AS0128

I^2C Real Time Clock/Calendar

Features

•Real Time Clock/Calendar

- Tracks Time in Hours, Minutes, and Seconds

- Day of the Week, Day, Month, and Year

• 15 Selectable Frequency Outputs

• Single Alarm

- Settable to the Second, Minute, Hour, Day of the Week, Day, or Month

- Single Event or Pulse Interrupt Mode

• Automatic Backup to Battery or Super Cap

• Power Failure Detection

• On-Chip Oscillator Compensation

• 2 Bytes Battery-Backed User SRAM

• I^2C Interface

- 400kHz Data Transfer Rate

• 400nA Battery Supply Current

• Same Pin Out as Intersil 1208 and Maxim DS13xx

• Small Package Options

-    SOP8 Packages

-    MSOP8 Packages

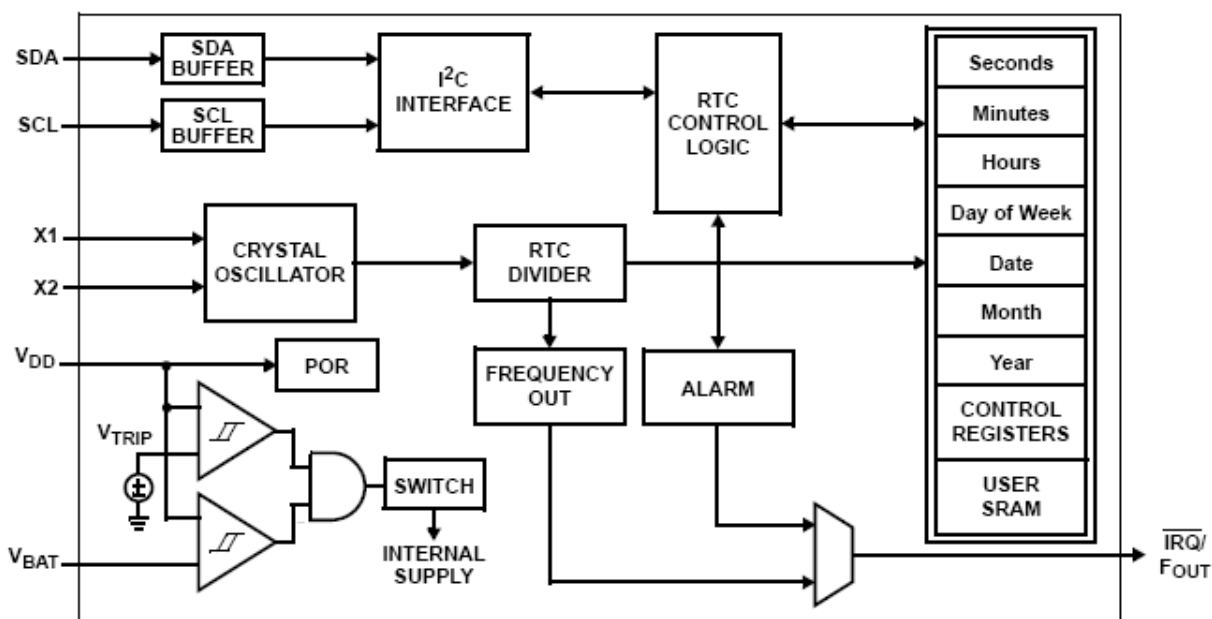• Pb-Free Available (RoHS Compliant)

General Description

The AS0128 device is a low power real time clock with timing and crystal compensation, clock/calendar, power fail indicator, periodic or polled alarm, intelligent battery backup switching and battery-backed user SRAM. The oscillator uses an external, low-cost 32.768kHz crystal.

The real time clock tracks time with separate registers for hours, minutes, and seconds. The device has calendar registers for date, month, year and day of the week. The calendar is accurate through 2099, with automatic leap year correction.

Applications

• Audio/Video Components

• Set Top Box/Television

• Network Routers, Hubs, Switches, Bridges

• Fixed Broadband Wireless Equipment

• PDA

• POS Equipment

• Test Meters/Fixtures

• Office Automation (Copiers, Fax)

• Home Appliances

• Computer Products

• Other Industrial/Medical/Automotive
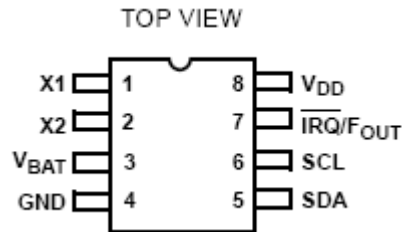
Functional Block Diagram

Pin Assignment and Package

TOP VIEW

PIN NUMBER	SYMBOL	DESCRIPTION
1	X1	The X1 pin is the input of an inverting amplifier and is intended to be connected to one pin of an external 32.768kHz quartz crystal. X1 can also be driven directly from a 32.768kHz source.
2	X2	The X2 pin is the output of an inverting amplifier and is intended to be connected to one pin of an external 32.768kHz quartz crystal.
3	VBAT	This input provides a backup supply voltage to the device. V_{BAT} supplies power to the device in the event that the V_{DD} supply fails. This pin should be tied to ground if not used.
4	GND	Ground.
5	SDA	Serial Data (SDA) is a bidirectional pin used to transfer serial data into and out of the device. It has an open drain output and may be wire OR'ed with other open drain or open collector outputs.
6	SCL	The Serial Clock (SCL) input is used to clock all serial data into and out of the device.
7	$\overline{IRQ}$/F$_{OUT}$	Interrupt Output/Frequency Output is a multi-functional pin that can be used as interrupt or frequency output pin. The function is set via the configuration register.
8	VDD	Power supply.

Electrical Characteristics

DC Operating Characteristics – RTC Temperature = -40°C to +85°C, unless otherwise stated.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP (Note 4)	MAX	UNITS	NOTES
VDD	Main Power Supply		2.7		5.5	V	
VBAT	Battery Supply Voltage		1.8		5.5	V	
IDD1	Supply Current	VDD = 5V		2	6	µA	1, 2
		VDD = 3V		1.2	4	µA	
IDD2	Supply Current With I2C Active	VDD = 5V		40	120	µA	1, 2
IDD3	Supply Current (Low Power Mode)	VDD = 5V, LPMODE = 1		1.4	5	µA	1
IBAT	Battery Supply Current	VBAT = 3V		400	950	nA	1
ILI	Input Leakage Current on SCL			100		nA	
ILO	I/O Leakage Current on SDA			100		nA	
VTRIP	VBAT Mode Threshold		1.6	2.2	2.6	V	
VTRIPHYS	VTRIP Hysteresis		10	30	75	mV	
VBATHYS	VBAT Hysteresis		15	50	100	mV	
VOL	Output Low Voltage	VDD = 5V IOL = 3mA			0.4	V	
		VDD = 2.7V IOL = 1mA			0.4	V	

Power-Down Timing Temperature = -40°C to +85°C, unless otherwise stated.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP (Note 4)	MAX	UNITS	NOTES
VDD SR	VDD Negative Slewrate				10	V/ms	3

Serial Interface Specifications Over the recommended operating conditions unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP (Note 4)	MAX	UNITS	NOTES
VIL	SDA and SCL Input Buffer LOW Voltage		-0.3		0.3xVDD	V	
VIH	SDA and SCL Input Buffer HIGH Voltage		0.7xVDD		VDD+0.3	V	
Hysteresis	SDA and SCL Input Buffer Hysteresis		0.05xVDD			V	
VOL	SDA Output Buffer LOW Voltage,Sinking 3mA		0		0.4	V	

General Description

The AS0128 device is a low power real time clock with timing and crystal compensation, clock/calendar, power fail indicator, periodic or polled alarm, intelligent battery backup switching, and battery-backed user SRAM.

The oscillator uses an external, low-cost 32.768kHz crystal. The real time clock tracks time with separate registers for hours, minutes, and seconds. The device has calendar registers for date, month, year and day of the week. The calendar is accurate through 2099, with automatic leap year correction.

The AS0128's powerful alarm can be set to any clock/calendar value for a match. For example, every minute, every Tuesday or at 5:23 AM on March 21. The alarm status is available by checking the Status Register, or the device can be configured to provide a hardware interrupt via the $\overline{IRQ}$ pin. There is a repeat mode for the alarm allowing a periodic interrupt every minute, every hour, every day, etc.

The device also offers a backup power input pin. This VBAT pin allows the device to be backed up by battery or SuperCap with automatic switchover from VDD to VBAT. The entire AS0128 device is fully operational from 2.0V to 5.5V and the clock/ calendar portion of the device remains fully operational down to 1.8V (Standby Mode).

Pin Description

X1, X2

The X1 and X2 pins are the input and output, respectively, of an inverting amplifier. An external 32.768kHz quartz crystal is used with the AS0128 to supply a timebase for the real time clock. Internal compensation circuitry provides high accuracy over the operating temperature range from -40°C to +85°C. This oscillator compensation network can be used to calibrate the crystal timing accuracy over temperature either during manufacturing or with an external temperature sensor and microcontroller for active compensation. The device can also be driven directly from a 32.768kHz source at pin X1.

VBAT

This input provides a backup supply voltage to the device. VBAT supplies power to the device in the event that the VDD supply fails. This pin can be connected to a battery, a Super Cap or tied to ground if not used.

$\overline{IRQ}$/FOUT (Interrupt Output/Frequency Output)

This dual function pin can be used as an interrupt or frequency output pin. The $\overline{IRQ}$/FOUT mode is selected via the frequency out control bits of the control/status register.

• **Interrupt Mode.** The pin provides an interrupt signal output. This signal notifies a host processor that an alarm has occurred and requests action. It is an open drain active low output.

• **Frequency Output Mode.** The pin outputs a clock signal which is related to the crystal frequency. The frequency output is user selectable and enabled via the I^2C bus. It is an open drain active low output.

Serial Clock (SCL)

The SCL input is used to clock all serial data into and out of the device. The input buffer on this pin is always active (not gated). It is disabled when the backup power supply on the VBAT pin is activated to minimize power consumption.

Serial Data (SDA)

SDA is a bidirectional pin used to transfer data into and out of the device. It has an open drain output and may be ORed with other open drain or open collector outputs. The input buffer is always active (not gated) in normal mode. An open drain output requires the use of a pull-up resistor. The output circuitry controls the fall time of the output signal with the use of a slope

controlled pull-down. The circuit is designed for 400kHz I2C interface speeds. It is disabled when the backup power supply on the VBAT pin is activated.

VDD, GND

Chip power supply and ground pins. The device will operate with a power supply from 2.0V to 5.5VDC. A 0.1μF capacitor is recommended on the VDD pin to ground.

Real Time Clock Operation

The Real Time Clock (RTC) uses an external 32.768kHz quartz crystal to maintain an accurate internal representation of second, minute, hour, day of week, date, month, and year. The RTC also has leap-year correction. The clock also corrects for months having fewer than 31 days and has a bit that controls 24 hour or AM/PM format. When the AS0128 powers up after the loss of both VDD and VBAT, the clock will not begin incrementing until at least one byte is written to the clock register.

Accuracy of the Real Time Clock

The accuracy of the Real Time Clock depends on the frequency of the quartz crystal that is used as the time base for the RTC. Since the resonant frequency of a crystal is temperature dependent, the RTC performance will also be dependent upon temperature. The frequency deviation of the crystal is a function of the turnover temperature of the crystal from the crystal's nominal frequency. For example, a ~20ppm frequency deviation translates into an accuracy of ~1 minute per month. These parameters are available from the crystal manufacturer. The AS0128 provides on-chip crystal compensation networks to adjust load capacitance to tune oscillator frequency from -94ppm to +140ppm. For more detailed information see the Application Section.

Single Event and Interrupt

The alarm mode is enabled via the ALME bit. Choosing single event or interrupt alarm mode is selected via the IM bit. Note that when the frequency output function is enabled, the alarm function is disabled. The standard alarm allows for alarms of time, date, day of the week, month, and year. When a time alarm occurs in single event mode, an $\overline{IRQ}$ pin will be pulled low and the alarm status bit (ALM) will be set to "1". The pulsed interrupt mode allows for repetitive or recurring alarm functionality. Hence, once the alarm is set, the device will continue to alarm for each occurring match of the alarm and present time. Thus, it will alarm as often as every minute (if only the nth second is set) or as infrequently as once a year (if at least the nth month is set). During pulsed interrupt mode, the $\overline{IRQ}$ pin will be pulled low for 250ms and the alarm status bit (ALM) will be set to "1".

NOTE: The ALM bit can be reset by the user or cleared automatically using the auto reset mode (see ARST bit).

The alarm function can be enabled/disabled during battery backup mode using the FOBATB bit. For more information on the alarm, please see the Alarm Registers Description.

Frequency Output Mode

The AS0128 has the option to provide a frequency output signal using the $\overline{IRQ}$/FOUT pin. The frequency output mode is set by using the FO bits to select 15 possible output frequency values from 0 to 32kHz. The frequency output can be enabled/disabled during battery backup mode using the FOBATB bit.

General Purpose User SRAM

The AS0128 provides 2 bytes of user SRAM. The SRAM will continue to operate in battery backup mode. However, it should be noted that the I^2C bus is disabled in battery backup mode.

I^2C Serial Interface

The AS0128 has an I^2C serial bus interface that provides access to the control and status registers and the user SRAM. The

I2C serial interface is compatible with other industry I^{2}C serial bus protocols using a bidirectional data signal (SDA) and a clock signal (SCL).

Oscillator Compensation

The AS0128 provides the option of timing correction due to temperature variation of the crystal oscillator for either manufacturing calibration or active calibration. The total possible compensation is typically -94ppm to +140ppm. Two compensation mechanisms that are available are as follows:

1. An analog trimming (ATR) register that can be used to adjust individual on-chip digital capacitors for oscillator capacitance trimming. The individual digital capacitor is selectable from a range of 9pF to 40.5pF (based upon 32.758kHz). This translates to a calculated compensation of approximately -34ppm to +80ppm. (See ATR description.)

2. A digital trimming register (DTR) that can be used to adjust the timing counter by ±60ppm. (See DTR description.)
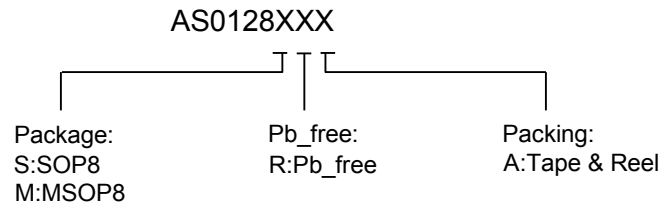
Also provided is the ability to adjust the crystal capacitance when the AS0128 switches from VDD to battery backup mode. (See Battery Mode ATR Selection for more details.)
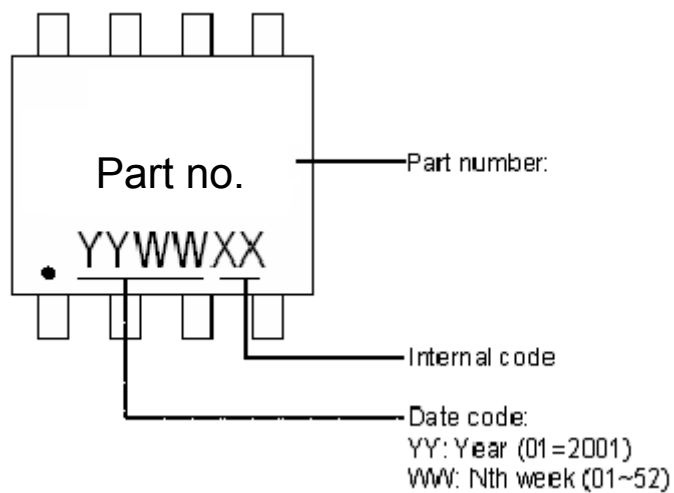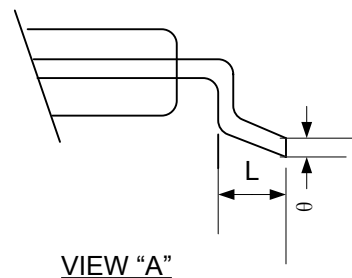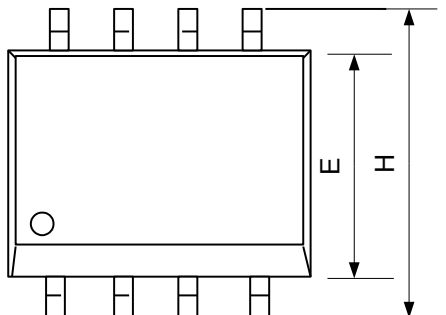
■ ORDERING INFORMATION

AS0128XXX

Package:
S:SOP8
M:MSOP8

Pb_free:
R:Pb_free

Packing:
A:Tape & Reel

■ MARKING INFORMATION

Part no.

YYWWXX

Part number:

Internal code

Date code:
YY: Year (01=2001)
WW: Nth week (01~52)

■ **PACKAGE INFORMATION**

VIEW "A"
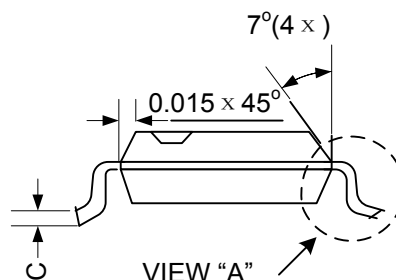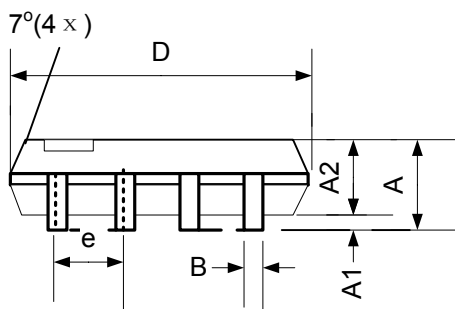
VIEW "A"

Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.35	1.60	1.75	0.053	0.063	0.069
A1	0.10		0.25	0..004		0.010
A2	1.35	1.45	1.55	0.053	0.057	0.061
B	0.33	0.41	0.51	0.013	0.016	0.020
C	0.19	0.20	0.25	0.0075	0.008	0.010
D	4.80	4.90	5.00	0.192	0.196	0.200
E	3.80	3.90	4.00	0.148	0.154	0.160
e	1.27TYP.			0.050TYP.		
H	5.80	5.99	6.30	0.228	0.236	0.248
L	0.38	0.71	1.27	0.015	0.028	0.050
θ	0°		8°	0°		8°