Dual Channel Charge Pump LED Driver

General Description

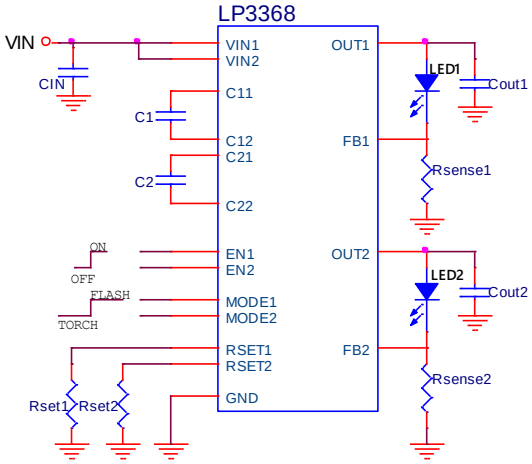
The LP3368 charge pump LED driver is designed for powering dual channel high brightness LEDs for camera flash applications. The LP3368 automatically switches modes between step-up and step-down ensuring that LED current does not depend on the forward voltage. The LP3368 provides two current levels for TORCH and FLASH modes in each channel. In TORCH mode, The LED current sense reference voltage is 50mV. The LED current can be determined by current sense resistor. In FLASH mode, the current sense reference voltage can be adjusted by external resistor. The maximum LED current can be set up to 1A. The LP3368 is available in a 16-lead 4mm*4mm TQFN-16 package and is rated over the -40°C to 85°C temperature range.

Order Information

LP3368 □ □ □

- F: Pb-Free
- Package Type
  - QV: TQFN-16

Typical Application Circuit



Features

- Input Voltage Range: 2.7V to 5.5V
- Adjustable FLASH Mode Current
- Output Current up to 1A in Each Channel
- Up to 95% Efficiency in Charge Pump Mode
- Automatic Step up/down Mode Switchover
- Minimum External Components: No Inductors
- <1uA Shutdown Current
- 2 MHz High Frequency Operation
- 50mV Reference for Low Loss Sensing
- PWM Dimming Control
- Automatic Soft Start Limits Inrush Current
- Over-Voltage Protection
- Over-Current protection
- Thermal Fault Protection
- Low Ripple and EMI
- Ultra-Low Dropout Voltage in Buck Mode
- 4mm×4mm TQFN-16 Package
- RohS Compliant and 100% Lead (Pb)-Free

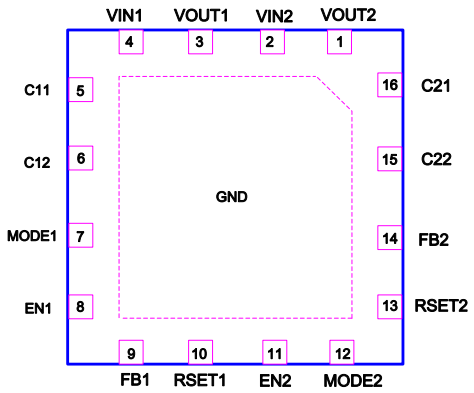
Applications

- White/Yellow LED Torch/Flash for mobile phone
- Generic lighting/Flash/Strobe Applications
- PDA/DSC/Camcorder
- MID/GPS Applications

Marking information

Device	Marking	Package	Shipping
LP3368	LPS LP3368 YWX	TQFN-16	3K/REEL
Y:Production year W:Production week X:Production batch			

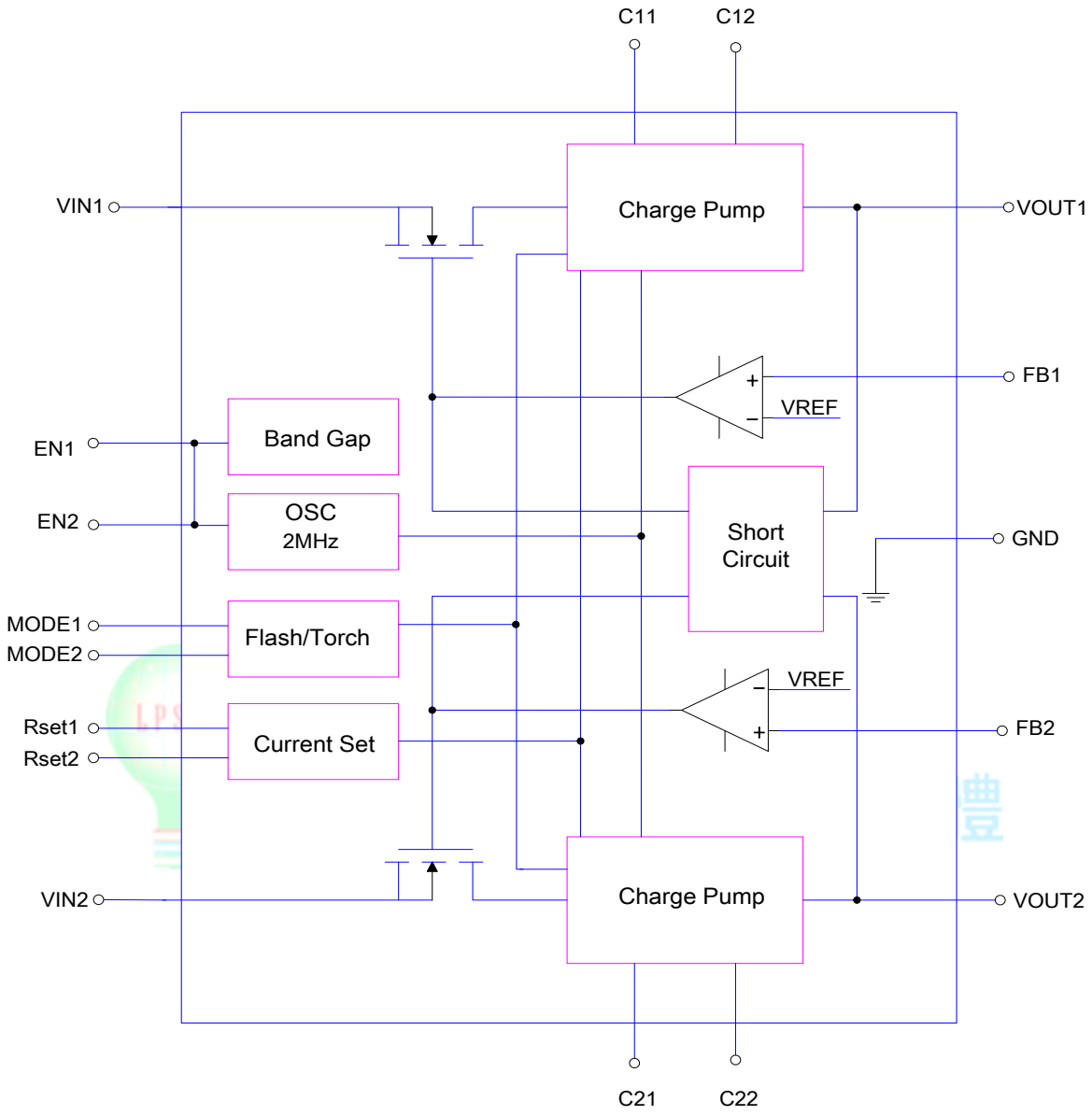
Functional Pin Description

Package Type	Pin Configurations
TQFN-16	

Pin Description

Pin	Name	Description
2,4	VIN1, VIN2	Input voltage for the charge pump, Decouple with 4.7uF ceramic capacitor close to the pins of the IC.
5,6	C11, C21	Positive input for the external flying capacitor. Connect a ceramic 1uF capacitor close to the pins of the IC.
15,16	C12, C22	Negative input for the external flying capacitor. Connect a ceramic 1uF capacitor close to the pins of the IC.
7,12	Mode1, Mode2	Logic input to toggle operation between FLASH and TORCH mode. In TORCH mode FB is regulated to the internal 50mV reference. In FLASH mode FB reference voltage can be adjusted by changing the resistor from R_{SET} pin to ground. Choose the external current sense resistor (R_{SENSE}) based on desired current in TORCH mode and FLASH mode.
8,11	EN1, EN2	Shutdown control Input. Connect to VIN for normal operation, connect to ground for shutdown.
10,13	Rset1, Rset2	Connect a resistor from this pin to ground, When in FLASH mode (MODE pin = High) this resistor sets the current regulation point according to the following: V_{FB} = (1.26V /R_{SET})×11.2kΩ
9,14	FB1, FB2	Feedback input for the current control loop. Connect directly to the current sense resistor.
1,3	VOUT1, VOUT2	Charge pump output voltage. Decouple with an external capacitor. At least 2uF is recommended. If Higher value capacitor is used output ripple is smaller.
Bottom Pad	GND	Ground pin.

Function Block Diagram



Absolute Maximum Ratings

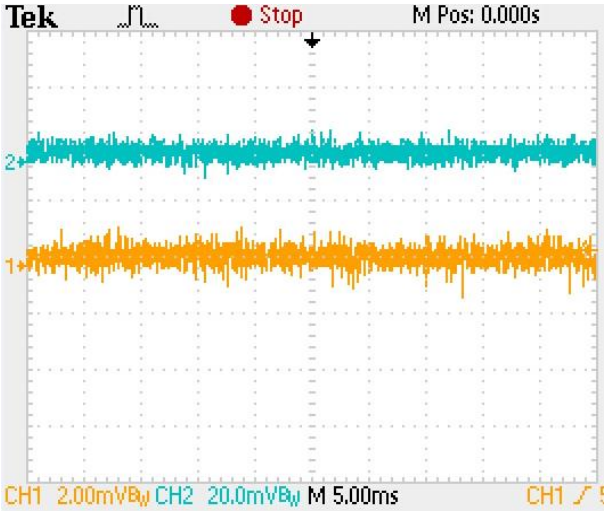
- ✧ Input/Outpt Voltage to GND ---------- -0.3V to +6V
- ✧ EN,FLASH to GND ---------- 0 V to +6V
- ✧ Operating Junction Temperature Range (TJ) ---------- 150℃
- ✧ Maximum Soldering Temperature (at leads, 10sec) ---------- 260℃
- ✧ Storage Temperature Range ---------- -65°C to 165°C
- ✧ Operation Ambient Temperature Range ---------- -20°C to 85°C
- ✧ QFN 4x4-16 Thermal Resistance (θJA) ---------- 50°C/W
- ✧ QFN 4x4-16 Power Dissipation at TA=25°C (PDmax) ---------- 2.5W

Electrical Characteristics

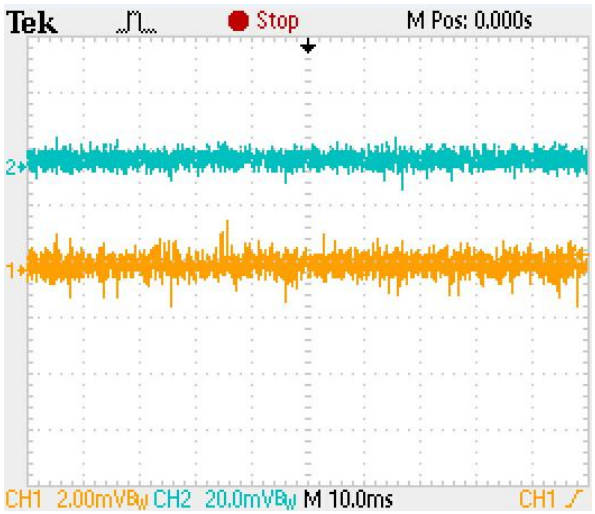
(VIN =VEN = 3.6V, CIN = COUT = 4.7uF , C1=C2=2uF, Typical values are TA=25℃)

Symbol	Parameter	Conditions	LP3368			Unit
			Min.	Typ.	Max.	
VIN	Input Voltage		2.7		5.5	V
RCH1	Charge Pump Equivalent Resistance (2×mode)	VIN = 3.6V, VFB = 0V		5		Ω
RCH2	Charge Pump Equivalent Resistance (1×mode)	VIN = 3.6V		0.4	0.7	Ω
IQ	Quiescent Current	VIN=2.7V-5.5V, FLASH = GND, 1×mode, ILOAD = 100uA		0.48	3	mA
		FLASH = High, 2×mode		2	3.5	
ISHDN	Shutdown Current	EN = GND, VIN = 5.5V			1	μA
VFB	FB Reference Voltage	FLASH = GND	45	50	55	mV
		FLASH = High, RSET = 95kΩ	138	150	162	
	FB Reference Voltage Range	FLASH = High, Guaranteed by design	100		400	mV
IFB	FB Current	VFB = 0.3V			0.5	uA
FOSC	Oscillator Frequency			2		MHz
VOL	EN,FLASH Logic Low				0.4	V
VOH	EN,FLASH Logic High		1.4			V
IEN	EN,FLASH Pin Current				0.5	uA
TOUT	VOUT Turn-On Time	VIN = 3.6V, FB within 90% of regulation		100	500	us
TSD	Thermal Shutdown Temperature			145		℃

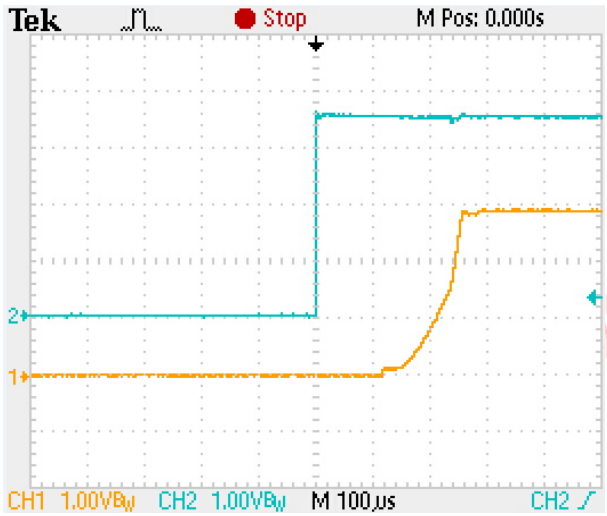
Typical Operating Characteristics



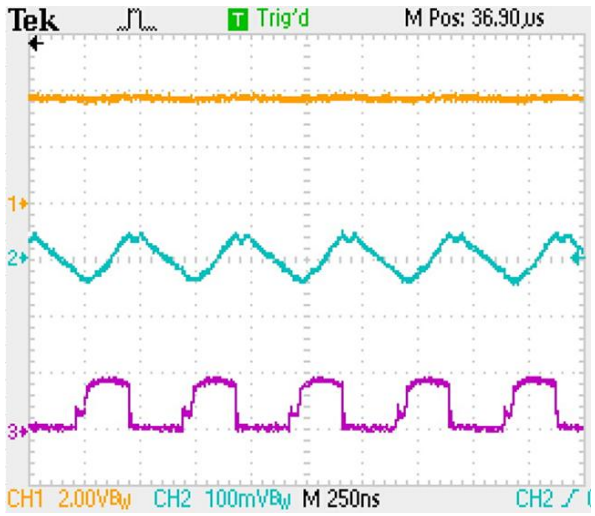
VIN=3V, Torch Mode, Iout=250mA



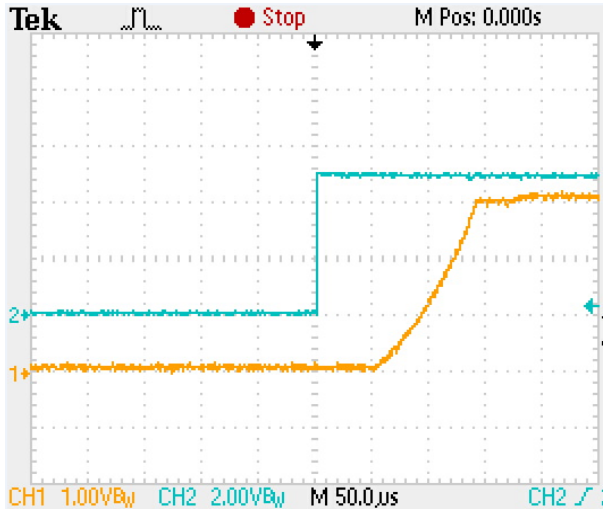
VIN=3.5V, Torch Mode, Iout=250mA



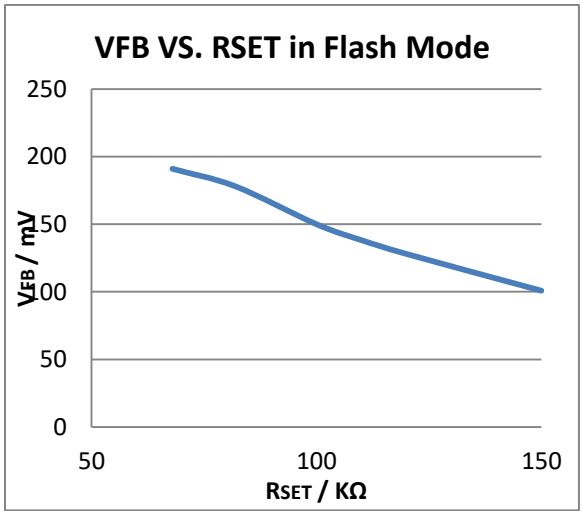
Start up waveform, VIN=3.5V, Torch Mode



Charge pump waveform, VIN=3.5V, Torch Mode



Start up waveform, VIN=3.5V, Flash Mode



V_{FB}=1.26×11.2kΩ/R_{SET}

Function Description

The LP3368 is designed for converting a Li-Ion battery voltage of 2.7V to 4.2V to drive two LEDs used in digital still camera Flash and Smart Phone applications. The LP3368 has two modes (Torch and Flash). Torch mode can be used continuously at a lower output current than Flash and is often used for several seconds in a digital still camera “movie” mode. Flash mode is usually used with a pulse of about 200 to 300 milliseconds to generate a high intensity Flash. Each channel can be operated independently through EN1/2 or MODE1/2. The LP3368 also has two modes of operation to control the output current. The 1x mode and 2x mode. Operation begins after the enable pin EN receives a logic high, then LP3368 starts in the 1x mode, which acts like a linear regulator to control the output current by continuously monitoring the feedback pin FB. In 1x mode, if the LP3368 auto detects a dropout condition, which is when the FB pin is below the regulation print for more than 32 cycles of the internal clock, the LP3368 automatically switches to the 2x mode. The LP3368 remains in the 2x mode until one of four things happens: 1. The enable pin EN has been toggled; 2. The Flash pin has changed from high to low; 3. Vin is cycled or; 4. A thermal fault occurs. The 2x mode is the charge pump mode where the output can be pumped as high as two times the input voltage, provided the output does not exceed the maximum voltage for the LP3368, which is internally limited to about 5.5V. In the 2x mode, as in the 1x mode, the output current is regulated by the voltage at the FB pin.

In the TORCH mode, the MODE1/2 pin is set to logic low and the LP3368 FB pin regulates to 50mV output:

$$V_{FB}=50mV \text{ (Torch mode)}$$

In the FLASH mode, (MODE=VIN), the FB regulation voltage is set by the external resistor (RSET) connected between the RSET pin and GND and the equation:

$$V_{FB}=1.26\times 11.2k\Omega/R_{SET}\ ,\ \text{(Flash mode)}$$

Where 1.26V is the internal band gap reference voltage and 11.2kΩ is an internal resistance used to scale the RSET current. Typical values of RSET are 40kΩ to 180kΩ for a range of VFB=300mV to 75mV in Flash mode.

The output current is then set in either Flash or Torch mode by the equation:

$$I_{OUT}= V_{FB}/R_{SENSE}$$

Over-Voltage Protection

The Over-Voltage Protection monitors the output voltage. When the output voltage rises above 5.5V, the Over-Voltage Protection shuts off all of the output switches to prevent the output voltage from rising further. When the output decreases below 5.5V, the device resumes normal operation.

Over-Current Protection

The Over-Current Protection circuitry monitors the average current out of the FB pin. If the average current exceeds the two times set current, then the over current protection circuitry shuts off the output switches to protect the chip.

Brightness Control Using PWM

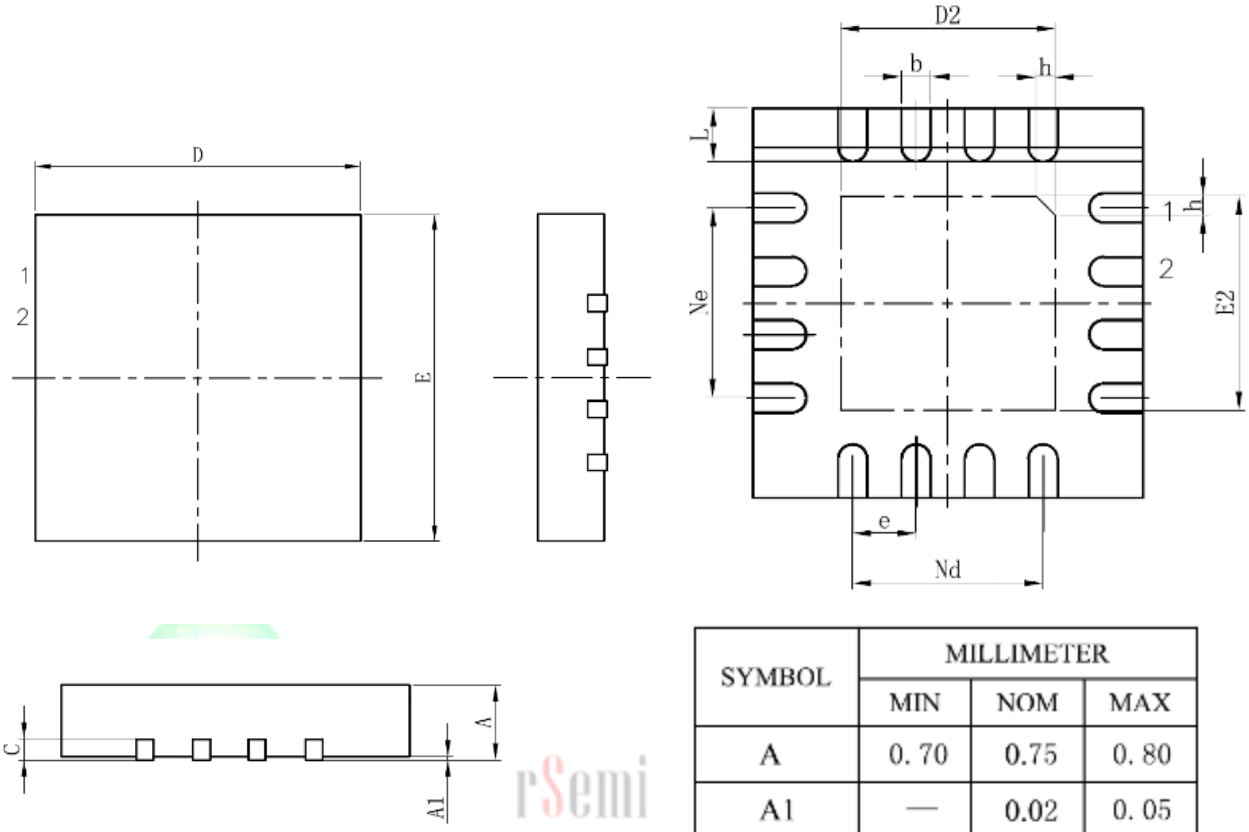
Dimming control can be achieved by applying a PWM control signal to the EN1/2 pin for each channel. The brightness of the white LEDs is controlled by increasing and decreasing the duty cycle of the PWM signal. While the operating frequency range of the PWM control is from 60Hz to 700Hz, the recommended maximum brightness frequency range of the PWM signal is from 200Hz to 500Hz. A repetition rate of at least 60Hz is required to prevent flicker.

Application Information

The LP3368 charge pump circuit requires 3 capacitors: 4.7μF input, 2μF output and 2μF fly capacitors are typically recommended. For the input capacitor, a value of 10μF will help reduce input voltage ripple for applications sensitive to ripple on the battery voltage. All the capacitors should be surface mount for low lead inductance necessary at the 2MHz switching frequency of the LP3368 and to obtain low ESR, which improves bypassing on the input and output and improves output voltage drive by reducing output resistance. The input and output capacitors should be located as close to the VIN and VOUT pins as possible to obtain best bypassing, and the returns should be connected directly to the GND pin under the LP3368. The fly capacitor should be located as close to the C1* and C2* pins as possible.

Packaging Information

TQFN-16



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	—	0.02	0.05
b	0.25	0.30	0.35
c	0.18	0.20	0.25
D	3.90	4.00	4.10
D2	2.10	2.20	2.30
e	0.650BSC		
Ne	1.95BSC		
Nd	1.95BSC		
E	3.90	4.00	4.10
E2	2.10	2.20	2.30
L	0.45	0.55	0.65
h	0.30	0.35	0.40