40V Synchronous Buck Converter With 2ch CC/CV

❖ GENERAL DESCRIPTION

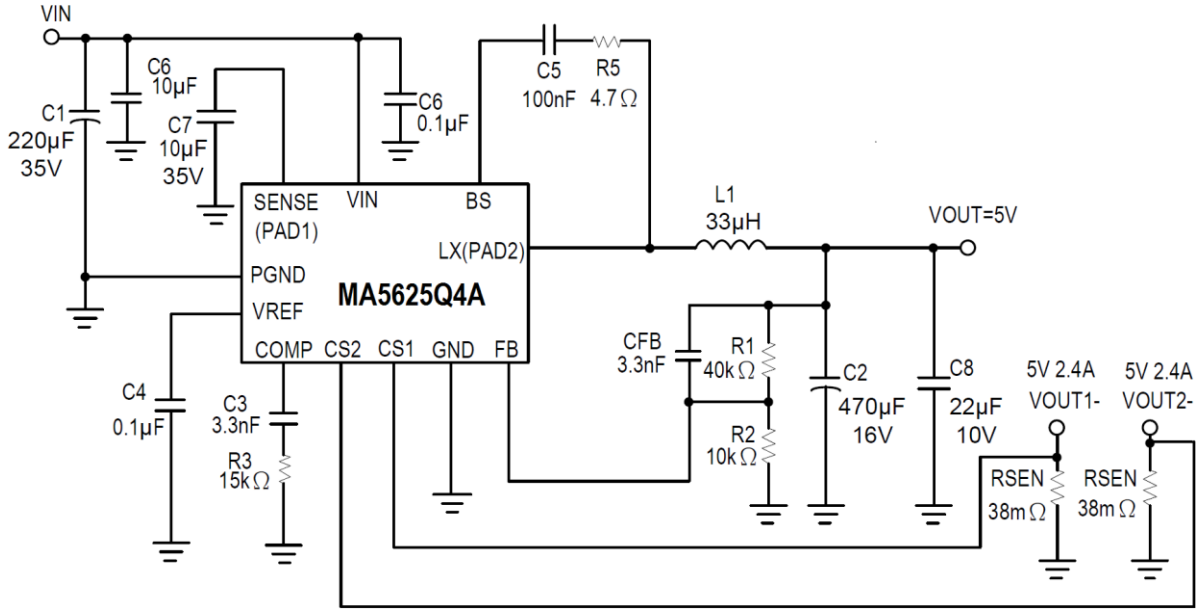
The MA5625 is a synchronous buck converter. The device includes internal high-side and internal low-side power MOSFETs. It provides not only 5A continuous load current but wide input voltage range from 8V to 40V. Besides the current mode control type is suitable for extreme transient response and cycle-by-cycle current limit.

The internal soft-start circuit also prevents inrush current from power-on and turn-on. This product is available in small QFN-23L (4x4) package - a real compact solution with minimal external components.

❖ FEATURES

- Wide Operating Input Range from 8V to 40V.
- Internal high-side and low-side Power MOSFET Switches.
- Output Voltage Adjustable: V_{FB} (1.00V±2%)
- Up to 95% Efficiency.
- Internal Soft-start and FIXED 160KHz Frequency.
- Duty on ratio: 0% to 91% PWM control.
- Cycle-by-Cycle Over Current Protection.
- Input Under/Over Voltage Lockout.

❖ APPLICATION CIRCUIT

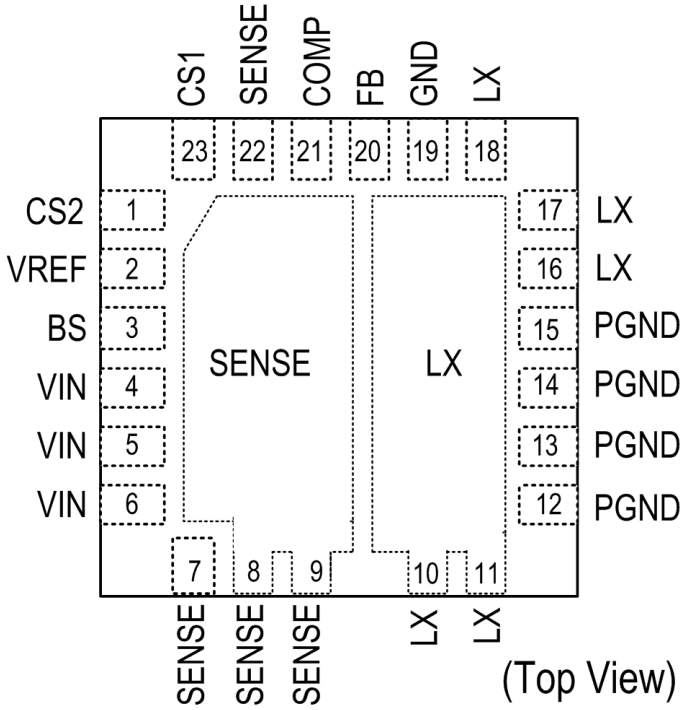


$V_{OUT}=V_{FB} \times (1+R1/R2)$, V_{FB} = 1.00V, R2 suggest 1k~30KΩ

I_{SEN} = 2.63A (I_{SEN}=VCS(0.1V) / RSEN(38mΩ))

❖ PIN ASSIGNMENT

The package of MA5625 is QFN-23L (4x4). The pin assignment is given by:

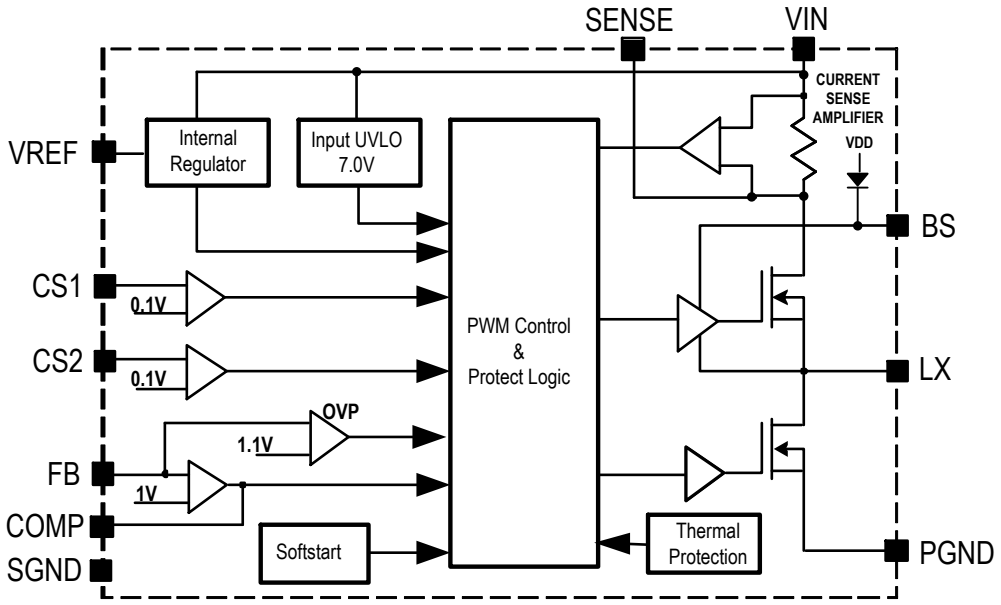


Name	Description
CS2	The Current Sense 2nd channel pin.
VREF	Internal Reference Regulator pin.
BS	Boot-Strap pin. It supplies high-side gate driver. Decouple this pin to LX pin with 0.1uf ceramic CAP (e.g. X5R) and a low resistance Resistor.
VIN	Power Input pin. Bypass VIN to PGND with a suitably high capacitance CAP to eliminate noise from Power MOSFETs, and bypass VIN to GND with a 0.1uf ceramic CAP (e.g. X5R) to eliminate noises.
SENSE	Power Input and Current Limit SENSE pin. Bypass SENSE to PGND with high capacitance ceramic CAP (e.g. X5R).
LX	Switching node and Switching Sense pin.
PGND	Power Ground and Input Ground.
GND	Signal Ground, output Ground, FB Ground and COMP Ground..
FB	Negative Feedback Input. FB senses the output voltage to regulate voltage. Drive FB with a resistive voltage divider from the output voltage, and connect a CFF (1nf to 10nf) ceramic CAP (e.g. X5R) as a feed-forward CAP from FB to output.
COMP	Compensation Node. COMP is used to compensate the regulation control loop. Connect a series RC network from COMP to GND.
CS1	The Current Sense 1st channel pin.

❖ ORDER/MARKING INFORMATION

Order Information	Top Marking
MA5625 XX X Packing Blank: Tube A : Taping Package Type Q4: QFN-23L (4×4)	MA 5 6 2 5 → Part number X X X X X → ID code:internal WW:01~52 Year:17=2017

❖ BLOCK DIAGRAM



❖ ABSOLUTE MAXIMUM RATINGS (@T_A=25°C)

Characteristics	Symbol	Rating	Unit
Supply Voltage	V_{IN}	–0.3～+42	V
Switch Node Voltage	V_{SW}	– 0.3～V_{IN} + 0.3	V
Boost Voltage	V_{BS}	V_{SW} – 0.3～V_{SW} + 6	V
All Other Pins		–0.3～+6	V
Lead Temperature		260	°C
Storage Temperature		–65～+150	°C
Junction Temperature	T_J	150	°C
Output Voltage	V_{OUT}	V_{FB}～24	V
Ambient Operating Temperature	T_A	–40～+85	°C
Thermal Resistance from Junction to case	θ_{JC}	15	°C/W
Thermal Resistance from Junction to ambient	θ_{JA}	40	°C/W

Note: θ_{JA} is measured with the PCB copper area of approximately 1 in^2(Multi-layer). That need connect to exposed pad.

❖ ELECTRICAL CHARACTERISTICS

(V_{IN} = 12V, T_A = +25°C, unless otherwise noted.)

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Input Voltage Range	V_{IN}		8	-	40	V
Quiescent Current	I_{CCQ}	V_{FB} = 1.05V	-	1	1.5	mA
Feedback Voltage	V_{FB}	8V ≤ V_{IN} ≤ 30V	0.98	1.00	1.02	V
Feedback Overvoltage Threshold	$OVP_{(FB)}$		-	1.1x	-	V_{FB}
Cable compensation current(Note)	I_{CFB}	V_{CS}=105mV	-	4	-	μA
High-Side Switch On Resistance (Note)	$R_{DS(ON)1}$		-	18	25	mΩ
Low-Side Switch On Resistance (Note)	$R_{DS(ON)2}$		-	13	18	mΩ
Oscillation Frequency	F_{OSC1}		-	160	-	KHz
Short Circuit Oscillation Frequency	F_{OSC2}	V_{FB} =< 0.4V	-	80	-	KHz
Short Circuit Retry time(Note)	RT_{SCP}	V_{FB} =< 0.5V	-	20	-	ms
Maximum Duty Cycle	D_{MAX}		-	91	-	%
Minimum On Time (Note)	$t_{ON(min)}$		-	220	-	ns
Current Sense Voltage	V_{CS1}、V_{CS2}		95	105	115	mV
Input Under Voltage Lockout Threshold	UVLO	V_{IN} Rising	6.5	7.0	7.5	V
Input Under Voltage Lockout Threshold Hysteresis	UVLO-Hys		-	800	-	mV
Soft-Start Period	t_{SS}		-	2	-	ms
Thermal Shutdown	T_{SD}		-	150	-	°C
Thermal Shutdown Hysterisis	T_{SH}		-	30	-	°C

Note: Guaranteed by design.

❖ FUNCTION DESCRIPTIONS

The MA5625 is a synchronous rectified, current-mode step-down converter. It regulates input voltages from 8V to 40V down to an output voltage, and supplies up to ≧5A of load current.

The MA5625 uses current-mode control to regulate the output voltage. The output voltage is measured at FB through a resistive voltage divider and amplified through the internal Tranconductance error amplifier. The voltage at the COMP pin is compared to the switch current measured internally to control the output voltage.

The controller uses external N-Channel MOSFETs switches to step-down the input voltage to the regulated output voltage. Since the high-side MOSFET requires a gate voltage greater than the input voltage, a boot-strap capacitor connected between LX and BS is needed to drive the high-side gate. The boot-strap capacitor is charged from the internal 5V rail when LX is low.

When MA5625 FB pin exceeds 10% of the nominal regulation voltage of V_{FB}, the over voltage comparator is tripped and the COMP pin is discharged to GND, forcing the high-side switch off.

❖ APPLICATION INFORMATION

Setting the Output Voltage

The output voltage is set through using a resistive voltage divider from the output voltage to FB pin. The voltage divider divides the output voltage down to the V_{FB} by the ratio. Thus the output voltage is:

$$V_{OUT} = V_{FB} \times \frac{R1 + R2}{R2}$$

e.g. V_{FB} =1.00V for a 5.0V output voltage, R2 is 10kΩ, and R1 is 40kΩ.

Inductor Selection

The inductor is required to supply constant current to the output load while being driven by the switched input voltage. A larger value inductor will result in less ripple current that will result in lower output ripple voltage. However, the larger value inductor will have a larger physical size, higher series resistance, and/or lower saturation current. A good rule for determining the inductance to use is to allow the peak-to-peak ripple current in the inductor to be approximately 30% of the maximum switch current limit.

Output Short-Circuit protection

The MA5625 provides output short-circuit protection retry function. When V_{OUT} is short (V_{FB}<0.5V), the auto restart function can be started that restart the regulator cycle by cycle. (Retry time 1ms , Shutdown regulator time 20ms.) .

Output Cable Resistance Compensation

To compensate for resistive voltage drop across the charger's output cable, the MA5625 integrates a simple, user-programmable cable voltage drop compensation using the impedance at the FB pin. Use the curve in Figure 1 to choose the proper feedback resistance values for cable compensation. R1 is the high side resistor of voltage divider.

$$V_{OUT} = V_{FB} \times (1+R1/R2) + R1 \times I_{CFB}(4uA)$$

12V→5V (R_{SEN}=39mΩ)

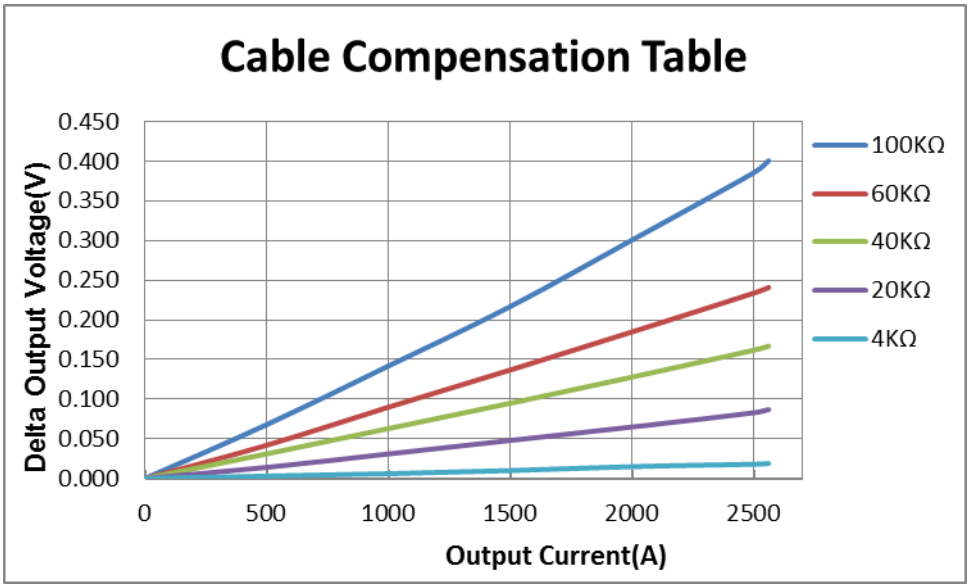


Figure1 Cable Compensation at Various Resistor Divider Values

When I_{SEN1} is max setting current, it can provide cable compensation amount (0.17V). And I_{SEN2} output current with I_{SEN1} at the same time, they totally can provide cable compensation amount (0.34V)

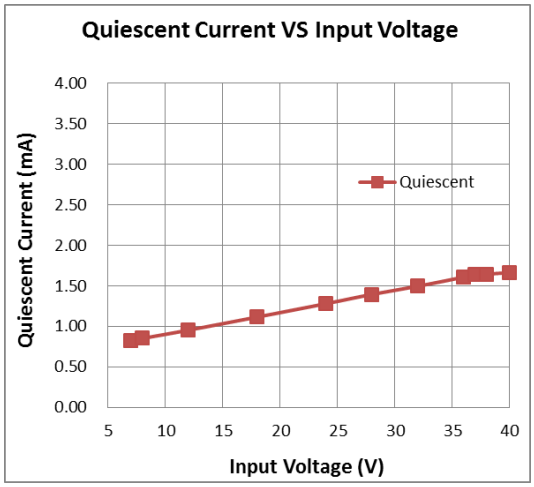
Setting Current : I_{SEN1}=0.1V/0.039R=2560mA , I_{SEN2}=0.1V/0.039R=2560mA,R1=40KΩ

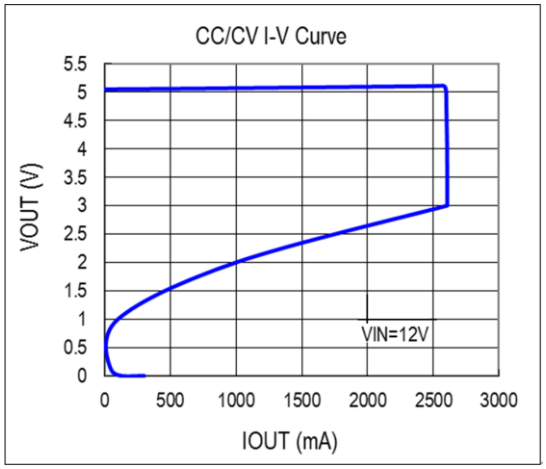
Example1: I_{SEN1}=2560mA , I_{SEN2}=2560mA The cable compensation amount 0.34V

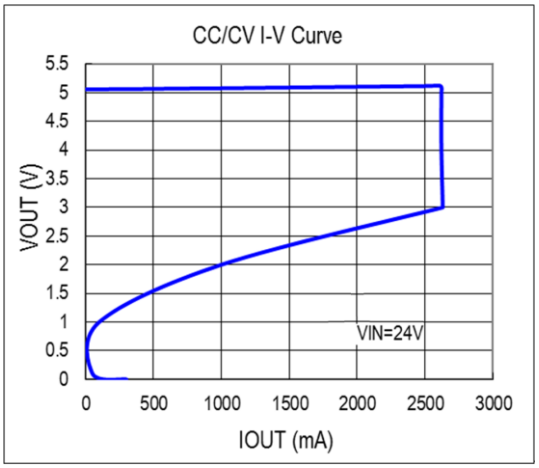
Example2: I_{SEN1}=2560mA , I_{SEN2}=0mA The cable compensation amount 0.17V

Example3: I_{SEN1}=0mA , I_{SEN2}=2560mA The cable compensation amount 0.17V

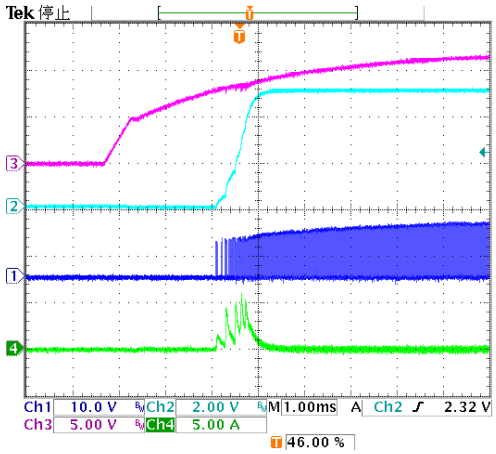
❖ TYPICAL CHARACTERISTICS





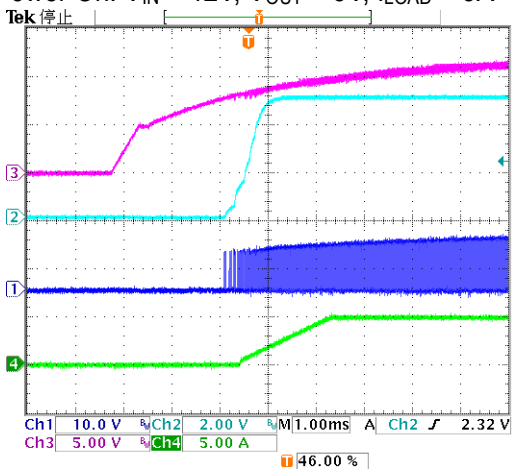


Power On: V_{IN} = 12V, V_{OUT} = 5V, I_{LOAD} = 0A



Ch1=SW , Ch2=V_{OUT} ,Ch3=V_{IN} , Ch4=I_{SW}

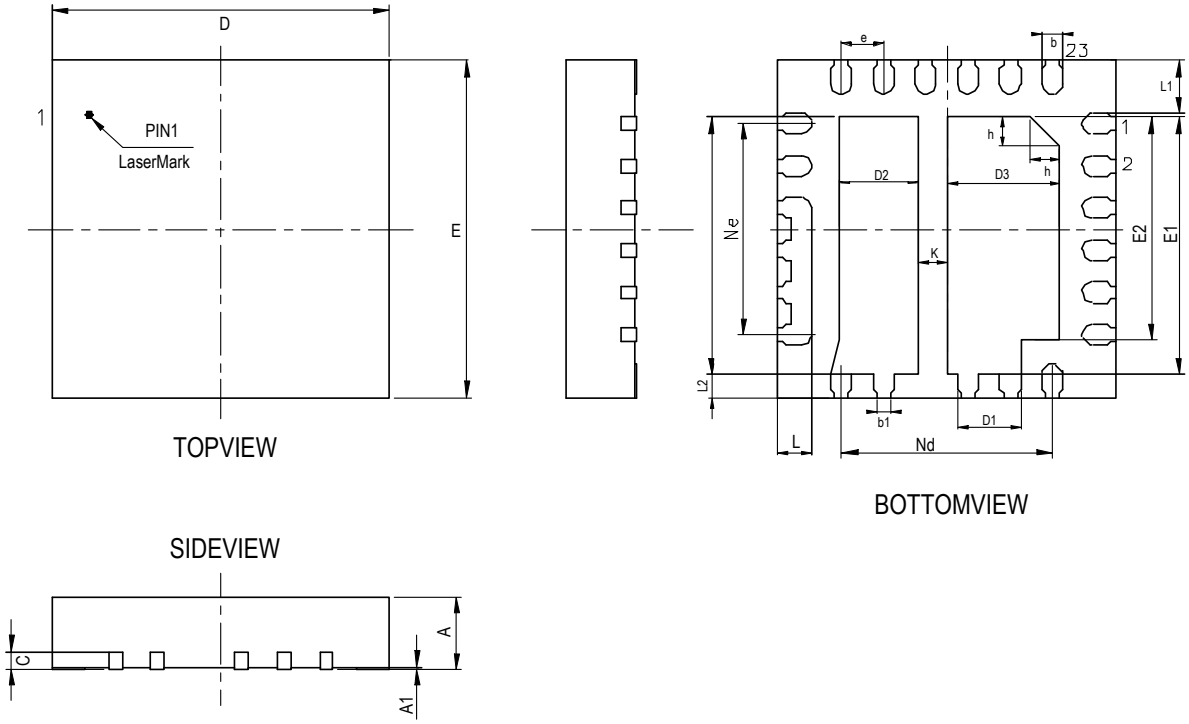
Power On: V_{IN} = 12V, V_{OUT} = 5V, I_{LOAD} = 5A



Ch1=SW , Ch2=V_{OUT} ,Ch3=V_{IN} , Ch4=I_{OUT}

❖ PACKAGE OUTLINES

QFN4x4-23L



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	0.8	0.85	0.9	0.031	0.033	0.035
A1	0	0.02	0.05	0.000	0.001	0.002
b	0.2	0.25	0.3	0.008	0.010	0.012
b1	0.16 REF			0.006 REF		
C	0.203 REF			0.008 REF		
D	3.9	4	4.1	0.154	0.157	0.161
D1	0.65	0.75	0.85	0.026	0.030	0.033
D2	0.85	0.95	1.05	0.033	0.037	0.041
D3	1.24	1.34	1.44	0.049	0.053	0.057
e	0.5 BSC			0.020 BSC		
Ne	2.5 BSC			0.098 BSC		
Nd	2.5 BSC			0.098 BSC		
E	3.9	4	4.1	0.154	0.157	0.161
E1	2.95	3.05	3.15	0.116	0.120	0.124

Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Min.	Nom.	Min.	Nom.
E2	2.6	2.65	2.7	0.102	0.104	0.106
L	0.35	0.4	0.45	0.014	0.016	0.018
L1	0.57	0.62	0.67	0.022	0.024	0.026
L2	0.23	0.28	0.33	0.009	0.011	0.013
K	0.33REF			0.013 REF		
h	0.3	0.35	0.4	0.012	0.014	0.016