	**Command**	**Function**
FR(EQ)	Sets or queries the carrier frequency.	DP(OL)	Sets data polarity
MO(D)	Sets or queries the modulation mode.	DS(RC)	Sets or queries the data source
DE	Sets differential encoding (ON or OFF).	ID(P)	Sets or queries the internal data pattern
RA(ND)	Sets data randomization (ON or OFF).	CS(CLKS)	Sets or queries the clock source (INT or EXT).
RF	Sets or queries the RF output.	IC(R)	Sets or queries the internal clock rate.
QA(LL)	Queries status of all basic commands.	FC(FEC)	Sets or queries forward error correction (ON or OFF).
VE(RS)	Queries manufacturer's name, model number, and serial number.	FC(FEC) YYYY	Set specific forward error correction (ON or OFF).
SV(SAVE)	Saves the current set-up	RP(RPWR)	Sets or queries the output RF power (HI or LO).
RL(RCLL)	Retrieves a transmitter set-up	TE(MP)	Queries the internal temperature.
RE(S)	Resets the transmitter	DV(DEV)	Deviation sensitivity for PCM/FM mode.
		SP(SLP)	Low power consumption mode, sleep mode.

These command sets provide a common interface definition that improves interchange of transmitters from various vendors but does not address common form factors, standard connectors or pin outs. It also does not define the actual electrical interface. Typical serial interfaces include RS-232, RS-422, RS-485, and TTL. Also missing is a standard format for a transmitter serial number ("US" as an example), which is required if several components are daisy-chained together using a common, "multi-drop" RS-485 programming interface.

FLIGHT TERMINATION RECEIVERS

The EFTR program was the first attempt at defining a digital programming interface for flight termination receivers. Prior receivers were typically set for center frequency and tone sets at the factory and had to be returned to the manufacturer for retuning if these parameters required changing. With the advent of high density Field Programmable Gate Arrays (FPGAs), digital tuning became possible and was implemented in the EFTR design. The set-up programming commands were developed by the prime contractor and have not been released to date. However, the EFTR project office in working on an RCC standard so that future receivers that may be developed will have common set-up and operational commands and be compatible with existing range safety set-up hardware

A digitally tunable flight termination receiver is also available from Teletronics Technology Corporation that allow the range safety officer to digitally set the center frequency, up to four tone decoders, and the failsafe conditions. The FTR-100 command set is shown in Table 2.

Table 2 FTR-100 Terminal Commands

Command	Function	Command	Function
FR_xxx or FRxxx	Sets Frequency	LOV	Loss of Voltage status query
FR? or FR	Frequency query	TMA	Tone Monitor A status query
ToneA X	Selects Tone A Frequency 1-11	TMB	Tone Monitor B status query
ToneA? or ToneA	Tone A query	TMC	Tone Monitor C status query
ToneB X	Selects Tone B Frequency 1-11	TMD	Tone Monitor D status query
ToneB? or ToneB	Tone B query	RF	RF Carrier status query
ToneC X	Selects Tone C Frequency 1-11	FPGA	Request FPGA code No. and version
ToneC? or ToneC	Tone B query	MICRO	Requests microcontroller version and rev
ToneD X	Selects Tone D Frequency 1-11	QP	Query for operational parameters
ToneD? or ToneD	Tone D query	QT	Query Temperature
FSSI	Failsafe System Input Status query	QI	Query for Identity. When powered up automatically sends this to serial port
FSSO	Failsafe System Output Status query	QS	Query for status signals
FST	Failsafe Timer count query	CMDxxxxxxxxxx	Password Access
FSEI	Failsafe System Enable Input Status query	DC	Date code query
FSEO	Failsafe System Enable Output Status query	DCxxxxxxxx	Date Code Set Command.
Mon	Monitor Output Command status query	PSxxxxxxxx	Password Set Command
Arm	Arm Output Command status query	SN	FTR Serial Number query
Term	Terminate Output Command status query	SNxxxxxxxx	Serial Number Set Command
Opt	Optional Output Command status query	MN	Model Number query
SS	Signal strength value query, 0 – 5 volts	MNx	Model Number Set Command

AIRBORNE TELEMETRY RECEIVER

Tunable telemetry receivers are now available that can be digitally tuned at any time, prior to flight or dynamically, during flight. The programming of these receivers has not been standardized at this time. Since these receivers are capable of demodulating both PCM-FM and SOQPSK, and can support bit rates from less than 1 to more than 20 Mb/s, there are many programmable parameters. Many of the commands are used for both setting parameters and as a query to check the values previously loaded. An example of a receiver command set is shown in Table 3.

Table 3 Airborne Telemetry Receiver Terminal Commands

Command	Function	Command	Function
BO	Bit Offset query	QD	DC Power Health query
BR	Bit Rate Set/query	QL	Local Oscillator Lock query
CL	Carrier Limit Set/query	QT	Temperature query
CF	Carrier Frequency Set/query	RH	Receiver Health query
CO	Carrier Offset Set/query	RI	Receiver Information query
CP	Clock Polarity Set/query	RL	Receiver locked query
DP	Data Polarity Set/query	SQ	Receiver quality query
DR	De-randomizer Set/query	SS	Signal Strength query

MO	Modulation Mode Set/query	US	Force to Listen Mode

RADAR TRANSPONDERS

The RCC IRIG published IRIG-262[2], in 2002 to attempt to standardize the performance and testing of radar transponders. The specification includes connector and size requirements but does not address digital programmability of the units. Current transponders are now capable of digitally adjusting such parameters as the transmit frequency, the receive frequency, the pulse spacing, the reply delay, and other factors. A typical set of control and query functions is shown below in Table 4. The connector pin connections and the programming protocols are vendor defined at this time.

Table 4 Radar Transponder Command Terminal Commands

Command	Function	Command	Function
FT	Transmit Frequency Set	P 0 to 9	Test Mode PRF
FR	Receiver Frequency Set	QP	Query for Set-up
PC	Interrogation Code Spacing	QS	Query for Operational Status
RD	Reply Pulse Delay	QI	Query Transponder Identification
PW	Reply Pulse Width	PS	Parameter Save

INTEROPERABILITY ISSUES

New technologies are now available, or are in development, that will enable quick configuration changes to airborne telemetry systems. Systems such as EFTR and iNET will allow for control messages to be easily linked into complex telemetry systems to reconfigure frequencies and formats of many components. As additional vendors introduce programmable components with different programming protocols, the complexity of trying to keep telemetry components interoperable will increase accordingly. Once telemetry-wiring harnesses are defined, it is expensive and complex to change it to accommodate another telemetry component that has different connector pin connections.

OPERATIONAL ISSUES

At the System level, there is a large cost savings to be able to configure the sub-components at the Telepack level, instead of the current approach of removing and replacing components. With the "Multi-drop" RS-485 approach as shown in

Figure 1, the system controller can interrogate the individual component of a telemeter and reconfigure them as needed by the test. In addition, this approach eliminates the need for individual communication ports, reducing wiring, while providing electronic serial number accounting of the equipments are supported by this implementation. To achieve this level of operation the command structures must be interoperable allowing Transmitters, Transponders, and Flight termination Receivers to communicate on a common bus.

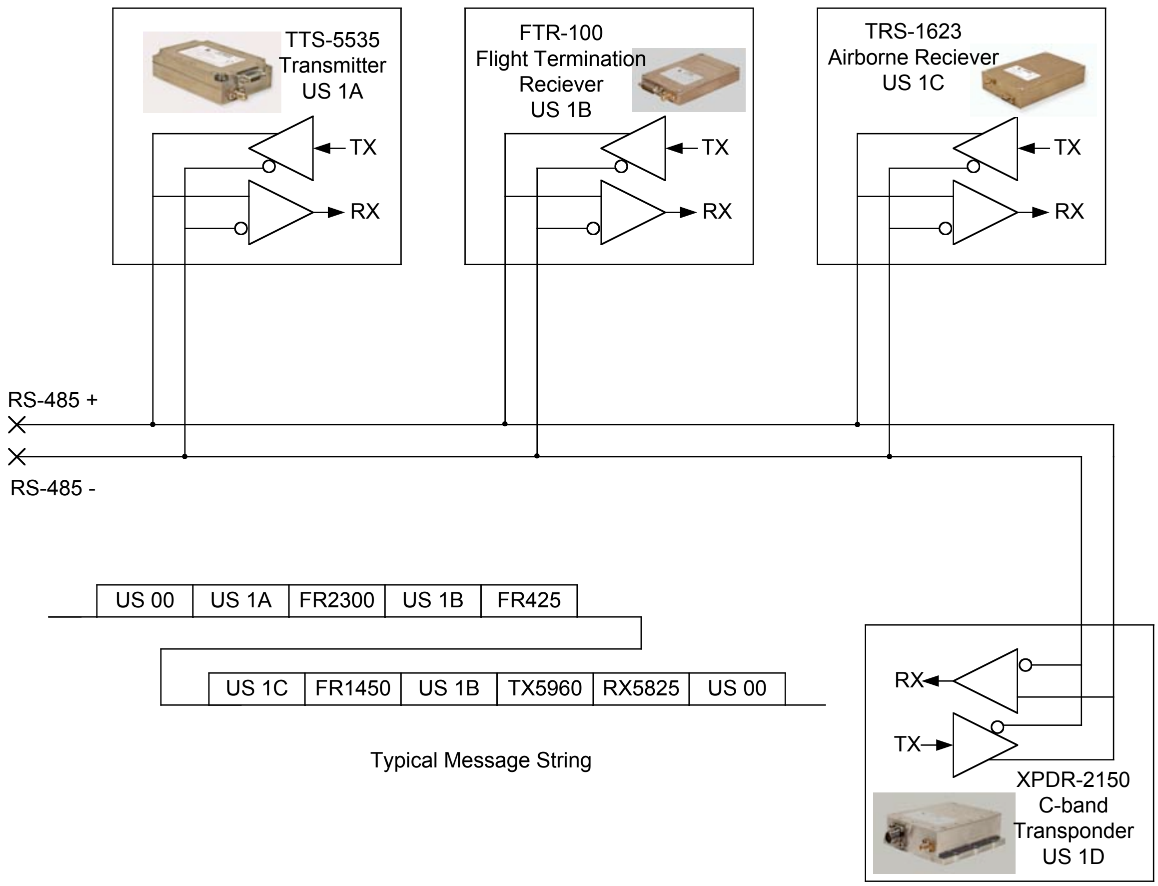

Figure 1 Multi-Drop Configuration

RECOMMENDATIONS

The RCC should address the standardization of telemetry components as quickly as possible. The standardization should not only include the case sizes, as was done in IRIG-262-02[2],but the data protocol and command sets needed to program digitally controllable components. The longer the RCC waits the more difficult, and costly it will be for manufactures to change the interface designs of their existing components and the greater variety of incompatible interfaces will be fielded. An added benefit will be the drop-in replacement of components manufactured by various vendors, which will foster competition and reduce system costs.

REFERENCES

[1] IRIG-106, Telemetry Standard RCC Document Appendix N, TELEMETRY TRANSMITTER COMMAND AND CONTROL PROTOCOL, April 2009

[2] IRIG-262-02, C(G)BAND & X(I) – BAND NONCOHERENT RADAR TRANSPONDER PERFORMANCE SPECIFICATION STANDARD, Range Commanders Council, U.S. Army White Sands Missile Range, April 2002