SFP+ Module Reference Design

SFP_022AL_R0

General Description

This evaluation board is a complete SFP+ module as defined in the SFP+ MSA document. The design uses Micrel's MIC3003 controller, the 10G DFB/FP laser driver SY88022AL, and any of the following 10G limiting amplifiers: SY88053C/073L. A picture of the fully loaded board is shown on the next page.

Datasheets and support documentation are available on Micrel's web site at: www.micrel.com.

Related Support Documentation

- MIC3003 datasheet: Fibre optic module controller featuring digital diagnostic monitoring interface, as per SFF-8472/SFF-8432, with internal/external calibration and full laser control with bias and modulation current compensation for temperature variations using lookup tables.
- SY88022AL datasheet
- SY88053CL datasheet
- SY88073L
- MIC3003 software user's guide.

Features

- Compliant with SFP+ MSA
- Allows for easy and fast evaluation of Micrel's chipset for SFP+ module
- Multi-rate operation up to 10Gbps
- Single, wide range power supply: 3.3V ±10%
- Industrial temperature range: –40°C to +85°C

Transmitter – FP/DFP Laser Diode Driver

- Operates from a single 3.3V supply
- Modulation current up to 60mA
- Fast edge rates of 25ps
- Bias current up to 80mA
- Input equalizer
- Small form factor 3mm × 3mm QFN package

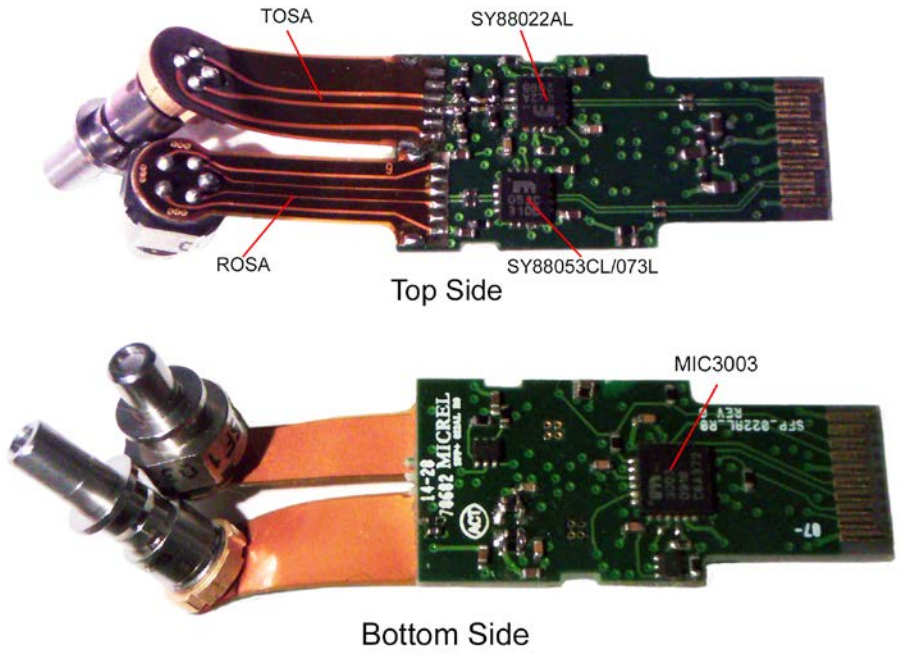
Receiver – Limiting Post Amplifier

- External crosspoint adjustment (053CL/073L)
- Digital offset correction (063CL/083L)
- Wide differential input range ($5mV_{PP}$ to $1800mV_{PP}$)
- Wide SD de-assert or LOS assert threshold range
  - $3mV_{PP}$ to $30mV_{PP}$ with 4dB typical electrical hysteresis
- Fast SD/LOS assert/de-assert time (053CL/063CL)
  - 75ns typical; 120ns maximum
- Selectable LOS or SD status signal indicator
- Selectable RXOUT+/RXOUT- polarity (053CL/073L)
- Available in a tiny 3mm × 3mm QFN package

Controller

- Extensive temperature range
- Alarms and warnings interrupt and TXFAULT masks
- Capability to support up to four chips on the serial interface
- Integrated digital temperature sensor
- Temperature compensation of modulation, bias, and fault levels via NVRAM lookup tables
- User-writeable EEPROM scratchpad
- Option to be used with Cisco security chip
- Diagnostic monitoring interface per SFF-8472/8432
- Space saving 3mm × 3mm package available (MIC3003GFL)

Evaluation Board



Evaluation Board Setup

TOSA and ROSA Installation

Check the pin configuration of the TOSA and ROSA and install them according to the diagram shown in Figure 1.

Driver Laser Coupling

The laser is AC-coupled to the driver. Compensation for laser parasitics can be improved by choosing appropriate values for R9 and C1. The laser's response can be improved by tuning, in addition to R9/C1, R1/R5 and L1/L2/L5/L6/R6/R7. The optimal values of these components depend on the length of the laser leads/flex and can vary from one family of lasers to another. It is up to the user to tune the values in order to achieve the best compensation for the laser used with this board.

Receiver Sensitivity and Hysteresis Setting

The limiting amplifier has a receive signal LOS/SD indicator. The LOS/SD sensitivity is set by the voltage at SD/LOSLVL (pin 8) adjusted by the value of R28, which forms a voltage divider with the 2.8kΩ internal resistor terminated to VCC-1.3V.

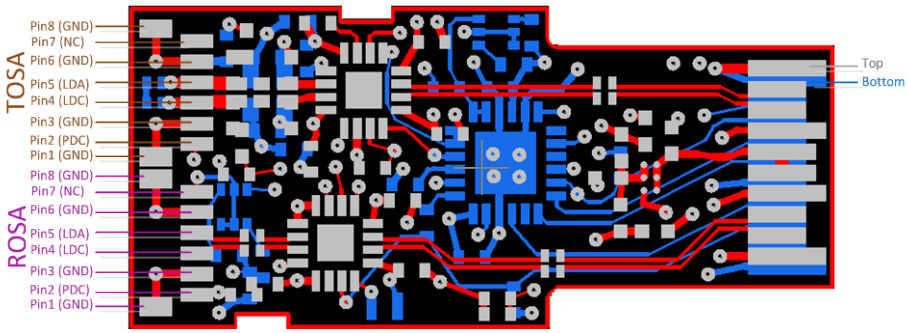


Figure 1. Mounting of TOSA and ROSA

Setup and Operation

1. Set the desired frequency on a pattern generator with amplitude between 200mV$_{PP}$ and 1800mV$_{PP}$. Typical data patterns are 2^7-1 or 2^{23}-1 PRBS patterns, depending on the application. Because the inputs to the board are AC-coupled, the voltage offset of the pattern generator is not significant, so it can be set between GND and VCC.
2. Connect the pattern generator with differential outputs as a data source to the TXIN+ and TXIN- inputs on the host board. Use matched length differential cables.
3. Connect the USB plug-in of the host board to the USB port of the computer.
4. Connect the 3.3V red post on the host board to the output of the 3.3V power supply and the black post to the GND and install a jumper between pin 2 and pin 3 of SW1.
5. Plug the SFP module into the host board connector and connect the laser to the optical plug-in of the scope.

6. Turn on the power supply.
7. Launch the MIC3003 software, select the serial address of the device to be scanned (A0 is the default address), and then click initialization. The main window will open.
8. Memory content can be read and/or modified on the panels or by accessing the registers directly by selecting **ALL REGISTERS**, enter the serial address and register address, then select **GET** to read the content or enter a new value, and select **SET NEW** to write. In this procedure, the bits are set on the panels.
9. Refer to the MIC3003 Software User's Guide for the detailed settings and illustrations.
10. On the **Panels** list, select **OEM CONFIG 3-4** and select **EXTERNAL CALIBRATION** (default setting), **LOS COMPARATOR ENABLE**, **SHDN**, **RXLUT INPUT TEMPERATURE**, and **RSOUT**. If needed, later set **ISTART** to a different value to speed up the APC loop during laser turn ON after a FAULT occurrence. Close this window to return to the main window.
11. On the **Calibration** list, select **EXTERNAL CALIBRATION**. Set all the **OFFSETS** to 0 and **SLOPES** to 1. For **RXPWR**, set only **RX_PWR(1)** to 1. These parameters might need to be changed later to correct the measured values (calibration). Close this window to return to the main window.
12. On the **Panels** list, select **OEM CONFIG 0-2** to open the OEM configuration windows for registers 0, 1, and 2. Check the default setting of each and reset the parameters to the correct values (below) if needed.
    a. In the OEM Configuration Register 0 window, set ENABLE/DISABLE to DISABLE, and set VMOD REFERENCE to GND.
    b. In the OEM Configuration Register 1 window, set APC OP-AMP TYPE to EMITTER FOLLOWER, select the voltage to report VINH:VINL, and set the feedback voltage source to 1.22V. Also set **FEEDBACK BIAS REF** and **RES TERMINATION** to **GND** and set **VBIAS DRIVE** to **SOURCE** (NPN). Set **INTERNAL FEEDBACK RESISTOR** to INF.
    c. In the OEM Configuration Register 2 window, the MIC3003 address can be modified.
13. In the OEM Configuration Register 0 window, set **ENABLE/DISABLE** to **ENABLE**.
14. On the **Panels** list, select **User**. Check **APCSET0** and **MODSET0** in the **USER CONTROL REGISTER** (default setting). All the other parameters' functionality can be checked later. Return to the main window.
15. On the Panels list, select OEM Settings and enter the following values:
    a. Enter 255 for the IBIAS FAULT and TX PWR FAULT thresholds.
    b. Enter 0 for LOSS-OF-SIGNAL threshold and 0 for FAULT SUPPRESSION TIMER.
    c. Enter desired DAC values for bias and modulation between 0 and 255.

d. After entering these values, select **SET NEW**. Select **GET CURRENT** to ensure the set values are written to the registers. You may come back to this panel to mask the faults by checking them at the bottom of the window. Now return to the main window.

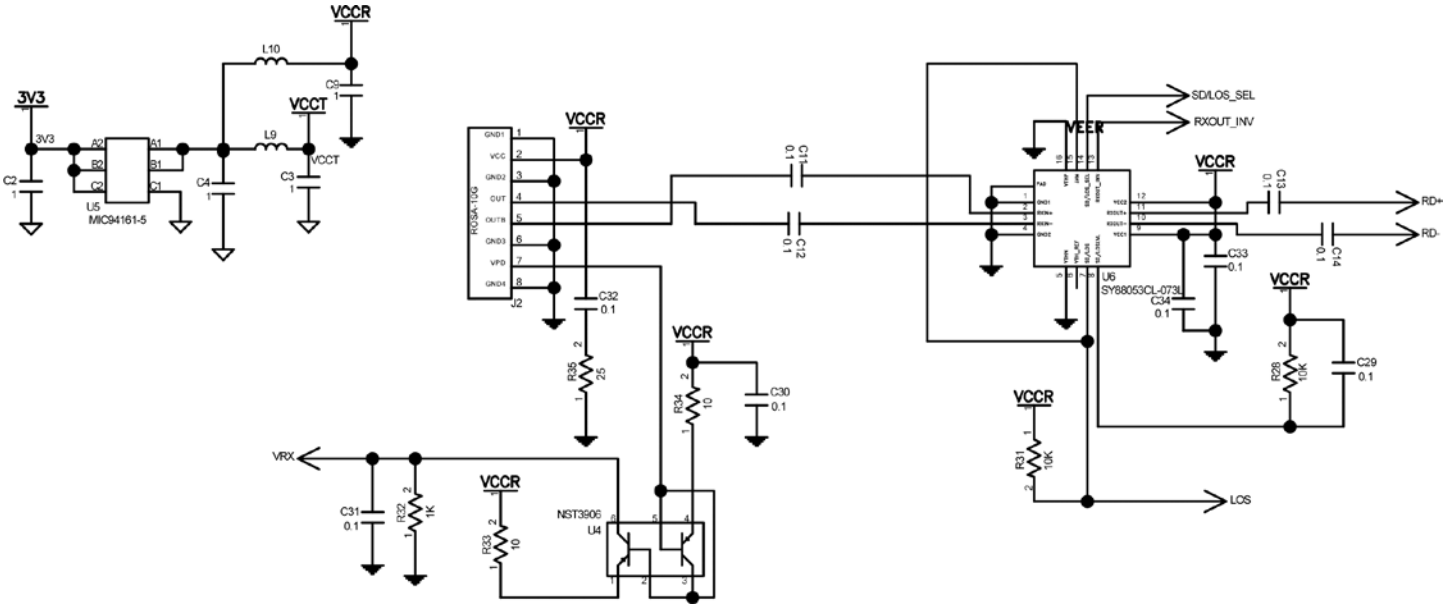
16. On the **Panels** list, select **Result**. The values of the five monitored parameters as per the SFF-8472 should now display. Set the **alarm** and **warning** thresholds (optional) and select **SET NEW LIMITS**. Select **GET CURRENT LIMITS** to check that the set values are written into the registers. Return to the main window.
17. After setting the new value for bias or modulation current, toggle TXDISABLE/TXENABLE in the main window or WARMRESET in the OEMCFG0-2 window.
18. Connect the laser to a variable optical attenuator (VOA) and adjust the attenuation to bring the optical power to the desired level at the input of the receiver. Then connect the output of the VOA to the input of the receiver using an appropriate fiber jumper.
19. If the installed receiver has RSSI signal, the value of the received power should display, but may need calibration.
20. At this stage, the masked faults should be unmasked. If there is a fault indication, mask the indicated fault in the OEMCONFG register (step 9) and try to find the cause of the fault by checking the monitored values and taking appropriate measurements.
21. Once the module runs without fault indication, proceed to BER measurement, eye diagram analysis, and laser driver and post amplifier performance evaluation.

Laser Response Tuning

Overshoot/Undershoot

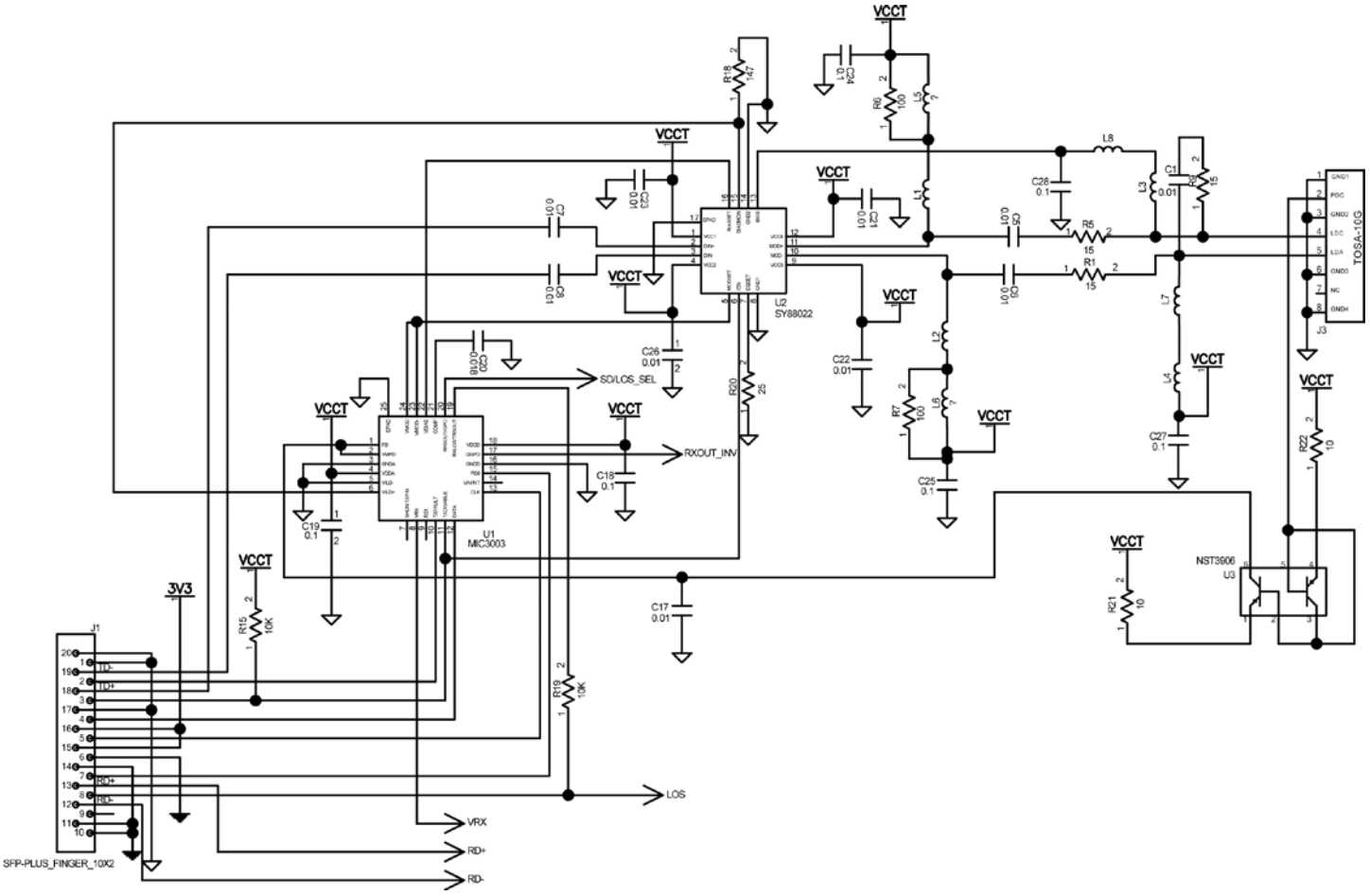
The damping resistors R1 and R5 installed in series with the laser are 5Ω. This value might be replaced with higher values to minimize or suppress any overshoot or undershoot on the optical signal out of the laser. Keep in mind that higher value damping resistors will lead to higher rise/fall time and less modulation current driving the laser.The compensation network comprised of R6/C15 can also be used for that purpose and to compensate for the laser package's parasitic inductance. The values indicated on the schematic and pre-installed on the board accordingly to the BOM may be replaced with different values to optimize the laser response. Other components that can be adjusted to improve the laser response are the elements of the output termination network (L2, L3, R2, R3, R4, R13).

Evaluation Board Schematic



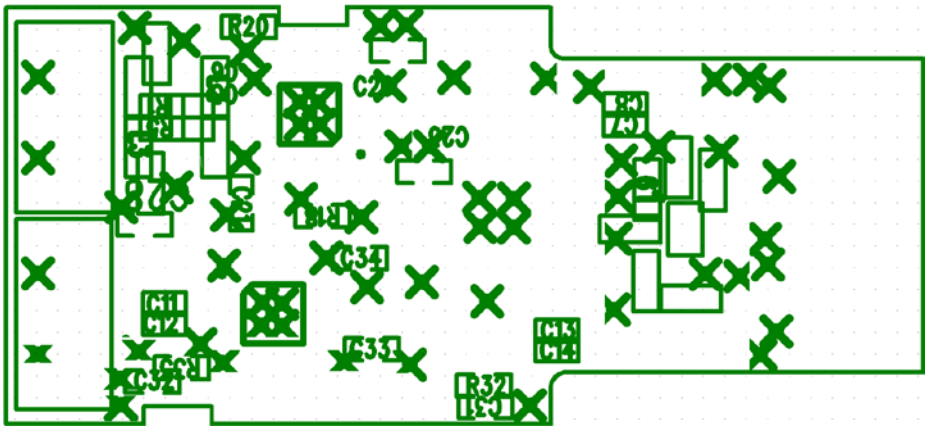
Power and Receiver

Evaluation Board Schematic (Continued)

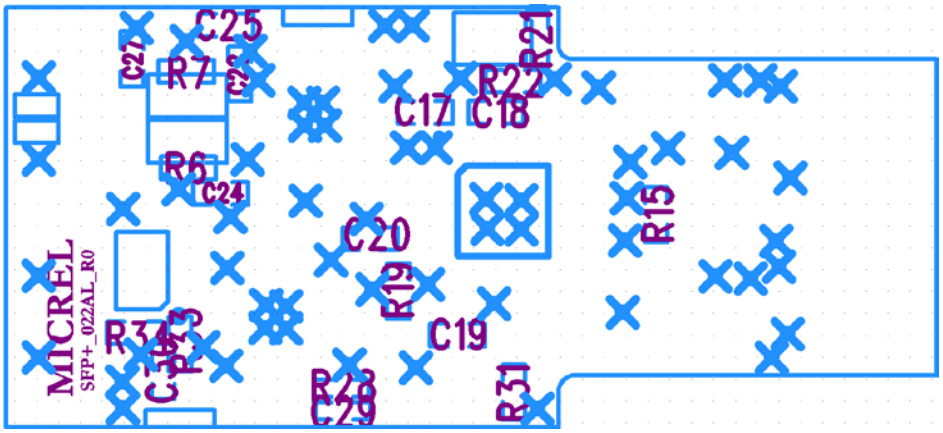


Transmitter

PCB Assembly



Top



Bottom

Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1	ECJZEC1E010C	Panasonic[1]	CAP CER 1PF 0201	1
C5-8	GRM033R71A103KA01D	Murata[3]	0.01µF, 25V, 10% Ceramic Capacitor, Size 0201, X5R, Dielectric	4
C17, C21-23, C26	C1005X7R1E103K050BB	TDK(Error! Reference source not found.)	0.01µF, 25V, 10% Ceramic Capacitor, Size 0402, X5R, Dielectric	5
C20	ECJ0EB1C183K	Panasonic	0.018µF, 25V, 10% Ceramic Capacitor, Size 0402, X5R, Dielectric	1
C2-4, C9, C18-19, C24-25, C27-34	C1005X7R1C104K050BC	TDK	CAP CER 0.1µF 16V 10% X7R 0402	16
C11-14	ECJZEB1A104M	Panasonic	CAP CER 0.1µF 16V 10% X7R 0201	4
C4	C1005X5R0J106M050B	TDK	CAP CER 10µF 6.3V 20% X5R 0402	1
L4-6, L8-10	BLM15BD121SN1	Murata	Ferrite, Filter Chip, 120 OHM@100Mhz 1.5A, 0402	6
L1-3, L7	HZ0402A601R-10 or BLM15HG601	Laird Technologies(Error! Reference source not found.) or Murata	Ferrite, 600 OHM@100Mhz 100mA, 0402	2
R1, R5	ERJ-1GEF15R0C	Panasonic	RES 15 OHM 1/10W 1% 0201 SMD	2
R21-22, R33-34	ERJ-2GEJ100X	Panasonic	RES 10 OHM 1/10W 5% 0402 SMD	4
R20, R35	ERJ-2RKF24R9X	Panasonic	RES 24.9 OHM 1/10W 1% 0402 SMD	1
R6-7	ERJ-2GEJ101X	Panasonic	RES 100 OHM 1/10W 5% 0402 SMD	2
R18	ERJ-2GEJ131X	Panasonic	RES 130 OHM 1/10W 1% 0402 SMD	1
R9	ERJ-1GEF1470C	Panasonic	RES 147 OHM 1/10W 1% 0201 SMD	1
R20	ERJ-2RKF4993X	Vishay[6]	RES 499K OHM 1/10W 1% 0402 SMD	1
R32	ERJ-2GEJ102X	Panasonic	RES 1K OHM 1/10W 5% 0402 SMD	2
R15, R19, R28, R31	ERJ-2GEJ103X	Panasonic	RES 10K OHM 1/10W 5% 0402 SMD	4
U3-4	NST3001	ON Semi[7]	Dual PNP transistor	2
U1	**MIC3003GML**	**Micrel, Inc.[7]**	**FOM Controller**	**1**
U2	**SY88022AL**	**Micrel, Inc.**	**10G DFB Laser Diode Driver**	**1**
U5	**MIC94161-5**	**Micrel, Inc.**	**Dual output LDO**	**1**
U6	**SY88053CL**	**Micrel, Inc.**	**10 Limiting Post Amplifier**	**1**
	SFP_022AL_R0	**Micrel, Inc.**	**SFP+ module PCB**	**1**

Note:

1. Panasonic: www.panasonic.com.
2. Murata: www.murata.com.
3. TDK: www.tdk.com.
4. Laird Technologies: www.lairdtech.com.
5. Vishay: www.vishay.com.
6. On Semi: www.onsemi.com.
7. **Micrel, Inc.: www.micrel.com.**

TCG Support

Hotline: 408-955-1690

Email Support: tcghelp@micrel.com

Application Hints and Notes

For application notes on high-speed termination on high bandwidth FOM and clock synthesizer products, SONET jitter measurement, and other high bandwidth products, go to Micrel's website at: http://www.micrel.com.

MICREL, INC. 2180 FORTUNE DRIVE SAN JOSE, CA 95131 USA

TEL +1 (408) 944-0800 FAX +1 (408) 474-1000 WEB http://www.micrel.com