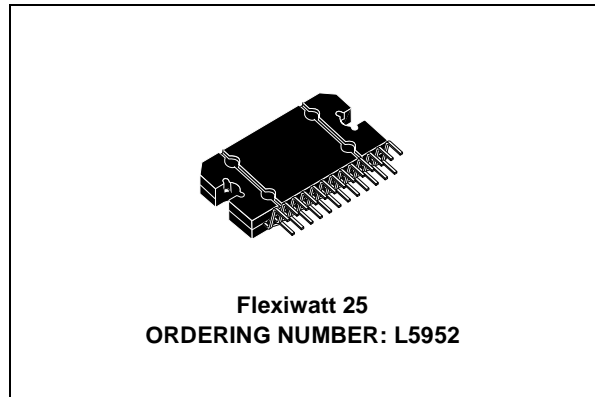


## MULTIPLE MULTIFUNCTION VOLTAGE REGULATOR

- FIVE REGULATED OUTPUTS
  - Vo1 5V @500mA
  - Vo2 8.3V @ 250mA
  - Vo3 7.7V to 8.5V @250mA (I<sup>2</sup>C presettable)
  - Vo4 5V to 7.3V @0.4A (I<sup>2</sup>C presettable)
  - Vo5 3.3V to 5V @500mA (I<sup>2</sup>C presettable)
  - HSDout R<sub>ON</sub> = 0.6Ω
- I<sup>2</sup>C ENABLE & OUT PRESET
- ADJUSTABLE BATTERY DETECTION CIRCUIT
- RESET OUTPUT
- BACKUP FACILITY
- LOW QUIESCENT CONSUMPTION
- HIGH RIPPLE REJECTION
- LOAD DUMP
- OVERCURRENT & SHORT CIRCUIT PROTECTORS
- THERMAL SHUTDOWN



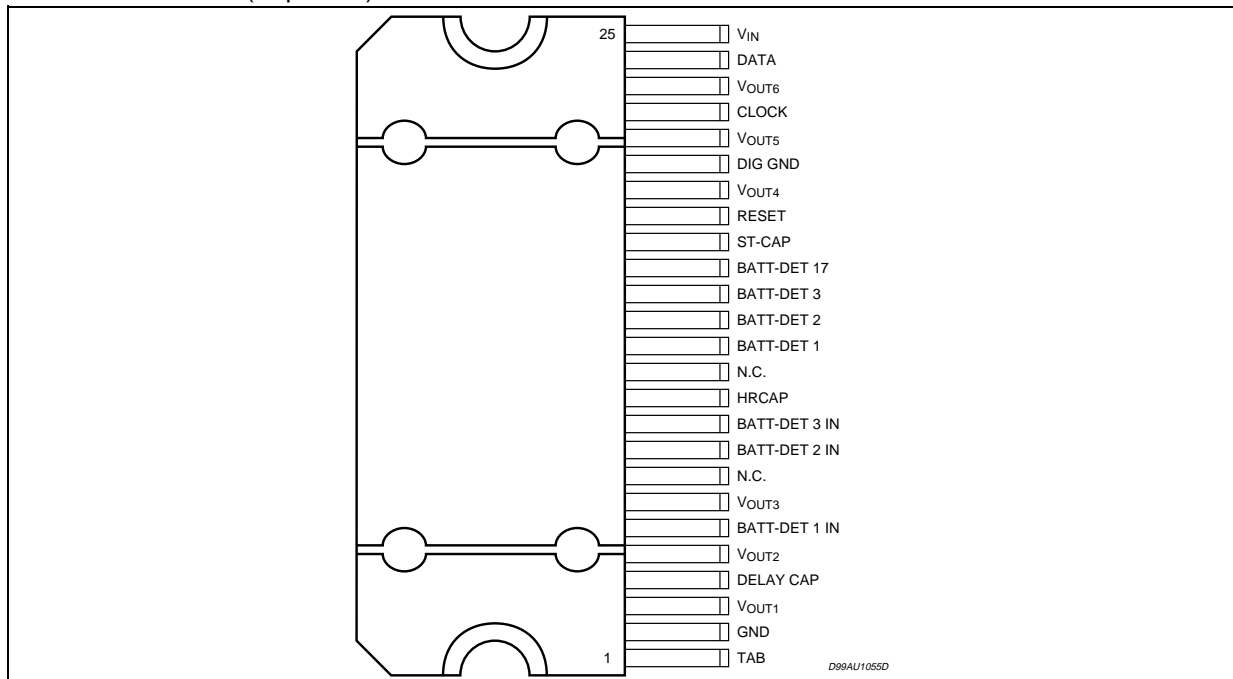
### DESCRIPTION

The L5952 is a multifunction 5 output voltage regulator plus a High Side Driver primarily developed for car radio applications.

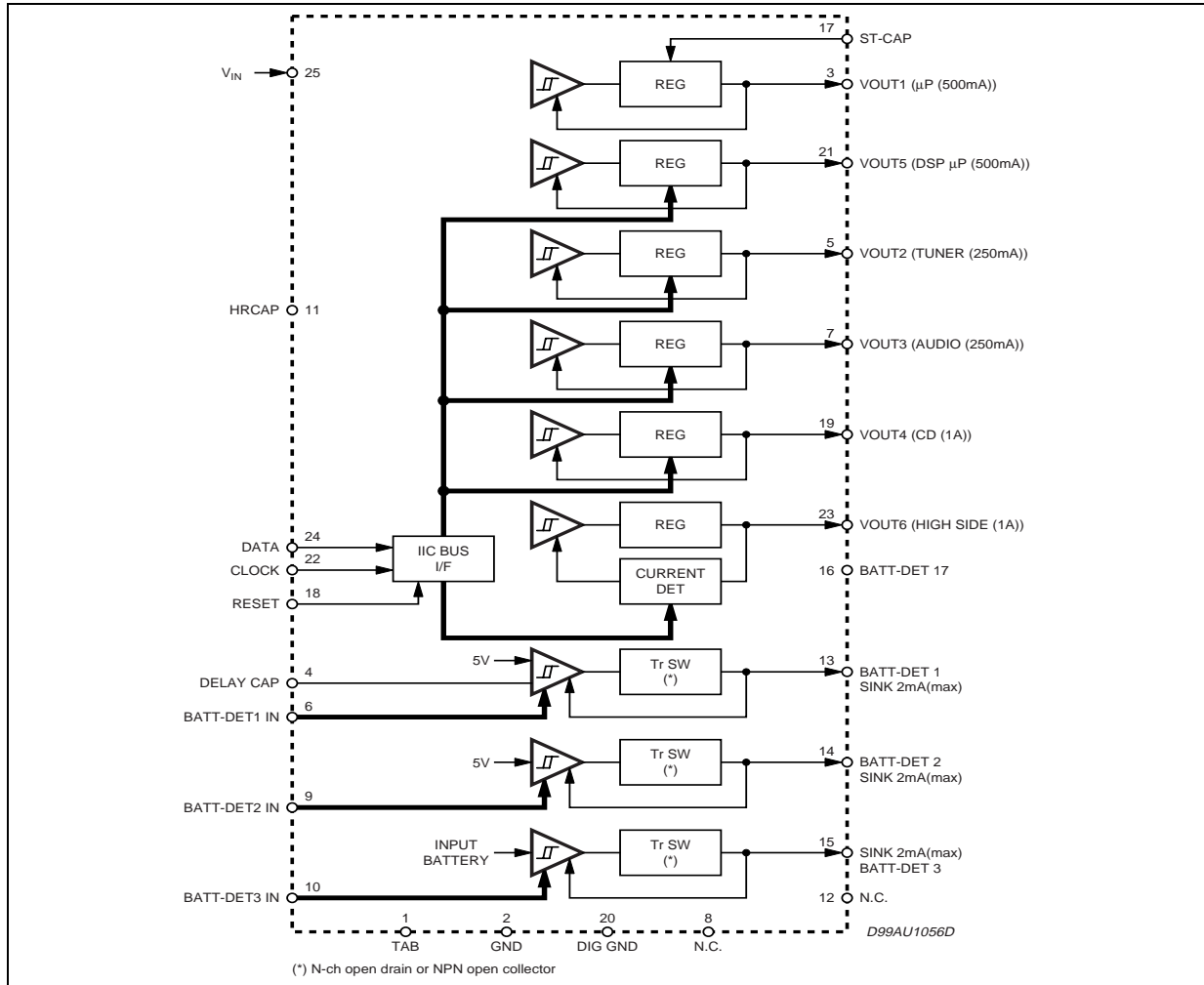
Three outputs are enabled and set via I<sup>2</sup>C bus.

Very low stand-by current consumption is achieved to specifically comply with entertainment and automotive environments.

### PIN CONNECTION (Top View)



**BLOCK DIAGRAM**



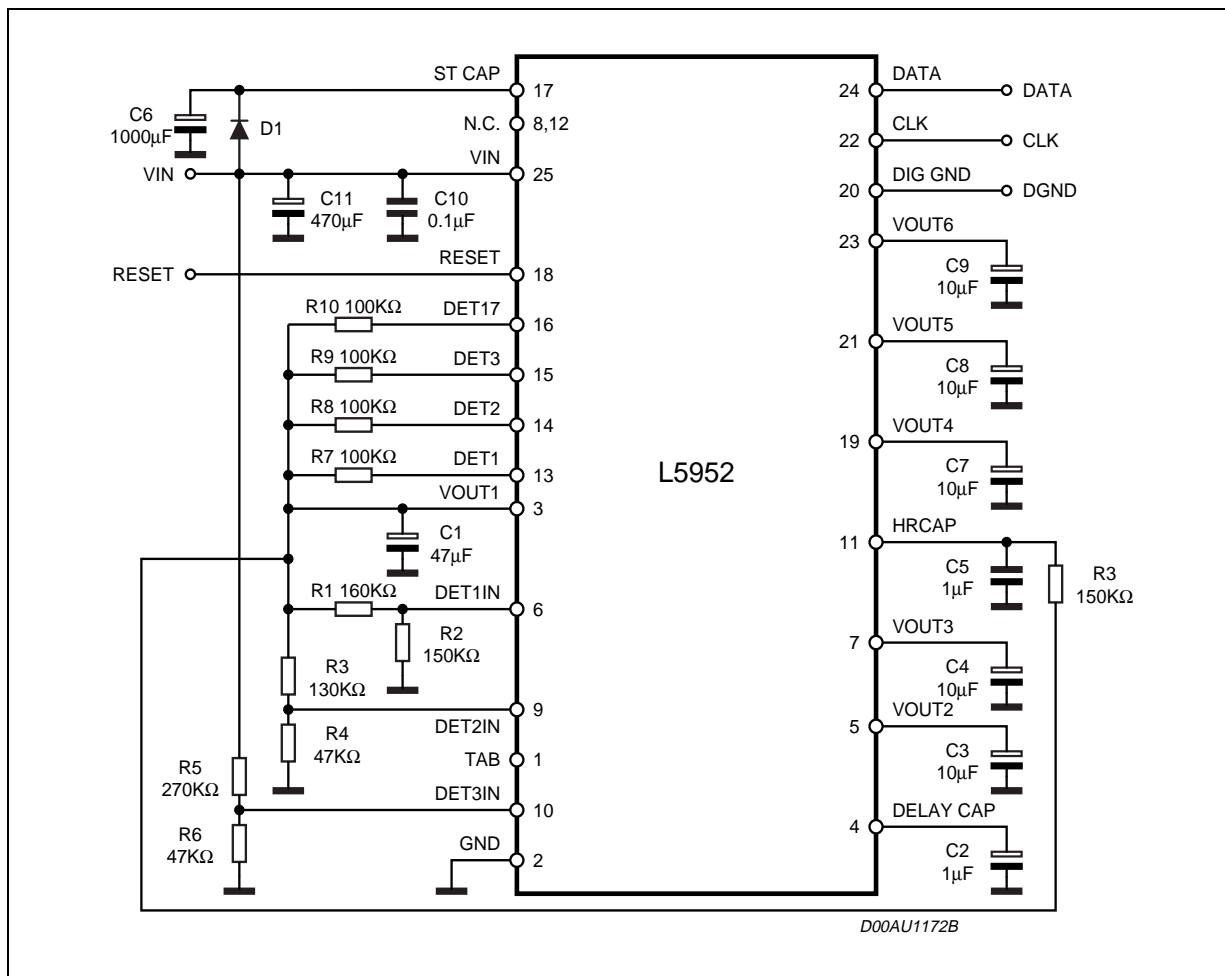
**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
V <sub>IN</sub>	DC Supply Voltage	-0.6 to 26	V
V <sub>IN</sub>	Transient Supply Overvoltage (50ms)	50	V
R <sub>ESR</sub>	Output Capacitor Series Eq. Series Resistors Allowed Range	0.2 to 10	Ω
T <sub>op</sub>	Operating Temperature Range	-40 to 85	°C
T <sub>stg</sub>	Storage Temperature Range	-40 to 150	°C

**THERMAL DATA**

Symbol	Parameter	Value	Unit
R <sub>th j-case</sub>	Thermal resistance junction-case	1.3	°C/W

TEST CIRCUIT



ELECTRICAL CHARACTERISTICS (Ref. to Test Circuit,  $V_{IN} = 14.4V$ ,  $T_{case} = 25^{\circ}C$ , unless otherwise noted).

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
<b>INPUT</b>						
$V_{op}$	Operating Voltage		9		16	V
	Jump Start	$t < 1min$ ; still in normal operation			27	V
	Load Dump	50V, 50ms; still in normal operation at $V_{out1}$ , Det 1,2,3			50	V
	Delay Reset	$C_2 = 1\mu F$	2	3	4	ms
	System Reset LO	$V_{out1}$ , Det 1,2,3,17 = active			1	V
	System Reset Hi		4			V
$I_Q$	Quiescent Current	$V_{out1}$ , Det 1,2,3,17 = active Not including I into $R_1$ to $R_6$		80	120	$\mu A$
	Hard Reset	$C = 1\mu F$ ; $R = 150k\Omega$	50	100		ms

## ELECTRICAL CHARACTERISTICS (Continued)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
--------	-----------	----------------	-----	-----	-----	------

## OUTPUTS:

Output voltage 1 ( $V_{out1}$ )

$V_{out}$	Output Voltage	$I_{out} < 500\text{mA}$ ; $V_{batt-up\ cap} = 9\text{ to }16\text{V}$ $I_{out} < 250\text{mA}$ ; $V_{batt-up\ cap} = 7\text{ to }9\text{V}$	4.75	5	5.25	V
$I_{max}$	Maximum Current	current limiter	600	1200		mA
$\Delta V_{load}$	Load Regulation	$I_{out} = 0\text{ to }500\text{mA}$		30	50	mV
SVRR	Ripple Rejection	1kHz, $V_{ripple} = 2\text{Vpp}$	50	60		dB
$V_{drop1}$	Voltage Drop	$I_{out} = 500\text{mA}$		1.5	2.5	V
$V_{drop2}$	Voltage Drop	$I_{out} = 250\text{mA}$		0.75	1.25	V
$\Delta V_{lin}$	Line Regulation	$I_{OUT} = 0$		0	50	mV

$V_{out1}$  is 5V regulator

Output voltage 2 ( $V_{out2}$ )

$V_{out}$	Output Voltage	$I_{out} < 250\text{mA}$ ; $V_{in} = 9\text{ to }16\text{V}$	8.1	8.3	8.5	V
$I_{max}$	Maximum Current	current limiter	300	450		mA
$\Delta V_{load}$	Load Regulation	$I_{out} = 0\text{ to }250\text{mA}$		20	50	mV
SVRR	Ripple Rejection	1kHz, $V_{ripple} = 2\text{Vpp}$	45	55		dB
$V_{drop}$	Voltage Drop	$I_{out} = 250\text{mA}$		0.5	0.6	V
$\Delta V_{lin}$	Line Regulation	$I_{OUT} = 0$		0	50	mV

$V_{out2}$  has On/OFF function by I<sup>2</sup>C. Default is OFF

Output voltage 3 ( $V_{out3}$ )

$V_{adj}$	Adjustable range	$I_{out} < 250\text{mA}$ ; $V_{in} = 9\text{ to }16\text{V}$	7.7		8.5	V
$I_{max}$	Maximum Current	current limiter	300			mA
$\Delta V_{load}$	Load Regulation	$I_{out} = 0$		20	50	mV
SVRR	Ripple Rejection	1kHz, $V_{ripple} = 2\text{Vpp}$	50	60		dB
$V_{drop}$	Voltage Drop	$I_{out} = 250\text{mA}$		0.45	0.6	V
$\Delta V_{lin}$	Line Regulation	$I_{OUT} = 0$		0	50	mV

 $V_{out3}$  Voltage configuration

	Setting 1	$I_{out} < 250\text{mA}$ ; $V_{in} = 10\text{ to }16\text{V}$	8.2	8.5	8.8	V
	Setting 2	$I_{out} < 250\text{mA}$ ; $V_{in} = 10\text{ to }16\text{V}$	8	8.3	8.6	V
	Setting 3	$I_{out} < 250\text{mA}$ ; $V_{in} = 10\text{ to }16\text{V}$	7.8	8.1	8.4	V
	Setting 4	$I_{out} < 250\text{mA}$ ; $V_{in} = 9\text{ to }16\text{V}$	7.6	7.9	8.2	V
	Setting 5	$I_{out} < 250\text{mA}$ ; $V_{in} = 9\text{ to }16\text{V}$	7.4	7.7	8.0	V

Select one of above settings as well as ON/OFF control by I<sup>2</sup>C. Default is OFF.

## ELECTRICAL CHARACTERISTICS (Continued)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
--------	-----------	----------------	-----	-----	-----	------

**Output 4: (V<sub>out4</sub>)**

V <sub>adj</sub>	Adjustable range	I <sub>out</sub> = 400mA	5		7.3	V
I <sub>max</sub>	Max. Current	Current limiter	1.2	2.4		A
SVRR	Ripple rejection	1kHz, V <sub>ripple</sub> = 2Vpp	50	60		dB
V <sub>drop</sub>	Voltage Drop	I <sub>out</sub> = 400mA		0.6	0.75	V
ΔV <sub>load</sub>	Load Regulation	I <sub>out</sub> = 0 to 400mA		20	50	mV
ΔV <sub>lin</sub>	Line Regulation	I <sub>OUT</sub> = 0		0	50	mV

**V<sub>out4</sub> Voltage configuration**

	Setting 1	I <sub>out</sub> < 400mA; V <sub>in</sub> = 9 to 16V	7	7.3	7.6	V
	Setting 2		6.7	7	7.3	V
	Setting 3		6.3	6.6	6.9	V
	Setting 4		6	6.3	6.6	V
	Setting 5		5.7	6	6.3	V
	Setting 6		5.3	5.5	5.7	V
	Setting 7		4.75	5	5.25	V

Select one of above settings as well as ON/OFF control by I<sup>2</sup>C. Default is OFF

**Output 5 (V<sub>out5</sub>)**

V <sub>adj</sub>	Adjustable range	I <sub>out</sub> < 500mA	3.3		5	V
I <sub>max</sub>	Max. Current	Current limiter	600	1000		mA
ΔV <sub>load</sub>	Load Regulation	I <sub>out</sub> = 0 to 500mA		30	50	mV
SVRR	Ripple Rejection	1kHz, V <sub>ripple</sub> = 2Vpp	50	60		dB
V <sub>drop</sub>	Voltage Drop	I <sub>out</sub> = 500mA		2.4	3.6	V
ΔV <sub>lin</sub>	Line Regulation	I <sub>OUT</sub> = 0		0	50	mV

**V<sub>out5</sub> Voltage configuration**

	Setting 1	I <sub>out</sub> < 500mA; V <sub>in</sub> = 9 to 16V	3.1	3.3	3.5	V
	Setting 2		4.75	5.0	5.25	V

Select one of above settings as well as ON/OFF control by I<sup>2</sup>C. Default is OFF

**Output 6 (V<sub>out6</sub>)**

V <sub>out</sub>	Output Voltage	I <sub>out</sub> < 800mA; V <sub>in</sub> = 9 to 16V	8.4		15.4	V
------------------	----------------	--	-----	--	------	---

**ELECTRICAL CHARACTERISTICS (Continued)**

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
$I_{max}$	Maximum Current	Current limiter	1.2			A
$V_{drop}$	Dropout Voltage	$I_{out} < 800mA$		0.45	0.6	V

Vout6 has On/OFF function by I<sup>2</sup>C. Default is OFF

**Battery Detection1 (Det1)**

	Vthreshold	ST-CAP rising	7	7.3	8	V
$V_{adj}$	Adjustable Range Th2 with ext. resistor	$V_{out1}$ falling	2.4	2.55	2.7	V
$V_{OL}$	L Output Voltage	$I_{out} = 2mA$		0.5	0.8	V

Note: 1μF is recommended for delay Cap (min: 100nF)

**Battery Detection2 (Det2)**

$V_{adj}$	Adjustable Range with ext. resistor		4.45	4.65	4.8	V
	Hysteresis		30	60	120	mV
$V_{OL}$	L Output Voltage	$I_{out} = 2mA$		0.5	0.8	V

**Battery Detection3 (Det3)**

$V_{adj}$	Adjustable Range with external resistor		7.25	8.35	8.55	V
	Hysteresis		50	100	150	mV
$V_{OL}$	L Output Voltage	$I_{out} = 2mA$		0.5	0.8	V

**Battery Detection17 (Det17)**

	Vthreshold	ST-CAP	16.5	17	18	V
$V_{OL}$	L Output Voltage	$I_{out} = 2mA$		0.5	0.8	V

**I<sup>2</sup>C bus**

$F_{ck}$	Clock Frequency				400	kHz
$t_R$	Rising Time				300	ns
$t_F$	Falling Time				300	ns
$V_{IL}$	Low Input Voltage				1	V
$V_{IH}$	High Input Voltage		3			V

**Hard Reset**

$V_{IL}$	Low Input Voltage				2	V
$V_{IH}$	High Input Voltage		3			V

Figure 1. Comparator Part

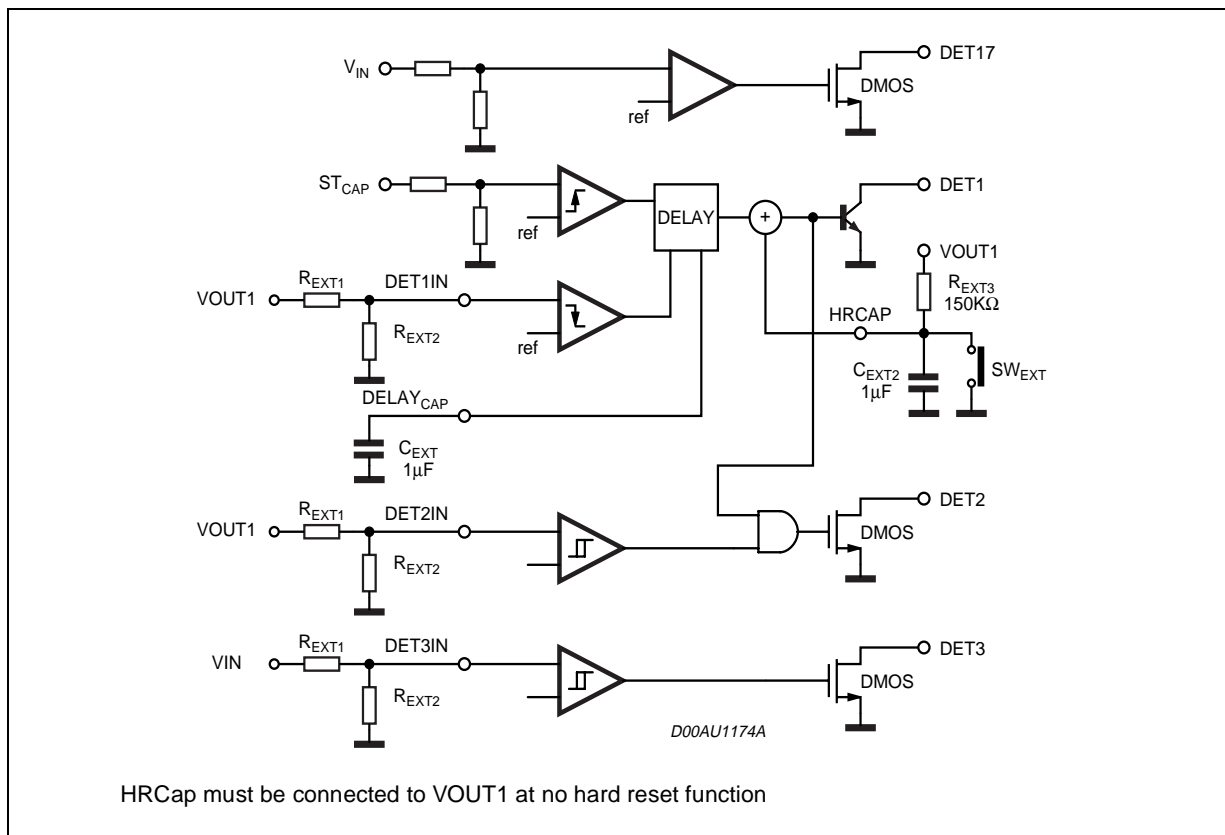
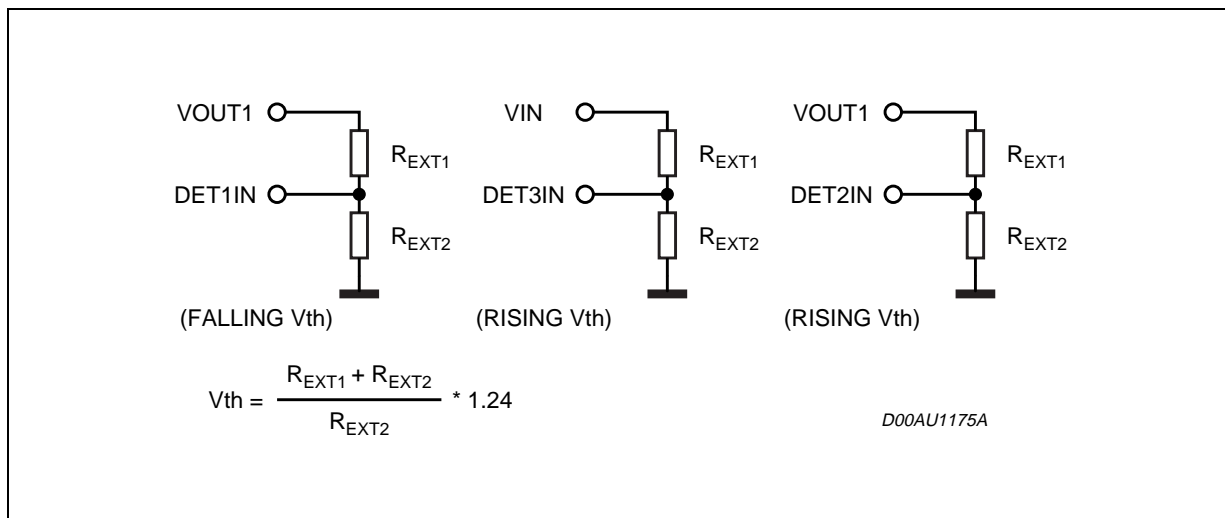


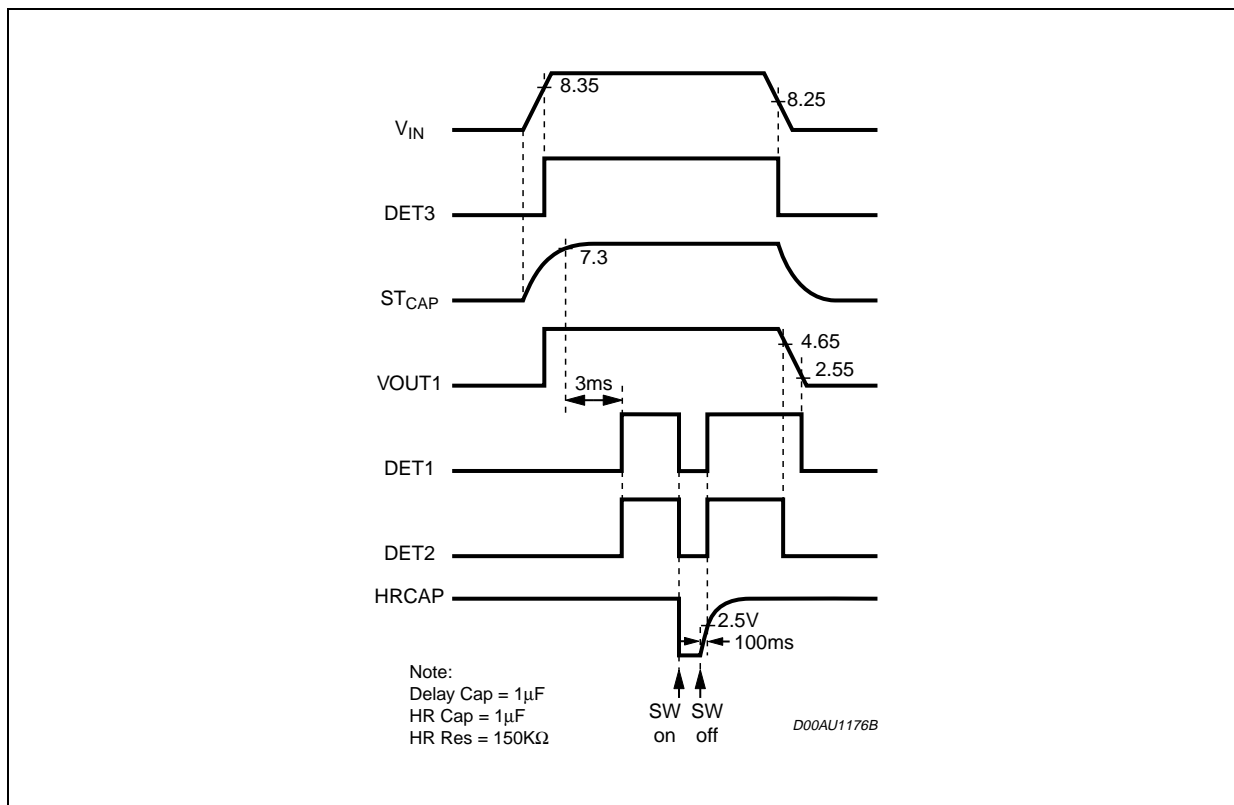
Figure 2. Reset Function



DET1,2 Delay Time:  $T = 3000 \times C <sec>$

Hard Reset Time:  $T = -CR \ln 0.7 <sec>$

Figure 3. Timing Chart (typical values)



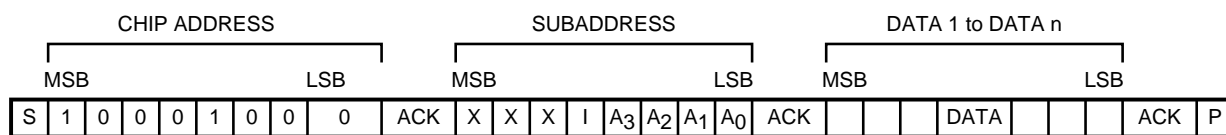
**SOFTWARE SPECIFICATION**

**Interface Protocol**

The interface protocol comprises:

- A start condition (S)
- A chip address byte, (LSB bit = 0 for write mode)
- A subaddress byte.
- A sequence of data (N-bytes + acknowledge)

A stop condition (P)



ACK = Acknowledge

S = Start

P = Stop

I = Auto Increment

X = Not used

MAX CLOCK SPEED 500kb/s

CHIP ADDRESS = 10001000 (88 Hex)



**AUTO INCREMENT**

If bit I in the subaddress byte is set to "1", the autoincrement of the subaddress is enabled, if bit I = 0 no auto-increment.

**SUBADDRESS**

MSB				LSB				FUNCTION
0	0	0	I	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	
				0	0	0	0	OUT 2
				0	0	0	1	OUT 3
				0	0	1	0	OUT 4
				0	0	1	1	OUT 5
				0	1	0	0	OUT 6

**DATA BYTE SPECIFICATION****OUT 2**

MSB							LSB	FUNCTION
D <sub>7</sub>	D <sub>6</sub>	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>	
							0	OFF
							1	ON

**OUT 3**

MSB							LSB	FUNCTION
D <sub>7</sub>	D <sub>6</sub>	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>	
							0	OFF
							1	ON
				0	0	0		OUT VOLTAGE 8.5V
				0	0	1		OUT VOLTAGE 8.3V
				0	1	0		OUT VOLTAGE 8.1V
				0	1	1		OUT VOLTAGE 7.9V
				1	X	X		OUT VOLTAGE 7.7V

X = don't care

## OUT 4

MSB							LSB	FUNCTION
D <sub>7</sub>	D <sub>6</sub>	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>	
							0	<u>OFF</u>
							1	ON
				0	0	0		OUT VOLTAGE 7.3V
				0	0	1		OUT VOLTAGE 7.0V
				0	1	0		OUT VOLTAGE 6.6V
				0	1	1		OUT VOLTAGE 6.3V
				1	0	0		OUT VOLTAGE 6.0V
				1	0	1		OUT VOLTAGE 5.5V
				1	1	X		OUT VOLTAGE 5.0V

## OUT 5

MSB							LSB	FUNCTION
D <sub>7</sub>	D <sub>6</sub>	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>	
							0	<u>OFF</u>
							1	ON
						0		OUT VOLTAGE 3.3V
						1		OUT VOLTAGE 5.0V

## OUT 6

MSB							LSB	FUNCTION
D <sub>7</sub>	D <sub>6</sub>	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>	
					0	0	0	<u>OFF</u>
					0	0	1	ON

Note: Default setting indicated with underline.

**EXAMPLES**

< Example 1 - no autoincrement mode - >  
 power on  $V_{in}$  = ON All output OFF (at RESET = "L")  
 release reset RESET = "H". Send sequence:

**Initial Set**

```

start I2C
    1000 1000 Chip address
    0000 0001 OUT3 subaddress
    0000 0010 OUT3 data (8.3V, OFF)

stop I2C
start I2C
    1000 1000 Chip address
    0000 0010 OUT4 subaddress
    0000 0010 OUT4 data (7.0V, OFF)

stop I2C
start I2C
    1000 1000 Chip address
    0000 0011 OUT5 subaddress
    0000 0000 OUT5 data (3.3V, OFF)

stop I2C

```

**Set Turn-On**

```

start I2C
    1000 1000 Chip address
    0000 0000 OUT2 subaddress
    0000 0001 OUT2 data (ON)

stop I2C
start I2C
    1000 1000 Chip address
    0000 0001 OUT3 subaddress
    0000 0011 OUT3 data (8.3V, ON)

stop I2C
start I2C
    1000 1000 Chip address
    0000 0010 OUT4 subaddress
    0000 0011 OUT4 data (7.0V, ON)

stop I2C
start I2C
    1000 1000 Chip address
    0000 0011 OUT5 subaddress
    0000 0001 OUT5 data (3.3V, ON)

stop I2C
start I2C
    1000 1000 Chip address
    0000 0100 OUT6 subaddress
    0000 0001 OUT6 data (ON)

stop I2C

```

**EXAMPLES**

< Example 1 - no autoincrement mode - >

power on  $V_{in}$  = ON All output OFF (at RESET = "L")

release reset RESET = "H". Send sequence:

**Initial Set**

start I<sup>2</sup>C

```

1000 1000 Chip address
0000 0001 OUT3 subaddress
0000 0010 OUT3 data (8.3V, OFF)
0000 0010 OUT4 subaddress
0000 0010 OUT4 data (7.0V, OFF)
0000 0011 OUT5 subaddress
0000 0000 OUT5 data (3.3V, OFF)

```

stop I<sup>2</sup>C

**Set Turn-On**

start I<sup>2</sup>C

```

1000 1000 Chip address
0000 0000 OUT2 subaddress
0000 0001 OUT2 data (ON)
0000 0001 OUT3 subaddress
0000 0011 OUT3 data (8.3V, ON)
0000 0010 OUT4 subaddress
0000 0011 OUT4 data (7.0V, ON)
0000 0011 OUT5 subaddress
0000 0001 OUT5 data (3.3V, ON)
0000 0100 OUT6 subaddress
0000 0001 OUT6 data (ON)

```

stop I<sup>2</sup>C

< Example 2A - autoincrement mode - >

power on  $V_{in}$  = ON All output OFF (at RESET = "L")

release reset RESET = "H"

start I<sup>2</sup>C

```

initial set 1000 1000 Chip address
            0001 0001 OUT3 subaddress, autoincrement ON
            0000 0010 OUT3 data (8.3V, OFF)
            0000 0010 OUT4 data (7.0V, OFF)
            0000 0000 OUT5 data (3.3V, OFF)

```

stop I<sup>2</sup>C

start I<sup>2</sup>C

```

set turn-on 1000 1000 Chip address
            0001 0000 OUT2 subaddress, autoincrement ON
            0000 0001 OUT2 data (ON)
            0000 0011 OUT3 data (8.3V, ON)
            0000 0011 OUT4 data (7.0V, ON)
            0000 0001 OUT5 data (3.3V, ON)
            0000 0001 OUT6 data (ON)

```

stop I<sup>2</sup>C

Before turning on (set turn on procedure), the output voltage should be fixed, as it is done in the initial set procedure. Do not change the bits of "turn on" and "output voltage" at the same time, otherwise the correct output

voltage may not be present.

Note - example 1 & 2 don't use the OUT2 and OUT6 bytes in the initial set procedure, since these two bytes are not related to the setting of output voltages

< Example 2B - autoincrement mode - >

power on  $V_{in}$  = ON All output OFF (at RESET = "L")

release reset RESET = "H"

start I<sup>2</sup>C

```
initial set    1000 1000  Chip address
              0001 0001  OUT3 subaddress, autoincrement ON
              0000 0010  OUT3 data (8.3V, OFF)
              0000 0010  OUT4 data (7.0V, OFF)
              0000 0000  OUT5 data (3.3V, OFF)
```

stop I<sup>2</sup>C

start I<sup>2</sup>C

```
set turn-on  1000 1000  Chip address
              0001 0010  OUT4 subaddress, autoincrement ON
              0000 0011  OUT4 data (7.0V, ON)
              0000 0001  OUT5 data (3.3V, ON)
              0000 0001  OUT6 data (ON)
              0000 0001  OUT2 data (ON)
              0000 0011  OUT3 data (8.3V, ON)
```

stop I<sup>2</sup>C

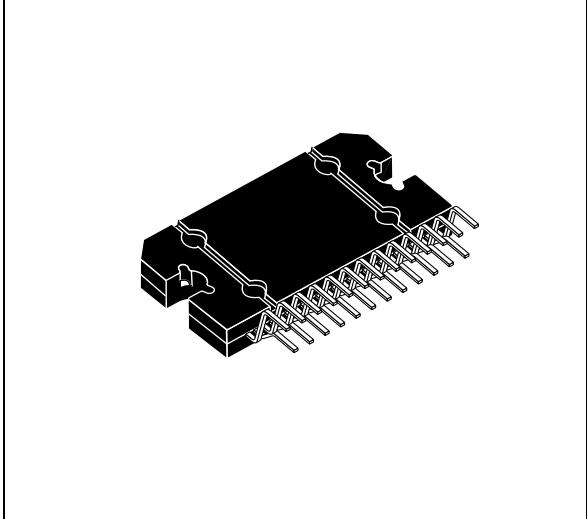
The autoincrement implements a counter by 5, this means that during autoincrement the next date after out 6 byte will be OUT2 date byte.

In the example are refreshed in sequence the bytes: OUT4 - OUT5 - OUT6 - OUT2 - OUT3

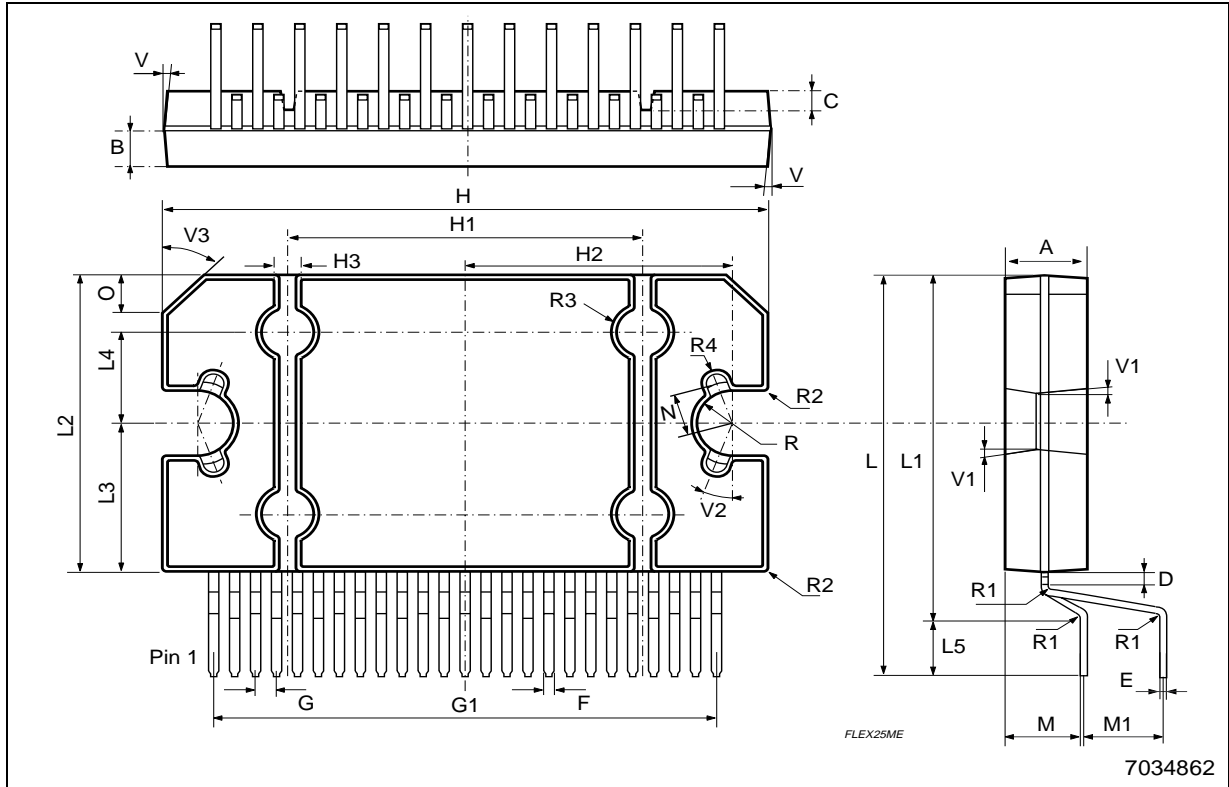
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.45	4.50	4.65	0.175	0.177	0.183
B	1.80	1.90	2.00	0.070	0.074	0.079
C		1.40			0.055	
D	0.75	0.90	1.05	0.029	0.035	0.041
E	0.37	0.39	0.42	0.014	0.015	0.016
F (1)			0.57			0.022
G	0.80	1.00	1.20	0.031	0.040	0.047
G1	23.75	24.00	24.25	0.935	0.945	0.955
H (2)	28.90	29.23	29.30	1.139	1.150	1.153
H1		17.00			0.669	
H2		12.80			0.503	
H3		0.80			0.031	
L (2)	22.07	22.47	22.87	0.869	0.884	0.904
L1	18.57	18.97	19.37	0.731	0.747	0.762
L2 (2)	15.50	15.70	15.90	0.610	0.618	0.626
L3	7.70	7.85	7.95	0.303	0.309	0.313
L4		5			0.197	
L5		3.5			0.138	
M	3.70	4.00	4.30	0.145	0.157	0.169
M1	3.60	4.00	4.40	0.142	0.157	0.173
N		2.20			0.086	
O		2			0.079	
R		1.70			0.067	
R1		0.5			0.02	
R2		0.3			0.12	
R3		1.25			0.049	
R4		0.50			0.019	
V			5° (T p.)			
V1			3° (Typ.)			
V2			20° (Typ.)			
V3			45° (Typ.)			

(1): dam-bar protusion not included  
 (2): molding protusion included

## OUTLINE AND MECHANICAL DATA



### Flexiwatt25 (vertical)



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