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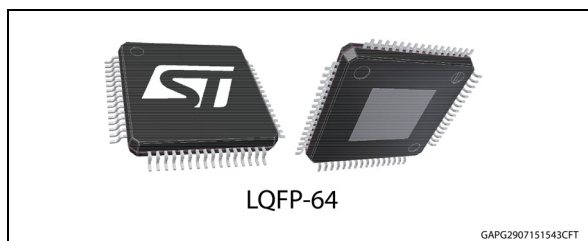
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Automotive door module with LIN and HS-CAN (L99DZ100G) or HS-CAN supporting selective wake up (L99DZ100GP)

Datasheet - production data



Features

- AEC Q100 compliant qualified 
- 1 half bridge for 7.5 A load ($R_{ON} = 100 \text{ m}\Omega$)
- 1 half bridge for 7.5 A load ($R_{ON} = 150 \text{ m}\Omega$)
- 2 half bridges for 0.5 A load ($R_{ON} = 2000 \text{ m}\Omega$)
- 2 half bridges for 3 A load ($R_{ON} = 300 \text{ m}\Omega$)
- 1 configurable high-side driver for up to 1.5 A ($R_{ON} = 500 \text{ m}\Omega$) or 0.35 A ($R_{ON} = 1600 \text{ m}\Omega$) load
- 1 configurable high-side driver for 0.8 A ($R_{ON} = 800 \text{ m}\Omega$) or 0.35 A ($R_{ON} = 1600 \text{ m}\Omega$) load
- 3 configurable high-side drivers for 0.15 A/0.35 A ($R_{ON} = 2 \Omega$)
- 1 configurable high-side driver for 0.25 A/0.5 A ($R_{ON} = 2 \Omega$) to supply EC Glass MOSFET
- 4 configurable high-side drivers for 0.15 A/0.25 A ($R_{ON} = 5 \Omega$)
- Internal 10bit PWM timer for each stand-alone high-side driver
- Buffered supply for voltage regulators and 2 high-side drivers (OUT15 & OUT_HS / both P-channel) to supply e.g. external contacts
- Programmable soft-start function to drive loads with higher inrush currents as current limitation value (for OUT1-6, OUT7, OUT8 and OUT_HS) with thermal expiration feature

- All the embedded outputs come with protection and supervision features:
 - Current Monitor (high-side only)
 - Open-load
 - Overcurrent
 - Thermal warning
 - Thermal shutdown
- Fully protected driver for external MOSFETs in H-bridge configuration or dual Half bridge configuration
- Fully protected driver for external high-side MOSFET
- Control block for electro-chromic element
- Two 5 V voltage regulators for microcontroller and peripheral supply
- Programmable reset generator for power-on and undervoltage
- Configurable window watchdog
- LIN 2.2a compliant (SAEJ2602 compatible) transceiver
- Advanced high speed CAN transceiver (ISO 11898-2:2003 /-5:2007 and SAE J2284 compliant) with local failure and bus failure diagnosis and selective wake-up functionality according to ISO 11898-6:2013
- Separated (Isolated) fail-safe block with 2 LS ($R_{ON} = 1 \Omega$) to pull down the gates of the external HS MOSFETs
- Thermal clusters
- A/D conversion of supply voltages and internal temperature sensors
- Embedded and programmable VS duty cycle adjustment for LED driver outputs

Applications

Door zone applications.

Contents

1	Description	13
2	Block diagram and pin descriptions	14
3	Electrical specifications	19
3.1	Absolute maximum ratings	19
3.2	ESD protection	21
3.3	Thermal data	22
3.3.1	LQFP64 thermal data	22
3.4	Electrical characteristics	26
3.4.1	Supply and supply monitoring	26
3.4.2	Oscillator	28
3.4.3	Power-on reset (VSREG)	28
3.4.4	Voltage regulator V1	29
3.4.5	Voltage regulator V2	30
3.4.6	Reset output	31
3.4.7	Watchdog timing	33
3.4.8	Current monitor output (CM)	35
3.4.9	Charge pump	36
3.4.10	Outputs OUT1 - OUT15, OUT_HS, ECV, ECDR	37
3.4.11	Power outputs switching times	39
3.4.12	Current monitoring	40
3.4.13	Heater	42
3.4.14	H-bridge driver	43
3.4.15	Gate drivers for the external Power-MOS switching times	44
3.4.16	Drain source monitoring external H-bridge	47
3.4.17	Drain source monitoring external heater MOSFET	48
3.4.18	Open-load monitoring external H-bridge	48
3.4.19	Open-load monitoring external heater MOSFET	49
3.4.20	Electro-chrome mirror driver	49
3.4.21	Fail safe low-side switch	50
3.4.22	Wake up input WU	51
3.4.23	High speed CAN transceiver	51
3.4.24	LIN transceiver	57

3.4.25	SPI	60
3.4.26	Inputs TxD_C and TxD_L for Flash mode	62
3.4.27	Inputs DIRH, PWMH	63
3.4.28	Debug input	63
3.4.29	ADC characteristics	63
3.4.30	Temperature diode characteristics	64
3.4.31	Interrupt outputs	64
3.4.32	Timer1 and Timer2	65
3.4.33	SGND loss comparator	68
4	Application information	69
4.1	Supply V_S , V_{SREG}	69
4.2	Voltage regulators	69
4.2.1	Voltage regulator: V1	69
4.2.2	Voltage regulator: V2	70
4.2.3	Voltage regulator failure	70
4.2.4	Short to ground detection	70
4.2.5	Voltage regulator behavior	71
4.3	Operating modes	71
4.3.1	Active mode	71
4.3.2	Flash modes	72
4.3.3	SW-debug mode	72
4.3.4	V1_standby mode	73
4.3.5	Interrupt	73
4.3.6	CAN wake-up signalization	74
4.3.7	VBAT_standby mode	75
4.4	Wake-up from Standby modes	75
4.4.1	Wake up input	76
4.5	Functional overview (truth table)	76
4.6	Configurable window watchdog	78
4.6.1	Change watchdog timing	81
4.7	Fail-safe mode	81
4.7.1	Temporary failures	81
4.7.2	Non-recoverable failures – forced Vbat_standby mode	82
4.8	Reset output (NReset)	83
4.9	LIN Bus Interface	84

4.9.1	Features	84
4.9.2	Error handling	85
4.9.3	Wake up from Standby modes	85
4.9.4	Receive-only mode	86
4.10	High-speed CAN bus transceiver	86
4.10.1	Features:	87
4.10.2	CAN transceiver operating modes	88
4.10.3	Automatic voltage biasing	89
4.10.4	Wake-up by CAN	89
4.10.5	CAN looping	91
4.10.6	Pretended networking	91
4.10.7	CAN error handling	91
4.11	Serial Peripheral Interface (ST SPI Standard)	92
4.12	Power supply failure	93
4.12.1	V _S supply failure	93
4.12.2	V _{SREG} supply failure	94
4.13	Temperature warning and thermal shutdown	96
4.14	Power outputs OUT1..15 and OUT_HS	97
4.15	Auto-recovery alert and thermal expiration	98
4.16	Charge pump	100
4.17	Inductive loads	101
4.18	Open-load detection	101
4.19	Overcurrent detection	101
4.20	Current monitor	101
4.21	PWM mode of the power outputs	101
4.22	Cross-current protection	101
4.23	Programmable soft-start function to drive loads with higher inrush current	102
4.24	H-bridge control	104
4.25	H-bridge driver slew-rate control	106
4.26	Resistive low	106
4.27	Short circuit detection / drain source monitoring	107
4.28	H-bridge monitoring in off-mode	107
4.29	Programmable cross current protection	110
4.30	Power window H-bridge safety switch off block	110

4.31	Heater MOSFET Driver	112
4.32	Controller of electro-chromic glass	113
4.33	Temperature warning and shutdown	114
4.34	Thermal clusters	115
4.35	V_S compensation (duty cycle adjustment) module	116
4.36	Analog digital converter	117
5	Serial Peripheral Interface (SPI)	119
5.1	ST SPI 4.0	119
5.1.1	Physical layer	120
5.2	Signal description	120
5.2.1	Clock and Data Characteristics	121
5.2.2	Communication protocol	122
5.2.3	Address definition	125
5.2.4	Protocol failure detection	131
6	Application	133
7	SPI Registers	134
7.1	Global Status Byte GSB	134
7.2	Control register overview	138
7.3	Status register overview	143
7.4	Control registers	145
7.4.1	Control Register CR1 (0x01)	145
7.4.2	Control Register CR2 (0x02)	148
7.4.3	Control Register CR3 (0x03)	151
7.4.4	Control Register CR4 (0x04)	153
7.4.5	Control Register CR5 (0x05)	155
7.4.6	Control Register CR6 (0x06)	157
7.4.7	Control Register CR7 (0x07)	158
7.4.8	Control Register CR8 (0x08)	160
7.4.9	Control Register CR9 (0x09)	161
7.4.10	Control Register CR10 (0x0A)	162
7.4.11	Control Register CR11 (0x0B)	164
7.4.12	Control Register CR12 (0x0C)	165
7.4.13	Control Register CR13 (0x0D) to CR17 (0x11)	166

7.4.14	Control Register CR18 (0x12) to CR22 (0x16)	167
7.4.15	Control Register CR23 (0x17)	169
7.4.16	Control Register CR24 (0x18)	169
7.4.17	Control Register CR25 (0x19)	171
7.4.18	Control Register CR26 (0x1A)	171
7.4.19	Control Register CR27 (0x1B)	172
7.4.20	Control Register CR28 (0x1C)	172
7.4.21	Control Register CR29 (0x1D)	173
7.4.22	Control Register CR34 (0x22)	173
7.4.23	Configuration Register (0x3F)	174
7.5	Status Registers	177
7.5.1	Status Register SR1 (0x31)	177
7.5.2	Status Register SR2 (0x32)	179
7.5.3	Status Register SR3 (0x33)	181
7.5.4	Status Register SR4 (0x34)	183
7.5.5	Status Register SR5 (0x35)	184
7.5.6	Status Register SR6 (0x36)	186
7.5.7	Status Register SR7 (0x37) to SR9 (0x39)	187
7.5.8	Status Register SR10 (0x3A)	188
7.5.9	Status Register SR11 (0x3B)	189
7.5.10	Status Register SR12 (0x3C)	190
8	Package information	192
8.1	LQFP-64 package information	192
8.2	LQFP-64 marking information	194
9	Order code	195
10	Revision history	196

List of tables

Table 1.	Pin definitions and functions	14
Table 2.	Absolute maximum ratings	19
Table 3.	ESD protection	21
Table 4.	Operating junction temperature	22
Table 5.	Temperature warning and thermal shutdown	22
Table 6.	Supply and supply monitoring.	27
Table 7.	Oscillator	28
Table 8.	Power-on reset (V_{SREG})	28
Table 9.	Voltage regulator V1	29
Table 10.	Voltage regulator V2	30
Table 11.	Reset output	31
Table 12.	Watchdog timing	33
Table 13.	Current monitor output (CM)	35
Table 14.	Charge pump electrical characteristics	36
Table 15.	Outputs OUT1 - OUT15, OUT_HS, ECV, ECDR	37
Table 16.	Power outputs switching times	39
Table 17.	Current monitoring	40
Table 18.	Heater	42
Table 19.	H-bridge driver	43
Table 20.	Gate drivers for the external Power-MOS switching times	44
Table 21.	Drain source monitoring external H-bridge	47
Table 22.	Drain source monitoring external heater MOSFET	48
Table 23.	Open-load monitoring external H-bridge	48
Table 24.	Open-load monitoring external heater MOSFET	49
Table 25.	Electro-chrome mirror driver	49
Table 26.	Fail safe low-side switch	50
Table 27.	Wake-up inputs	51
Table 28.	CAN communication operating range	51
Table 29.	CAN transmit data input: pin TxDC	52
Table 30.	CAN receive data output: Pin RxDC	52
Table 31.	CAN transmitter dominant output characteristics	52
Table 32.	CAN transmitter recessive output characteristics, CAN normal mode	53
Table 33.	CAN transmitter recessive output characteristics, CAN low-power mode, biasing active	53
Table 34.	CAN transmitter recessive output characteristics, CAN low-power mode, biasing inactive	54
Table 35.	CAN receiver input characteristics during CAN normal mode	54
Table 36.	CAN receiver input characteristics during CAN low power mode, biasing active	54
Table 37.	CAN Receiver input characteristics during CAN Low power mode, biasing inactive	55
Table 38.	CAN receiver input resistance biasing active	55
Table 39.	CAN transceiver delay	55
Table 40.	Maximum leakage currents on CAN_H and CAN_L, unpowered	56
Table 41.	Biasing control timings	56
Table 42.	LIN transmit data input: pin TxD	57
Table 43.	LIN receive data output: pin RxD	57
Table 44.	LIN transmitter and receiver: pin LIN	57
Table 45.	LIN transceiver timing	59
Table 46.	Input: CSN	60
Table 47.	Inputs: CLK, DI	60
Table 48.	DI, CLK and CSN timing	61

Table 49.	Output: DO	61
Table 50.	DO timing	61
Table 51.	CSN timing	62
Table 52.	Inputs: TxD_C and TxD_L for Flash mode	62
Table 53.	Inputs DIRH, PWMH	63
Table 54.	Debug input	63
Table 55.	ADC characteristics	63
Table 56.	Temperature diode characteristics	64
Table 57.	Interrupt outputs	64
Table 58.	Timer1 and Timer2	65
Table 59.	SGND loss comparator	68
Table 60.	CAN wake-up signalization	74
Table 61.	Wake-up events description	75
Table 62.	Status of different functions/features vs operating modes	76
Table 63.	Temporary failures description	82
Table 64.	Non-recoverable failure	83
Table 65.	Power output settings	98
Table 66.	H-bridge control truth table	105
Table 67.	H-bridge monitoring in off-mode	109
Table 68.	Heater MOSFET control truth table	113
Table 69.	Thermal cluster definition	116
Table 70.	Operation codes	122
Table 71.	Global Status Byte	124
Table 72.	Device application access	125
Table 73.	Device information read access	125
Table 74.	RAM address range	125
Table 75.	ROM address range	126
Table 76.	Information Registers Map	127
Table 77.	SPI Mode Register	128
Table 78.	Burst Read Bit	128
Table 79.	SPI Data Length	129
Table 80.	Data Consistency Check	129
Table 81.	WD Type/Timing	129
Table 82.	WD bit position	130
Table 83.	Global Status Byte (GSB)	134
Table 84.	GSB signals description	134
Table 85.	Control register overview	138
Table 86.	Status register overview	143
Table 87.	Control Register CR1	145
Table 88.	CR1 signals description	145
Table 89.	Wake-up input1 filter configuration	147
Table 90.	CAN transceiver mode	147
Table 91.	Voltage regulator V2 configuration	148
Table 92.	Standby transition configuration	148
Table 93.	Control Register CR2	148
Table 94.	CR2 signals description	148
Table 95.	Configuration of Timer x on-time	150
Table 96.	Control Register CR3	151
Table 97.	CR3 signals description	152
Table 98.	Control Register CR4	153
Table 99.	CR4 signals description	153
Table 100.	Control Register CR5	155

Table 101.	CR5 signals description	155
Table 102.	OUTx Configuration bits	156
Table 103.	Control Register CR6	157
Table 104.	CR6 signals description	157
Table 105.	Control Register CR7	158
Table 106.	CR7 signals description	158
Table 107.	Half-bridge minimum ON time and related overcurrent recovery frequency	159
Table 108.	High-side minimum ON time and related overcurrent recovery frequency	159
Table 109.	Control Register CR8	160
Table 110.	CR8 signals description	160
Table 111.	Control Register CR9	161
Table 112.	CR9 signals description	161
Table 113.	Control Register CR10	162
Table 114.	CR10 signals description	162
Table 115.	Control Register CR11	164
Table 116.	CR11 signals description	164
Table 117.	Control Register CR12	165
Table 118.	CR12 signals description	165
Table 119.	Control Register CR13 to CR17	166
Table 120.	CR13 to CR17 signals description	167
Table 121.	Control Register CR18	167
Table 122.	CR18 to CR22 signals description	168
Table 123.	Control Register CR23	169
Table 124.	CR23 signals description	169
Table 125.	Control Register CR24	169
Table 126.	CR24 signals description	169
Table 127.	Control Register CR25	171
Table 128.	CR25 signals description	171
Table 129.	Control Register CR26	171
Table 130.	CR26 signals description	171
Table 131.	Control Register CR27	172
Table 132.	CR27 signals description	172
Table 133.	Control Register CR28	172
Table 134.	CR28 signals description	173
Table 135.	Control Register CR29	173
Table 136.	CR29 signals description	173
Table 137.	Control Register CR34	173
Table 138.	CR34 signals description	174
Table 139.	Configuration Register	174
Table 140.	CR signals description	174
Table 141.	Status Register SR1 (0x31)	177
Table 142.	SR1 signals description	177
Table 143.	Status Register SR2 (0x32)	179
Table 144.	SR2 signals description	179
Table 145.	Status Register SR3 (0x33)	181
Table 146.	SR3 signals description	182
Table 147.	Status Register SR4 (0x34)	183
Table 148.	SR4 signals description	183
Table 149.	Status Register SR5 (0x35)	184
Table 150.	SR5 signals description	185
Table 151.	Status Register SR6 (0x36)	186
Table 152.	SR6 signals description	186

Table 153.	Status Register SR7 (0x37) to SR9 (0x39).....	187
Table 154.	SR7 to SR9 signals description	187
Table 155.	Status Register SR10 (0x3A)	188
Table 156.	SR10 signals description	188
Table 157.	Status Register SR11 (0x3B)	189
Table 158.	SR11 signals description	189
Table 159.	Status Register SR12 (0x3B)	190
Table 160.	SR12 signals description	190
Table 161.	LQFP-64 mechanical data	192
Table 162.	Device summary	195
Table 163.	Document revision history	196

List of figures

Figure 1.	Block diagram	14
Figure 2.	Pin connection (top view)	18
Figure 3.	Activation profile 1	23
Figure 4.	Activation profile 1 (first cycle)	24
Figure 5.	Activation profile 2	25
Figure 6.	Activation profile 2 (first cycle)	25
Figure 7.	LQFP64 package and PCB thermal configuration	26
Figure 8.	Voltage regulator V1 characteristics (quiescent current and accuracy)	30
Figure 9.	Watchdog timing	34
Figure 10.	Watchdog early, late and safe windows	35
Figure 11.	H-driver delay times	46
Figure 12.	IGHx ranges	46
Figure 13.	IGHf ranges	47
Figure 14.	LIN transmit, receive timing	60
Figure 15.	SPI – transfer timing diagram	65
Figure 16.	SPI input timing	66
Figure 17.	SPI output timing	67
Figure 18.	SPI CSN - output timing	68
Figure 19.	SPI – CSN high to low transition and global status bit access	68
Figure 20.	Voltage regulator behaviour and diagnosis during supply voltage	71
Figure 21.	Sequence to disable/enable the watchdog in CAN Flash mode	72
Figure 22.	NINT pins	73
Figure 23.	Main operating modes	78
Figure 24.	Watchdog in normal operating mode (no errors)	79
Figure 25.	Watchdog with error conditions	80
Figure 26.	Watchdog in Flash mode	80
Figure 27.	NReset pin	83
Figure 28.	RxDL pin	84
Figure 29.	Wake-up behavior according to LIN 2.2a	85
Figure 30.	RxDC pin	86
Figure 31.	CAN transceiver state diagram	88
Figure 32.	CAN wake up capabilities	90
Figure 33.	Thermal shutdown protection and diagnosis	96
Figure 34.	Example of long auto-recovery on OUT7. Temperature acquisition starts after t_{AR} , thermal expiration occurs after a $\Delta T = 30^\circ$	99
Figure 35.	Block diagram of physical realization of AR alert and thermal expiration	100
Figure 36.	Charge pump low filtering and start up implementation	100
Figure 37.	Software strategy for half bridges before applying auto-recovery mode	103
Figure 38.	Overcurrent recovery mode	104
Figure 39.	H-bridge GSHx slope	106
Figure 40.	H-bridge diagnosis	107
Figure 41.	H-bridge open-load-detection (no open-load detected)	108
Figure 42.	H-bridge open-load-detection (open-load detected)	108
Figure 43.	H-bridge open-load-detection (short to ground detected)	109
Figure 44.	H-bridge open-load detection (short to V_S detected)	109
Figure 45.	PWMH cross current protection time implementation	110
Figure 46.	LSx_FSO: low-side driver “passively” turned on, taking supply from output pin (if main supply fails), can guarantee $V_{LSx_FSO} < V_{OUT_max}$	111

Figure 47.	Safety concept	111
Figure 48.	Heater MOSFET open-load and short-circuit to GND detection	112
Figure 49.	Electro-chrome control block	114
Figure 50.	Thermal clusters identification	116
Figure 51.	Block diagram V_S compensation (duty cycle adjustment) module	117
Figure 52.	Sequential ADC Read Out for V_{SREG} , V_S , WU and THCL1 ..THCL6	118
Figure 53.	SPI pin description	120
Figure 54.	SDO pin	121
Figure 55.	SPI signal description	121
Figure 56.	SDI Frame	122
Figure 57.	SDO frame	124
Figure 58.	Window watchdog operation	130
Figure 59.	Typical application diagram	133
Figure 60.	Timer_x controlled by DIR1	151
Figure 61.	Extended ID and extended ID mask	172
Figure 62.	LQFP-64 package dimension	192
Figure 63.	LQFP-64 footprint	194
Figure 64.	LQFP-64 marking information	194

1 Description

The L99DZ100G and L99DZ100GP are door zone systems IC providing electronic control modules with enhanced power management power supply functionality, including various standby modes, as well as LIN and HS CAN physical communication layers.

The two low-drop voltage regulators of the devices supply the system microcontroller and external peripheral loads such as sensors and provide enhanced system standby functionality with programmable local and remote wake-up capability. In addition 8 high-side drivers to supply LEDs, 2 high-side drivers to supply bulbs increase the system integration level.

Up to 5 DC motors and 4 external MOS transistors in H-bridge configuration can be driven. An additional gate drive can control an external MOSFET in high-side configuration to supply a resistive load connected to GND (e.g. mirror heater). An electro-chromic mirror glass can be controlled using the integrated SPI-driven module in conjunction with an external MOS transistor. All outputs are SC protected and implement an open-load diagnosis.

The ST standard SPI interface (4.0) allows control and diagnosis of the device and enables generic software development.

2 Block diagram and pin descriptions

Figure 1. Block diagram

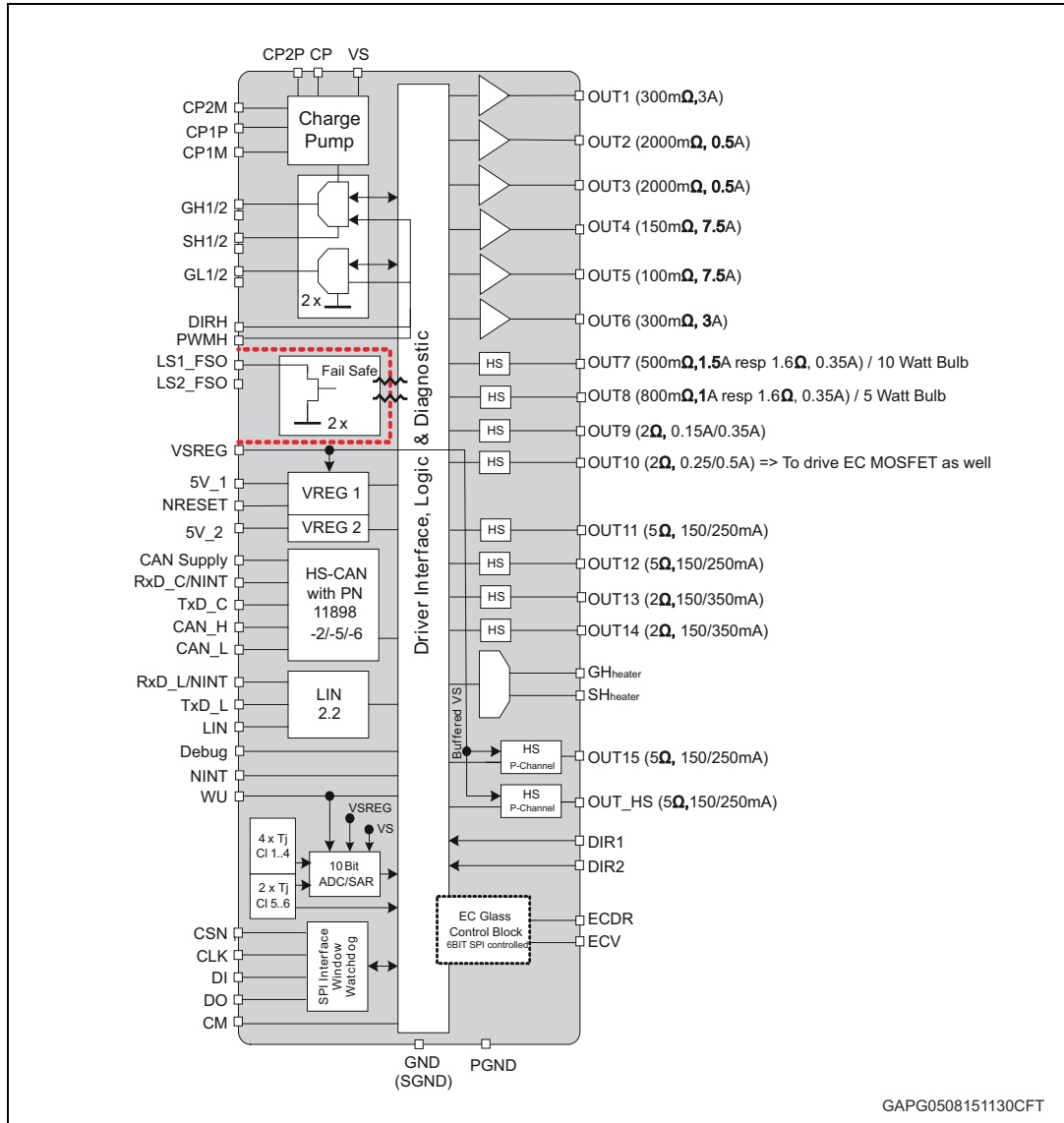


Table 1. Pin definitions and functions

Pin	Symbol	Function
1	WU	Wake-up Input: Input pin for static or cyclic monitoring of external contacts
2	CP2M	Charge pump pin for capacitor 2, negative side
3	CP2P	Charge pump pin for capacitor 2, positive side
4	CP	Charge pump output
5	CP1P	Charge pump pin for capacitor 1, positive side
6	CP1M	Charge pump pin for capacitor 1, negative side

Table 1. Pin definitions and functions (continued)

Pin	Symbol	Function
7	GHheater	Gate driver for external power N-Channel MOSFET in high-side configuration to control the heater
8	SHheater	Source of high-side MOSFET to control the heater
9	OUT14	High-side-driver output to drive LEDs
10	OUT13	High-side-driver output to drive LEDs
11	OUT12	High-side-driver output to drive LEDs
12	OUT9	High-side-driver output to drive LEDs
13	OUT10	High-side-driver-output; Important: Beside the bits <i>OUT10_x</i> (CR 5) this output can be switched on setting the <i>ECON</i> bit for electro-chrome control mode with higher priority.
14	OUT11	High-side-driver output to drive LEDs
15	LS1_FSO	Fail Safe low-side switch (Active low)
16	LS2_FSO	Fail Safe low-side switch (Active low)
17	VS	Power supply voltage for power stage outputs (external reverse battery protection required), for this input a ceramic capacitor as close as possible to GND is recommended. Important: For the capability of driving, the full current at the outputs all pins of VS must be connected externally!
18	VS; 2nd pin	Current capability (pin description see above)
19	OUT7	High-side-driver output to drive LEDs or a 10 Watt bulb (programmable R_{dson})
20	OUT6	Half-bridge outputs: the output is built by a high-side and a low-side switch which are internally connected. The output stage of both switches is a power DMOS transistor. Each driver has an internal parasitic reverse diode (bulk-drain-diode: high-side driver from output to VS, low-side driver from GND to output)
21	OUT1	Half-bridge outputs: the output is built by a high-side and a low-side switch which are internally connected. The output stage of both switches is a power DMOS transistor. Each driver has an internal parasitic reverse diode (bulk-drain-diode: high-side driver from output to VS, low-side driver from GND to output)
22	OUT2	Half-bridge outputs: the output is built by a high-side and a low-side switch which are internally connected. The output stage of both switches is a power DMOS transistor. Each driver has an internal parasitic reverse diode (bulk-drain-diode: high-side driver from output to VS, low-side driver from GND to output)
23	OUT5	Half-bridge outputs: the output is built by a high-side and a low-side switch which are internally connected. The output stage of both switches is a power DMOS transistor. Each driver has an internal parasitic reverse diode (bulk-drain-diode: high-side driver from output to VS, low-side driver from GND to output)
24	OUT5; 2nd pin	Current capability (pin description see above)

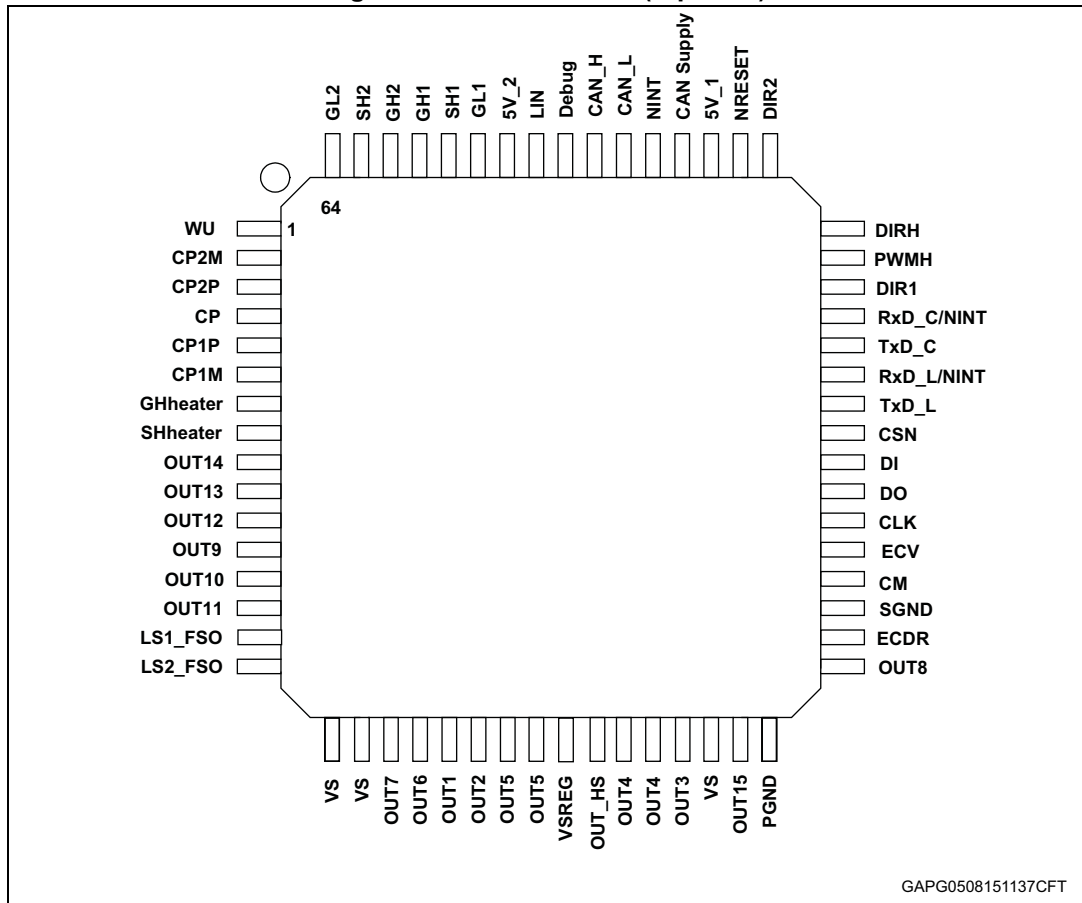
Table 1. Pin definitions and functions (continued)

Pin	Symbol	Function
25	V _{SREG}	Power supply voltage to supply the internal voltage regulators, OUT15 and the OUT_HS (external reverse battery protection required / Diode) for this input a ceramic capacitor as close as possible to GND and an electrolytic back up capacitor is recommended.
26	OUT_HS	High-side-driver output to drive LEDs or to supply contacts
27	OUT4	Half-bridge outputs: the output is built by a high-side and a low-side switch which are internally connected. The output stage of both switches is a power DMOS transistor. Each driver has an internal parasitic reverse diode (bulk-drain-diode: high-side driver from output to V _S , low-side driver from GND to output)
28	OUT4; 2 nd pin	Current capability (pin description see above)
29	OUT3	Half-bridge outputs: the output is built by a high-side and a low-side switch which are internally connected. The output stage of both switches is a power DMOS transistor. Each driver has an internal parasitic reverse diode (bulk-drain-diode: high-side driver from output to V _S , low-side driver from GND to output)
30	V _S ; 3rd pin	Current capability (for the pin description see above)
31	OUT15	High-side-driver output to drive LEDs
32	PGND	Power GND
33	OUT8	High-side-driver output to drive LEDs or a 5 Watt bulb (programmable R _{dson})
34	ECDR	ECDR: using the device in EC control mode this pin is used to control the gate of an external N-Channel MOSFET
35	SGND	Signal Ground
36	CM	Current monitor output: depending on the selected multiplexer bits CM_SEL_x (CR 7) of the; Control Register this output sources an image of the instant current; through the corresponding high-side driver with a fixed ratio
37	ECV	ECV: using the device in EC control mode this pin is used as voltage monitor input. For fast discharge an additional low-side-switch is implemented
38	CLK	SPI: serial clock input
39	DO	SPI: serial data output (push pull output stage)
40	DI	SPI: serial data input
41	CSN	SPI: chip select not input
42	TxD_L	LIN Transmit data input
43	RxD_L/NINT	RxDL -> LIN receive data output; NINT -> indicates local/remote wake-up events (push pull output stage)
44	TxD_C	CAN transmit data input
45	RxD_C/NINT	CAN receive data output NINT -> indicates local/remote wake-up events (push pull output stage)
46	DIR1	Direct Drive Input 1

Table 1. Pin definitions and functions (continued)

Pin	Symbol	Function
47	PWMH	PWMH input: this input signal can be used to control the H-bridge Gate Drivers.
48	DIRH	Direction Input: this input controls the H-bridge Drivers for the external MOSFETs
49	DIR2	Direct Drive Input 2
50	NRESET	NReset output to micro controller; (reset state = LOW) (Low-side switch with drain connected to the output pin and internal pull up resistance to 5V_1)
51	5V_1	Voltage regulator 1 output: 5 V supply e.g. micro controller, CAN transceiver
52	CAN Supply	CAN supply input; to allow external CAN supply from V1 or V2 regulator
53	NINT	Interrupt output (low active; push-pull output stage) to indicate V _{SREG} early warning (Active mode); indicates wake-up events from V1_standby mode
54	CAN_L	CAN low level voltage I/O
55	CAN_H	CAN high level voltage I/O
56	Debug	Debug input to deactivate the window watchdog (high active)
57	LIN	LIN bus line
58	5V_2	Voltage regulator 2 output: 5 V supply for external loads (potentiometer, sensors) or CAN Transceiver. V2 is protected against reverse supply
59	GL1	Gate driver for PowerMOS low-side switch in half-bridge 1
60	SH1	Source of high-side switch in half-bridge 1
61	GH1	Gate driver for PowerMOS high-side switch in half-bridge 1
62	GH2	Gate driver for PowerMOS high-side switch in half-bridge 2
63	SH2	Source of high-side switch in half-bridge 2
64	GL2	Gate driver for PowerMOS low-side switch in half-bridge 2

Figure 2. Pin connection (top view)



3 Electrical specifications

3.1 Absolute maximum ratings

Stressing the device above the rating listed in [Table 2](#) may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability

Table 2. Absolute maximum ratings

Symbol	Parameter / test condition	Value [DC voltage]	Unit
V_S, V_{SREG}	DC supply voltage / "jump start"	-0.3 to +28	V
	Load dump	-0.3 to +40	V
5V_1	Stabilized supply voltage, logic supply	-0.3 to 6.5 $V1 < V_{SREG}$	V
5V_2 ⁽¹⁾	Stabilized supply voltage	-0.3 to +28 ⁽²⁾	V
$V_{DI}, V_{CLK}, V_{CSN}, V_{DO}, V_{RXDL/NINT}, V_{RXDC}, V_{NRESET}, V_{CM}, V_{DIR}, V_{DIR2}, V_{PWMH}, V_{DIRH}, V_{INT}$	Logic input / output voltage range	-0.3 to $V1+0.3$	V
V_{TXDC}, V_{TXDL}	Multi Level Inputs	-0.3 to 40	V
V_{Debug}	Debug input pin voltage range	-0.3 to 40	V
V_{LS1_FSO}, V_{LS2_FSO}	Output voltage range of Fail-Safe Low-side Switches	-0.3 to 35	V
V_{WU}	DC Wake up input voltage / "jump start"	-0.3 to +28	V
	Load dump	-0.3 to +40	V
V_{LIN}	LIN bus I/O voltage range	-20 to +40	V
$I_{Input}^{(3)}$	Current injection into V_S related input pins	20	mA
$I_{OUT_INJ}^{(3)}$	Current injection into V_S related outputs	20	mA
V_{CANSUP}	CAN supply	-0.3 to +5.25	V
V_{CANH}, V_{CANL}	CAN bus I/O voltage range	-27 to +40	V
$V_{CANH} - V_{CANL}$	Differential CAN-Bus Voltage	-5 to +10	V
$V_{OUTn}, V_{ECDR}, V_{ECV}, V_{out_HS}$	Output voltage (n = 1 to 15)	-0.3 to $V_S+0.3$	V
$V_{GH1}, V_{GH2} (V_{Gxy})$	High Voltage Signal Pins	$V_{Sxy}-0.3$ to $V_{Sxy}+13; V_{CP}+0.3$	V
$V_{GL1}, V_{GL2} (V_{Gxy})$	High Voltage Signal Pins	$V_{Sxy}-0.3$ to $V_{Sxy}+13; V_{CP}-0.3V$ to +12V; $V_{cp}+0.3V$	V

Table 2. Absolute maximum ratings (continued)

Symbol	Parameter / test condition	Value [DC voltage]	Unit
V _{SH1} , V _{SH2} (V _{Sxy})	High Voltage Signal Pins	-1 to 40	V
	High Voltage Signal Pins; single pulse with t _{max} = 200ns	-5 to 40	V
V _{CP1P}	High Voltage Signal Pins	V _S -0.3 to V _S +14	V
V _{CP2P}	High Voltage Signal Pins	V _S -0.6 to V _S +14	V
V _{CP1M} , V _{CP2M}	High Voltage Signal Pins	-0.3 to V _S +0.3	V
V _{CP}	High Voltage Signal Pin V _S ≤ 26 V	V _S -0.3 to V _S +14	V
	High Voltage Signal Pin V _S > 26 V	V _S -0.3 to +40	V
V _{GH_heater}		V _{Sheater} -0.3 to V _{Sheater} +13; V _{CP} +0.3	V
V _{SH_heater}		-0.3 to 40V Or -0.3 to V _S +0.3	V
ISH_Heater		+/-10	mA
I _{ECV} , I _{OUT2} , I _{OUT3} , I _{OUT9} , I _{OUT10} , I _{OUT11} , I _{OUT12} , I _{OUT13} , I _{OUT14} , I _{OUT15} , I _{OUT_HS}	Output current ⁽²⁾	±1.25	A
I _{OUT8}		±2.5	A
I _{OUT7}		±5	A
I _{OUT1,6}		±5	A
I _{OUT4,5}		±10	A
I _{VScum}	Maximum cumulated current at V _S drawn by OUT1 & OUT2 ⁽²⁾	±7.5	A
I _{VScum}	Maximum cumulated current at V _S drawn by OUT3, OUT8 & OUT10 ⁽²⁾	±2.5	A
I _{VScum}	Maximum cumulated current at V _S drawn by OUT4 ⁽²⁾	±10	A
I _{VScum}	Maximum cumulated current at V _S drawn by OUT5 ⁽²⁾	±10	A
I _{VScum}	Maximum cumulated current at V _S drawn by OUT6 & OUT7 ⁽²⁾	±7.5	A
I _{VScum}	Maximum cumulated current at V _S drawn by OUT9, OUT11, OUT12, OUT13, OUT14, OUT15 and CP	±2.5	A
I _{VSREG}	Maximum current at V _{SREG} pin ⁽²⁾ (5V_1, 5V_2 and OUT_HS)	±2.5	A
I _{PGNDcum}	Maximum cumulated current at PGND drawn by OUT1 & OUT6 ⁽²⁾	±7.5	A

Table 2. Absolute maximum ratings (continued)

Symbol	Parameter / test condition	Value [DC voltage]	Unit
$I_{PGNDcum}$	Maximum cumulated current at PGND drawn by OUT2 & OUT5 ⁽²⁾	±12.5	A
$I_{PGNDcum}$	Maximum cumulated current at PGND drawn by OUT3, OUT4 & ECV ⁽²⁾	±12.5	A
I_{SGND}	Maximum current at SGND ⁽²⁾	±1.25	A
GND pins	PGND versus SGND	-0.3 to 0.3	V

- 5V_2 is robust against SC to 28 V only in case V_{SREG} is supplied.
- Values for the absolute maximum DC current through the bond wires. This value does not consider maximum power dissipation or other limits.
- Guaranteed by design.

Note: All maximum ratings are absolute ratings. Leaving the limitation of any of these values may cause an irreversible damage of the integrated circuit!

Note: Loss of ground or ground shift with externally grounded loads: ESD structures are configured for nominal currents only. If external loads are connected to different grounds, the current load must be limited to this nominal current.

3.2 ESD protection

Table 3. ESD protection

Parameter	Value	Unit
All pins ⁽¹⁾	+/-2	kV
All power output pins ⁽²⁾ : OUT1 – OUT15, OUT_HS, ECV	+/-4	kV
LIN	+/-8 ⁽²⁾ +/-9 ^{(3) (4)} +/-6 ⁽⁵⁾	kV
CAN_H, CAN_L	+/-8 ⁽²⁾ +/-6 ^{(5) (4)}	kV
All pins ⁽⁶⁾	+/-500	V
Corner pins ⁽⁶⁾	+/-750	V
All pins ⁽⁷⁾	+/- 200	V

- HBM (human body model, 100 pF, 1.5 kΩ) according to MIL 883C, Method 3015.7 or EIA/JESD22A114-A.
- HBM with all none zapped pins grounded.
- Indirect ESD Test according to IEC 61000-4-2 (150 pF, 330 Ω) and 'Hardware Requirements for LIN, CAN and Flexray Interfaces in Automotive Applications' (version 1.3, 2012-05-04).
- Value has been verified by an external test house; the result was equal or better than minimum requirement.
- Direct ESD Test according to IEC 61000-4-2 (150 pF, 330 Ω) and 'Hardware Requirements for LIN, CAN and Flexray Interfaces in Automotive Applications' (version 1.3, 2012-05-04).
- Charged device model.
- Machine model; C = 220 pF, R = 0 Ω.

3.3 Thermal data

Table 4. Operating junction temperature

Symbol	Parameter	Value	Unit
T_j	Operating junction temperature	-40 to 175	°C

All parameters are guaranteed in the junction temperature range -40 to 150°C (unless otherwise specified); the device is still operative and functional at higher temperatures (up to 175°C).

Note: Parameters limits at higher junction temperatures than 150°C may change respect to what is specified as per the standard temperature range.

Note: Device functionality at high junction temperature is guaranteed by characterization.

Table 5. Temperature warning and thermal shutdown

Symbol	Parameter	Min.	Typ.	Max.	Unit	
T_W	Thermal overtemperature warning threshold	$T_j^{(1)}$	140	150	160	°C
T_{SD1}	Thermal shutdown junction temperature 1	$T_j^{(1)}$ Cluster 1-4 Cluster 5-6	165 165	175 175	185 190	°C
T_{SD2}	Thermal shutdown junction temperature 2	$T_j^{(1)}$	175	185	195	°C
$T_{SD12hys}$	Hysteresis		5		°C	
T_{jft}	Thermal warning / shutdown filter time		32		µs	

1. Non-overlapping.

3.3.1 LQFP64 thermal data

Devices belonging to L99DZxxx family embed a multitude of junctions (i.e. Outputs based on a PowerMOSFET stage) housed in a relatively small piece of silicon. The devices contain, among all the described features, 6 Half-bridges (12 N-Channel PowerMOS), 10 high-sides and two voltage regulators; all the other derivatives, even if smaller than the family super set device, still contain a significant number of junctions.

For this reason, using the Thermal Impedance of a single junction (i.e. voltage regulator or major power dissipation contributor) does not allow to predict thermal behavior of the whole device and therefore it is not possible to assess if a device is thermally suitable for a given activation profile and loads characteristics.

Thermal information is provided as temperature reading by different clusters placed close to the most dissipative junctions.

Some representative and realistic worst-case thermal profiles are described in the below paragraph.

Following measurement methods can be easily implemented, by final user, for a specific activation profile.

L99DZ100G and L99DZ100GP thermal profiles

Profile 1

Battery Voltage: 16V, Ambient temperature start: 85°C

DC activation

- V1 charged with 70 mA (DC activation)
- V2 charged with 30 mA (DC activation)
- OUT7: 1 x10W bulb (DC activation)
- OUT8: 1 x 5W bulb (DC activation)
- OUT11: 300 Ω resistor (DC activation)
- OUT12: 300 Ω resistor (DC activation)
- OUT13: 300 Ω resistor (DC activation)
- OUT14: 300 Ω resistor (DC activation)

Cyclic activation

- OUT4 – OUT5: 3,3 Ω resistor placed across those outputs
 - 10 activations of Lock/Un-lock (250 ms ON Lock; 500 ms wait; 250 ms ON Un-lock unlock; 500 ms wait)
- OUT5 – OUT6: 10 Ω resistor placed across those outputs
 - (250 ms ON Safe Lock; 500 ms wait; 250 ms ON Safe unlock; 500 ms wait)

Test execution:

Once thermal equilibrium is reached with all DC load active, the “Cyclic Activation” sequence is applied.

Temperature reading is logged just at the end of the whole sequence.

Figure 3. Activation profile 1

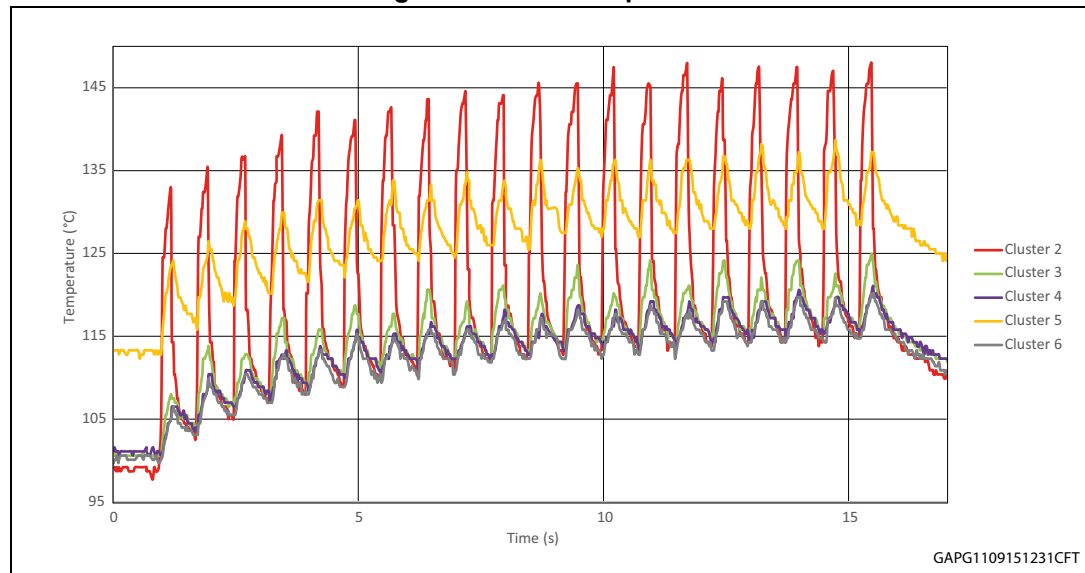
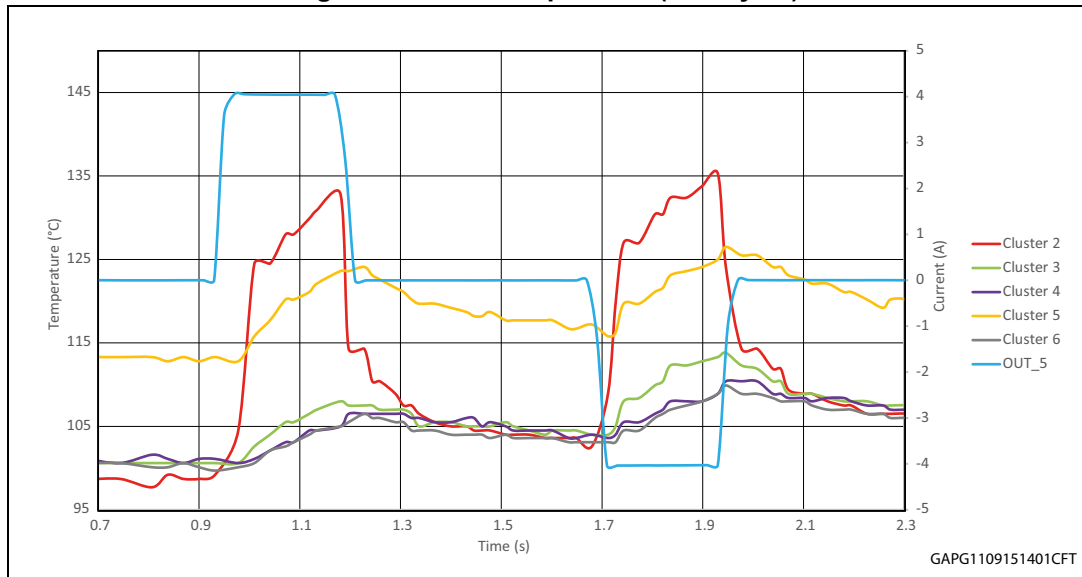


Figure 4. Activation profile 1 (first cycle)



Note: All curves are plotted interpolating measured samples with 15 ms of period.

Profile 2

Battery Voltage: 16V, Ambient temperature start: 85°C

DC activation

- V1 charged with 70 mA (DC activation)
- V2 charged with 30 mA (DC activation)
- OUT7: 1 x10W bulb (DC activation)
- OUT8: 1 x 5W bulb (DC activation)
- OUT11: 300 Ω resistor (DC activation)
- OUT12: 300 Ω resistor (DC activation)
- OUT13: 300 Ω resistor (DC activation)
- OUT14: 300 Ω resistor (DC activation)

Cyclic activation

- OUT1 – OUT6: 6,8 Ω resistor placed across those outputs
 - 2 activations of Fold/Unfold. (3s ON; 1s OFF; 2x)

Test execution:

Once thermal equilibrium is reached with all DC load active, the “Cyclic Activation” sequence is applied.

Figure 5. Activation profile 2

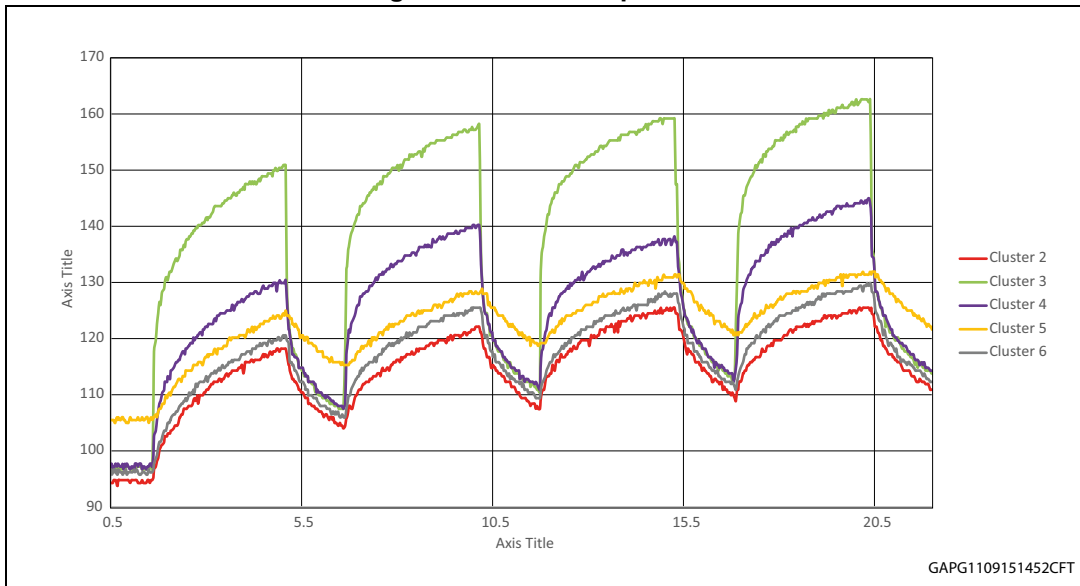
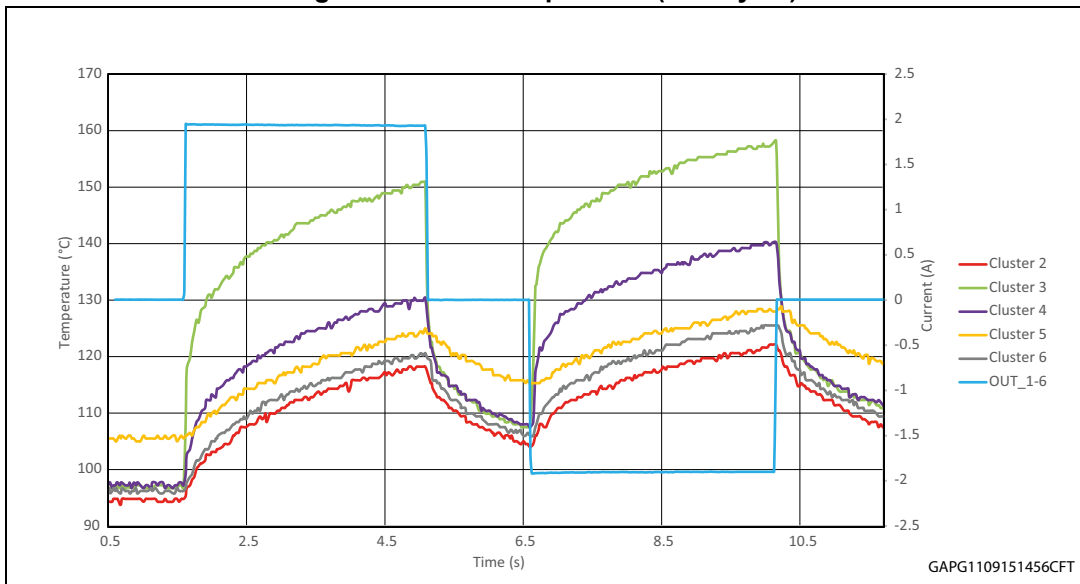


Figure 6. Activation profile 2 (first cycle)



Note: All curves are plotted interpolating measured samples with 15 ms of period.