

Power Management Solutions

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DC/DC Solutions

Lowering power consumption in next-generation devices

Lowering power consumption is an issue that is attracting growing attention. The industry-wide focus on the issue has been boosted by the US Environmental Agency's Energy Star Scheme to promote energy-efficient equipment and a similar programme in Europe called Blue Angel. Energy Star has specified that, from 2006, the standby power of electronic devices should be below 0.3 watts for a DVD player or similar and below 1 watt for a computer. At present, the standby power of a computer is typically above 2.5 watts! The Blue Angel standard, for example, requires that Blue Angel compatible products draw 1/20th of their operating current, or less, when in standby mode. This push towards lowering power consumption has been accompanied by a trend for smaller packaging which has meant that power supplies are often external, leaving on-board power distribution to small, localised power converters. The efficiency of these devices, and the quiescent current that they draw, equally contribute to the overall power consumption of the finished product. This is where Torex come in!

The first major breakthrough in converter technology for low power consumption and longer battery life was the Torex XC9215/16/17 series, which was developed for use with Lithium-Ion batteries. These were high efficiency synchronous converters, with very low output ripple of less than 10mV (see Figure 1). With such a low output ripple no filters or regulator circuits were needed to make the output stable enough for today's RF chipsets. The quiescent current drawn was 50-60 μ A, and the maximum output current was 500mA. A number of leading RF chipset vendors quickly adopted the XC9216 for use in bluetooth and wireless LAN applications.

The latest generation power ICs have performance characteristics that far exceed these. Torex Semiconductor has continued to work on its power technology, and has now developed a series of converters that

draw just 15 μ A in operation, or 0.1 μ A in standby mode. The XC9225/26/27 series are synchronous step-down DC/DC converters that have a typical efficiency of 92%, making the series one of the most energy efficient available, while still supplying a stable output current of 500mA. Torex sets the fixed output voltage by laser trimming, giving an output that is selectable in increments of 100mV in the range 0.9V to 4.0V. Minimum operating voltage is 2.0V.

These converters are also very stable, having the same exceptionally low output ripple of less than 10mV as their predecessors. A built in frequency generator oscillates at 600kHz or 1.2MHz to make available the frequency best suited to the application. The XC9225 is PWM controlled, while the XC9226 series is automatic PWM/PFM switching controlled. The XC9227 series can be manually switched between the PWM and PWM/PFM switching control modes, allowing fast response, low ripple and high efficiency over the full range of load conditions. The soft-start and current control functions of all three models are internally optimised.

The devices can be configured using only a coil and two ceramic capacitors connected externally. The IC and companion components will fit on a board space just 6mm² (see Figure 2), making them ideal for applications where PCB space is at a premium.

For applications that require a higher current, Torex has introduced the XC9223/24 series that can provide output currents of up to 1.2A with output voltages down to 0.8V (see Figure 3 – typ app cct). With switching frequencies of 1MHz or 2MHz, small inductors can be used, making the series ideally suited to applications where height and PCB area is limited. Depending on application conditions, efficiencies of up to 94% can be achieved (see Figure 4).

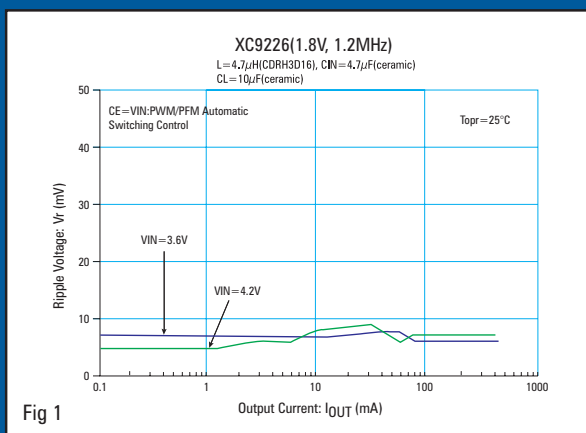


Fig 1

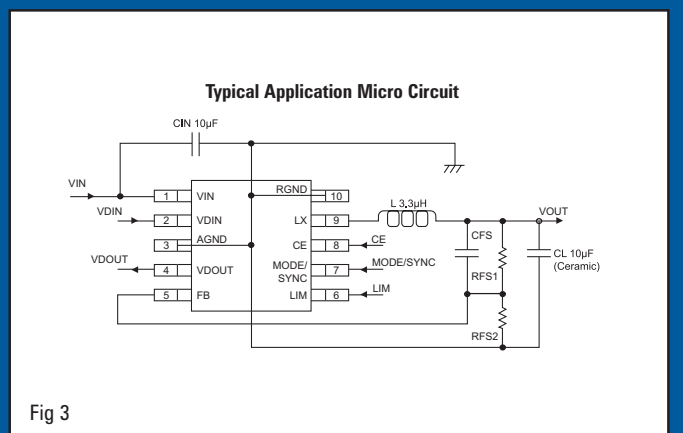
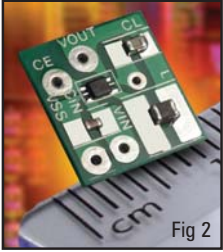


Fig 3



For applications influenced by switching noise, the XC9223/24 series can be synchronised with an external clock signal within the range of $\pm 25\%$ toward an internal clock signal via the MODE/SYNC pin. The series automatically operates in PWM mode when synchronised in this way. The MODE/SYNC pin also allows the user to select fixed PWM mode or PFM/PWM auto-switching control. With PFM/PWM control, the XC9223/24 series selects the best switching mode depending on output load thus ensuring the highest efficiencies from light to heavy loads.

The series also has a built-in current limiter circuit that safely enables the user to fix either a 0.5A or a 1.5A threshold thereby allowing a smaller inductor to be used safely in the knowledge that it will be protected from over-current. For example, a 2.2 μ H inductor can be used in place of a typical 10 μ H inductor.

A built-in voltage comparator is incorporated, which could be configured to monitor battery output for low battery protection. Alternatively it could be used for monitoring a start-up sequence and ensuring that a particular circuit will be activated at the right step. To prevent an over-current state, the IC detects overshoot current by analysing the voltage difference between the VDD and Lx pin. After an over current state continues for a few milliseconds, the IC's operation goes into suspension mode and the driver transistor is turned off.

The series also incorporates a thermal shutdown circuit that operates if the IC's junction temperature reaches 150°C. When the temperature drops to 130°C or less, the IC performs the soft start function and full operation is resumed. In addition the short-circuit protection will shut down the IC when the FB voltage decreases less than half of the setting voltage.

To satisfy increased demand from chipset vendors for dynamic voltage control, Torex has designed the XC9228/29 series of converters. These are suitable for use with next generation applications that have varying power demands, such as 3G cellular phones and PDAs. The XC9228/29 series are synchronous step-down DC/DC converters that allow the output voltage to be adjusted via an external voltage reference (Vref) input. The converters feature a comparator that gives a precise linear output selectable from Vref x 1.2 or Vref x 2.4 (see Figure 5). This dynamic output can be used, for example, with a 3G/UMTS radio where the power needed for the TX/RX depends on the distance from the handset to the base-station. The nearer the base-station, the less power is needed. One way to regulate this TX/RX power is to dynamically control the voltage of the PA in the RF chipset.

The series has a built in 0.6 Ω P-channel driver transistor and 0.7 Ω N-channel switching transistor and can provide high efficiencies (92%), a stable power supply and output currents of 500mA using only a coil and two ceramic capacitors connected externally. Quiescent current is only 18 μ A and during stand-by, all circuits are shutdown to reduce current consumption to 0.1 μ A or less. Minimum operating voltage of the series is 2.0 V.

The XC9228 series is a PWM control type, while the XC9229 series has automatic PWM/PFM switching control, allowing fast response, low ripple and high efficiency over the full range of current load. A built-in under voltage lock out (UVLO) function, current limiter and latch-protection circuit protects the device.

Electronic devices will undoubtedly continue to develop, continuing the trend of packing more and more features into an ever-smaller space. The challenge for power solutions providers is to continue to develop supplies that will provide the required power whilst drawing minimal current themselves.

Typical Performance Characteristics
Efficiency vs. Output Current

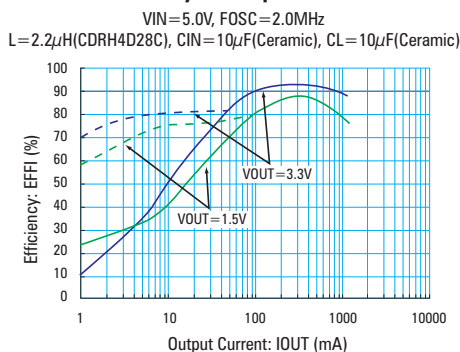


Fig 4

Typical Performance Characteristics

Output Voltage Variable Characteristics (simulation)
Vref vs. VOUT

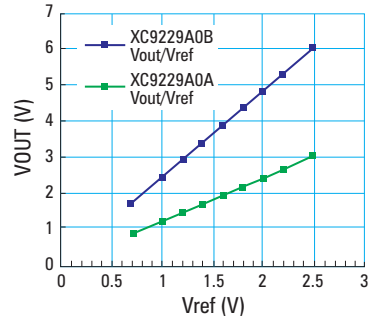


Fig 5

Buck DC/DCs

XC9220/21 16V Step-Down DCDC Controller

- XC9220 PWM only
- XC9221 PWM/PFM (auto-switching)

The XC9220/9221 series are multi-purpose step-down DC/DC controller IC able to handle input voltages up to 16V. Highly efficient, stable power supplies, with output currents up to 3A can be realized using only a transistor, coil, diode, and two ceramic capacitors connected externally.

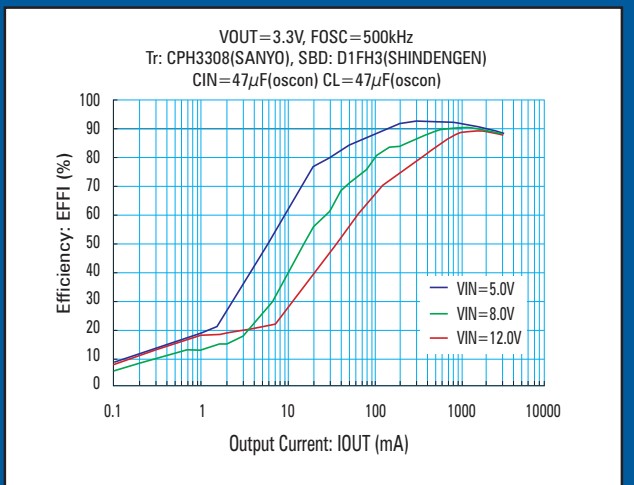
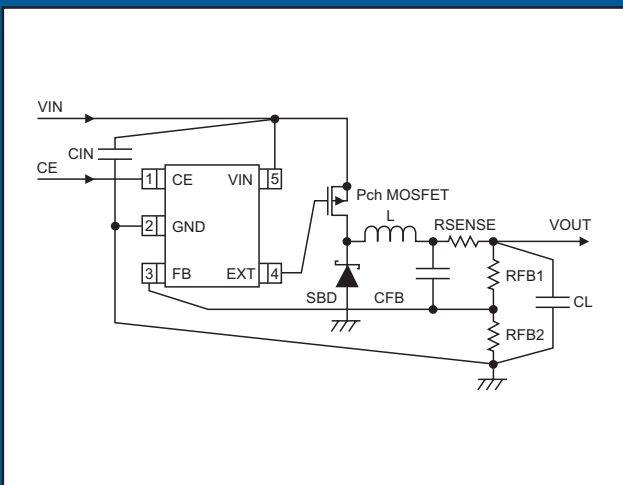
The XC9220/9221 series has a 0.9V ($\pm 1.5\%$) reference voltage, and using externally connected resistors, the output voltage can be set freely. With an internal switching frequency of 300kHz

and 500kHz (1MHz as custom), small external components can also be used. The XC9220 series is PWM control, and the XC9221 series is PWM/PFM mode, which automatically switches from PWM to PFM during light loads and high efficiencies can be achieved over a wide range of load conditions.

As for the soft-start time, the XC9220/9221A series is internally set to 4msec and the XC9220/9221B series can be externally set-up. With the built-in U.V.L.O. (Under Voltage Lock Out) function, the internal P-channel driver transistor is forced OFF when input voltage becomes 2.3V or lower. Two types of package, SOT-25 (250mW) and USP-6 (100 mW), are available.

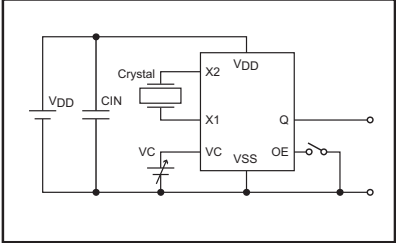
- Input Voltage: 2.8V ~ 16.0V
- Output Voltage: 0.9V $\pm 1.5\%$
- Output Current: ~ 3A
- Oscillator Frequency: 300kHz, 500kHz & 1.0MHz
- Compatible with Low ESR/Ceramic Capacitors
- Programmable soft start

- Built-in Protection circuits
 - Short circuit protection
 - Latch protection (1.0msec)
- Stand-by Current: 0.1 μ A (typ)
- Small SOT23-5 or USP-6C ultra small package (2.0mm x 1.8mm x 0.6mm)



VCXO IC

XC2311 VCXO with Built-in VariCap Diodes

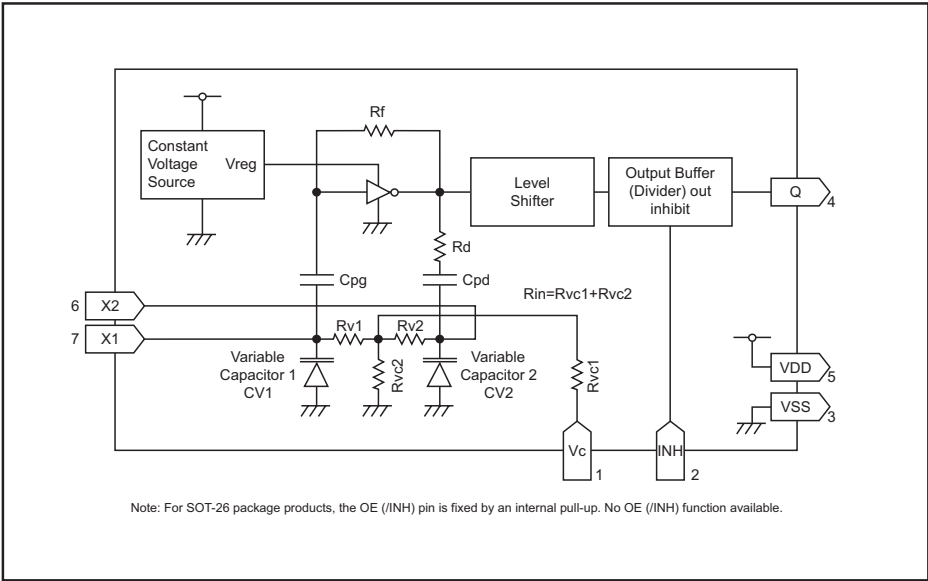


- Input Voltage Range: 2.6V~ 3.6V
- Operating Frequency Range:
16MHz~50MHz (varies with version)
- Supply Current: 3mA (TYP)
- CMOS Output

The XC2311 VCXO (Voltage Controlled Crystal Oscillator) IC has a built-in variable capacitor diode. With the originally developed variable capacitor diode and a constant-voltage circuit built-in, the series achieves the wide variable frequency range, frequency stability to supply voltage and low power consumption.

Combined with an AT-cut crystal oscillator an ultra small and highly accurate Voltage Controlled Crystal Oscillator of 16 to 50MHz can be formed. The small SOT-26, USP-6C, and SOP-8 packages make high density mounting possible.

- Output Frequency Range: 16MHz ~ 50MHz
 - XC2311V2B0 = 16MHz~36MHz
 - XC2311V3B0 = 30MHz~50MHz
- Pull Range: more than ± 110 ppm
(Condition: XC2311V2B0xx, VC = $1.65V \pm 1.35V$)
- Output Waveform Symmetry: 50% ± 5 %
- Operating Ambient Temperature: - 40° ~ +85°
- Ultra Small Packages: SOT-26, USP-6C, SOP-8

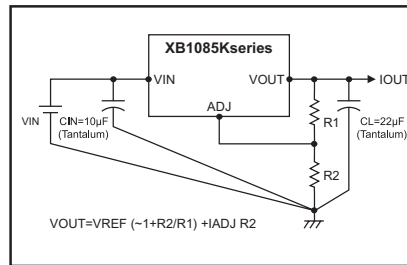
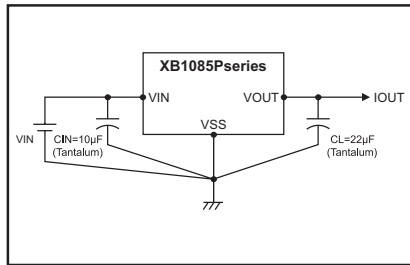
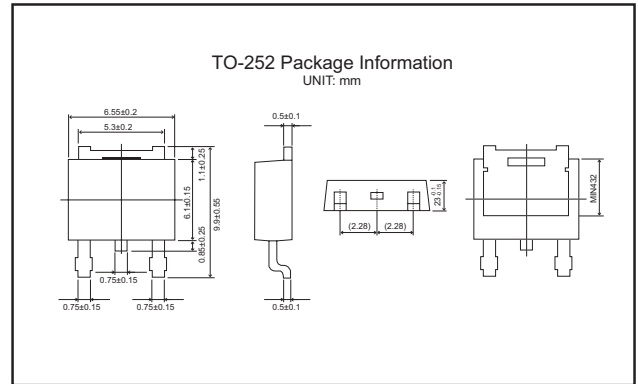


Power Management

XB1085/86 Series High Current LDO Voltage Regulator

XB1085 (1.5A LDO)

- Vin: 15.0V (max)
- Low dropout voltage 1.3V typ @ 1.5A
- Vout: Adjustable or 2.5V, 3.3V fixed voltage
- Line regulation: 0.015% (typ)
- Load regulation: 0.1% (typ)
- Adjust pin (ADJ) current < 120μA
- Over-current protection
- Thermal protection
- Package: TO-252



XB1086 (3.0A LDO)

- Vin: 12.0V (max)
- Low dropout voltage 1.3V (typ) @ 3A
- Vout: Adjustable or 2.5V fixed voltage
- Line regulation: 0.015% (typ)
- Load regulation: 0.1% (typ)
- Adjust pin (ADJ) current $I < 120\mu A$
- Over-current protection
- Thermal protection
- Package: TO-252

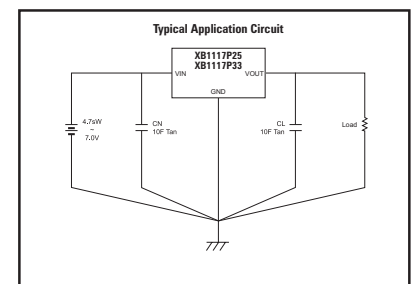
XB1117 LDO Voltage Regulator

The XB1117 series is a 1A low-dropout positive voltage regulator, available with 2.5V, 3.3V, and 5.0V fixed output voltages (XB1117P). An adjustable output voltage variant is also available (XB1117K) where the voltage is set by external resistors. The absolute maximum input voltage of the fixed 5.0V part is 10V, and the maximum input voltage for the 2.5V and 3.3V parts and the adjustable variant is 7V.

A max 1A output current can be generated with a low 1.2V (typ) dropout voltage.



The built-in over-current and thermal protection circuits operate when either output current reaches the current limit level or junction temperature reaches 150°C. The XB1117 series provides stable input and load stability as well as stable



temperature variation by using 10μF tantalum capacitors for the input (CIN) and output (CL). The XB1117 is available in a SOT-223 package, with a power dissipation of 625mW @ 100°C.

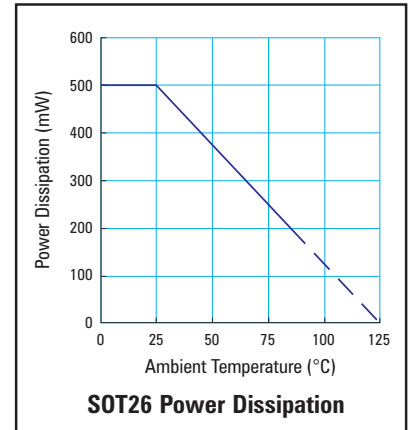
Power Management

XC6214 Series High Current LDO Regulator

- Max Output Current:
> 500mA (800mA limit)
- Dropout Voltage: 500mV @ 500mA
- Operating Voltage: 1.8V ~ 6.0V
- Output Voltage: 1.5V, 1.8V, 2.5V, 3.3V
(others available as semi custom)
- Quiescent Current: 8 μ A (Typ)
- High Accuracy:
2% Standard across the range
- High PSRR: 40dB @1 kHz
- Op. Temp Range: - 40 °C ~ 85 °C
- Packages: SOT-26 & SOT89

The new XC6214 offers extremely high output current capabilities using the SOT26 package. The thermally enhanced SOT26 gives much higher levels of power dissipation and allows the XC6214 to deliver outputs over 0.5A.

The XC6214 series uses low ESR ceramic capacitors, which give additional output stability and help ensure excellent transient response. The internal over-current protection circuit kicks in at 800mA and the additional thermal shutdown circuit protects the IC when the junction temp reaches the predefined limit (typically 150°C).

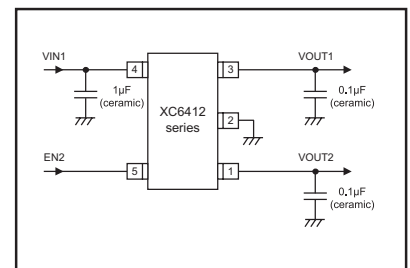
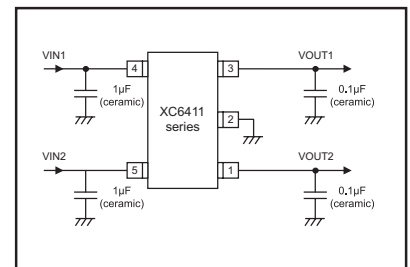


XC6411/2 Series Dual Low Iq LDO Regulator

The XC6411/6412 are Dual channel low noise, LDO, CMOS Voltage Regulators, which offer extremely low supply currents, typically 0.8 μ A/ch. The output voltage of each channel is selectable in 100mV increments within a range of 0.9V ~ 5.0V.

The series is also compatible with low ESR ceramic capacitors, which ensure extremely high output stability. Both VR's are completely isolated and cross talk between each channel is greatly reduced. The current limiter's foldback circuit also operates as a short protect for the output pin and the standard package is SOT25.

- Output Current: 200mA (max)
- Dropout Voltage:
320mV @ 100mA (typ)
- Vin Range: 1.5V ~ 6.0V
- Vout Range: 0.9V ~ 5.0V (0.1V steps)
- Low Power Consumption:
0.8 μ A / ch.(TYP.)
- Stand-by Current: Less than 0.1 μ A
- Operating Temperature Range:
- 40° ~ 85°
- Compatible with Low ESR
& Ceramic capacitors
- Ultra Small Package: SOT-25



Power Management

XC6101~11 Voltage Supervisors with Manual Reset and Watchdog Timer

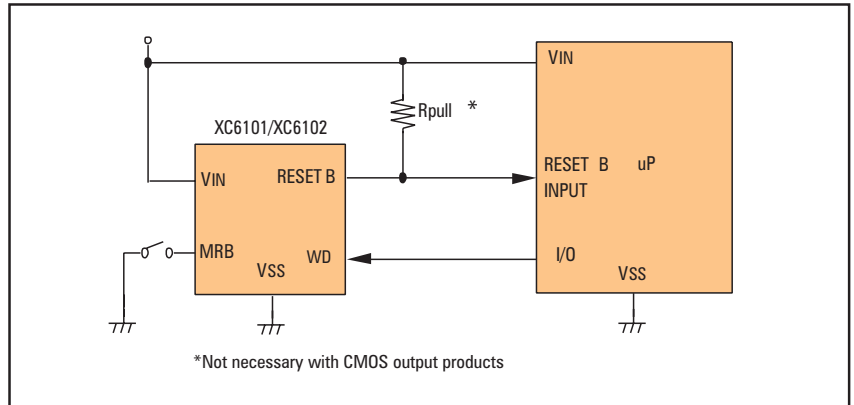
This new family of supply voltage supervisors addresses the problems of system initialization, power brownout, noisy power feed and software dead loops.

The series has a VDD sensing comparator (with hysteresis), reset delay logic and a watchdog timer that is edge triggered. A manual reset input is also available together with the option of active-high and active-low reset.

The series is offered with a range of threshold voltages suitable for nominal supply voltages up to 5.0V. They are supplied in the 5-pin SOT25 package for minimum footprint on the application PCB.

Features

- Operating Voltage: 1.0V ~ 6.0V
- Detect Voltage: 1.6V ~ 5.0V (0.1V steps)
- Low Power consumption: 12 μ A (typ)
- Output Configuration: N channel open drain or CMOS
- Watchdog Pin: Watchdog input.



If no watchdog input takes place within the watchdog timeout period, a reset signal is output to the RESET pin

- Manual Reset Pin: When driven low, the MRB pin input asserts forced reset on the VOUT pin
- Transient Delay Time 2: Selectable from 1.6, 400m, 200m, 100m, 50m, 25m, 3.13msec (typ)
- Watchdog Timeout Period: Selectable from 1.6, 400m, 200m, 100m, 50m, 6.25msec (typ)
- Extended temp range -40°C to +85°C
- Small SOT25 package
- Selectable hysteresis: 2~8% or 0~1%

Applications

- Applications Using DSPs, Microcontrollers, or Microprocessors
- Industrial Equipment
- Programmable Controls
- Automotive Systems
- Portable/Battery-Powered Equipment
- Intelligent Instruments
- Wireless Communications Systems
- Notebook/Desktop Computers

Series	Watchdog	Manual Reset	Reset Output	
			Reset B (VDFL)	Reset (VDFH)
XC6101/11	✓	✓	CMOS	-
XC6102/12	✓	✓	N channel open drain	-
XC6103/13	✓	✓	-	CMOS
XC6104/14	✓	✗	CMOS	CMOS
XC6105/15	✓	✗	N channel open drain	CMOS
XC6106/16	✗	✓	CMOS	CMOS
XC6107/17	✗	✓	N channel open drain	CMOS

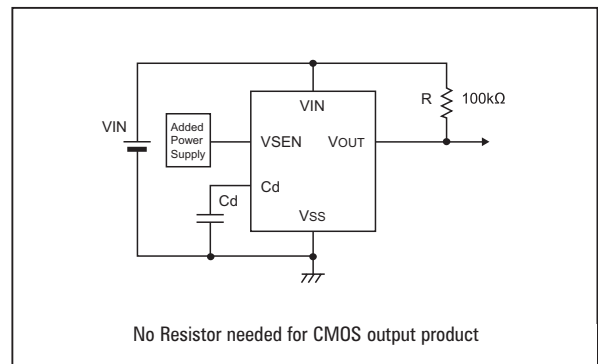
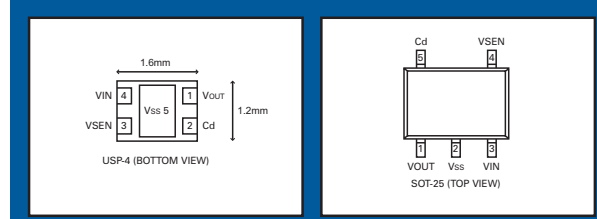
Power Management

XC6108 Voltage Detector with Sense Pin & Ext. Delay

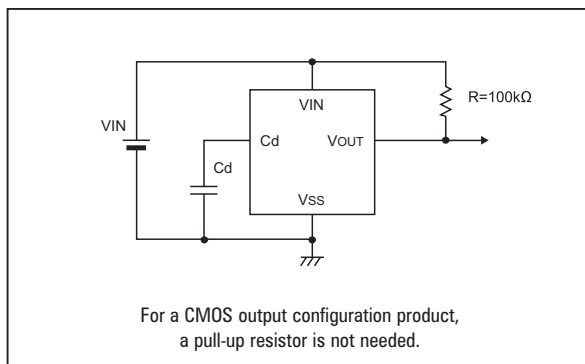
This family of low power Voltage Detectors has a sense pin separated from its power supply (Vin), so the IC can monitor an external power supply.

Moreover, with the built-in delay circuit, connecting the delay capacitance pin to the capacitor enables the IC to provide an arbitrary release delay time. Both CMOS and N-channel open drain output configurations are available.

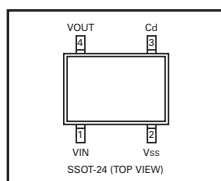
- Detect Range: 0.8V to 5.0V in 0.1V step
- Supply Current: $0.8\mu\text{A}$
- Low Active Reset Output
- CMOS or Open Drain Outputs
- SOT25 or USP4 Package



XC6109 Super Low Power Voltage Detector with Ext. Delay



- Detect Range: 0.8V to 5.0V in 0.1V steps
- Supply Current: $0.8\mu\text{A}$
- Low Active Reset Output
- CMOS or Open Drain Outputs
- SSOT-24 (SC-82) Package



The XC6109 series is highly precise, low power consumption voltage detector, manufactured using CMOS and laser trimming technologies.

With the built-in delay circuit, connecting the delay capacitance pin to the capacitor enables the IC to provide an arbitrary release delay time. Both CMOS and N-channel open drain output configurations are available.

Selection Guide

Voltage Detectors / RESET IC

Part Number	Type	Detect Voltage	Accuracy	Operating Voltage	Power Consumption	Output Configuration	On-chip delay circuit	Comments	Package
XC61C Series	Low Current	0.8V ~ 6.0V	+/-2% (1%)	0.7V ~ 10V	Typ. 0.7µA	N-Channel Open Drain or CMOS	n/a	1% parts for output voltages between 2.6V~5.0V only	SC-82 SOT23 / 25 SOT89 TO92
XC61F Series	Built in Delay Circuit	1.6V ~ 6.0V	+/-2%	0.7V ~ 10V	Typ. 1.0µA	N-Channel Open Drain or CMOS	1ms to 50ms 50ms to 200ms (std) 80ms to 400ms		SOT23 SOT89 TO92
XC61G Series	Small Package	0.8V ~ 6.0V	+/-2%	0.7V ~ 10V	Typ. 0.7µA	N-Channel Open Drain or CMOS	n/a	1.2mm x 1.2mm x 0.6mm pkg	USP-3
NEW! XC6101 Series	Watchdog Timer & MR	1.6V~5.0V	+/-2%	1.0V~6.0V	Typ. 12µA	N-Channel Open Drain or CMOS	User Selectable	Hysteresis selectable from 2~8% & 0~1%	SOT25
NEW! XC6108 Series	External Delay & VSEN Pin	0.8V~5.0V	+/-2%	1.0V~6.0V	Typ. 0.8µA	N-Channel Open Drain or CMOS	Yes	External power supply monitoring	SOT25 USP-4
NEW! XC6109 Series	External Delay	0.8V~5.0V	+/-2%	0.7V~6.0V	Typ. 0.9µA	N-Channel Open Drain or CMOS	Yes	Cd pin for setting delay time	SC-82
XC612 Series	Dual Channel	1.5V ~ 5.0V	+/-2% (1%)	1.0V ~ 10V	Typ. 2.0µA	N-Channel Open Drain or CMOS	n/a	VD levels set independently	SOT25

CMOS LDO Voltage Regulators

Positive Voltage Regulators

Part Number	Type	Input Voltage Range	Output Voltage	Max Output Current	Accuracy	Power Consumption		Dropout Voltage	Comments	Package
						Typical	Standby			
XB1117 Series	High Current	10V max	2.5V, 3.3V, 5.0V & Adj.	1A	+/-1%	6mA	n/a	1.2V @ 1A	Bi-Polar	SOT223
XC62FP Series	General Purpose	10V max	1.1V ~ 6.0V	>250mA	+/-2% (1%)	2.0µA		120mV @ 100mA 380mV @ 200mA		SOT23 / 25 SOT89 TO92
XC62RP Series	Reference Source	6V max	1.5V ~ 3.5V	6mA		3.2µA		140mV @ 300µA	Low output currents	SOT23 SOT89
XC6201 Series	Low ESR Caps	10V max	1.3V ~ 6.0V	>250mA		2.0µA		160mV @ 100mA	Low ESR Ceramics Capacitors	SOT25 SOT89 USP-6B TO92
XC6202 Series	High Input Voltage	20V max	1.8V ~ 18V	>150mA	10.0µA	200mV @ 30mA		SOT23 SOT89 SOT223 USP-6B TO92		
XC6203 Series	High Output Current	8V max	1.8V ~ 6.0V	>400mA	2%	8.0µA		150mV @ 100mA 300mV @ 200mA		SOT23 SOT89 SOT223 TO92
XC6206 Series	Low Quiescent Current	6V max	1.2V ~ 5.0V	>250mA		1.0µA		160mV @ 100mA 400mV @ 200mA	Low ESR Ceramics Capacitors	SOT23 SOT89 USP-6B TO92
XC6214 Series	High Output Current	6V max	1.5V~5.0V	>500mA		8.0µA		100mV @ 100mA 500mV @ 500mA	1.5V, 1.8V, 2.5V, 3.3V, Standard	SOT26 SOT89
XC6406 Series	Dual LDO	10V max	1.8V~6.0V	>400mA		20.0µA		150mV @ 100mA 300mV @ 200mA		SOP8 SOP8FD

Negative Voltage Regulators

Part Number	Type	Input Voltage Range	Output Voltage	Max Output Current	Accuracy	Power Consumption		Dropout Voltage	Comments	Package
						Typical	Standby			
XC62KN Series	General Purpose	-10V max	-2.1V to -6.0V	100mA	+/-2% (1%)	3.0µA	n/a	120mV @ 50mA 380mV @ 100mV		SOT23 SOT89 TO92

Selection Guide

Positive Voltage Regulators with Output On/Off Control

	Type	Input Voltage Range	Output Voltage	Max Output Current	Accuracy	Power Consumption		Dropout Voltage	Comments	Package
						Typical	Standby			
XC62HR Series	Standard	10V max	2.0V~6.0V (1.1V~1.9V)	>165mA	+/-2% (1%)	3μA	0.1μA	180mV @ 60mA 580mV @ 160mV	Low Quiescent Current	USP-6B SOT25 SOT89-5
XC62GR Series	High Speed		2.1V~5.0V	>150mA		13μA		200mV @ 80mA 380mV @ 160mA	Higher speed version available	SOT25 SOT89-5
XC6204 Series	Low Noise / High Speed		1.8V~6.0V	ABCD > 150mA EFGH > 300mA		70μA		60mV @ 30mA 200mV @ 100mA	Low ESR Caps Noise 30μVrms typ PSRR > 70dB Fast turn on time	SOT25 USP-6B SOT89-5
XC6205 Series	Low Noise / High Speed		0.9V~1.75V	>150mA					SOT25 USP-6B	
XC6207 Series	Green Operation	6V max	0.8V~5.0V	>300mA	+/-2%	50μA (5.5μA)	0.1μA	40mV @ 30mA 135mV @ 100mA	Only 5.5μA quiescent current in power save mode	SOT25 USP-6C SOT89-5
XC6209 Series	Low Noise / High Speed	10V max	0.9V~6.0V	ABCD > 150mA EFGH > 300mA				60mV @ 30mA 200mV @ 100mA	Noise 30μVrms typ PSRR > 70dB	SOT25 USP-6B SOT89-5
XC6210 Series	High Current	6V max	0.8V~5.0V	>700mA		25μA		50mV @ 100mA 100mV @ 200mA	Ultra Low Dropout	SOT25 SOT89-5 USP-6B
XC6211 Series	Low Noise/ High Speed	6V max	0.9V~5.0V	~300mA				60mV @ 30mA 200mV @ 100mA	Noise 30μVrms typ PSRR > 70dB	SOT25
XC6212 Series	TK112 pin-out compatible	10V max	0.9V~6.0V	>150mA		60mV @ 30mA 200mV @ 100mA	Noise 30μVrms typ PSRR > 70dB	SOT25		
XC6213 Series	Low Noise / High Speed	6V max	1.2V~5.0V	~150mA	+/-2%	35μA	0.1μA	400mV @ 100mA	V.small pkgs	SC-82 SOT25 USP-4
XC6215 Series	Low Noise / High Speed		0.9V~5.0V	~200mA		0.8μA		320mV @ 100mA	Only 0.8μA Quiescent Current	SC-82 USP-4 USP-3
XC6219 Series	Low Noise / High Speed		0.9V~5.0V	~300mA		25μA		60mV @ 30mA 200mV @ 100mA	Low Cost	USP-6B SOT25 SOT89-5
XC6401 Series	Dual Channel Low Noise / High Speed		0.8V~5.0V	>150mA		25μA/ch		100mV @ 100mA	Low ESR Caps PSRR > 70dB Power Saving mode	USP-6B USP-6C SOT26W
NEW! XC6411 Series	Dual Channel Low Noise / High Speed	0.9V~5.0V	~300mA	0.8μA/ch	320mV @ 100mA	Dual LDO with dual input	SOT25			
NEW! XC6412 Series	Dual Channel Low Noise / High Speed	0.9V~5.0V	~300mA	0.8μA/ch	320mV @ 100mA	Single input with EN pin on VR2	SOT26			
XC62E Series	Boosting	10V max	1.5V~6.0V	> 1000mA		50μA	0.2μA	100mV @ 100mA < 400mV @ 1A	Ext. Transistor required	SOT25

The XC6204 series is only available with a 1% output accuracy for voltages between 3.0V~6.0V

Positive Voltage Regulators with built in Voltage Detector

Part Number	Type	Input Voltage Range	Output Voltage	Max Output Current	Accuracy	Power Consumption		Dropout Voltage	Detect Voltage Range	D.V.Output Configuration	Package
						Typical	Standby				
XC6402 Series	Low V-Drop	6V max	0.8V ~ 5.0V	> 700mA	+/-2%	35μA	n/a	50mV @ 100mA	0.8V ~ 5.0V	N-ch open drain	USP-6B SOT25 SOT89-5
XC6403 Series	Semi-custom		0.9V ~ 5.6V	> 300mA			0.1μA				
XC6404 Series	Delay circuit built-in		0.9V~5.1V	> 500mA		n/a					
XC6405 Series	Delay circuit built-in					90μA	n/a	60mV @ 30mA 200mV @ 100mA			
XC6413 Series	Semi-custom	10V max	0.9V~5.5V	> 300mA	+/-2%	35μA	0.1μA	60mV @ 30mA 200mV @ 100mA	0.9V ~ 6.0V	USP-6B SOT25 SOT89-5	
XC6414 Series			> 500mA								

Selection Guide

DC/DC Convertors & Controllers

Step-up DC/DC Convertors

Part Number	Type	Efficiency	Operating Voltage Range	Output Voltage Range	High Accuracy	Max. Oscillator Frequency	Comments	Package
XC6381 Series	PFM	85%	0.9V ~ 10V	2.0V ~ 7.0V	+/-2.5%	155kHz (+/-15%)	Low Output Currents	SOT23 & SOT25 SOT89 & SOT89-5
XC6382 Series						100kHz (+/-15%)	Fixed Duty Ratio	
XC6383 Series							Switchable Duty Ratio	
XC6385 Series						Low Noise		
XC6371 Series	PWM	Typ. 85%	0.9V ~ 10V	2.0V ~ 7.0V	+/-2.5%	50kHz, 100kHz & 180kHz (+/-15%)	Low Cost	SOT89 & SOT89-5
XC6372 Series	PFM / PWM							
XC6373 Series	PWM	Typ. 82%				30kHz	Low Noise	
XC9110 Series	PFM	87%	0.9V ~ 10V	1.5V ~ 7.0V	+/-2.5%	100kHz (+/-15%)	Fixed Duty Ratio	SOT25 USP-6C
XC9111 Series							Switchable Duty Ratio	

Step-up DC/DC Controllers

Part Number	Type	Efficiency	Operating Voltage Range	Output Voltage Range	High Accuracy	Max. Oscillator Frequency	Comments	Package
XC6367 Series	PFM	Typ. 84%	0.9V ~ 10V	1.5V ~ 30V (fixed or adjustable)		100kHz, 180kHz, 300kHz, 500kHz	Output > 500mA Standby Current 0.5µA Max	SOT25
XC6368 Series	PFM/PWM							
XC9101 Series	PWM	Typ. 85%	20V max	1.5V ~ 30V (fixed or adjustable)		100kHz ~ 600kHz (user selectable)	Outputs upto 1.5A Low ESR ceramic caps	MSOP-8A
XC9103 Series	PWM	Typ. 85%	0.9V ~ 10V	1.5V ~ 30V (externally adjustable)	+/-2.5%	100kHz, 180kHz, 300kHz, 500kHz	Auto PFM /PWM Manual Switching Mode	SOT25 USP-6B
XC9104 Series	PFM / PWM							
XC9105 Series	PFM / PWM							
XC9106 Series	PWM							
XC9107 Series	PFM / PWM							
XC9116 Series	PWM	88%	2.5V ~ 6.0V	17.5V max	+/-5%	1MHz	Backlight LED Driver	SOT25 USP-6B
XC9119 Series	PWM	>80%	2.5V ~ 6.0V	18.0V max	+/-2%	1MHz	High Switching Frequency	SOT25 USP-6C

Step-down DC/DC Convertors

Part Number	Type	Efficiency	Operating Voltage Range	Output Voltage Range	High Accuracy	Max. Oscillator Frequency	Comments	Package
XC6376 Series	PWM	Typ. 95%	1.8V ~ 10V	1.5V ~ 6.0V (fixed or adjustable)	+/-2.5%	180kHz, 300kHz, 500kHz	Built in P-Ch MOSFET Standby current 1.5µA	SOP-8
XC6377 Series	PFM / PWM							
XC9206 Series	PWM							
XC9207 Series	PFM / PWM	Typ. 90%	1.8V ~ 6.0V	0.9V ~ 4.0V	+/-2%	300kHz, 600kHz, 1.2MHz	Output upto 500mA Low ESR ceramic caps Switching mode externally selectable	USP-6B SOT25
XC9208 Series	PFM / PWM PFM disable mode							
XC9215 Series	Synchronous PWM	Typ. 92%	2.0V ~ 6.0V	0.9V ~ 4.0V	+/-2%	600kHz or 1.2MHz	Outputs upto 500mA Low ESR ceramic caps	USP-6B SOT25
XC9216 Series	Synchronous PFM / PWM							
XC9217 Series	Synchronous PWM or PFM/PWM							
XC9223 Series	Synchronous PWM or PFM/PWM	Typ. 92%	2.2V ~ 6.0V	0.8V ~ VIN	+/-2%	1MHz or 2MHz	Outputs upto 1A Voltage Detector Built-in Low ESR ceramic caps	MSOP-10 USP-10
XC9224 Series								
XC9225 Series	Synchronous PWM	Typ. 92%	2.0V ~ 6.0V	0.9V ~ 4.0V	+/-2%	600kHz, 1.2MHz	Only 15µA Quiescent Current, Outputs up to 500mA	USP-6B SOT25
XC9226 Series	Synchronous PFM / PWM							
XC9227 Series	Synchronous PWM or PFM / PWM							
XC9228 Series	Synchronous PWM or PFM / PWM	Typ. 92%	2.0V ~ 6.0V	0.7V ~ 6.0V Vref	+/-2%	600kHz, 1.2MHz	Dynamic Output Voltage Outputs up to 500mA	USP-6B SOT25
XC9229 Series								

Selection Guide

Step-down DC/DC Converters with built-in Voltage Regulators and Detector

Part Number	Type	Efficiency	Operating Voltage Range	Output Voltage /Detect Range	High Accuracy	Max. Oscillator Frequency	Comments	Package
XC9508 Series	Synchronous PWM or PFM / PWM	Typ. 94%	2.4V ~ 6.0V	DC/DC: 1.6V~4.0V VR: 0.9V~4.0V VD: 0.9V~5.0V	+/-2%	300kHz, 600kHz, 1.2MHz	DC/DC Iout > 600mA VR Iout > 300mA	MSOP-10 USP-10
XC9509 Series				DC/DC: 0.9V~4.0V VR: 0.9V~4.0V VD: 0.9V~5.0V				
XC9510 Series				DC/DC: 1.6V~4.0V VR: 0.9V~4.0V VD: 0.9V~5.0V			DC/DC Iout > 800mA VR Iout > 400mA	SOP-8
XC9511 Series				DC/DC: 0.9V~4.0V VR: 0.9V~4.0V VD: 0.9V~5.0V				

Step-down DC/DC Controllers

	Type	Efficiency	Operating Voltage Range	Output Voltage Range	High Accuracy	Max. Oscillator Frequency	Comments	Package
XC6365 Series	PWM	Typ. 92%	2.2V ~ 10V	1.5V ~ 6.0V (fixed or adjustable)	+/-2.0%	180kHz, 300kHz, 500kHz	Output Current > 1A Standby Current 0.5μA Max	SOT25
XC6366 Series	PFM / PWM							
XC9201 Series	PWM	Typ. 93%	2.5V ~ 20V	1.2V ~ 16V (fixed or adjustable)	+/-2.5%	100kHz ~ 600kHz (user selectable)	Outputs upto 3A Low ESR ceramic caps	MSOP-8A
XC9210 Series	Synchronous PFM/PWM	Typ. 90%	2.0V ~ 10V	0.9V ~ 6.0V	+/-2%	300kHz (+/-15%)	Outputs > 2A CE pin & internal soft-start	MSOP-8A
XC9213 Series	Synchronous PFM/PWM	Typ. 93%	4V ~ 25V	1.5V ~ 15V	+/-2%	300kHz (+/-15%)	Outputs > 5A Boot strap method	TSSOP-16
NEW! XC9220 Series	PWM	Typ. 93%	2.8V ~ 16V	1.2V~	+/-2%	300kHz, 500kHz, 1MHz	Outputs up to 3A Low ESR ceramic caps	SOT25 USP-6C
XC9221 Series	PFM/PWM							

Step-up & down DC/DC Controllers

Part Number	Type	Efficiency	Operating Voltage Range	Output Voltage Range	High Accuracy	Max. Oscillator Frequency	Comments	Package
XC9301 Series	PWM	Typ. 80%	2.0V ~ 10V	2.4V ~ 6.0V	+/-2.5%	180kHz, 300kHz (+/-15%)	Outputs > 250mA CE pin & internal soft-start	SOT25
XC9302 Series	PFM/PWM							
XC9303 Series	Synchronous PFM/PWM	Typ. 84%	2.0V ~ 10V	2.0V ~ 6.0V	+/-2%	300kHz (+/-15%)	Outputs > 800mA CE pin & internal softstart	MSOP-8A

Dual Channel DC/DC Controllers

Part Number	Type	Efficiency	Operating Voltage Range	Output Voltage Range	High Accuracy	Max. Oscillator Frequency	Comments	Package
XC9501 Series	Dual Step-up	Typ. 83%	2.0V ~ 10V	1.5V ~ 30V	+/-2%	180kHz (+/-15%) 300kHz, 500kHz (custom)	Switching Mode Pin: PWM or PFM/PWM Low ESR Ceramic Caps 3.0μA in Standby	MSOP-10
XC9502 series	Step-up + Step-down	Typ. 83% Typ. 92%		1.5V ~ 30V 0.9V ~ 6.0V				
XC9503 Series	Dual Step-down	Typ. 92%		0.9V ~ 6.0V				
XC9504 Series	Step-up + Inverting	Typ. 83% Typ. 76%		1.5V ~ 30V 30V ~ 0.0V				
XC9505 Series	Step-down + Inverting	Typ. 92% Typ. 76%		0.9V ~ 6.0V -30V ~ 0.0V				

Charge Pump Converters

Part Number	Type	Efficiency	Operating Voltage Range	Output Voltage Range	Low Supply Current	Max. Oscillator Frequency	Comments	Package
XC6351A120MR	Inverting	Typ. 90%	1.2V ~ 5.0V	-1.2V to -5.0V	310μA typ.	120kHz	Standby current 2.0μA	SOT26
XC9801/02 Series	Doubler / Regulated Step-up	Typ. 80%	1.8V ~ 5.5V	2.5V ~ 5.2V	80μA	300kHz	Standby current 2.0μA	USP-8 MSOP-8

Schottky Barrier Diode

Part Number	IF	VR	VF1	VF2	IR	Package
XB0ASB03A1BR	0.5A	30V	0.28V@100mA	0.41V@500mA	35μA@VR=20V	SOD-323
XB01SB04A2BR	1.0A	40V	0.5V@1A		6μA@VR=40V	SOD-123

Selection Guide

Power MOSFET

N-Channel

Type Number	Absolute Max. Rating			Electrical Characteristic										Driving Voltage (V)	Package	
	Vdss (V)	Vgss (V)	Id (A)	Rds(ON) (Ω)								Vgs (off) (V)				Ciss (pF)
				Vgs=1.5V		Vgs=2.5V		Vgs=4.5V		Vgs=10V		MIN	MAX			
				TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX					
XP131A1145SR	30	±20	7	-	-	-	-	0.035	0.045	0.025	0.03	1.0	2.5	620	4.5	SOP-8 (Single)
XP131A1235SR	20	±12	7	-	-	0.035	0.048	0.025	0.035	-	-	0.5	1.2	760	2.5	
XP131A1330SR	20	±8	8	0.045	0.07	0.03	0.04	0.025	0.03	-	-	0.5	1.2	950	1.5	
XP131A1520SR	30	±20	10	-	-	-	-	0.016	0.02	0.012	0.015	1.0	2.5	1370	4.5	
XP131A1617SR	20	±12	10	-	-	0.013	0.019	0.01	0.014	-	-	0.7	1.4	1650	2.5	
XP131A1715SR	20	±8	10	0.017	0.025	0.011	0.015	0.009	0.012	-	-	0.5	1.2	2000	1.5	
XP133A1145SR	30	±20	6	-	-	-	-	0.035	0.045	0.026	0.033	1.0	2.5	620	4.5	SOP-8 (Dual)
XP133A1235SR	20	±12	6	-	-	0.035	0.048	0.026	0.035	-	-	0.5	1.2	760	2.5	
XP133A1330SR	20	±8	6	0.045	0.07	0.03	0.04	0.025	0.03	-	-	0.5	1.2	950	1.5	
XP151A11B0MR	30	±20	1	-	-	-	-	0.13	0.17	0.09	0.12	1.0	3.0	150	4.5	SOT-23 (Single)
XP151A12A2MR	20	±12	1	-	-	0.12	0.16	0.075	0.10	-	-	0.7	1.4	180	2.5	
XP151A13A0MR	20	±8	1	0.17	0.25	0.10	0.14	0.075	0.10	-	-	0.5	1.2	220	1.5	
XP161A11A1PR	30	±20	4	-	-	-	-	0.075	0.105	0.05	0.065	1.0	2.5	270	4.5	SOT-89 (Single)
XP161A1265PR	20	±12	4	-	-	0.07	0.095	0.042	0.055	-	-	0.7	1.4	320	2.5	
XP161A1355PR	20	±8	4	0.10	0.15	0.05	0.07	0.037	0.05	-	-	0.5	1.2	390	1.5	

P-Channel

Type Number	Absolute Max. Rating			Electrical Characteristic										Driving Voltage (V)	Package	
	Vdss (V)	Vgss (V)	Id (A)	Rds(ON) (Ω)								Vgs (off) (V)				Ciss (pF)
				Vgs=-2.5V		Vgs=-4.5V		Vgs=-5.0V		Vgs=-10V		MIN	MAX			
				TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX					
XP132A11A1SR	-30	±20	-5	-	-	0.095	0.11	-	-	0.055	0.065	-1.0	-2.5	680	-4.5	SOP-8 (Single)
XP132A1275SR	-20	±12	-5	0.092	0.115	0.05	0.075	-	-	-	-	-0.5	-1.2	770	-2.5	
XP132A1545SR	-30	±20	-8	-	-	0.038	0.045	-	-	0.025	0.03	-1.0	-2.5	1500	-4.5	
XP132A1635SR	-20	±12	-8	0.04	0.055	0.025	0.033	-	-	-	-	-0.5	-1.2	1700	-2.5	
XP134A11A1SR	-30	±20	-4	-	-	0.09	0.11	-	-	0.055	0.065	-1.0	-2.5	680	-4.5	
XP134A1275SR	-20	±12	-4.5	0.095	0.115	0.062	0.075	-	-	-	-	-0.5	-1.2	770	-2.5	
XP152A11E5MR	-30	±20	-0.7	-	-	0.35	0.45	-	-	0.2	0.25	-1.0	-3.0	160	-4.5	SOT-23 (Single)
XP152A12C0MR	-20	±12	-0.7	0.37	0.5	0.23	0.3	-	-	-	-	-0.5	-1.2	180	-2.5	
XP162A11C0PR	-30	±20	-2.5	-	-	0.2	0.28	-	-	0.11	0.15	-1.0	-2.5	280	-4.5	SOT-89 (Single)
XP162A12A6PR	-20	±12	-2.5	0.22	0.3	0.13	0.17	-	-	-	-	-0.5	-1.2	310	-2.5	

*1) : @ Vgs=-5.5V

N-Channel & P-Channel (Complementary)

Type Number	Absolute Max. Rating			Electrical Characteristic										Driving Voltage (V)	Package	
	Vdss (V)	Vgss (V)	Id (A)	Rds(ON) (Ω)								Vgs (off) (V)				Ciss (pF)
				Vgs=±1.5V		Vgs=±2.5V		Vgs=±4.5V		Vgs=±10V		MIN	MAX			
				TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX					
XP135A1145SR	30	±20	5	-	-	-	-	-	0.045	-	0.03	1	2.5	520	4.5	SOP-8
	-30	±20	-3.5	-	-	-	-	-	0.11	-	0.065	-1	-2.5	600	-4.5	

Selection Guide

CMOS Mini-Logic

Part Number	Type	Operating Voltage Range	Input Voltage Range	Speed (tpd)	Power Consumption	Package
XC74UL Series	Single Logic Gate	2.0V ~ 5.5V	0.0V ~ 5.5V	4~8ns typ.	1.0 μ A Max	SSOT25
XC74WL Series	Dual / Triple Logic Gate	2.0V ~ 5.5V	0.0V ~ 5.5V	3~8.7ns typ.	1~2 μ A Max	MSOP-8

Operational Amplifiers

Part Number	Description	Gain Margin	Slew Rate	Power Consumption	Operating Voltage	Package
XC221A1100MR	Rail to Rail CMOS Op Amp	210kHz	0.07V/ μ S	15 μ A typ.	1.2V ~ 10V (single cell) +/-0.6V ~ 5V (+ve/-ve supply)	SOT25
XC221A1200MR	Rail to Rail CMOS Op Amp	550kHz	0.5V/ μ S	100 μ A typ.	1.2V ~ 10V (single cell) +/-0.6V ~ 5V (+ve/-ve supply)	SOT25

Analog Temperature Sensor

Part Number	Type	Temp. Range	Input Voltage Range	Output Voltage Range	Accuracy	Power Consumption		Output Voltage Temp. Coefficient	Package
						Typical	Standby		
XC31B Series	Bandgap Sensor	-30°C to +80°C	3.0V ~ 10V	2.0V ~ 6.0V	+/-3%	7 μ A	0.1 μ A	-3900ppm/°C typ.	SOT25

Oscillator IC's and PLL Clock Generator ICs

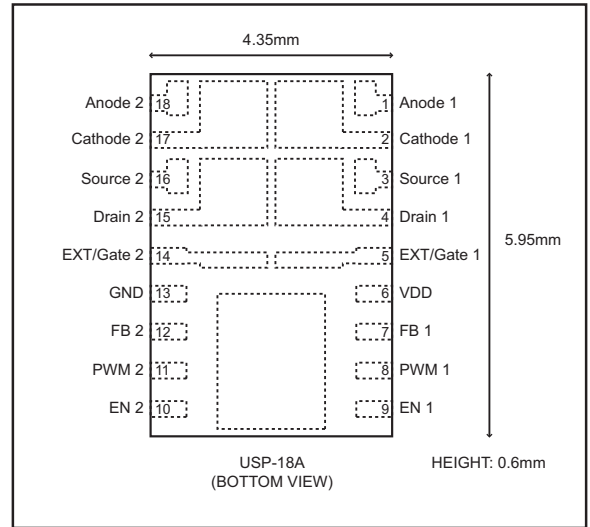
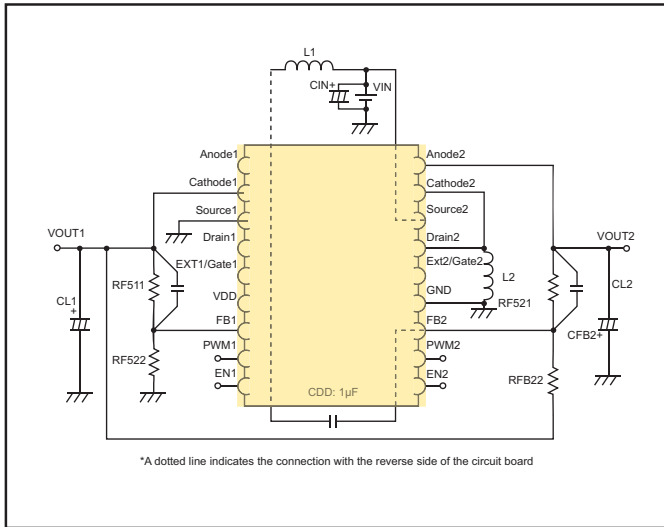
Part Number	Description	Oscillator Freq.	Op. Volt.	Divider Ratio	Multiplier Ratio	Output	Comments	Package
XC2163 Series	Divider / Buffer	20MHz ~ 125MHz (160MHz Buffer)	3.3V / 5.0V	f0/1, f0/2, f0/4, f0/8	n/a	3 state	3rd Overtone	SOT26
XC2164 Series	Divider / Buffer	4MHz ~ 125MHz	3.3V / 5.0V	f0/1, f0/2, f0/4, f0/8	n/a	3 state	Fundamental 3rd Overtone	SOT26 DIE
XC2165 Series	Divider / Buffer	8MHz ~ 120MHz	1.5V ~ 3.6V	f0/1, f0/2, f0/4, f0/8	n/a	3 state	Fundamental	SOT26 DIE
XC2173 Series	PLL / Divider	50MHz ~ 160MHz	3.3V / 5.0V	f0/2, f0/4, f0/8	f0 x 5,6,7,8	3 state		SOT26
XC2300 Series	Tri-State Buffer	70MHz (max)	3.3V / 5.0V	f0/1, f0/2, f0/4, f0/8	n/a	3 state		SOT26
XC2301 Series	Tri-State Buffer	160MHz (max)	3.3V	f0/1, f0/2, f0/4, f0/8	n/a	3 state		SOT26
<small>NEW!</small> XC2311 Series	VCXO with built-in variable capacitor diode	16MHz~50MHz	2.6V~3.6V	n/a	n/a	n/a		SOT26 USP-6C SOP-8
XC25BS3 Series	PLL	9MHz~80MHz (Q0 = f0 x N/M)	2.97V~5.5V	1~2047	20~2047	3 state	CE Pin	SOT26
XC25BS5 Series	PLL	3MHz~30MHz (Q0 = f0 x N/M)	2.97V~5.5V	1~2047	6~2047	3 state	CE Pin	SOT26
XC25BS6 Series	PLL	32.768kHz	2.3V~4.0V	f0/1024, f0/512, f0/256, f0/128	n/a	3 state	CE Pin	SOT26

Available with internal or external oscillation capacitors and feedback resistors

With the XC25BS3 & XC25BS5, the second output (Q1) is selectable from reference oscillation, PLL output freq/2, comparative freq/2 or GND

Under Development

XCM505 Multi-Chip Module for LCD and TFT Applications



Dual DC/DC controller with integrated FET (x2) & SBD (x2), USP-18A.

- 2-Ch Step-up and Inverting DC/DC Controller (XC9504) with integrated FET (XP151A12 and XP152A12) plus SBD
- Vout1: 1.5V~30V (externally adjustable)
- Vout2: -30V~0V (externally adjustable)
- Iout: >20mA (per channel)

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