IRAM Plateau de Bure Observatory

FIBER OPTIC TRANSMITTER

User manual

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Revision B - August 21st, 2006

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3. Introduction

The aim of the FIBER OPTIC TRANSMITTERS[1] rack is to convert electrical signal output from the receivers equipment in light signal and monitor the ageing of both laser diodes.

Receiver assembly output 2 electrical signals that are transported through mono mode optical fibers down to the correlator room located inside the building. An Intermediate Frequency carries each band of signal between 4 GHz and 8 GHz.

The FIBER OPTIC TRANSMITTERS[1] rack is made of an electronic board and two laser diode devices with Peltier cooler. All is enclosed in a 19” rack located at the bottom and on the left of the receiver assembly inside antennas.

The electronic board receives commands through the CAN[3] bus, a micro-controller (MCU[14]) translates them and monitors two FIBER OPTIC TRANSMITTERS[1].

Laser diodes, fans, power supply voltages, temperature and IDentification information can be monitored with few CAN[14] commands.

4. General Specifications

4.1 Background

The motherboard carries amplifiers, connectors and voltage regulators, and a C164[6] micro-controller (MCU[14]) located on a DIP40 daughter board.

Fans, Peltier coolers and laser diodes are fed through the motherboard. Return information is monitored by the MCU[14].

The interface between the CAN bus and the lasers is a commercial daughter board with a C164 micro-controller (MCU[14]). It is a derivative of the famous Infineon C167[8] family. It receives commands through the CAN bus, computes data and translates them in SPI format. Interruption routines process CAN frames and monitor a Real Time Clock. The MCU[14] can be reset by a local pushbutton located on the mother printed circuit board with front rack access.

A data storage EEPROM is controlled through a port compatible with the Serial Peripheral Interface (SPI[14]) standard. Daily laser data is recorded and stored into it. Peltier device current, laser diode power and temperature are measured every day.

Each laser diode device is cooled with a Peltier device mounted on a heat sink with a fan.

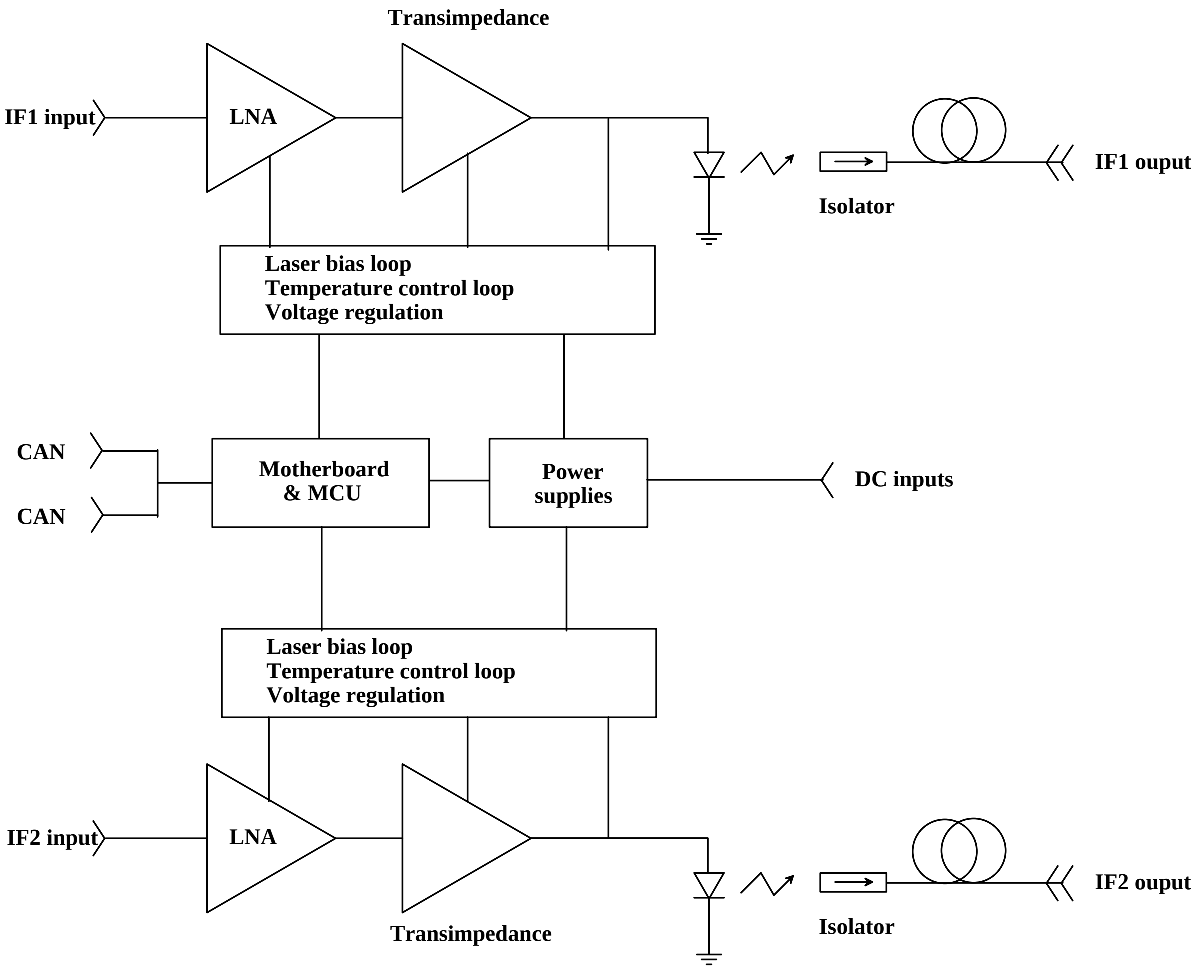

Figure 1: Block diagram

4.2 Power requirements

The module requires a +15VDC regulated power supply, a -15VDC regulated power supply and a +5VDC regulated power supply, all supplied through an Amphenol socket located at the rear side of the rack. Three fuses located on the motherboard protect the electronic devices.

Total power requirement:	+15VDC/500mA	-15VDC/300mA	+ 5VDC / 2.5A
Fuses values are:	**F1 = 800mA**	**F2 = 800mA**	**F3 = 3.15A**

4.3 Operating Temperature Range

All components currently used have standard temperature range specifications of 0 – 70°C.

4.4 Printed circuit boards details

The motherboard is a four-layer surface-mount 180mm x 100mm PCB.

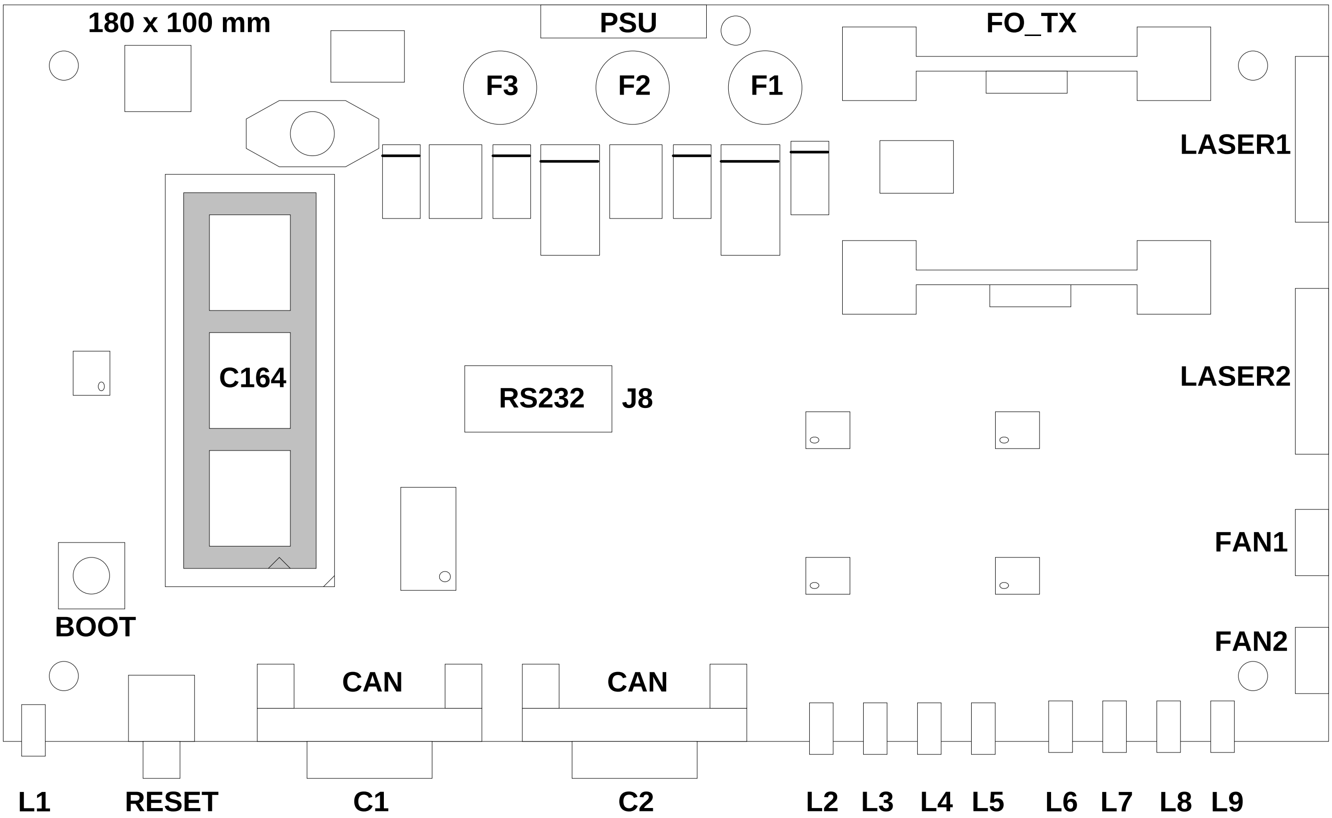

Figure 2: PCB[14] & components layout (real size)

5. Device connections

5.1 Mechanical Details

The module is a 19” rack that measures 440mm x 310mm. Height is 130mm.

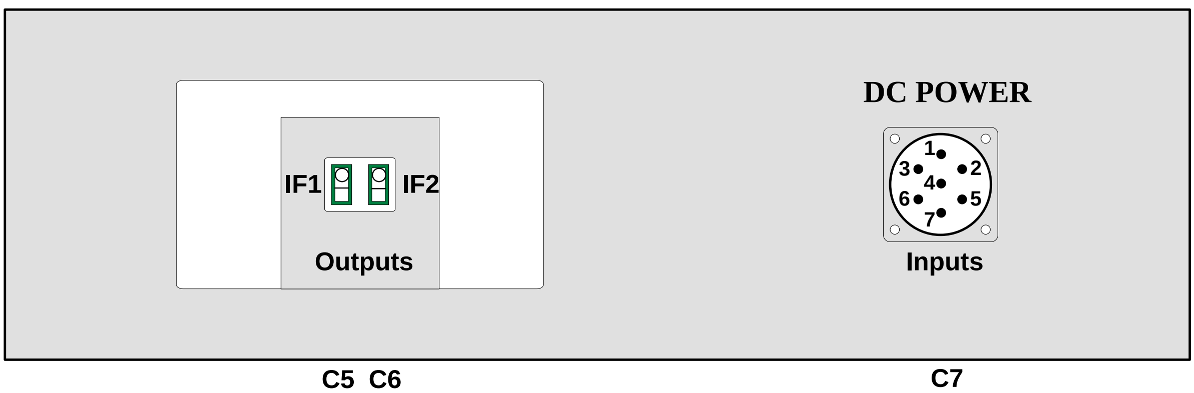

Figure 3: Rack rear view

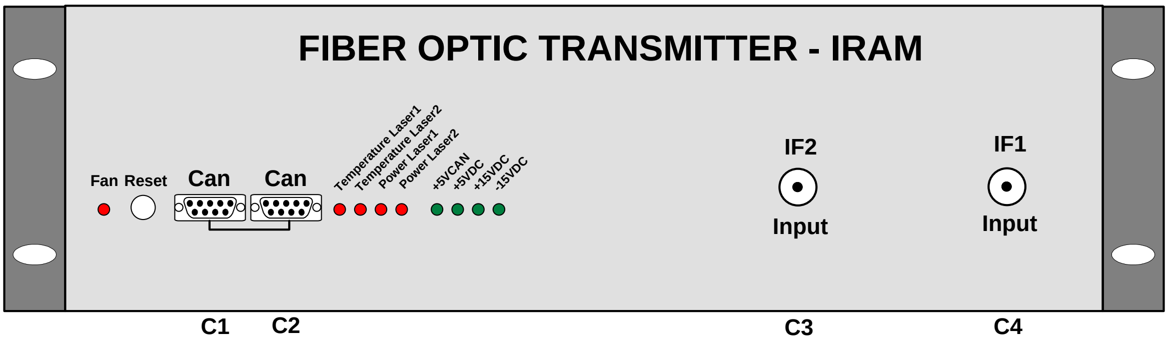

Figure 4: Rack front view

5.2 Connections

The module has several connectors located in the front panel of the rack and only 3 at the rear side.

Front panel connectors are classified by function as it follows:

- C1: SubD-9 connection to CAN bus.
- C2: SubD-9 connection to CAN bus.
- C3: SMA connection to IF[19] number 2 input.
- C4: SMA connection to IF[19] number 1 input.

Rear panel connectors are classified by function as it follows:

- C5: Diamond E2000 fiber optic connector to IF[19] number 1 output.
- C6: Diamond E2000 fiber optic connector to IF[19] number 2 output.
- C7: Amphenol 7-pin circular socket for DC Power supplies input.

(#1 >> +15V, #3 >> -15V, #4 >> +5V, #2 & #5 >> GND, #6 & #7 >> NC)
The panel with Serial Number 01 has an extra ECC22 socket.

5.3 Front panel indicators

The module has 9 external indicators located in front of the module. Indicators are classified by function as it follows:

- L1 red: Fan failure when flashing.

- L2 red: Laser1 temperature alarm.
- L3 red: Laser2 temperature alarm.
- L4 red: Laser1 diode power alarm.
- L5 red: Laser2 diode power alarm.

- L6 green: +5VCAN on, flashes when a CAN frame is received or transmitted.
- L7 green: +5VDC on.
- L8 green: +12VDC on.
- L9 green: -12VDC on.

5.4 CAN connector pin-out

- C1 & C2: SUBD9 connection to CAN bus

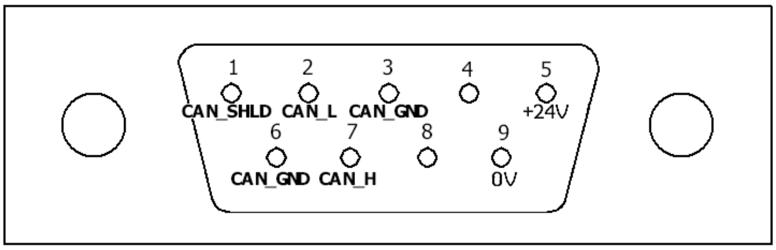

Figure 5: The DB9 male connector is shown view from the pin side

Pin	Signal	I/O	Function
1	CAN_SHLD	-	CAN Shield (Non standard!)
2	**CAN_L**	I/O	CAN_L Bus Line (dominant low)
3	**CAN_GND**	-	CAN Ground, connected to board ground
4	N/C	-	Not connected
5	POWER 24V	-	Power distribution +24V (Non standard!)
6	**CAN_GND**	-	CAN Ground, connected to board ground
7	**CAN_H**	I/O	CAN_L Bus Line (dominant high)
8	N/C	-	Not connected
9	POWER 0V	-	Power distribution return (Non standard!)

Table 1: C1, CAN connector pin out

5.5 Internal RS232 connector pin-out

- J8: HE10 connection to terminal RS232 (Access from inside only)

Pin	Signal	Dir	Function
1	N/C	-	Not Connected
2	N/C	-	Not Connected
3	SERIAL_TxD	O	RS232 Transmit
4	N/C	-	Not Connected
5	SERIAL_RxD	I	RS232 Receive
6	N/C	-	Not Connected
7	N/C	-	Not Connected
8	N/C	-	Not Connected
9	GND	-	Board Ground
10	GND	-	Board Ground

Table 2: J8, RS232 connector pin out

6. Instrument Interfaces

6.1 CAN bus I/O Signals

The DB9 socket C1 & C2 connect the module to the external CAN bus[3] network. CAN_L & CAN_H feed a CAN transceiver (PCA82C251) located on the MCU daughter board. The CAN controller is embedded inside the MCU C164.

6.2 RS232 Serial Port

The RS232 port is connected to a MAX232[14], transceiver and levels translator, before feeding the asynchronous serial channel #0 of the MCU. This port is used to download the user software into the FLASH memory. The HE10 socket J8, described in paragraph 0 table 2[7], is dedicated to maintenance and software upgrade. The 3M 10-pin connector J8 is only available when the rack is open.

6.3 Two IF[14] front inputs

The Intermediate Frequency that carries the signal output from the receiver is connected in front of the rack by a SMA connector. The input is AC coupled with a level of -25dBm.

6.4 Two optical IF[14] rear outputs

The output of each laser diode is connected with a mono mode optical fiber to a DIAMOND E2000 socket located at the rear side of the rack. Their output level is around -10dBm.

6.5 Laser devices

Laser device 1 is connected by J3. Laser device 2 is connected by J4. Each connector delivers +12VDC, -12VDC, +5VDC and return the optical power plus a temperature information to the MCU. Peltier cooling devices currents are measured through serial shunt resistors located on the motherboard.

7. Local Interfaces

7.1 Synchronous Peripheral Interface (SPI)

A high speed Synchronous Serial Controller is embedded into the MCU to handle the SPI protocol. After initialisation, the interface is ready to handle 1Mbit/s serial rates. Four dedicated lines are used:

- SCLK for serial clock,
- SPI data in for master slave receive input,
- SPI data out for master transmit output,
- CS for EEPROM chip select.

We use the master transmit mode, thus the transmit clock (SCLK) is automatically generated while data is transmitted. Transfers are performed MSB[14] first.

A serial operation start with an instruction cycle, an 8-bit transfer which specify SEND or RECEIVE and the address of the register being accessed. Then a data byte transfer cycle follows.

- SEND mode: Data is loaded in the transmit register and the serial clock is activated.
- RECEIVE mode: Serial clock is activated and data is loaded in the receive register.

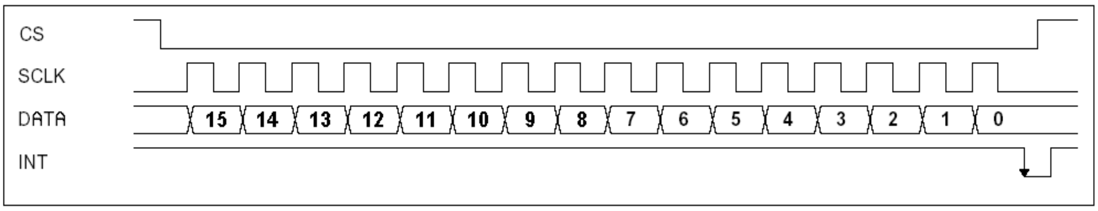

Figure 6: SPI data transfers

7.2 One Wire interface

Each motherboard has a unique serial ID number generated by a Dallas Semiconductor DS18S20[11] device, which offers a temperature sensor in addition. The serial ID number is delivered in 48-bit format (6 bytes) and temperature in 9 bits format (2 bytes). For maintenance purpose, module temperature and ID number can be requested with CAN commands.

7.3 Analog Voltages Monitoring

The MCU includes an on-chip 8-channel Analog to Digital Converter with 10-bit resolution. For maintenance purpose, voltages reading can be requested through CAN commands.

ADC[13] Channel	Signal	Dir	Function
0	Laser1 diode Power	I	Read power output of Laser1 in V
1	Laser1 Temp	I	Read temperature of Laser1 in V
2	I Peltier1	I	Read Peltier current of Laser1 in A
3	Laser2 diode Power	I	Read power output of Laser2 in V
4	Laser2 Temp	I	Read temperature of Laser2 in V
5	I Peltier2	I	Read Peltier current of Laser2 in A
6	+/-12V diff	I	Read +12V –12V difference
7	+5VCAN	I	Read +5.0V digital voltage

Table 3: ADC[14] channels assignment

8. Implementation Details

8.1 Micro Controller Unit (MCU)

The MCU is a DIPmodul-164[4] from SYSTEC used as a daughter board. It carries a C164 Micro Controller Unit running at 20MHz with a 10MHz quartz, 128 KB of FLASH memory, 32 KB of SRAM, 2 KB of serial EEPROM, a RTC[14], 8 dipswitches and a CAN transceiver. A single +5V / 80mA power supply is required. According to SYSTEC company, its MTBF is 1,307,950 hours or 149 years.

8.1.1 C164 Micro-Controller Unit (MCU)

The micro-controller is a C164[6], a 16-bit processor from INFINEON. It is a derivative of the C167[8] family in an 80-pin TQFP package. It combines high CPU performance (up to 10 MIPS) with high peripheral functionality: full CAN interface, 8-input 10-bit ADC[14], Asynchronous serial port, High Speed synchronous serial port, timers, RTC[14], 14 digital I/Os available to user and high speed DMA[14] under interruption. A bootstrap loader is available to download user software into Flash memory. For more information, refer to the datasheet listed at the end the document.

8.1.2 CAN Controller

The micro-controller has an on-chip CAN controller (Rev. 2.0B) with 15 message objects. It is capable of 1-Mbaud operations.

8.1.3 Analog to Digital Converter

The micro-controller has an 8-channel Analog to Digital Converter with 10-bit resolution. A conversion can take place in less than 10 microseconds.
Any unused channel can be used as an extra conventional digital input.

8.1.4 Digital I/O

The micro-controller has up to 59 general purpose I/Os among which 14 are available outside of the daughter board. This is enough for our application.

8.1.5 Asynchronous Serial Controller

The micro-controller has a single serial channel dedicated to the RS232 interface. This link is used to download user software.

8.1.6 Synchronous Serial Controller

The micro-controller has a high-speed synchronous serial channel capable of 5-Mbaud operations. It can be used for: I2C, SPI or any serial transmission. In this module, it is dedicated to communicate with an EEPROM and is not available on external pins.

8.1.7 One Wire controller

One-Wire interfacing has easily been developed in C for this micro-controller. The link uses one pin and is dedicated to DALLAS integrated circuits.

8.2 Voltage regulators

Two voltage regulators[13][14] in TO220 package with heat sink are used to provide +12VDC and –12VDC. They feed the two laser devices and the interface amplifiers. A third IC is a step-down regulator[15] that delivers +5V digital for the MCU.

- +12VDC / 400mA for the Lasers + interface amplifiers
- -12VDC / 300mA for the Lasers + interface amplifiers
- +5VDC / 2.4A for the Peltier devices
- +5.0VCAN / 80mA for the MCU

8.3 Instrument amplifiers

U5 & U7[16] amplify the laser diode emitting power and temperature signals before being read by the ADC. Peltier devices currents are measured through serial shunt resistors located on the PCB**[14]** and amplified by U4 & U6[17] before being read by the ADC. Analog and digital grounds are connected together at the laser devices level.

8.4 Optical transmitters

Optical devices are from MITEQ and their reference is SCMT-4G8G-28-20-M14. They are made of a laser diode with bias loop and a Peltier cooler with a temperature control loop. Each device is mounted on a heat sink with a fan. The input is an SMA socket and the output is an optical fiber with a Diamond E2000 fiber optic socket.
For more information, refer to the datasheet listed at the end the document[18].

9. Built-in Firmware

9.1 Bootstrap loader

A bootstrap loader is available to download user software. By simultaneously pressing RESET and BOOT then release first RESET, and 3 seconds later release BOOT. Now the MCU is ready to accept user software from the RS232 line. Next run Flashtools16W on any PC to download the software into the FLASH memory. At the end of the download process, pressing RESET will initialise the firmware.

9.2 Power up or Reset sequence

When the rack is either powered up or reset, all four green LEDs should be on, all five red LEDs flicker for 2 seconds then turn off upon successful completion of the initialisation test. The Real Time Clock starts counting from zero and now the module is ready to receive CAN frames. After a warming up time, all red LEDs should stay off. If a green LED is off or a red LED stays on for an abnormally long period of time, refer to the troubleshooting section[11].

10. Device-Specific Software / CAN Functions Interface

10.1 Monitoring program

In normal operation, every day is recorded a set of data into the EEPROM. The record is made of 8 bytes which contents laser power voltages, laser temperature voltages and Peltier cooler currents. The EEPROM can hold 255 data records; the first record always holds data pointers. When the EEPROM is full, the oldest daily data is averaged and compacted by group of 30 days. The result is written in the 30th record position to free 29 records before it. In the same time, compacted data is regularly pushed in front of the oldest daily data and so on. This method allows recording for more than 20 years.

10.2 CAN Overview

The FO_TX module is controlled and monitored by the PdB^2 CAN network, revision 2.0B (extended format), operating at 1Mbauds. The module is a slave CAN node operating at the address 0x0820 0000 (hex). Its CAN relative address space spans from 0x0 0000 to 0x3 FFFF (hex). The 8 switches located on the MCU daughter board define the module global address. Each switch being a power of 2, the result ranging from 0 up to 255 is multiplied by 0x4 0000 (hex) to generate the module global address. When a broadcast message 0 is received, the module transmits its address. CAN payload bytes are listed from 1 up to 8.

Address range	0x0820 0000	0x0823 FFFF (hex)
Relative address	0x0000 0000	0x0003 FFFF (hex)
Module global address	0x0820 0000	0x0823 FFFF (hex)

Note: L6 indicator flashes when a CAN frame is received or transmitted.

10.3 Summary of the CAN Monitor points

Name	***Relative CAN Address (hex)***	***Data Size (Bytes)***	***Target***	***Timing Event Related?***
MODULE_ID	*0x0 00 00*	*8*	*Maintenance*	*No*
SERIAL_&_TEMP	*0x0 00 01*	*8*	*Maintenance*	*No*
POWER_SUPPLY_DATA	*0x0 00 02*	*8*	*Maintenance*	*No*
LASER_DATA	*0x0 00 03*	*8*	*Maintenance*	*No*
FAN_SPEED	*0x0 00 04*	*4*	*Maintenance*	*No*
ELAPSED_TIME	*0x0 00 05*	*5*	*Maintenance*	*No*
MODULE_STATUS	*0x0 00 06*	*4*	*Maintenance*	*No*
DOWNLOAD _LASER_1	*0x0 00 10*	*5*	*Maintenance*	*No*
DOWNLOAD _LASER_2	*0x0 00 11*	*5*	*Maintenance*	*No*

Table 4: Summary of Monitor Points

10.4 Summary of the CAN Control points

Name	*Relative CAN Address (hex)*	*Data Size (Bytes)*	*Target*	*Timing Event Related?*
INIT_IO	*0x0 01 F0*	*1*	*Operation*	*No*
CPU_RESET	*0x0 01 FF*	*1*	*Operation*	*No*

Table 5: Summary of Control Points

10.5 CAN payload contents

10.5.1 Monitor points in detail

a) MODULE_ID

Relative CAN Address	*0x0 00 00*
Description	*This monitor point returns the module ID and waste.*
Target	*Maintenance*
TE Related	*No*
Data	*8 bytes:* *Byte 1: Integrated circuit family code* *Byte 2, 3, 4, 5, 6 & 7: 48 bits serial number* *Byte 8: CRC*

b) SERIAL_&_TEMP

Relative CAN Address	*0x0 00 01*
Description	*This command returns the module serial number followed by its internal temperature. The answer is sent within 2 seconds.*
Target	*Maintenance*
TE Related	*No*
Data	*8 bytes:* *Byte 1, 2, 3, 4, 5 & 6: 48 bits Serial number* *Byte 7 & 8: Module temperature*
Conversion factor	*Temperature = First Byte + Second Byte/100*
Operating Range	*15°C <->/ 55°C recommended range*

c) POWER_SUPPLY_DATA

Relative CAN Address	*0x0 00 02*
Description	*This monitor point indicates the measured voltages of the Power Supplies and both Peltier devices currents.*
Target	*Maintenance*
TE Related	*No*
Data	*8 bytes:* *Byte 1 & 2: Peltier1 current (0.00 <-> 2.00 A)* *Byte 3 & 4: Peltier2 current (0.00 <-> 2.00 A)* *Byte 5 & 6: +/-12V Difference (0 <-> 100%)* *Byte 7 & 8: 5.0VCAN (0.00 <-> 5.50 V)*

Conversion factor	*Voltage = First Byte + Second Byte/100*
Operating Range	*Peltier1 current -> (0.00 <-> 1.20 A)* *Peltier2 current -> (0.00 <-> 1.20 A)* *+/-12V Difference -> (0 <-> 20%)* *5.0V Digital -> (4.75 <-> 5.25 V)*

d) LASER_DATA

Relative CAN Address	*0x0 00 03*
Description	*This monitor point indicates the measured voltages of the Laser output Power and Temperature.*
Target	*Maintenance*
TE Related	*No*
Data	*8 bytes:* *Byte 1 & 2: Laser1 output Power (0.00 <-> 2.50 V)* *Byte 3 & 4: Laser1 Temperature (-1.00 <-> 1.00 V)* *Byte 5 & 6: Laser2 output Power (0.00 <-> 2.50 V)* *Byte 7 & 8: Laser2 Temperature (-1.00 <-> 1.00 V)*
Conversion factor	*Power Voltage = First Byte + Second Byte/100* *Temperature Voltage = First Byte + Second Byte/255*
Operating Range	*Laser1 output Power -> (1.00 <->2.00 V)* *Laser1 Temperature -> (0.00 <-> 0.25 V)* *Laser2 output Power -> (1.00 <-> 2.00 V)* *Laser2 Temperature -> (0.00 <-> 0.25 V)*

e) FAN_SPEED

Relative CAN Address	*0x0 00 04*
Description	*This monitor point indicates the fans speed of the Peltier cooling assembly.*
Target	*Maintenance*
TE Related	*No*
Data	*4 bytes:* *Byte 1 & 2: Laser1 Fan speed (0 <-> 6000 RPM)* *Byte 3 & 4: Laser2 Fan speed (0 <-> 6000 RPM)*
Conversion factor	*Voltage = 256*First Byte + Second Byte*
Operating Range	*Laser1 Fan speed -> (1000 <-> 3500 RPM)* *Laser2 Fan speed -> (1000 <-> 3500 RPM)*

f) ELAPSED_TIME

Relative CAN Address	*0x0 00 05*
Description	*This monitor point indicates the elapsed time since last reset.*
Target	*Maintenance*
TE Related	*No*

Data	*5 bytes:* *Byte 1 & 2: Elapsed days (0 <-> 65535 days)* *Byte 3: Elapsed hours (0 <-> 24 hours)* *Byte 4: Elapsed minutes (0 <-> 60 minutes)* *Byte 5: Elapsed seconds (0 <-> 60 seconds)*
Conversion factor	*Reading = 256*First Byte + Second Byte or single Byte only*
Operating Range	*Elapsed days -> (0 <-> 5000 days)* *Elapsed hours -> (0 <-> 24 hours)* *Elapsed minutes -> (0 <-> 60 minutes)* *Elapsed seconds -> (0 <-> 60 seconds)*

g) MODULE_STATUS

Relative CAN Address	*0x0 00 06*
Description	*This monitor point reports the CAN bus reliability and the firmware revision date.*
Target	*Maintenance*
TE Related	*No*
Data	*4 bytes:* *Byte 1: CAN bus errors (0-255)* *Byte 2, 3, 4: Firmware revision date Day, Month, Year*

h) DOWNLOAD_LASER_1

Relative CAN Address	*0x0 00 10*
Description	*This monitor point downloads the recorded laser1 data stored into the EEPROM. (Period = 2ms)*
Target	*Maintenance*
TE Related	*No*
Data	*First 5 bytes: (sent once)* *Byte 1: 0* *Byte 2: Read pointer (0 <-> 255)* *Byte 3: Write pointer (0 <-> 255)* *Byte 4: Compact number (0 <-> 255)* *Byte 5: Step of compact data (0 <-> 255)*
Data	*Next 5 bytes: (sent from record Number 1 up to N)* *Byte 1: Record Number* *Byte 2& 3: Laser1 output Power (0.00 <-> 2.50 V)* *Byte 4: Laser1 Temperature (-1.00 <-> 1.00 V)* *Byte 5: Peltier1 current (0.00 <-> 2.00 A)*
Conversion factor	*Byte 2 & 3: Voltage = (256*First Byte + Second)/410* *Byte 4: Voltage = 1.3 – Byte/102* *Byte 5: Current = Byte/178*
Operating Range	*Laser1 record Number (0 <-> 255)* *Laser1 output Power -> (1.00 <-> 2.00 V)* *Laser1 Temperature -> (0.00 <-> 0.25 V)* *Peltier1 current -> (0.00 <-> 1.20 A)*

i) DOWNLOAD_LASER_2

Relative CAN Address	*0x0 00 11*
Description	*This monitor point downloads the recorded laser2 data stored into the EEPROM. (Period = 2ms)*
Target	*Maintenance*
TE Related	*No*
Data	*First 5 bytes: (sent once)* *Byte 1: 0* *Byte 2: Read pointer (0 <-> 255)* *Byte 3: Write pointer (0 <-> 255)* *Byte 4: Compact number (0 <-> 255)* *Byte 5: Step of compact data (0 <-> 255)*
Data	*Next 5 bytes: (sent from record Number 1 up to N)* *Byte 1: Record Number* *Byte 2& 3: Laser2 output Power (0.00 <-> 2.50 V)* *Byte 4: Laser2 Temperature (-1.00 <-> 1.00 V)* *Byte 5: Peltier2 current (0.00 <-> 2.00 A)*
Conversion factor	*Byte 2 & 3: Voltage = (256*First Byte + Second)/410* *Byte 4: Voltage = 1.3 – Byte/102* *Byte 5: Current = Byte/178*
Operating Range	*Laser2 record Number (0 <-> 255)* *Laser2 output Power -> (1.00 <-> 2.00 V)* *Laser2 Temperature -> (0.00 <-> 0.25 V)* *Peltier2 current -> (0.00 <-> 1.20 A)*

10.5.2 Control points in detail

a) INIT_IO

Relative CAN Address	*0x0 01 F0*
Description	*This command initialises the I/Os with their default values.*
Target	*Operation*
TE Related	*No*
Data	*1 byte:* *Byte 1: Don't care*

b) CPU_RESET

Relative CAN Address	*0x0 01 FF*
Description	*This command initialises the MCU.*
Target	*Operation*
TE Related	*No*
Data	*1 byte:* *Byte 1: Don't care*

11. Troubleshooting

The FIBER OPTIC TRANSMITTER front panel shows 9 diagnostic indicators. From left to right, they are:

5 LEDs illuminate red when an alarm condition occurs.

- L1 (red): Fan alarm flashes when at least one fan rotates too slowly.

When this LED flashes, clean the fans or replace both if necessary.

- L2 (red): **Laser1 temperature** illuminates when the Laser1 temperature is off range.
- L3 (red): **Laser2 temperature** illuminates when the Laser2 temperature is off range.

- L4 (red): **Laser1 power** illuminates when the Laser1 diode power is too low.
- L5 (red): **Laser2 power** illuminates when the Laser2 diode power is too low.

When a red LED is on, consider replacing the laser transmitter.

4 power LEDs illuminate green as soon as the rack power adapter is connected.

- L6 (green): **+5VCAN** on, flashes when a CAN frame is received or transmitted
- L7 (green): **+5VDC** on, for the Peltier modules
- L8 (green): **+12VDC** on, for the laser modules and the instrument amplifiers
- L9 (green): **-12VDC** on, for the laser modules and the instrument amplifiers

When a green LED is off, check the fuses located on the main printed circuit board.

A LabVIEW test program named “FO_TX_test.vi” has been developed to help making a diagnostic of the rack. Its self-explanatory front panel display is shown next page.

12. LabVIEW Test Software

The FIBER OPTIC TRANSMITTER rack can be controlled and monitored by the “FO_TX_test.vi”. It can be run with LABVIEW from any PC[19] hosting a CAN interface. The test equipment is self-teaching and a view of its control screen is displayed next.

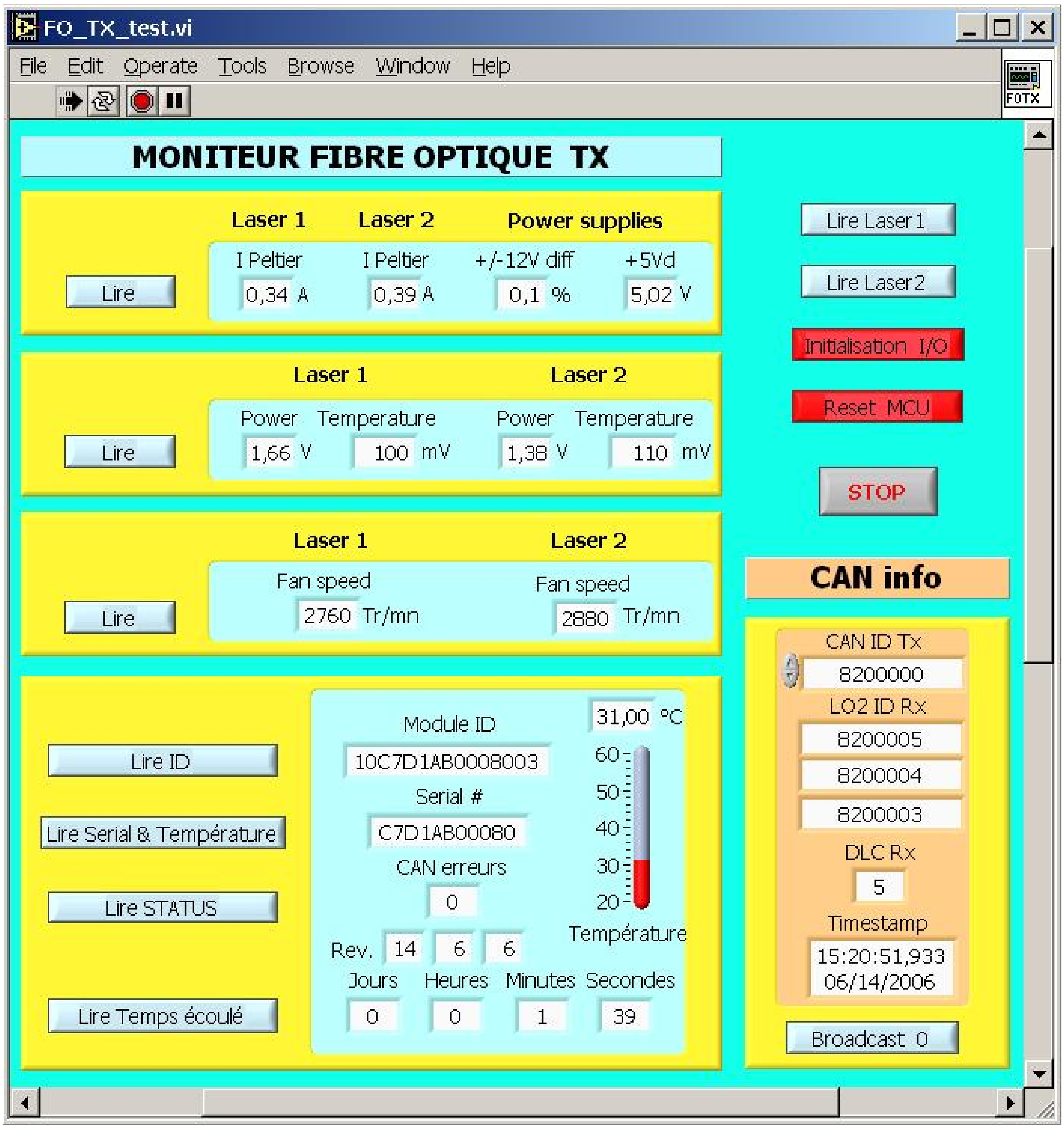

Figure 7: Fiber optic Transmitter test panel

13. References

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15. LM2676S-5, +5V high efficiency step-down regulator, data sheet, october 2003, National Semiconductor.

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14. Abbreviations and Acronyms

ADC	Analog to Digital Converter
C164	Reduced version of the C167 (Infineon – Siemens)
C167	16-bit micro-controller of the C166 family (Infineon – Siemens)
CAN	Controller Area Network, field bus dedicated to control. (Bosch)
CPU	Central Processing Unit
DMA	Direct Memory Access
EEPROM	Electrically Erasable & Programmable Read Only Memory
FLASH	Permanent memory that can be reprogrammed
IF	Intermediate frequency
I/O	Inputs and Outputs
LSB / MSB	Least Significant Bit / Most Significant Bit
MCU	Micro Controller Unit
MTBF	Mean Time Between Failures
One-Wire	Serial bus using one wire with ground return (DALLAS)
PC	Personal Computer
PCB	Printed Circuit Board
RS232	Standard computer interface for serial communication with a terminal
RTC	Real Time Clock
SPI	Synchronous Peripheral Interface (Motorola)

15. Drawing List

CAN Micro-controller

Power supplies & Interface amplifiers