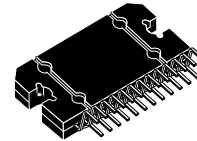


MULTIPLE MULTIFUNCTION VOLTAGE REGULATOR

- FIVE REGULATED OUTPUTS
 - Vo1 5V @500mA
 - Vo2 8.3V @ 250mA
 - Vo3 7.7V to 8.5V @250mA (I²C presettable)
 - Vo4 5V to 7.3V @0.4A (I²C presettable)
 - Vo5 3.3V to 5V @500mA (I²C presettable)
 - HSDout R_{ON} = 0.6Ω
- I²C 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



Flexiwatt 25
ORDERING NUMBER: L5952

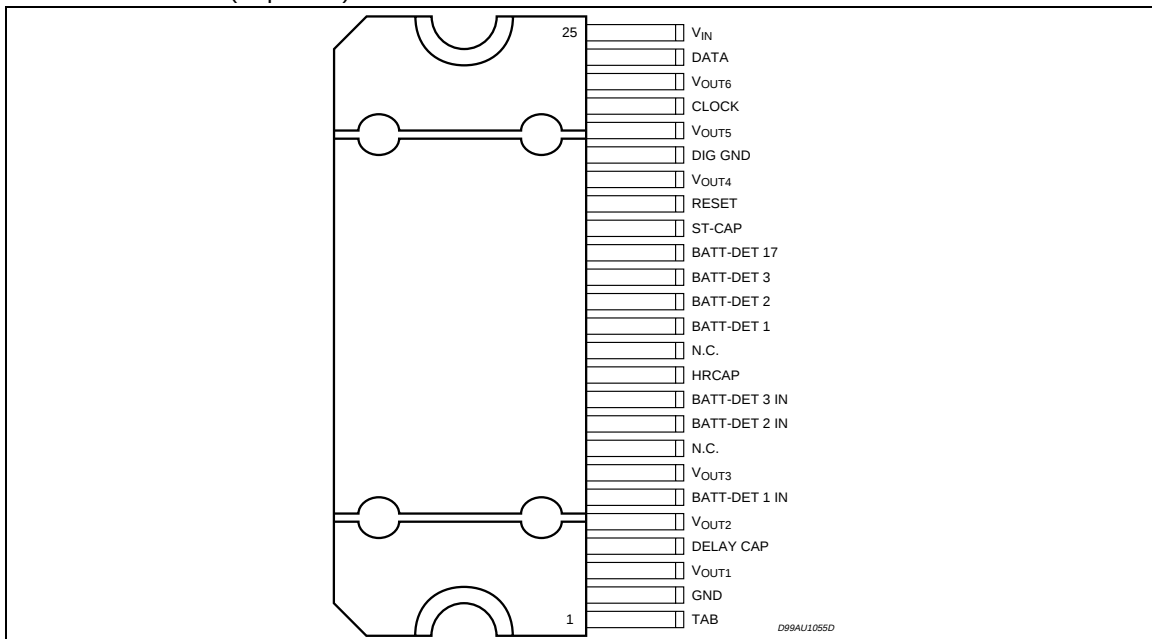
DESCRIPTION

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

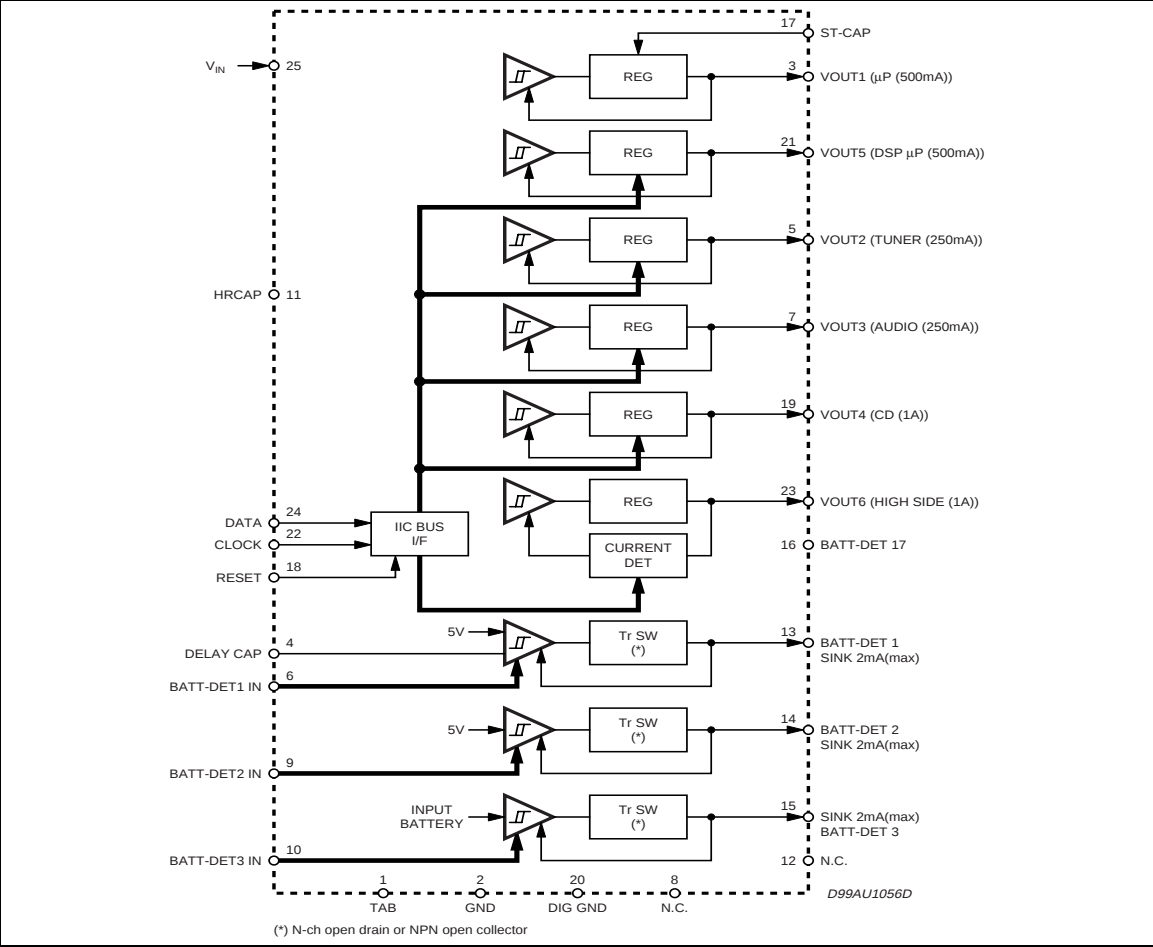
Three outputs are enabled and set via I²C bus.

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

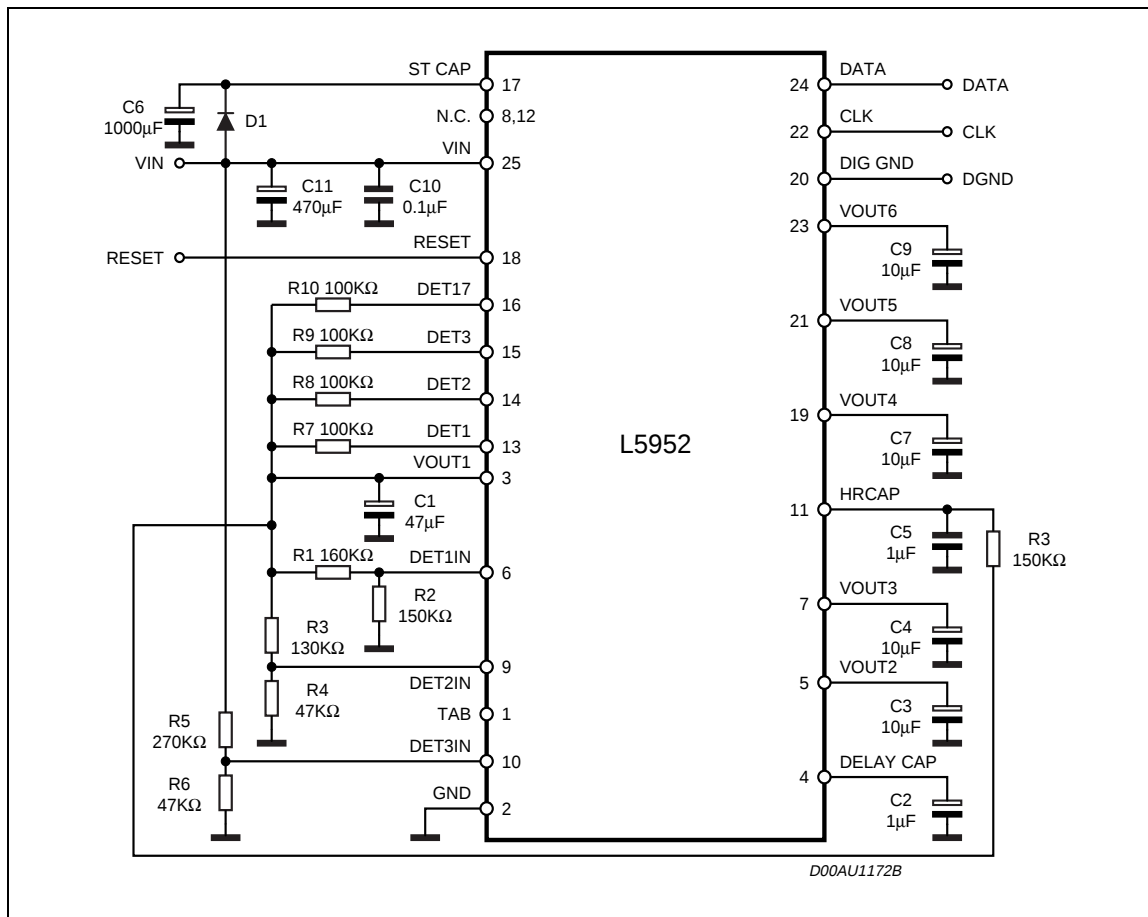
Symbol	Parameter	Value	Unit
V_{IN}	DC Supply Voltage	-0.6 to 26	V
V_{IN}	Transient Supply Overvoltage (50ms)	50	V
R_{ESR}	Output Capacitor Series Eq. Series Resistors Allowed Range	0.2 to 10	Ω
T_{op}	Operating Temperature Range	-40 to 85	$^{\circ}\text{C}$
T_{stg}	Storage Temperature Range	-40 to 150	$^{\circ}\text{C}$

THERMAL DATA

Symbol	Parameter	Value	Unit
$R_{th\ j-case}$	Thermal resistance junction-case	1.3	$^{\circ}\text{C/W}$



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
INPUT						
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 Vout1, 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	μA
	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	$I_{out} < 500mA$; $V_{batt-up\ cap} = 9\ to\ 16V$ $I_{out} < 250mA$; $V_{batt-up\ cap} = 7\ to\ 9V$	4.75	5	5.25	V
$I_{max.}$	Maximum Current	current limiter	600	1200		mA
ΔV_{load}	Load Regulation	$I_{out} = 0\ to\ 500mA$		30	50	mV
SVRR	Ripple Rejection	1kHz, $V_{ripple} = 2V_{pp}$	50	60		dB
V_{drop1}	Voltage Drop	$I_{out} = 500mA$		1.5	2.5	V
V_{drop2}	Voltage Drop	$I_{out} = 250mA$		0.75	1.25	V
ΔV_{lin}	Line Regulation	$I_{OUT} = 0$		0	50	mV

 V_{out1} is 5V regulatorOutput voltage 2 (V_{out2})

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

 V_{out2} has On/OFF function by I^2C . Default is OFFOutput voltage 3 (V_{out3})

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

 V_{out3} Voltage configuration

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

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

ELECTRICAL CHARACTERISTICS (Continued)

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

Output 4: (V_{out4})

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

V_{out4} Voltage configuration

	Setting 1	I _{out} < 400mA; V _{in} = 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 I²C. Default is OFF

Output 5 (V_{out5})

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

V_{out5} Voltage configuration

	Setting 1	I _{out} < 500mA; V _{in} = 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 I²C. Default is OFF

Output 6 (V_{out6})

V _{out}	Output Voltage	I _{out} < 800mA; V _{in} = 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	$I_{\text{out}} < 800\text{mA}$		0.45	0.6	V

V_{out6} has On/OFF function by $I^2\text{C}$. Default is OFF

Battery Detection1 (Det1)

	$V_{\text{threshold}}$	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	$I_{\text{out}} = 2\text{mA}$		0.5	0.8	V

Note: $1\mu\text{F}$ 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	$I_{\text{out}} = 2\text{mA}$		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	$I_{\text{out}} = 2\text{mA}$		0.5	0.8	V

Battery Detection17 (Det17)

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

 $I^2\text{C}$ 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

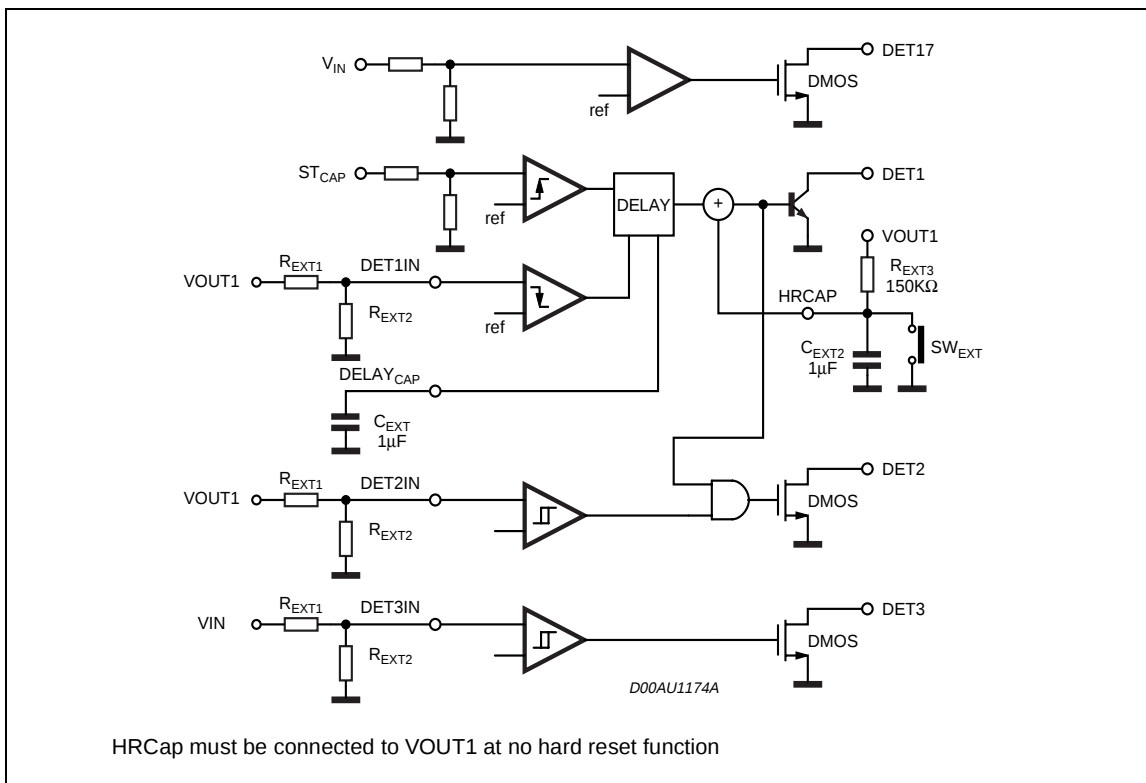
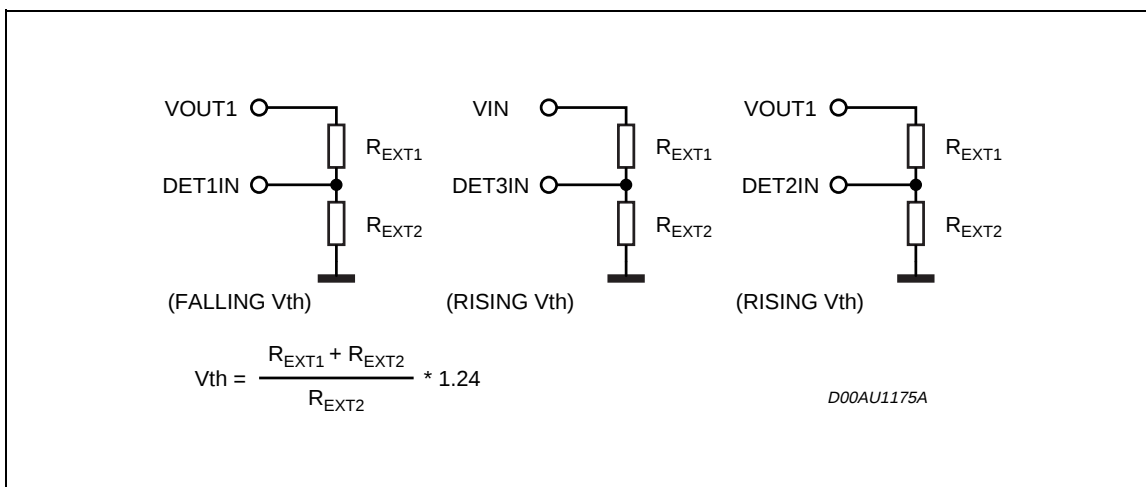


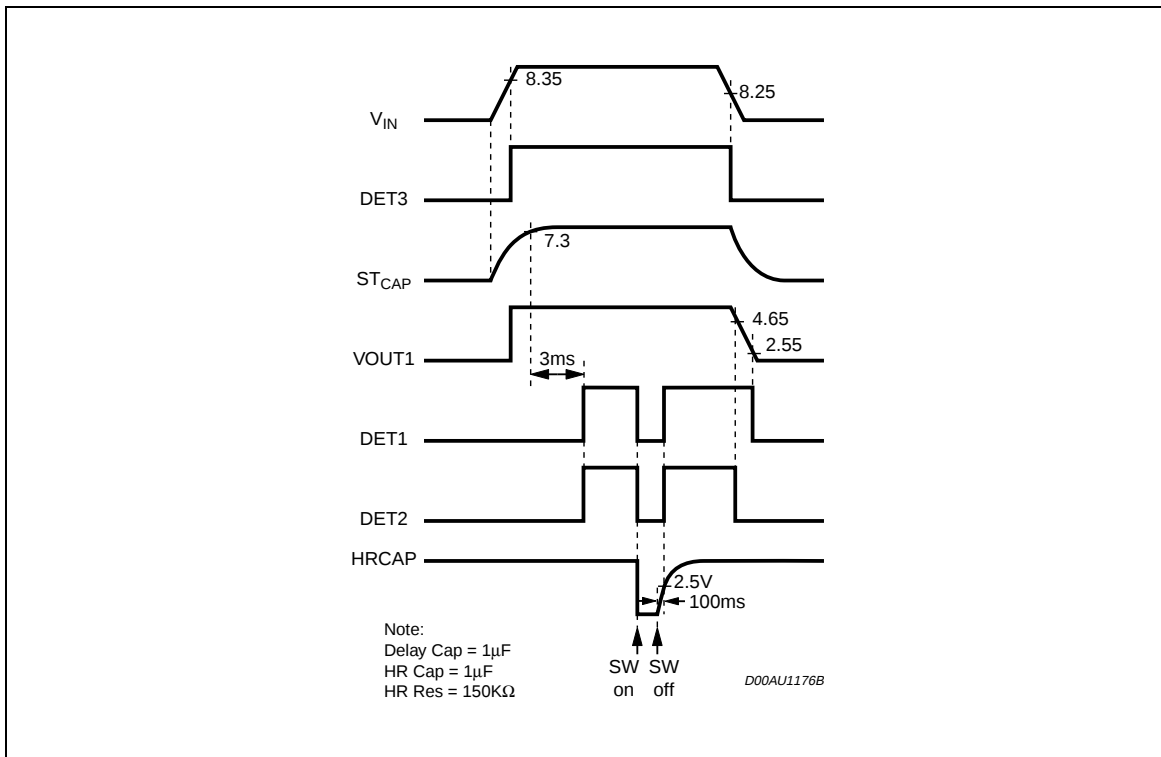
Figure 2. Reset Function



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

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

Figure 3. Timing Chart (typical values)



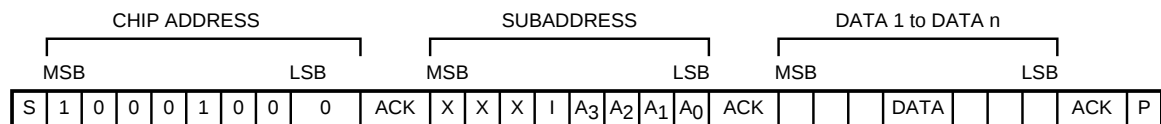
SOFTWARE SPECIFICATION

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 500kbits/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 ₃	A ₂	A ₁	A ₀	
				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 ₇	D ₆	D ₅	D ₄	D ₃	D ₂	D ₁	D ₀	
							0	OFF
							1	ON

OUT 3

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

OUT 6

MSB							LSB	FUNCTION
D ₇	D ₆	D ₅	D ₄	D ₃	D ₂	D ₁	D ₀	
					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 I²C

```
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 I²C

Set Turn-On

start I²C

```
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 I²C

< Example 2A - autoincrement mode - >

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

release reset RESET = "H"

start I²C

```
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 I²C

start I²C

```
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 I²C

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 I²C

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 I²C

start I²C

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 I²C

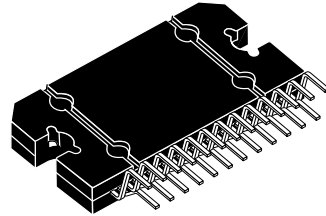
The autoincrement implements a counter by 5, this means that during autoincrement the next data after out 6 byte will be OUT2 data byte.

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

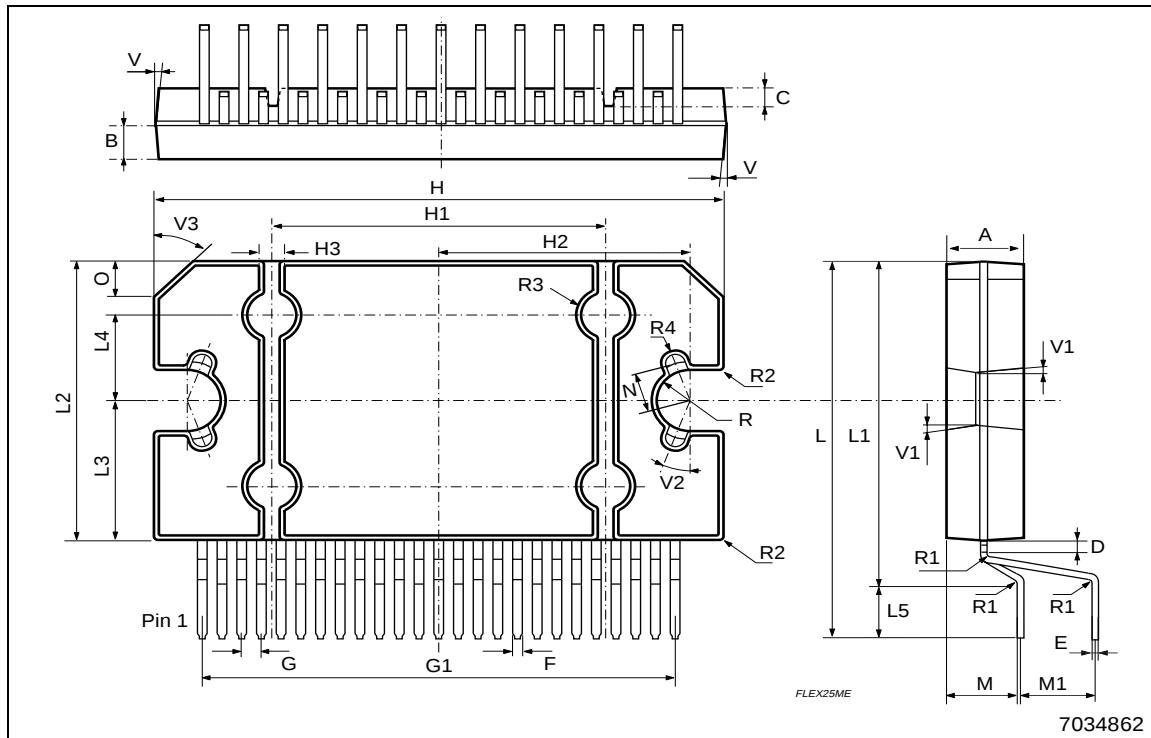
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.45	4.50	4.65	0.175	0.177	0.183
B	1.80	1.90	2.00	0.070	0.074	0.079
C		1.40			0.055	
D	0.75	0.90	1.05	0.029	0.035	0.041
E	0.37	0.39	0.42	0.014	0.015	0.016
F (1)			0.57			0.022
G	0.80	1.00	1.20	0.031	0.040	0.047
G1	23.75	24.00	24.25	0.935	0.945	0.955
H (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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