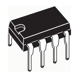
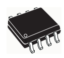
Low Noise Dual Operational Amplifier

- Low voltage noise: **4.5nV/√Hz**
- High gain bandwidth product: **15MHz**
- High slew rate: **7V/μs**
- Low distortion: 0.002%
- Large output voltage swing: +14.3V / -14.6V
- Low input offset voltage
- Excellent frequency stability
- ESD protection 2kV
- Macromodel included in this specification

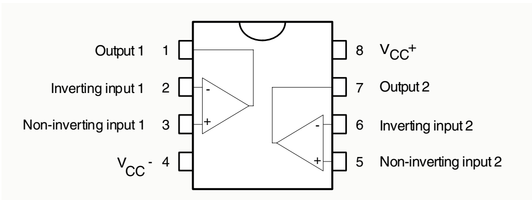


N
DIP8
(Plastic Package)



D
SO-8
(Plastic Micropackage)

Pin connections (top view)



Description

The MC33078 is a monolithic dual operational amplifier particularly well suited for audio applications.

It offers low voltage noise (4.5nV/√Hz) and high frequency performances (15MHz gain bandwidth product, 7V/μs slew rate).

In addition, the MC33078 has a very low distortion (0.002%) and excellent phase/gain margins.

The output stage allows a large output voltage swing and symmetrical source and sink currents.

Order Codes

Part Number	Temperature Range	Package	Packing	Marking
MC33078N		DIP8	Tube	MC33078N
MC33078D/DT	-40, +105°C	SO-8	Tube or Tape & Reel	33078
MC33078YD/YDT		SO-8 (automotive grade level)		33078Y

1 Absolute Maximum Ratings

Table 1. Key parameters and their absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	±18 or +36	V
V_{id}	Differential Input Voltage - note (1)	±30	V
V_i	Input Voltage - see note 1	±15	V
	Output Short Circuit Duration	Infinite	s
T_{oper}	Operating Free-Air Temperature Range	-40 to 105	°C
T_j	Junction Temperature	+150	°C
T_{stg}	Storage Temperature	-65 to +150	°C
P_{tot}	Maximum Power Dissipation - note (2)	500	mW

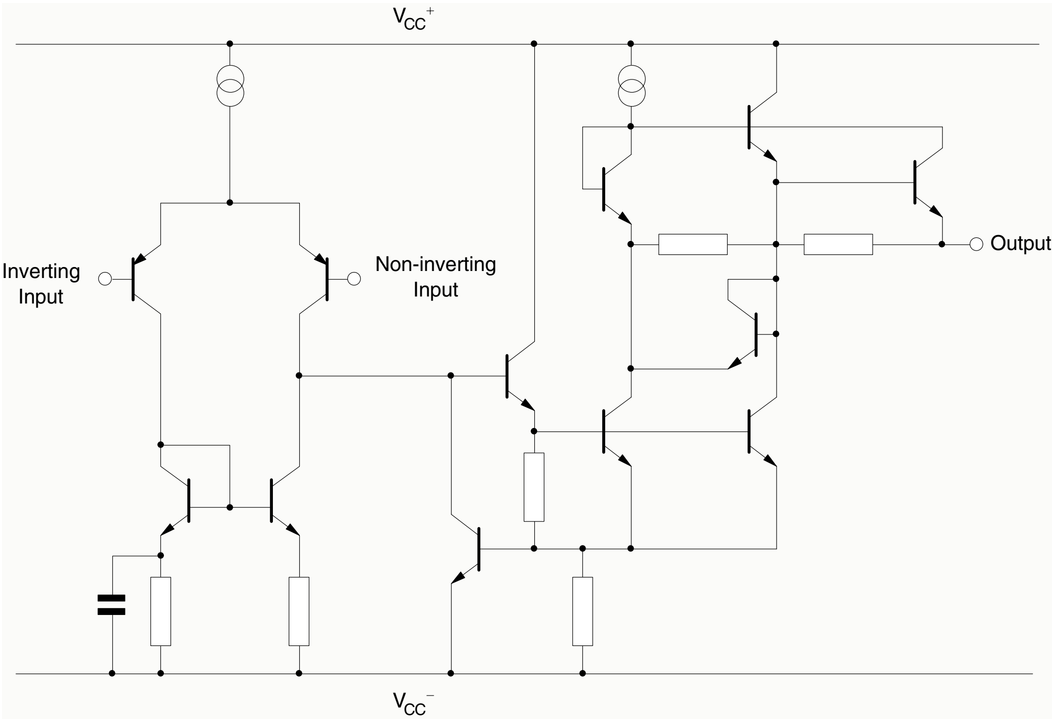
1. Either or both input voltages must not exceed the magnitude of V_{CC}^+ or V_{CC}^-.
2. Power dissipation must be considered to ensure maximum junction temperature (T_j) is not exceeded.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	±2.5 to ±15	V

2 Typical Application Schematic

Figure 1. Schematic diagram (1/2 MC33078)



3 Electrical Characteristics

Table 3. $V_{CC}^+ = +15V$, $V_{CC}^- = -15V$, $T_{amb} = 25°C$ (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage ($V_o = 0V$, $V_{ic} = 0V$) $T_{amb} = +25°C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		0.15	2 3	mV
DV_{io}	Input Offset Voltage Drift $V_o = 0V$, $V_{ic} = 0V$, $T_{min.} \leq T_{amb} \leq T_{max.}$		2		μV/°C
I_{io}	Input Offset Current ($V_o = 0V$, $V_{ic} = 0V$) $T_{amb} = +25°C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		10	150 175	nA
I_{ib}	Input Bias Current ($V_o = 0V$, $V_{ic} = 0V$) $T_{amb} = +25°C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		250	750 800	nA
V_{icm}	Input Common Mode Voltage Range ($\Delta V_{io} = 5mV$, $V_o = 0V$)	±13	±14		V
A_{vd}	Large Signal Voltage Gain ($R_L = 2k\Omega$, $V_o = \pm10V$) $T_{amb} = +25°C$ $T_{min.} \leq T_{amb} \leq T_{max.}$	90 85	100		dB
$\pm V_{opp}$	Output Voltage Swing ($V_{id} = \pm1V$) $R_L = 600\Omega$ $R_L = 600\Omega$ $R_L = 2.0k\Omega$ $R_L = 2.0k\Omega$ $R_L = 10k\Omega$ $R_L = 10k\Omega$	13.2 13.5	12.2 -12.7 14 -14.2 14.3 -14.6	-13.2 -14	V
CMR	Common-mode Rejection Ratio ($V_{ic} = \pm13V$)	80	100		dB
SVR	Supply Voltage Rejection Ratio $V_{CC}^+ / V_{CC}^- = +15V / -15V$ to $+5V / -5V$	80	105		dB
I_o	Output Short Circuit Current ($V_{id} = \pm1V$, Output to Ground) Source Sink	15 20	29 27		mA
I_{CC}	Supply Current ($V_o = 0V$, All amplifiers) $T_{amb} = +25°C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		4	5 5.5	mA
SR	Slew Rate $V_i = -10V$ to $+10V$, $R_L = 2k\Omega$, $C_L = 100pF$, $A_V = +1$	5	7		V/μs
GBP	Gain Bandwidth Product $R_L = 2k\Omega$, $C_L = 100pF$, $f = 100kHz$	10	15		MHz
B	Unity Gain Bandwidth (Open loop)		9		MHz
A_m	Gain Margin ($R_L = 2k\Omega$), $C_L = 0pF$ $C_L = 100pF$		-11 -6		dB
ϕm	Phase Margin ($R_L = 2k\Omega$), $C_L = 0pF$ $C_L = 100pF$		55 30		Degrees

Table 3. V_{CC}^+ = +15V, V_{CC}^- = -15V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
e_n	Equivalent Input Noise Voltage R_S = 100Ω, f = 1kHz		4.5		nV/√Hz
i_n	Equivalent Input Noise Current (f = 1kHz)		0.5		pA/√Hz
THD	Total Harmonic Distortion R_L = 2kΩ, f = 20Hz to 20kHz, V_o = 3V_{rms}, A_V = +1		0.002		%
V_{O1}/V_{O2}	Channel Separation f = 20Hz to 20kHz		120		dB
FPB	Full Power Bandwidth V_o = 27V_{pp}, R_L = 2kΩ, THD ≤ 1%		120		kHz
Z_o	Output Impedance V_o = 0V, f = 9MHz		37		Ω
R_i	Input Resistance V_{ic} = 0V		175		kΩ
C_i	Input Capacitance V_{ic} = 0V		12		pF

Figure 2. Total supply current vs. supply voltage

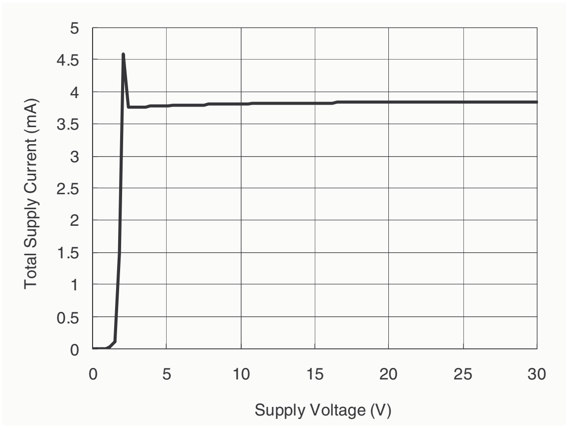


Figure 3. Output voltage vs. supply voltage

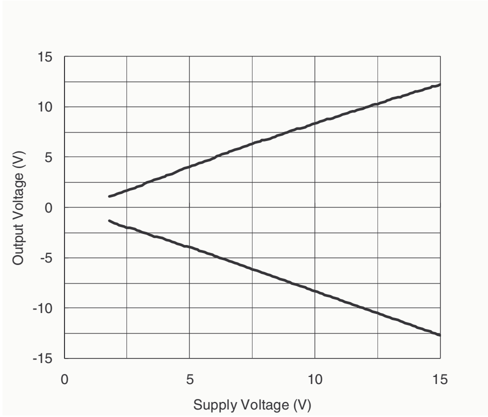


Figure 4. Equivalent input noise voltage vs. frequency

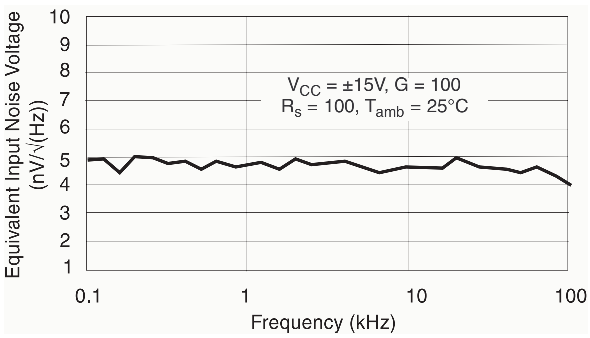


Figure 5. Output short circuit current vs. output voltage

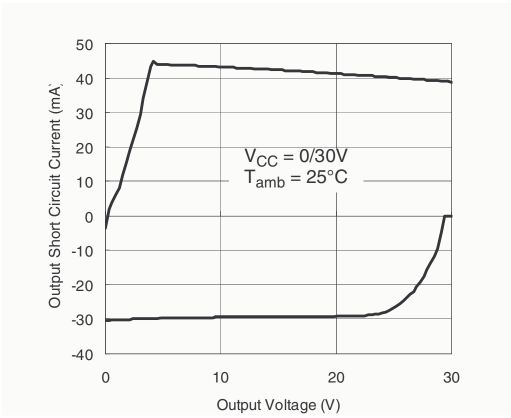


Figure 6. Output voltage vs. supply voltage

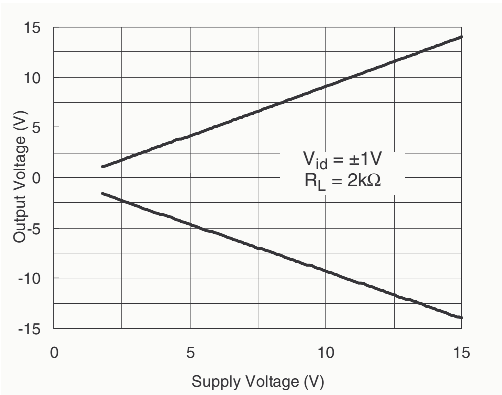


Figure 7. THD + Noise vs. frequency

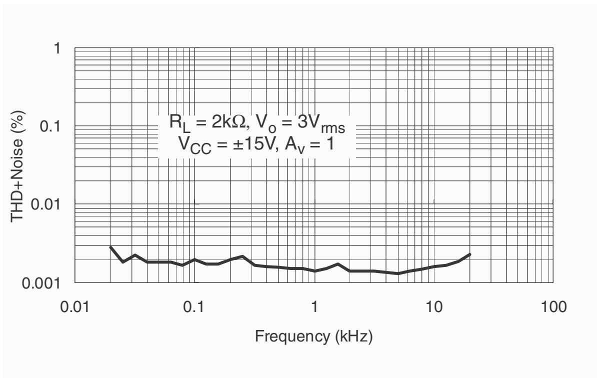


Figure 8. Voltage gain and phase vs. frequency

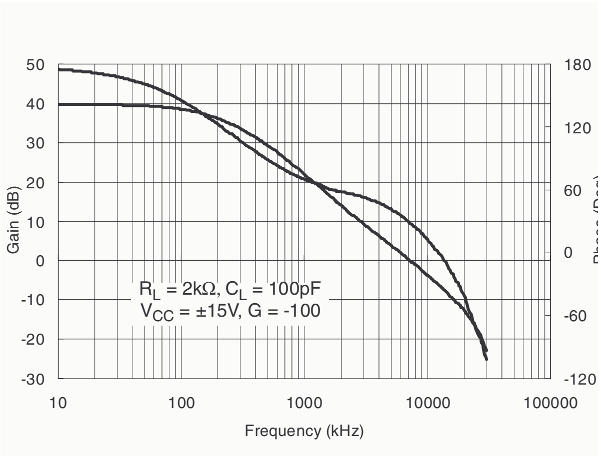
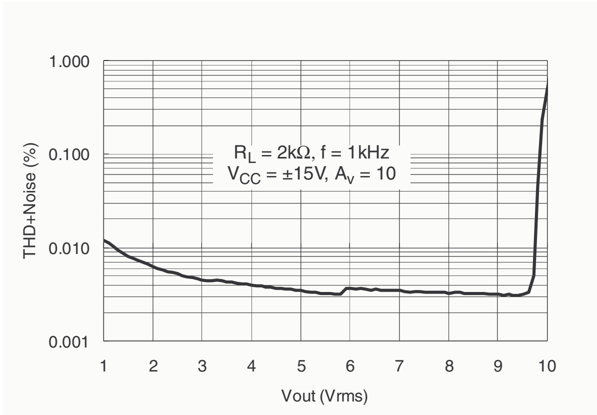


Figure 9. THD noise vs. V_{out}



4 Macromodels

4.1 Important note concerning this macromodel

Please consider following remarks before using this macromodel.

- All models are a trade-off between accuracy and complexity (i.e. simulation time).
- Macromodels are not a substitute to breadboarding; rather, they confirm the validity of a design approach and help to select surrounding component values.
- A macromodel emulates the NOMINAL performance of a TYPICAL device within SPECIFIED OPERATING CONDITIONS (i.e. temperature, supply voltage, etc.). Thus the macromodel is often not as exhaustive as the datasheet, its goal is to illustrate the main parameters of the product.
- Data issued from macromodels used outside of its specified conditions (V_{CC}, Temperature, etc.) or even worse: outside of the device operating conditions (V_{CC}, V_{icm}, etc.) are not reliable in any way.

In *Section 4.2*, the electrical characteristics resulting from the use of this macromodel are presented.

4.2 Electrical characteristics from macromodelization

Table 4. Electrical characteristics resulting from macromodel simulation at V_{CC}^+ = +15V, V_{CC}^- = -15V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Conditions	Value	Unit
V_{io}		0	mV
A_{VD}	R_L = 2kΩ, V_O = ±10V	100	dB
I_{CC}	No load, per operator	2	mA
V_{icm}	ΔV_{io} = 5mV, V_O = 0V	28	V
V_{opp}	R_L = 2kΩ	28.2	V
I_{sink}	V_O = 0V	37	mA
I_{source}	V_O = 0V	29	mA
GBP	R_L = 2kΩ, C_L = 100pF	15	MHz
SR	R_L = 10kΩ, C_L = 100pF, A_V = +1	7	V/µs
ϕm	R_L = 2kΩ, C_L = 0pF	55	Degrees

4.3 Macromodel code

```
** Standard Linear Ics Macromodels, 1993.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY
.SUBCKT MC33078 1 3 2 4 5 (analog)
*********************************************************
.MODEL MDTH D IS=1E-8 KF=2.286238E-16 CJO=10F
* INPUT STAGE
CIP 2 5 1.200000E-11
CIN 1 5 1.200000E-11
EIP 10 5 2 5 1
EIN 16 5 1 5 1
RIP 10 11 2.363636E+00
RIN 15 16 2.363636E+00
RIS 11 15 1.224040E+01
DIP 11 12 MDTH 400E-12
DIN 15 14 MDTH 400E-12
VOFP 12 13 DC 0
VOFN 13 14 DC 0
IPOL 13 5 1.100000E-04
CPS 11 15 2.35E-09
DINN 17 13 MDTH 400E-12
VIN 17 5 1.000000e+00
DINR 15 18 MDTH 400E-12
VIP 4 18 1.000000E+00
FCP 4 5 VOFP 1.718182E+01
FCN 5 4 VOFN 1.718182E+01
FIBP 2 5 VOFN 4.545455E-03
FIBN 5 1 VOFP 4.545455E-03
* AMPLIFYING STAGE
FIP 5 19 VOFP 9.545455E+02
FIN 5 19 VOFN 9.545455E+02
CC 19 29 1.500000E-08
HZTP 30 29 VOFP 1.523529E+02
HZTN  5 30 VOFN 1.523529E+02
DOPM 51 22 MDTH 400E-12
DONM 21 52 MDTH 400E-12
HOPM 22 28 VOUT 5.172414E+03
VIPM 28 4 1.500000E+02
HONM 21 27 VOUT 4.054054E+03
VINM 5 27 1.500000E+02
DBIDON1 19 53 MDTH 400E-12
V1 51 53 0.68
DBIDON2 54 19 MDTH 400E-12
V2 54 52 0.68
RG11 51 5 3.04E+05
RG12 51 4 3.04E+05
```

```
RG21 52 5 0.6072E+05
RG22 52 4 0.6072E+05
E1 50 40 51 0 1 E2 40 39 52 0 1
EDEC1 38 39 4 0 0.5
EDEC2 0 38 5 0 0.5
DOP 51 25 MDTH 400E-12
VOP 4 25 1.474575E+00
DON 24 52 MDTH 400E-12
VON 24 5 1.474575E+00
RAJUS 50 5 1E12
GCOMP 5 4 4 5 8.1566068E-04
RPM1 5 80 1E+06
RPM2 4 80 1E+06
GAVPH 5 82 50 80 3.26E-03
RAVPHGH 82 4 613
RAVPHGB 82 5 613
RAVPHDH 82 83 1000
RAVPHDB 82 84 1000
CAVPHH 4 83 0.159E-09
CAVPHB 5 84 0.159E-09
EOUT 26 23 82 5 1
VOUT 23 5 0
ROUT 26 3 4.780354E+01
COUT 3 5 1.000000E-12
.ENDS
```

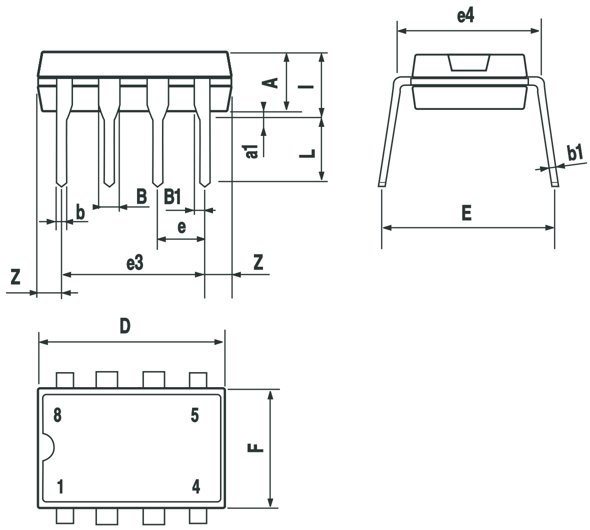
5 Package Mechanical Data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

5.1 DIP8 Package

Plastic DIP-8 MECHANICAL DATA

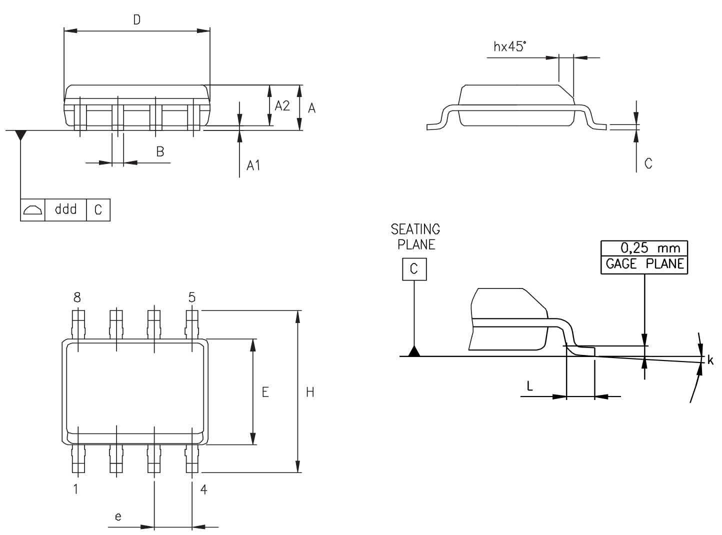
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A		3.3			0.130	
a1	0.7			0.028		
B	1.39		1.65	0.055		0.065
B1	0.91		1.04	0.036		0.041
b		0.5			0.020	
b1	0.38		0.5	0.015		0.020
D			9.8			0.386
E		8.8			0.346	
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			7.1			0.280
I			4.8			0.189
L		3.3			0.130	
Z	0.44		1.6	0.017		0.063



P001F

5.2 SO-8 Package

SO-8 MECHANICAL DATA						
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.04		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D	4.80		5.00	0.189		0.197
E	3.80		4.00	0.150		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	8° (max.)					
ddd			0.1			0.04



0016023/C

6 Revision History

Table 5. Document revision history

Date	Revision	Changes
Nov. 2001	1	Initial release.
June 2005	2	PPAP references inserted in the datasheet see *Order Codes on page 1*.
Sept. 2005	3	The following changes were made in this revision: – *Order Codes on page 1* updated with complete list of markings and packages were corrected. – Reorganization of *Chapter 4.3: Macromodel code on page 9*.
Feb. 2006	4	Error in the first page title.