MUETA B.V.

MU201: class-D controller / modulator for high-power audio amplifiers with ultra-low distortion

Features

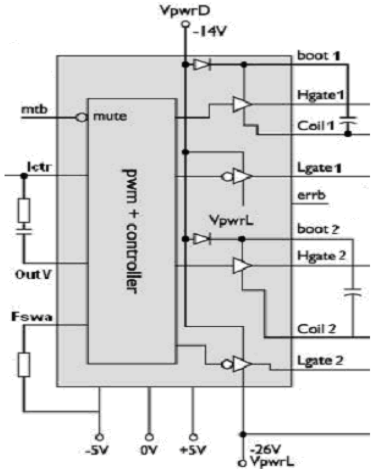
- Superior audio quality:
  < 0.001% THD+noise at 25Wrms
  < 0.01% THD+noise at 200Wrms
- High efficiency (93% typical)
- Up to 1000Wrms output power
- Excellent power-supply rejection
- Low output ripple
- Adjustable gain
- Self-oscillating operation principle, no fixed clock
- Load independent (output filtering/frequency transfer)
- Mute function
- Error (distortion) detector output
- Short-circuit proof
- Driver under-voltage protection
- 20-pin SSOP package

Applications

- High-end power amplifiers
- Home theatre systems
- Audio sets
- Television sets
- Automotive
- Active loudspeakers

Description

The MU201 is the world's first class-D audio amplifier modulator, which makes use of direct feedback of loudspeaker voltage ***and*** current. The result is a unique audio performance, which has never been achieved by any other class-D, class AB, or even class-A, amplifier.



The MU201 is self-oscillating with feedback from behind the output filter. This eliminates the common output-filter problems of other class-D amplifiers. An amplifier with a MU201 modulator is highly insensitive for the type of load: highly inductive, capacitive, or both. Result is a guaranteed flat frequency response over the whole audio band combined with ultra-low distortion and extremely high signal-to-noise ratio. High power-supply rejection is another strong plus of this class-D controller/modulator.

The MU201 has a mute function and a build-in error (distortion) detector, which flags output overloads.

This complex modulator has been integrated in an ultra-modern BCDMOS-process with Silicon-On-Insulator (SOI) technology. Due to the high level of integration the superior quality of the Mueta Class-D amplifier is now within the cost targets of the consumer market.

Electrical Characteristics (f=1kHz, G_v=18.3dB, R_{load} 4Ω, unless otherwise specified)

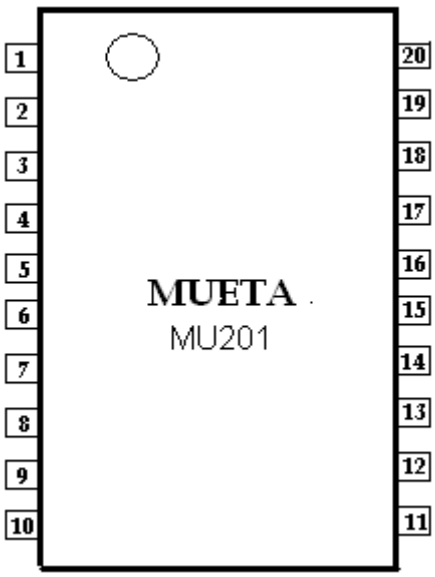
SYMBOL	PARAMETER	TEST CONDITION	Min.	Typ.	Max.	Unit
AVD	Positive analog supply		4.5	5	5.5	V
AVS	Negative analog supply		-4.5	-5	-5.5	V
V_{pwrD}	Driver supply voltage	Relative to V_{pwrL}	10	12	15	V
V_{pwrL}	Negative supply		-30	-26	0	V
Coil1 Coil2	Bridge output 1 Bridge output 2		-30		+30	V
P_{out}	Output power over audio bandwidth	0.004% THD+N 0.5% THD+N		100 300		W_{rms} W_{rms}
η	Efficiency	P_{out} > 25W		93		%
I_{idle}	Power rails quiescent current	Mute active		3.2		mA
THD+N	Distortion + noise	Power<200W, audio frequencies		0.01		%
f_{sw}	Switching frequency		100	350		kHz
V_{offset}	Output offset voltage			4		mV
G_v	Voltage gain	Defined by feedback		18.3		dB
$\hat{U}_{out}$	Output amplitude				50	V
Z_{load}	Load impedance	Power 100W	>1			Ω
t_{dead}	Dead-time			80		nsec
Z_{out}	Output impedance	1kHz 20kHz		0.5	 10	mΩ mΩ
ω_{LC}	LC output filter cutoff frequency			20		kHz
Errb	Error Output sink current				40	mA
Igso	Gate Driver source current	Capacitive load 2nF		0.4		A
Igsi	Gate Driver sink current	Capacitive load 2nF		2		A

Absolute Maximum Ratings

SYMBOL	PARAMETER		Value	Unit
AVD	Positive analog supply		6	V
AVS	Negative analog supply		-6	V
V_{pwrD}	Driver supply voltage; Relative to V_{pwrL}		17	V
V_{pwrL}	Negative supply		-40	V
Coil1 Coil2	Bridge outputs	Max Min	+40 -40	V V
Errb	Error Output sink current		50	mA
T_{stg}	Storage Temperature	-50 to 150		°C
T_{amb}	Operating Free-air Temperature Range	-25 to 85		°C
T_j	Junction Temperature	125		°C

Pin Description

PIN	SYMBOL	DESCRIPTION
1	V_{pwrD}	Driver positive power supply
2	Muteb	Active low to V_{pwrL}
3	Errb	Error output (open drain, active low to V_{pwrL})
4	AVS	Analog negative supply voltage -5V
5	F_{swa}	Switching Frequency adjustment
6	CP-in	Comparator in
7	OutV	Current controller output
8	Ictr	Current controller input
9	Gnd	Analog ground
10	AVD	Analog positive supply voltage +5V
11	Boot2	Bootstrap capacitor for 2
12	Hgate2	High gate output 2
13	Coil2	Coil output 2
14	Lgate2	Low gate output 2
15	V_{pwrL}	Negative powersupply
16	V_{pwrL}	Negative powersupply
17	Lgate1	Low gate output 1
18	Coil1	Coil output 1
19	Hgate1	High gate output 1
20	Boot1	Bootstrap capacitor for 1



ESD CAUTION

ESD (electrostatic discharge) sensitive device. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

Functional Description

The Mueta MU201 is a single channel modulator for class-D audio amplifiers, see block diagram in *Figure 1*. The modulator is based on a current-feedback hysteresis controller.
The current through the filter capacitor is measured through a small parallel capacitor. The measured current is compared with a reference current: the mathematical derivative of the input voltage. If the error exceeds a predefined value (the hysteresis window) the output state is changed, which results in reduction of the error.
The current feedback is supplemented with an output voltage feedback, which runs through a PI controller.

Block Diagram

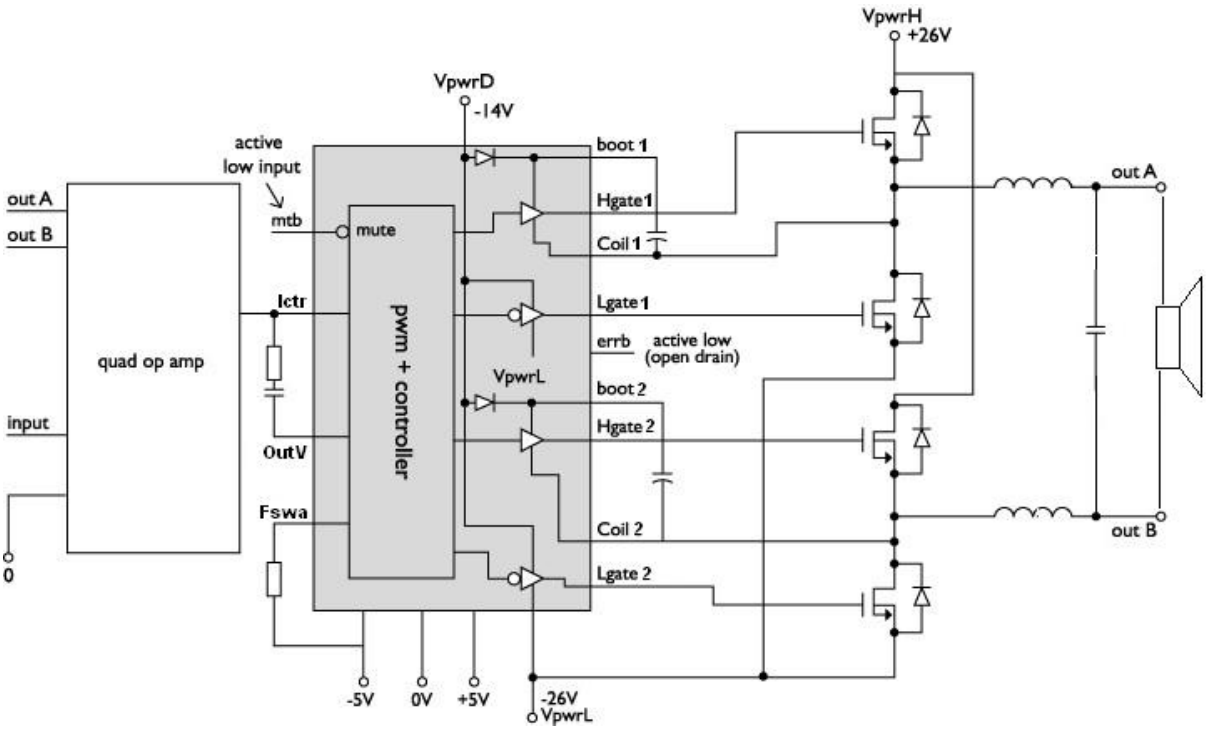
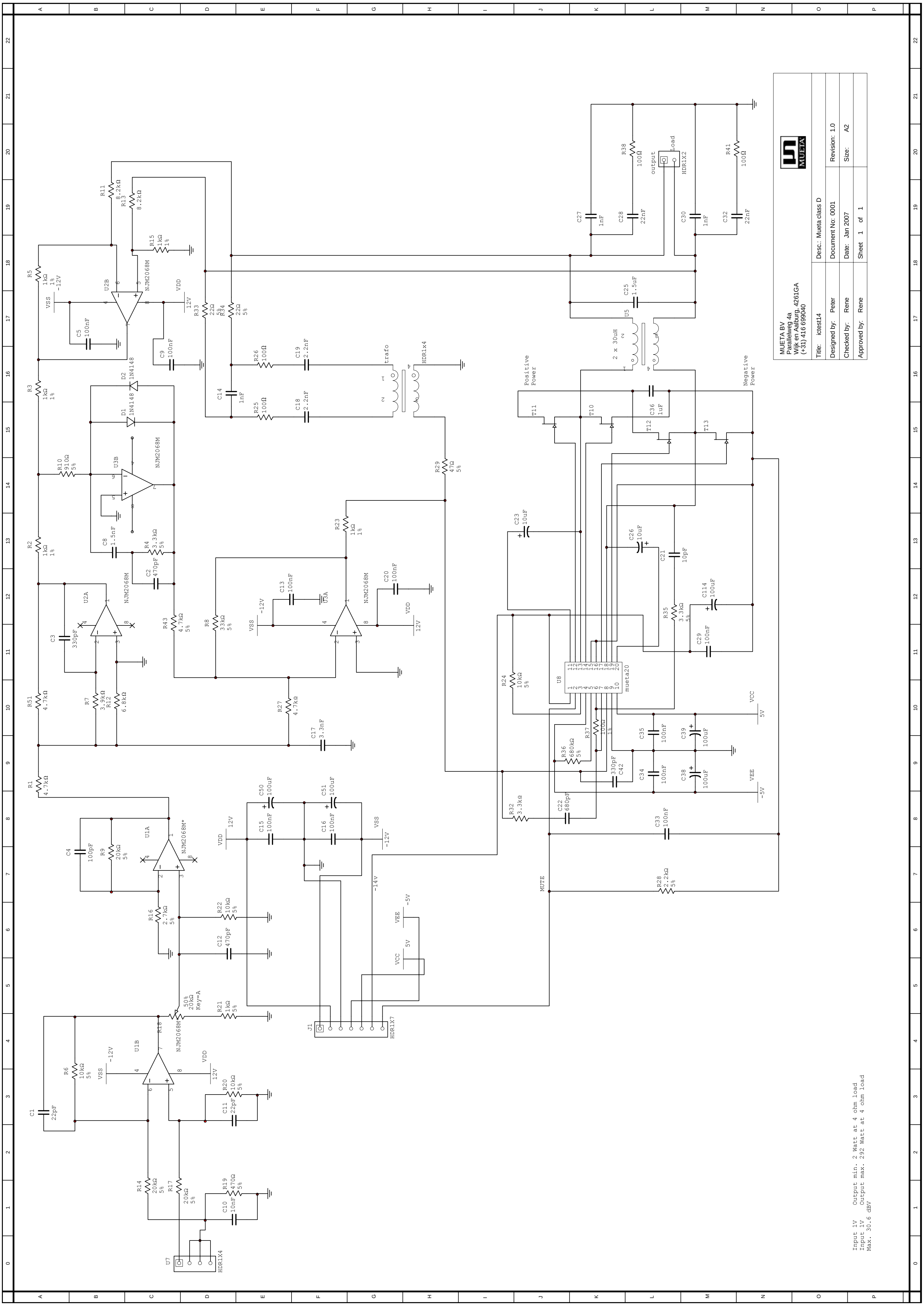


Figure 1.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Desc.: Mueta class D
Designed by: Peter
Document No: 0001
Revision: 1.0
Checked by: Rene
Date: Jan 2007
Size: A2
Approved by: Rene
Sheet 1 of 1
MUETA
Input 1V Output min. 2 Watt at 4 ohm load
Input 1V Output max. 292 Watt at 4 ohm load
Max. 30.6 dBV
Positive Power
Negative Power
trafo
output
Load
MUTE

Figure 2.

Schematic in *Figure 2*. shows the application as used to test MU201 parameters and how to set an amplifying factor. In *Table 1*. an overview what values determine the amplifying factor.

Amplifier Gain

Two formulas are given.
Equation 1. for calculating the amplification and *equation 2*. for calculating the correct values in the feedback path.

$$A = \frac{R_{11}}{R_5}$$

Equation 1.

$$C_{18} = 2 \cdot \frac{R_7 \cdot C_3 \cdot R_8}{R_{27} \cdot R_{23} \cdot A}$$

Equation 2.

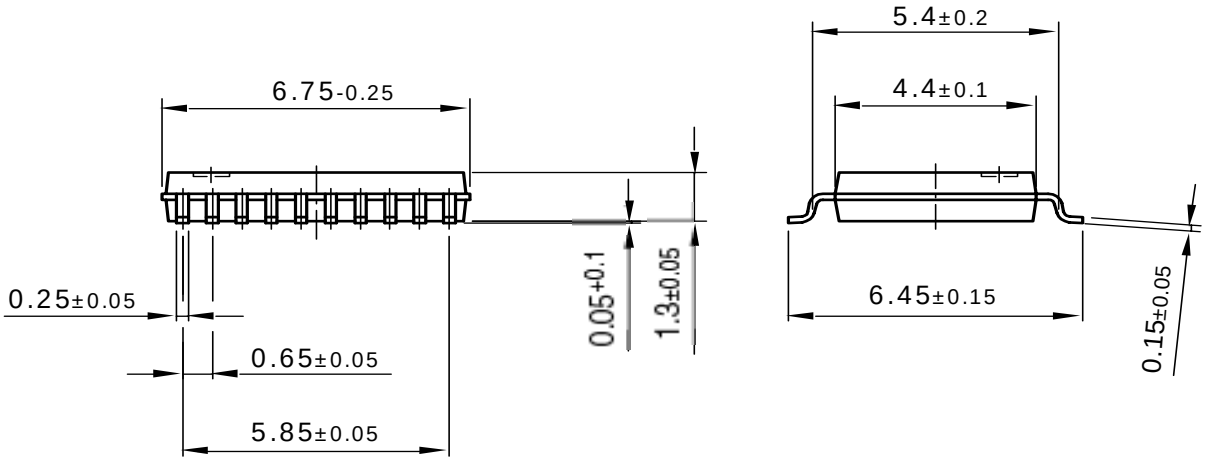
A=R11/R5									
	Amplification	C18 C19 [nF]	R11 R13 [kΩ]	R15 R5 [kΩ]	R7 [kΩ]	C3 [pF]	R23 [kΩ]	R27 [kΩ]	R8 [kΩ]
A=	6,80	2,66	6.8	1	3.9	330	1	4.7	33
A=	7,47	2,42	6.8	910	3.9	330	1	4.7	33
A=	8,29	2,18	6.8	820	3.9	330	1	4.7	33
A=	9,07	1,99	6.8	750	3.9	330	1	4.7	33
A=	10,00	1,81	6.8	680	3.9	330	1	4.7	33
A=	10,97	1,65	6.8	620	3.9	330	1	4.7	33
A=	12,14	1,49	6.8	560	3.9	330	1	4.7	33
A=	13,33	1,36	6.8	510	3.9	330	1	4.7	33
A=	14,47	1,25	6.8	470	3.9	330	1	4.7	33
A=	15,81	1,14	6.8	430	3.9	330	1	4.7	33
A=	17,44	1,04	6.8	390	3.9	330	1	4.7	33
A=	18,89	0.957	6.8	360	3.9	330	1	4.7	33
A=	20,61	0.877	6.8	330	3.9	330	1	4.7	33
A=	22,67	0.797	6.8	300	3.9	330	1	4.7	33
A=	25,19	0.718	6.8	270	3.9	330	1	4.7	33
A=	28,33	0.638	6.8	240	3.9	330	1	4.7	33
A=	30,91	0.585	6.8	220	3.9	330	1	4.7	33
A=	8,20	2.20	8.2	1	3.9	330	1	4.7	33
A=	9,01	2,01	8.2	910	3.9	330	1	4.7	33
A=	10,00	1,81	8.2	820	3.9	330	1	4.7	33
A=	10,93	1,65	8.2	750	3.9	330	1	4.7	33
A=	12,06	1,50	8.2	680	3.9	330	1	4.7	33
A=	13,23	1,37	8.2	620	3.9	330	1	4.7	33
A=	14,64	1,23	8.2	560	3.9	330	1	4.7	33
A=	16,08	1,12	8.2	510	3.9	330	1	4.7	33
A=	17,45	1,04	8.2	470	3.9	330	1	4.7	33

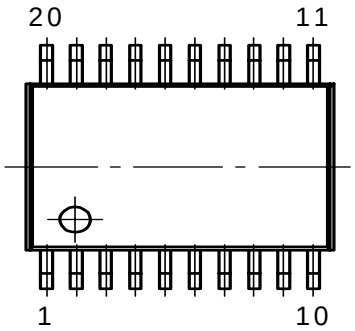
A=	19,07	0.948	8.2	430	3.9	330	1	4.7	33
A=	21,03	0.860	8.2	390	3.9	330	1	4.7	33
A=	22,78	0.793	8.2	360	3.9	330	1	4.7	33
A=	24,85	0.727	8.2	330	3.9	330	1	4.7	33
A=	27,33	0.661	8.2	300	3.9	330	1	4.7	33
A=	30,37	0.595	8.2	270	3.9	330	1	4.7	33
A=	34,17	0.529	8.2	240	3.9	330	1	4.7	33
A=	37,27	0.485	8.2	220	3.9	330	1	4.7	33
A=	10,00	1,81	10	1	3.9	330	1	4.7	33
A=	10,99	1,64	10	910	3.9	330	1	4.7	33
A=	12,20	1,48	10	820	3.9	330	1	4.7	33
A=	13,33	1,36	10	750	3.9	330	1	4.7	33
A=	14,71	1,23	10	680	3.9	330	1	4.7	33
A=	16,13	1,12	10	620	3.9	330	1	4.7	33
A=	17,86	1,01	10	560	3.9	330	1	4.7	33
A=	19,61	0.922	10	510	3.9	330	1	4.7	33
A=	21,28	0.849	10	470	3.9	330	1	4.7	33
A=	23,26	0.777	10	430	3.9	330	1	4.7	33
A=	25,64	0.705	10	390	3.9	330	1	4.7	33
A=	27,78	0.651	10	360	3.9	330	1	4.7	33
A=	30,30	0.596	10	330	3.9	330	1	4.7	33
A=	33,33	0.542	10	300	3.9	330	1	4.7	33
A=	37,04	0.488	10	270	3.9	330	1	4.7	33
A=	41,67	0.434	10	240	3.9	330	1	4.7	33
A=	45,45	0.398	10	220	3.9	330	1	4.7	33
A=	8,20	2,20	8.2	1	3.9	330	1	4.7	33

Table 1.

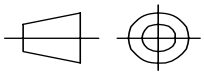
Note: In last row the resistor values and capacitor values used to measure data sheet parameters.

Package Outlines





Package: SSO20
Dimensions in mm



technical drawings
according to DIN
specifications

Drawing-No.: 6.543-5056.01-4
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