

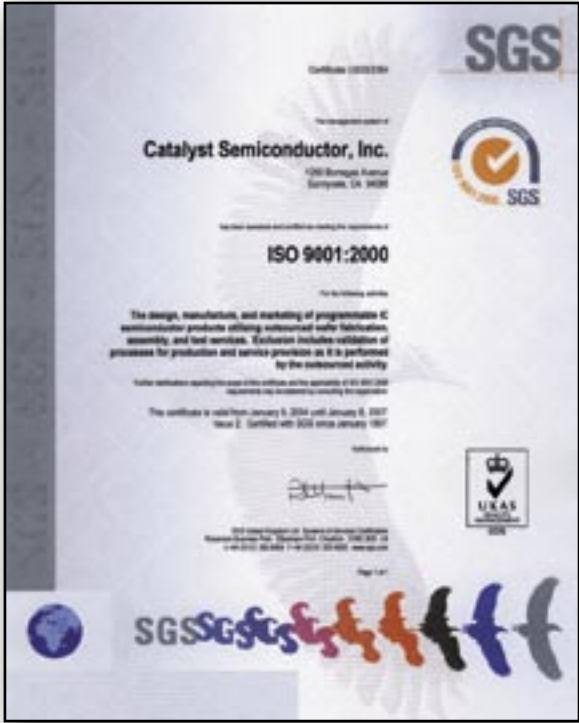


Product Guide 2005

 **CATALYST**
SEMICONDUCTOR, INC.

catalyst semiconductor quality policy

Catalyst Semiconductor's Quality Policy is to provide customers with high quality, leading edge non-volatile memory based products. In addition to providing high quality products, Catalyst strives to promote customer satisfaction, emphasizes the prevention of non-conformances and continually pursues improvements in its company-wide operations.



green package program

Catalyst Semiconductor made the commitment in Q4 2002 to deliver volume production of lead-free, halogen-free “Green” package integrated circuits. Catalyst offers “Green” packages for its complete product offering of analog and mixed-signal ICs, as well as serial and parallel EEPROM memory. The “Green” Package Program is a total system solution encompassing lead plating, package compound and die attach epoxy technology.

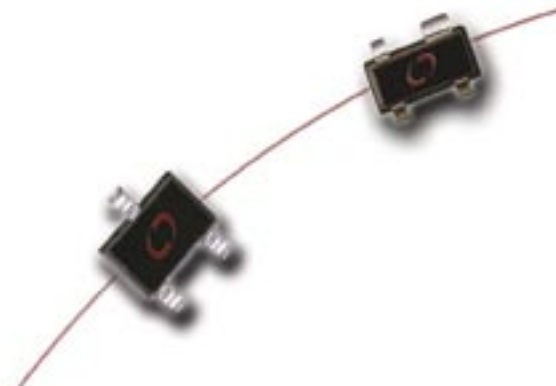
Catalyst continues to meet the requirements of regulatory agencies world wide:

- Waste from Electrical and Electronics Equipment (WEEE)
- Japanese Ministry of International Trade and Industry
- Japan Electrical Insulating Materials Association
- European Union Directives

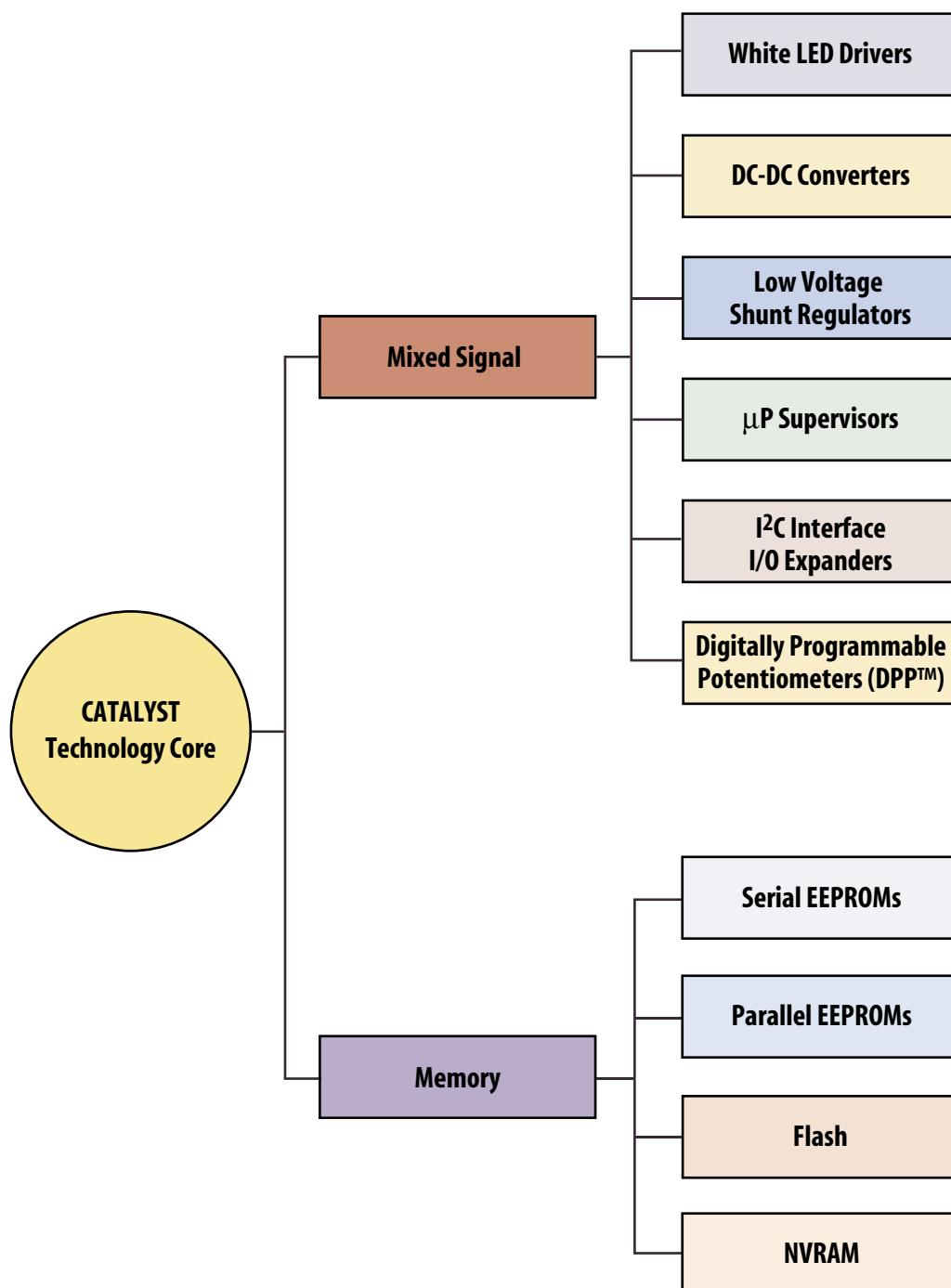


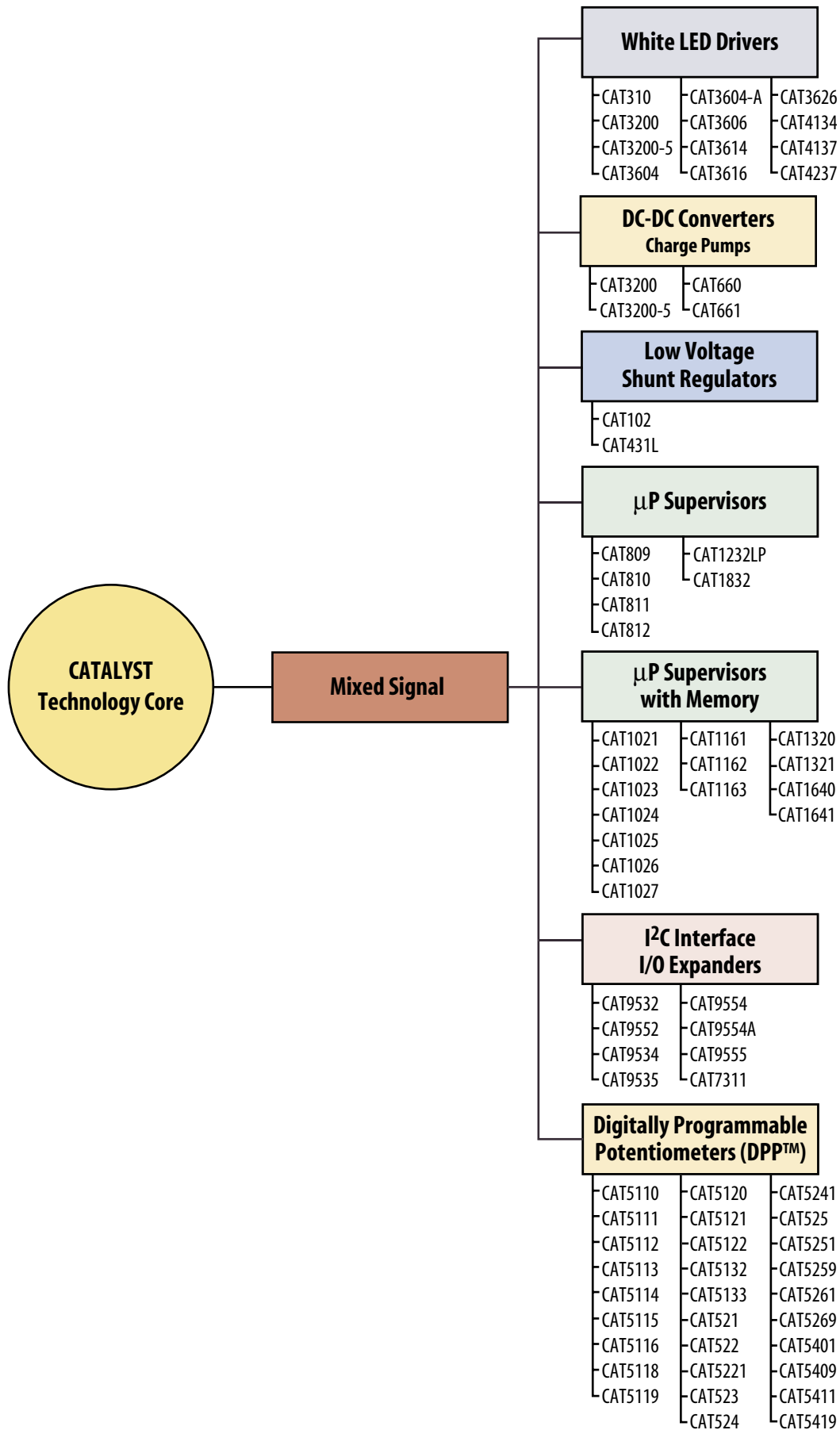
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Founded in 1985, Catalyst Semiconductor, Inc. is headquartered in Sunnyvale, California. Catalyst is a leading supplier of high performance analog/mixed-signal solutions and nonvolatile memory products used in automotive, aircraft, telecommunications, computation, industrial and consumer markets. Catalyst designs and markets a broad range of analog/mixed-signal products such as White LED Drivers, DC-DC converters, GPI/O expanders, Digitally Programmable Potentiometers (DPP™), Microcontroller Supervisory circuits and other analog/mixed-signal products. Programmable products include Serial and Parallel EEPROMs with I²C, SPI and Microwire interfaces, as well as NVRAM and low density Flash Memories. Typical applications include LCD displays, digital cameras, cell phones, automotive instrumentation, modems, wireless LANs, network cards, DIMM modules, digital satellite box receivers, set-top boxes and Internet routers. Catalyst's Quality Management System is ISO 9001:2000 certified. For additional information about Catalyst Semiconductor, visit our website at: www.catsemi.com.



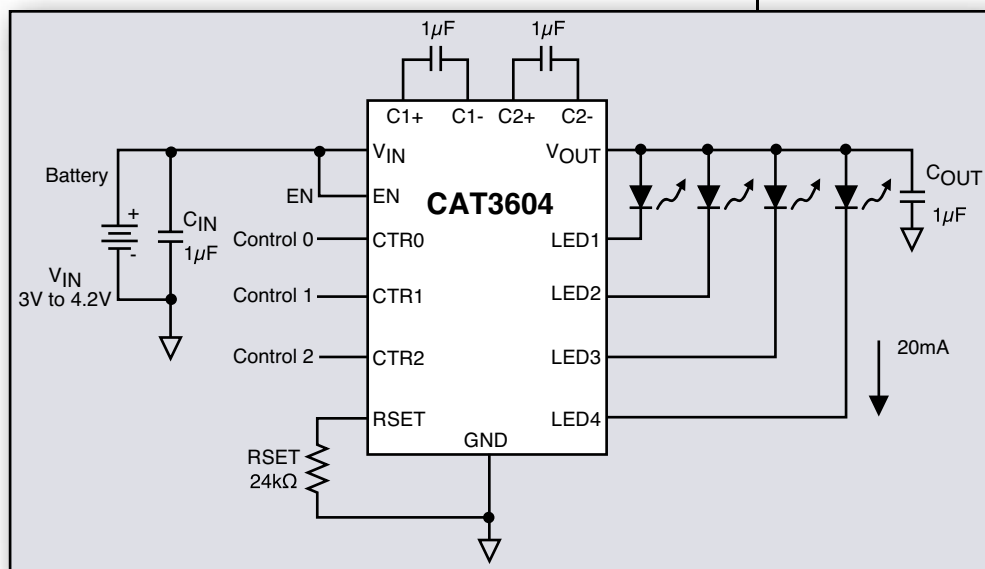


CAT3604**4-Channel Fractional Charge Pump LED Driver****Features**

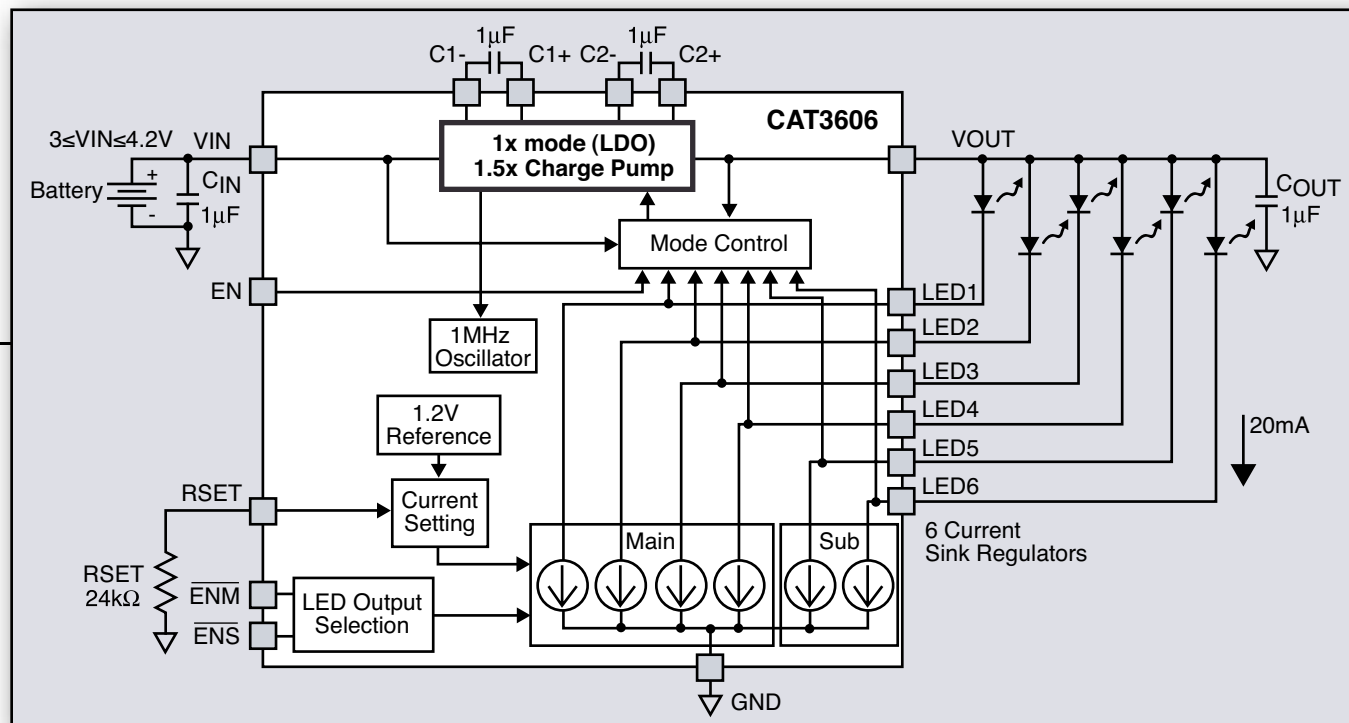
- automatically switches from 1x LDO mode to 1.5x boost mode
- inductor-less design minimizes EMI interference
- drives up to 4 Parallel LEDs at 30mA per channel
- very low input ripple and noise
- "zero" shutdown current extends battery life
- power efficiency up to 93%
- optimized for use with Lithium-Ion battery systems

Package Information

- 16 pad TQFN (4x4mm, height 0.8mm max)



Featured Products

CAT3606**6-Channel Fractional Charge Pump LED Driver****Features**

- independent dimming and standby control for Main and Sub displays
- automatically switches from 1x LDO mode to 1.5x boost mode
- inductor-less design minimizes EMI interference
- drives up to 6 Parallel LEDs at 30mA per channel
- very low input ripple and noise
- "zero" shutdown current extends battery life
- power efficiency up to 90%
- short circuit detect/disable on all channels
- optimized for use with Lithium-Ion battery systems

Package Information

- 16-pad TQFN (4x4mm, height 0.8mm max)

CAT4237

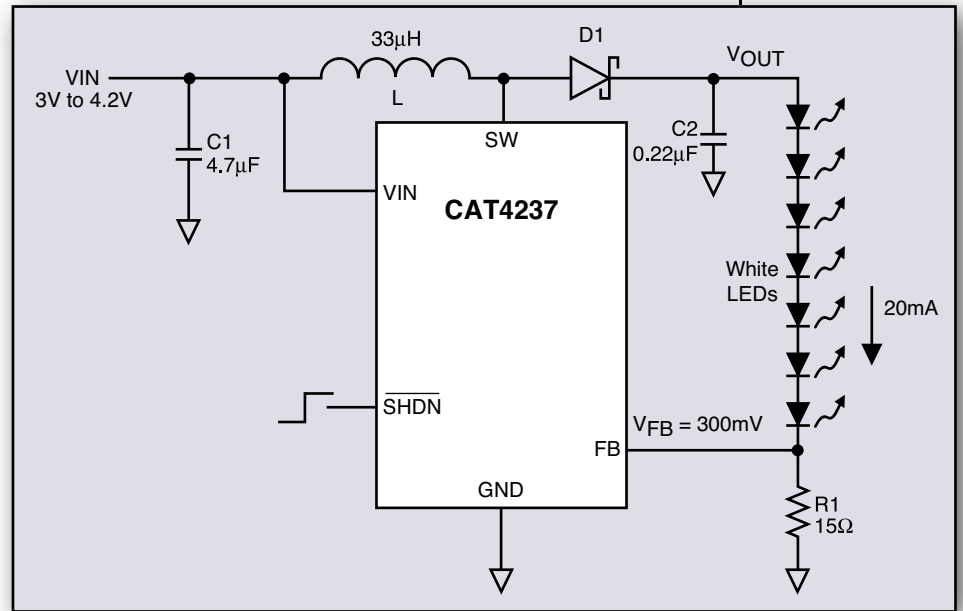
High Voltage CMOS Boost White LED Driver

Features

- drives 8 white LEDs in series from 3V
- low quiescent ground current 0.3mA
- power efficiency over 84%
- adjustable output current (up to 40mA)
- high-frequency 1MHz operation
- high voltage power switch
- shutdown current less than 1 μ A
- load fault protection against open-circuits
- tight line/load regulation

Package Information

- thin SOT23 5-lead (1mm max height)



CAT310

Automotive 10-Channel Serial Latched LED Driver

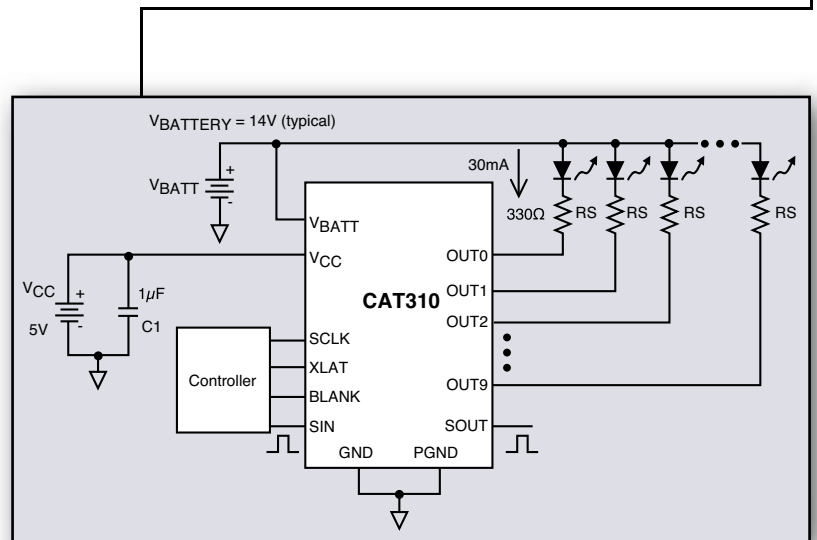
Featured Products

Features

- output drivers withstand load-dump transients up to 40V
- operates over automotive temperature range: -40 to +125°C
- drives 10 LEDs in parallel at 50mA per channel
- output channels can drive a combination of white or color LEDs
- serial output allows cascading of multiple CAT310's to drive greater than 10 LEDs
- operating voltage up to 17V
- simple LED pattern programming through the 10 MHz serial interface
- blank pin provides global on/off control of all LEDs
- under Voltage Lockout
- over Voltage Protection

Package Information

- 20-lead SOIC



PRODUCT LIST

WHITE LED DRIVERS

Part Number	LEDs (max)	V_{IN} (typ)	I_{OUT} Per Channel	Mode	Interface	Packages (Pin Count) ¹				
						MSOP (R, Z, GZ)	SOIC (J, W, GW)	Thin SOT23 (TS, TD, GTD)	TQFN (HS4, HV4, GV4) (4 x 4 mm)	TQFN (HS3, HV3, GV3) (3 x 3 mm)
CAT3200	6	2.7 - 4.5V	100mA	Charge pump	Logic: Shutdown	8		6		
CAT3604	4	3.0 - 5.5V	30mA	Charge pump	3-wire				16	
CAT3604-A	4	3.0 - 5.5V	30mA	Charge pump	3-wire				16	
CAT3606	6	3.0 - 5.5V	30mA	Charge pump	3-wire				16	
CAT3616	6	3.0 - 5.5V	30mA	Charge pump	Parallel				16	
CAT3626	6	3.0 - 5.5V	30mA	Charge pump	Parallel					16
CAT4134	6	2.5 - 4.5V	150mA	Inductor-boost	Logic: Shutdown				16	
CAT4237	10	2.5-5.5V	40mA	Inductor-boost	Serial			5		
CAT310	10	3.0 - 5.5V	50mA	n/a	Serial		20			

APPLICATION LITERATURE / EVALUATION AND DEMONSTRATION BOARDS

WHITE LED DRIVER APPLICATION NOTES

Document Number	Title	
AN12	CAT32DB1 Demonstration Board for CAT32 White LED Driver	
AN14	CAT32EVAL1 Evaluation Board for CAT32 White LED Driver	
AN15	CAT3200DB1 Board Hardware for the CAT3200 DC-DC Converter	
AN17	CAT37EVAL1 Evaluation Board for the CAT37 White LED Driver	
AN20	CAT3604EVAL1 Evaluation Board for the CAT3604 White LED Driver	
AN22	CAT310DB1 Demonstration Board for the CAT310 White LED Driver	
AN23	CAT3606EVAL1 Evaluation Board for the CAT3606 White LED Driver	

WHITE LED DRIVER DESIGN NOTE

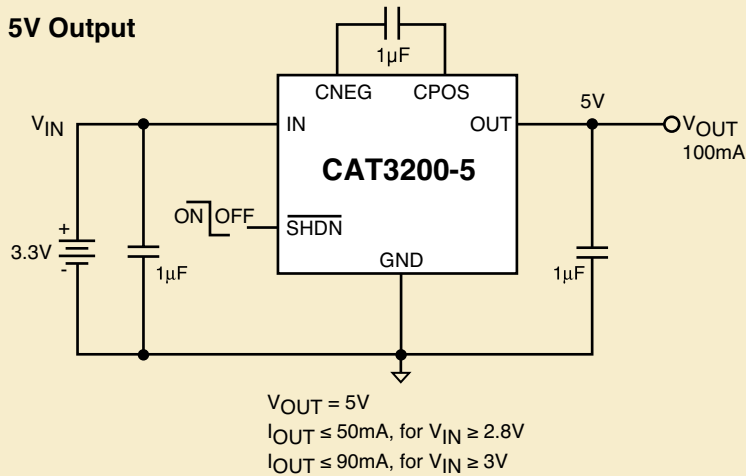
DN9	CAT32 White LED Driver Efficiency and Inductor Value Tradeoffs	
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Note:

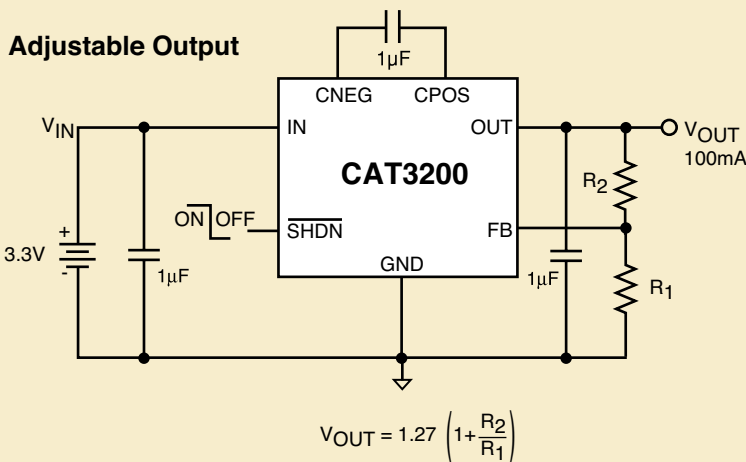
1. Available in standard and "green" packages.

All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.

5V Output



Adjustable Output



CAT3200/CAT3200-5 Low Noise Regulated Charge Pump DC-DC Converter

Features

- regulated output voltage
(5V fixed CAT3200-5, adjustable CAT3200)
- 100 mA output current
- fixed high operating frequency at 2 MHz
- input voltage operation down to 2.7 V
- low quiescent current (1.7 mA typ)
- low value external capacitors (1 µF)
- low output ripple voltage, typical 30mV @ $C_{OUT} = 1 \mu F$
- shutdown current less than 1 µA
- foldback current overload protection
- soft start, slew rate control
- thermal overload shutdown protection

Package Information

- CAT3200 in MSOP-8
- CAT3200-5 in low profile (1mm thin) 6-lead TSOT23
- pin compatible with LTC3200 and LTC3200-5

CAT661

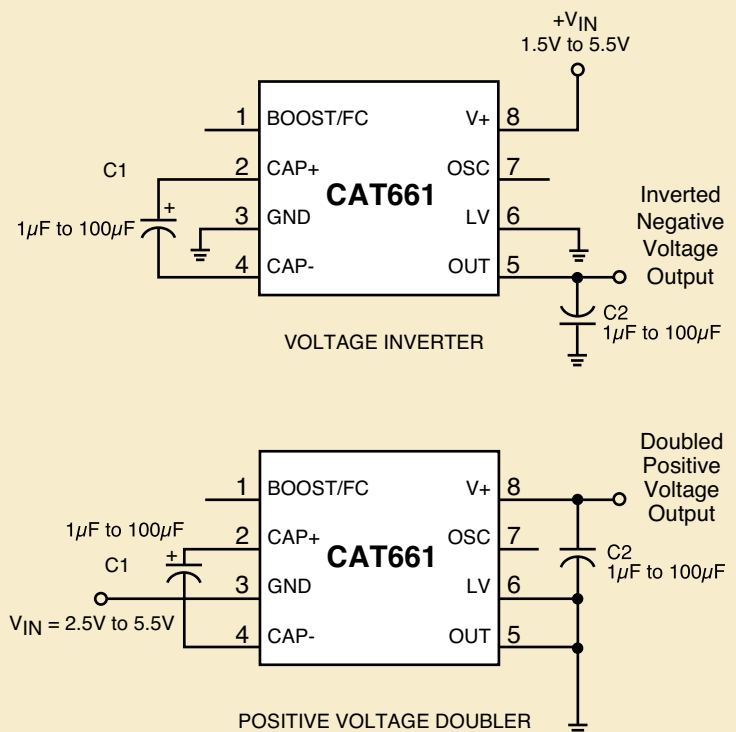
100mA CMOS Charge Pump Inverter/Doubler

Features

- converts V_+ to V_- or V_+ to $2V_+$
- high power efficiency
- industrial temperature range
- low output resistance, 4Ω typical
- low quiescent current
- pin-compatible, high-current alternative to 7660/1044
- selectable charge pump frequency
 - 25kHz or 135kHz
 - enables optimum external capacitors

Package Information

- 8-pin SOIC, DIP and 0.8mm thin 8-pad TDFN
- pin compatible with MAX660, LTC660 and LM2660



PRODUCT LIST

DC-DC CONVERTERS

Part Number	Operating Modes	Input Voltage	Ground Current	Output Current	Switching Frequency	Output Impedance	Internal Regulation	Packages (Pin Count) ¹				
								DIP (P, L, GL)	MSOP (R, Z, GZ)	SOIC (S, V, GV)	TSOT23 (TS, TD, GTD)	TDFN (RD8, ZD8, GD8)
												(4 x 4 mm)
CAT3200	2xV _{IN}	2.7-4.5V	1.6mA	100mA	2MHz	10Ω	Yes		8			
CAT3200-5	2xV _{IN}	2.7-4.5V	1.6mA	100mA	2MHz	10Ω	Yes				6	
CAT660	2xV _{IN} , -1xV _{IN}	1.5-5.5V	0.3mA	100mA	10/80kHz	4Ω	No	8		8		8
CAT661	2xV _{IN} , -1xV _{IN}	1.5-5.5V	0.3mA	100mA	25/135kHz	4Ω	No	8		8		8

APPLICATION LITERATURE / EVALUATION AND DEMONSTRATION BOARDS

Document Number	Title
AN15	CAT3200DB1 Board Hardware for the CAT3200 DC-DC Converter
AN18	CAT660EVAL1 Evaluation Board for the CAT660 Charge Pump Voltage Converter

PRODUCT LIST

LOW VOLTAGE SHUNT REGULATORS

Part Number	Reference Voltage (V)	Reference Voltage Across Temp ²		Initial Accuracy	Packages (Pin Count) ¹	
		Min	Max		SOT23 (TP, TB, GTB)	TO-92 (TN, TL, GTL)
CAT102	0.6	0.588	0.612	±1%	5	
CAT431L	1.24	1.228	1.252	±0.5%	3, 5	3

Notes:

1. Available in standard and "green" packages.
2. Operating temp range of -40°C to +85°C with junction temperatures from -40°C to +105°C.

All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.

CAT809 / CAT810 / CAT811 / CAT812

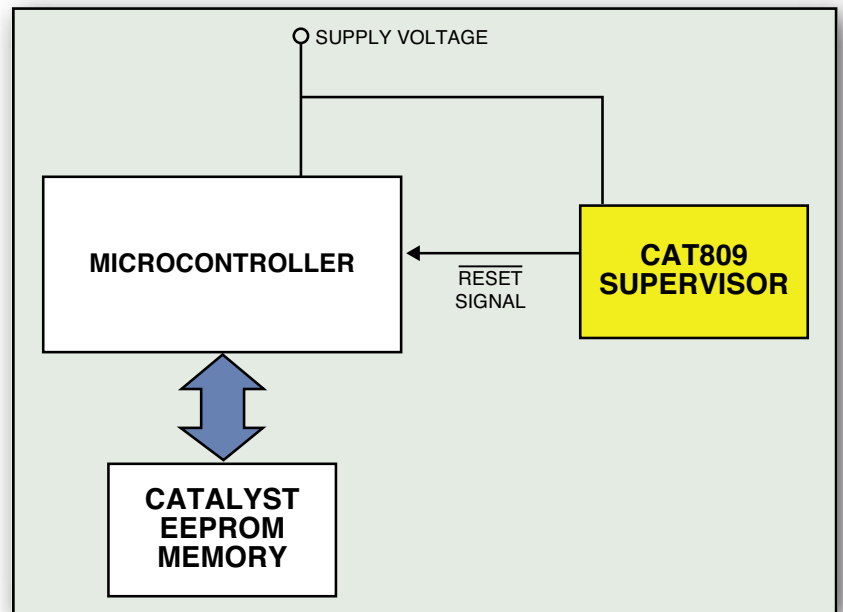
3-Pin/4-Pins Microprocessor Power Supply Supervisors

Features

- 6 μA power supply current
- pin compatible with MAX809, 810, 811 and 812
- offered in two output configurations:
 - push-pull RESET, active LOW (CAT809 and CAT811)
 - push-pull RESET, active HIGH (CAT810 and CAT812)
- power supply transient immunity
- manual reset (MR) (CAT811 / CAT812 only)
- precision monitoring of 5.0 V, 3.3 V, 3.0 V and 2.5 V power supplies
- reset valid down to $V_{CC} = 1.0 V$
- custom reset threshold voltage offered

Package Information

- 3-pin SOT23 (CAT809 / CAT810)
- 3-pin SC70 (CAT809 / CAT810)
- 4-pin SOT143 (CAT811 / CAT812)



Featured Products



CAT1232LP

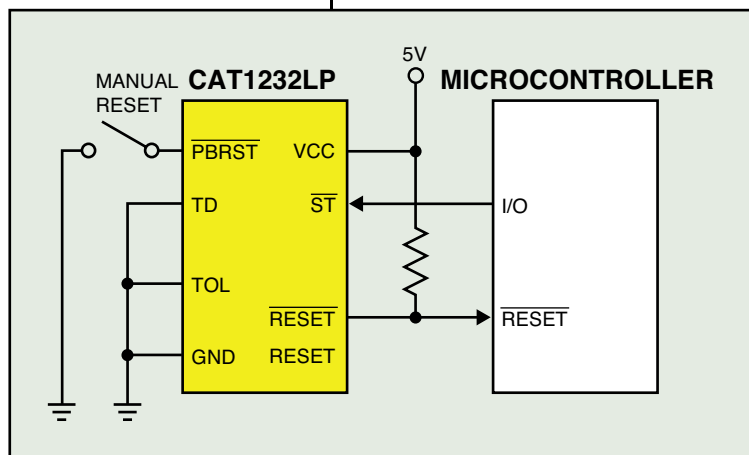
5 V μP Supply Voltage Monitor and μP Reset Circuit

Features

- power-up, power-down and brownout protection
- watchdog timer
 - selectable watchdog period
 - 150ms, 600ms or 1.2 sec
- selectable reset voltage tolerance
 - 5% or 10%
- two reset outputs
 - active low, open-drain reset output
 - active high, push-pull reset output
- debounced manual push-button reset
- pin compatible with DS1232 and DS1232LP

Package Information

- 8-pin DIP
- 8-pin & 16-pin SOIC
- 8-pin MSOP



PRODUCT LIST

µP SUPERVISORY CIRCUITS

Part Number	Threshold Letter	Nominal Threshold (V)	Reset		Manual Reset	Watchdog Timer	Packages (Pin Count) ¹		
			Low	High			SC70 (SB,SD,GSD)	SOT23 (TP,TB,GTB)	SOT143 (TP,TB,GTB)
CAT809	J	4.0	●				3	3	
	L	4.63	●				3	3	
	M	4.38	●				3	3	
	R	2.63	●				3	3	
	S	2.93	●				3	3	
	T	3.08	●				3	3	
	Z	2.32	●				3	3	
CAT810	J	4.0		●			3	3	
	L	4.63		●			3	3	
	M	4.38		●			3	3	
	R	2.63		●			3	3	
	S	2.93		●			3	3	
	T	3.08		●			3	3	
	Z	2.32		●			3	3	
CAT811	J	4.0	●		●				4
	L	4.63	●		●				4
	M	4.38	●		●				4
	R	2.63	●		●				4
	S	2.93	●		●				4
	T	3.08	●		●				4
	Z	2.32	●		●				4
CAT812	J	4.0		●	●				4
	L	4.63		●	●				4
	M	4.38		●	●				4
	R	2.63		●	●				4
	S	2.93		●	●				4
	T	3.08		●	●				4
	Z	2.32		●	●				4
							DIP (P,L, GL)	MSOP (R,Z, GZ)	SOIC (S,V, GV)
CAT1232LP		4.62 or 4.37	●	●	●	●	8	8	8, 16
CAT1832		2.88 or 2.55	●	●	●	●	8	8	8

Note:

1. Available in standard and "green" packages.

All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.

SUPERVISORS WITH EEPROM MEMORY

Part Number	Density (org)	Reset		Typ Reset Pulse Width	Write Protect	Manual Reset	Watchdog Timer Input	Packages (Pin Count) ¹					
		Low	High					DIP (P, L, GL)	MSOP (R, Z, GZ)	SOIC (J, W, GW)	TSSOP (U, Y, GY)	TDFN (RD4, ZD4, GD4)	TDFN (RD2, ZD2, GD2)
												(3x3mm)	(3x4.9mm)
CAT1021	2Kb (256x8)	●	●	200ms	●	●	SDA	8	8	8	8	8	
CAT1022	2Kb (256x8)	●		200ms		●	SDA	8	8	8	8	8	
CAT1023	2Kb (256x8)	●	●	200ms		●	WDI	8	8	8	8	8	
CAT1024	2Kb (256x8)	●		200ms		●		8	8	8	8	8	
CAT1025	2Kb (256x8)	●	●	200ms	●	●		8	8	8	8	8	
CAT1026	2Kb (256x8)	●	●	200ms		● ²		8	8	8	8	8	
CAT1027	2Kb (256x8)	●		200ms		● ²	WDI	8	8	8	8	8	
CAT1161	16Kb(2048x8)	●	●	200ms	●	● ²	SDA	8		8			
CAT1162	16Kb (2048x8)	●	●	200ms	●	● ²		8		8			
CAT1163	16Kb (2048x8)	●	●	200ms	●	● ²	WDI	8		8			
CAT1320	32Kb (4096x8)	●		200ms		● ²		8		8	8		8
CAT1321	32Kb (4096x8)		●	200ms				8		8	8		8
CAT1640	64Kb (8192x8)	●		200ms		● ²		8		8	8		8
CAT1641	64Kb (8192x8)		●	200ms				8		8	8		8

Note:

1. Available in standard and "green" packages.
2. RESET pin can be used as an input for Push-Button MR.

 All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.

CAT9554 / CAT9554A — 8-bit I²C and SMBus I/O Port Expander with Interrupt

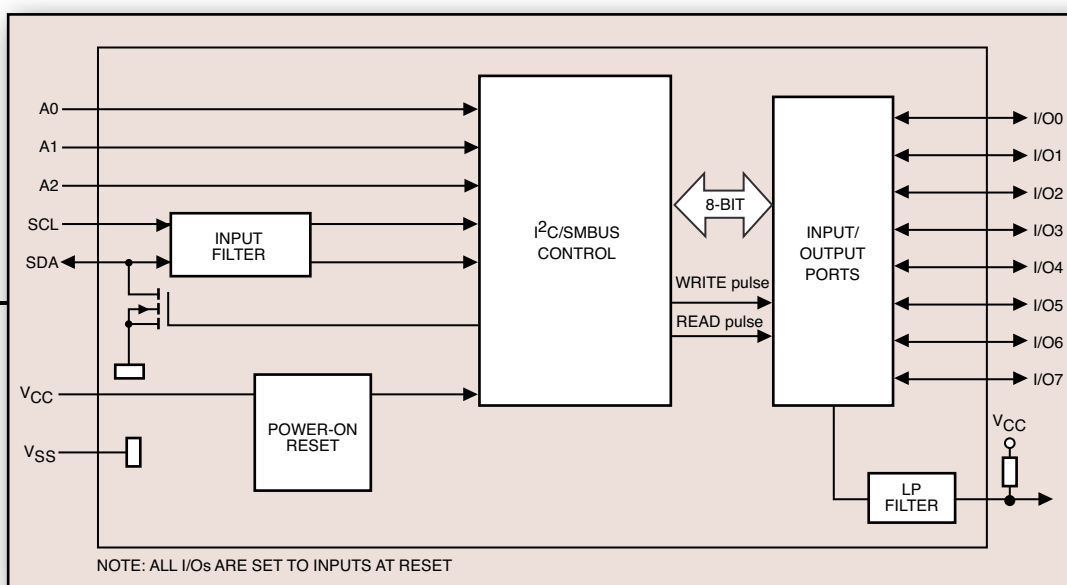
CAT9555 — 16-bit I²C and SMBus I/O Port Expander with Interrupt

Features

- 2.3V to 5.5V operation
- drive LEDs by sinking 25mA current
- individual I/O configuration
- -40°C to +85°C operation
- active low interrupt output
- internal power-on reset
- 400kHz I²C bus compatible
- cascadable up to 8 devices-16 devices (CAT9555)
- noise filter on SDA/SCL inputs
- 5V tolerant I/Os
- high drive capability

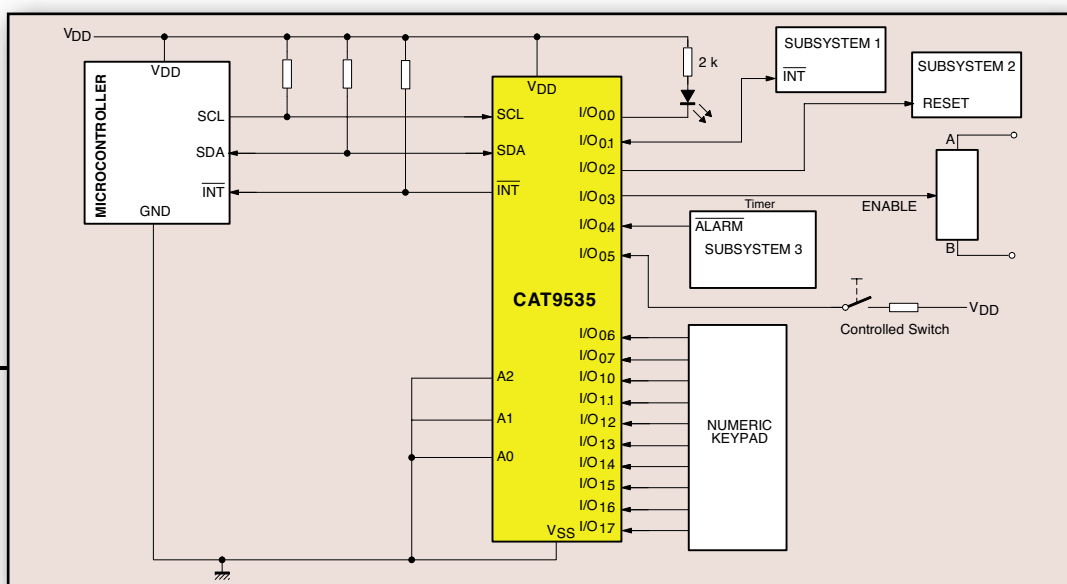
Package Information

- 16-pin SOIC (CAT9554), 24-pin SOIC (CAT9555)
- 16-pin TSSOP (CAT9554), 24-pin TSSOP (CAT9555)
- 16-pad TQFN (4 x 4 mm) (CAT9554), 24-pin TQFN (4x4mm) (CAT9555)
- pin compatible with PCA9554/9554A and PCA9555



Applications

- RAID systems
- servers
- test equipment
- fan control



CAT9534 / CAT9535

8-bit / 16-bit I²C and SMBus Low Power I/O Port expander with Interrupt

Features

- low stand-by current
- active low interrupt output
- 0 to 400 kHz clock frequency
- internal power-on reset
- 2.3 V to 5.5 V operation
- noise filter on SCL/SDA inputs
- 5V tolerant I/Os

Package Information

- 16-pin SOIC & 16-pin TSSOP (CAT9534), 24-pin SOIC (CAT9535)
- 16-pad TQFN (4 x 4 mm) (CAT9534), 24-pin TQFN (4x4mm) (CAT9535)
- pin compatible with PCA9534

Visit our website for samples, data sheets, and additional product information.

CAT9532 — I²C Interfaced 16-bit LED Dimmer

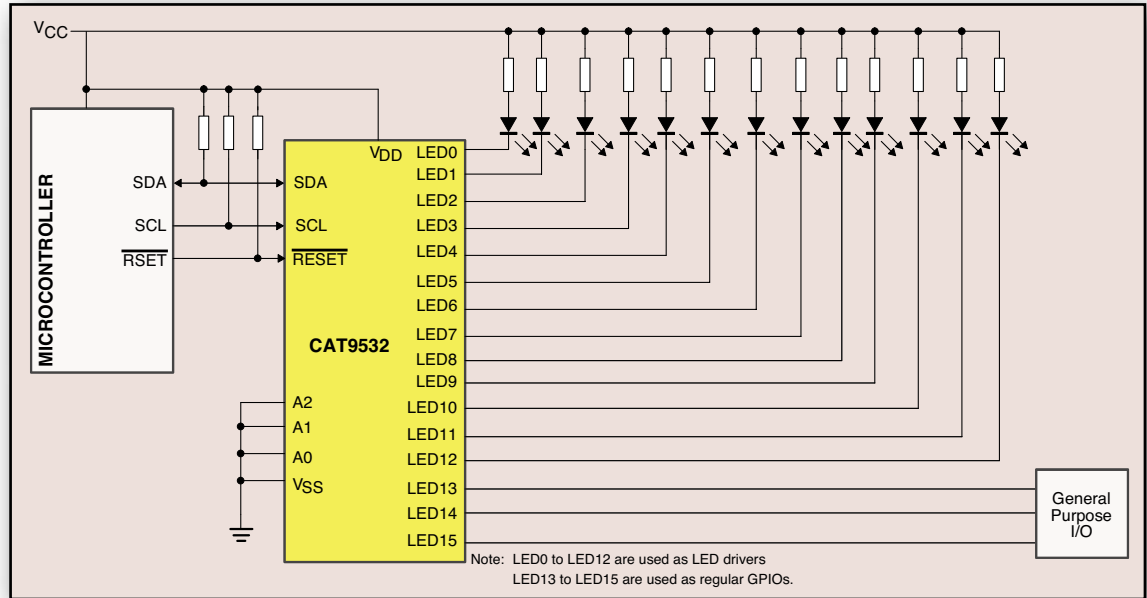
CAT9552 — I²C Interfaced 16-bit LED Blinker

Features

- 256 discrete brightness steps for easy LED dimming and color mixing
- two programmable blinking rate between 0.625 sec and 1.6 sec for CAT9532; 0.02sec and 6.4 sec for CAT9552
- eliminates repeated commands to turn on/off LEDs, reducing I²C traffic
- drives up to 16 LEDs; any bit that is not used to drive an LED can be used as a GPIO
- 25mA sink current per bit (max 200mA per device)
- each port can be individually turned on, off, or programmed to blink
- during power-up or when a manual reset (hardware reset) is asserted, all outputs are set to off-mode
- built in noise filter for SDA/SCL inputs
- 0-400KHz clock frequency

Applications

- LED dimming
- LCD backlighting
- cellular phones



PRODUCT LIST

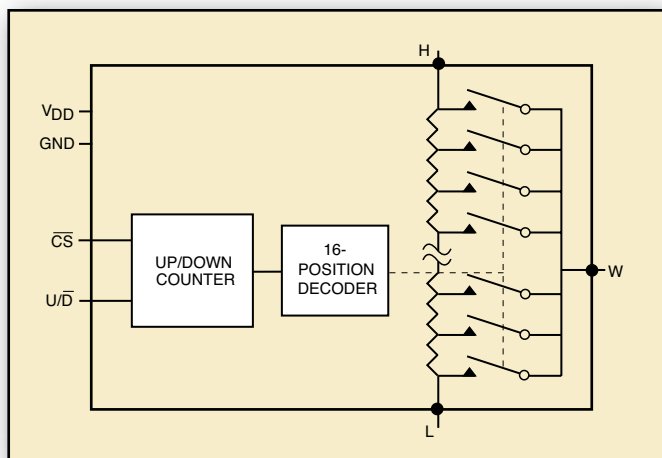
I²C INTERFACE I/O EXPANDERS

Part Number	I/Os	Cascadable	Operating Voltage	INT/ RESET	Internal I/O Pullups	LED Blink/ PWM	Packages (Pin Count) ¹		
							SOIC (S,V,GV)	TSSOP (U,Y,GY)	TQFN (HS4,HV4,GV4) (4x4mm)
CAT9554	8 GPIO	8 Slave ID Addresses	2.3 V to 5.5 V	INT out	●	NA	16 ³	16	16
CAT9554A	8 GPIO	8 Slave ID Addresses	2.3 V to 5.5 V	INT out	●	NA	16 ³	16	16
CAT9534	8 GPIO	8 Slave ID Addresses	2.3 V to 5.5 V	INT out		NA	16 ³	16	16
CAT9555	16 GPIO	8 Slave ID Addresses	2.3 V to 5.5 V	INT out	●	NA	24	24	24
CAT9535	16 GPIO	8 Slave ID Addresses	2.3 V to 5.5 V	INT out		NA	24	24	24
CAT7311 ²	16 GPIO	64 Slave ID Addresses	2.3 V to 5.5 V	INT out	●	NA	24	24	24
CAT9532	16 LED Dimmer/ GPIO	8 Slave ID Addresses	2.3 V to 5.5 V	RESET in		BLINK0/PWM0, BLINK1/PWM1	24	24	24
CAT9552	16 LED Blinker/ GPIO	8 Slave ID Addresses	2.3 V to 5.5 V	RESET in		BLINK0/PWM0, BLINK1/PWM1	24	24	24

Notes:

1. Available in standard and "green" packages.
2. CAT7311 is pin compatible with the MAX7311. All other products are pin compatible with Philips (replace PCA with CAT to order).
3. 300 mil wide

All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.



CAT5120 / CAT5121 / CAT5122

16-Tap MiniPot™ Digitally Programmable Potentiometers with Increment/Decrement Interface

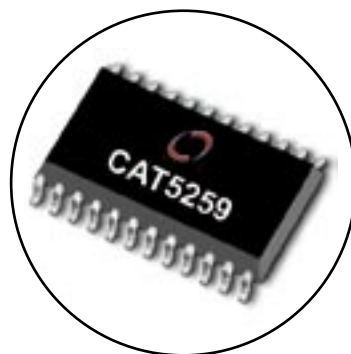
Features

- 0.3µA ultra-low supply current
- 2-wire up/down serial interface
- resistance values: 10kΩ, 50kΩ and 100kΩ
- single-supply operation: 2.7 V to 5.5 V
- glitchless switching between resistor taps
- power-on reset to midscale

Package Information

- 5- and 6-pin SC70 and SOT23 packages

Featured Products



CAT5259

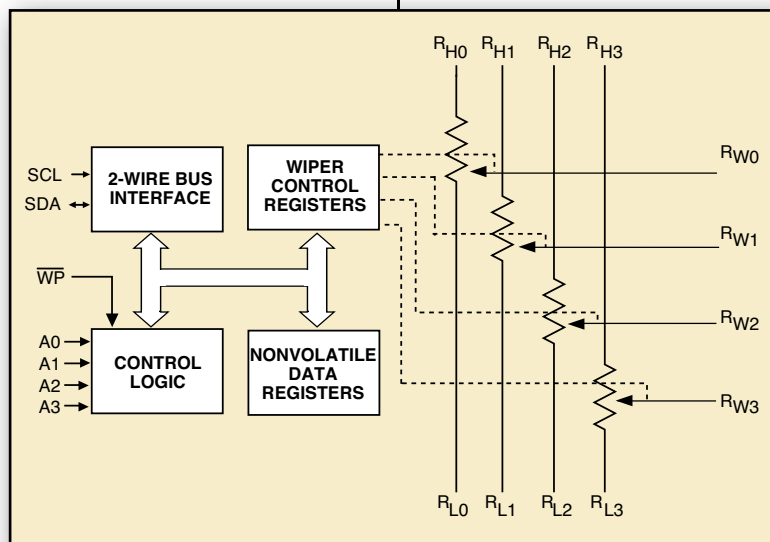
256-Tap Quad Digitally Programmable Potentiometer

Features

- four linear taper digitally programmable potentiometers
- end-to-end resistance 50kΩ or 100kΩ
- low wiper resistance, typically 100Ω
- non-volatile memory storage for up to four wiper settings for each potentiometer
- automatic recall of saved wiper settings at power up
- 2.5 V to 6.0 V volt operation
- standby current less than 5µA

Package Information

- 24-pin SOIC & TSSOP packages



PRODUCT LIST
DIGITALLY PROGRAMMABLE POTENTIOMETERS (DPP™)

Part Number	Number of Pots	Number of Taps	Resistance (kΩ)	Potentiometer Inputs	Buffered Wiper	Interface	Temp Range ²	Volatile	Nonvolatile	Package (Pin Count) ¹						
										DIP (P, GL)	SOIC (S, J, GV)	MSOP (R, Z, GZ)	SOT23 (TP, TB, GTB)	SC70 (SB, SD, GSD)	TSSOP (U, Y, GV)	BGA (B)
CAT5120	1	16	10, 50, 100	Independent		INC/DEC	I	●					6	6		
CAT5121	1	16	10, 50, 100	Common		INC/DEC	I	●					6	6		
CAT5122	1	16	10, 50, 100	Common		INC/DEC	I	●					5	5		
CAT5112	1	32	10, 50, 100	Independent	●	INC/DEC	C, I		●	8	8	8			8	
CAT5114	1	32	10, 50, 100	Independent		INC/DEC	C, I		●	8	8	8			8	
CAT5115	1	32	10, 50, 100	Independent		INC/DEC	I	●		8	8	8			8	
CAT5110	1	32	10, 50, 100	Independent		INC/DEC	I	●					6	6		
CAT5118	1	32	10, 50, 100	Common		INC/DEC	I	●					5	5		
CAT5119	1	32	10, 50, 100	Common		INC/DEC	I	●					6	6		
CAT5111	1	100	10, 50, 100	Independent	●	INC/DEC	C, I		●	8	8	8			8	
CAT5113	1	100	1, 10, 50, 100	Independent		INC/DEC	C, I		●	8	8	8			8	
CAT5116	1	100	32 (Log Taper)	Independent		INC/DEC	I		●	8	8	8			8	
CAT5132	1	128	10, 50, 100	Independent		2-Wire	I		●			10				
CAT5133	1	128	10, 50, 100	Independent		INC/DEC	I		●			10				
CAT521	1	256	6	Independent	●	Microwire	C, I		●	20	20					
CAT5221	2	64	2.5, 10, 50, 100	Independent		2-Wire	I		●	14	14					
CAT5411	2	64	2.5, 10, 50, 100	Independent		SPI	I		●		24				24	24
CAT5419	2	64	2.5, 10, 50, 100	Independent		2-Wire	I		●		24				24	24
CAT522	2	256	24	Independent	●	Microwire	C, I		●	14	14					
CAT523	2	256	6	Common	●	Microwire	C, I		●	14	14					
CAT5261	2	256	50, 100	Independent		SPI	I		●		24				24	
CAT5269	2	256	50, 100	Independent		2-Wire	I		●		24				24	
CAT5241	4	64	2.5, 10, 50, 100	Independent		2-Wire	I		●		20				20	
CAT5401	4	64	2.5, 10, 50, 100	Independent		SPI	I		●		24				24	24
CAT5409	4	64	2.5, 10, 50, 100	Independent		2-Wire	I		●		24				24	24
CAT524	4	256	6	Common	●	Microwire	C, I		●	14	14					
CAT525	4	256	24	Independent	●	Microwire	C, I		●	20	20					
CAT5251	4	256	50, 100	Independent		SPI	I		●		24				24	
CAT5259	4	256	50, 100	Independent		2-Wire	I		●		24				24	

Notes:

1. Available in standard and "green" packages.
2. Temp Range - C is 0°C to 70°C; I is -40°C to +85°C

 All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.

APPLICATION LITERATURE / EVALUATION AND DEMONSTRATION BOARDS

DPP APPLICATION NOTES

Document Number	Title
AN7	Programmable Analog Functions
AN7J	Programmable Analog Functions - Japanese Translation
AN8	Everything You Wanted To Know About Digitally Programmable Potentiometers
AN8J	Everything You Wanted To Know About Digitally Programmable Potentiometers - Japanese Translation
AN9	Minimizing The Temperature Dependence Of Digitally Programmable Potentiometers
AN11	CAT51DB1 Digitally Programmable Potentiometer Demonstration Board With Incremental Up/Down Interface
AN13	CAT51DB2 Digitally Programmable Potentiometer Demonstration Board With Incremental Up/Down Interface

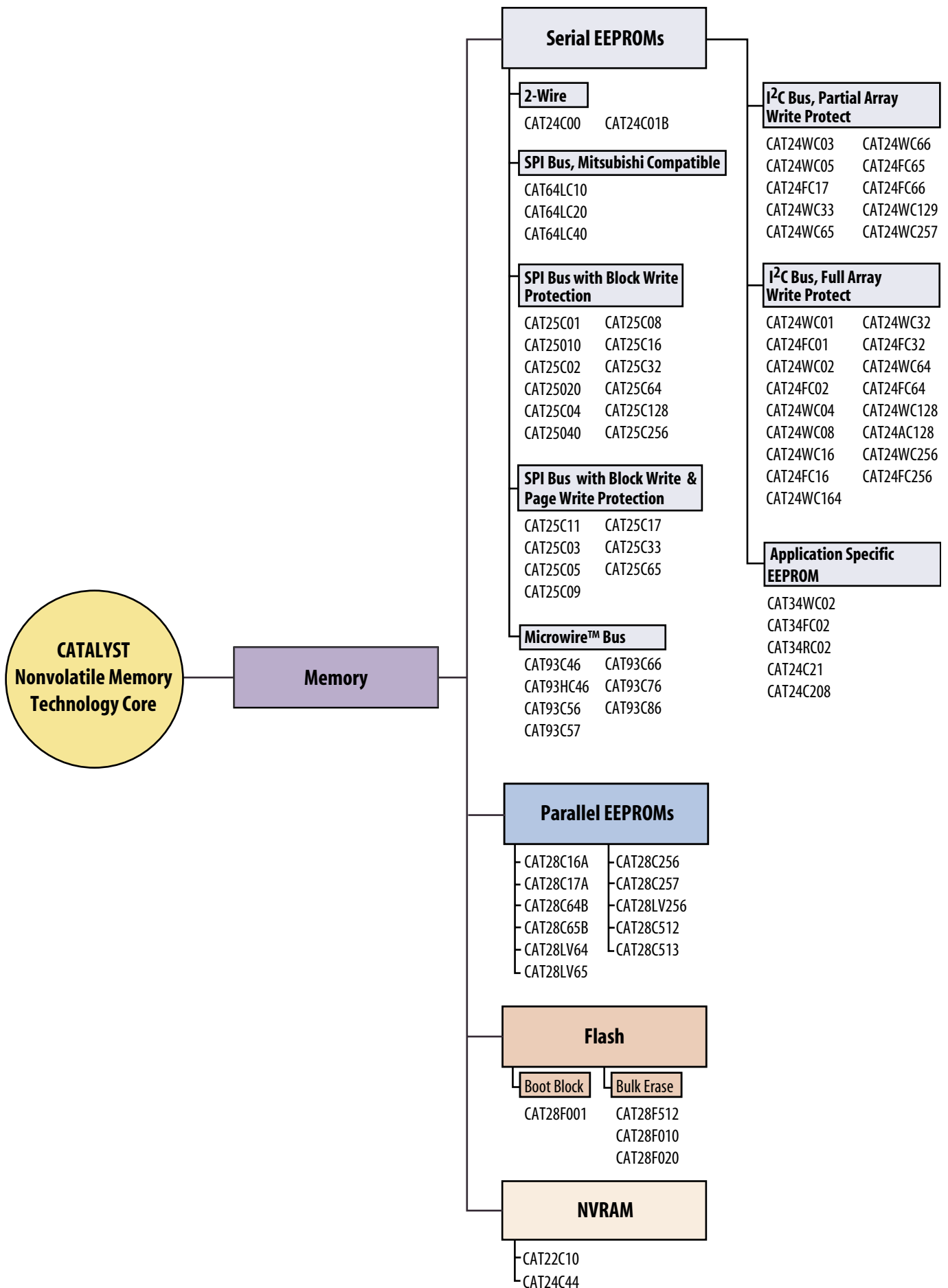
DPP APPLICATION BRIEF

AB6	Digitally Programmable Potentiometer To Control LED Brightness
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DPP DESIGN NOTES

DN1	Push Button Control Of Digitally Programmable Potentiometers With An Increment/Decrement Interface
DN2	Electronic Versus Mechanical Potentiometers - A Comparison
DN3	Operating Speeds Of Digitally Programmable Potentiometers
DN4	Improving The Resolution Of Digitally Programmable Potentiometer Applications
DN5	Making A Stop-Less Digitally Programmable Potentiometer
DN6	Power-up And Power-down Characteristics For Digitally Programmable Potentiometers
DN7	Package Thermal Characteristics

All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.



CAT34RC02

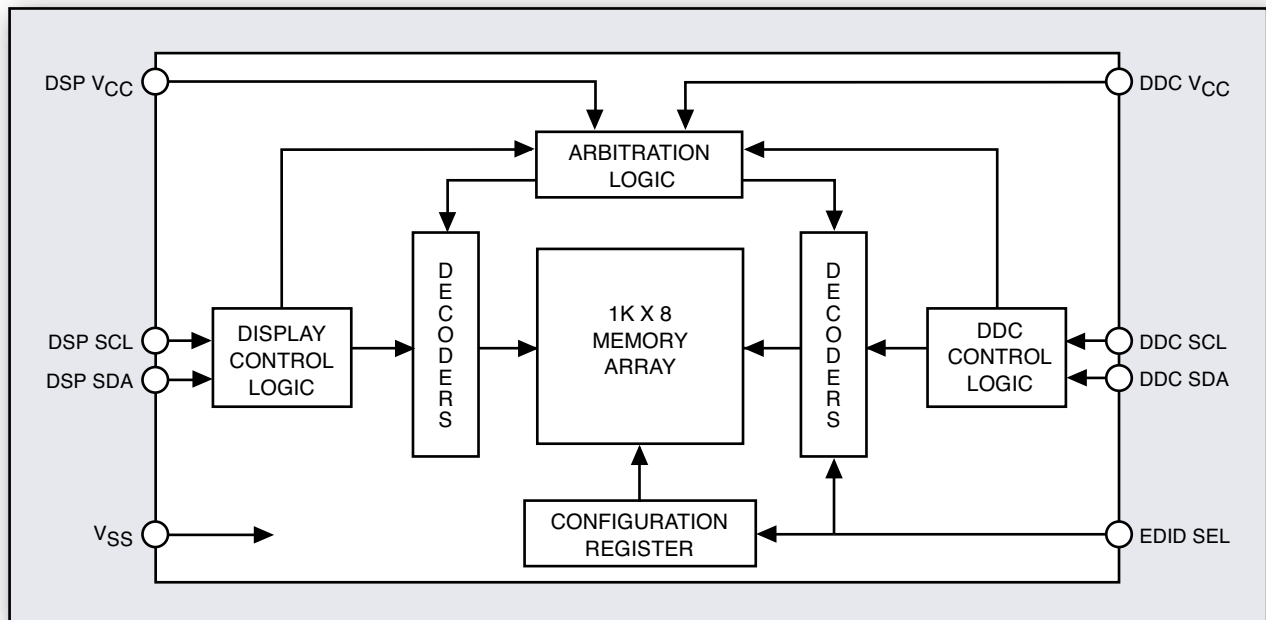
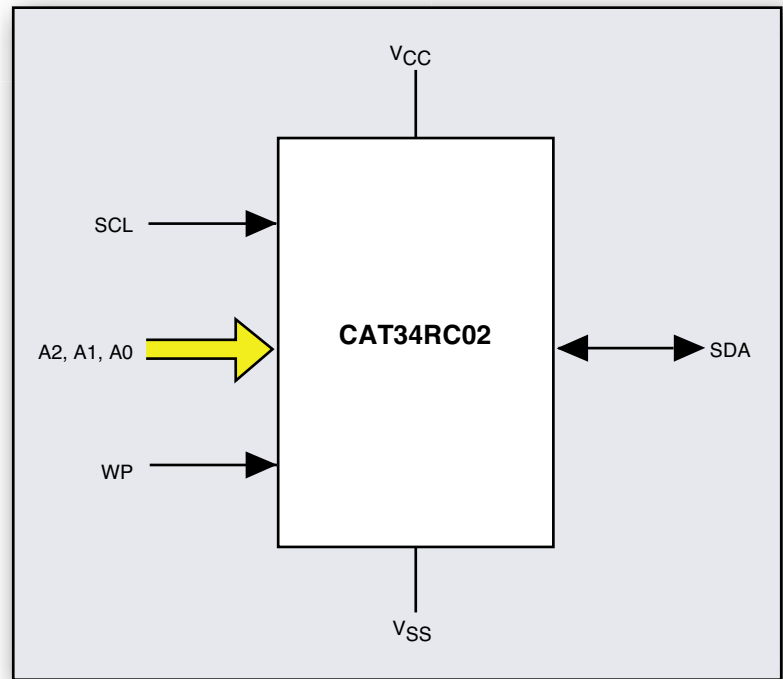
2-kb I²C Serial EEPROM, Serial Presence Detect

Features

- 1.7 to 5.5 volt operation
- 16-byte page write buffer
- 100 year data retention
- 400 KHz I²C bus compatible*
- 1,000,000 program/erase cycles
- hardware write protection for entire memory
- industrial and extended temperature ranges
- low power CMOS technology
- permanent and reversible software write protection for lower 128 bytes
- schmitt trigger on SCL and SDA inputs

Package Information

- 8-pin DIP package
- 8-pin TSSOP package
- 8-pin SOIC package
- 8-pad TDFN (2x3 mm) package



CAT24C208

8k (1k x 8) -Bit Dual Port Serial EEPROM for VESA Plug and Play Applications in LCD Projectors and Monitors

Features

- 3.0 to 5.5 volt operation
- 16-byte page write buffer
- 100 year data retention
- 400 KHz I²C bus compatible*
- 1,000,000 program/erase cycles
- hardware write protection for entire memory
- industrial and extended temperature ranges
- low power CMOS technology
- complies with VESA E-DID, E-DDC, DI-EXT and M1 specifications

Package Information

- 8-pin DIP package
- 8-pin MSOP package
- 8-pin SOIC package
- 8-pin TSSOP package

*Catalyst Semiconductor is licensed by Philips Corporation to carry the I²C Bus Protocol.

PRODUCT LIST
2-Wire Serial EEPROM Family

Part Number	Temp Range	Density (org)	ICC (Active/ Standby)	Min Voltage/ Max Clock Frequency	Voltage Range	Package (Pin Count) ¹							
						DIP (P,L, GL)	SOIC		MSOP (R, Z, GZ)	SOT23 (TP,TB, GTB)	TSSOP (U, Y, GY)	TDFN	
							JEDEC (J, W, GW)	EIAJ (K, X, GX)				(3x4.9) (RD2, ZD2, GD2)	(3x3) (RD4, ZD4, GD4)
CAT24C00	I, E	128b (16x8)	2mA/1µA	1.8V/100kHz, 2.5V/400kHz	1.8 - 5.5V	8	8			5	8		
CAT24C01B	C, I, A	1Kb (128x8)	3mA/1µA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8	8	8	8			

I²C Bus Serial EEPROM Family with Full Array Write Protect

CAT24WC01	C, I, A, E	1Kb (128x8)	3mA/1µA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 6.0V	8	8		8		8		
CAT24FC01	I, E	1Kb (128x8)	3mA/1µA	2.5V/400kHz	1.8 - 5.5V	8	8		8		8		
CAT24WC02	C, I, A, E	2Kb (256x8)	3mA/1µA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8		8		8		
CAT24FC02	I, E	2Kb (256x8)	3mA/1µA	2.5V/400kHz	1.8 - 5.5V	8	8		8		8		
CAT24WC04	C, I, A, E	4Kb (512x8)	3mA/1µA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8		8		8		
CAT24WC08	C, I, A, E	8Kb (1024x8)	3mA/1µA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8						
CAT24WC16	C, I, A, E	16Kb (2048x8)	3mA/1µA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8						
CAT24FC16	I, E	16Kb (2048x8)	3mA/1µA	2.5V/400kHz	1.8 - 5.5V	8	8		8		8		8
CAT24WC164	C, I, A, E	16Kb (2048x8)	3mA/1µA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8		8		8		
CAT24WC32	C, I, A, E	32Kb (4096x8)	3mA/1µA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8	8					
CAT24FC32	I, E	32Kb (4096x8)	3mA/1µA	2.5V/400kHz	2.5 - 5.5V	8	8	8			8		
CAT24WC64	C, I, A, E	64Kb (8192x8)	3mA/1µA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8	8					
CAT24FC64	I, E	64Kb (8192x8)	3mA/1µA	2.5V/400kHz	2.5 - 5.5V	8	8	8			8	8	
CAT24WC128	C, I, A, E	128Kb (16Kx8)	3mA/1µA	1.8V/100kHz, 2.5V/400kHz	1.8 - 5.5V	8	8	8			14		
CAT24AC128	C, I, E	128Kb (16Kx8)	3mA/1µA	1.8V/100kHz, 2.5V/400kHz	1.8 - 5.5V	8	8	8			14		
CAT24WC256	C, I, A, E	256Kb (32Kx8)	3mA/1µA	1.8V/100kHz, 2.5V/400kHz	1.8 - 5.5V	8	8	8					
CAT24FC256	I, A, E	256Kb (32Kx8)	3mA/1µA	1.8V/400kHz, 2.5V/1MHz	1.8 - 5.5V	8	8	8					

Note:

1. Available in standard and "green" packages.

 All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.


PRODUCT LIST

I²C Bus Serial EEPROM Family with Partial Array Write Protect

Part Number	Temp Range	Density (org)	ICC (Active/ Standby)	Min Voltage/ Max Clock Frequency	Voltage Range	Package (Pin Count) ¹							
						DIP (P, L, GL)	SOIC		MSOP (R, Z, GZ)	TSSOP (U, Y, GY)	TDFN		
							JEDEC (J, W, GW)	EIAJ (K, X, GX)			2x3mm (SP2, VP2, GP2)	3x3mm (RD4, ZD4, GD4)	3x4.9mm (RD2, ZD2, GD2)
CAT24WC03	C, I, A, E	2Kb (256x8)	3mA/1μA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8		8	8			
CAT24WC05	C, I, A, E	4Kb (512x8)	3mA/1μA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8		8	8			
CAT24FC17	I, E	16Kb (2048x8)	3mA/1μA	1.8V/100kHz, 2.5V/400kHz	1.8 - 5.5V	8	8		8	8		8	
CAT24WC33	C, I, A, E	32Kb (4096x8)	3mA/1μA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8	8					
CAT24WC65	C, I, A, E	64Kb (8192x8)	3mA/1μA	1.8V/100kHz, 2.5V/100kHz, 4.5V/400kHz	1.8 - 5.5V	8	8	8					
CAT24WC66	C, I, A, E	64Kb (8192x8)	3mA/1μA	1.8V/400kHz, 2.5V/400kHz	1.8 - 5.5V	8	8	8					
CAT24FC65	I, E	64Kb (8192x8)	3mA/1μA	2.5V/400kHz	2.5 - 5.5V	8	8	8		8			8
CAT24FC66	I, E	64Kb (8192x8)	3mA/1μA	2.5V/400kHz	2.5 - 5.5V	8	8	8		8			8
CAT24WC129	C, I, A, E	128Kb (16Kx8)	3mA/1μA	1.8V/100kHz, 2.5V/400kHz	1.8 - 5.5V	8	8	8					
CAT24WC257	C, I, A, E	256Kb (32Kx8)	3mA/1μA	1.8V/100kHz, 2.5V/400kHz	1.8 - 5.5V	8		8					

SPI Bus Serial EEPROM Family (Mitsubishi Compatible)

Part Number	Temp Range	Density (org)	ICC (Active/ Standby)	Min Voltage/ Max Clock Frequency	Voltage Range	Package (Pin Count) ¹					
						DIP (P, L, GL)	SOIC			TSSOP (U, Y, GY)	TSSOP Rotated (UR, YR, GYR)
							JEDEC (J, W, GW)	JEDEC (S, V, GV)	EIAJ (K, X, GX)		
CAT64LC10	C, I, A	1Kb (64x16)	1mA/1μA	1MHz	2.5 - 6.0V	8	8	8		8	8
CAT64LC20	C, I, A	2Kb (128x16)	1mA/1μA	1MHz	2.5 - 6.0V	8	8	8		8	8
CAT64LC40	C, I, A	4Kb (256x16)	1mA/1μA	1MHz	2.5 - 6.0V	8	8	8		8	8

Note:

1. Available in standard and "green" packages.

All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.

PRODUCT LIST
Microwire™ Bus Serial EEPROM Family

Part Number	Temp Range	Density (org)	ICC (Active/ Standby)	Min Voltage/ Max Clock Frequency	Voltage Range	Package (Pin Count) ¹						
						DIP (P,L, GL)	SOIC			MSOP (R, Z, GZ)	TSSOP (U, Y, GY)	TDFN 3x3mm (RD4, ZD4, GD4)
							JEDEC (J, W, GW)	JEDEC (S, V, GV)	EIAJ (K, X, GX)			
CAT93C46	C, I, A, E	1Kb (64x16/128x8)	3mA/10µA	1.8V/250kHz, 2.5V/500kHz, 4.5V/1MHz	1.8 - 6.0V	8	8	8	8	8	8	8
CAT93HC46	I, A, E	1Kb (64x16/128x8)	3mA/10µA	1.8V/1MHz, 2.5V/3MHz	1.8 - 5.5V	8	8	8		8	8	8
CAT93C56	C, I, A, E	2Kb (128x16/256x8)	3mA/11µA	1.8V/250kHz, 2.5V/500kHz, 4.5V/1MHz	1.8 - 6.0V	8	8	8	8	8	8	8
CAT93C57	C, I, A, E	2Kb (128x16/256x8)	3mA/11µA	1.8V/250kHz, 2.5V/500kHz, 4.5V/1MHz	1.8 - 6.0V	8	8	8	8	8	8	8
CAT93C66	C, I, A, E	4Kb (256x16/512x8)	3mA/10µA	1.8V/250kHz, 2.5V/500kHz, 4.5V/1MHz	1.8 - 6.0V	8	8	8	8	8	8	8
CAT93C76	I, A, E	8Kb (512x16/256x8)	3mA/10µA	1.8V/1MHz, 2.5V/3MHz	1.8 - 5.5V	8	8	8		8	8	8
CAT93C86	C, I, A, E	16Kb (1Kx16/2Kx8)	3mA/10µA	1.8V/250kHz, 2.5V/500kHz, 4.5V/1MHz	1.8 - 6.0V	8	8	8	8			8

SPI Bus Serial EEPROM Family With Block Write Protection

Part Number	Temp Range	Density (org)	ICC (Active/ Standby)	Min Voltage/ Max Clock Frequency	Voltage Range	Package (Pin Count) ¹						
						DIP (P,L, GL)	SOIC			MSOP (R, Z, GZ)	TSSOP	
							JEDEC (S, V, GV)	EIAJ (K, X, GX)			(U, Y, GY)	(U14, Y14, GY14)
CAT25C01	C, I, A, E	1K (128x8)	5mA/1µA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8	8			8	8	
CAT25010	C, I, A, E	1K (128x8)	5mA/1µA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8	8			8	8	
CAT25C02	C, I, A, E	2K (256x8)	5mA/1µA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8	8			8	8	
CAT25020	C, I, A, E	2K (256x8)	5mA/1µA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8	8			8	8	
CAT25C04	C, I, A, E	4K (512x8)	5mA/1µA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8	8			8		
CAT25040	C, I, A, E	4K (512x8)	5mA/1µA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8	8			8		
CAT25C08	C, I, A, E	8K (1Kx8)	5mA/1µA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8	8			8	14	
CAT25C16	C, I, A, E	16K (2Kx8)	5mA/1µA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8	8			8	14	
CAT25C32	C, I, A, E	32K (4Kx8)	10mA/1µA	1.8V/1MHz, 2.5V/3MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8	8				14	20
CAT25C64	C, I, A, E	64Kb (8Kx8)	10mA/1µA	1.8V/1MHz, 2.5V/3MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8	8				14	20
CAT25C128	C, I, A, E	128Kb (16Kx8)	5mA/1µA	1.8V/0.5MHz, 2.5V/3MHz, 4.5V/5MHz	1.8 - 6.0V, 2.5 - 6.0V	8	8	8			14	20
CAT25C256	C, I, A, E	256Kb (32Kx8)	5mA/1µA	1.8V/1MHz, 2.5V/2MHz, 4.5V/5MHz	1.8 - 6.0V, 2.5 - 6.0V	8		8				

Note:

1. Available in standard and "green" packages.

 All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.

PRODUCT LIST

SPI BUS SERIAL EEPROM FAMILY WITH BLOCK WRITE & PAGE WRITE PROTECTION

Part Number	Temp Range	Density (org)	ICC (Active/ Standby)	Min Voltage/ Max Clock Frequency	Voltage Range	Package (Pin Count) ¹								
						DIP (P, L, GL)	SOIC		MSOP (R, Z, GZ)	TSSOP			TDFN	
							JEDEC (J, W, GW)	JEDEC (S, V, GV)		(U, Y, GY)	(U14, Y14, GY14)	(U20, Y20, GY20)	2x3mm (SP2, VP2, GP2)	3x3mm (RD4, ZD4, GD4)
CAT25C11	C, I, A, E	1K (128x8)	5mA/1μA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8		8	8	8				
CAT25C03	C, I, A, E	2K (256x8)	5mA/1μA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8		8	8	8				
CAT25C05	C, I, A, E	4K (512x8)	5mA/1μA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8		8		8				
CAT25C09	C, I, A, E	8K (1Kx8)	5mA/1μA	1.8V/1MHz, 2.5V/5MHz, 4.5V/10MHz	1.8 - 6.0V, 2.5 - 6.0V	8		8		8	14			
CAT25C17	C, I, A, E	16K (2Kx8)	3mA/1μA	1.8V/250kHz, 2.5V/500kHz, 4.5V/1MHz	1.8 - 6.0V, 2.5 - 6.0V	8		8			14	20		
CAT25C33	C, I, A, E	32K (4Kx8)	3mA/1μA	1.8V/250kHz, 2.5V/500kHz, 4.5V/1MHz	1.8 - 6.0V, 2.5 - 6.0V	8		8			14	20		
CAT25C65	C, I, A, E	64Kb (8Kx8)	3mA/1μA	1.8V/250kHz, 2.5V/500kHz, 4.5V/1MHz	1.8 - 6.0V, 2.5 - 6.0V	8		8			14	20		

APPLICATION SPECIFIC EEPROM

CAT34WC02	I	2Kb (256x8)	3mA/1μA	1.7V/100kHz, 4.5V/400kHz	1.7 - 5.5V					8				
CAT34FC02	I	2Kb (256x8)	3mA/1μA	1.7V/100kHz, 2.5V/400kHz	1.7 - 5.5V					8			8	
CAT34RC02	I	2Kb (256x8)	3mA/1μA	1.7V/100kHz, 2.5V/400kHz	1.7 - 5.5V					8			8	
CAT24C21	I, E	1K (128x8)	2mA/1μA	2.5V / 400kHz	2.5 - 5.5V	8	8		8	8				8
CAT24C208	I, E	8K (1Kx8)	3mA/50μA	3.0V / 400kHz	3.0 - 5.5V	8	8		8	8				

APPLICATION LITERATURE / EVALUATION AND DEMONSTRATION BOARDS

Document Number	Title
AN1	Using Catalyst's Serial EEPROMs in Shared Input/Output Configuration
AN2	I ² C Interface to 8051 Microcontroller
AN3	CAT64LC10: A User-Friendly Serial EEPROM
AN5	Interfacing Multiple CAT24WCXX Serial EEPROMs on the I ² C Bus
AN6	CAT93CXX Serial EEPROM Design Guidelines for Power Up and Power Down Operation
AN6J	CAT93CXX Serial EEPROM Design Guidelines for Power Up and Power Down Operation - Japanese Translation
AN10	Data Protection and Power Up/Down Sequence for CAT25CXX SPI Serial EEPROM Devices
AN10J	Data Protection and Power Up/Down Sequence for CAT25CXX SPI Serial EEPROM Devices - Japanese Translation

Note:

1. Available in standard and "green" packages.

All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.

PRODUCT LIST
PARALLEL EEPROMs

Part Number	Temp Range	Density (org)	Access Time (ns)	ICC (Active/Standby)	Voltage Range	Package (Pin Count) ¹					
						DIP (P, L, GL)	SOIC		PLCC (N, G, GG)	TSOP (T, H, GH)	TSOP (T13, H13, G13)
							JEDEC (J, W, GW)	EIAJ (K, X, GX)			
CAT28C16A	C, I, A	16Kb (2Kx8)	90/120/200	25mA/100µA	4.5 - 5.5V	24	24	24	32		
CAT28C17A	C, I, A	16Kb (2Kx8)	200	25mA/100µA	4.5 - 5.5V	24	24	24	32		
CAT28C64B	C, I, A	64Kb (8Kx8)	90/120/150	25mA/100µA	4.5 - 5.5V	28	28	28	32		
CAT28C65B	C, I, A	64Kb (8Kx8)	90/120/150	25mA/100µA	4.5 - 5.5V	28	28	28	32		
CAT28LV64	C, I	64Kb (8Kx8)	150/200/250	8mA/100µA	3.0 - 3.6V	28	28	28	32		28
CAT28LV65	C, I	64Kb (8Kx8)	150/200/250	8mA/100µA	3.0 - 3.6V	28	28	28	32		28
CAT28C256	C, I, A	256Kb (32Kx8)	120/150	25mA/150µA	4.5 - 5.5V	28			32		28
CAT28C257	C, I, A	256Kb (32Kx8)	120/150	25mA/150µA	4.5 - 5.5V	28			32		
CAT28LV256	C, I	256Kb (32Kx8)	250/300	15mA/150µA	3.0 - 3.6V	28			32		28
CAT28C512	C, I, A	512Kb (64Kx8) 512Kb (64Kx8)	120/150	50mA/500µA	4.5 - 5.5V	32			32	32	
CAT28C513	C, I, A	512Kb (64Kx8)	120/150	50mA/500µA	4.5 - 5.5V				32		

PRODUCT LIST
FLASH MEMORIES - Boot Block

Part Number	Temp Range	Density (org)	Access Time (ns)	ICC (Active/Standby)	Voltage Range	Package (Pin Count) ¹					
						DIP (P, L, GL)	SOIC		PLCC (N, G, GG)	TSOP	
							JEDEC (J, W, GW)	JEDEC (S, V, GV)		TSOP (T, H, GH)	TSOP Reverse Pinout (TR, HR, GHR)
CAT28F001	C, I, A	1Mb (128Kx8)	90/120	30mA/100µA	5/12V	32			32	32	

PRODUCT LIST
FLASH MEMORIES - Bulk Erase

CAT28F512	C, I, A	512Kb (64Kx8)	90/120	30mA/100µA	5/12V	32			32	32	32
CAT28F010	C, I, A	1Mb (128Kx8)	90/120	30mA/100µA	5/12V	32			32	32	32
CAT28F020	C, I, A	2Mb (256Kx8)	90/120	30mA/100µA	5/12V	32			32	32	32

PRODUCT LIST
NVRAM

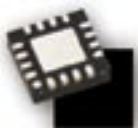
CAT22C10	C, I, A	256b (64x4)	200, 300 ns	40mA/30µA	4.5 - 5.5V	18	16				
CAT24C44	C, I, A	256b (16x16)	1MHz	3mA/30µA	4.5 - 5.5V	8		8			

Note:

1. Available in standard and "green" packages.

 All product documentation can be found on the Catalyst Semiconductor web site at www.catsemi.com.

PACKAGE INFORMATION

Package	Description	Package Codes			Number of Leads/Pads																
		Std	“Green”	“Green” Ni Pd Au	3	4	5	6	8	14	16	18	20	22	24	28	32	40	44		
CERDIP	Ceramic DIP 600mils	C														●					
MSOP	MSOP (3.0mm)	R	Z	GZ					●												
PLCC	PLCC	N	G	GG													●		●		
PDIP	PDIP 300 mils	P	L	GL					●	●	●	●	●	●							
	PDIP 600 mils	P	L	GL											●	●	●	●			
	SC-70	SB	SD	GSD	●		●	●													
SOIC	SOIC 150 mils	S, J	V, W	GV, GW					●	●											
	SOIC 300 mils	S, J	V, W	GV, GW							●	●	●		●	●					
	SOIC 208 mils	K	X	GX					●												
	SOIC 300 mils, ext leads	K	X	GX											●	●					
	SOT-23	TP	TB	GTB	●		●	●													
	SOT-223	TA	TG	GTG		●															
	TSOT-23	TS	TD	GTD		●	●	●													
	SOT-143	TP	TB	GTB		●															
SSOP	SSOP	SS	SV																		
T0-92	T0-92	TN	TL	GTL	●																
TSOP	TSOP (8x13.4mm)	T13	H13	G13												●					
	TSOP (10x14mm)	T14	H14	G14														●			
	TSOP (8x20mm)	T	H	GH													●	●			
TSSOP	TSSOP (4.4mm)	U	Y	GY					●	●	●		●		●	●					
	TDFN-S-MSOP (3X4.9mm)	RD2	ZD2	GD2					●												
	TDFN (3X3mm)	RD4	ZD4	GD4					●												
	TDFN-S-SOIC (6X4.9mm)	RD6	ZD6	GD6					●												
	TDFN (2X2.5mm)	RD7	ZD7	GD7					●												
	TDFN (4X4mm)	RD8	ZD8	GD8					●												
	TDFN-S-TSSOP (3x6.4mm)	RD9	ZD9	GD9					●												
	TDFN (2X3mm)	SP2	VP2	GP2					●												
	TQFN (4X4mm)	HS4	HV4	GV4							●				●						

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