

# MC2042-4

**LED/Laser Driver for FDDI, Fast Ethernet, Fibre Channel, OC3/STM-1,  
IEEE1394  
Data Sheet**

Preliminary Information

LED/Laser Driver for FDDI, Fast Ethernet, Fibre Channel, OC3/STM-1, IEEE1394

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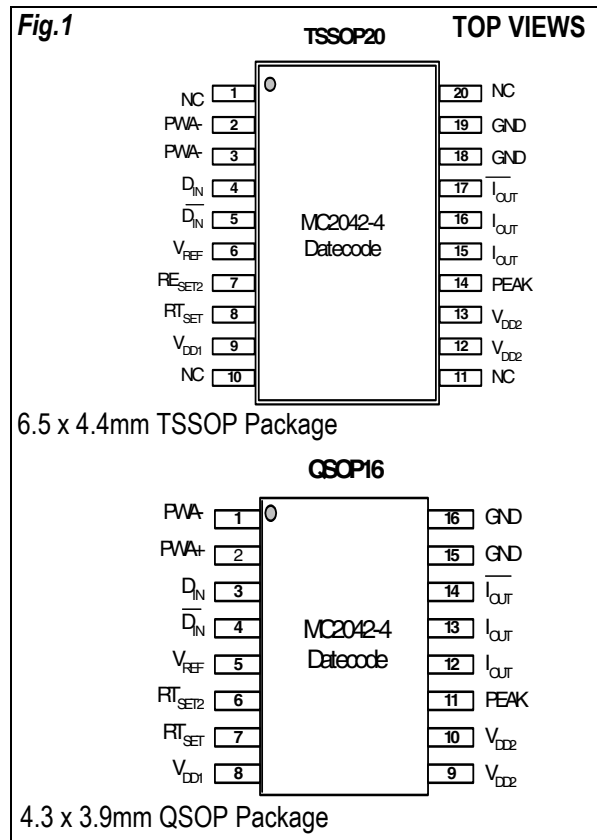
FEATURES

- ❑ Data rates to >300 Mbps, depending on LED
- ❑ Single chip solution, available as die or in TSSOP20 or QSOP16 fabricated in deep sub-micron CMOS for lowest cost & power consumption and long term reliability
- ❑ Programmable output current from 5 mA to 100 mA
- ❑ RC programmable pre-emphasis or 'peaking' circuit giving drive current rise and fall times <500 ps
- ❑ Resistor programmable compensation for temperature dependence of LED output power
- ❑ PECL input with optional Pulse Width Adjust
- ❑ Single-ended CMOS input compatible at low speeds
- ❑ V<sub>REF</sub> voltage generator and output pin
- ❑ Supports most LED types (e.g. 660 to 1300 nm)
- ❑ Single +5 V to +3.3 V operation

APPLICATIONS

- ❑ FDDI, fiber Channel
- ❑ Fast Ethernet, IEEE1394
- ❑ OC3/STM1

CONNECTIONS



GENERAL DESCRIPTION

The MC2042-4 is a CMOS IC designed for high-speed LED drive in low-cost optical fiber based transmission systems. Depending on the LED used, data rates to >300Mbps can be achieved.

The LED drive current is set by a resistor. To improve LED 'on' time, a pre-emphasis circuit is included, which may be set via a simple RC network.

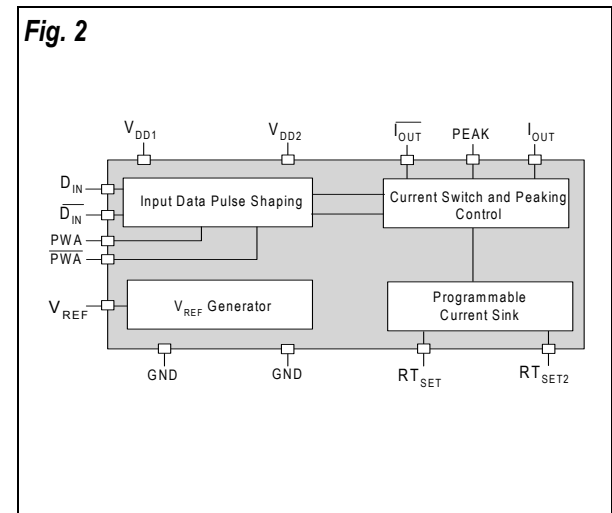
To minimize the effects of temperature on LED output power, LED drive temperature compensation can be set by resistor over a 500 - 10,000 ppm/°C range.

Differential positive-ECL (PECL) data on the input pins can be shaped, if desired, by the differential voltage on the Pulse Width Adjust (PWA) pins. This adjustment is continuous over a ±500 ps range. In addition, the V<sub>REF</sub> output pin allows single-ended input to the MC2042 and provides compatibility with industry-standard FO modules.

TABLE 1 ORDERING INFORMATION

Part	Pin-Package
MC2042-4DIEWP	Waffle pack
MC2042-4WAFER	Expanded Whole Wafer on a ring
MC2042-4Q16	QSOP16
MC2042-4T20	TSSOP20

TOP LEVEL DIAGRAM



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TABLE 2 \_\_\_\_\_ PIN DESCRIPTIONS

TSSOP20 Pin	QSOP16 Pin	Die Pin	Name	Description
1	-	-	NC	Not connected, leave open
2	1	13	$\overline{PWA}$	Inverse pulse width adjust input
3	2	14	PWA	Differential pulse width adjust input. Allows continuous adjustment of input data pulse width
4	3	15	$D_{IN}$	Differential data input
5	4	16	$\overline{D}_{IN}$	Inverse differential data input
6	5	1	$V_{REF}$	Reference output. Can be used with single-ended data input
7	6	2	$RT_{SET2}$	Temperature compensation adjustment pin. Allows temperature dependence of LED light output to be reduced or removed
8	7	3	$RT_{SET}$	Sets nominal LED drive current
9	8	4	$V_{DD1}$	Power pin, connect to most positive supply
10	-	-	NC	Not connected
11	-	-	NC	Not connected
12	9	5	$V_{DD2}$	LED shorting pin, connect to most positive supply. Speeds LED switch off
13	10	6	$V_{DD2}$	LED shorting pin, connect to most positive supply. Speeds LED switch off
14	11	7	PEAK	Connection for pre-emphasis or peaking circuit
15	12	8	$I_{OUT}$	Driver output. Connect LED between this pin and $V_{DD}$
16	13	9	$I_{OUT}$	Driver output. Connect LED between this pin and $V_{DD}$
17	14	10	$\overline{I_{OUT}}$	Logical inverse of pin 8. Connect resistor of approximately the same value as LED (at the programmed drive current level) between this pin and $V_{DD}$
18	15	11	GND	Ground pin. Connect to the most negative supply
19	16	12	GND	Ground pin. Connect to the most negative supply
20	-	-	NC	Not connected, leave open

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TABLE 3 \_\_\_\_\_ ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Rating	Units
$P_{TOT}$	Total power dissipation (TSSOP20)	255	mW
$V_{CC}$	Power supply ( $V_{CC}$ -GND)	7	V
$T_J$	Junction temperature	150	°C
$T_A$	Operating ambient	-40 to +85	°C
$T_{STG}$	Storage temperature	-65 to +50	°C

These are the absolute maximum ratings at or beyond which the IC can be expected to fail or be damaged. Reliable operation at these extremes for any length of time is not implied.

TABLE 4 \_\_\_\_\_ DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Min	Typ	Max	Units
$V_{CC}$	Supply Voltage	3.0	-	5.5	V
Din	Allowable voltage at data inputs	Gnd - 0.3	-	$V_{CC}+0.3$	
$V_{REF}$	Voltage reference	$V_{CC}-1.6$	$V_{CC}-1.4$	$V_{CC}-1.03$	
$I_{LED\_ON}$	LED drive current	5	-	120	mA
$I_{LED\_OFF}$	LED off current	-	-	50	µA
$I_{COMP}$	LED drive current temperature compensation range	0.05	-	1	%/°C
$V_{LED\_H}$	Minimum allowable voltage at IOUT	$V_{DD}-2.0$	-	-	V

TABLE 5 \_\_\_\_\_ AC ELECTRICAL CHARACTERISTICS

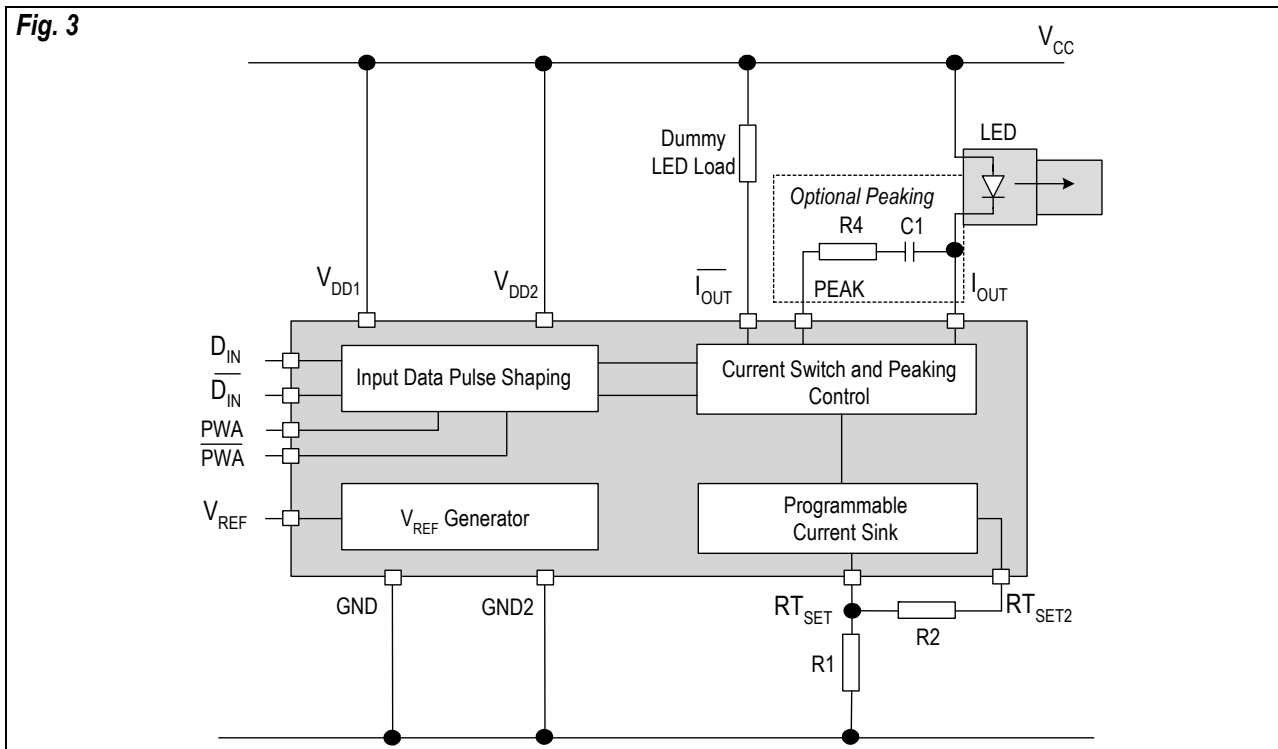
Symbol	Parameter	Min	Typ	Max	Units
$V_{in(Diff)}$	Differential Input Voltage, $2*(DinH - DinL)$	300mV	-	$2*V_{CC}$	V
	Common Mode Input Voltage	$V_{CC}/2$	-	$(V_{CC}-(V_{in[Diff]})/4)$	V
$f_C$	Maximum data rate	300	-	-	Mbps
$T_{PWA}$	Input data pulse width adjust range	-500	-	500	ps
LED $t_r$	LED drive rise time	-	0.7	1	ns
LED $t_f$	LED drive fall time	-	0.7	1	ns
$I_{PEAK}$	Peaking current (as % of LED drive current)	0	-	50	%
PEAK $t_r$	Peaking current rise time	-	-	1	ns
PEAK $t_f$	Peaking current fall time	-	-	1	ns
PEAK $t_d$	Peaking current decay time	-	$C1x(R4+5)$	-	S
$I_{DD}$	Supply current	-	$I_{LED}+10$	$I_{LED}+20$	mA

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TYPICAL APPLICATIONS CIRCUIT

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Fig. 3



FUNCTIONAL DESCRIPTION

**Current Switch**

Differential Positive-ECL (PECL) data on the data input pins controls the LED current switch. The LED current flows either through the LED or via the dummy load so that  $V_{DD}$  noise is minimized. To reduce LED 'turn-off' time, the LED is momentarily short-circuited, via  $V_{DD2}$ , before the current is switched to the dummy load.

**LED Drive and Temperature Compensation**

The two resistors R1 and R2 set the LED drive current and temperature compensation. The simplified application diagram (Fig. 3) shows R1 connected between  $RT_{SET}$  and GND, and R2 between  $RT_{SET}$  and the  $RT_{SET2}$  pin.

The current flowing out of the  $RT_{SET}$  pin determines the LED drive current.

The temperature independent component of the LED drive current is set primarily by R1. The temperature

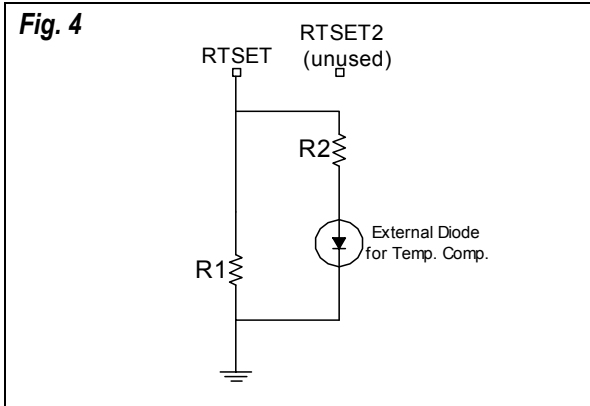
dependent component is set primarily by R2. However, R1 and R2 are not independent.

The  $RT_{SET2}$  pin connects to an internal diode in the IC, which exhibits standard diode behaviour with temperature. As temperature rises, the voltage on the diode drops, the current flowing through R2 increases and the LED drive current increases.

The LED 'on' current is controlled to  $\pm 5\%$ .

If the operating temperature of the MC2042 is not representative of the LED temperature, an external diode may be used in place of the temperature compensating diode internal to the MC2042. Figure 4 illustrates a circuit using an external diode for temperature compensation.

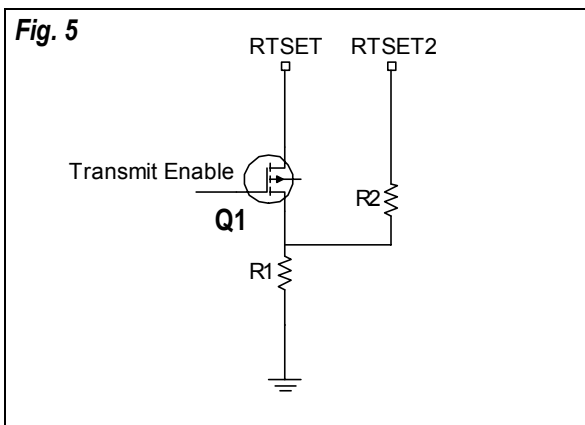
A Microsoft Excel file is available from Mindspeed which will calculate appropriate values for  $RT_{set}$  resistors R1 and R2 given your LED current, forward voltage, and LED temperature coefficient. The file may be obtained from a Mindspeed Field Applications Engineer and is named '**MC2042-4 resistor selection.xls**'.



**Transmit Enable/Disable**

There is no dedicated pin on the MC2042 to disable the LED drive current. However, the LED drive current can be disabled by disabling the current out of pin RTSET. The LED current is approximately 100x the current out of pin RTSET, so if the current out of this pin is 0, the LED drive current is 0. However, if peaking is used the peaking current will not be disabled.

Figure 5 illustrates how the current out of RTSET can be disabled by adding a MOSFET (Q1) at the RTSET node of the R1/R2 temperature compensation network. The voltage on the gate of Q1 then controls transmit enable/disable. When selecting Q1, a MOSFET should be chosen with an Rds(on) which is negligible compared to R1 and R2.



**Pre-Emphasis Or ‘Peaking’**

To improve LED ‘turn on’ time an optional pre-emphasis function is included on the MC2042-4. If this is not required, then the PEAK pin should be left floating.

Two external components (R4, C1) are required as shown in Fig. 3 to implement peaking.

When the LED is turned on, the voltage on PEAK is pulled LOW very rapidly. This voltage transient is coupled through R4 and C1 and exerts a transient current on the LED.

When the LED is turned off, the voltage on PEAK is pulled HIGH rapidly. This voltage transient is coupled through R4 and C1 and exerts a transient current in the opposite direction on the LED.

The transient current amplitude and RC decay are given approximately by:

$$\text{Peak current (Amps): } 4/(R4 + 5)$$

$$\text{Decay (seconds): } C1 \times (R4 + 5)$$

The above approximations assume an ideal LED model with 0 Ohms resistance. Real LEDs will slightly alter the peaking effect. Typical values for R4 and C1 are:

$$R4 = 50 \Omega$$

$$C1 = 20 \text{ pF}$$

**LED Clamping, Laser Driving**

Since most LEDs exhibit a longer ‘turn off’ time than ‘turn on’ time, a clamping function is included on the MC2042 in order to reduce the ‘turn off’ time. Clamping is enabled via the two V<sub>DD2</sub> connections.

The disadvantage of clamping is that the LED’s internal capacitance has to be fully charged again before the LED starts to emit light. This delayed ‘turn on’ effect becomes noticeable when the nominal LED drive current is low. Use of the peaking circuit helps solve this problem. Thus, the combination of peaking and clamping results in very fast ‘turn on’ and ‘turn off’ times for the LED.

When driving lasers, it will often be helpful to disable this clamping. This can be achieved by leaving the V<sub>DD2</sub> connections floating. V<sub>DD1</sub> must still be connected.

**LED Drive Pulse Width Adjust (PWA)**

The input pulse width can be adjusted prior to application to the LED switch. The differential voltage on the PWA (Pulse Width Adjust) pins shapes the input pulse linearly over a nominal -500 to +500 ps range, according to the formula:

$$\Delta PW (ps) = K \times V_{PWA}$$

Where:

$$K = 500 \pm 100$$

and

$$V_{PWA} = (V_{PWA+}) - (V_{PWA-})$$

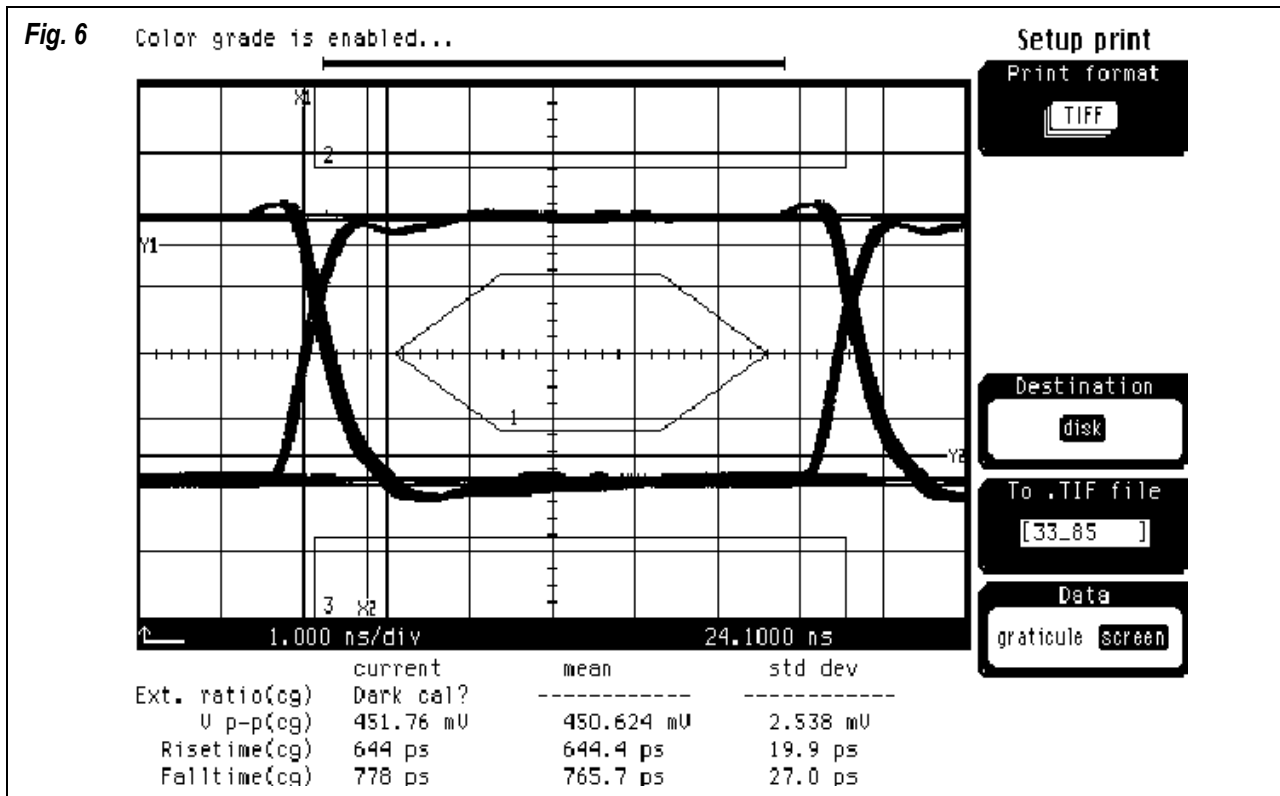
The maximum range for  $V_{PWA}$  is  $\pm 1V$ . The input impedance is  $3.6 k\Omega$ .  $V_{PWA+}$  and  $V_{PWA-}$  will settle at a nominal voltage equal to  $(0.6 * V_{DD})$  if left floating. It is recommended that adjustment be implemented by pull down resistors on PWA+ or PWA-. However, it is common for one or other pin to be tied to ground as a zero-cost, 'gross' adjustment.

If pulse width adjustment is not required PWA+ and PWA- should be tied to ground.

**Eye Diagram**

The eye diagram below is typical of the electrical output of the MC2042-4. The crossover point can be moved up and down using the PWA pin. The overshoot can be increased by using the PEAK pin.

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BARE DIE

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Fig. 8

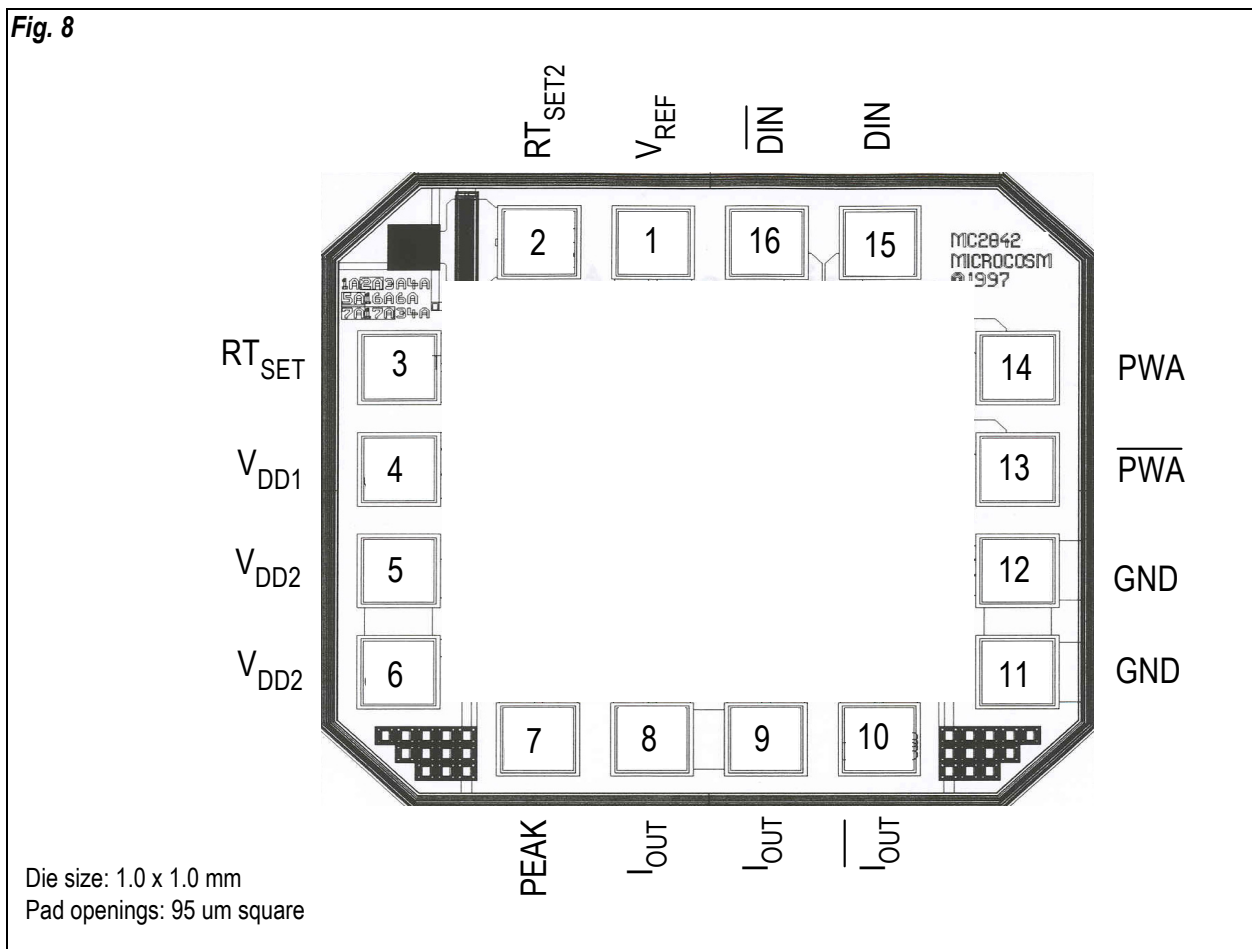


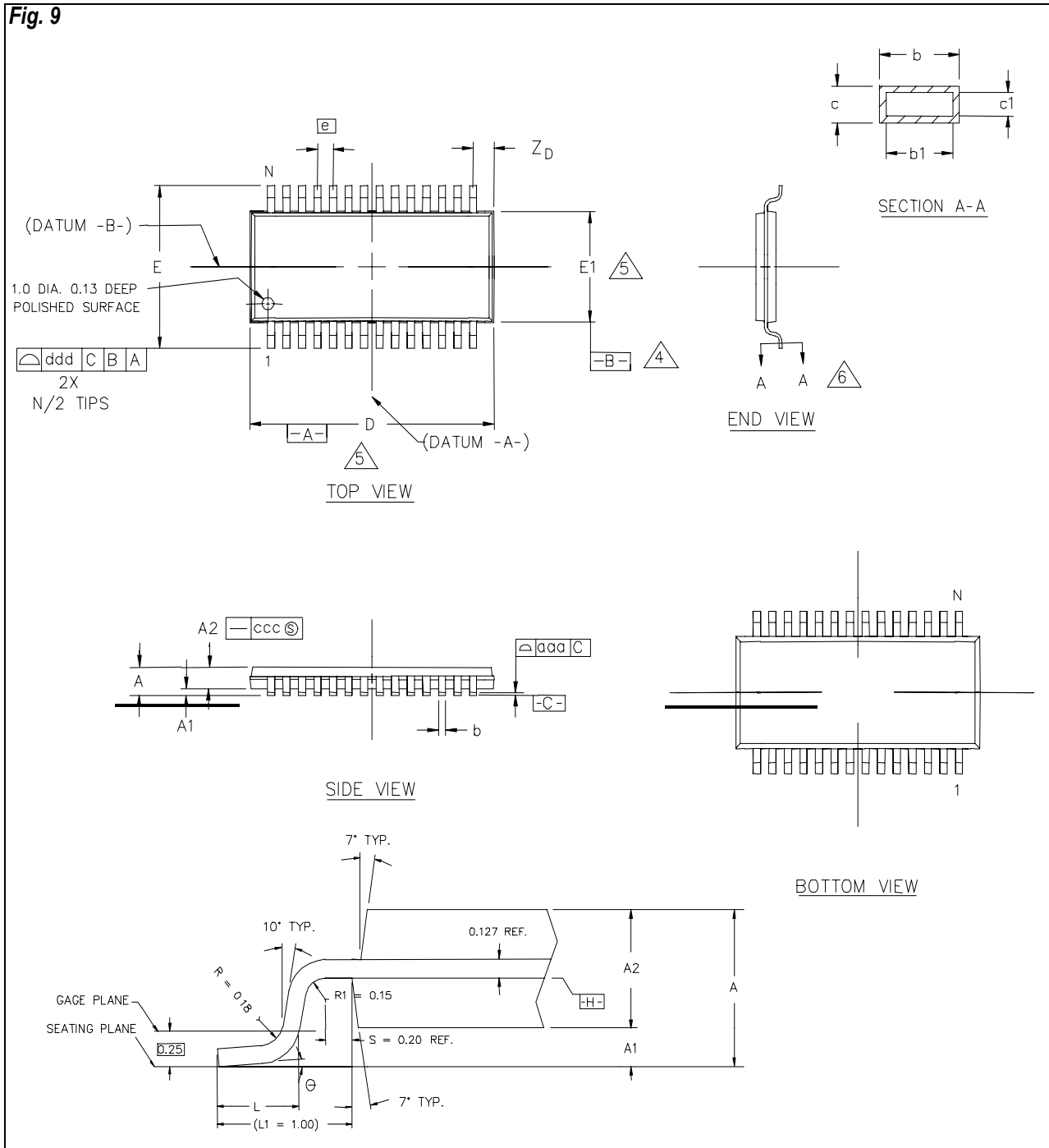
TABLE 6 BARE DIE PAD COORDINATES

Pad	Description	X	Y	Pad	Description	X	Y
1	V <sub>REF</sub>	-73	394.5	9	I <sub>OUT</sub>	73	-394.5
2	RT <sub>SET2</sub>	-219	394.5	10	I <sub>OUT</sub>	219	-394.5
3	RT <sub>SET</sub>	-397	214.7	11	GND	397	-223.3
4	V <sub>DD1</sub>	-397	68.7	12	GND	397	-77.3
5	V <sub>DD2</sub>	-397	-77.3	13	PWA	397	68.7
6	V <sub>DD2</sub>	-397	-223.3	14	PWA	397	214.7
7	PEAK	-219	-394.5	15	D <sub>IN</sub>	219	394.5
8	I <sub>OUT</sub>	-73	-394.5	16	D <sub>IN</sub>	73	394.5

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TSSOP20 PACKAGE INFORMATION

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Note:

Package dimensions on page 12.

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QSOP16 PACKAGE INFORMATION

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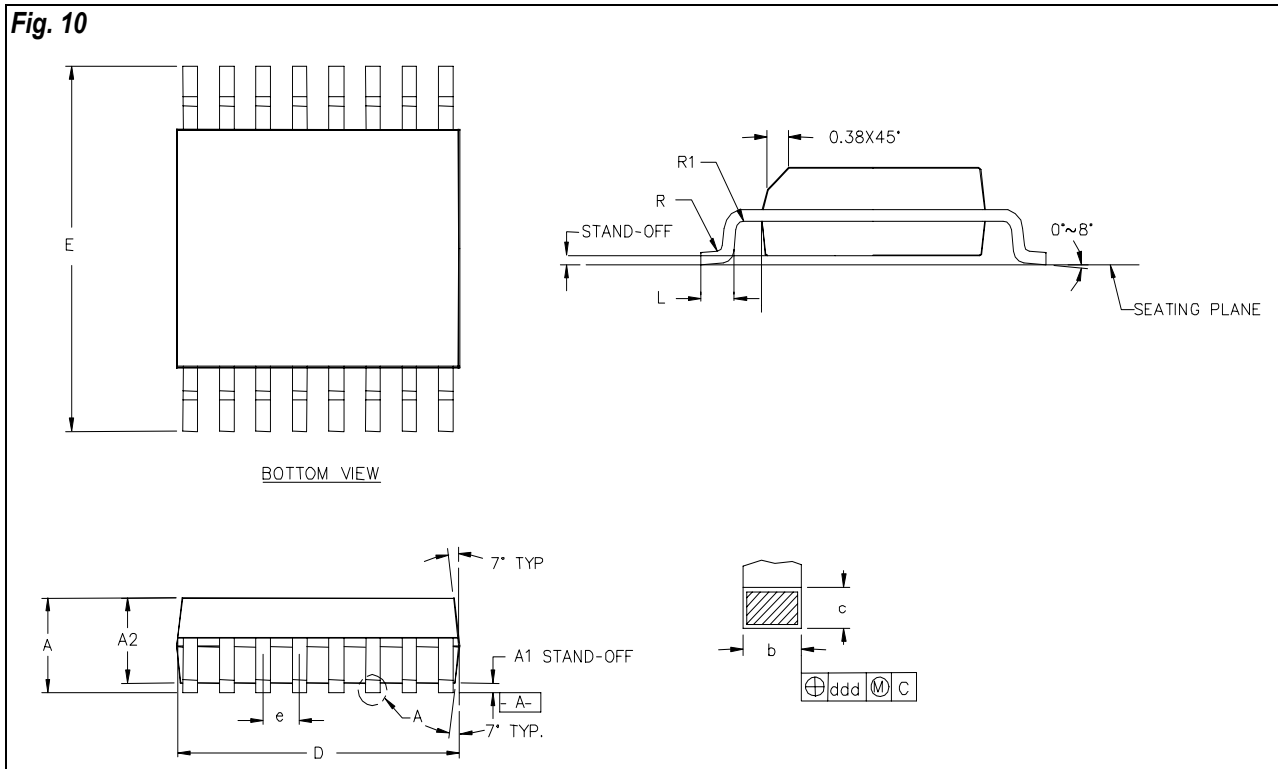


TABLE 7 TSSOP20 DIMENSIONS

Dims.	Tols/leads	TSSOP20L
A	MAX	1.20
A1		0.5MIN/.10MAX.
A2	NOM	.90
D	±.05	6.50
E	±.10	6.40
E1	±.10	4.40
L	+ .15/- .10	.60
L1	REF.	1.00
Zp	REF.	.325
e	BASIC	.65
b	±.05	.22
c		.13MIN/.20MAX
e	±4°	4°
aaa	MAX.	.10
bbb	MAX.	.10
ccc	MAX	.05
ddd	MAX.	.20

TABLE 8 QSOP16 DIMENSIONS

Dims.	Tols/N	QSOP16
A	MAX.	1.60
A1	±.05	0.1
A2	±.10	1.40
D	±.10	4.9
E	±.20	6.00
E1	±.10	3.90
L	±.05	0.6
ccc	MAX.	0.10
ddd	MAX.	0.10
e	BASIC	0.65
b	±.05	0.25
c	±.05	.2 Min. .24 Max.
R	±.05	0.20
R1	Min.	0.20

## LED/Laser Driver for FDDI, Fast Ethernet, Fibre Channel OC3/STM-1

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