# i7030-ES
# i7031-ES

## 200 Mbps Laser-Diode Driver

## Data Sheet

**iCreate Technologies Corporation**

# i7030-ES
# i7031-ES



## Data sheet marking

iCreate uses various markings in the data sheet to designate each document phase as it relates to the product development stage.

| Marking | Description |
|---|---|
| Objective Specification | The objective specification contains data for new product development. |
| Advance Information | The information is on products in the design phase. Your designs should not be finalized with this information. |
| Preliminary | This is preliminary information on new products but not yet fully characterized. The specifications in these data sheets are subject to change in any manner without notice. |
| No Marking | Information contained in the data sheet is on products in full production. |

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Revision: 1.0
Date: 07/2002

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

# 1. Introduction

## 1.1. General description

The i7030-ES and i7031-ES are the 3.3V to 5V, 200Mbps laser-diode drivers 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 i7031-ES 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 i7030-ES and i7031-ES are in 24-pin SSOP 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 (i7031-ES).

## 1.3. Applications

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

# 2. Pin configuration and definition

## 2.1. Pin configuration

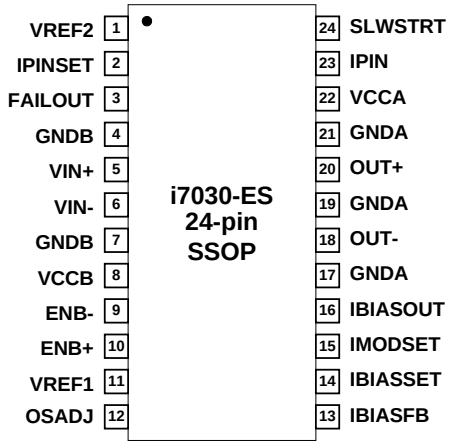



Figure 1. i7030-ES pin configuration

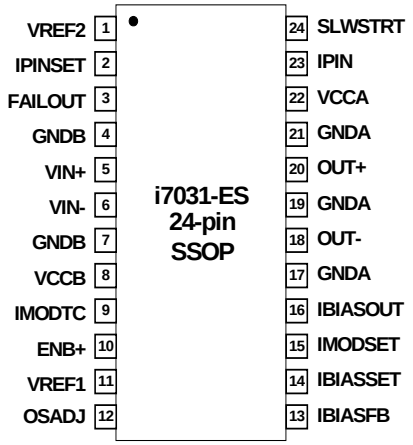



Figure 2. i7031-ES pin configuration

## 2.2. Pin definition

| Pin Name | Pin No. | Function |
|---|---|---|
| VREF2 | 1 | Temperature-compensated reference output |
| IPINSET | 2 | Monitor photodiode programming input |
| FAILOUT | 3 | Fail output |
| GNDB | 4,7 | Ground |
| VIN+ | 5 | Non-inverting PECL data input |
| VIN- | 6 | Inverting PECL data Input |
| VCCB | 8 | +3.3V to +5V supply voltage |
| ENB- | 9 | Inverting enable TTL input (i7030-ES) |
| IMODTC | | Connecting a resistor between this pin and ground set the temperature independency of the modulation current (i7031-ES) |
| ENB+ | 10 | Non -inverting enable TTL input |
| VREF1 | 11 | Temperature-compensated reference output |
| OSADJ | 12 | Overshoot-adjust input |
| IBIASFB | 13 | Bias feedback current output |
| IBIASSET | 14 | Laser bias current programming input |
| IMODSET | 15 | Laser modulation current programming input |
| IBIASOUT | 16 | Laser bias current output |
| GNDA | 17,19,21 | Ground |
| OUT- | 18 | Modulation output |
| OUT+ | 20 | Modulation output |
| VCCA | 22 | +3.3V to +5V supply voltage |
| IPIN | 23 | Monitor photodiode current input |
| SLWSTRT | 24 | Slow start input |

# 3. Block diagram

## 3.1. i7030-ES block diagram

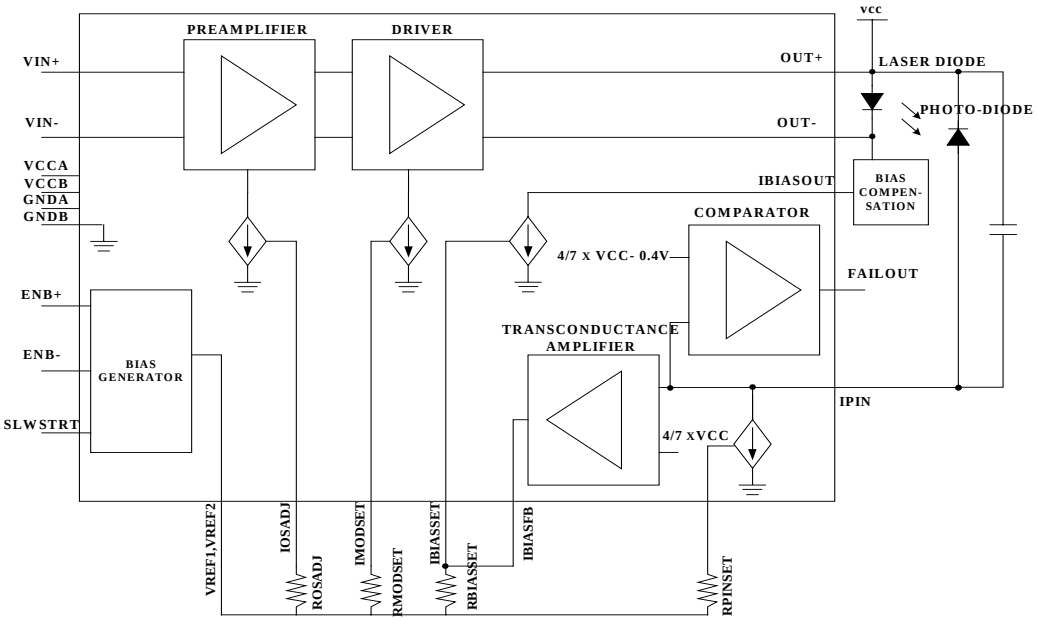



Figure 3. i7030-ES block diagram

## 3.2. i7031-ES block diagram

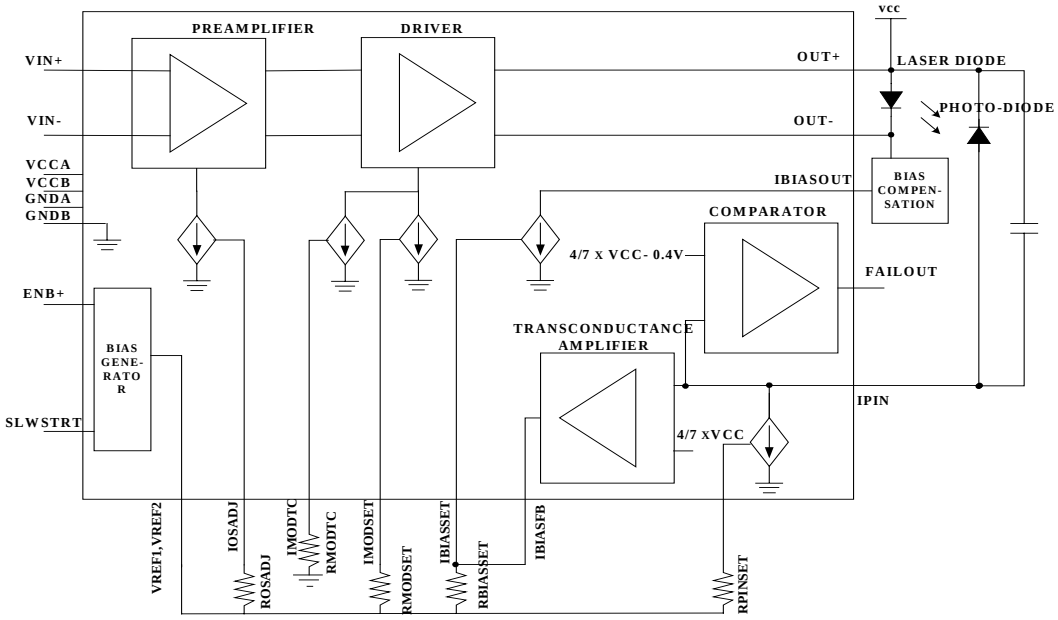



Figure 4. i7031 block diagram

# 4. Electrical specifications

Vcc=VccA=VccB=+3.0V to +5.5V, $T_A$= -40 °C to 85 °C, unless otherwise noted. Typical values are at Vcc=VccA=VccB=+3.3V, $T_A$=+25 °C

## 4.1. DC characteristics

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Range of Programmable Laser Bias Current | IBIAS | | | | 80 | mA |
| Reference Voltage | VREF | TA=25 °C | | 2.5 | | V |
| Available Reference Current | IREF | | | | 10 | mA |
| Differential Input Voltage | VID | | 100 | | 1600 | mVp-p |
| TTL High Input | VIH | | 2 | | | V |
| TTL Low Input | VIL | | | | 0.8 | V |
| FAILOUT Output High | VOH | Loaded with 2.7kΩ pull-up resister to Vcc | Vcc - 0.3 | | | V |
| FAILOUT Output Low | VOL | Loaded with 2.7kΩ pull-up resister to Vcc | | | 0.3 | V |

## 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, $I_{MOD}$=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)

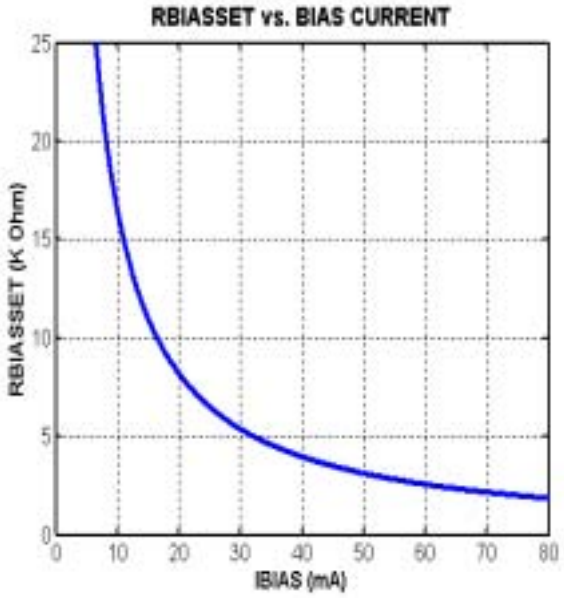



Figure 5. $R_{BIASSSET}$ vs. $I_{BIAS}$ current

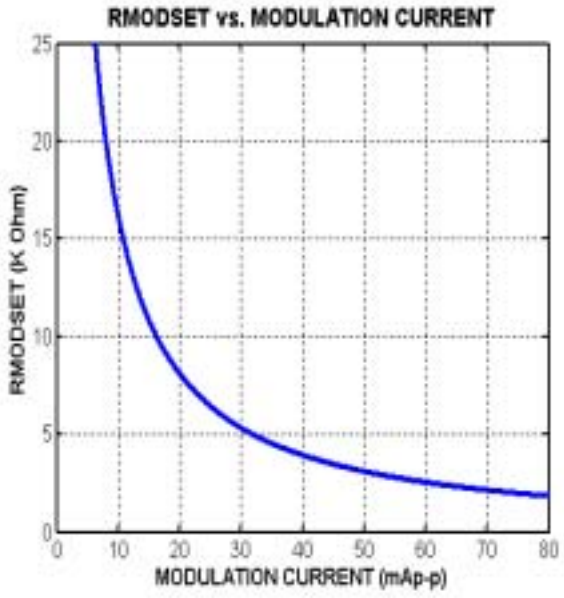



Figure 6. $R_{MODSET}$ vs. Modulation current

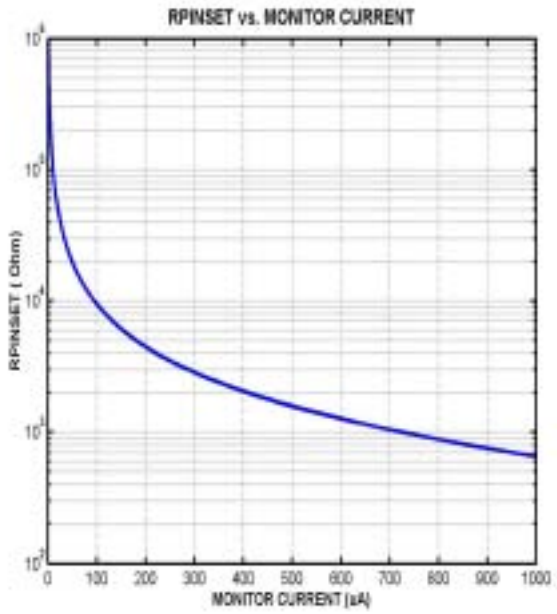



Figure 7. $R_{PINSET}$ vs. Monitor current

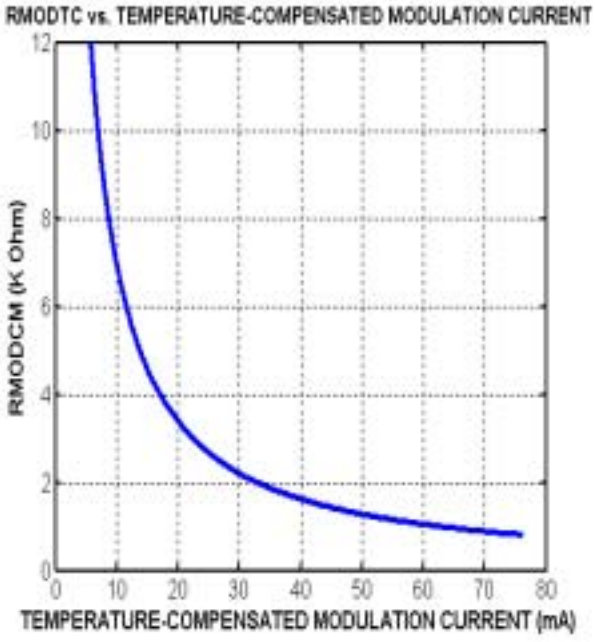



Figure 8. $R_{MODTC}$ vs. Temperature-compensated modulation current (i7031-ES)

# 5. Product description

The i7030-ES and i7031-ES consist 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 (i7030-ES) or with resistors at IMODSET and IMODTC pins (i7031-ES). Please refer to 4.3. Typical operating characteristics figure 6 and figure 8 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 5). To maintain constant average optical power, i7030-ES and i7031-ES incorporate 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 4/7xVcc 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 i7030-ES and i7031-ES provide 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 Vcc through an external 2.7KΩ resistor.

## 5.4. Enable inputs

The i7030-ES provides complementary enable inputs (ENB+, ENB-), while the i7031-ES provides only one enable inputs (ENB-). The laser is disabled by reducing the reference voltage outputs (VREF1, VREF2). Only one logic state enables laser operation (please refer to Table 1. i7030-ES and i7031-ES truth table).

| i7030-ES | | |
|---|---|---|
| ENB- | ENB+ | VREF |
| 0 | 0 | Off |
| 0 | 1 | On |
| 1 | 0 | Off |
| 1 | 1 | Off |

| i7031-ES | |
|---|---|
| ENB+ | VREF |
| 1 | On |
| 0 | Off |

Table 1. i7030-ES and i7031-ES truth table

## 5.5. Slow-start

For the laser safety reason, the i7030-ES and i7031-ES set start-up time for enabling a laser diode by an external capacitor connected to ground.

## 5.6. Temperature compensation

The i7030-ES and i7031-ES output currents are 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 the IMODTC pin of i7031-ES 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 8 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 4/7xVcc. 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 7.

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 i7030-ES is used, the external resistor connected to IMODSET pin can be used to set the modulation current. This modulation current is independent of temperature. When the i7031-ES is used, resistors at the IMODSET and IMODTC pins set the amplitude of the modulation current.

The resistor $R_{MODTC}$ sets the temperature-stable portion of the modulation current while the resistor $R_{MODTC}$ 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 9 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 i7030-ES and i7031-ES 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 1KΩ) is recommended to be a good 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 table

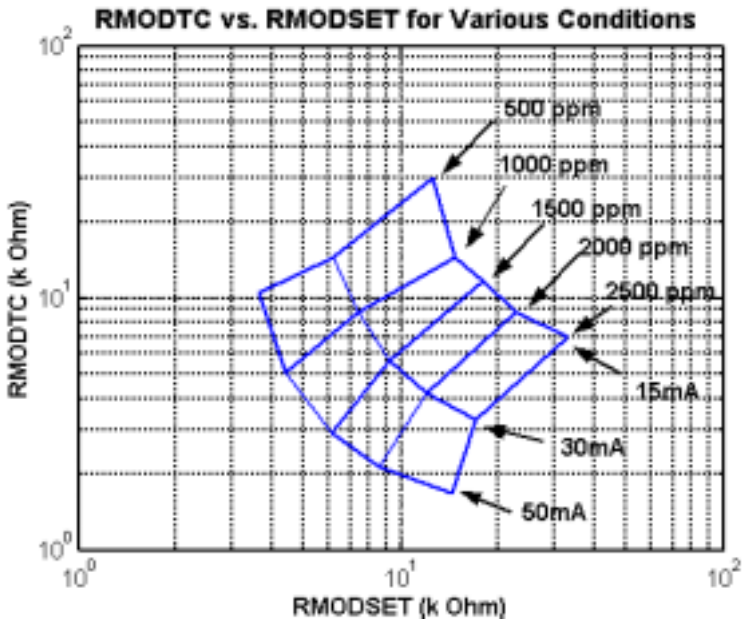
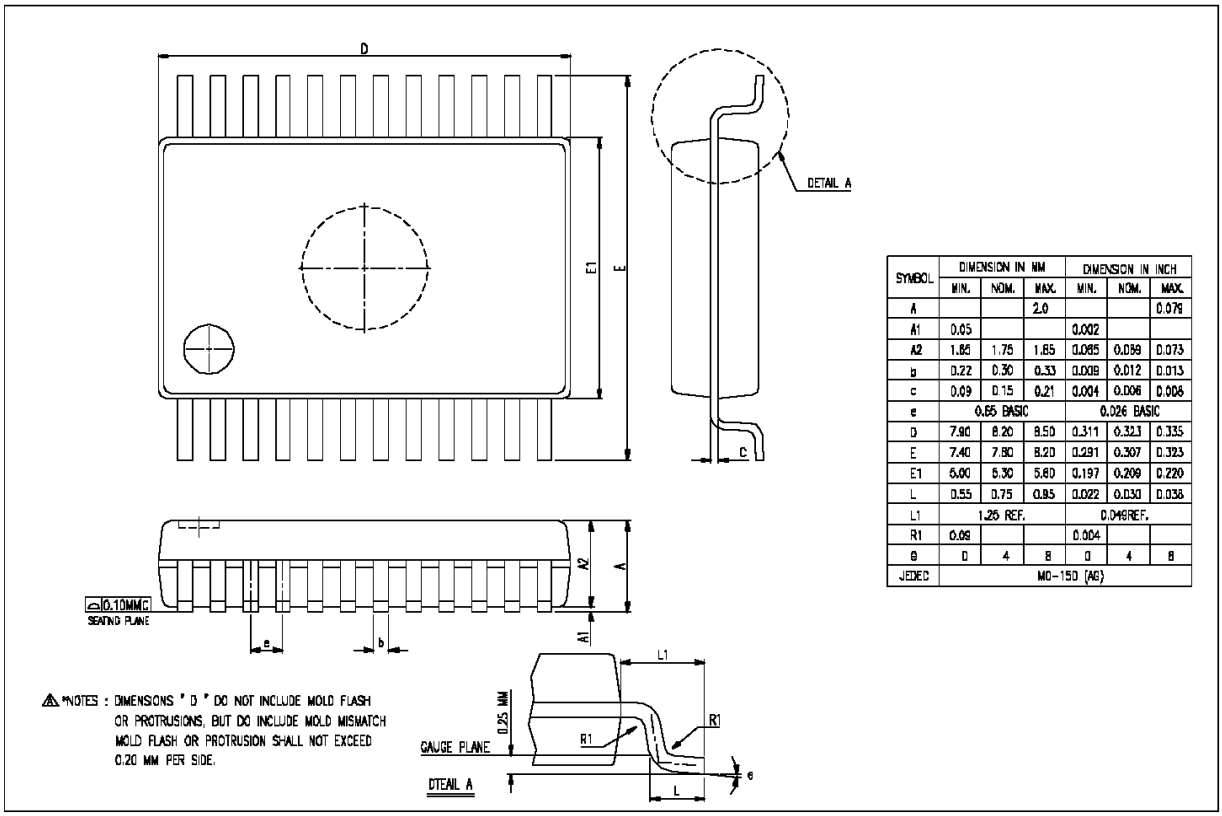



Figure 9. $R_{MODTC}$ vs. $R_{MODSET}$ for various conditions

# 7. Package outline




| SYMBOL | DIMENSION IN MM | | | DIMENSION IN INCH | | |
|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | | | 2.0 | | | 0.078 |
| A1 | 0.05 | | | 0.002 | | |
| A2 | 1.85 | 1.75 | 1.85 | 0.065 | 0.069 | 0.073 |
| b | 0.22 | 0.30 | 0.33 | 0.009 | 0.012 | 0.013 |
| c | 0.09 | 0.15 | 0.21 | 0.004 | 0.006 | 0.008 |
| e | 0.65 BASIC | | | 0.026 BASIC | | |
| D | 7.90 | 8.20 | 8.50 | 0.311 | 0.323 | 0.335 |
| E | 7.40 | 7.80 | 8.20 | 0.291 | 0.307 | 0.323 |
| E1 | 5.00 | 5.30 | 5.60 | 0.197 | 0.209 | 0.220 |
| L | 0.55 | 0.75 | 0.95 | 0.022 | 0.030 | 0.038 |
| L1 | 1.25 REF. | | | 0.049REF. | | |
| R1 | 0.09 | | | 0.004 | | |
| θ | 0 | 4 | 8 | 0 | 4 | 8 |
| JEDEC | MO-150 (AG) | | | | | |

Figure 10. Package outline – 24-pin SSOP

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