

3.0 A, Step-Down Switching Regulator

Description

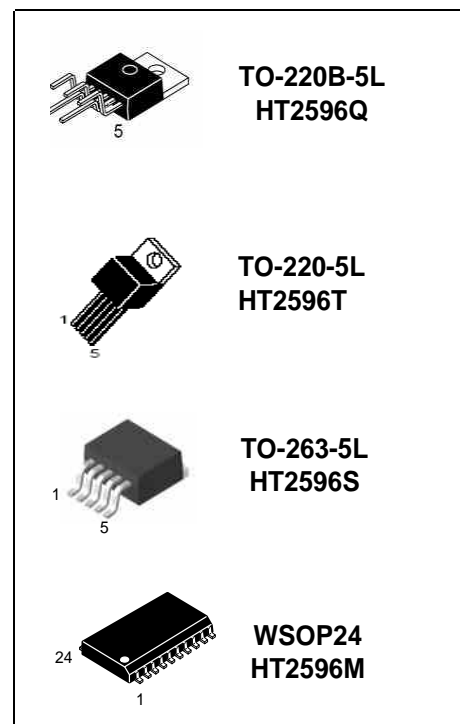
HT2596, HT2596-3.3, HT2596-5.0, HT2596-12 - are monolithic ICs of a step-down DC-DC converters. The principle of operation of ICs is based on control of built-in power NPN transistor, quantity of energy transferred to load is regulated by means of pulse-width modulation. So output voltage practically do not depends from load. ICs are purposed for application inside power supply units of consumer & industrial devices.

Family consist of:

- HT2596 - PWM voltage regulator with adjustable output voltage;
- HT2596-3.3 - PWM voltage regulator with fixed output voltage 3,3V;
- HT2596-5.0 - PWM voltage regulator with fixed output voltage 5,0V;
- HT2596-12 - PWM voltage regulator with fixed output voltage 12,0V;

Features:

- Output voltage: 3.3V, 5V, 12V and adjustable output version;
 - Adjustable version output voltage range, 1.23V to 37V+4%;
 - Oscillator with build-in capacity for 150Khz switching frequency;
 - PWM control circuit of output voltage;
 - Overheating and current-limit protection ;
 - Switch on/off control circuit;
 - Up to 40V operating voltage
 - Output load current: 3A
 - Standby mode with low power consumption
 - Built-in switching transistor on chip
- IC realized in 5-pin plastic package TO220AR/5 and TO263

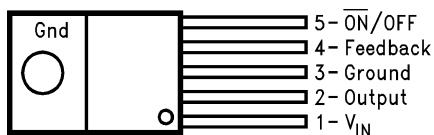
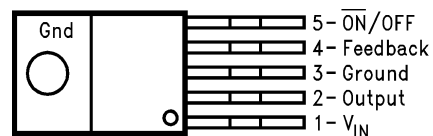
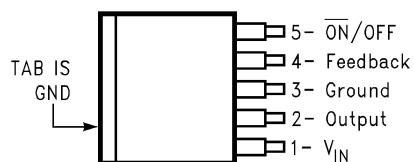
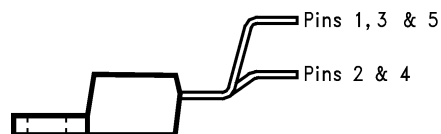
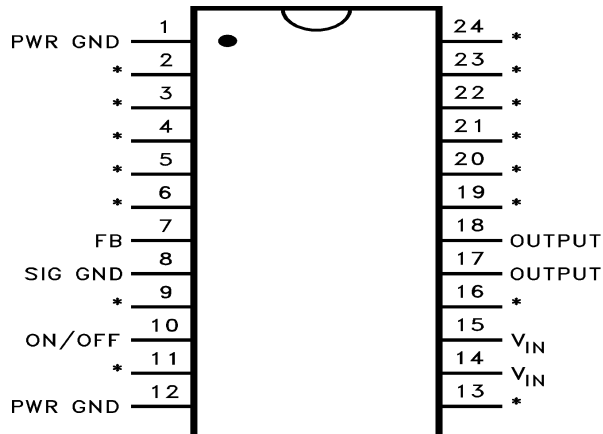


Pin Description Table

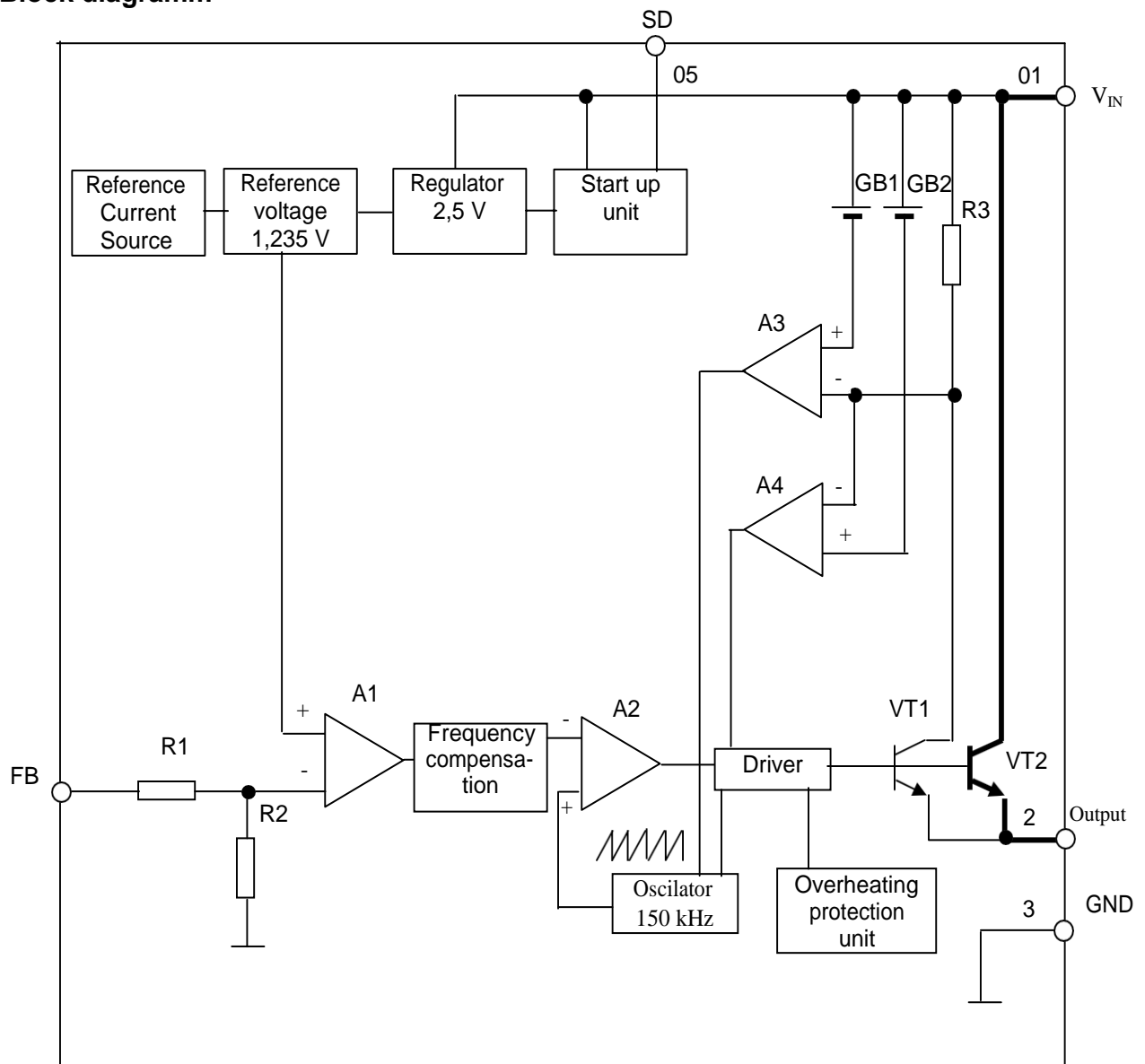
Pin number	Symbol	Purpose description
01	V_{IN}	Input (operating voltage)
02	Output	Output
03	GND	Common pin
04	FB	Feedback control pin
05	SD	Switching on/off pin

Connection Diagrams

(XX indicates output voltage option.)

HT2596T

HT2596Q

HT2596S

HT2596Q

HT2596M


*No Internal Connection

Block diagramm


A1 - amplifier;
 A2 – A4 – comparators;
 GB1 – battery 200 mV;
 GB2 – battery 220 mV;
 R1 - R3 –resistors; VT1,
 VT2 - transistors

Recommended mode and Absolute Maximum Ratings

Parameter, unit	Symbol	Recommended mode		Absolute Maximum Ratings	
		min	max	min	max
Input (operating) voltage, V	V_{IN}	4,5	40	-	45
Output voltage relative to GND, V	V_{OUT}	-	-	-1,0	-
CD pin input voltage, V	V_{SD}	-	-	-0,3	25
Feedback control voltage, V	V_{FB}	-	-	-0,3	25
Storage temperature, °C	T_{stg}	-	-	-60	150
Junction temperature, °C	T_j	-40*	125	-40*	150
Thermal resistance junction-case, °C/W	$R_{th\ j-c}$	-	2,5***	-	2,5***
Thermal resistance junction-ambient, °C/W	$R_{th\ j-a}$	-	65**	-	65**
Thermal resistance junction-ambient (with heat sink), °C/W	$R_{th\ j-a}$	-	28**	-	28**

* Ambient temperature is indicated

** $R_{th\ j-a}$ – Thermal resistance junction-ambient (for IC without additional heat sink is equal 65 °C/W, for IC with copper radiator 19 sm² the value of parameter is estimated as 28 °C/W).

Thermal resistance junction-ambient $R_{th\ j-a}$, °C/W for ICs with additional heat sink is calculated by formula:

$$R_{th\ j-a} = R_{th\ j-c} + R_{th\ c-a} \quad , \quad (1)$$

*** $R_{th\ j-c}$ - thermal resistance junction case, °C/W. (the value of parameter is estimated as 2,5 °C/W);

$R_{th\ c-a}$ - thermal resistance case ambient

Heat sink, application mode (power consumption) and ambient temperature have to provide junction temperature $T_j \leq 125$ °C.

Maximum dissipation power, P_{tot} , W, is calculated by formula

$$P_{tot} = (125 - T_A) \cdot R_{th\ j-a} \quad , \quad (2)$$

125 – maximum permissible junction temperature, °C

T_A – ambient temperature, °C;

$R_{th(j-a)}$ – thermal resistance junction-ambient, °C/W.

Electric parameters

IC	Parameter, unit	Symbol			Test condition	T _A , °C
			min	max		
HT2596	Feedback bias current, nA	I _B	-	$\frac{60}{100}$	V _{FB} = 1,3 V; V _{IN} = 12 V	25 ± 10 125* -40
	Oscillator frequency, kHz	f _{OSC}	$\frac{127}{110}$	$\frac{173}{173}$	V _{IN} = 12 V V _{IN} = 40 V	
	Saturation voltage V	V _{SAT}	-	$\frac{1,4}{1,5}$	V _{FB} = 0 V; V _{IN} = 12 V; I _{OUT} = -3 A no external circuit	
	Current limit, A	I _{CL}	$\frac{3,6}{3,6}$	$\frac{5,5}{6,5}$	V _{FB} = 0 V; V _{IN} = 12 V; -3 A ≤ I _{OUT} ≤ -7 A no external circuit	
	Output leakage current, mA	I _{L(0)}	-	-0,2	V _{FB} = 12 V; V _{IN} = 40 V; V _{OUT} = 0 V no external circuit	25±10
		I _{L(-1)}	-	-60	V _{FB} = 12 V; V _{IN} = 40 V; V _{OUT} = -1 V	
	Quiescent current, mA	I _Q	-	10	V _{FB} = 12 V; V _{IN} = 12 V	
	Standby mode Quiescent current, uA	I _{STBY}	-	$\frac{250}{300}$	V _{FB} = 0 V; V _{IN} = 40 V; V _{SD} = 5 V	25 ± 10 125* -40
	SD pin low level input voltage (switching on), V	V _{IL}	-	0,6	V _{IN} = 12 V; V _{SD} from 2,5 to 0,5V	25±10
	SD pin high level input voltage (switching off), V	V _{IH}	2,0	-	V _{FB} = 0 V; V _{IN} = 12 V; V _{SD} from 0,5 to 2,5 V	
	SD pin high level input current (switching off), uA	I _H	-	25	V _{IN} = 12 V; V _{SD} = 2,5 V	
	SD pin low level input current (switching on), uA	I _L	-	5,0	V _{IN} = 12 V; V _{SD} = 0,5 V	
	Feedback voltage, V	V _{FB}	$\frac{1,193}{1,18}$	$\frac{1,267}{1,28}$	4,5 B ≤ V _{IN} ≤ 40 V; -0,2 ≤ I _{OUT} ≤ -3 A; V _{OUT} programmed on 3 V	25 ± 10 125* -40

Electric parameters (continued)

IC	Parameter, unit	Symbol			Test condition	T _A , °C
			min	max		
HT2596-33	Oscillator frequency, kHz	f _{OSC}	<u>127</u>	<u>173</u>	V _{IN} = 12 V	<u>25±10</u> 125* -40
			110	173	V _{IN} = 40 V	
	Saturation voltage V	V _{SAT}	-	<u>1,4</u> 1,5	V _{FB} = 0 V; V _{IN} = 12 V; I _{OUT} = -3 A no external circuit	25±10
	Current limit, A	I _{CL}	<u>3,6</u> 3,6	<u>5,5</u> 6,5	V _{FB} = 0 V; V _{IN} = 12 V; -3 A ≤ I _{OUT} ≤ -7 A no external circuit	
	Output leakage current, mA	I _{L(0)}	-	-0,2	V _{FB} = 12 V; V _{IN} = 40 V; V _{OUT} = 0 V no external circuit	
		I _{L(-1)}	-	-60	V _{FB} = 12 V; V _{IN} = 40 V; V _{OUT} = -1 V	
	Quiescent current, mA	I _Q	-	10	V _{FB} = 12 V; V _{IN} = 12 V	<u>25±10</u> 125* -40
	Standby mode Quiescent current, uA	I _{STBY}	-	<u>250</u> 300	V _{IN} = 40 V; V _{SD} = 5 V	
	SD pin low level input voltage (switching on), V	V _{IL}	-	0,6	V _{IN} = 12 V; V _{SD} = 2,5 V	25±10
	SD pin high level input voltage (switching off), V	V _{IH}	2,0	-	V _{IN} = 12 V; V _{SD} = 0,5 V	
	SD pin high level input current (switching off), uA	I _{IH}	-	25	V _{IN} = 12 V; V _{SD} = 2,5 V	
	SD pin low level input current (switching on), uA	I _{IL}	-	5,0	V _{IN} = 12 V; V _{SD} = 0,5 V	
	Output voltage, V	V _{OUT}	<u>3,168</u> 3,135	<u>3,432</u> 3,465	4,75 V ≤ V _{IN} ≤ 40 V; -0,2 ≤ I _{OUT} ≤ -3 A;	<u>25±10</u> 125* -40

Electric parameters (continued)

IC	Parameter, unit	Symbol			Test condition	T _A , °C
			min	max		
HT2596-50	Oscillator frequency, kHz	f _{OSC}	<u>127</u>	<u>173</u>	V _{IN} = 12 V	<u>25±10</u> 125*
			110	173	V _{IN} = 40 V	
	Saturation voltage V	V _{SAT}	-	<u>1,4</u> 1,5	V _{FB} = 0 V; V _{IN} = 12 V; I _{OUT} = -3 A no external circuit	-40
	Current limit, A	I _{CL}	<u>3,6</u> 3,6	<u>5,5</u> 6,5	V _{FB} = 0 V; V _{IN} = 12 V; -3 A ≤ I _{OUT} ≤ -7 A no external circuit	
	Output leakage current, mA	I _{L(0)}	-	-0,2	V _{FB} = 12 V; V _{IN} = 40 V; V _{OUT} = 0 V no external circuit	25±10
		I _{L(-1)}	-	-60	V _{FB} = 12 V; V _{IN} = 40 V; V _{OUT} = -1 V	
	Quiescent current, mA	I _Q	-	10	V _{FB} = 12 V; V _{IN} = 12 V	
	Standby mode Quiescent current, uA	I _{STBY}	-	<u>250</u> 300	V _{FB} = 0 V; V _{IN} = 40 V; V _{SD} = 5 V	<u>25±10</u> 125* -40
	SD pin low level input voltage (switching on), V	V _{IL}	-	0,6	V _{FB} = 0 V; V _{IN} = 12 V; V _{SD} from 2,5 to 0,5 V	25±10
	SD pin high level input voltage (switching off), V	V _{IH}	2,0	-	V _{IN} = 12 V; V _{SD} from 0,5 to 2,5 V	
	SD pin high level input current (switching off), uA	I _H	-	25	V _{IN} = 12 V; V _{SD} = 2,5 V	
	SD pin low level input current (switching on), uA	I _L	-	5,0	V _{IN} = 12 V; V _{SD} = 0,5 V	
Output voltage, V	V _{OUT}	<u>4,8</u> 4,75	<u>5,2</u> 5,25	7,0 V ≤ V _{IN} ≤ 40 V; -0,2 ≤ I _{OUT} ≤ -3 A	<u>25±10</u> 125* -40	

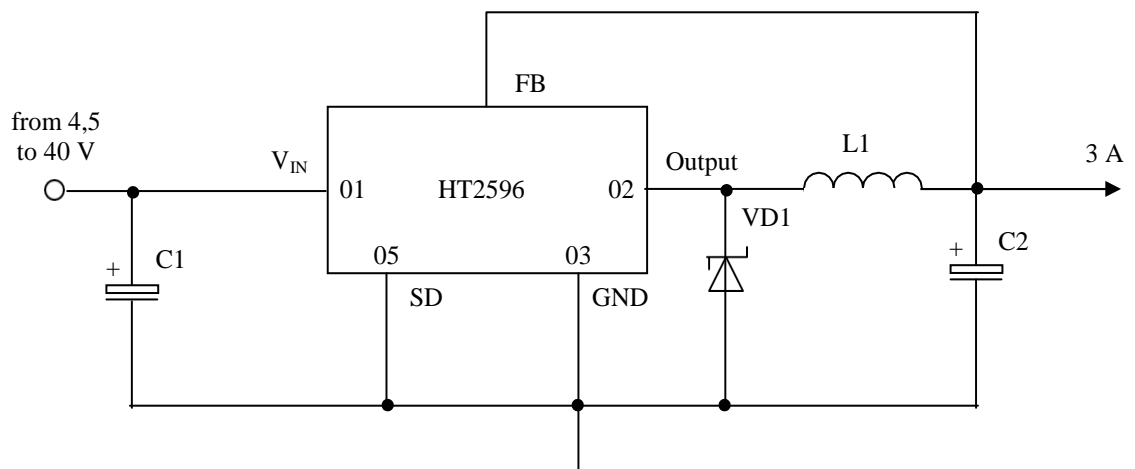
Electric parameters (continued)

IC	Parameter, unit	Symbol			Test condition	T _A , °C
			min	max		
HT2596-12	Oscillator frequency, kHz	f _{OSC}	<u>127</u> 110	<u>173</u> 173	V _{IN} = 24 V	<u>25±10</u> 125*
	Saturation voltage V	V _{SAT}	-	<u>1,4</u> 1,5	V _{FB} = 0 V; V _{IN} = 24 V; I _{OUT} = -3 A no external circuit	-40
	Current limit, A	I _{CL}	<u>3,6</u> 3,6	<u>5,5</u> 6,5	V _{FB} = 0 V; V _{IN} = 24 V; -3 A ≤ I _{OUT} ≤ -7 A no external circuit	
	Output leakage current, mA	I _{L(0)}	-	0,2	V _{FB} = 15 V; V _{IN} = 40 V; V _{OUT} = 0 V no external circuit	25±10
		I _{L(-1)}	-	60	V _{FB} = 15 V; V _{IN} = 40 V; V _{OUT} = -1 V	
	Quiescent current, mA	I _Q	-	10	V _{FB} = 15 V; V _{IN} = 24 V	
	Standby mode Quiescent current, uA	I _{STBY}	-	<u>250</u> 300	V _{IN} = 40 V; V _{SD} = 5 V	<u>25±10</u> 125* -40
	SD pin low level input voltage (switching on), V	V _{IL}	0,6	-	V _{IN} = 24 V; V _{SD} from 2,5 to 0,5 V	25±10
	SD pin high level input voltage (switching off), V	V _{IH}	-	2,0	V _{IN} = 24 V; V _{SD} from 0,5 to 2,5 V	
	SD pin high level input current (switching off), uA	I _H	-	25	V _{IN} = 24 V; V _{SD} = 2,5 V	
	SD pin low level input current (switching on), uA	I _L	-	5,0	V _{IN} = 24 V; V _{SD} = 0,5 V	
	Output voltage, V	V _{OUT}	<u>11,52</u> 11,4	<u>12,48</u> 12,6	15 V ≤ V _{IN} ≤ 40 V; -0,2 ≤ I _{OUT} ≤ -3 A	<u>25±10</u> 125* -40

* Junction temperature. Because of measurements of electric parameters are executed in pulse mode, junction temperature is equal to ambient.

Typical Electric Parameters

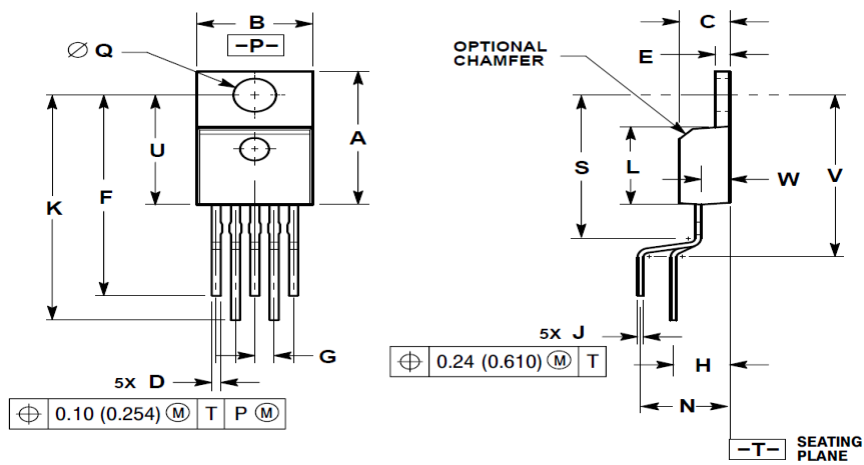
Parameter, unit	Symbol	Typ.	Test condition	Note
Efficiency, %	η	73	$V_{IN} = 12\text{ V}; I_{OUT} = 3\text{ A}$	1
- HT2596				
- HT2596-33				
- HT2596-50		80		
- HT2596-12	90	$V_{IN} = 15\text{ V}; I_{OUT} = -3\text{ A}$		
Max. Duty Cycle(ON), %	DC_{max}	100	$V_{FB} = 0\text{ V}$	2
Max. Duty Cycle(OFF), %	DC_{min}	0	$V_{FB} = 12\text{ V}$	3
Overheating protection operation threshold, °C	T_h	160*		

Application diagramm


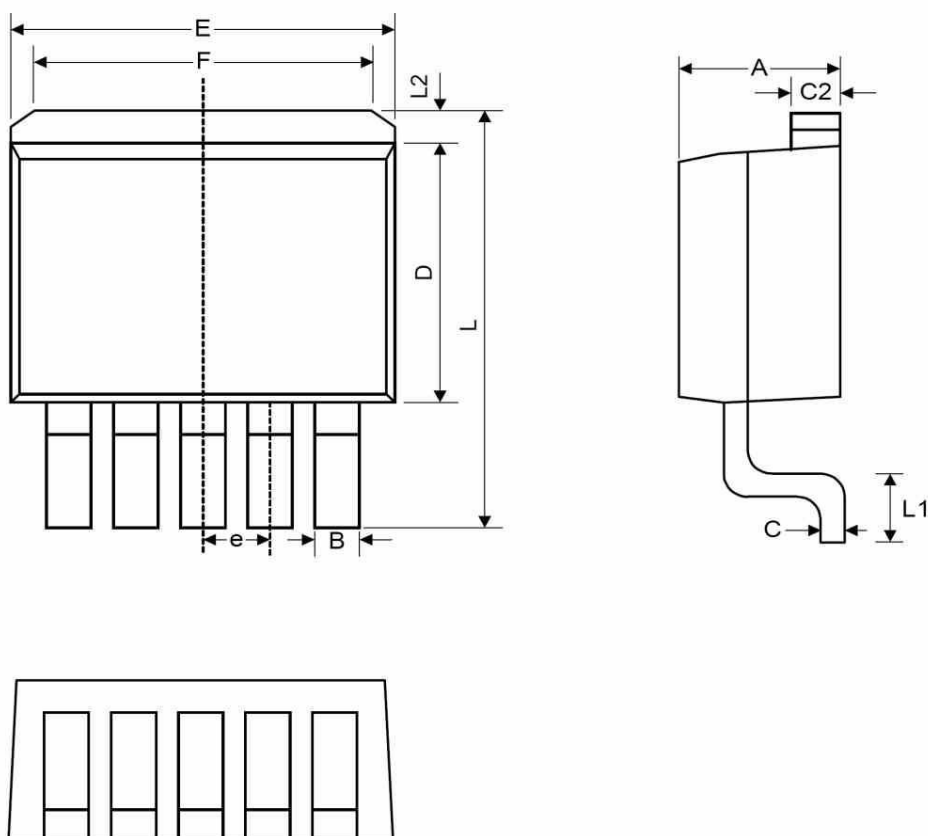
C1, C2 – electrolytic capacitors
 L1 – inductor;
 VD1 – diode

TO-220SD-5L (Bent Staggered)

TO-220
 TV SUFFIX
 CASE 314B-05
 ISSUE J



구분	IK TO 220SD 5L		
	min	avg	max
A	14.529		15.570
B	9.906		10.541
C	4.318		4.572
D	0.635		0.965
E	1.219		1.397
F	21.590		23.749
G	1.702BSC		
H	4.216BSC		
J	0.381		0.635
K	22.860		27.940
L	8.128		9.271
N	8.128BSC		
ØQ	3.556		3.886
S			15.748
U	11.888		12.827
V			18.669
W	2.286		2.794

TO-263-5L


Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	4.07	4.46	4.85	0.160	0.176	0.191
B	0.66	0.84	1.02	0.026	0.033	0.040
C	0.36	0.50	0.64	0.014	0.020	0.025
C2	1.14	1.27	1.40	0.045	0.050	0.055
D	8.65	9.15	9.65	0.341	0.360	0.380
E	9.78	10.16	10.54	0.385	0.400	0.415
e	1.57	1.71	1.85	0.062	0.068	0.073
F	6.60	6.86	7.11	0.260	0.270	0.280
L	14.61	15.24	15.88	0.575	0.600	0.625
L1	2.29	2.54	2.79	0.090	0.100	0.110
L2	-	-	2.92	-	-	0.115