

i7032

200 Mbps Laser-Diode Driver

Data Sheet

iCreate Technologies Corporation

i7032

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+3.3V to +5.0V, 200Mbps Laser-Diode Driver

1. Introduction

1.1. General description

The i7032 is the 3.3V to 5V, 200Mbps laser-diode driver with automatic power control (APC). Both accept differential PECL inputs and provide complementary output currents. A temperature-compensated reference voltage is provided for laser bias and modulation current programming. This allows maximum 80mA to be programmed for bias and modulation current with two external resistors.

The i7032 provides adjustable temperature-compensated modulation current to keep the optical extinction rate within specifications over the operation temperature range.

The APC circuits incorporated with a monitor photo-diode and two external resistors maintain laser's average power. A failure-monitor output is provided to indicate when the APC loop is unable to maintain average power. To prevent laser diode damage, an integrated soft-start circuit is provided. The output load can be DC and AC coupled in both 3.3V and 5V applications.

The i7032 is in 24-pin QFN package.

1.2. Features

- ✧ Rise / fall time less than 1 ns.
- ✧ Maximum 80mA bias current.
- ✧ Maximum 80mA modulation current.
- ✧ Differential PECL inputs.
- ✧ Automatic Power Control (APC).
- ✧ +3.3V to +5V supply voltage.
- ✧ On chip temperature-compensated reference voltage.
- ✧ Wide operation temperature range: -40 ~ +85 .
- ✧ Integrated soft-start circuit.
- ✧ On chip temperature-compensated modulation current.

1.3. Applications

- ✧ 155Mbps SDH/SONET
- ✧ Laser-Diode Transmitters

1.4 Ordering information

| Part | Pin-Package |
|----------|-------------------|
| i7032-EN | 24 QFN (4mmX4mm) |
| i7032-ET | 32 TQFP (5mmX5mm) |

2. Pin configuration and definition

2.1. Pin configuration

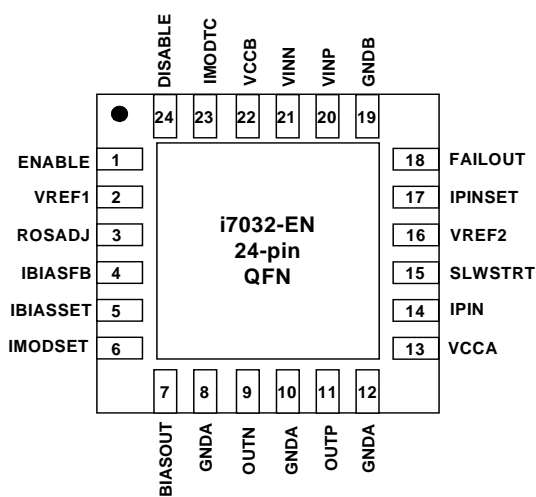


Figure 1. i7032-EN pin configuration

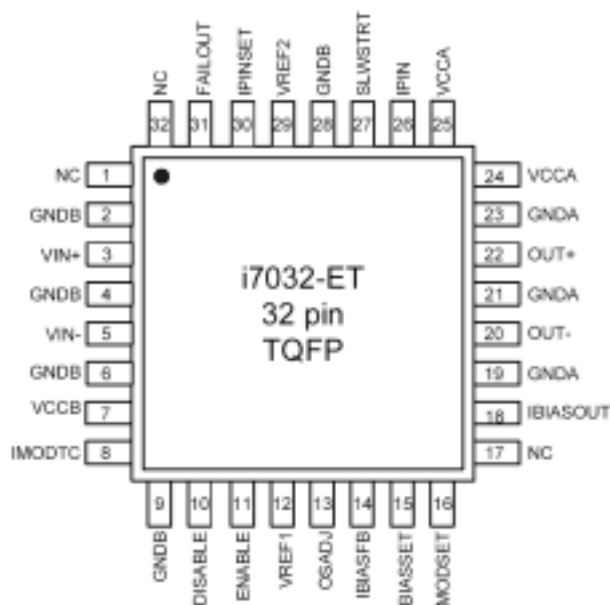


Figure 2. i7032-ET pin configuration

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2.2. Pin definition

| Pin Name | 24-pin QFN Pin No. | 32-pin TQFP Pin No. | Function |
|----------|--------------------------|---------------------------|--|
| ENABLE | 1 | 11 | Non -inverting enable TTL input |
| VREF1 | 2 | 12 | Temperature-compensated reference output |
| OSADJ | 3 | 13 | Overshoot-adjust input |
| IBIASFB | 4 | 14 | Bias feedback current output |
| IBIASSET | 5 | 15 | Laser bias current programming input |
| IMODSET | 6 | 16 | Laser modulation current programming input |
| IBIASOUT | 7 | 18 | Laser bias current output |
| GNDA | 8,10,12 | 19,21,23 | Ground |
| OUT- | 9 | 20 | Modulation output |
| OUT+ | 11 | 22 | Modulation output |
| VCCA | 13 | 24,25 | +3.3V to +5V supply voltage |
| IPIN | 14 | 26 | Monitor photodiode current input |
| SLWSTRT | 15 | 27 | Slow start input |
| VREF2 | 16 | 29 | Temperature-compensated reference output |
| IPINSET | 17 | 30 | Monitor photodiode programming input |
| FAILOUT | 18 | 31 | Fail output |
| GNDB | 19 | 2,4,6,9,28 | Ground |
| VIN+ | 20 | 3 | Non-inverting PECL data input |
| VIN- | 21 | 5 | Inverting PECL data Input |
| VCCB | 22 | 7 | +3.3V to +5V supply voltage |
| IMODTC | 23 | 8 | Connecting a resistor between this pin and ground set the temperature independency of the modulation current |
| DISABLE | 24 | 10 | Inverting enable TTL input |
| NC | | 1,17,32 | No Connect |

3. Block diagram

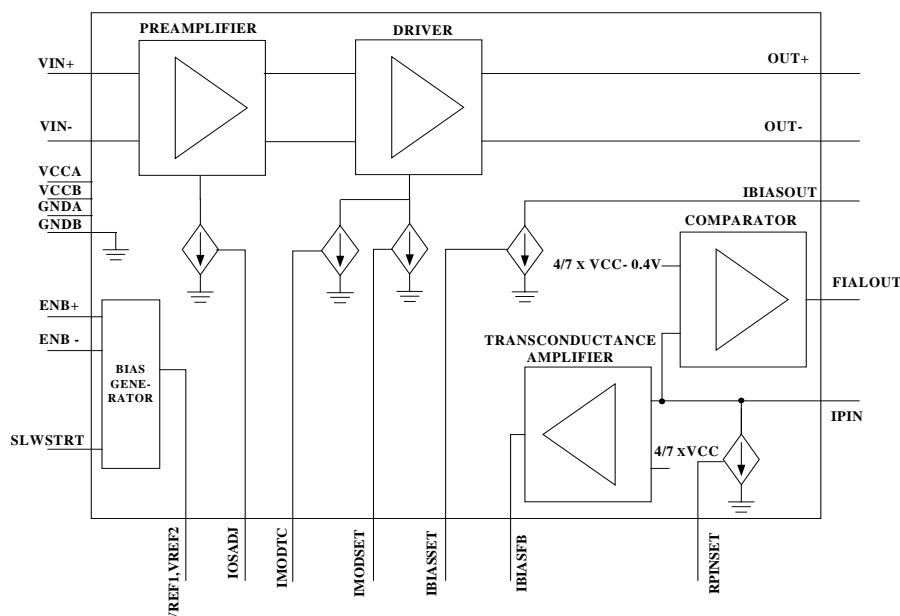


Figure 3. i7032 block diagram

4. Electrical specifications

$V_{CC}=V_{CCA}=V_{CCB}=+3.0V$ to $+5.5V$, $T_A = -40^{\circ}C$ to $85^{\circ}C$, unless otherwise noted. Typical values are at $V_{CC}=V_{CCA}=V_{CCB}=+3.3V$, $T_A=+25^{\circ}C$

4.1. DC characteristics

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|--------|---|----------------|-----|------|-------|
| Range of Programmable Laser Bias Current | IBIAS | | | | 80 | mA |
| Reference Voltage | VREF | $T_A=25^{\circ}C$ | | 2.5 | | V |
| Available Reference Current | IREF | | | | 10 | mA |
| Differential Input Voltage | VIL | | 100 | | 1600 | mVp-p |
| TTL High Input | VIH | | 2 | | | V |
| TTL Low Input | VIL | | | | 0.8 | V |
| FAILOUT Output High | VOH | Loaded with $2.7k\Omega$ pull-up resistor to V_{CC} | $V_{CC} - 0.3$ | | | V |
| FAILOUT Output Low | VOL | Loaded with $2.7k\Omega$ pull-up resistor to V_{CC} | | | 0.3 | V |

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4.2. AC characteristics

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|--------|--|-----|-----|-----|-------|
| Range of Programmable Modulation Current | IMOD | Minimum differential input swing is 1100mVp-p | | | 80 | mA |
| Modulation-Current Rise and Fall Time | tR, tF | IBIAS=25mA, IMOD=60mA, measures from 10% to 90% | | | 1 | ns |
| Modulation-Current Pulse-width Distortion | PWD | | | | 100 | ps |

4.3. Typical operating characteristics

(Vcc=3.3V, TA=+25°C, unless otherwise noted)

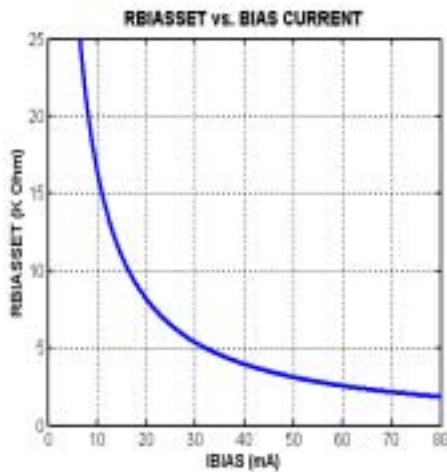


Figure 4. $R_{BIASSET}$ vs. I_{BIAS} current

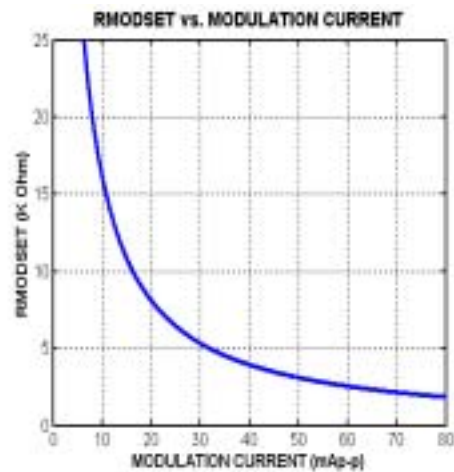


Figure 5. R_{MODSET} vs. Modulation current

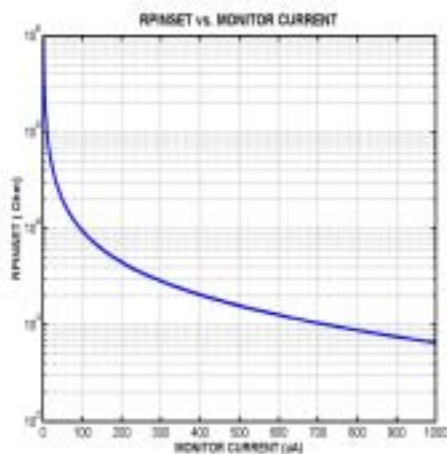


Figure 6. R_{PINSET} vs. Monitor current

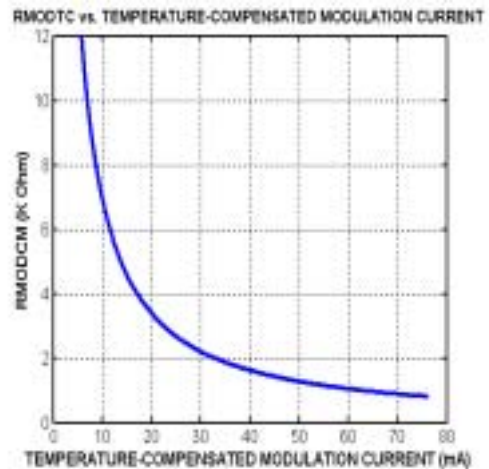


Figure 7. R_{MODTC} vs. Temperature-compensated modulation current

5. Product description

The i7032 consists of a laser bias generator with automatic power control (APC), a modulation current driver, and a reference generator with temperature compensation.

5.1. Modulation circuitry

The modulator output stage is designed to drive up to 80mA into 25Ω load in either AC-couple or DC-coupled mode. The amplitude of the modulation current is set with a resistor at IMODSET pin or with resistors at IMODSET and IMODTC pins. Please refer to 4.3. Typical operating characteristics figure 5 and figure 7 for more information.

The input swing is required to completely switch the output stage depends on both R_{OASDJ} and modulation current.

5.2. Automatic power control

The amplitude of DC current to the laser diode is determined by setting the resistor at IBIASSET pin (Please refer to 4.3. Typical operating characteristics figure 4). To maintain constant average optical power, i7032 incorporates a control loop to compensate for change in laser threshold current over temperature and lifetime.

A monitor photodiode mounted in the laser package is used to convert the optical power into a monitor current. This current flow into the IPIN input. The IPINSET current mirror draws current away from IPIN node. When the current into IPIN node equals the current drawn away by IPINSET, the node voltage is set by $4/7 \times V_{cc}$ reference. When the monitor current exceeds IPINSET, the IPIN node voltage will be forced higher. If the monitor current decreases, the IPIN node voltage is decreased. In either case the voltage change results in a feedback current at IBIASFB node.

5.3. APC failure Indicator

The i7032 provides an APC failure indicator to indicate an APC loop tacking failure. FAILOUT is set low when the APC loop can no longer adjust the bias current to maintain the desired monitor current. This output is pulled up to V_{cc} through an external 2.7KΩ resistor.

5.4. Enable inputs

The i7032 provides complementary enable inputs (ENB+, ENB-). The laser is disabled by reducing the reference voltage outputs (VREF1, VREF2). Both ENB+ and ENB- pins can not be floating and only one logic state enables laser operation (please refer to Table 1).

| ENB- | ENB+ | VREF |
|------|------|------|
| 0 | 0 | Off |
| 0 | 1 | On |
| 1 | 0 | Off |
| 1 | 1 | Off |

Table 1. i7032 truth table

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5.5. Slow-start

For the laser safety reason, the i7032 sets start-up time for enabling a laser diode by an external capacitor connected to ground.

5.6. Temperature compensation

The i7032 output current is programmed by current mirrors. These mirrors each have a $2xV_{BE}$ temperature coefficient. The reference voltage (VREF1, VREF2) is adjusted $2xV_{BE}$ to greatly cancel these changes. This provides very stable output currents with respect to temperature.

Utilizing a resistor at IMODTC pin can compensate the reduction in slope efficiency of typical laser diodes caused by increased temperature. This feature adds the temperature-compensated portion of the modulation current. Please refer to 4.3. Typical operating characteristics figure 7 for more details.

6. Application information

6.1 Typical closed loop application

When the laser-diode/VCSEL includes a monitor photodiode, the closed loop scheme should be adopted. The voltage at IPIN is equal to $4/7xV_{cc}$. The automatic power control loop increases or decreases IBIASFB such that the current from the monitor photodiode remains constant. Knowing the monitor photodiode current at the desired output power, we can determine the RPINSET value from 4.3. Typical operating characteristics figure 6.

The automatic power control circuit can adjust the bias current 50mA from the initial set point. This feature makes the laser driver circuit reasonably insensitive to variations of laser

threshold from lot to lot. The bias setting can be determined using the laser threshold current or the midpoint of the highest and lowest expected threshold value.

6.2 Setting modulation current

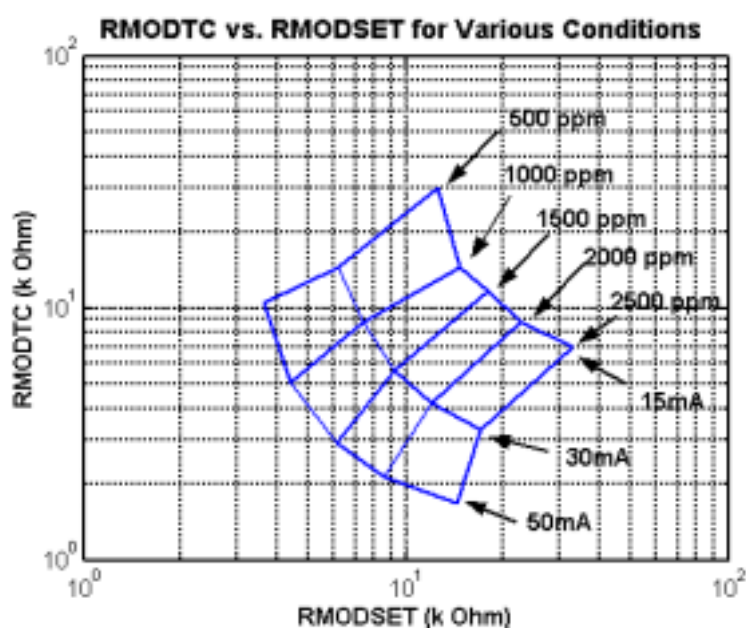
When the temperature-independent modulation current is used, the external resistor connected to IMODSET pin can be used to set the modulation current and IMODTC pin should be connected to VCC while the temperature-compensated modulation is used, resistors at the IMODSET and IMODTC pins set the amplitude of the modulation current (please refer to 7. Typical application circuits, figure 9 and figure 10).

The resistor R_{MODTC} sets the temperature-stable portion of the modulation current while the resistor R_{MODSET} sets the temperature-increasing portion of the modulation current. By varying the value of R_{MODTC} with respect to R_{MODSET} , the positive temperature coefficient can be set from 2500 ppm/°C to 500 ppm/°C. Table 2 is the reference value of how the modulation current changes with resistance over temperature. Figure 8 shows a family of curves which depict the relationship between temperature coefficients and constant modulation currents.

6.3 Rise/fall time and overshoot adjustment

The rise/fall time and overshoot of i7032 can be adjusted by an external resistor at ROSADJ pin, increasing this resistor slows the rise/fall time and reduces overshoot in the modulation signal. A smaller resistor value (around 1K Ω) is recommended to an initial point.

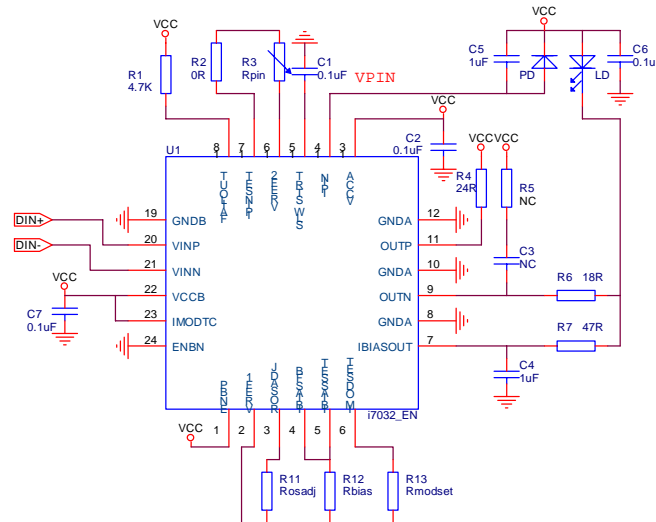
| TEMPCO | IMOD=50mA | | IMOD=30mA | | IMOD=15mA | |
|----------|---------------------|--------------------|---------------------|--------------------|---------------------|--------------------|
| (ppm/°C) | R _{MODSET} | R _{MODTC} | R _{MODSET} | R _{MODTC} | R _{MODSET} | R _{MODTC} |
| | (KΩ) | (KΩ) | (KΩ) | (KΩ) | (KΩ) | (KΩ) |
| 2500 | 14.45 | 1.68 | 17.12 | 3.31 | 33.13 | 7.01 |
| 2000 | 8.56 | 2.14 | 12.03 | 4.18 | 22.75 | 8.78 |
| 1500 | 6.08 | 2.9 | 9.22 | 5.64 | 17.96 | 11.7 |
| 1000 | 4.39 | 5.05 | 7.36 | 8.79 | 14.77 | 14.57 |
| 500 | 3.64 | 10.55 | 6.19 | 14.57 | 12.54 | 30.15 |

Table 2. R_{MODTC} and R_{MODSET} selection tableFigure 8. R_{MODTC} vs. R_{MODSET} for various conditions

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7. Typical application circuits

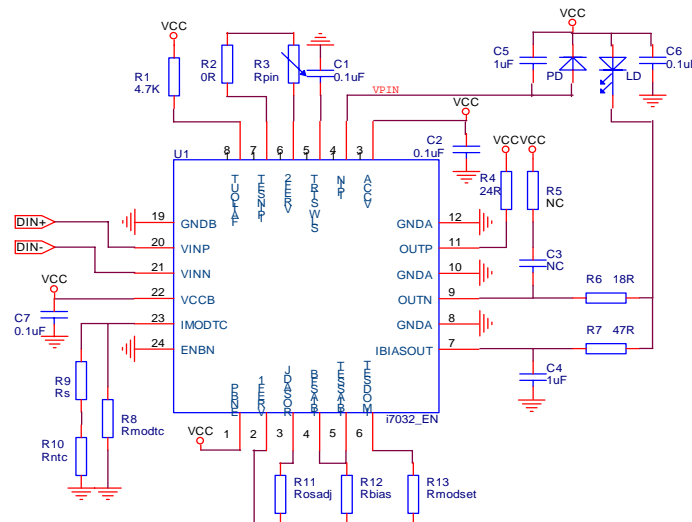
7.1. Application circuit with temperature-independent modulation current



Rmodset : Reserve if need.
 Rbias : Reserve if need.
 Rpin : Setting for LD current.
 Rmodtc : Setting for modulation current
 & Temperature compensation control.
 R5 & C3 : are optional for overshooting improvement.
 Rs & Rntc : Modulation temperature compensation if need.
 Check VPIN : $4/7 \times VCC$ to make sure APC functional work.

Figure 9. Typical application circuit with temperature-independent modulation current

7.2. Application circuit with temperature-compensated modulation current



Rmodset : Reserve if need.
 Rbias : Reserve if need.
 Rpin : Setting for LD current.
 Rmodtc : Setting for modulation current
 & Temperature compensation control.
 R5 & C3 : Overshoot filter.
 Rs & Rntc : Modulation temperature compensation if need.
 Check VPIN : $4/7 \times VCC$ to make sure APC functional work.

Figure 10. Typical application circuit with temperature-compensated modulation current

8. Package outline

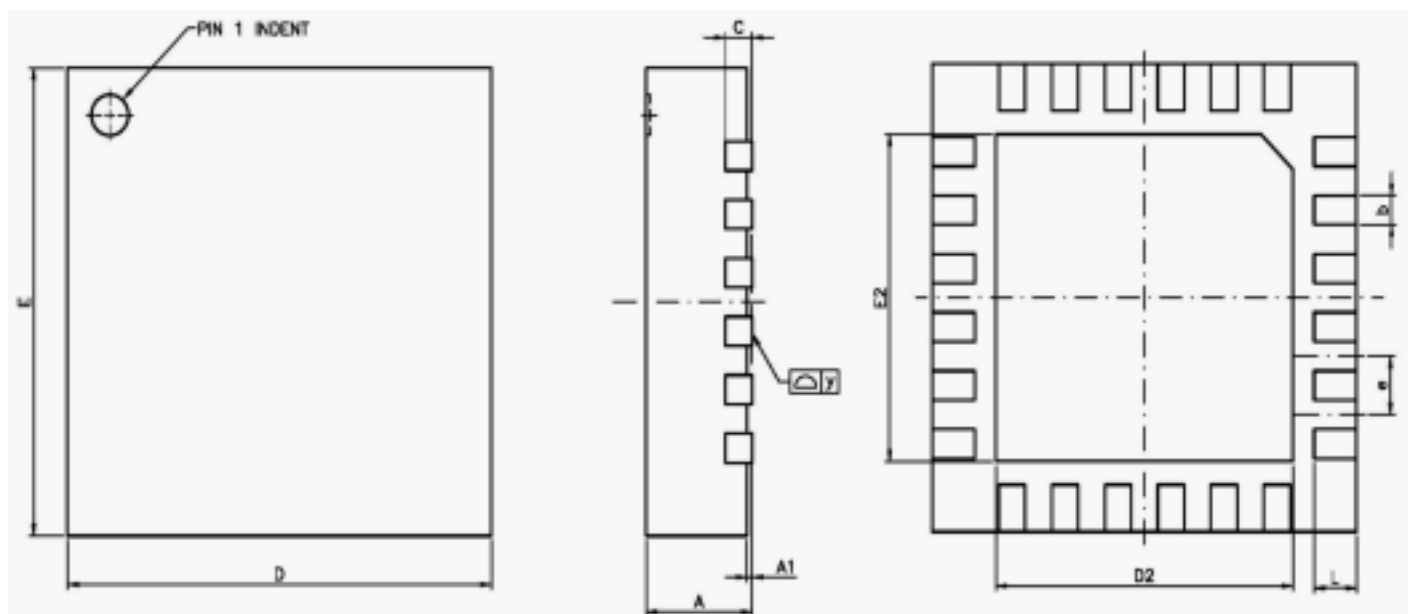


Figure 11. Package outline –24-pin QFN

| SYMBOL | DIMENSION IN MM | | | DIMENSION IN INCH | | |
|--------|-----------------|-------|-------|-------------------|--------|--------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.80 | 0.90 | 1.00 | 0.035 | 0.035 | 0.039 |
| A1 | 0.00 | 0.02 | 0.05 | 0.000 | 0.0008 | 0.002 |
| b | 0.225 | 0.25 | 0.275 | 0.009 | 0.010 | 0.011 |
| C | 0.19 | 0.20 | 0.25 | 0.0075 | 0.008 | 0.0098 |
| D | 3.9 | 4.00 | 4.10 | 0.1535 | 0.1575 | 0.1615 |
| D2 | 2.650 | 2.800 | 2.950 | 0.104 | 0.110 | 0.116 |
| E | 3.90 | 4.00 | 4.10 | 0.1535 | 0.1575 | 0.1615 |
| E2 | 2.650 | 2.800 | 2.950 | 0.104 | 0.110 | 0.116 |
| e | | 0.50 | | | 0.0197 | |
| L | 0.35 | 0.40 | 0.45 | 0.014 | 0.016 | 0.018 |
| y | 0.00 | | 0.076 | 0.000 | | 0.003 |

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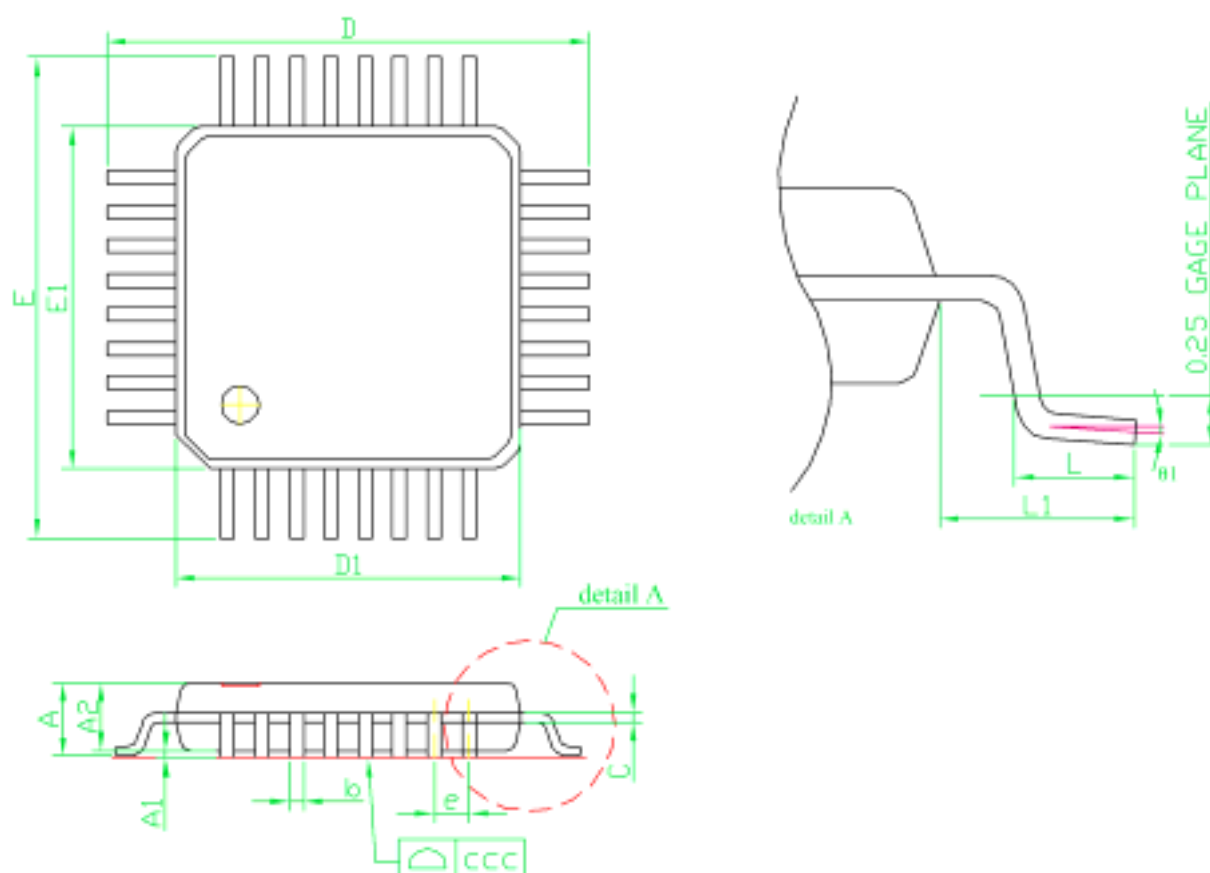


Figure 12. Package outline –32-pinTQFP

| SYMBOL | DIMENSION IN MM | | | DIMENSION IN INCH | | |
|--------|-----------------|------|------|-------------------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | — | — | 1.20 | — | — | 0.047 |
| A1 | 0.05 | — | 0.15 | 0.002 | — | 0.006 |
| A2 | 0.95 | — | 1.05 | 0.037 | 0.039 | 0.041 |
| b | 0.17 | 1.00 | 0.27 | 0.007 | 0.009 | 0.011 |
| C | 0.09 | 0.22 | 0.20 | 0.003 | — | 0.008 |
| D1 | 4.90 | — | 5.10 | 0.193 | 0.197 | 0.201 |
| D | 6.80 | 5.00 | 7.20 | 0.267 | 0.275 | 0.283 |
| E1 | 4.90 | 7.00 | 5.10 | 0.193 | 0.197 | 0.201 |
| E | 6.80 | 5.00 | 7.20 | 0.267 | 0.275 | 0.283 |
| e | — | 0.50 | — | — | 0.02 | — |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.029 |
| L1 | — | 1.00 | — | — | 0.039 | — |
| θ1 | 0° | 3.5° | 7° | 0° | 3.5° | 7° |
| ccc | — | — | 0.08 | — | — | 0.003 |

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