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# 4-Chloro-*N*-(3-chlorophenyl)-2-methylbenzenesulfonamide

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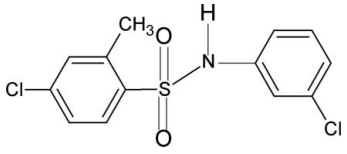
Key indicators: single-crystal X-ray study; $T$ = 299 K; mean $\sigma$(C–C) = 0.005 Å; $R$ factor = 0.055; $wR$ factor = 0.161; data-to-parameter ratio = 16.3.

In the title compound, $C_{13}H_{11}Cl_2NO_2S$, the conformation of the N—H bond in the C—$SO_2$—NH—C segment is *anti* to the *meta*-Cl atom on the aniline ring and *syn* to the *ortho*-methyl group on the sulfonylbenzene ring. Furthermore, the torsion angle of the C—$SO_2$—NH—C segment in the molecule is 80.1 (3)°. The two benzene rings are tilted relative to each other by 70.9 (1)°. In the crystal, pairs of intermolecular N—H···O hydrogen bonds link the molecules *via* inversion-related dimers into infinite column-like chains.

## Related literature

For the preparation of the title compound, see: Savitha & Gowda (2006). For our studies of the effect of substituents on the structures of *N*-(aryl)arylsulfonamides, see: Gowda *et al.* (2008, 2009*a,b*). For related structures, see: Gelbrich *et al.* (2007); Perlovich *et al.* (2006).




## Experimental

*Crystal data*

$C_{13}H_{11}Cl_2NO_2S$
$M_r$ = 316.19
Monoclinic, $P2_1/c$
$a$ = 7.9757 (7) Å
$b$ = 11.3472 (8) Å
$c$ = 15.569 (1) Å
$\beta$ = 91.490 (8)°
$V$ = 1408.55 (18) Å$^3$
$Z$ = 4
Mo $K\alpha$ radiation
$\mu$ = 0.61 mm$^{-1}$
$T$ = 299 K
0.36 × 0.28 × 0.04 mm

*Data collection*

Oxford Diffraction Xcalibur diffractometer with a Sapphire CCD detector
Absorption correction: multi-scan (*CrysAlis RED*; Oxford Diffraction, 2009)
$T_{min}$ = 0.812, $T_{max}$ = 0.976
5849 measured reflections
2866 independent reflections
1853 reflections with $I > 2\sigma(I)$
$R_{int}$ = 0.017

*Refinement*

$R[F^2 > 2\sigma(F^2)]$ = 0.055
$wR(F^2)$ = 0.161
$S$ = 1.04
2866 reflections
176 parameters
1 restraint
H atoms treated by a mixture of independent and constrained refinement
$\Delta\rho_{max}$ = 0.43 e Å$^{-3}$
$\Delta\rho_{min}$ = −0.52 e Å$^{-3}$

**Table 1**
Hydrogen-bond geometry (Å, °).

| $D$—H···$A$ | $D$—H | H···$A$ | $D$···$A$ | $D$—H···$A$ |
|---|---|---|---|---|
| N1—H1$N$···O2$^{i}$ | 0.85 (2) | 2.08 (2) | 2.926 (4) | 175 (4) |

Symmetry code: (i) $-x+1, -y, -z+1$.

Data collection: *CrysAlis CCD* (Oxford Diffraction, 2009); cell refinement: *CrysAlis RED* (Oxford Diffraction, 2009); data reduction: *CrysAlis RED*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *PLATON* (Spek, 2009); software used to prepare material for publication: *SHELXL97*.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: VM2031).

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# supporting information

*Acta Cryst.* (2010). E**66**, o1702 [doi:10.1107/S1600536810022968]

## 4-Chloro-*N*-(3-chlorophenyl)-2-methylbenzenesulfonamide

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### S1. Comment

As part of a study of the substituent effects on the crystal structures of *N*-(aryl)-arylsulfonamides (Gowda *et al.*, 2008; Gowda *et al.*, 2009*a,b*), in the present work, the structure of 4-chloro-2-methyl-*N*-(3-chlorophenyl)benzenesulfonamide (I) has been determined (Fig. 1). The conformation of the N—H bond on the C—$SO_2$—NH—C segment is *anti* to the *meta*-Cl on the aniline ring and *syn* to the *ortho*-methyl group in the sulfonyl benzene ring.

The torsion angle of the segment C—$SO_2$—NH—C in (I) is 80.1 (3)°, compared to the values of -61.9 (4)° and 69.7 (4)° in the two independent molecules of 4-chloro-2-methyl-*N*-(phenyl)-benzenesulfonamide(II) (Gowda *et al.*, 2009*a*), 74.8 (4)° in 4-chloro-2-methyl-*N*-(2-chlorophenyl)-benzenesulfonamide (III) (Gowda *et al.*, 2009*b*) and -60.1 (2)° in *N*-(3-chlorophenyl)-benzenesulfonamide (IV)(Gowda *et al.*, 2008).

The sulfonyl and the aniline benzene rings in (I) are tilted relative to each other by 70.9 (1)°, compared to the values of 86.6 (2)° and 83.0 (2)° in the two independent molecules of (II), 45.5 (2)° in (III) and 65.4 (1)° in (IV).

The other bond parameters in (I) are similar to those observed in (II), (III), (IV) and other aryl sulfonamides (Perlovich *et al.*, 2006; Gelbrich *et al.*, 2007).

In the crystal structure, pairs of intermolecular N–H···O hydrogen bonds (Table 1) link the molecules into inversion-related dimers, which are further linked into infinite column like chains through C—H···$\pi$ and C—Cl···$\pi$ interactions. Part of the crystal structure is shown in Fig. 2.

### S2. Experimental

The solution of *m*-chlorotoluene (10 cc) in chloroform (40 cc) was treated dropwise with chlorosulfonic acid (25 cc) at 0 ° C. After the initial evolution of hydrogen chloride subsided, the reaction mixture was brought to room temperature and poured into crushed ice in a beaker. The chloroform layer was separated, washed with cold water and allowed to evaporate slowly. The residual 2-methyl-4-chlorobenzenesulfonylchloride was treated with 3-chloroaniline in the stoichiometric ratio and boiled for ten minutes. The reaction mixture was then cooled to room temperature and added to ice cold water (100 cc). The resultant solid 4-chloro-2-methyl-*N*- (3-chlorophenyl)-benzenesulfonamide was filtered under suction and washed thoroughly with cold water. It was then recrystallized to constant melting point from dilute ethanol. The purity of the compound was checked and characterized by recording its infrared and NMR spectra (Savitha & Gowda, 2006).

The plate like colourless single crystals used in X-ray diffraction studies were grown in ethanolic solution by slow evaporation at room temperature.

### S3. Refinement

The H atom of the NH group was located in a difference map and later restrained to N—H = 0.86 (2) Å. The other H atoms were positioned with idealized geometry using a riding model with C—H = 0.93–0.96 Å. All H atoms were refined

with isotropic displacement parameters (set to 1.2 times of the $U_{eq}$ of the parent atom).

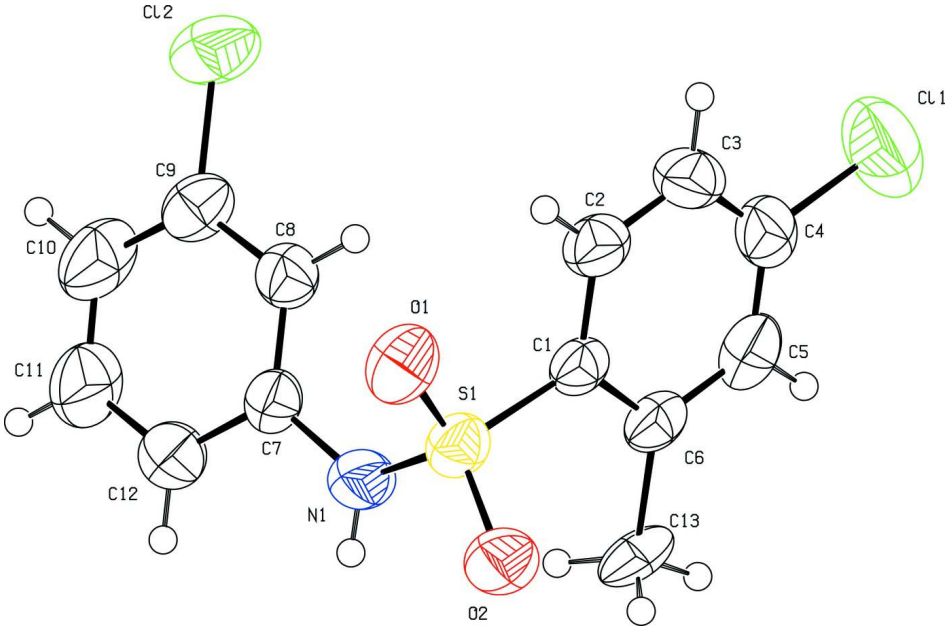


**Figure 1**

Molecular structure of (I), showing the atom labelling scheme and displacement ellipsoids are drawn at the 50% probability level.

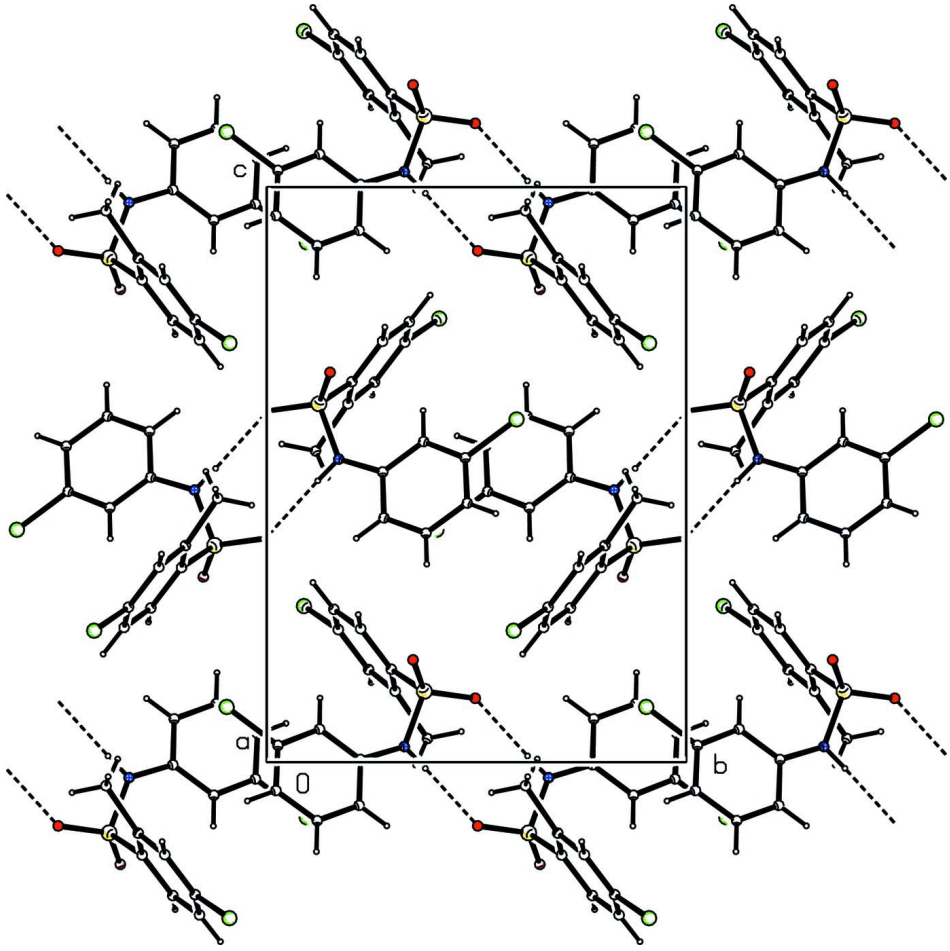


**Figure 2**

Molecular packing of (I) with hydrogen bonding shown as dashed lines.

### 4-Chloro-*N*-(3-chlorophenyl)-2-methylbenzenesulfonamide

*Crystal data*

$C_{13}H_{11}Cl_2NO_2S$
$M_r$ = 316.19
Monoclinic, $P2_1/c$
Hall symbol: -P 2ybc
$a$ = 7.9757 (7) Å
$b$ = 11.3472 (8) Å
$c$ = 15.569 (1) Å
$\beta$ = 91.490 (8)°
$V$ = 1408.55 (18) Å$^3$
$Z$ = 4
$F$(000) = 648
$D_x$ = 1.491 Mg m$^{-3}$
Mo $K\alpha$ radiation, $\lambda$ = 0.71073 Å
Cell parameters from 2107 reflections
$\theta$ = 2.6–27.8°
$\mu$ = 0.61 mm$^{-1}$
$T$ = 299 K
Plate, colourless
0.36 × 0.28 × 0.04 mm

*Data collection*

Oxford Diffraction Xcalibur diffractometer with a Sapphire CCD detector
Radiation source: fine-focus sealed tube
Graphite monochromator
Rotation method data acquisition using $\omega$ and phi scans
Absorption correction: multi-scan (*CrysAlis RED*; Oxford Diffraction, 2009)
$T_{min}$ = 0.812, $T_{max}$ = 0.976
5849 measured reflections
2866 independent reflections
1853 reflections with $I > 2\sigma(I)$

$R_{int}$ = 0.017
$\theta_{max}$ = 26.4°, $\theta_{min}$ = 2.6°
$h$ = −9→7
$k$ = −14→14
$l$ = −19→19

*Refinement*

Refinement on $F^2$
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)]$ = 0.055
$wR(F^2)$ = 0.161
$S$ = 1.04
2866 reflections
176 parameters
1 restraint
Primary atom site location: structure-invariant direct methods
Secondary atom site location: difference Fourier map
Hydrogen site location: inferred from neighbouring sites
H atoms treated by a mixture of independent and constrained refinement
$w = 1/[\sigma^2(F_o^2) + (0.0763P)^2 + 0.8836P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max}$ = 0.001
$\Delta\rho_{max}$ = 0.43 e Å$^{-3}$
$\Delta\rho_{min}$ = −0.52 e Å$^{-3}$

*Special details*

**Experimental**. CrysAlis RED (Oxford Diffraction, 2009) Empirical absorption correction using spherical harmonics, implemented in SCALE3 ABSPACK scaling algorithm.

**Geometry**. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

**Refinement**. Refinement of $F^2$ against ALL reflections. The weighted $R$-factor $wR$ and goodness of fit $S$ are based on $F^2$, conventional $R$-factors $R$ are based on $F$, with $F$ set to zero for negative $F^2$. The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating $R$-factors(gt) *etc*. and is not relevant to the choice of reflections for refinement. $R$-factors based on $F^2$ are statistically about twice as large as those based on $F$, and $R$- factors based on ALL data will be even larger.

*Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å$^2$)*

| | $x$ | $y$ | $z$ | $U_{iso}$*/$U_{eq}$ |
|---|---|---|---|---|
| C1 | 0.3431 (4) | 0.2031 (3) | 0.66150 (19) | 0.0451 (7) |
| C2 | 0.3719 (5) | 0.2761 (3) | 0.7319 (2) | 0.0571 (9) |
| H2 | 0.4793 | 0.2818 | 0.7563 | 0.069* |
| C3 | 0.2436 (6) | 0.3398 (3) | 0.7657 (2) | 0.0642 (10) |
| H3 | 0.2638 | 0.3897 | 0.8122 | 0.077* |
| C4 | 0.0858 (5) | 0.3293 (3) | 0.7305 (2) | 0.0617 (10) |
| C5 | 0.0557 (5) | 0.2571 (3) | 0.6608 (3) | 0.0630 (10) |
| H5 | −0.0530 | 0.2507 | 0.6383 | 0.076* |
| C6 | 0.1829 (4) | 0.1936 (3) | 0.6234 (2) | 0.0508 (8) |
| C7 | 0.6346 (4) | 0.2765 (3) | 0.5046 (2) | 0.0486 (8) |
| C8 | 0.6426 (4) | 0.3741 (3) | 0.5575 (2) | 0.0543 (8) |
| H8 | 0.5940 | 0.3729 | 0.6111 | 0.065* |
| C9 | 0.7240 (5) | 0.4732 (3) | 0.5292 (2) | 0.0585 (9) |
| C10 | 0.7951 (6) | 0.4781 (4) | 0.4506 (3) | 0.0809 (13) |
| H10 | 0.8492 | 0.5459 | 0.4325 | 0.097* |
| C11 | 0.7847 (6) | 0.3796 (4) | 0.3983 (3) | 0.0887 (15) |
| H11 | 0.8319 | 0.3815 | 0.3444 | 0.106* |
| C12 | 0.7061 (5) | 0.2795 (4) | 0.4249 (2) | 0.0641 (10) |
| H12 | 0.7007 | 0.2137 | 0.3893 | 0.077* |

| | | | | |
|---|---|---|---|---|
| C13 | 0.1457 (5) | 0.1168 (3) | 0.5412 (2) | 0.0595 (10) |
| H13A | 0.1807 | 0.0371 | 0.5519 | 0.071* |
| H13B | 0.2060 | 0.1481 | 0.4937 | 0.071* |
| H13C | 0.0276 | 0.1182 | 0.5276 | 0.071* |
| N1 | 0.5495 (4) | 0.1719 (3) | 0.5270 (2) | 0.0640 (9) |
| H1N | 0.539 (5) | 0.120 (3) | 0.488 (2) | 0.077* |
| O1 | 0.6571 (3) | 0.1510 (2) | 0.67778 (17) | 0.0697 (7) |
| O2 | 0.4690 (3) | 0.0031 (2) | 0.61100 (16) | 0.0660 (7) |
| Cl1 | −0.0771 (2) | 0.41129 (13) | 0.77137 (10) | 0.1162 (6) |
| Cl2 | 0.73479 (16) | 0.59549 (9) | 0.59594 (8) | 0.0858 (4) |
| S1 | 0.51639 (11) | 0.12421 (7) | 0.62307 (6) | 0.0533 (3) |

*Atomic displacement parameters (Å²)*

| | $U^{11}$ | $U^{22}$ | $U^{33}$ | $U^{12}$ | $U^{13}$ | $U^{23}$ |
|---|---|---|---|---|---|---|
| C1 | 0.0512 (19) | 0.0407 (16) | 0.0432 (17) | −0.0108 (14) | 0.0010 (14) | 0.0041 (13) |
| C2 | 0.062 (2) | 0.061 (2) | 0.0488 (19) | −0.0148 (18) | −0.0021 (16) | −0.0027 (17) |
| C3 | 0.087 (3) | 0.057 (2) | 0.049 (2) | −0.011 (2) | 0.012 (2) | −0.0088 (17) |
| C4 | 0.070 (3) | 0.048 (2) | 0.068 (2) | −0.0030 (18) | 0.023 (2) | 0.0086 (18) |
| C5 | 0.049 (2) | 0.058 (2) | 0.082 (3) | −0.0104 (18) | 0.0034 (19) | 0.012 (2) |
| C6 | 0.054 (2) | 0.0417 (18) | 0.057 (2) | −0.0135 (15) | 0.0006 (16) | 0.0043 (15) |
| C7 | 0.0451 (18) | 0.0475 (18) | 0.0533 (19) | −0.0033 (15) | 0.0043 (15) | 0.0037 (15) |
| C8 | 0.055 (2) | 0.050 (2) | 0.058 (2) | −0.0003 (16) | 0.0070 (16) | 0.0008 (16) |
| C9 | 0.059 (2) | 0.0453 (19) | 0.070 (2) | −0.0021 (17) | −0.0067 (18) | 0.0079 (17) |
| C10 | 0.098 (3) | 0.072 (3) | 0.073 (3) | −0.031 (2) | 0.002 (2) | 0.020 (2) |
| C11 | 0.105 (4) | 0.100 (4) | 0.061 (3) | −0.034 (3) | 0.021 (2) | 0.010 (3) |
| C12 | 0.069 (2) | 0.068 (2) | 0.055 (2) | −0.010 (2) | 0.0066 (19) | −0.0050 (18) |
| C13 | 0.056 (2) | 0.058 (2) | 0.063 (2) | −0.0245 (17) | −0.0249 (17) | −0.0032 (17) |
| N1 | 0.084 (2) | 0.0510 (18) | 0.0578 (19) | −0.0174 (16) | 0.0191 (16) | −0.0079 (14) |
| O1 | 0.0540 (15) | 0.0750 (18) | 0.0794 (18) | −0.0031 (13) | −0.0104 (13) | 0.0085 (14) |
| O2 | 0.0826 (19) | 0.0420 (13) | 0.0738 (17) | −0.0038 (12) | 0.0094 (14) | 0.0032 (11) |
| Cl1 | 0.1189 (12) | 0.0990 (10) | 0.1336 (12) | 0.0235 (8) | 0.0566 (10) | 0.0030 (8) |
| Cl2 | 0.1005 (9) | 0.0488 (6) | 0.1077 (9) | −0.0067 (5) | −0.0032 (7) | −0.0073 (5) |
| S1 | 0.0557 (5) | 0.0457 (5) | 0.0584 (5) | −0.0046 (4) | 0.0028 (4) | 0.0040 (4) |

*Geometric parameters (Å, º)*

| | | | |
|---|---|---|---|
| C1—C2 | 1.388 (4) | C8—H8 | 0.9300 |
| C1—C6 | 1.399 (5) | C9—C10 | 1.362 (6) |
| C1—S1 | 1.764 (3) | C9—Cl2 | 1.734 (4) |
| C2—C3 | 1.369 (5) | C10—C11 | 1.384 (6) |
| C2—H2 | 0.9300 | C10—H10 | 0.9300 |
| C3—C4 | 1.365 (5) | C11—C12 | 1.366 (5) |
| C3—H3 | 0.9300 | C11—H11 | 0.9300 |
| C4—C5 | 1.375 (5) | C12—H12 | 0.9300 |
| C4—Cl1 | 1.733 (4) | C13—H13A | 0.9600 |
| C5—C6 | 1.386 (5) | C13—H13B | 0.9600 |
| C5—H5 | 0.9300 | C13—H13C | 0.9600 |

| | | | |
|---|---|---|---|
| C6—C13 | 1.571 (5) | N1—S1 | 1.619 (3) |
| C7—C12 | 1.380 (5) | N1—H1N | 0.850 (18) |
| C7—C8 | 1.380 (5) | O1—S1 | 1.424 (3) |
| C7—N1 | 1.416 (4) | O2—S1 | 1.436 (2) |
| C8—C9 | 1.377 (5) | | |

| | | | |
|---|---|---|---|
| C2—C1—C6 | 120.7 (3) | C8—C9—Cl2 | 118.5 (3) |
| C2—C1—S1 | 117.1 (3) | C9—C10—C11 | 118.4 (4) |
| C6—C1—S1 | 122.1 (2) | C9—C10—H10 | 120.8 |
| C3—C2—C1 | 120.6 (3) | C11—C10—H10 | 120.8 |
| C3—C2—H2 | 119.7 | C12—C11—C10 | 121.0 (4) |
| C1—C2—H2 | 119.7 | C12—C11—H11 | 119.5 |
| C4—C3—C2 | 119.3 (3) | C10—C11—H11 | 119.5 |
| C4—C3—H3 | 120.3 | C11—C12—C7 | 119.7 (4) |
| C2—C3—H3 | 120.3 | C11—C12—H12 | 120.1 |
| C3—C4—C5 | 120.6 (4) | C7—C12—H12 | 120.1 |
| C3—C4—Cl1 | 119.9 (3) | C6—C13—H13A | 109.5 |
| C5—C4—Cl1 | 119.5 (3) | C6—C13—H13B | 109.5 |
| C4—C5—C6 | 121.8 (4) | H13A—C13—H13B | 109.5 |
| C4—C5—H5 | 119.1 | C6—C13—H13C | 109.5 |
| C6—C5—H5 | 119.1 | H13A—C13—H13C | 109.5 |
| C5—C6—C1 | 116.9 (3) | H13B—C13—H13C | 109.5 |
| C5—C6—C13 | 120.4 (3) | C7—N1—S1 | 126.7 (3) |
| C1—C6—C13 | 122.7 (3) | C7—N1—H1N | 116 (3) |
| C12—C7—C8 | 120.2 (3) | S1—N1—H1N | 115 (3) |
| C12—C7—N1 | 117.0 (3) | O1—S1—O2 | 118.89 (17) |
| C8—C7—N1 | 122.8 (3) | O1—S1—N1 | 109.67 (17) |
| C9—C8—C7 | 118.7 (3) | O2—S1—N1 | 104.33 (16) |
| C9—C8—H8 | 120.7 | O1—S1—C1 | 107.51 (16) |
| C7—C8—H8 | 120.7 | O2—S1—C1 | 108.91 (15) |
| C10—C9—C8 | 122.1 (4) | N1—S1—C1 | 106.97 (16) |
| C10—C9—Cl2 | 119.4 (3) | | |

| | | | |
|---|---|---|---|
| C6—C1—C2—C3 | 0.4 (5) | C8—C9—C10—C11 | −0.2 (7) |
| S1—C1—C2—C3 | −179.7 (3) | Cl2—C9—C10—C11 | −179.9 (4) |
| C1—C2—C3—C4 | 1.2 (5) | C9—C10—C11—C12 | −0.4 (7) |
| C2—C3—C4—C5 | −1.0 (5) | C10—C11—C12—C7 | 0.5 (7) |
| C2—C3—C4—Cl1 | −178.9 (3) | C8—C7—C12—C11 | −0.1 (6) |
| C3—C4—C5—C6 | −0.7 (6) | N1—C7—C12—C11 | 177.6 (4) |
| Cl1—C4—C5—C6 | 177.2 (3) | C12—C7—N1—S1 | 155.4 (3) |
| C4—C5—C6—C1 | 2.1 (5) | C8—C7—N1—S1 | −27.0 (5) |
| C4—C5—C6—C13 | −177.0 (3) | C7—N1—S1—O1 | −36.2 (4) |
| C2—C1—C6—C5 | −2.0 (5) | C7—N1—S1—O2 | −164.6 (3) |
| S1—C1—C6—C5 | 178.1 (2) | C7—N1—S1—C1 | 80.1 (3) |
| C2—C1—C6—C13 | 177.2 (3) | C2—C1—S1—O1 | 2.0 (3) |
| S1—C1—C6—C13 | −2.8 (4) | C6—C1—S1—O1 | −178.1 (3) |
| C12—C7—C8—C9 | −0.5 (5) | C2—C1—S1—O2 | 132.0 (3) |
| N1—C7—C8—C9 | −178.1 (3) | C6—C1—S1—O2 | −48.0 (3) |

| | | | |
|---|---|---|---|
| C7—C8—C9—C10 | 0.6 (6) | C2—C1—S1—N1 | −115.7 (3) |
| C7—C8—C9—Cl2 | −179.7 (3) | C6—C1—S1—N1 | 64.2 (3) |

*Hydrogen-bond geometry (Å, º)*

| *D*—H···*A* | *D*—H | H···*A* | *D*···*A* | *D*—H···*A* |
|---|---|---|---|---|
| N1—H1*N*···O2$^{i}$ | 0.85 (2) | 2.08 (2) | 2.926 (4) | 175 (4) |

Symmetry code: (i) −*x*+1, −*y*, −*z*+1.