



# SY88022AL

## 11.3Gbps Laser Diode Driver

### General Description

The SY88022AL is a single 3.3V supply, small form-factor, multi-rate laser driver for telecom/datacom applications using FP/DFB lasers at data rates up to 11.3125Gbps. The driver can deliver a modulation current of up to 75mA into a 15Ω external load with a fast edge rate below 25ps, and a bias current of up to 80mA. Having an equalizer at the input will compensate for the SFP+ connector and line card long traces.

The SY88022AL interfaces with MIC3003, Micrel's highly advanced optical module controller, as an easy-to-use chipset solution for SFP+ optical module applications. The MIC3003 allows for many features, including modulation and bias current control, automatic power control, and temperature compensation using look up tables. The MIC3003 comes in 4mm x 4mm QFN (MIC3003GML) and 3mm x 3mm QFN (MIC3003GFL) packages.

The SY88022AL operates on a single 3.3V power supply and comes in a 3mm x 3mm QFN package.

All support documentation can be found on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

### Features

- Operates from a single 3.3V supply
- Data rate operation up to 11.3125Gbps
- Modulation current up to 75mA
- Fast edges rates, below 25ps
- Bias current up to 80mA
- Input equalizer
- Small form factor 3mm x 3mm QFN package

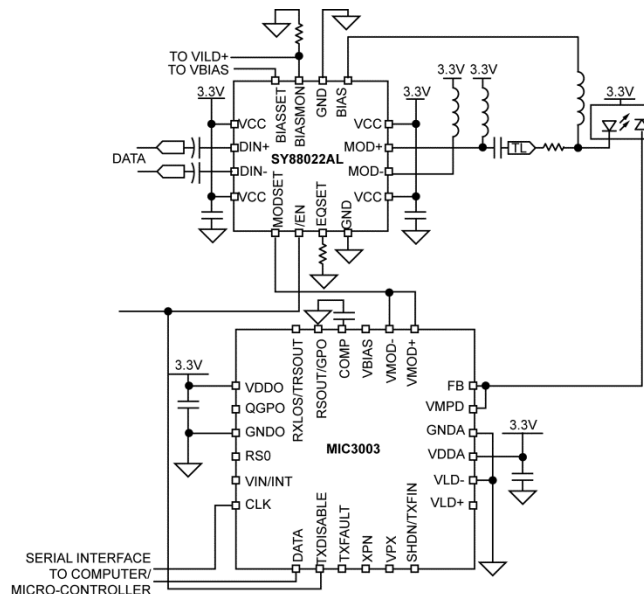
### Applications

- Multi-rate LAN, MAN applications up to 11.3Gbps: 8xFC, 10G GbE, SONET OC-192,, and SDH STM-64
- SFP+, XFP, XPAK, XENPAK, X2, MSA 300 optical modules
- OBSAI, CPRI

### Markets

- Fibre channel storage area networks
- Datacom/enterprise
- Telecom
- Wireless base stations

### Typical Application Circuit



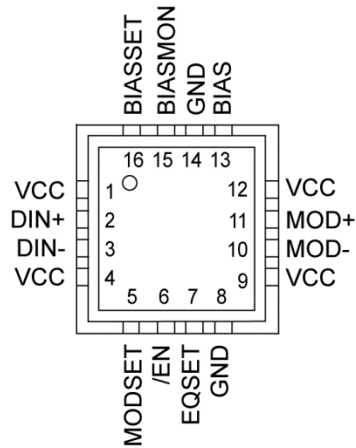
## Ordering Information

| Part Number                   | Package Type     | Operating Range | Package Marking                      | Lead Finish    |
|-------------------------------|------------------|-----------------|--------------------------------------|----------------|
| SY88022ALMG                   | 3mm x 3mm QFN-16 | Industrial      | 022A with Pb-Free bar line indicator | NiPdAu Pb-Free |
| SY88022ALMG TR <sup>(1)</sup> | 3mm x 3mm QFN-16 | Industrial      | 022A with Pb-Free bar line indicator | NiPdAu Pb-Free |

**Note:**

1. Tape and reel.

## Pin Configuration



**16-Pin 3mm x 3mm QFN  
(Top View)**

## Pin Description

| Pin Number            | Pin Name | Pin Function   |
|-----------------------|----------|--|
| 1, 4, 9, 12           | VCC      | Supply Voltage. Bypass with a 0.1 $\mu$ F//0.01 $\mu$ F low ESR capacitor as close to VCC pin as possible.   |
| 8, 14,<br>Exposed Pad | GND      | Ground. Ground and exposed pad must be connected to the plane of the most negative potential.  |
| 2                     | DIN+     | Non-inverting input data. Internally terminated with 50 $\Omega$ .   |
| 3                     | DIN-     | Inverting input data. Internally terminated with 50 $\Omega$ .   |
| 5                     | MODSET   | Modulation current setting and control. Apply a voltage within the range 0V - 1.2V to this pin to set the modulation current. Input impedance 25k $\Omega$ .   |
| 6                     | /EN      | Active Low TTL. Internal 75k $\Omega$ pull down to GND. The driver is enabled when this pin is unconnected or /EN asserted low and disabled when /EN asserted high.  |
| 7                     | EQSET    | Install a resistor from this pin to GND to set the desired equalization level. 0 $\Omega$ will provide maximum equalization and 2k $\Omega$ or higher will provide negligible equalization. Leave open if no equalization is needed. |
| 10                    | MOD-     | Inverted modulation current output. Provides modulation current when input data is negative. Internally terminated with 25 $\Omega$ to VCC.  |
| 11                    | MOD+     | Non-inverted modulation current output. Provides modulation current when input data is positive. Internally terminated with 25 $\Omega$ to VCC.  |
| 13                    | BIAS     | Bias current output.   |
| 15                    | BIASMON  | Bias current monitor. Outputs a current which represents 1/100 <sup>th</sup> of the bias current. Install an external resistor from this pin to GND to convert the output current to a voltage proportional to the bias current.     |
| 16                    | BIASSET  | Bias current setting and control. Apply a voltage within the range 0V - 1.2V to this pin to set the bias current. Input impedance 25k $\Omega$ .   |

## Truth Table

| DIN+ | DIN- | /EN | MOD+ <sup>(2)</sup> | MOD- | Laser Output <sup>(3)</sup> |
|------|------|-----|---------------------|------|-----------------------------|
| L    | H    | L   | H                   | L    | L                           |
| H    | L    | L   | L                   | H    | H                           |
| X    | X    | H   | H                   | L    | L                           |

### Notes:

- $I_{MOD} = 0$  when MOD+ = H.
- Assuming that the laser cathode is tied to MOD+.

### Absolute Maximum Ratings<sup>(4)</sup>

Supply Voltage ( $V_{IN}$ )..... -0.5V to +4.0V  
 CML Input Voltage ( $V_{IN}$ ) .....  $V_{CC}-1.2V$  to  $V_{CC}+0.5V$   
 TTL Control Input Voltage ( $V_{IN}$ )..... 0V to  $V_{CC}$   
 Lead Temperature (soldering, 20sec.)..... +260°C  
 Storage Temperature ( $T_s$ )..... -65°C to +150°C

### Operating Ratings<sup>(5)</sup>

Supply Voltage ( $V_{CC}$ )..... +3.0V to +3.6V  
 Ambient Temperature ( $T_A$ ) ..... -40°C to +85°C  
 Package Thermal Resistance<sup>(6)</sup>  
 QFN  
 ( $\theta_{JA}$ ) Still-Air ..... 60°C/W  
 ( $\Psi_{JB}$ )..... 33°C/W

### DC Electrical Characteristics

$T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$  and  $V_{CC} = +3.0V$  to  $+3.6V$ , unless otherwise noted. 25Ω external load. Typical values are  $V_{CC} = +3.3V$ ,  $T_A = 25^\circ\text{C}$ ,  $I_{MOD} = 30\text{mA}$ ,  $I_{BIAS} = 30\text{mA}$ .

| Symbol                   | Parameter   | Condition                                   | Min | Typ               | Max               | Units            |
|--------------------------|---|---|-----|-------------------|-------------------|------------------|
| $I_{CC}$                 | Power Supply Current  | Modulation and bias currents excluded       |     | 65 <sup>(7)</sup> | 85 <sup>(7)</sup> | mA               |
| $V_{MOD\_MIN}$           | Minimum Voltage Required at the Driver Output (headroom) for Proper Operation |   | 1.2 |                   |                   | V                |
| $V_{BIAS\_MIN}$          | Minimum Voltage Required at the BIAS Output (headroom) for Proper Operation   |   | 1.2 |                   |                   | V                |
| $R_{IN}$                 | Input Resistance, Single Ended  |   | 45  | 50                | 55                | Ω                |
| $V_{ID}$                 | Differential Input Voltage Swing  |   | 200 |                   | 1000              | mV <sub>pp</sub> |
| $V_{IL}$                 | /EN Input Low   |   |     |                   | 0.8               | V                |
| $V_{IH}$                 | /EN Input High  |   | 2   |                   |                   | V                |
| $I_{BIAS}$               | Bias Current  |   | 10  |                   | 80                | mA               |
| $I_{BIAS\_OFF}$          | Bias OFF Current  | Current at BIAS when the device is disabled |     |                   | 150               | μA               |
| $I_{BIASMON} / I_{BIAS}$ | $I_{BIASMON}$ to $I_{BIAS}$ Ratio   | Resistor installed from BIASMON to GND      |     | 10                |                   | μA/mA            |
|                          | Accuracy of $I_{BIASMON}$ to $I_{BIAS}$ ratio                                 | Resistor installed from BIASMON to GND      | -5  |                   | +5                | %                |
| $R_{MODSET}$             | Input Resistance at MODSET pin  |   |     | 25                |                   | kΩ               |
| $V_{MODSET}$             | Voltage Range at MODSET Pin   | $I_{MOD}$ range 10mA to 60mA                |     |                   | 1.2               | V                |
| $R_{BIASSET}$            | Input Resistance at BIASSET pin   |   |     | 25                |                   | kΩ               |
| $V_{BIASSET}$            | Voltage Range at BIASSET pin  | $I_{BIAS}$ range 10mA to 80mA               |     |                   | 1.2               | V                |

**Note:**

- Exceeding the absolute maximum ratings may damage the device.
- The device is not guaranteed to function outside its operating rating.
- Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5kΩ in series with 100pF.
- $I_{MOD}$  and  $I_{BIAS}$  not included. MOD+/- tied to VCC through inductors. Maximum  $I_{CC}$  measured with  $I_{MOD} = 60\text{ mA}$ ,  $I_{BIAS} = 80\text{ mA}$ , and  $V_{CC}=3.6V$ .

## AC Electrical Characteristics

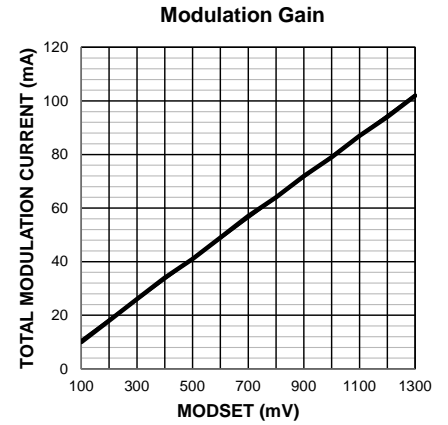
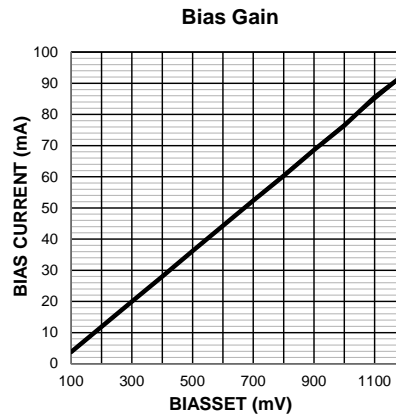
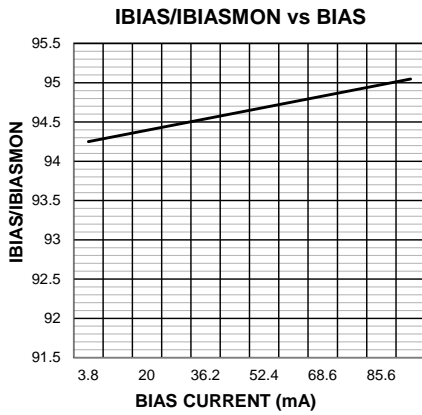
$T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$  and  $V_{CC} = +3.0\text{V}$  to  $+3.6\text{V}$ , unless otherwise noted. Typical values are  $V_{CC} = +3.3\text{V}$ ,  $T_A = 25^\circ\text{C}$ ,  $I_{MOD} = 30\text{mA}$ ,  $I_{BIAS} = 30\text{mA}$ .

| Symbol             | Parameter                  | Condition   | Min | Typ | Max     | Units         |
|--------------------|----------------------------|---|-----|-----|---------|---------------|
|                    | Data Rate                  | NRZ   |     |     | 11.3125 | Gbps          |
| $I_{MODMAX}^{(8)}$ | Maximum Modulation Current | AC-coupled into 25 $\Omega$ external load               | 60  |     |         | mA            |
|                    |                            | AC-coupled into 15 $\Omega$ external load               | 75  |     |         |               |
|                    |                            | AC-coupled into 10 $\Omega$ external load               | 85  |     |         |               |
| $I_{MODMIN}^{(8)}$ | Minimum Modulation Current | AC-coupled into 25 $\Omega$ external load               |     |     | 10      | mA            |
| $I_{MOD\_OFF}$     | Modulation OFF Current     | Current at MOD+ and MOD- when the device is disabled    |     |     | 150     | $\mu\text{A}$ |
| $t_r$              | Output Current Rise Time   | 20% to 80%, 25 $\Omega$ load                            |     | 25  |         | ps            |
| $t_f$              | Output Current Fall Time   | 20% to 80%, 25 $\Omega$ load                            |     | 25  |         | ps            |
| DJ                 | Deterministic Jitter       | K25.8 pattern at 11.3Gbps,<br>$V_{IN} = 200\text{mVpp}$ |     | 4   |         | pSPP          |
| RJ                 | Random Jitter              | K25.8 pattern at 11.3Gbps,<br>$V_{IN} = 200\text{mVpp}$ |     | 0.3 |         | pSPP          |

### Notes:

8.  $I_{MOD}$  is defined as the current going into the external load.

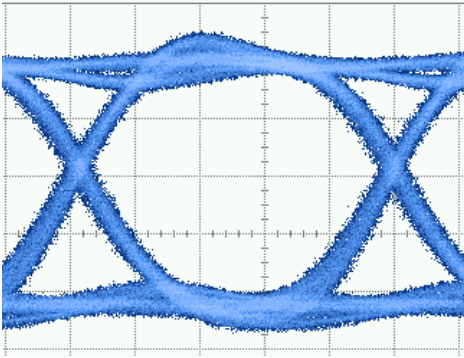
## Typical Characteristics<sup>(9)</sup>



**Note:**

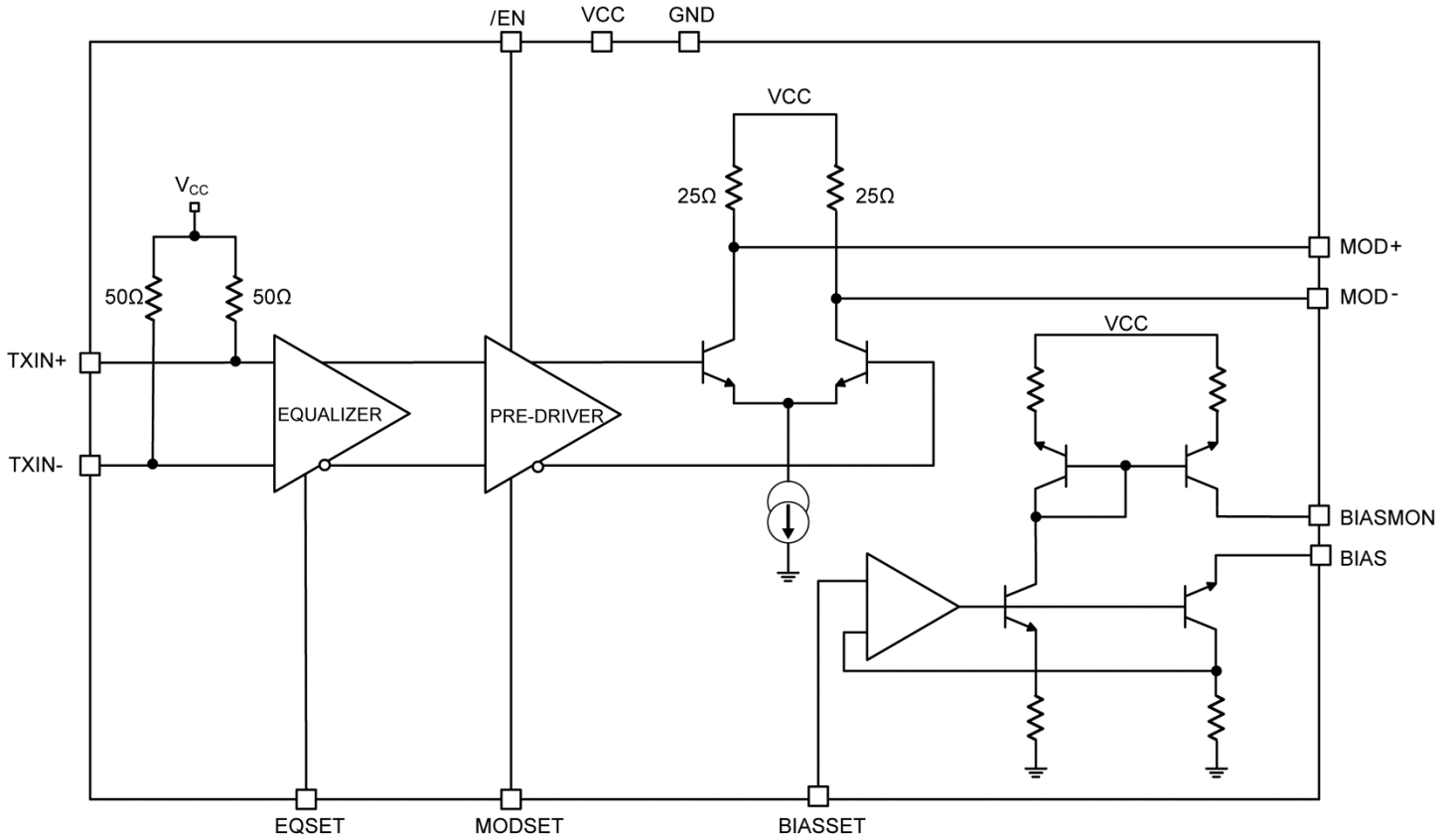
- The plotted modulation current is the total modulation current which includes the current into the internal 25Ω termination and  $I_{MOD}$  into the external load.

## Functional Characteristics



Electrical Eye Diagram at 10.3125Gbps

### Functional Block Diagram



### Input and Output Stages

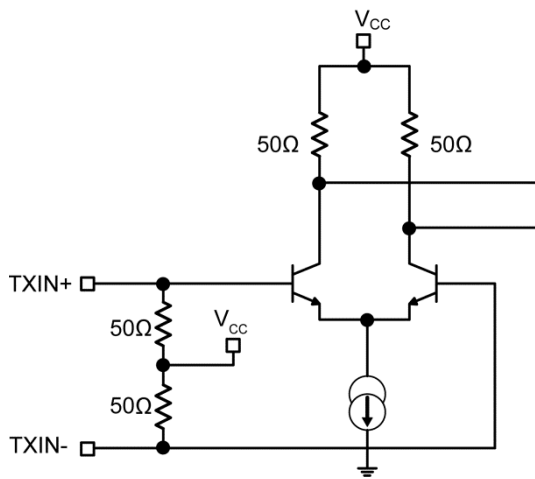


Figure 1. Simplified Input Stage

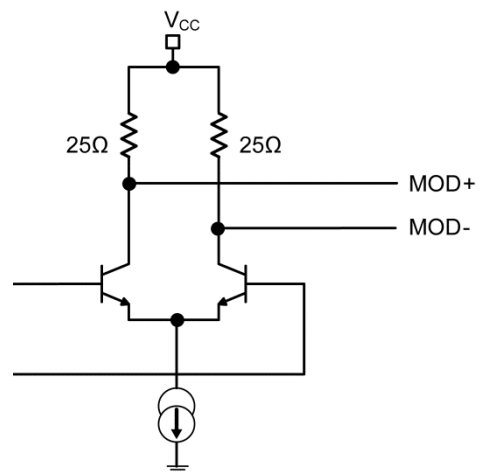


Figure 2. Simplified Output Stage



## Functional Description

As shown in the block diagram, the driver is composed of an input equalizer, a modulation block consisting of a pre-driver, and a current source.

### Equalizer

The input equalizer allows for compensation up to 12" of the FR4 microstrip trace or equivalent. In high frequency components, the equalization restores the losses of the signal caused by its travel along the line card traces and through the connectors between the line card and the module before it reaches the input stage. The amount of equalization is programmable with a resistor from Pin 7 to Ground.

### Modulator

The modulator consists of a pre-driver and a current source. The modulation current is set in the pre-driver by applying a voltage within the range 0V - 1.2V to Pin 5 (MODSET). The pre-driver provides a current to the output stage. This stage consists of a current source composed from a differential pair in which collectors are connected to MOD+/MOD- pins and have 25 $\Omega$  internal termination to VCC. The modulation gain curve shows modulation current variation versus the applied voltage at MODSET pin.

### Bias

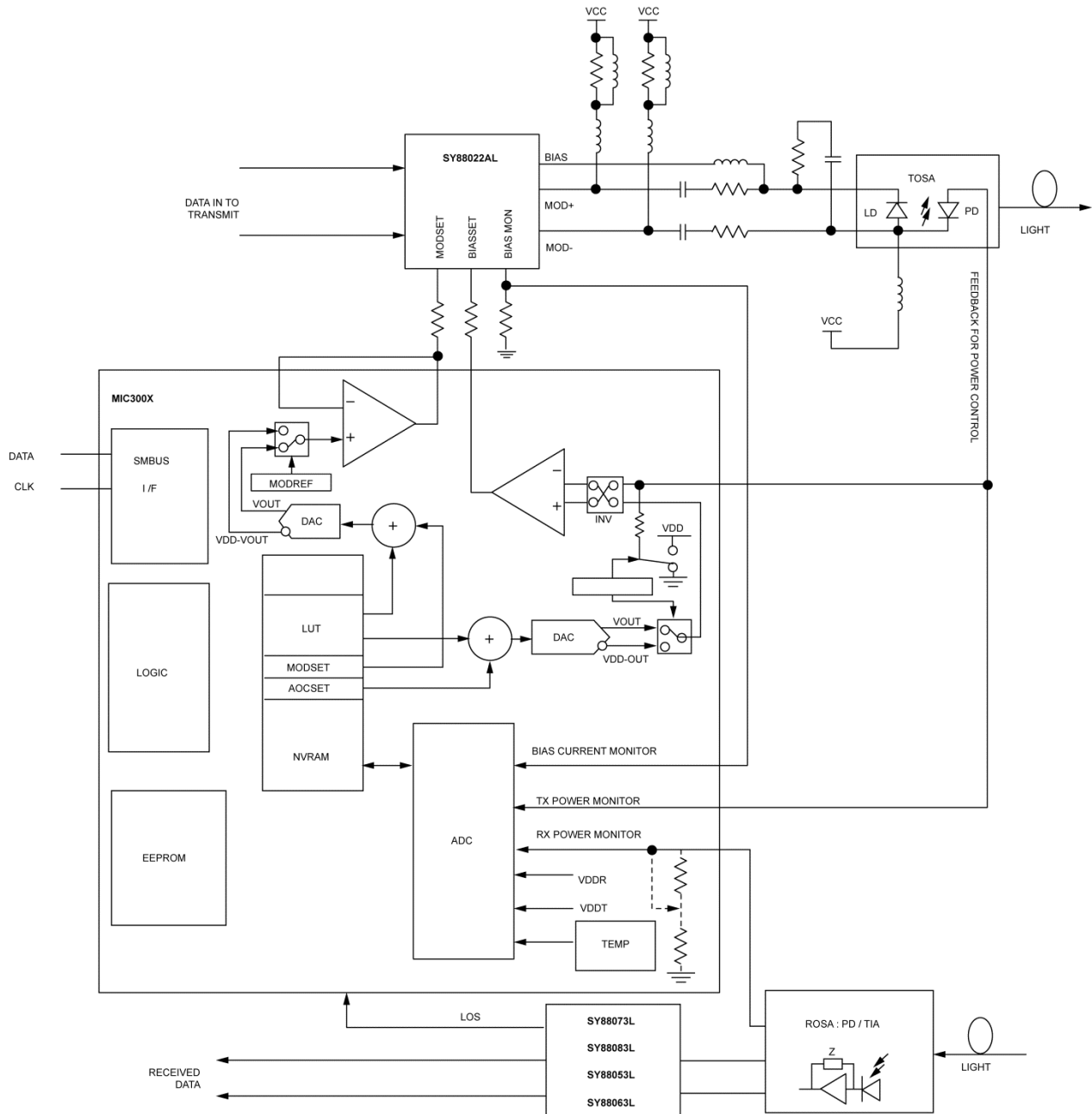
The bias is set by applying a voltage within a 0V - 1.2V range to Pin 16 (BIASSET). The Bias Gain curve on page 6 shows bias current variation versus the applied voltage at Pin 16.

The SY88022AL driver is designed to work with one of the Micrel's MIC300X series of controllers which have a built-in Automatic Power Control (APC) circuit and a serial interface for programming modulation and bias, temperature compensation tables, setting registers, and monitoring registers read back. Refer to the [Optical Module Controllers](#) datasheets for more details. The applications section below shows how to set up the driver to work correctly with the MIC300X controller.

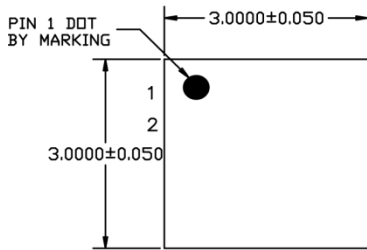
### Application Information

The following typical application schematic shows the diagram for a typical 10G optical transceiver using the Micrel's chip set comprised from SY88022AL driver, SY88053CL/073L/063CL/083L post amplifier, and FOM management IC MIC3003.

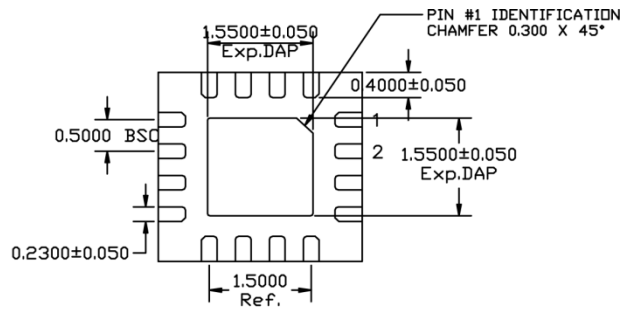
### Typical Application Schematic



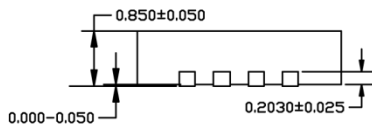
# Package Information<sup>(10)</sup>



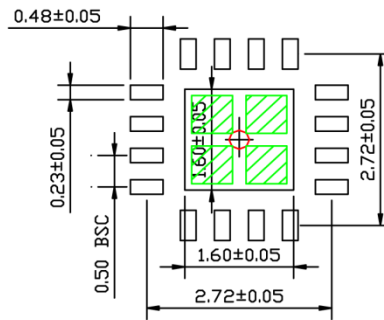
**TOP VIEW**  
NOTE: 1, 2, 3



**BOTTOM VIEW**  
NOTE: 1, 2, 3



**SIDE VIEW**  
NOTE: 1, 2, 3



**RECOMMENDED LAND PATTERN**  
NOTE: 4, 5

- NOTE:
1. MAX PACKAGE WARPAGE IS 0.05 MM
  2. MAX ALLOWABLE BURR IS 0.076MM IN ALL DIRECTIONS
  3. PIN #1 IS ON TOP WILL BE LASER MARKED
  4. RED CIRCLE IN LAND PATTERN INDICATE THERMAL VIA. SIZE SHOULD BE 0.30-0.3M IN DIAMETER AND SHOULD BE CONNECTED TO GND FOR MAX THERMAL PERFORMANCE
  5. GREEN RECTANGLES (SHADED AREA) indicate SOLDER STENCIL OPENING ON EXPOSED PAD AREA. SIZE SHOULD BE 0.60x0.60 MM IN SIZE, 0.20 MM SPACING.

## 16-Pin (3mm x 3mm) QFN-16

**Note:**

10. Package information is correct as of the publication date. For updates and most current information, go to [www.micrel.com](http://www.micrel.com).

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