ELM186CxA 120mA laser diode driver

■General description

ELM186CxA is a bipolar IC with APC drive circuit for laser diode(LD) applications. It can drive up to 120mA of LD forward current. Laser output power is controlled at constant value by a function of APC.

It consist of a band gap reference and an APC circuit. Laser power is adjusted by an external resistor which defines output laser power. ELM186CxA application circuit occupies only small area on PCB by SC-70-5 small package and a few external passive parts.

Four versions, ELM186C1A, ELM186C2A, ELM186C3A and ELM186C4A are prepared to drive all kinds of laser diode modules(LDMs) which have 4 combinations of each pin's polarity. All types of LDMs which have pins of LD cathode/LD anode and MD cathode/MD anode can be driven by a suitable version of ELM186CxA.

ELM186CxA consumes 0.6mA typ, and operates from 3.0V to 12.0V VCC.

■Features

- External adjustment for output laser power
- Internal voltage reference : Typ.1.25V
- Operation voltage : 3.0V to 12.0V
- Low power consumption : Typ.0.6mA
- LD drive current : Max.120mA
- Package : SC-70-5 (5 Pin)

■Application

- Laser pointers
- Laser levels
- Other LD applications

■Maximum absolute ratings

Parameter	Symbol	Limit	Unit
Operation voltage	Vcc	13.0	V
Power dissipation	Pd	300	mW
Operation temperature range	Top	-40 to +85	°C
Storage temperature range	Tstg	-55 to +150	°C

■Selection guide

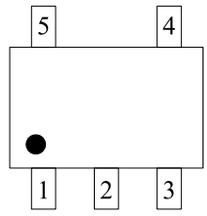
ELM186CxA-x

Symbol		
a	Package	C: SC-70-5
b	Pin configuration type	1 : type1 2 : type2 3 : type3 4 : type4 (Refer to pin configuration)
c	Product version	A
d	Taping direction	S, N: Refer to PKG file

ELM186C x A - x
↑ ↑ ↑ ↑
a b c d

■Pin configuration

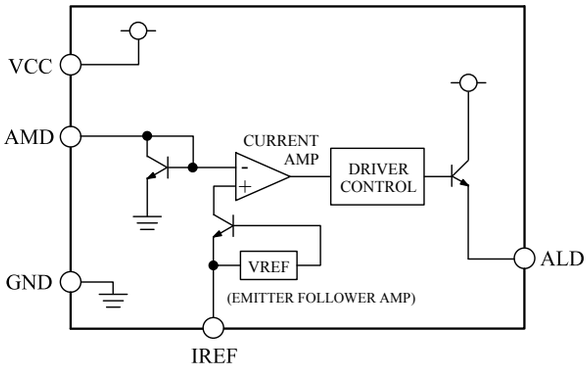
SC-70-5(TOP VIEW)



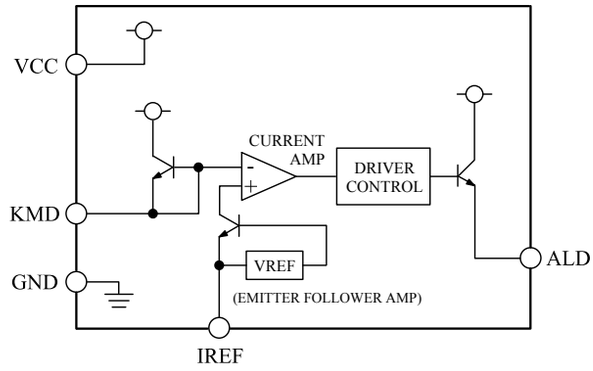
Pin No.	Pin name			
	type1	type2	type3	type4
	ELM186C1A	ELM186C2A	ELM186C3A	ELM186C4A
1	ALD	ALD	KLD	KLD
2	GND	GND	GND	GND
3	VCC	VCC	VCC	VCC
4	IREF	IREF	IREF	IREF
5	AMD	KMD	AMD	KMD

■Block diagram

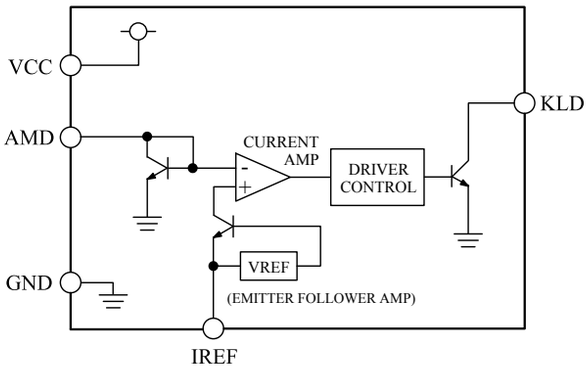
ELM186C1A



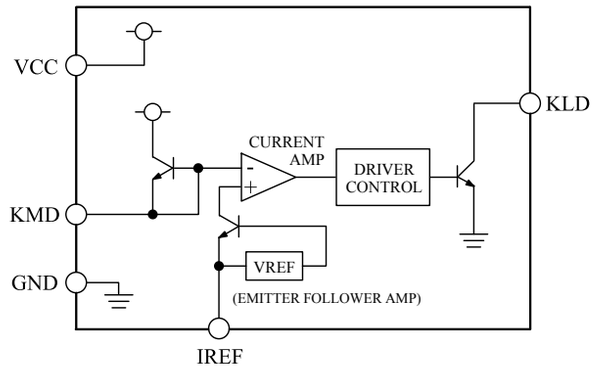
ELM186C2A



ELM186C3A



ELM186C4A



Pin descriptions

Pin Name	Function	Description
ALD	LD drive output	Connect to anode of laser diodes. Emitter output of internal NPN transistor.
KLD	LD drive output	Connect to cathode of laser diodes. Collector output of internal NPN transistor.
AMD	MD current input	Connect to anode of monitor diode. Sinks photo current from monitor diode.
KMD	MD current input	Connect to cathode of monitor diode. Sources photo current to monitor diode.
IREF	Iref setting	Connect an external resistor from IREF to GND. Emitter output of reference voltage source. The current at the resistor is copied to be a reference current for APC operation.
VCC	Power input	Power input of IC.
GND	Ground	Ground of IC.

Internal blocks and operation :

ELM186CxA consists of a reference voltage circuit, a reference current generator, a current operation circuit and a LD driving output transistor.

The reference current generator has a function to generate reference current for APC function defined by an external resistor at IREF pin. The current operational circuit controls output current to the LD in condition of flowing same current between the reference current and the photo current from a monitor diode's anode or cathode. The output transistor is a 120mA capable NPN bipolar transistor.

ELM186CxA has two types of output, ALD is an emitter output for LD anode drive and KLD is a collector output for LD cathode drive. Two photo current polarity inputs are prepared. AMD is connected to an anode of the monitor diode. KMD is connected to the cathode of monitor diode. AMD is a input pin to an anode of internal PN diode, and KMD is a input pin to a cathode of internal PN diode. Each diode works as a part of current mirrors.

ELM186CxA works as follows.

The reference current which defines output power of the LD is generated as a constant value by a band gap reference and a external resistor. The monitor current is proportional to the laser power. When ELM186CxA is in operation, the laser monitor current is compared with the reference current by a current operational amplifier. The difference current is maginified in very large amplitude. The amplified current is output to drive the laser diode. Consequently the output current is increased when the monitor current is smaller than the reference. And the output current is decreased when the monitor current is larger. Eventually the laser output is controlled in a constant power defined by the external resistor. The control error is caused from current gain of the amplifier. AMD/KMD current is recommended to be less than 1000μA. Since the reference voltage is approximately 1.25 V, the IREF pin resistance in that case is 1.25 kΩ or more.

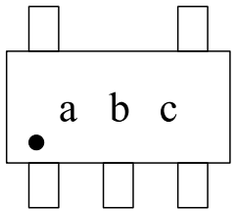
■Electrical characteristics

VCC=+5V, Top=25°C, unless otherwise noted

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating voltage	Vcc		3.0		12.0	V
Current consumption	Icc	Vcc=5.0V, Iref register=22kΩ	0.3	0.6	1.2	mA
IREF reference voltage	Vref	Vcc=5.0V, Iref register=22kΩ	1.15	1.25	1.35	V
IREF current range	Iref			50		μA
ALD output current	Io_ald		-120			mA
KLD output current	Io_kld				120	mA
ALD leak current	Il_ald				1.0	μA
KLD leak current	Il_kld		-1.0			μA
AMD input current	Ii_amd			50	1000	μA
KMD input current	Ii_kmd		-1000	-50		μA

■Marking

SC-70-5



Symbol	Mark	Content
a	M	Series : 186
d	1 to 4	Pin type display
c	0 to 9 and A to Z (I, O, X excepted)	Assembly lot No.

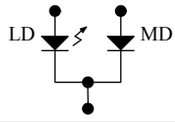
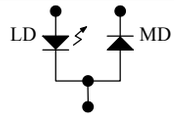
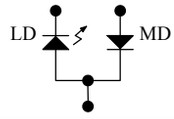
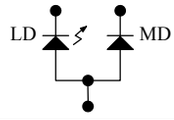
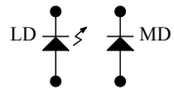
■Appliation circuits

LDMs are used in many LD applications. A LDM contain a laser diode and a monitor diode in one package. These two diodes are optically connected inside the package. The monitor diode is a PN diode generates photo current to measure photo power from the LD.

ELM186CxA can drive 4 kinds of laser diode modules(LDMs) having different polarity pins.

Each ELM186CxA can drive only corresponding polarity of laser diodes(LD) and monitor diodes(MD). Table1 shows ELM186CxA and laser diode modules (LDM) combinations.

Table 1 :

No.	Laser diode module pins	Parts number of ELM186CxA
1	 : LD anode, common, MD anode	ELM186C1A(Fig.2) or ELM186C3A(Fig.6)
2	 : LD anode, common, MD cathode	ELM186C2A(Fig.4) or ELM186C4A(Fig.8)
3	 : LD cathode, common, MD anode	ELM186C1A(Fig.1) or ELM186C3A(Fig.5)
4	 : LD cathode, common, MD cathode	ELM186C2A(Fig.3) or ELM186C4A(Fig.7)
5	 : Other LDM without a common pin	All ELM186CxA

LD anode driving applications

ELM186C1A and C2A are used when LD anode is driven. ALD is NPN emitter follower output. LD anode driving application only requires a resister for output power definition. Only a noise absorbing capacitor at VCC is recommended.

Operation voltage is 5V or higher because it is necessary to have the sum of IC operation voltage and to LD forward voltage. LD anode drive has advantages on heat dissipation and fewer RC parts. The cases of LD modules can be directly grounded in Fig.1 for good heat dissipation.

ELM186C2A needs to have a compensation capacitor and a resistor at KMD pin for stable operation in Fig.3 and Fig4.

LD anode driving application circuits Fig.1, Fig.2, Fig.3, Fig.4.

Fig.1

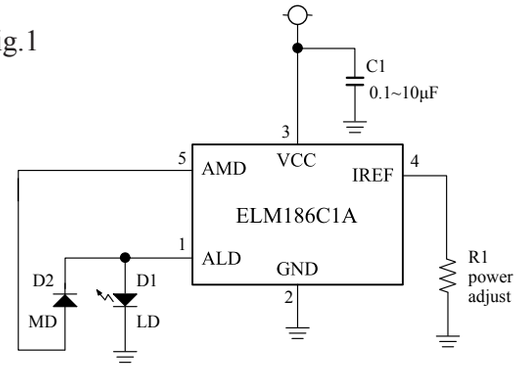


Fig.2

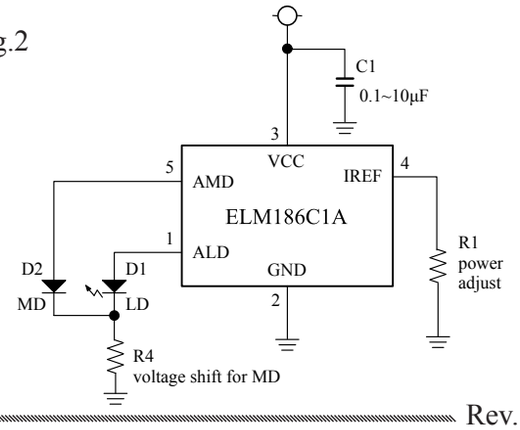


Fig.3

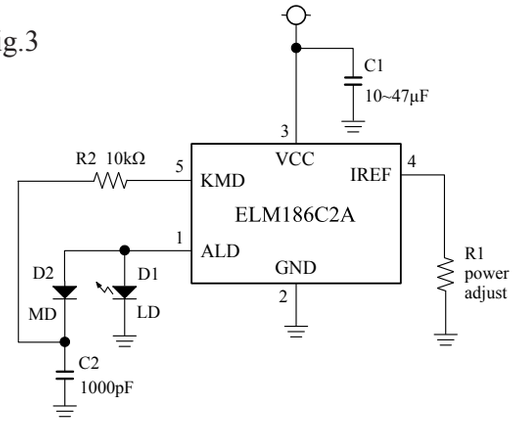
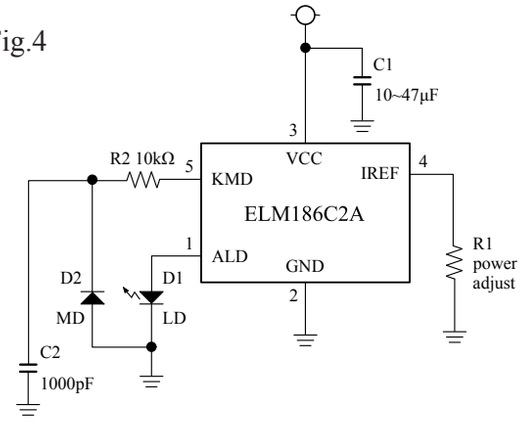


Fig.4



Method of determining circuit constants (Figures 1 to 4)

The laser diode module is assumed to have the characteristics of drive current IF = 40mA, forward voltage VF = 2.2V, and monitor current IM = 100μA at the rated 5mW operation.

In the case of Fig.1:

Supply voltage VCC = VF + 3V = 5.2V or more, reference resistor R1 = VREF / IM = 1.25V / 100μA = 12.5kΩ, and supply capacitor C1 is 0.1μF to 10μF.

In the case of Fig.2 (Use a voltage drop of 1V on R4 to reverse bias MD) :

Power supply voltage VCC = VF + 4V = 6.2V or more, reference resistance R1 = VREF / IM = 1.25V / 100μA = 12.5kΩ, voltage shift resistance R4 = shift voltage / IF = 1V / 40mA = 25Ω, power supply capacitor C1 is 0.1 μF to 10 μF, optional for power stabilization.

In the case of Fig. 3 (Add R2 and C2 for APC stabilization):

Power supply voltage VCC = VF + 3V = 5.2V or more, reference resistance R1 = VREF / IM = 1.25V / 100μA = 12.5kΩ, stabilized CR is C = 1000pF, R = 10kΩ, power supply capacitor C1 is 10μF to 47μF, It is optional for power stabilization.

In the case of Fig. 4 (Add R2 and C2 for APC stabilization):

Power supply voltage VCC = VF + 3V = 5.2V or more, reference resistance R1 = VREF / IM = 1.25V / 100μA = 12.5kΩ, stabilized CR is C = 1000pF, R = 10kΩ, power capacitor C1 is 10μF to 47μF, It is optional for power stabilization.

CR Example: R1 = 12kΩ (Iref = 100μA), R2 = 10kΩ to 2kΩ, C2 = 1000pF, R4 = 25Ω (Ild = 40 mA)

LD cathode driving applications

ELM186C3A and C4A are used when LD cathode is driven. KLD is NPN Collector output. Power supply voltage is possible to down till 3V(forward voltage of LD +0.5V). A decoupling CR network for VCC pin and a compensation CR network for AMD/KMD pin are needed to keep APC loop stability.

Decoupling CR filter's time constant is more than 1msec. Examples are 100Ω×10μF and etc. .

LD cathode driving application circuits Fig.5, Fig.6, Fig.7, Fig.8.

Fig.5

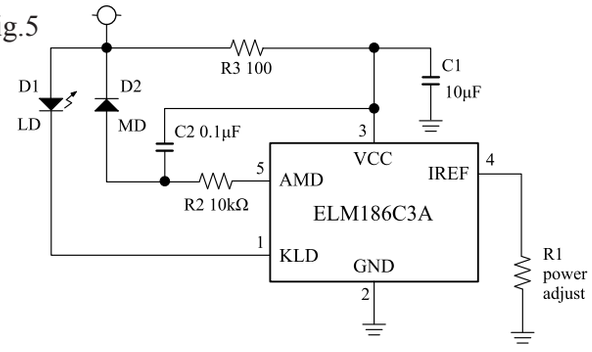


Fig.6

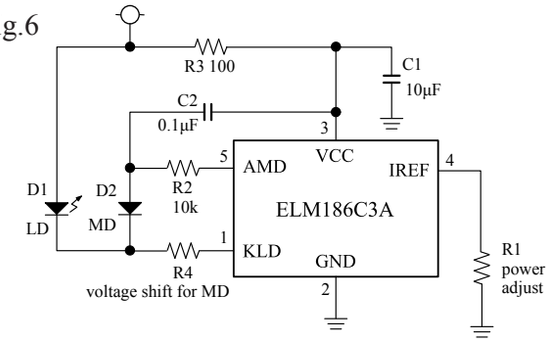


Fig.7

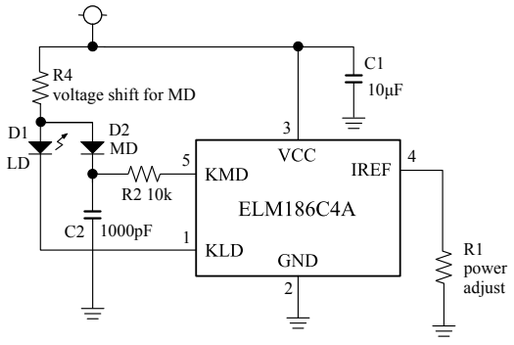
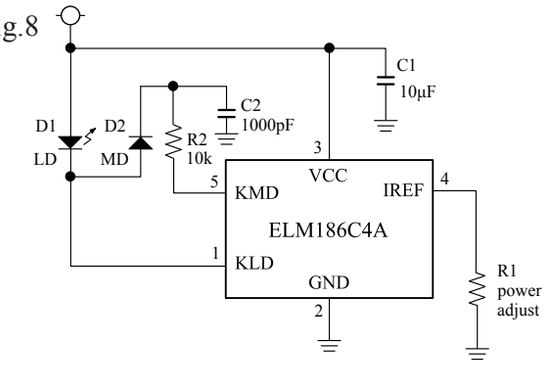


Fig.8



CR example : R1=12kΩ(Iref=100μA), C1=10μF, C2=0.1μF(ELM186C3A), C2=1000pF(ELM186C4A), R2=10kΩ, R4=25Ω(Ild=40mA)

Tips for PCB design:

Consider low thermal resistance on PCB layout design. Thermal vias are recommended on PCB.

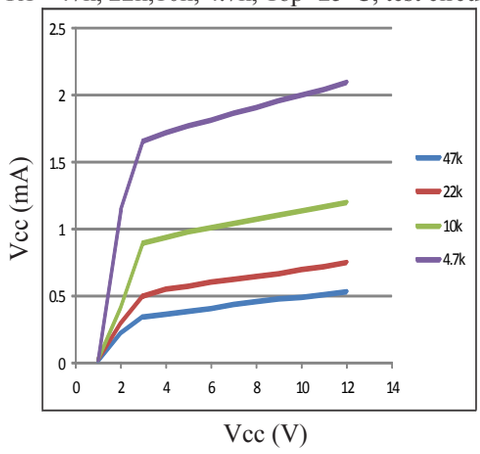
IREF pin to resistor connection should be a short line to reduce stray capacitance. Power lines toVCC and LD are branched at input point of PCB to prevent influence of voltage drops on power lines. Ground plane is strongly recommended to get lower ground impedance by using a multi layers PCB.

■Electrical characteristics curves

1. Power consumption

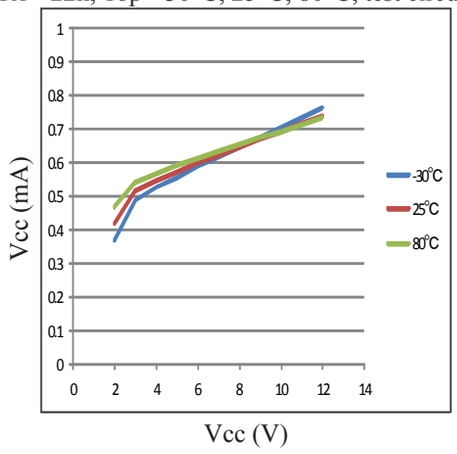
Vcc vs. Icc

R1= 47k, 22k,10k, 4.7k, Top=25°C, test circuit 1



Vcc vs. Icc

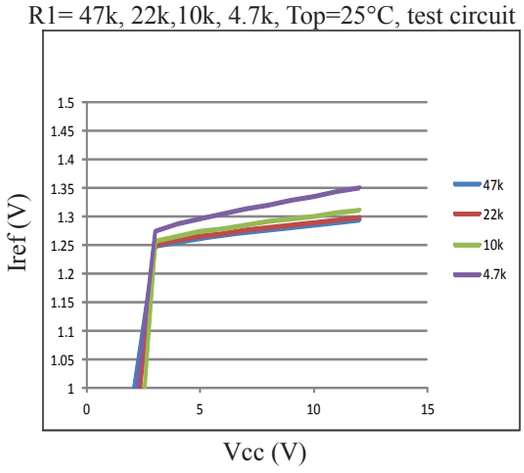
R1= 22k, Top=-30°C, 25°C, 80°C, test circuit 1



2. Voltage reference stability

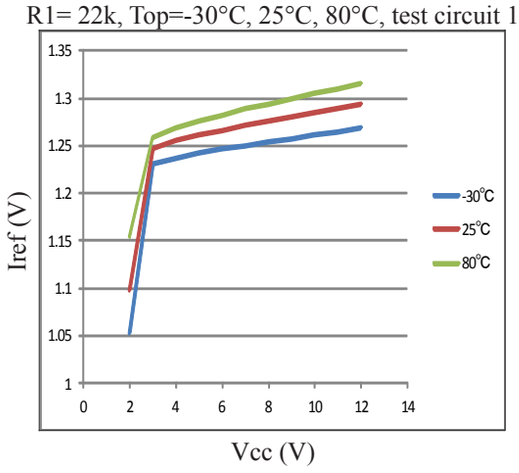
Vcc vs. Iref voltage

R1= 47k, 22k,10k, 4.7k, Top=25°C, test circuit 1



Vcc vs. Iref voltage

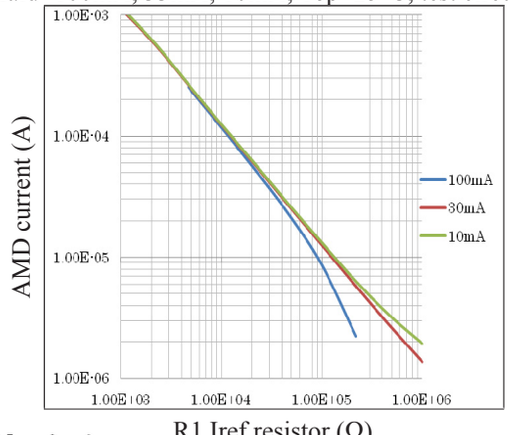
R1= 22k, Top=-30°C, 25°C, 80°C, test circuit 1



3. LD drive characteristics

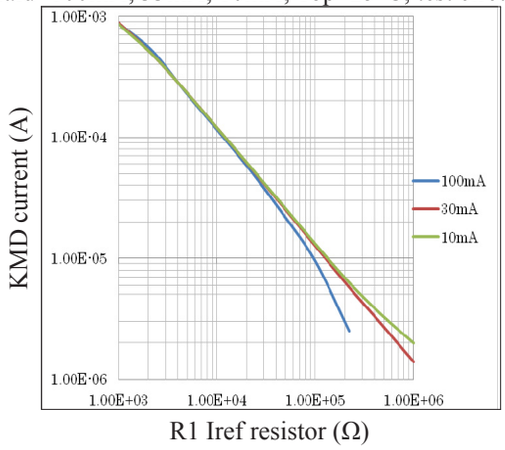
Iref resistor vs. AMD current

Iald=100mA, 33mA, 10mA, Top=25°C, test circuit 2



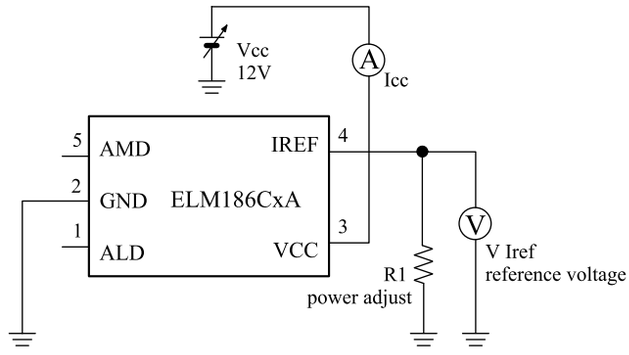
Iref resistor vs. KMD current

Iald=100mA, 33mA, 10mA, Top=25°C, test circuit 3

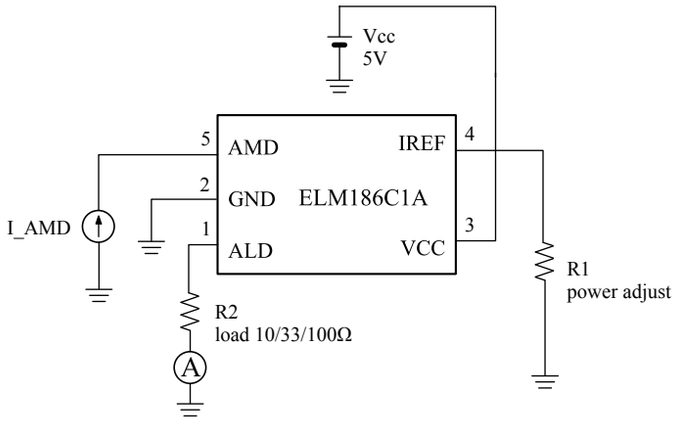


■Test circuits

• Test circuit 1



• Test circuit 2



• Test circuit 3