TCM PowerLink
Diagnostics & Simulation

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Overview

• System Description
• Maintenance System
• Data Analysis
• Simulation
FADEC - Customer Value

- Starting Ease
- Reduced Pilot Workload
- Reduced Fuel Burn
- Reduced Maintenance Cost
- General Engine Health Increased
- Monitors and Controls Critical Engine Parameters
- Data Port for Maintenance and Display Interfaces
FADEC Operating Method

- Closed Loop on EGT in Cruise - Absolute Mixture Detection and Control
- Individual Cylinder Control
- Best Power for Takeoff, Climb, and Max Cruise
- Best Economy for Normal Cruise
- Mixture Modified as Required for Cylinder Temps, Detonation or T.I.T. Limiting
Component Array for 4-Cylinder Engine
Four Cylinder FADEC System
Six Cylinder FADEC System
PowerLink™ V2 Engine Data Processing and Service Support System Configuration

FADEC SYSTEM BLOCK DIAGRAM

**LEVEL 2 DIAGNOSTIC CAPABILITY**
FBO Fault History Analysis Implemented by removing CompactFlash Card and installing in PocketPC PDA

**LEVEL 3 DIAGNOSTIC CAPABILITY**
Level 3 Analysis Implemented by removing CompactFlash Card and installing in standard reader for TCMLink upload

**ENGINE DATA INTERFACE (EDI)**

- RS-232
- RS-232
- RS-485

**SERIAL BUS CONTROLLER**

- Correct & Total Fuel Flow & Calculate %Power
- Average Multiple Channel Parameters

**ENGINE CONTROL PANEL**

- 76.4% BCRUISE
- MESSAGE DISPLAY
- BEST ECON
- PAGE
- ACK
- TEST A
- TEST B
- STRAP
- ECON
- CD
- CASE
- CYL
- Vibs

**IOF or TSIOF ENGINE**

**ECU 1**

**ECU 2**

**ECU 3**

**Starter Relay**

**LOW VOLTAGE HARNESS**

**HIGH VOLTAGE HARNESS**

**CABIN HARNESS**

**Conventional Engine Displays** [Optional]

- Real-Time Blended Data & Faults RS-232
- Identical RS232 Data Transmissions

**REAL-TIME DIAGNOSTICS**

- Raw Data & Faults RS-232

**REMOTE SHUTDOWN**

**SECONDARY POWER**

**PRIMARY POWER**

**FAULT FILE DOWNLOAD**

**Fuel Flow, MOP, MOT, OAT, OAP, TIT, UDP, UDT, CD, DPCASE, DPCYL, Vibrations**

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Engine Control Panel –ECP–

- FADEC Faults
- Low Fuel Pressure
- Boost Pump On
- Electrical Power
- Over Temp Cylinders
- Oil Pressure
- Oil Temperature
Signal Conditioning
Serial Bus Controller (SBC)

- SBC Inputs Digital & Analog Data
  - FADEC
  - Analog Sensors
  - Multi-function Displays
  - Arinc 429 data
Signal Conditioning
Serial Bus Controller (SBC)

- SBC Outputs Digital & Analog Data
  - Multi-Function Displays
  - Gauges
  - Cautions & Warning Lights
  - Cowl Flap Controller
  - Engine Data Interface
  - Removable Data Module
Operational Simplicity

- Automatic Mixture Control
- Automatic Boost Pump Control
- Automatic Cowl Flap Control
- Automatic Electrical Power System
Engine Data Interface

• Captures Engine Data
  – Time and Date
  – Event History
  – Individual Cylinders
  – Outside Air Pressure
  – Fuel Flow
  – Faults
ALPHA MAINTENANCE SYSTEM

- Data Recording System
- Engine Trend Monitoring
- On Condition Maintenance
- Glass Panel Displays
LEVEL I DIAGNOSTICS

- REAL-TIME, IN-FLIGHT HIGH LEVEL FAULT ANNUNCIATION
- REAL-TIME FAULT AND ENGINE PARAMETER DATA DISPLAY
- GROUND-BASED DIAGNOSTIC SOFTWARE WITH LIVE DATA FEED TO TCM
A LOT OF DATA

- Each Cylinder’s Control Computer transmits 30 Parameters and 96 Status Bits
- 4 Cylinder Engines: 120 parameters and 384 Status Bits every 0.88 seconds
- 6 Cylinder Engines: 180 parameters and 576 Status Bits every 1.32 seconds

MIXTURE OPTIMIZATION PROCESS DISPLAY

STABILITY

CALIBRATE (Leaning)

Partially Complete

COMPLETE (Optimized)
LEVEL II DIAGNOSTICS

- ENGINE RUNTIME LOG
- OFF-LINE DETAILED FAULT LISTING
- OFF-LINE FAULT TROUBLESHOOTING AID
- EXCEEDANCE LISTING
• Integrated Analysis System including
  – Complete Level 3 Analysis
  – Oil Analysis
  – Cylinder Compression Analysis
  – Call Center Data

• Fully Integrated TCM Engine Performance Diagnostic and Analysis System
  TCMLink-based Factory Full Service Performance Analysis System

• Requires TCMLink interface and integration of customer service databases
Maintenance Summary

- Real-Time Cautions/Warnings
- Ground Trouble-Shooting with PDA/Laptop
- Data transfer to TCM
  - Technical Expertise
  - Trend Monitoring
- On-Condition Replacements
- Extended TBO’S
- Normal Condition Validation
Removable Data Module – RDM –

- Captures Engine Data
- Incorporates Aircraft Data – 80 Parameters
  - GPS Location
  - Airspeed
  - Altitude
  - Fuel Level
  - Other as required
PowerLink™ RDM Retrievable Engine Parameters

Engine Data Display - Caution

PowerLink™ LEVEL I DIAGNOSTICS (VM1000 / SBC-100)

Engine Parameters:
- RPM: 1620
- MAN PRESS: 16.9 inHg
- % POWER: 22%
- FUEL FLOW: 2.9 GPH

PowerLink™ IOF-240B Engine
LOW POWER MODE

EGT (°F):
- 1076
- 1110
- 1116

CHT (°F):
- 215
- 235

FADEC STATUS:
- Fuel Pump Failure
- Dead Cylinder
- Lean Misfire
- Secondary Injection
- Channel Disabled
- Low Voltage Fault

EXCEEDANCES:
- Engine Overspeed
- CHT Overtemp
- EGT OverTemp
- Hot Head Operation
- Low Takeoff CHT

TRANIENT DATA ON
SBC/EDI DATA
ECU SOFTWARE: VD12296-

TMAN: 94°F

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VFADEC: 14.2 VDC
PFUEL: 48.0 PSIA
FUEL USED: 0.1 GAL
BHP: 28 HP
FUEL FLOW: 17.2 PPH
BSFC: 0.614

STOP
PowerLink™ RDM Plotted Parameters
Development Programs

Simulations

- Aircraft Flight Paths
- Ground Display
- Weather Displays
Development Programs

In-flight Aircraft Downlinks

- Data from RDM and EDI is securely transmitted via wireless and continuously updating an aircraft information database located at Teledyne Continental Motors and or Airframe manufactures.
- Database immediately accessible to recognizing faults.
- Flight data comparison between recent flights and base line engine data.
- Maintenance activity can become on demand using data analysis
- Extended TBO based on recorded data and compared to base lines.
- Gather Data, Analyze Data, Trend Data, Provide Recommendation on Data.
ALPHA SERVICE SYSTEM
Flight Reconstruction
QUESTIONS?