MAX8814

28V Linear Li+ Battery Charger with Smart Autoboot Assistant

General Description

The MAX8814 intelligent, stand-alone constant-current, constant-voltage (CCCV), thermally regulated linear charger is designed for charging a single-cell lithium-ion (Li+) battery.

The MAX8814 controls the charging sequence from the prequalification state through constant-current fast-charge and the final constant voltage charge. The IC achieves high flexibility by providing an adjustable fast-charge current through an external resistor. It also features a booting assistant circuit that distinguishes input sources and battery connection, and provides an output signal (ABO) for system booting.

The device operates over the extended temperature range (-40°C to +85°C), and is available in an 8-pin thermally enhanced 2mm x 2mm TDFN package (0.8mm max height).

Applications

Smartphones
Portable Music Players
Digital Still Cameras
USB Appliances
Charging Cradles and Docks
Bluetooth® Equipment

Benefits and Features

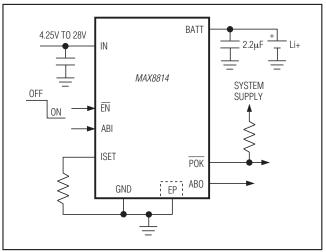
- Reduces External Components and Total Cost
 - Integrated Current-Sensing Circuit, MOSFET Pass Element, and Thermally Regulation Circuitry
 - · No Reverse Blocking Diode Required
- Guarantees Safe and Accurate Battery Charging
 - Proprietary Die Temperature Regulation Control (+115°C) Allows Maximum Charging Current Without Damaging the IC
 - 4.25V to 28V Input Voltage Range with Over-Voltage Protection Above +7V to Protect Against Unqualified or Faulty AC Adapters
 - Soft-Start Limits Inrush Current
- Integrated System Features for Compact Designs
 - Programmable Fast-Charge Current: 1A_{RMS} Max
 - Charge-Current Monitor for Fuel Gauging (ISET)
 - Input Power-Source Detection Output (POK) and Charge-Enable Input (EN)
 - Output for Autobooting (ABO)
- Reduce Power Dissipation
 - Low Dropout Voltage (300mV at 500mA)

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX8814ETA+	-40°C to +85°C	8 TDFN (2mm x 2mm)	ABI

⁺Denotes a lead-free and RoHS-compliant package.

Typical Operating Circuit



Bluetooth is a registered trademark of Bluetooth SIG.

Pin Configuration appears at end of data sheet.



Absolute Maximum Ratings

IN to GND	0.3V to +30V
ABI, BATT, EN, POK to GND	0.3V to +6V
ABO to GND	
ISET to GND	0.3V to +4V
IN to BATT Continuous Current	1ARMS
Continuous Power Dissipation ($T_A = +7$	0°C)
8-Pin TDFN (derate 11.9mW/°C abov	re +70°C)
(multilayer PCB)	953.5mW

Continuous
40°C to +85°C
+150°C
65°C to +150°C
+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics

 $(V_{IN}=5V, V_{BATT}=4V, R_{\overline{POK}}=1M\Omega$ to BATT, $\overline{EN}=0V, R_{ISET}=2.8k\Omega$ to GND, $C_{BATT}=2.2\mu F, T_A=-40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted. Typical values are at $T_A=+25^{\circ}C$.) (Note 1)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Input Voltage Range			0		28	V
Input Operating Voltage Range			4.25		6.80	V
Power-OK Threshold	V _{IN} - V _{BATT} ,	V _{IN} rising		40		mV
Tower OK Theshold	10mV hysteresis (typ)	V _{IN} falling		30		1110
Overvoltage-Lockout Trip Threshold	V _{IN} rising, 100mV hysteres	sis (typ)	6.8	7	7.5	V
	Constant-current charging	mode (I _{BATT} = 0A)		0.8	1.35	
IN Input Current	IC disabled (VEN = 5V)			0.23	0.50	
IN Input Current	$V_{IN} = 4V$,	$T_A = +25^{\circ}C$		0.021	0.065	mA mA
	$V_{BATT} = 4.2V$	$T_A = +85^{\circ}C$		0.021		
BATT Input Current	V _{IN} = 0 to 4V, V _{BATT} = 4.2V			1	10	μA
	IC disabled			3]
Battery Regulation Voltage	IBATT = 0A	$T_A = 0$ °C to +85°C	4.179	4.200	4.221	V
Battery negulation voltage		$T_A = -40^{\circ}C \text{ to } +85^{\circ}C$	4.158	4.200	4.242	
Minimum BATT Bypass Capacitance				2.2		μF
	V _{BATT} = 3.5V	$T_A = 0$ °C to +85°C	524	570	616	mA
Fact Charge Current		$T_A = -40^{\circ}C \text{ to } +85^{\circ}C$	485	570	656	
Fast-Charge Current	$V_{BATT} = 3.5V$,	$T_A = 0$ °C to +85°C	89	107	125	
	$R_{ISET} = 14k\Omega$	$T_A = -40^{\circ}C \text{ to } +85^{\circ}C$	80	107	134	
Prequalification Charge Current	Percentage of the fast-charge current, $V_{BATT} = 2.2V$, $T_A = 0$ °C to +85°C		4	10	15	%
Die Temperature Regulation Threshold				+115		°C
V _{BATT} Prequalification Threshold Voltage	V _{BATT} rising, 100mV hysteresis (typ)		2.3	2.5	2.7	V
Current-Sense Amplifier Gain (IBATT to IISET)	I _{BATT} = 570mA			877.2		μA/A

Electrical Characteristics (continued)

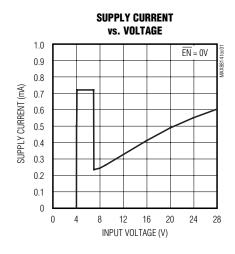
 $(V_{IN}=5V,\,V_{BATT}=4V,\,R_{\overline{POK}}=1M\Omega$ to BATT, $\overline{EN}=0V,\,R_{ISET}=2.8k\Omega$ to GND, $C_{BATT}=2.2\mu F,\,T_{A}=-40^{\circ}C$ to $+85^{\circ}C,\,unless$ other-

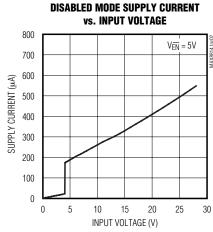
PARAMETER	CON	MIN	TYP	MAX	UNITS	
Regulator Dropout Voltage (VIN - VBATT)	V _{BATT} = 4.1V, I _{BATT} = 425		240	500	mV	
EN Logic-Input Low Voltage	4.25V < V _{IN} < 6.5V				0.4	V
EN Logic-Input High Voltage	4.25V < V _{IN} < 6.5V		1.3			V
EN and ABI Internal Pulldown Resistance			100	200	400	kΩ
ABI Logic-Input Low Voltage	$V_{IN} = 0V$	$V_{IN} = 0V$			0.4	V
ABI Logic-Input High Voltage	V _{IN} = 0V		1.3			V
ABO Output Low Voltage	I _{ABO} (SINK) = 1mA	I _{ABO} (SINK) = 1mA			0.4	V
ABO Output High Voltage	IABO (SOURCE) = 1mA		V _{BATT} - 0.4V			V
POK Output Low Voltage	$I_{\overline{POK}} = 5mA$				0.4	V
POK Output High Leakage	V sov F EV	T _A = +25°C		0.001	1	
Current	$V_{\overline{POK}} = 5.5V$			0.002		μΑ

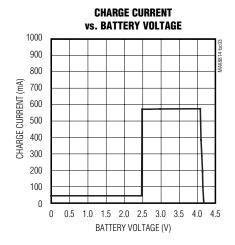
Note 1: Specifications are 100% production tested at T_A = +25°C. Limits over the operating temperature range are guaranteed by design and characterization.

Typical Operating Characteristics

 $(V_{IN} = 5V, V_{BATT} = 4V, R_{\overline{POK}} = 1M\Omega$ to BATT, $\overline{EN} = 0V, R_{ISET} = 2.8k\Omega$ to GND, $C_{BATT} = 2.2\mu F, T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless other-

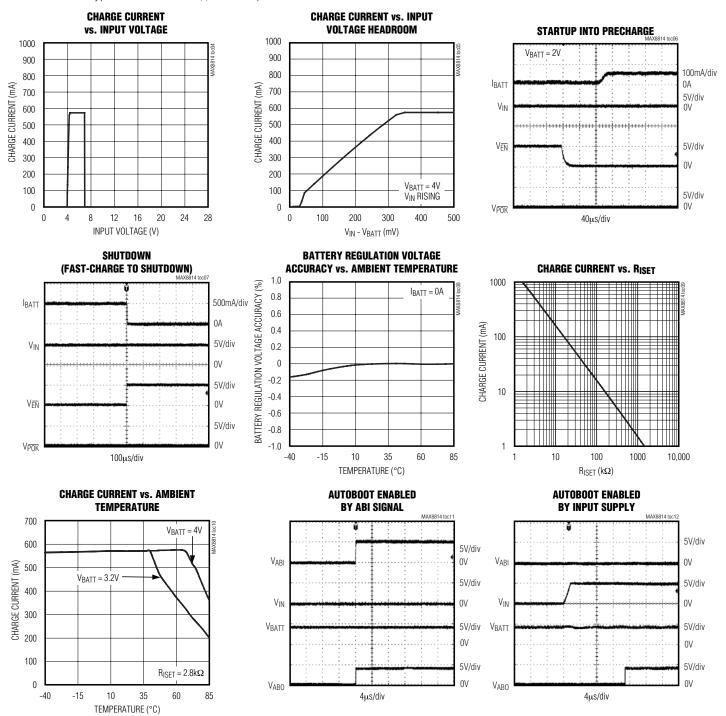






Package Information (continued)

 $(V_{IN}=5V, V_{BATT}=4V, R_{\overline{POK}}=1M\Omega)$ to BATT, $\overline{EN}=0V, R_{ISET}=2.8k\Omega$ to GND, $C_{BATT}=2.2\mu F, T_{A}=-40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted. Typical values are at $T_{A}=+25^{\circ}C$.)



Pin Description

PIN	NAME	FUNCTION
1	IN	Input Supply Voltage. Bypass IN to GND with a $1\mu F$ or larger ceramic capacitor to minimize line noise and maximize input transient rejection.
2	GND	Ground. Connect GND and the exposed paddle to a large copper ground plane for maximum power dissipation. Connect GND to the exposed paddle directly under the IC.
3	ISET	Charge-Current Program and Fast-Charge Current Monitor. Output current from ISET is 877.2µA per ampere of battery charging current. Set the charging current by connecting a resistor (R2 in Figure 3) from ISET to GND. IFAST-CHARGE = 1596V / RISET. To configure the MAX8814 as a USB charger, see Figure 4.
4	ABI	Autobooting External Input. See the <i>Autobooting Assistant</i> section and Table 1 for autobooting conditions. ABI is pulled to GND through an internal $200k\Omega$ resistor.
5	ABO	Autobooting Logic Output. See the <i>Autobooting Assistant</i> section and Table 1 for autobooting conditions.
6	ĒN	Logic-Level Enable Input. Drive $\overline{\text{EN}}$ high to disable charger. Drive $\overline{\text{EN}}$ low or leave unconnected for normal operation. $\overline{\text{EN}}$ has an internal 200k Ω pulldown resistor.
7	POK	Input-Voltage Status Indicator. Connect a $1M\Omega$ pullup resistor from \overline{POK} to an external system supply. \overline{POK} is an open-drain output that asserts low when $V_{IN} > 4.25V$ and $(V_{IN} - V_{BATT}) \ge 40 \text{mV}$. If $V_{BATT} \ge (V_{IN} - 40 \text{mV})$, the IC is shut down and \overline{POK} becomes high impedance.
8	BATT	Battery Connection. Bypass BATT to GND with a minimum of 2.2µF of capacitor.
_	EP	Exposed Paddle. Connect the exposed paddle to a large ground plane for maximum power dissipation. Connect GND to the exposed paddle directly under the IC.

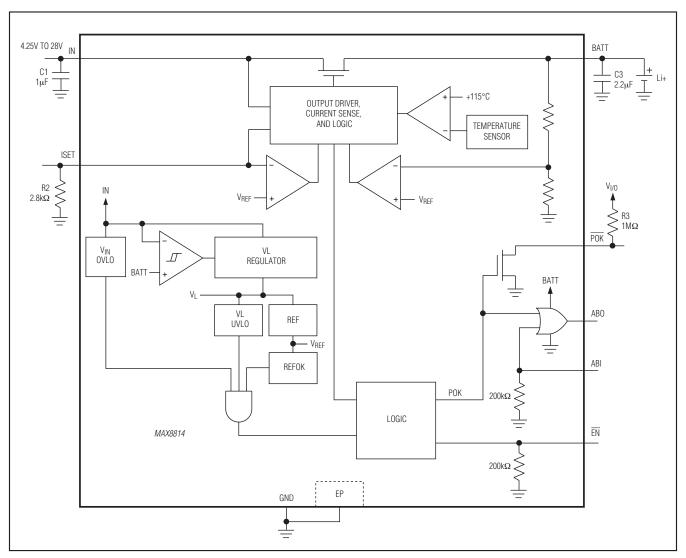


Figure 1. Functional Diagram

Detailed Description

The MAX8814 charger uses voltage, current, and thermal-control loops to charge a single Li+ cell and protect the battery (Figure 1). When a Li+ battery with a cell voltage below 2.5V is inserted, the MAX8814 charger enters the prequalification stage where it precharges that cell with 10% of the user-programmed fast-charge current (Figure 2). When the battery voltage exceeds 2.5V, the charger soft-starts as it enters the fast-charge stage. In the MAX8814, the fast-charge current level is programmed through a resistor from

ISET to GND. As the battery voltage approaches 4.2V, the charging current is reduced. Once the battery voltage reaches 4.2V, the IC then enters a constant voltage regulation mode to maintain the battery at full charge.

Thermal Regulation

The thermal-regulation loop limits the MAX8814 die temperature to +115°C by reducing the charge current as necessary. This feature not only protects the IC from overheating, but also allows a higher charge current without risking damage to the IC.

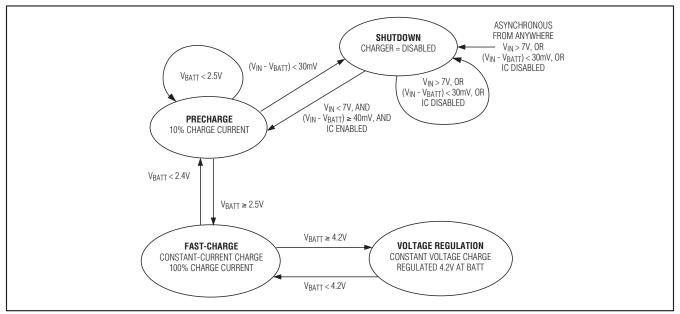


Figure 2. Charge-State Diagram

Charger Enable Input

The MAX8814 contains an active-low logic input (\overline{EN}) used to enable the charger. Drive \overline{EN} low, leave unconnected, or connect to GND to enable the charger-control circuitry. Drive \overline{EN} high to disable the charger-control circuitry. \overline{EN} has an internal 200k Ω pull-down resistor.

POK Output

The open-drain \overline{POK} output asserts low when $V_{IN} \ge 4.25V$ and $(V_{IN} - V_{BATT}) \ge 40 \text{mV}$ (typ, V_{IN} rising). \overline{POK} requires an external pullup resistor (1M Ω typ) to an external power supply. \overline{POK} is high impedance when $V_{BATT} \ge (V_{IN} - 40 \text{mV})$.

Autobooting Assistant

The MAX8814 contains an autobooting assistant circuit that generates an enable signal for system booting (ABO). The booting assistant functions as an internal "OR" gate (Figure 1). The first input is dependent on the input voltage (V_{IN}), and the second input is an external signal applied to ABI. The first input (POK) is driven high once $V_{IN} \ge 4.25V$ and ($V_{IN} - V_{BATT}$) $\ge 40\text{mV}$ (typ, V_{IN} rising).

The second input signal (ABI) is driven by an external source. ABI enables an autoboot signal (ABO high) when a battery is connected at BATT and is independent

Table 1. ABO and POK States

ABI	BATT	POK	CHARGER STATE	ABO
Low	Present	Hi-Z	Shutdown	Low
High	Present	Hi-Z	Shutdown	High
Х	Not present	Low	Fast-charge/voltage regulation	High
Х	Present	Low	Fast-charge/voltage regulation	High

X = Don't care.

of $\overline{\text{POK}}$. If $\overline{\text{POK}}$ is pulled low, the booting assistant always drives ABO high, regardless of ABI (see Table 1). ABI is pulled to GND through an internal $200\text{k}\Omega$ resistor. If ABI is driven externally, a RC filter (R1 and C2 of Figure 3) is required for ESD protection and noise filtering. If ABI is supplied by a system's internal GPIO, or logic, the RC filter is not required.

Soft-Start

The soft-start algorithm activates when entering fast-charge mode. In the MAX8814, when the prequalification state is complete ($V_{BATT} \ge 2.5V$), the charging current ramps up in 250µs to the full charging current. This reduces the inrush current on the input supply.

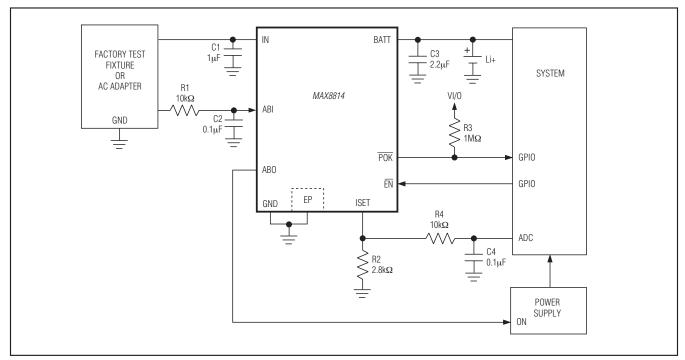


Figure 3. Microprocessor-Interfaced Li+ Battery Charger

Applications Information

Charge-Current Selection

The maximum charging current is programmed by an external resistor connected from ISET to GND (RISET). Calculate RISET as follows:

$$R_{ISET} = \frac{1596V}{I_{FAST-CHARGE}}$$

where IFAST-CHARGE is in amperes and RISET is in ohms. ISET can be used to monitor the fast-charge current level. The output current from ISET is 877.2µA per ampere of charging current. The output voltage at ISET is proportional to the charging current:

$$V_{ISET} = \frac{I_{CHARGE} \times R_{ISET}}{1140}$$

The voltage at ISET is nominally 1.4V at the selected fast-charge current and falls with charging current as the cell becomes fully charged or as the thermal-regulation circuitry activates.

Capacitor Selection

Connect a ceramic capacitor from BATT to GND for proper stability. Use a 2.2µF X5R ceramic capacitor for most applications. Connect a 1µF ceramic capacitor from IN to GND. Use a larger input bypass capacitor for high charging currents to reduce supply noise.

Thermal Considerations

The MAX8814 is available in a thermally enhanced TDFN package with an exposed paddle. Connect the exposed paddle to a large copper ground plane to provide a thermal contact between the device and the circuit board for increased power dissipation. The exposed paddle transfers heat away from the device, allowing the IC to charge the battery with maximum current, while minimizing the increase in die temperature.

DC Input Sources

The MAX8814 operates from a well-regulated DC source. The full charging input voltage range is 4.25V to 7V. The device can withstand up to 28V on the input without damage to the IC. If V_{IN} is greater than 7V, the internal overvoltage-protection circuitry disables charging until the input falls below 7V. An appropriate power supply must provide at least 4.25V at the desired peak charging current.

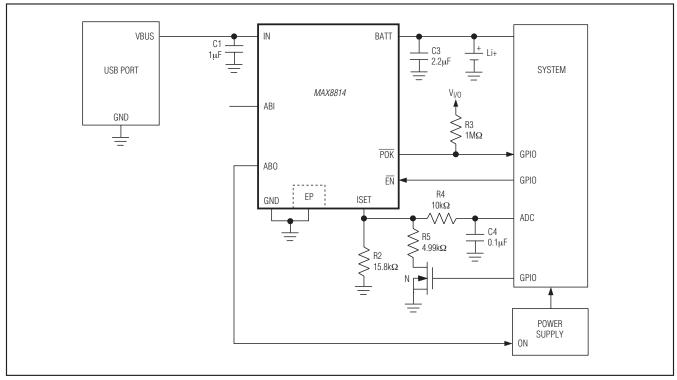


Figure 4. USB Battery Charger

Application Circuits

Microprocessor-Interfaced Charger

Figure 3 shows the MAX8814 as a microprocessor-cooperated Li+ battery charger. The MAX8814 begins charging the battery when $\overline{\text{EN}}$ is low. The microprocessor can drive $\overline{\text{EN}}$ high to disable the charger. The MAX8814 generates a $\overline{\text{POK}}$ signal to indicate the presence of an input supply. By monitoring VISET, the system can measure the charging current and decide when to terminate the charge.

USB-Powered Li-Ion Charger

The universal serial bus (USB) provides a high-speed serial communication port as well as power for the remote device. The MAX8814 can be configured to charge a battery at the highest current possible from the host port. Figure 4 shows the MAX8814 as a USB battery charger. To make the circuit compatible with either 100mA or 500mA USB ports, the circuit initializes at 100mA charging current. The microprocessor then enumerates the host to determine its current capability. If the host port is capable, the charging current is increased to 425mA to avoid exceeding the 500mA USB specification.

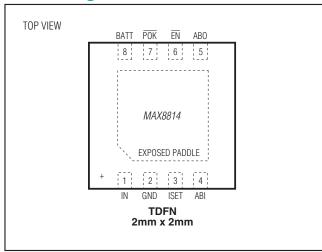
Layout and Bypassing

Place the input and output capacitors as close as possible to the IC. Provide a large copper ground plane to allow the exposed paddle to sink heat away from the IC. Connect the battery to BATT as close as possible to the IC to provide accurate battery voltage sensing. Make all high-current traces short and wide to minimize voltage drops. A sample layout is available in the MAX8814 Evaluation Kit to speed designs.

Chip Information

PROCESS: BICMOS

Pin Configuration



Package Information

For the latest package outline information and land patterns (footprints), go to www.maximintegrated.com/package. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
8 TDFN	T822+2	<u>21-0168</u>

MAX8814

28V Linear Li+ Battery Charger with Smart Autoboot Assistant

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/07	Initial release	_
1	2/08	Changed OVP (min) to 6.8V from 6.5V with 6 sigma without silicon change	2
2	3/08	Changed Input Operating Voltage maximum range from 6.8V to 6.5V.	1
3	5/15	Revised General Description and Benefits and Features section	1

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at www.maximintegrated.com.

ПОСТАВКА ЭЛЕКТРОННЫХ КОМПОНЕНТОВ

многоканальный

Общество с ограниченной ответственностью «МосЧип» ИНН 7719860671 / КПП 771901001 Адрес: 105318, г.Москва, ул.Щербаковская д.3, офис 1107

Данный компонент на территории Российской Федерации Вы можете приобрести в компании MosChip.

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

http://moschip.ru/get-element

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

Офис по работе с юридическими лицами:

105318, г. Москва, ул. Щербаковская д. 3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:

moschip.ru moschip.ru_6 moschip.ru_4 moschip.ru_9