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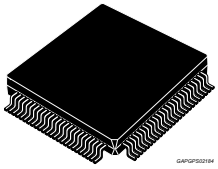
L9679P

Automotive advanced airbag IC for mid/high end applications

Datasheet - production data



TQFP100 exposed pad down (14x14x1.0mm)

Features

- AEC-Q100 qualified
- Boost regulator for energy reserve
  - 1.882 MHz operation, I_{load} = 55 mA max
  - Output voltage user selectable, 23 V/ 33 V ±5%
  - Capacitor value & ESR diagnostics
- Boost regulator for PSI-5 SYNC pulse
  - 1.882 MHz operation,
  - Output voltage, 12 V/14.75 V, user configurable
- Buck regulator for remote sensor
  - 1.882 MHz operation
  - Output voltage, 7.2 V/9 V ±4%, user configurable
- Buck regulator for micro controller unit
  - 1.882 MHz operation
  - Output voltage user selectable, 3.3 V or 5.0 V ±3%
- Integrated energy reserve crossover switch
  - 3 Ω - 912 mA max
  - Switch active output indicator
- Battery voltage monitor & shutdown control with Wake-up control
- System voltage diagnostics with integrated ADC
- Squib deployment drivers
  - 8 channel HSD/LSD
  - 25 V max deployment voltage
  - Various deployment profiles
  - Current monitoring
  - $R_{measure}$, STB, STG & Leakage diagnostics
  - High & low side driver FET tests
- High side safing switch regulator and enable control
- Two channel remote sensor interface
  - PSI-5 satellite sensors
- Three channel GPO, HSD or LSD configurable, with PWM 0-100% control
- Nine channel hall-effect, resistive or switch sensor interface
- User customizable safing logic
- Specific disarm signal for passenger airbag
- Temporal and algorithmic Watchdog timers
- End of life disposal interface
- Temperature sensor
- 32 bit SPI communications
- 5.5 V minimum operating voltage at device battery pin
- Operating temperature, -40 to 95 °C
- Packaging - 100 pin

Table 1. Device summary

Order code	Package	Pacing
L9679P	TQFP100	Tray
L9679PTR		Tape & Reel

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1 Description

The L9679P is an advanced airbag system chip solution targeted for mature airbag market and integrated safety markets. This device is family compatible with the L9678 and L9680 devices. Safety system integration is enabled through higher power supply currents and integrated PSI-5 satellite interface.

High frequency power supply design allows further cost reduction by using smaller and less expensive external components. All switching regulators operate at 1.882 MHz while buck converters have integrated synchronous rectifiers.

Additional attention is given to system integrity and diagnostics. The reserve capacitor is electrically isolated from the boost regulator by a 50 mA nominal fixed current source, controlling in-rush an additional capacitor discharge fixed current source is integrated to diagnose the reserve capacitor value and ESR. The same current sources can be used to discharge the capacitor at shutdown.

Thanks to low quiescent current, the device can be directly connected to battery. In this way, the device start-up and shutdown are controlled through the wake-up input function. The power supply and crossover function are controlled automatically through the internal state machine.

The user can select both ECU logic voltage (V_{CC} at 3.3 V or 5.0 V) and energy reserve output voltage (at either 23 V or 33 V). Deployment voltage is set to a maximum of 25 V for all profiles and can be controlled through external safing switch circuit using the high side safing switch reference enabled through the system SPI interface or the arming logic.

2 Absolute maximum ratings

This part may be irreparably damaged if taken outside the specified absolute maximum ratings. Operation above the absolute maximum ratings may also cause a decrease in reliability.

The operating junction temperature range is -40 °C to +150 °C. The maximum junction temperature must not be exceeded except when in deployment and within the deploy power stages. Deployment is possible starting with a junction temperature of 150 °C. A power dissipation calculation has to be performed for the final application limiting the available functionality to a subset of it in order to respect to the power dissipation capability.

Table 2. Absolute maximum ratings

Pin#	Pin name	Pin function	Min	Max	Unit
1	CS_RS	Remote SPI interface chip select	-0.3	VCC+0.3 ≤ 6.5	V
2	SCLK_RS	Remote SPI interface clock	-0.3	VCC+0.3 ≤ 6.5	V
3	MOSI_RS	Remote SPI interface data in	-0.3	VCC+0.3 ≤ 6.5	V
4	MISO_RS	Remote SPI interface data out	-0.3	VCC+0.3 ≤ 6.5	V
5	RESET	Reset output	-0.3	VCC+0.3 ≤ 6.5	V
6	MISO_G	Global SPI interface data out	-0.3	VCC+0.3 ≤ 6.5	V
7	MOSI_G	Global SPI interface data in	-0.3	VCC+0.3 ≤ 6.5	V
8	SCLK_G	Global SPI interface clock	-0.3	VCC+0.3 ≤ 6.5	V
9	CS_G	Global SPI interface chip select	-0.3	VCC+0.3 ≤ 6.5	V
10	WDT/TM	Watchdog disable	-0.3	20	V
11	SR4	Squib 4 low-side pin	-0.3	40	V
12	SF4	Squib 4 high-side pin	-1.0	40	V
13	SS45	Squib 4 & 5 deployment supply pin	-0.3	40	V
14	SF5	Squib 5 high-side pin	-1.0	40	V
15	SR5	Squib 5 low-side pin	-0.3	40	V
16	SR0	Squib 0 low-side pin	-0.3	40	V
17	SF0	Squib 0 high-side pin	-1.0	40	V
18	SS01	Squib 0 & 1 deployment supply pin	-0.3	40	V
19	SF1	Squib 1 high-side pin	-1.0	40	V
20	SR1	Squib 1 low-side pin	-0.3	40	V
21	NC	Not connected			
22	NC	Not connected			
23	NC	Not connected			
24	NC	Not connected			
25	NC	Not connected			
26	DCS8	DC Sensor interface channel 8	-2	40	V

Table 2. Absolute maximum ratings (continued)

Pin#	Pin name	Pin function	Min	Max	Unit
27	DCS7	DC Sensor interface channel 7	-2	40	V
28	DCS6	DC Sensor interface channel 6	-2	40	V
29	DCS5	DC Sensor interface channel 5	-2	40	V
30	DCS4	DC Sensor interface channel 4	-2	40	V
31	DCS3	DC Sensor interface channel 3	-2	40	V
32	DCS2	DC Sensor interface channel 2	-2	40	V
33	DCS1	DC Sensor interface channel 1	-2	40	V
34	DCS0	DC Sensor interface channel 0	-2	40	V
35	RSU0	PSI-5/WSS ch. 0 remote sensor output	-1	40	V
36	RSU1	PSI-5/WSS ch. 1 remote sensor output	-1	40	V
37	NC	Not connected			
38	NC	Not connected			
39	GPOD0	GPO driver 0 drain output pin	-1	40	V
40	GPOS0	GPO driver 0 source output pin	-1	40	V
41	GPOS1	GPO driver 1 source output pin	-1	40	V
42	GPOD1	GPO driver 1 drain output pin	-1	40	V
43	GPOD2	GPO driver 2 drain output pin	-1	40	V
44	GPOS2	GPO driver 2 source output pin	-1	40	V
45	COVRACT	External Crossover Switch Driver	-0.3	40	V
46	ISOK	ISO9141 bus pin (K-LINE)	-18	40	V
47	NC	Not connected			
48	SATSYNC	Initiate Satellite Sensor Sync Pulse	-0.3	VCC+0.3 ≤ 6.5	V
49	PSINHB	Active Low Passenger Airbag Inhibit Control	-0.3	VCC+0.3 ≤ 6.5	V
50	GNDSUB1	Substrate ground / Squib ground	-0.3	0.3	V
51	NC	Not connected			
52	NC	Not connected			
53	NC	Not connected			
54	NC	Not connected			
55	NC	Not connected			
56	SR3	Squib 3 low-side pin	-0.3	40	V
57	SF3	Squib 3 high-side pin	-1.0	40	V
58	SS23	Squib 2 & 3 deployment supply pin	-0.3	40	V
59	SF2	Squib 2 high-side pin	-1.0	40	V
60	SR2	Squib 2 low-side pin	-0.3	40	V
61	SR7	Squib 7 low-side pin	-0.3	40	V

Table 2. Absolute maximum ratings (continued)

Pin#	Pin name	Pin function	Min	Max	Unit
62	SF7	Squib 7 high-side pin	-1.0	40	V
63	SS67	Squib 6 & 7 deployment supply pin	-0.3	40	V
64	SF6	Squib 6 high-side pin	-1.0	40	V
65	SR6	Squib 6 low-side pin	-0.3	40	V
66	GNDA	Analog ground	-0.3	0.3	V
67	SAF_CS0	SPI interface safing sensor chip select 0	-0.3	VCC+0.3 ≤ 6.5	V
68	SAF_CS1	SPI interface safing sensor chip select 1	-0.3	VCC+0.3 ≤ 6.5	V
69	SAF_CS2	SPI interface safing sensor chip select 2	-0.3	VCC+0.3 ≤ 6.5	V
70	ISOTX	ISO9141 transmit pin	-0.3	VCC+0.3 ≤ 6.5	V
71	WD2_LockOut	WD2 fault output	-0.3	VCC+0.3 ≤ 6.5	V
72	NC	Not connected			
73	ISORX	ISO9141 receiver pin	-0.3	VCC+0.3 ≤ 6.5	V
74	WS1	Wheel speed output Ch1	-0.3	VCC+0.3 ≤ 6.5	V
75	WS0	Wheel speed output Ch0	-0.3	VCC+0.3 ≤ 6.5	V
76	VCCSEL	VCC select	-0.3	40	V
77	ACL	EOL disposal control input	-0.3	40	V
78	WAKEUP	Wake-up control input	-0.3	40	V
79	VBATMON	Battery line voltage monitor	-18(1)	40	V
80	VSF	Safing regulator supply output	-0.3	40	V
81	VIN	Battery connection	-0.3	40	V
82	VER	Reserve voltage	-0.3	40	V
83	ERBOOST	Energy reserve regulator output	-0.3	40	V
84	ERBSTSW	ER Boost switching output	-0.3	40	V
85	BSTGND	Boost regulators ground	-0.3	0.3	V
86	SYNCBSTSW	SYNC Boost switching output	-0.3	40	V
87	SYNCBOOST	SYNC boost output voltage	-0.3	40	V
88	SATBCKSW	SAT Buck switching output	-0.3	40	V
89	SATGND	SAT Buck regulator ground	-0.3	0.3	V
90	SATBUCK	SAT Buck output voltage	-0.3	40	-
91	VCCBCKSW	VCC Buck switch output	-0.3	40	V
92	VCCGND	VCC Buck Ground	-0.3	0.3	V
93	CVDD	Internal 3.3V regulator output	-0.3	4.6	V
94	GNDD	Digital ground	-0.3	0.3	-
95	VCC	VCC Buck voltage	-0.3	6.5	V
96	ARM1	Arming output 1	-0.3	VCC+0.3 ≤ 6.5	V

Table 2. Absolute maximum ratings (continued)

Pin#	Pin name	Pin function	Min	Max	Unit
97	ARM2	Arming output 2	-0.3	VCC+0.3 ≤ 6.5	V
98	NC	Not connected			
99	FENL	LS driver FET control input	-0.3	VCC+0.3 ≤ 6.5	V
100	GNDSUB2	Substrate ground / Squib ground	-0.3	0.3	V
-	Exposed pad down	Substrate ground / Squib ground	-0.3	0.3	V

1. VBATMON negative AMR is -18 V or -20 mA.

3 Operative maximum ratings

Within the operating ratings the part operates as specified and without parameter deviations. Once taken beyond the operative ratings and returned back within, the part will recover with no damage or degradation.

Additional supply voltage and temperature conditions are given separately at the beginning of each specification table.

Table 3. Operative maximum ratings

Pin #	Pin name	Pin function	Min	Max	Unit
1	CS_RS	Remote SPI interface chip select	-0.1	VCC+0.1 ≤ 5.5	V
2	SCLK_RS	Remote SPI interface clock	-0.1	VCC+0.1 ≤ 5.5	V
3	MOSI_RS	Remote SPI interface data in	-0.1	VCC+0.1 ≤ 5.5	V
4	MISO_RS	Remote SPI interface data out	-0.1	VCC+0.1 ≤ 5.5	V
5	RESET	Reset output	-0.1	VCC+0.1 ≤ 5.5	V
6	MISO_G	Global SPI interface data out	-0.1	VCC+0.1 ≤ 5.5	V
7	MOSI_G	Global SPI interface data in	-0.1	VCC+0.1 ≤ 5.5	V
8	SCLK_G	Global SPI interface clock	-0.1	VCC+0.1 ≤ 5.5	V
9	CS_G	Global SPI interface chip select	-0.1	VCC+0.1 ≤ 5.5	V
10	WDT/TM	Watchdog disable	-0.1	15	V
11	SR4	Squib 4 low-side pin	-0.1	SS45	V
12	SF4	Squib 4 high-side pin	-1.0	SS45	V
13	SS45	Squib 4 & 5 deployment supply pin	-0.1	VER	V
14	SF5	Squib 5 high-side pin	-1.0	SS45	V
15	SR5	Squib 5 low-side pin	-0.1	SS45	V
16	SR0	Squib 0 low-side pin	-0.1	SS01	V
17	SF0	Squib 0 high-side pin	-1.0	SS01	V
18	SS01	Squib 0 & 1 deployment supply pin	-0.1	VER	V
19	SF1	Squib 1 high-side pin	-1.0	SS01	V
20	SR1	Squib 1 low-side pin	-0.1	SS01	V
21	NC	Not connected			
22	NC	Not connected			
23	NC	Not connected			
24	NC	Not connected			
25	NC	Not connected			
26	DCS8	DC sensor interface channel 8	-1	18	V
27	DCS7	DC sensor interface channel 7	-1	18	V

Table 3. Operative maximum ratings (continued)

Pin #	Pin name	Pin function	Min	Max	Unit
28	DCS6	DC sensor interface channel 6	-1	18	V
29	DCS5	DC sensor interface channel 5	-1	18	V
30	DCS4	DC sensor interface channel 4	-1	18	V
31	DCS3	DC sensor interface channel 3	-1	18	V
32	DCS2	DC sensor interface channel 2	-1	18	V
33	DCS1	DC sensor interface channel 1	-1	18	V
34	DCS0	DC Sensor interface channel 0	-1	18	V
35	RSU0	PSI-5/WSS ch. 0 remote sensor output	-1	$V_{RSU\_SYNC\_MAX}$	V
36	RSU1	PSI-5/WSS ch. 1 remote sensor output	-1	$V_{RSU\_SYNC\_MAX}$	V
37	NC	Not connected			
38	NC	Not connected			
39	GPOD0	GPO driver 0 drain output pin	-0.1	40	V
40	GPOS0	GPO driver 0 source output pin	-1	40	V
41	GPOS1	GPO driver 1 source output pin	-1	40	V
42	GPOD1	GPO driver 1 drain output pin	-0.1	40	V
43	GPOD2	GPO driver 2 drain output pin	-0.1	40	V
44	GPOS2	GPO driver 2 source output pin	-1	40	V
45	COVRACT	External crossover switch driver	-0.1	40	V
46	ISOK	ISO9141 bus pin (K-LINE)	-0.1	VCC+0.1 ≤ 5.5	V
47	NC	Not connected			
48	SATSYNC	Initiate satellite sensor sync pulse	-0.1	VCC+0.1 ≤ 5.5	V
49	PSINHB	Active low passenger airbag inhibit control	-1	18	V
50	GNDSUB1	Substrate ground / Squib ground	-0.1	0.1	V
51	NC	Not connected			
52	NC	Not connected			
53	NC	Not connected			
54	NC	Not connected			
55	NC	Not connected			
56	SR3	Squib 3 low-side pin	-0.1	SS23	V
57	SF3	Squib 3 high-side pin	-1.0	SS23	V
58	SS23	Squib 2 & 3 deployment supply pin	-0.1	VER	V
59	SF2	Squib 2 high-side pin	-1.0	SS23	V
60	SR2	Squib 2 low-side pin	-0.1	SS23	V
61	SR7	Squib 7 low-side pin	-0.1	SS67	V

Table 3. Operative maximum ratings (continued)

Pin #	Pin name	Pin function	Min	Max	Unit
62	SF7	Squib 7 high-side pin	-1.0	SS67	V
63	SS67	Squib 6 & 7 deployment supply pin	-0.1	VER	V
64	SF6	Squib 6 high-side pin	-1.0	SS67	V
65	SR6	Squib 6 low-side pin	-0.1	SS67	V
66	GNDA	Analog ground	-0.1	0.1	V
67	SAF_CS0	SPI interface safing sensor chip select 0	-0.1	VCC+0.1 <= 5.5	V
68	SAF_CS1	SPI interface safing sensor chip select 1	-0.1	VCC+0.1 <= 5.5	V
69	SAF_CS2	SPI interface safing sensor chip select 2	-0.1	VCC+0.1 <= 5.5	V
70	ISOTX	ISO9141 transmit pin	-0.1	VCC+0.1 <= 5.5	V
71	WD2_LockOut	WD2 Fault Output	-0.1	VCC+0.1 <= 5.5	V
72	NC	Not connected			
73	ISORX	ISO9141 receiver pin	-0.1	VCC+0.1 <= 5.5	V
74	WS1	Wheel Speed Output Ch1	-0.1	VCC+0.1 <= 5.5	V
75	WS0	Wheel Speed Output Ch0	-0.1	VCC+0.1 <= 5.5	V
76	VCCSEL	VCC select	-0.1	35	V
77	ACL	EOL disposal control input	-0.1	35	V
78	WAKEUP	Wake-up control input	-0.1	VIN	V
79	VBATMON	Battery line voltage monitor	-1	18	V
80	VSF	Safing regulator supply output	-0.1	27	V
81	VIN	Battery connection	-0.1	35	V
82	VER	Reserve voltage	-0.1	35	V
83	ERBOOST	Energy reserve regulator output	-0.1	35	V
84	ERBSTSW	ER Boost switching output	-0.1	35	V
85	BSTGND	Boost regulators ground	-0.1	0.1	V
86	SYNCBSTSW	SYNC Boost switching output	-0.1	35	V
87	SYNCBOOST	SYNC boost output voltage	-0.1	35	V
88	SATBCKSW	SAT Buck switching output	-0.1	35	V
89	SATGND	SAT Buck regulator ground	-0.1	0.1	V
90	SATBUCK	SAT Buck output voltage	-0.1	10	-
91	VCCBCKSW	VCC Buck switch Output	-0.1	10	V
92	VCCGND	VCC Buck Ground	-0.1	0.1	V
93	CVDD	Internal 3.3V regulator output	-0.1	3.6	V
94	GNDD	Digital ground	-0.1	0.1	-
95	VCC	VCC Buck Voltage	-0.1	5.5	V

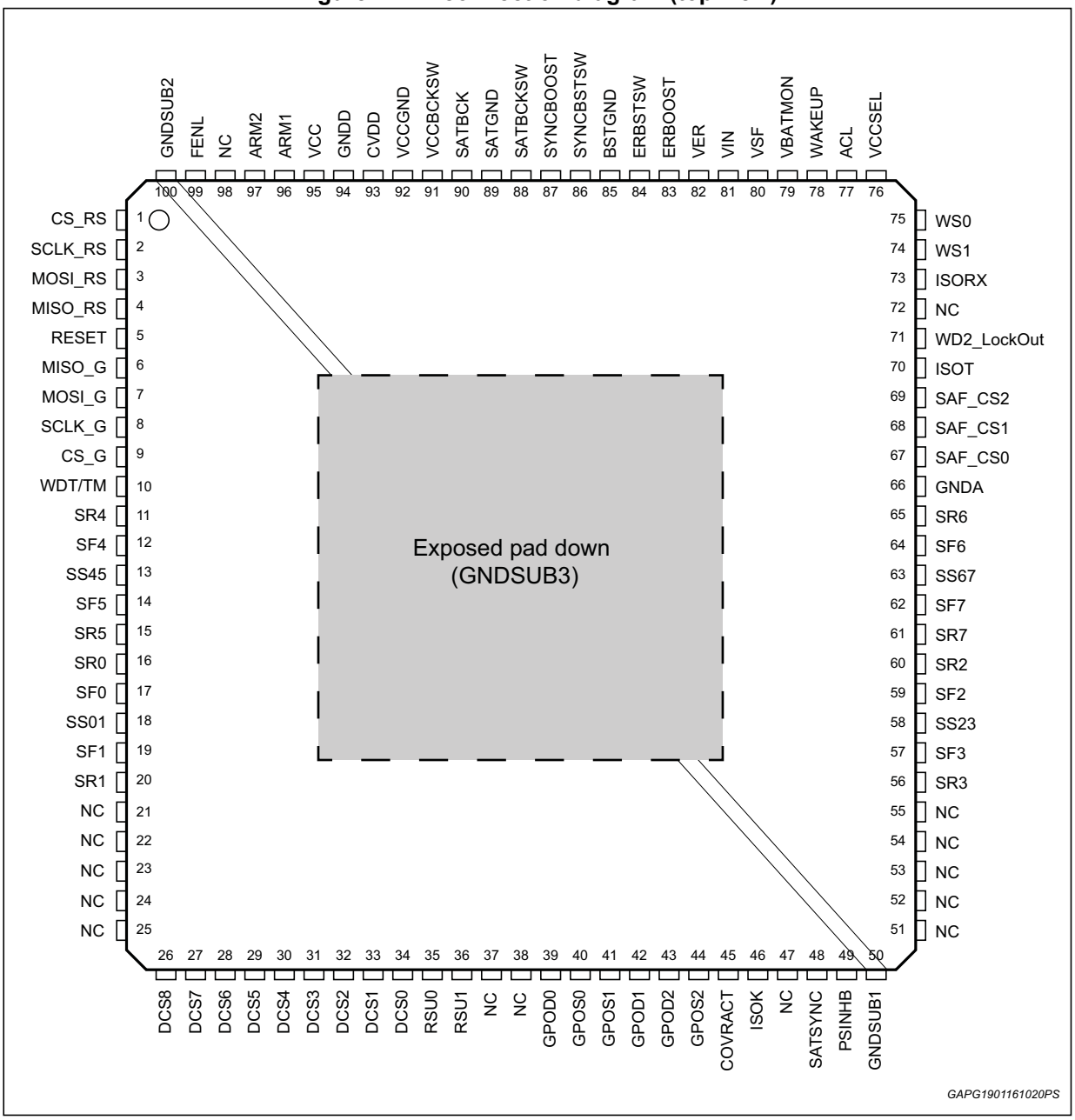
Table 3. Operative maximum ratings (continued)

Pin #	Pin name	Pin function	Min	Max	Unit
96	ARM1	Arming Output 1	-0.1	VCC+0.1 <= 5.5	V
97	ARM2	Arming Output 2	-0.1	VCC+0.1 <= 5.5	V
98	NC	Not connected			
99	FENL	LS Driver FET control input	-0.1	VCC+0.1 <= 5.5	V
100	GNDSUB2	Substrate ground / Squib ground	-0.1	0.1	V
-	Exposed Pad Down	Substrate ground / Squib ground	-0.1	0.1	V

4 Pin out

The L9679P pin out is shown below. The IC is housed in a 100 pin package (14 x 14 x 1.0mm) with a 7.6 x 7.6 mm exposed pad down.

Figure 1. Pin connection diagram (top view)

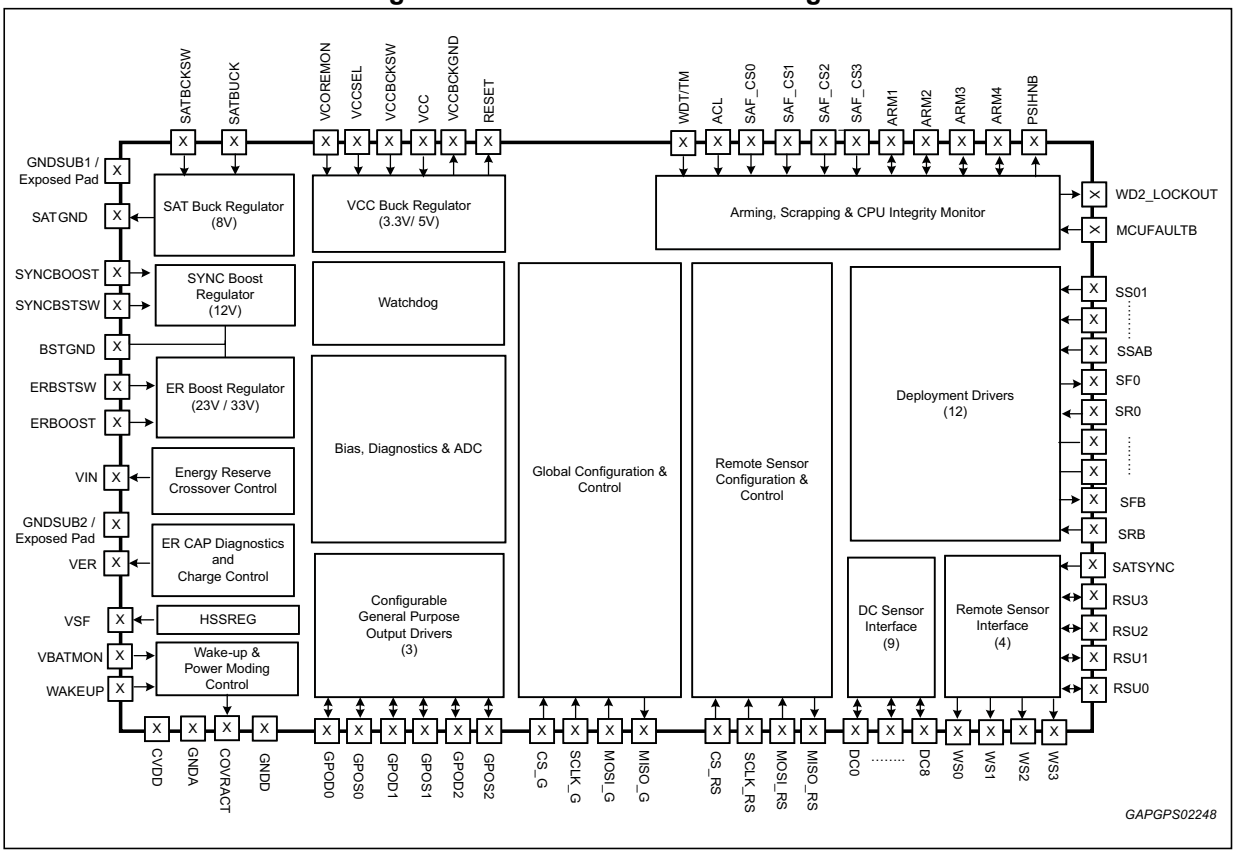


The exposed pad is electrically shorted to the substrate pins GNDSUB1 and GNDSUB2. These three connection nodes are to be kept shorted on the application.

5 Overview and block diagram

The L9679P IC is an application specific standard component air bag system chip. Its main functions include, power management, deployment drivers, remote sensor interfaces (PSI-5 satellite sensors, diagnostics, deployment arming, hall-effect sensor interface, general purpose output drivers, watchdog timer and a dedicated passenger airbag disarm signal. A block diagram for this IC is shown in *Figure 2*.

Figure 2. Device function block diagram



5.1 Power supply

- Integrated 1.882 MHz boost regulator, 33 V ± 5% or 23 V ± 5% nominal output
- Integrated 1.882 MHz boost regulator,12 V/14.75 V nominal output, user selectable via SPI command
- Integrated 1.882 MHz synchronous buck regulator, 7.2 V/9 V ± 4% nominal output, user selectable via SPI command
- Integrated 1.882 MHz synchronous buck regulator, 5 V ± 3% or 3.3 V ± 3% nominal output, user selectable via VCCSEL pin
- Over and under voltage detection and shutdown for all regulators
- Under-voltage lockout to guarantee buck regulator outputs disabled and discharged
- Integrated energy reserve capacitor fixed constant current source (50 mA, nominal) switch for controlled inrush and charge characteristics
- Integrated energy reserve diagnostics, capacitor value and ESR
- Integrated energy reserve crossover switch with current limit and battery input voltage monitoring
- Crossover switch ‘active’ output signal
- Integrated 25 V/20 V SPI selectable linear regulator for high side safing FET gate supply enabled via SPI or arming logic
- Reset output

5.2 Deployment drivers

- 8 high side deployment drivers, 8 low side deployment drivers
- User programmable deployment options
  - 1.20 A or 1.75 A minimum
  - programmable time in 0.1ms increments
- Capability to deploy a squib with a minimum current of 1.2 / 1.75 A and the low side FET shorted to ground up to 25 V on SSxy
- Independently-controlled high-side and low-side FETs
- Squib resistance measurement
- Firing current monitor feature
- High and low side FET tests
- Open & shorts diagnostics, including between loop drivers
- Independent fire enable logic, SPI and discrete digital input

5.3 Remote sensor interfaces

- Two channel receiver
  - standard PSI-5 v1.3 compatible with sync pulse
- Current limit with short circuit protection diagnostics
- PSI-5 satellite sensor mode
  - Auto-adjusting current trip points for each satellite channel
  - Even parity, 8 or 10 bit messages, 125k or 189kbps
  - Satellite message error detection

5.4 DC sensor interfaces

- Nine integrated switch interfaces with current sense capability
- Compatible with Hall-effect, resistive and switch sensors
- Current limit protected
- System dedicated path to disable the passenger airbag with input from DC sensor interface

5.5 General purpose outputs

- Three configurable high-side or low-side drivers
- ON-OFF mode and PWM 0-100% fine control
- Diagnostics for short circuit protection and open load detection
- Current limit and reverse battery protected

5.6 Arming logic

- User configurable safing algorithms with 12 safing records
- Four digital sensor interfaces through SPI
- Independent user programmable thresholds
- Independent user programmable latch timers
- Two discrete and independent arming logic outputs
- Two discrete and independent internal arming signals
- End-of-life interface