International Practice on Road Traffic Signal Control
Country Report Germany and Austria

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4 Germany and Austria

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Bibliography
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Traffic Signal Standards

- German Technical Standards for Road Transport, such as RiLSA for Traffic Signals, are edited by the German Road and Transport Research Association (FGSV).
- The Austrian Research Association for Roads, Railways and Transport (FSV) has a similar role, editing RVS 05.04.31 (Deployment Criteria, 1998), RVS 05.04.32 (Planning of Traffic Signals, 1998), and others.
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Important Control Principles

- **Right-hand traffic.**
- **Standard speed limit** within built-up areas: 50 km/h.
- Maximum speed limit at signalized intersections: 70 km/h.
- Typically **three vertically aligned discs** of 200 mm diameter (300 mm at 70 km/h).
- Signals for vehicles located at the **near side of the intersection**.
- Signal heads next to or above the relevant lane. (Each vehicular signal head repeated.)
- Standard vehicular **signal sequence**: RED, RED AND YELLOW, GREEN, YELLOW, RED.
- Austria: **FLASHING GREEN** of 4 seconds follows each GREEN signal.
- **Arrow signals indicate protected turns.**
- **Group-based control.**

![Image of traffic signals and symbols](image)

**Figure 4.2** Signal heads. (A) Vehicular signal sequence (in Austria 4 s flashing green before yellow), (B) Signal heads with arrow symbols (protected turning; in Austria through/right signal, right movement is permitted), (C) Permitted-protected right turn signals. (D) Static green arrow for right-turn on red. (Wolfermann et al. 2019)

**Figure 4.3** Pedestrian, cyclist, and public transport signal heads. (A) Pedestrian signals; in Austria green is also followed by 4 s green flashing. (B) Combined pedestrian/cyclist signal. (C) Bicycle signals. (D) Signals for public transport on separate lanes. (Wolfermann et al. 2019)


**Intersection Layout**

- **Intersection geometry** determines intergreen times and may influence saturation flow rates.

- **Compact layout** to increase visibility and to reduce intergreen time.

- **Centre islands for pedestrians** influencing their minimum green times, intergreen times and possible signal groups.

- **Bicycle facilities** and bike signalization.

- Trams and buses may have separate lanes and **special public transport signals**.

*Figure 4.7 Complex urban intersection with detectors and public transport lanes. Source: Wissenschaftstadt Darmstadt. (Wolfermann et al. 2019)*
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Saturation Flow Rate

- Basic headway of 1.8 s (i.e. 2000 veh/h).
- Adjusted by factors for vehicle mix, turning radius (if r<20m), lane width (if w<3.0m) and grade (if >2% or <-2%).
- If more than one factor (lane width, radius, grade) is applicable, only the maximum factor is applied.
- The German Highway Capacity Manual HBS (FGSV 2015) provides linear diagrams to determine these factors.

\[
s = \frac{3600}{h}
\]

\[
h = f_{HV} f_1 f_2 1.8 \text{ s}
\]

\[
f_{HV} = \frac{V_{\text{car}} + 1.75 V_{\text{Lorry/Bus}} + 2.5 V_{\text{Trac/Trail}}}{V_{\text{car}} + V_{\text{Lorry/Bus}} + V_{\text{Trac/Trail}}}
\]

\[
f_1 = \max (f_{lw}, f_r, f_g)
\]

\[
f_2 = \min (1, f_g)
\]

where \( s \) = saturation flow rate (vehicles/h); \( h \) = time headway (s/vehicles); \( f \) = modification factor (HV: heavy vehicles, lw: lane width, r: turning radius, g: approach grade); \( V \) = vehicle volume (vehicle/h) (car: light vehicles, Lorry/Bus: heavy vehicles without tractor-trailer; Trac/Trail: tractor-trailers and similar).

(Wolfermann et al. 2019)
Definition of Intergreen time:
The time between the end of GREEN for one traffic stream and the beginning of GREEN for another traffic stream which is not compatible with the first stream.

Detailed analysis of conflicts during stage transition.

- **Definition of Intergreen time:**
- **Detailed analysis of conflicts during stage transition.**
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Signal Phasing

- Group-based control.
- Movements belonging to different signal groups must have a separate lane.
- The combination of signal groups to stages is based on minimum critical traffic demand (sum of flow ratios).
- Stage sequence is influenced by the sum of intergreen times (to reduce cycle time).
- Many specific regulations. Example: If pedestrians receive GREEN in the same stage as permitted turning vehicles, they have to receive a head start in a way that the first pedestrian enters the street before the first entering vehicle arrives at the pedestrian crossing.

Typical four-stage program with protected left-turns as separate stages
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Cycle Time and GREEN Times

- Cycle time is calculated **based on motorized vehicle demand** (equation below).
- With respect to delay for non-motorized traffic, **cycle time is limited to 30 – 90 s**, as an exception, up to 120 s may be applied.
- Delay for pedestrians and cyclists should not exceed 85 s, also due to acceptance.
- **Minimum GREEN time is 5 s**.
- In addition, minimum GREEN time for pedestrians must ensure that they can cross at least half of the carriageway during GREEN (standard pedestrian speed: 1.2 m/s).
- Many specific regulations exist to consider the **needs of impaired people**.

\[
C = \frac{\sum_{i} t_{ig,i} + \sum_{j} t_{g,\text{min},j}}{1 - \sum_{k} \frac{q_{k}}{s_{k}}} = \frac{\sum_{i} t_{ig,i} + \sum_{j} t_{g,\text{min},j}}{1 - \sum_{k} b_{k}}
\]

where \( C \) = cycle time (s); \( q_{k} \) = relevant vehicle demand (vehicles/h) of stage \( k \); \( t_{ig} \) = intergreen time (s); \( s_{k} \) = relevant saturation flow rate (vehicles/h) of stage \( k \); \( t_{g,\text{min}} \) = green times independent of cycle time (s); \( b_{k} \) = maximum flow rate of stage \( k \).

(Wolfermann et al. 2019)
Quality check according to the German Highway Capacity Manual HBS (FGSV 2015):
- average delay for motor vehicles
- maximum waiting times of pedestrians and cyclists
- Delay for public transport, if applicable
- Queue length, if relevant for adjacent intersections of other facilities (e.g. railway crossings)
- Coordination with adjacent intersections, if applicable (performance index)

Calculation of average vehicle delay considers effective GREEN time (signaled GREEN time plus 1 s).

RiLSA: Separate chapter on Quality Management for traffic signals during planning, implementation and operation (since 2010 edition).

<table>
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<th>LOS</th>
<th>Motorized Vehicles</th>
<th>Public Transport (on separate lanes)</th>
<th>Pedestrians and Cyclists</th>
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<td>Average Delay [s]</td>
<td>Maximum Delay [s]</td>
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<td>&gt; 3)</td>
<td>&gt; 60</td>
<td>&gt; 85)</td>
</tr>
</tbody>
</table>

LOS Definitions for Different Road User Groups
Source: German Highway Capacity Manual HBS (FGSV 2015)
Conclusions

- Quite high standard of road traffic signal control.
- Detailed guidelines.
- Mostly similar regulations in Germany and Austria with only a few major differences (e.g. flashing GREEN).
- Group-based control with very detailed calculation of intergreen times.
- Strict limitation of cycle time to a maximum of 90 s (in exceptional situations 120 s).
- Comprehensive consideration of pedestrians, cyclists, and public transport.
- Evaluation of traffic signal control programs mostly based on delay.
- A broader consideration of other criteria is desirable, but not covered by guidelines, so far.

Photo: © Boltze 2018
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