Product Specification

10Gbps/1Gbps 850nm Multimode Embedded Data Link

Endurance™ - FTE8511K1LT*

PRODUCT FEATURES

- **Optical transceiver module for duplex data links up to 550 meters**
- **Selectable data rate to support Gigabit Ethernet or 10 Gigabit Ethernet**
- **Compact form-factor: Half the size of Small-Form Factor transceivers**
- **Board Mounted**
- **Built-in digital diagnostic functions**
- **Duplex LC optical connection**
- **Utilizes Finisar 850nm Oxide VCSEL laser and SmartLDPA integrated circuit**
- **Extended operating temperature range of -40°C to 85°C**
- **Extended storage temperature range of -57°C to 100°C**
- **Metal enclosure, for low EMI**
- **Interoperable with SFP+ SR transceivers**
- **Option for conformal coating for high reliability in harsh environments**

DESCRIPTION

Finisar's Endurance™ transceiver modules are designed to be rugged and robust so they are optimal for industrial and military applications. They have a wide operating temperature range, a metal housing to minimize effects of Electro-Magnetic Interference, two through-hole mounting posts to stabilize in environments with shock and vibration, and the pins are soldered directly to the Printed Circuit Board (PCB) to ensure constant connectivity. Endurance is available with conformal coating for additional reliability in harsh environments. It has been qualified to Telecordia and Military standards.

The FTE8511K1LT* Transceivers are designed for use in 10 Gigabit Ethernet or 1 Gigabit Ethernet links over multimode fiber – the data rate is selected through the I2C communication interface. They are compatible with the applicable portions of SFF-8431 Rev. 4.1[1] and SFF-8472 Rev 11.0[2]. The simple serial interface is independent of protocol and can thus be used in a wide range of applications. Digital diagnostic functions for monitoring and control of the module are provided via a 2-wire serial interface.

PRODUCT SELECTION

Product	Description
FTE8511K1LTN	10Gb/s & 1Gb/s Rate Select, 850nm multi-mode, optical data transceiver, -40C to 85C, no conformal coating
FTE8511K1LTY	10Gb/s & 1Gb/s Rate Select, 850nm multi-mode, optical data transceiver, -40C to 85C, with conformal coating

I. Pin Descriptions

Pin	Symbol	Name/Description	Note
1	V_{EE}	Ground	1
2	TX-	Transmitter Inverted DATA in	3
3	TX+	Transmitter Non-Inverted DATA in	3
4	V_{EE}	Ground	1
5	V_{CC}	Power Supply (+3.3V ± 5%)	
6	TxDIS	Transmitter Disable	4
7	SCL	Two Wire Serial Interface Clock	2
8	SDA	Two Wire Serial Interface Data	2
9	V_{EE}	Ground	1
10	RX+	Receiver Non-inverted DATA out	3
11	RX-	Receiver Inverted DATA out	3
12	V_{EE}	Ground	1

Notes:
1. Circuit ground is internally isolated from chassis ground.
2. Should be pulled up with 4.7k-10kohms on host board to a voltage between 2.0V and 3.6V.
3. Host must be AC Coupled
4. Laser output disabled when TxDIS>2.0V and enabled when TxDIS<0.8V
5. No pins for RX_LOS loss of signal indication, TX FAULT transmitter fault indication, MOD_ABS module absent indication, and RS0 for rate select. These monitoring and control features are accessible through the digital diagnostic interface.

Figure 1. Top view – pin numbering

II. Absolute Maximum Ratings

Parameter	Symbol	Min	Typ	Max	Unit	Note
Maximum Supply Voltage	Vcc	-0.5		3.7	V	
Storage Temperature	T_S	-40		85	°C	
Case Operating Temperature	T_{OP}	-40		85	°C	
Relative Humidity	RH	0		85	%	1
Hand-soldering Temp/time				260°C/10sec		2

Notes:
1. Non-condensing.
2. Hand-soldering and/or hot-bar soldering are recommended for the through-hole posts and the surface-mount pins. Contact Finisar for solder process recommendations. The Endurance module cannot be processed through a solder reflow oven.

III. Electrical Characteristics (V_{CC} = 3.3 ± 5% Volts)

Parameter	Symbol	Min	Typ	Max	Unit	Note
Supply Voltage	Vcc	3.135		3.465	V	
Supply Current Case Temperature -40°C to 25°C Case Temperature 26°C to 85°C	Icc			 300 180	 mA mA	
Transmitter						
Input differential impedance	Rin		100		Ω	1
Differential data input swing	Vin,pp	180		700	mV	2
Receiver						
Differential data output swing	Vout,pp	370		850	mV	3
Data output rise time	t_r	28			ps	4
Data output fall time	t_f	28			ps	4
Power Supply Noise Tolerance	VccT/VccR	Per SFF-8431 Rev4.1			mVpp	5

Notes:
1. DC coupled internally. Self-biasing 100Ω differential input. **Must be AC-coupled on HOST.**
3. Less than 600mV is recommended for best EMI performance.
4. DC coupled internally with 100 ohm differential output impedance. **Must be AC coupled on HOST**.
5. 20-80%. Measured with module compliance test board and OMA test pattern, SFF-8431 Rev4.1.
6. Test methodology per SFF-8431 Rev4.1.

IV. Optical Characteristics – High (10G Operation - Default)

(over temperature, V_{CC} = 3.3 ± 5% Volts)

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Transmitter						
Optical Output Power	P_{OUT}	-5		-1	dBm	1
Optical Modulation Amplitude (OMA)	P_{OMA}		-1.5		dBm	2
Optical Wavelength	λ	840	850	860	nm	2
RMS Spectral Width	$\Delta\lambda_{rms}$			0.45	nm	2
Optical Extinction Ratio	ER	3.0	5.5		dB	
Transmitter and Dispersion Penalty	TDP			3.9	dB	
Average Launch power of OFF transmitter	P_{OFF}			-30	dBm	
Relative Intensity Noise	$RIN_{12}OMA$			-128	dB/Hz	
Receiver						
Receiver Sensitivity (OMA) @ 10.3Gb/s	R_{SENS1}			-11.1	dBm	3
Stressed Receiver Sensitivity (OMA) @ 10.3Gb/s	R_{SENS2}			-7.5	dBm	4
Maximum Input Power	P_{MAX}			+0.5	dBm	
Wavelength Range	λ_C	840		860	nm	
Receiver Reflectance	R_{rx}			-12	dB	
LOS De-Assert	LOS_D			-14	dBm	
LOS Assert	LOS_A	-30	-23		dBm	
LOS Hysteresis		0.5			dB	

Notes:
1. Average Power. Provided as information only, per IEEE802.3-2005.
2. Per Tradeoff Table 52.8, IEEE 802.3ae-2005
3. Measured with worst extinction ratio (ER); Bit Error Rate (BER) $<10^{-12}$; $2^{31} - 1$ PRBS.
4. Per IEEE 802.3ae-2005.

V. Optical Characteristics for Rate Select - Low (1G Operation)

(over temperature, V_{CC} = 3.3 ± 5% Volts)

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Transmitter						
Average Launch Power	P_{AVE}	-9.5		-1	dBm	1
Optical Wavelength	λ	840	850	860	nm	2
Rise-Fall Time	T_{rise}/T_{fall}			0.26	ns	3
RMS Spectral Width	Dl_{rms}			0.45	dB	
Optical Extinction Ratio	ER	9			dB	
Average Launch power of OFF transmitter	P_{OFF}			-30	dBm	
Tx Jitter	Tx_j	Per IEEE 802.3-2005 Table 38-10				
Relative Intensity Noise	$RIN_{12}OMA$			-117	dB/Hz	
Coupled Power Ratio	CPR	9			dB	
Receiver						
Wavelength Range	l_C	840		860	nm	2
Receiver Sensitivity	R_{SENS}	-17			dBm	
Stressed Receiver Sensitivity 50 µm MMF	SRS_{50um}			-13.5	dBm	4
Stressed Receiver Sensitivity 62.5 µm MMF	SRS_{62um}			-12.5	dBm	4
Maximum Input Power	P_{MAX}	+0.5			dBm	
Return Loss	R_{rx}	12			dB	
Receive electrical 3dB upper cutoff frequency			1500		MHz	2
LOS De-Assert	LOS_D			-18	dBm	
LOS Assert	LOS_A	-30	-23		dBm	
LOS Hysteresis		0.5			dB	

Notes:
1. Max is equivalent to 10G max spec.
2. This product has not been designed to support 780-nm laser operation.
3. 20%-80%.
4. Per IEEE 802.3-2005. 9dB extinction ratio transmitter.

VI. General Specifications

Parameter	Symbol	Min	Typ	Max	Units	Ref.
Bit Rate (Rate Select = LOW)	BR		1.25		Gb/s	1,2
Bit Rate (Rate Select = HIGH)	BR	9.95	10.3		Gb/s	1,3

Fiber Type	850nm OFL Bandwidth	Symbol	Max. Supported Distance		Units
			@ 1G	@ 10G	
62.5µm	160 MHz-km	Lmax	220	26	m
	OM1 200 MHz-km		275	33	
50µm	400 MHz-km	Lmax	500	66	m
	OM2 500 MHz-km		550	82	
	OM3 2000 MHz-km		>550	300	

Notes:
1. Transceiver data rate is selected through the 2-wire bus in accordance with SFF-8472 Rev 11.0. Rx Rate Select RS0 is set at Bit 3, Byte 110, Address A2h. Tx Rate Select RS1 is set at Bit 3, Byte 118, Address A2h. Rate select default state on power up is '1' HIGH, and the state is reset following a power cycle.
2. 1000BASE-SX. Tested with a $2^7 - 1$ PRBS. Writing '0' LOW at RS0 and RS1 sets the module to operate at 1.25 Gb/s data rate operation.
3. 10GBASE-SR/SW. Tested with a $2^{31} - 1$ PRBS. Writing '1' HIGH at RS0 and RS1 sets the module to operate at 10.3 Gb/s data rate operation.

VII. Regulatory Compliance

- US FDA regulations, Class 1 Laser Products
- EN (IEC) 60825 Class 1 eye safety requirements, certified by TÜV and CSA
- EN (IEC) 60950 electrical safety requirements, certified by TÜV and CSA
- ROHS-6

Copies of certificates are available from Finisar Corporation upon request.

VIII. Reliability

- Damp heat:
    - 85C/85% relative humidity for 500 hours, Non-Powered
    - 70ºC/85% relative humidity for 1000 Hours, Powered
- Accelerated Aging - High Temperature Operating Life (HTOL): GR-486-CORE, +85°C, nominal voltage, 2000 hours
- High Storage Temperature Testing: MIL-STD-810G, METHOD 501.5 Procedure I, +100°C, Relative Humidity Uncontrolled, 4 hours
- Low Storage Temperature Testing: MIL-STD-810G, METHOD 502.5 Procedure I, -57°C, 4 hours
- Vibration:
    - MIL-STD-810G, Category 13 – Fixed wing propeller aircraft, 3 and 6 blades
    - MIL-STD-883 Method 2007, 3-axis, 20G, Frequency 20 – 2000 Hz, swept sine, 4 cycles/axis, 4 min/cycle
- Mechanical shock: MIL-STD-883 Method 2002, 500G, 1 ms, 5 times/axis, 6 faces
- Thermal shock: MIL-STD-883 Method 1011, 100 cycles, -40°C to +85°C
- Temperature Cycling: MIL-STD-833 Method 1010, 500 cycles, -40°C to +85°C
- Cyclic Moisture: MIL-STD-883 Method 1004.7, 10 cycles
- Humidity B1 (Biased): MIL-STD-810G Method 507.5, 25°C/95% relative humidity for 1100 hours
- Humidity B1 (Non biased): MIL-STD-810G Method 507.5, 25°C/95% relative humidity for 2200 hours
- ESD: EIA/JESD22-A114-C, human body model, 2 KV High Speed
- Salt Spray*: MIL-STD-810G, Test method 509.5

*Conformal-coated version only

IX. Digital Diagnostic Functions

Finisar's Endurance embedded data link transceivers support the 2-wire serial communication protocol as defined in the SFP MSA. It is very closely related to the E^2PROM defined in the GBIC standard, with the same electrical specifications.

The standard transceiver serial ID provides access to identification information that describes the transceiver's capabilities, standard interfaces, manufacturer, and other information.

Additionally, Finisar transceivers provide a unique enhanced digital diagnostic monitoring interface, which allows real-time access to device operating parameters such as transceiver temperature, laser bias current, transmitted optical power, received optical power and transceiver supply voltage. It also defines a sophisticated system of alarm and warning flags, which alerts end-users when particular operating parameters are outside of a factory set normal range.

The SFP MSA defines a 256-byte memory map in E^2PROM that is accessible over a 2-wire serial interface at the 8 bit address 1010000X (A0h). The digital diagnostic monitoring interface makes use of the 8 bit address 1010001X (A2h), so the originally defined serial ID memory map remains unchanged. The interface is identical to, and is thus fully backward compatible with both the GBIC Specification and the SFP Multi Source Agreement. The complete interface is described in Finisar Application Note AN-2030: "Digital Diagnostics Monitoring Interface for SFP Optical Transceivers".

The operating and diagnostics information is monitored and reported by a Digital Diagnostics Transceiver Controller (DDTC) inside the transceiver, which is accessed through a 2-wire serial interface. When the serial protocol is activated, the serial clock signal (SCL) is generated by the host. The positive edge clocks data into the transceiver into those segments of the E^2PROM that are not write-protected. The negative edge clocks data from the transceiver. The serial data signal (SDA) is bi-directional for serial data transfer. The host uses SDA in conjunction with SCL to mark the start and end of serial protocol activation. The memories are organized as a series of 8-bit data words that can be addressed individually or sequentially.

For more information, please see the SFP MSA documentation or Finisar Application Note AN-2030.

X. Digital Diagnostic Specifications

Finisar's Endurance embedded data link transceivers can be used in host systems that require either internally or externally calibrated digital diagnostics.

Parameter	Symbol	Min	Typ	Max	Units	Ref.
Accuracy						
Internally measured transceiver temperature	$DD_{Temperature}$			±5	ºC	
Internally measured transceiver supply voltage	$DD_{Voltage}$			±100	mV	
Measured TX bias current	DD_{Bias}			±10	%	1
Measured TX output power	$DD_{Tx\text{-}Power}$			±3	dB	
Measured RX received average optical power	$DD_{Rx\text{-}Power}$			±3	dB	
Dynamic Range for Rated Accuracy						
Internally measured transceiver temperature	$DD_{Temperature}$	-40		85	ºC	
Internally measured transceiver supply voltage	$DD_{Voltage}$	3.1		3.5	V	
Measured TX bias current	DD_{Bias}	0		20	mA	
Measured TX output power	$DD_{Tx\text{-}Power}$	-9		0	dBm	
Measured RX received average optical power	$DD_{Rx\text{-}Power}$	-20		0	dBm	
Max Reporting Range						
Internally measured transceiver temperature	$DD_{Temperature}$	-40		125	ºC	
Internally measured transceiver supply voltage	$DD_{Voltage}$	2.8		4.0	V	
Measured TX bias current	DD_{Bias}	0		20	mA	
Measured TX output power	$DD_{Tx\text{-}Power}$	-10		0	dBm	
Measured RX received average optical power	$DD_{Rx\text{-}Power}$	-22		0	dBm	

Notes:
1. Accuracy of Measured Tx Bias Current is 10% of the actual Bias Current from the laser driver to the laser.

XI. Mechanical Dimensions

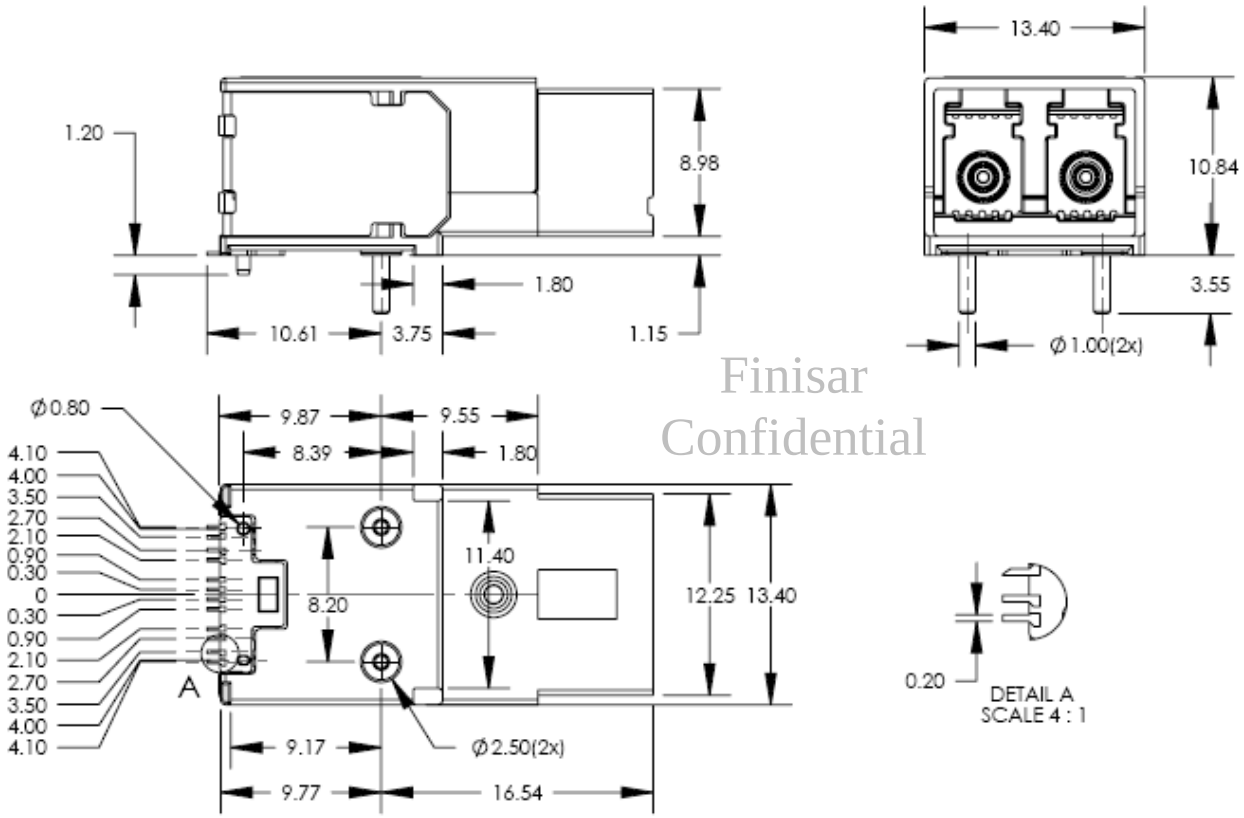

Figure 2. Side, End and Bottom views.

XII. Host Board Layout and Bezel Recommendations

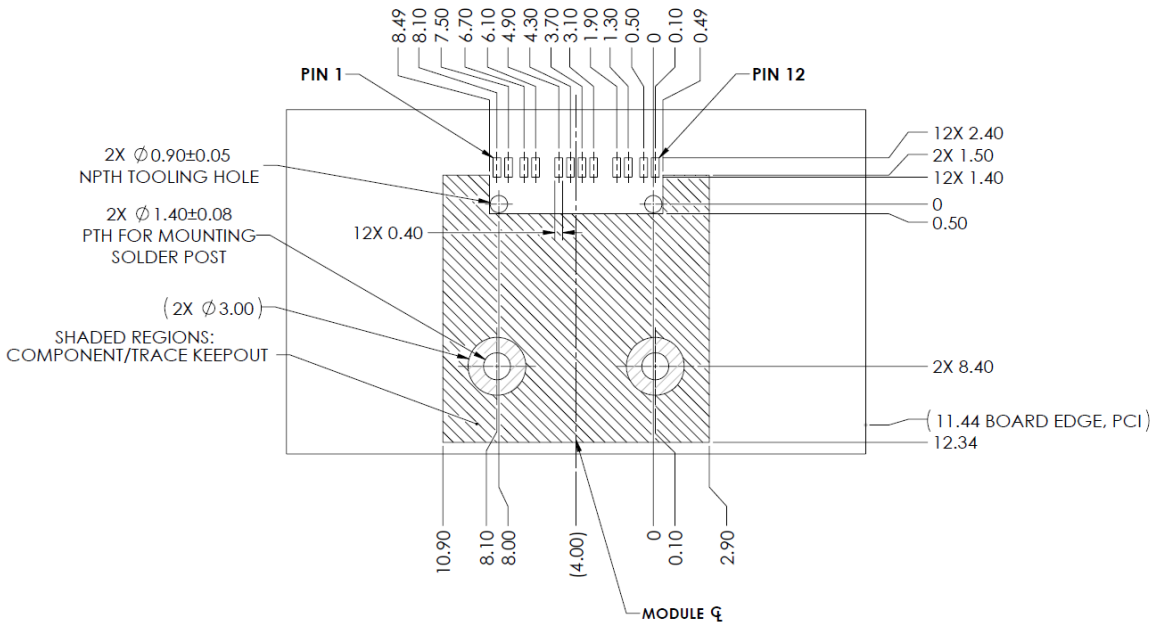

Figure 3. Bezel and Board Position Dimensions

XIII. Application diagram showing power supply filter recommendation.

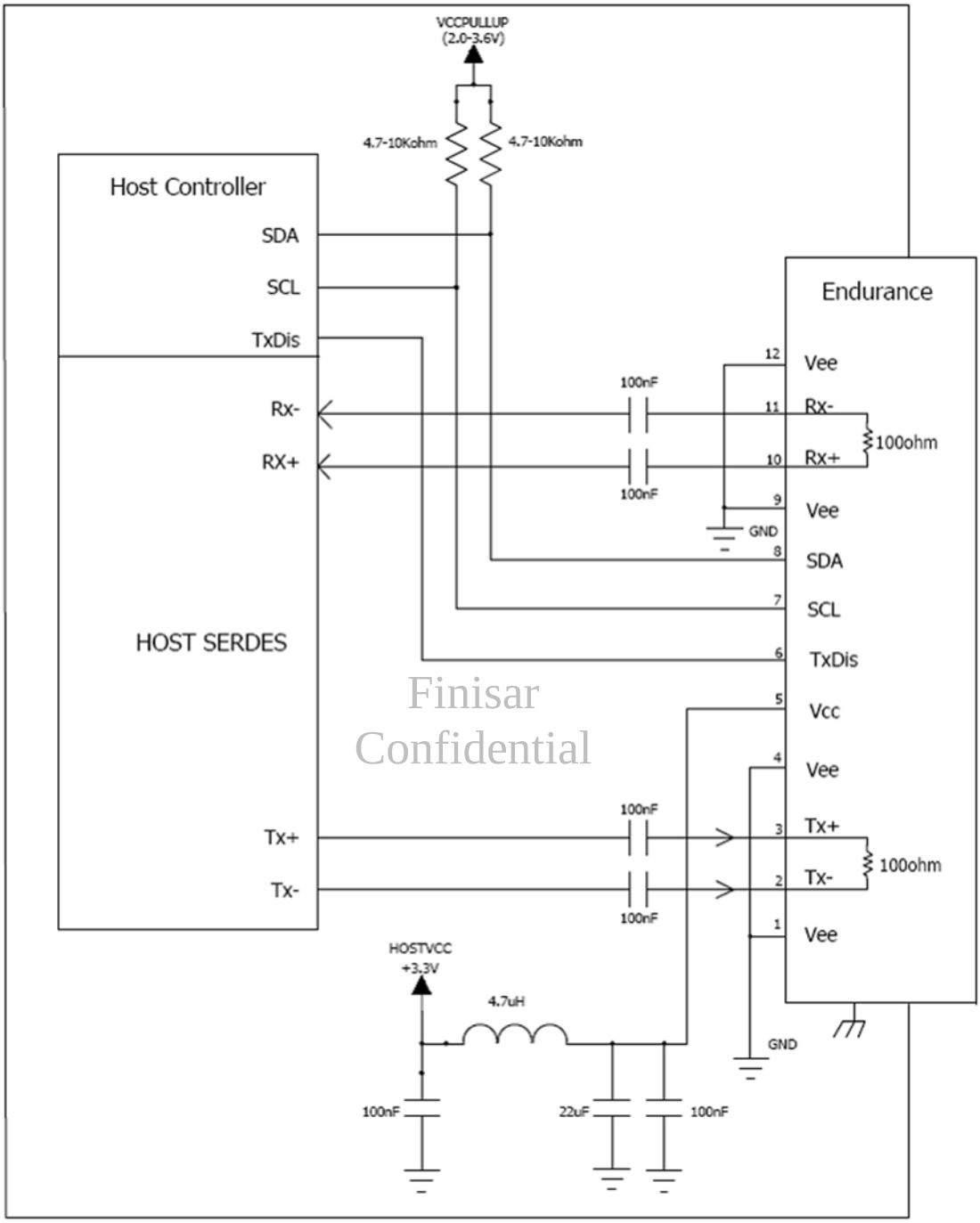

Figure 5. Recommended host board configuration showing power supply filtering, AC coupling caps, and status pull-up resistors.

XIV. References

1. "Specifications for Enhanced Small Form Factor Pluggable Module SFP+", SFF Document Number SFF-8431, Revision 4.1.

2. SFF-8472 rev 11.0 – Specifications, SFF Committee, September 14 2010.

3. Directive 2002/95/EC of the European Council Parliament and of the Council, "on the restriction of the use of certain hazardous substances in electrical and electronic equipment." January 27, 2003.

4. "Application Note AN-2038: Finisar Implementation Of RoHS Compliant Transceivers", Finisar Corporation, January 21, 2005

XV. For More Information

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