A 4026

LED Controller, 6-Channel, with Fault Diagnostics

Description

The CAT4026 is a high performance, large panel LED controller designed to control six constant current high voltage LED strings. Added control circuitry monitors the lowest cathode voltage and generates a feedback control signal to an external Switch Mode Power Supply (SMPS) to provide a low cost and efficient solution for large panel high voltage LED backlighting.

Each LED channel current is accurately matched and controlled by sensing an external resistor in series with a low cost bipolar power transistor. This allows current and heat dissipation concerns to be mitigated from the CAT4026 device package.

For added system reliability, both Open−Cathode−Anode (OCA) and Shorted−Cathode−Anode (SCA) fault detection circuitry has been included along with independent Fault flag logic outputs for diagnostic purposes.

LED current dimming in all six channels can be precisely controlled by either a Pulse Width Modulation signal via the PWM input pin or by an analog dimming voltage applied at the ANLG pin. In addition the ANLG pin provides a convenient method for limiting the overall maximum power dissipation in the event of excessive LED shorting within any LED string.

The device will automatically enter low current shutdown mode by taking the PWM pin low for an extended length of time.

Features

- 6 Channel LED Controller
- Adaptive Feedback Control to External SMPS for Better Efficiency
- PWM and Analog Mode Dimming
- Short Cathode−Anode (SCA) Fault Protection
- Open Cathode−Anode (OCA) Fault Protection
- Over−Voltage Protection
- Thermal Shutdown Protection
- Automatic Inactivity Power Down Mode
- SOIC−28L Package
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Typical Applications

- LCD−TV LED Backlighting
- LED General Lighting

http://onsemi.com

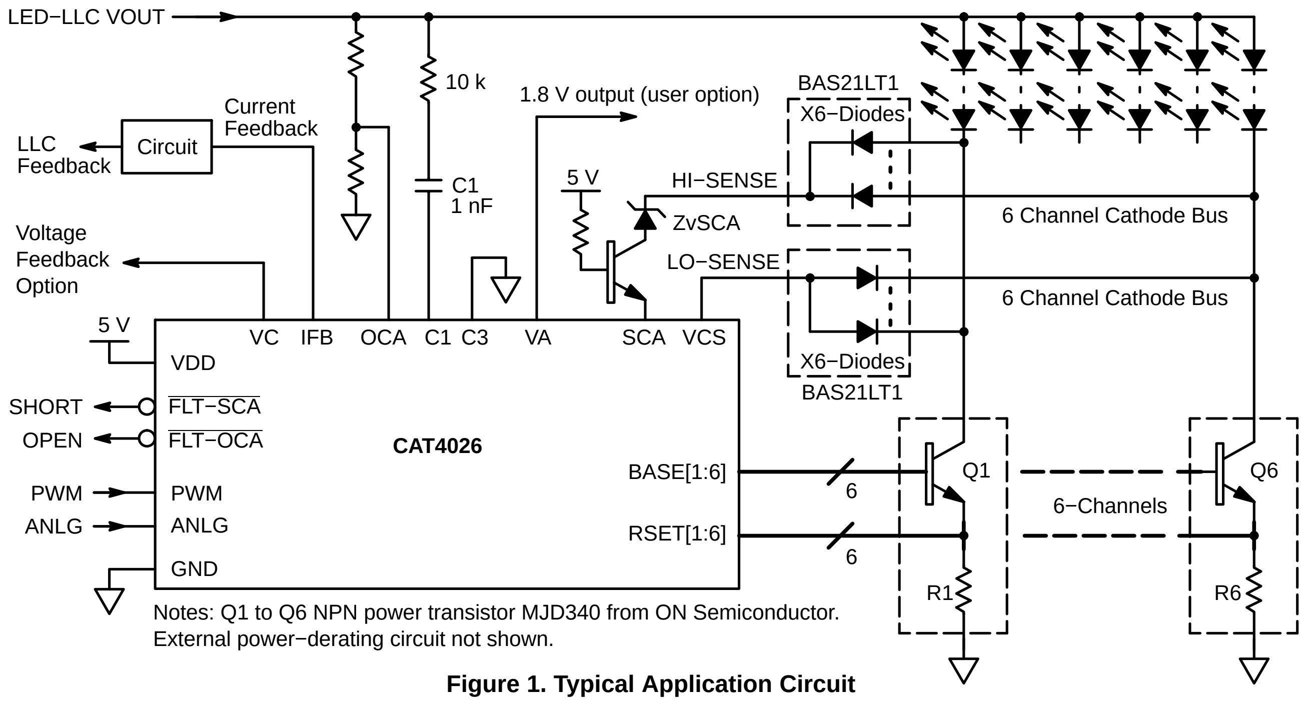
SOIC−28
V SUFFIX
CASE 751BM

PIN CONNECTIONS

MARKING DIAGRAM

L = Assembly Location Code
3 = Mark “3” for (lead finish Matte−XXXXt

May, 2011 − Rev. 5
Publication Order Number:
CAT4026/D



Notes: Q1 to Q6 NPN power transistor MJD340 from ON Semiconductor.
External power−derating circuit not shown.

Figure 1. Typical Application Circuit

Table 1. ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
VDD Voltage Range	V_{in}	−0.3 to 7	V
PWM, ANLG, $\overline{\text{FLT−OCA}}$, $\overline{\text{FLT−SCA}}$ Voltage Range	PWM	−0.3 to 7 V or (V_{in} + 0.3), whichever is lower	V
RSET[x], BASE[x]		−0.3 to 7 V or (V_{in} + 0.3), whichever is lower	V
Maximum Junction Temperature	$T_{J(max)}$	150	°C
Storage Temperature Range	T_{STG}	−65 to 150	°C
Lead Temperature Soldering Reflow (SMD Styles Only), Pb−Free Versions (Note 3)	T_{SLD}	260	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

2. This device series incorporates ESD protection and is tested by the following methods:
   ESD Human Body Model tested per AEC−Q100

2.Charact

Table 4. ELECTRICAL CHARACTERISTICS (V_{DD} = 5 V, V_{PWM} = V_{DD}, V_{ANLG} = 3.3 V, for typical values T_A = 25°C, for min/max values T_A = −40°C to +85°C; unless otherwise noted.)

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
RSET[x] pin voltage		V_{RSET}	0.97	1.00	1.03	V
RSET channel to channel voltage matching	$(V_{RSET} – V_{RSETAVR}) / V_{RSETAVR}$, Nominal current 100 mA per channel	$V_{RSET−MAT}$		±0.6	±2.0	%

Table 4. ELECTRICAL CHARACTERISTICS (V_{DD} = 5 V, V_{PWM} = V_{DD}, V_{ANLG} = 3.3 V, for typical values T_A = 25°C, for min/max values T_A = −40°C to +85°C; unless otherwise noted.) (continued)

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
TIMING						
PWM Enable Time	V_{PWM} = 0 V to V_{DD} I_{out} = 0 mA to 90% of $I_{out(nom)}$	t_{EN}		800		ns
PWM Disable Time	V_{PWM} = V_{DD} to 0 V I_{out} = $I_{out(nom)}$ to 10% of $I_{out(nom)}$	t_{DIS}		1		μs
Turn−off Shutdown Time, PWM falling to shutdown	V_{PWM} = 5 V to 0 V I_{out} = $I_{out(nom)}$ to shutdown mode	t_{OFF}		25		ms
Channel to channel turn on and turn off delay (staggering)		t_{CC}		50		ns
THERMAL SHUTDOWN						
Thermal Shutdown TemperatureChs2 Tc65.5fBTemperature						

TYPICAL PERFORMANCE CHARACTERISTICS

(V_{DD} = V_{PWM} = 5 V, V_{ANLG} = 3.3 V, T_{AMB} = 25°C unless otherwise specified.)

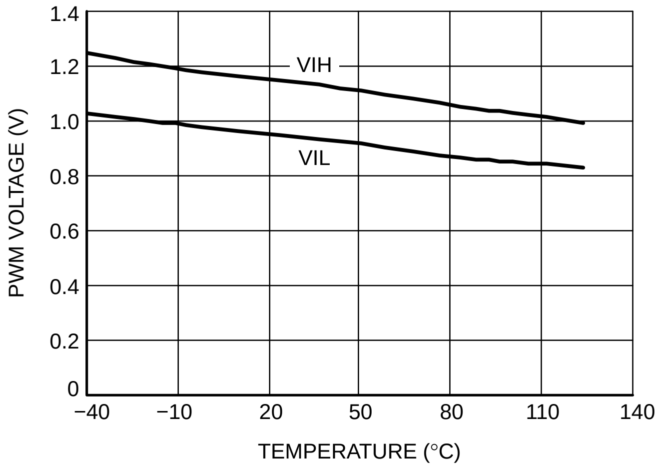


Figure 3. PWM Threshold Voltage vs. Temperature

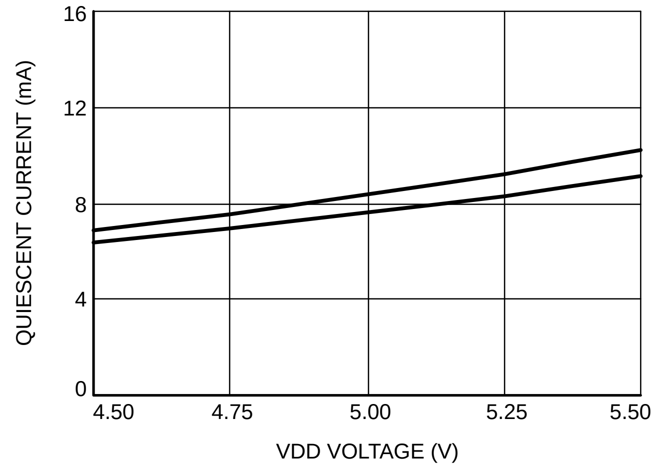


Figure 4. Quiescent Current vs. Temperature

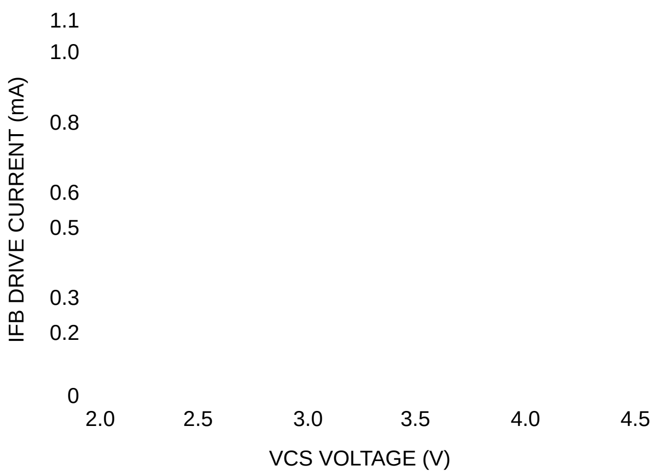


Figure 5. IFB Sink Current vs. VCS Voltage

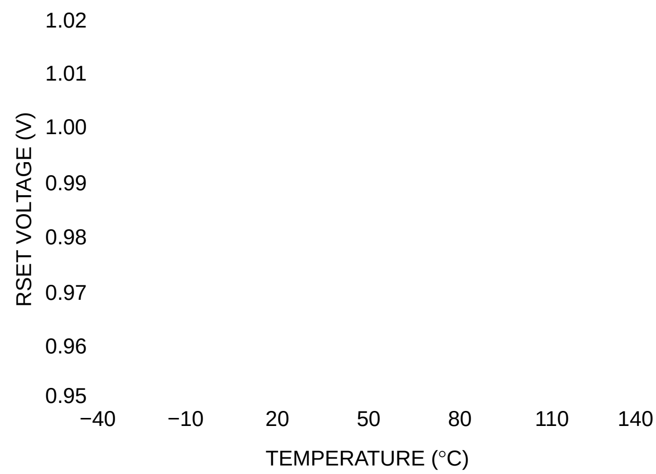


Figure 6. RSET Voltage vs. Temperature

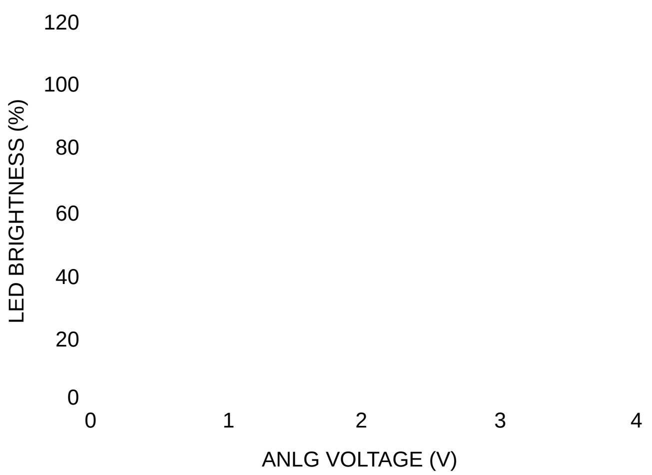


Figure 7. LED Brightness vs. ANLG Voltage

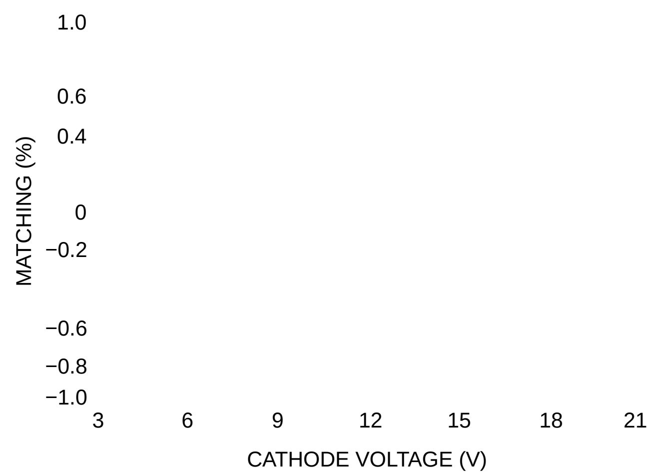


Figure 8. Matching Channel−to−Channel vs. Cathode Voltage

TYPICAL PERFORMANCE CHARACTERISTICS

($V_{DD} = V_{PWM}$ = 5 V, V_{ANLG} = 3.3 V, T_{AMB} = 25°C unless otherwise specified.)

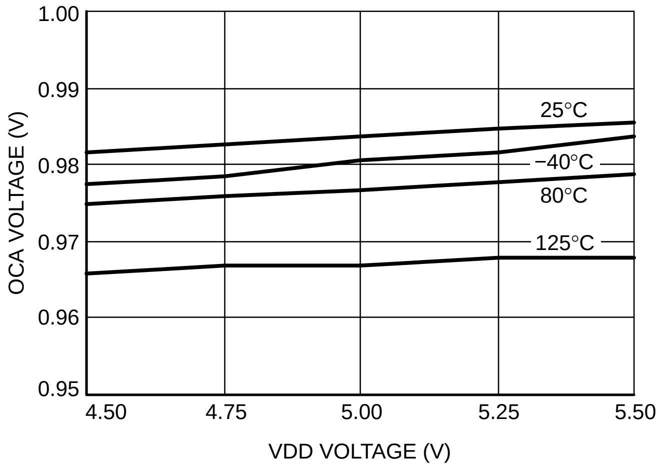


Figure 9. OCA Threshold Voltage vs. Temperature

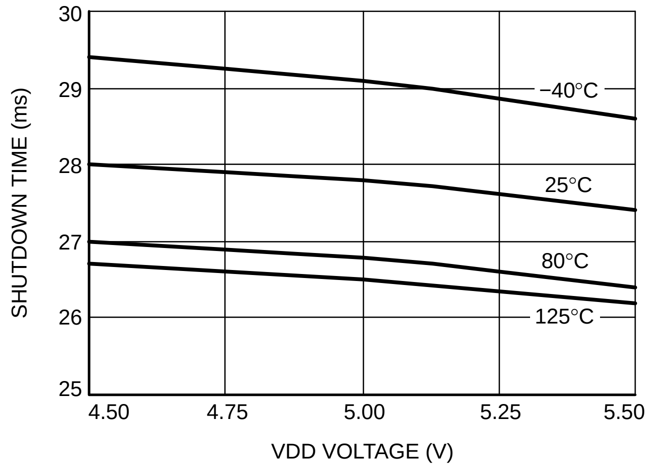


Figure 10. Shutdown Time vs. Temperature

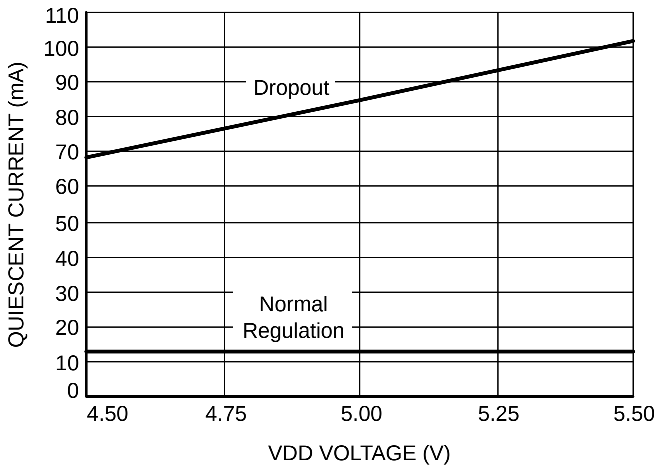


Figure 11. Quiescent Current vs. Supply Voltage (Note 6)

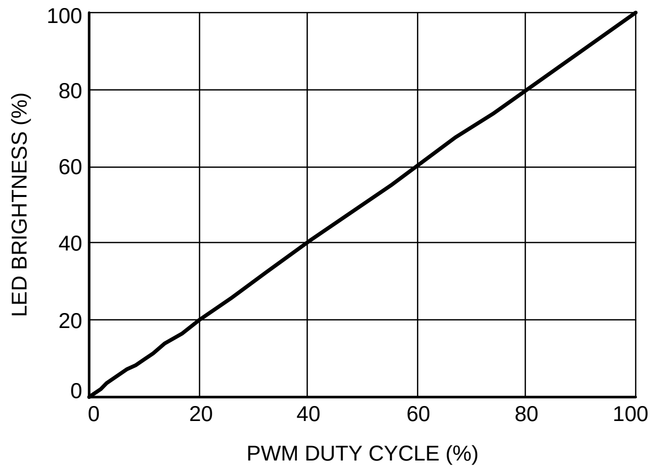


Figure 12. LED Brightness vs. PWM Duty Cycle

6. At initial power up, the CAT4026 will draw a higher quiescent current equal to the “dropout” current until it reaches normal regulation.

TYPICAL PERFORMANCE CHARACTERISTICS

(V_{DD} = V_{PWM} = 5 V, V_{ANLG} = 3.3 V, T_{AMB} = 25°C unless otherwise specified.)

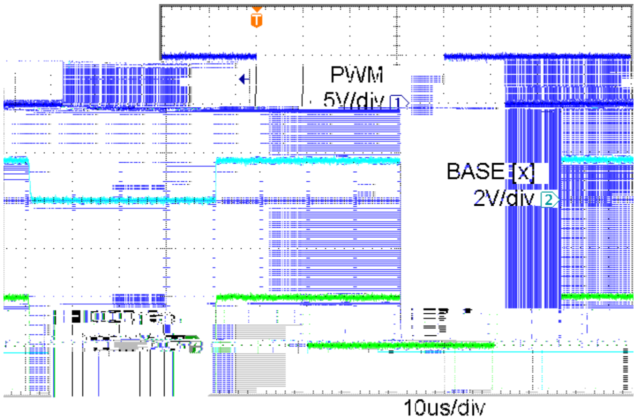


Figure 13. LED Current Transient During PWM Dimming

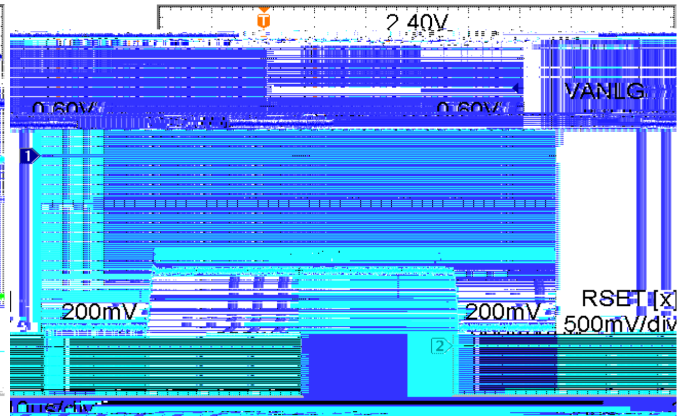


Figure 14. ANLG Transient, 20% to 80% Brightness

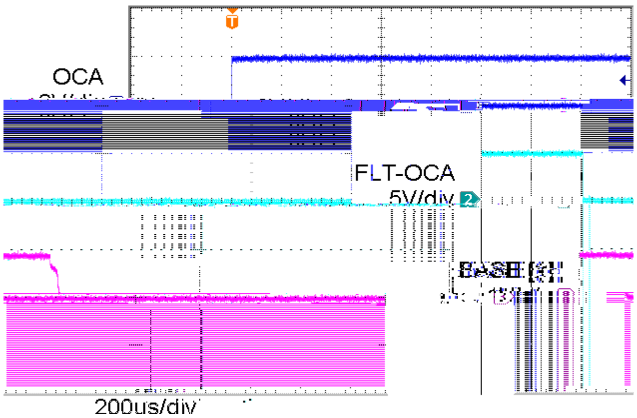


Figure 15. Open Cathode−Anode Waveform

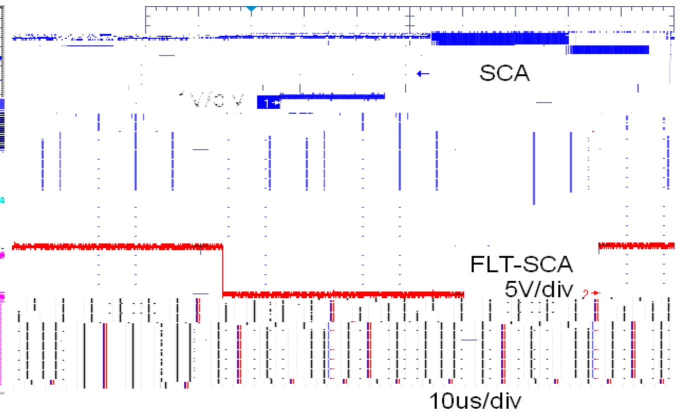


Figure 16. Short Cathode−Anode Waveform

Pin Functions

VDD

The VDD input is the positive supply to the devices. VDD should be nominally 5 V.

PWM

The PWM control input provides multiple functions. When the first rising edge is applied to PWM input, the CAT4026 will immediately power−up and remain powered up until the PWM input has been held low for at least typically 25 ms, at which point the device will enter full shutdown mode and draw zero current.

When PWM is active (high level), all LED channels are enabled. When PWM is inactive (low level), all LED channels are disabled. For PWM dimming frequencies in the

External adjustment of LED Anode supply voltage is controlled by the IFB current sink in conjunction with an external feedback circuit. The external circuit should be configured so that 1 mA drive signal will achieve the desired necessary dynamic adjustment range for expected worst case maximum LED string operating voltage range

A linear transconductance relationship exists for the drive current (1 mA/V) for Cathode operation between 2.5 V and 3.5 V.

C1

Connect a capacitor of 1 nF and a 10 kΩ resistor from the C1 pin to the LED Anode voltage. Capacitor voltage rating must be greater than the highest LED anode voltage.

C3

Connect pin to GND.

SCA

The SCA pin is used to detect a severe mismatch in LED string voltage, such as the occurrence of an Anode−Cathode short. The SCA pin is connected to each LED cathode via a diode array and a voltage level translator. The threshold voltage of the detector can be adjusted by using an external Zener diode.

A conduction level of 1.5 mA into the SCA pin will trigger a FAULT condition. The FAULT condition will be cleared upon the conduction current level falling below 0.5 mA and normal operation will resume.

OCA

The OCA input is used to detect and protect against abnormally high LED Anode condition. An external resistive divider connected to the OCA pin, from the LED Anode voltage, will trigger a $\overline{\text{FLT−OCA}}$ condition once the OCA input level exceeds 1.0 V. Any open−LED channel will automatically be disabled and removed from the feedback loop when OCA is triggered. This method provides an auto−recovery feature for the system to resume normal operation ensuring only the ‘good’ LED channels are included in the feedback loop.

If the open−LED function is not used, the OCA pin should be tied to GND.

VCS

The VCS pin is connected to each LED cathode via a diode array. This pin detects the lowest LED cathode voltage and sets the feedback signaling to allow the SMPS to adjust the LED Anode voltage to the appropriate levels for optimum efficiency (3 V operating point for the minimum cathode voltage on any string). An external high voltage diode array such as BAS21LT is recommended.

VA

The VA output pin is optional and allows the user to power an external feedback control circuit for setting the common LED Anode operating voltage level.

This output is a buffered voltage signal, which tracks 50% of the internal reference being used to control and set the nominal operating level of the lowest LED Cathode string voltage. An internal source impedance of 250 Ω is present on this output and the nominal voltage is set to 1.8 V (thermal compensation exists to cancel out the external sensing diode temperature coefficient present on the VCS pin).

VC

The VC pin is a buffered voltage signal, which tracks 50% of the voltage level present at the VCS input pin (i.e. the VC voltage is determined by the lowest operating Cathode voltage present on any LED string).

This signal provides a convenient feedback control method for systems which use standalone converters to generate the LED Anode supply voltage (as opposed to a current feedback option). An external suitable resistive divider, at the VC pin, can be used to directly control the feedback input of the standalone converter.

During shutdown mode, the VC pin is forced into high impedance mode, while during normal operation an output source impedance of 360 Ω is present on the VC pin.

Simplified Block Diagram

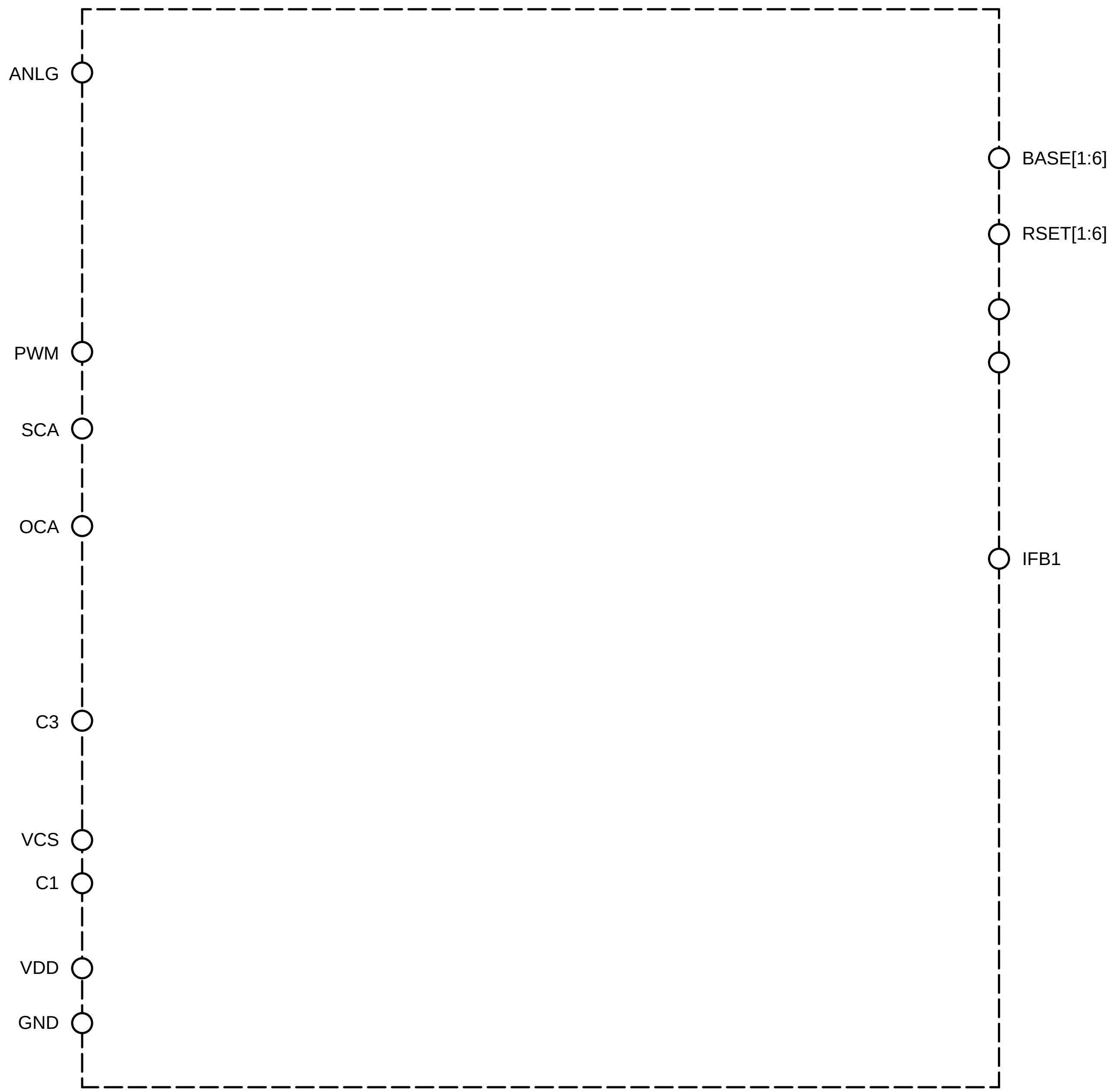
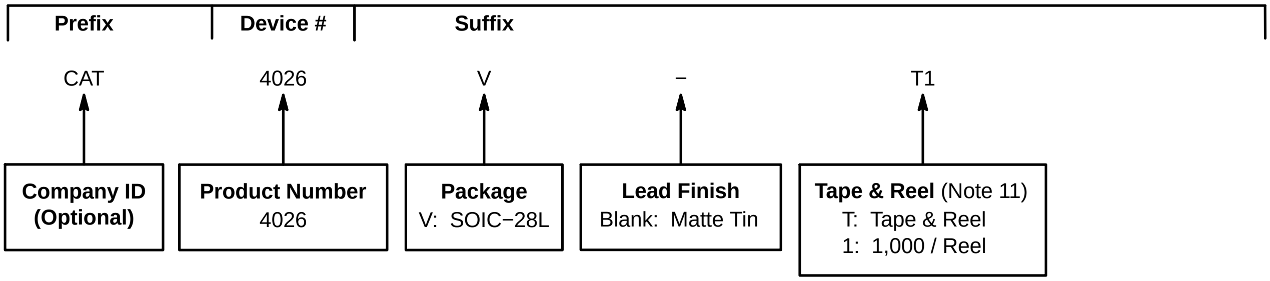


Figure 17. Simplified Block Diagram

Example of Ordering Information (Note 9)



7. All packages are RoHS−compliant (Lead−free, Halogen−free).
8. The standard lead finish is Matte Tin.
9. The device used in the above example is a CAT4026V−T1 (SOIC−28L, Matte Tin, Tape & Reel, 1,000/Reel).
10. For additional package and temperature options, please contact your nearest ON Semiconductor Sales office.
11. For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

SOIC−28, 300 mils
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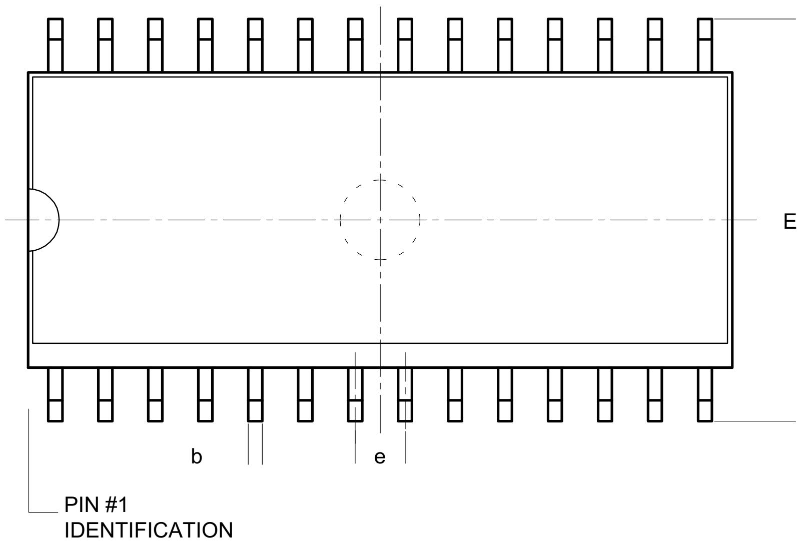
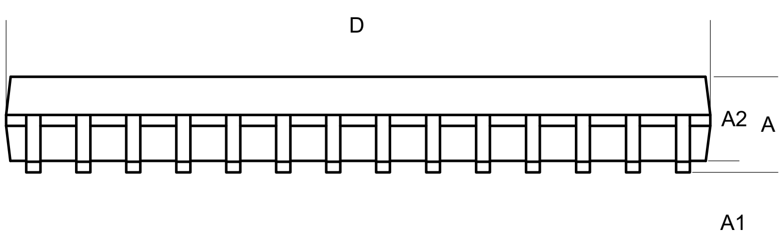
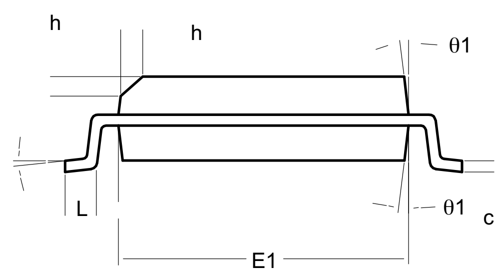
DATE 19 DEC 2008



TOP VIEW



SIDE VIEW



END VIEW

Notes:

(1) All dimensions are in millimeters. Angles in degrees.