1. PREPARING THE INTEGRATION

1.1 CHECKING THE UNITS WITH RESPECT TO THE CUSTOMER SPECIFICATION

All components of the drive and their fitting must be checked and compared with the detials given in the customer spec. This might include parts not delivered by Bosch. they are marked with a (*) in the spec.

Compare the following points:

a) motor data
b) data of the smoothing chokes
c) transformer data
d) Specification number and AB number of the amplifier

} see type labels

e) Position of jumpers JP1 to JP4
f) Type and setting of bi-metal relays
g) Optimising data (if given in the spec.)

Should , in some cases, the details in the spec. not coincide with the information given in the section "Connections" the data in the specification is applicable.

1.2 CHECKING THE MOUNTING AND CONNECTION OF THE UNITS

- The amplifiers must be mounted with the heat sink in an upright position on a plane surface. For the Z25 it must also be ensured that the ribs of the heat sink are perpendicular. If this is not observed it is possible that the amplifier might become overloaded before the type nominal current is reached. (see also section "Fitting instructions")
- The installation must be checked to be in keeping with the connection instructions by going through the MTB drawings, especially important on installations where our amplifiers are used for the first time. Special attention should be paid to the correct polarity of the double chokes (term. 1+4 connected to transf. & t. 2 +3 to the ampl.
- Special attention should be given to the choke polarity, since chokes with incorrect polarity can cause problems with the servo loop later (see connections fig. 7)

1.3 CHECKING THE OV CONNECTION

- Disconnect command lines at t. X11/5+6, X12/5+6, X13/5+6 (leave screen connected!)
- Open "OV" plug connection
- Take measurement of resistance between plug connection "OV" and ground star point in interface cabinet.
- There must be <u>no</u> connection to be measured! Should there be any connection, locate and eliminate it!
- re-connect command lines

reconnect connection "OV"

2. INTEGRATION OF THE AMPLIFIER

2.1 INTEGRATION OF THE CONTROL MODULE

- Unplug connections L1, L2, C and D
- Switch on main switch
- Measure voltage L1-L2 with multi-meter
  Should be: 380 V +10 -15%
- Switch off main switch
- Plug connections L1 and L2 back in and switch on main switch
  The "BTB" ready LED must come on
- Switch on transformer (power contactor)
- If unit contains transformer with switchable tappings measure voltage between U and V and compare with details given in the specification.

  Example: Specification: 2 x 180 V
  measured voltage: 360 V

- Measure the phase relationship between L1 and U and
  L2 and V with an oscilloscope

  Notes:
  you must either use the centre point N of the transformer as reference point, or you must take a differential measurement (absolutely necessary for autotransformers where the point N must not be grounded).

  The voltage between the two points must be in phase in both cases.

- Repeat both measurements with any further existing transformer tappings.
- Switch off main switch
- Plug connections on term. C and D back in.

2.2 CHECKING THE DIRECTION OF MOTOR ROTATION AND TACHO POLARITY

- Resistors R23, R24, R25, R26, R33 and R34 are to be removed.
- Connect in each case a 68 kOhm resistor in parallel to the RC combinations R15/C14, R28/C16 and R38/C18, in order to limit the speed regulators to 1:3 amplification.
- Turn potentiometers R20, R30 and R39 (current) to CCW limit.
- Connect an adjustable command source (e.g. a battery box) to term. X11/5 and 6.
- Connect X11/6 to 0V
- Establish bridges on JP4 as follows:

In order to establish the polarities follow the table below:

No.	action	response	correct response ? yes	no
1	switch on main switch an power contactor	signal "general enable" (X6/1) comes (LED)	go on to 2	search for fault
2	switch on 1st axis	Only the 1st axis motor must be switched on. Apart from the gen. enable only the axis enable of the 1st axis must be present	3	search for fault
3	introduce small command value steps with battery box. Polarity: X11/5 = + X11/6 = -	axis moving in plus direction	4	change polarity of 1st axis motor
4	Introduce small command value steps with battery box polarity: X11/5 = + X11/6 = -	tacho voltage on X11/3 negative on X11/3 positive	5	change polarity of 1st axis tacho
5	switch to 2nd axis	(as 2, for 2nd motor) X12/1	6	search for fault
6	(as 3)	(as 3)	7	change polarity of 2nd axis
7	(as 4)	(as 4) on X12/3 negative on X12/2 positive	8	change polarity of 2nd axis tacho
8	switch to 3rd axis	(as 2, for 3rd motor) X13/1	9	Search for fault
9	(as 3)	(as 3)	10	change polatiry of 3rd axis
10	(as 4)	(as 4) on X13/3 negative on X13/2 positive		change polarity of 3rd axis tacho

- switch off main switch

2.3 DETERMINATION OF THE TACHO INPUT RESISTANCES

If the customer spec does not give any details re the tacho input resistors (R25/26), these can be determined as follows:

1.

$$R_T = \frac{U_{T1000} \cdot n_N}{U_{SW} \cdot 1000} \cdot 13 \; [\text{kOhm}] \quad \text{to be calculated}$$

U_{T1000} = EMF of the tacho for n = 1000 min^{-1} (V)

n_N = required max. motor speed (min^{-1})

U_{SW} = command voltage for n_N (V)

2. choose the nominal value nearest to R_T

2.4 IMPORTANT NOTES

a) all procedures described below are only described with the example of the 1st axis. Of course all this work must also be carried out for the other axes.
The following table enables you to make a comparison of the positions required for the optimisation.

function	1st axis	2nd axis	3rd axis
tacho input resistors (RT)	R23 + R24	R25 + R26	R33 + R34
P-portion speed regulator	R15	R28	R38
I-portion speed regulator	C14	C16	C18
firing angle shift	R18	R29	R40
D-portion in tacho input	C13	C15	C17
pot. for speed adjustment (tacho)	R19	R27	R35
pot. for current limitation (curr.)	R20	R30	R39
pot. for balance (offset)	R22	R32	R42
meas. point normed tacho voltage	TP1	TP3	TP5
meas. point speed regul. output	TP2	TP4	TP6

b) For all measuring required for the optimisation a storage scope or a recorder should be used.
c) Scope or recorder must not be grounded during the measuring operations or differential measurements must be taken.
d) All voltages listed relate to 0V

2.5 SETTING OF THE CURRENT LIMITATION

- Solder in tacho input resistors (R_T) given in the specification or calculated acc. to chapter 2.3 in R23 and R24.
- Unsolder 68 kOhm resistor over R15/C14.
- Connect R/C decade instead of the resistor
  Rough values: R15: 220 kOhm
  C14: 0.15 uF
- Connect decade to resistor R18
  Rough value 68 kOhm

2.5.1 SETTING CURRENT LIMITATION WHILE MOTOR IS BLOCKED

On many small machines there is the possibility to block the motor mechanically or keep it still. In this case the setting of the current limitation is very easy:

- Connect current meter into the armature circuit of the motor (preferably between ampl. term. C/D and switching contactors)
  Caution:
  Since the nominal currents given in the specification or the motor data sheet always represent effective currents, the current meter used must be a moving iron instrument! (⊥ scale). The moving coil measuring values typical for multi-meters (Δ scale) are not suitable because they show the arithmetic average, which, in the case of 2-pulse amplifiers might only be 60 - 70% of the effective value in some circumstances.!
  Measuring instruments with digital displays are not suitable either!
- Block axis mechanically
- Switch on main switch and power contactor
- Select axis
- Introduce small command value (e.g. 1V) with battery box.
- Adjust the current to the value specified under "I_1" (current limit with n = 0) in the specification with potentiometer R20 (turning the pot in CW direction increases the current).
- Switch off main switch
- Unblock the axis

2.5.2 SETTING THE CURRENT LIMITATION WHILE MOTOR IS RUNNING

- Switch DCmeasuring instrument (with physical separation between measuring circuit and output) into the armature circuit of the motor (preferably between term. C/D of the amplifier and the switching contactors).
- Connect oscilloscope to the measuring transformer
- If no DC transformer is available a measuring shunt can be used.
  Please note the following - important!
  If an autotransformer is used for the voltage adaptation, half of the mains voltage (measured against mass) is present at the shunt, as long as the power contactor is switched on!! So, with the usual mains voltage of 380 V this will be 190 V!
  It is therefore strongly advised to use a differential input when measuring with the oscilloscope, since otherwise the dangerous voltage is also present on the scope housing.
- Switch on main switch and power contactor
- Select axis
- Introduce short command value steps with the battery box. Ensure that the speed regulator runs into the limitation (±10V on TP2) during this operation. Caution: max. speed has not been set yet.
- Set peak current with pot R20 to $I_1 \cdot \sqrt{2}$ (I_1 see spec., item 7)

Example: $I_1 = 30$ A

peak curr. $\hat{I}_1 = 30 \text{ A} \cdot \sqrt{2} = 42$ A

2,6 DRIFT ADJUSTMENT

- Introduce command value "0"
- If motor is drifting noticibly the engineer must reduce the drift with potentiometer R22 down to 0 if possible.

2.7 ADJUSTMENT OF THE MAXIMUM SPEED

- Introduce half of the maximum voltage to be output later by the definite command value output. Slowly increase or decrease the command value.

  Measure motor speed with manual speed meter
- Adjust the speed with potentiometer R19 to half the value given in the specification.
- Introduce full voltage level. Slowly increase or decrease command value. The speed must reach the maximum value given in the specification. If it does not, correct with R19.

2.8 ADJUSTMENT OF THE FIRING ANGLE SHIFT

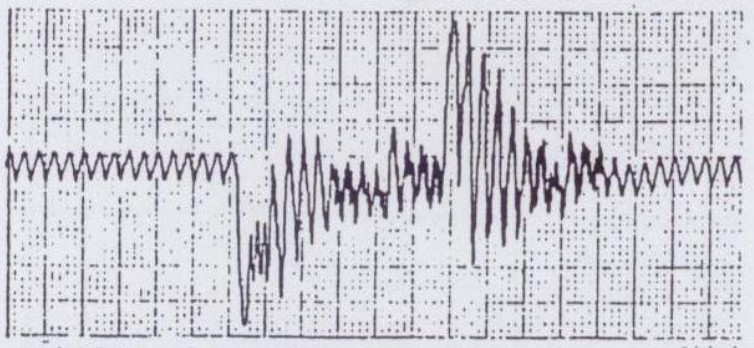
- Accelerate the motor to max. speed and brake. (introduce command value as step function)
- Observe the current during the deceleration procedure with a storage oscilloscope.
- At the beginning of the braking the peak current must be $I_2 \cdot \sqrt{2}$
- At the end it should be $I_1 \cdot \sqrt{2}$.
- for I_1 and I_2 : see specification, item 7
- The current flow can be changedwith adjustment of R18

  Caution: If R18 becomes equal or smaller than the resistance set on R20 this might result in uncontrolled acceleration of the motor above the max. speed.

2.9 OPTIMISATION OF THE SPEED REGULATOR

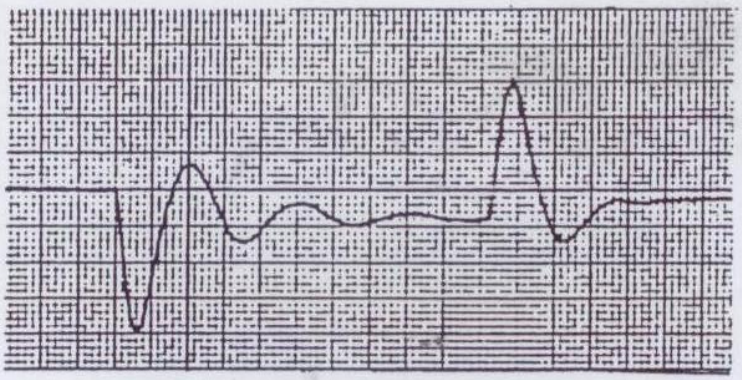
- During the optimisation of the speed regulator the command value should be introduced acc. to the same function as later in normal use. I.e.: if later the command value will be introduced as E-function with 60 ms time constant (=KV1) the battery box should also be switched to E-function. But the time constant should, however, be approx. 10% lower, i.e. approx. 55 ms.
- Measure the speed regulator output (TP2) with the storage scope.
- The level of the command value must be such that the amplifier works just below the current limit during acceleration and deceleration (current limit = 10V on TP2)

- If the P-portion is amplified too much or the I-portion made too small, the speed regulator will become unstable.

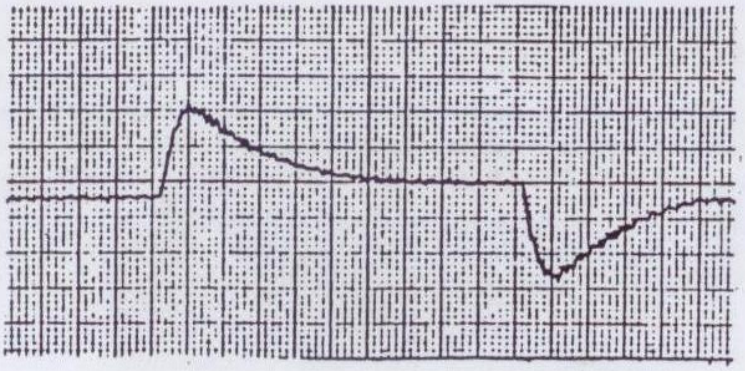


The instability is mainly due to the excessive tacho roughness.

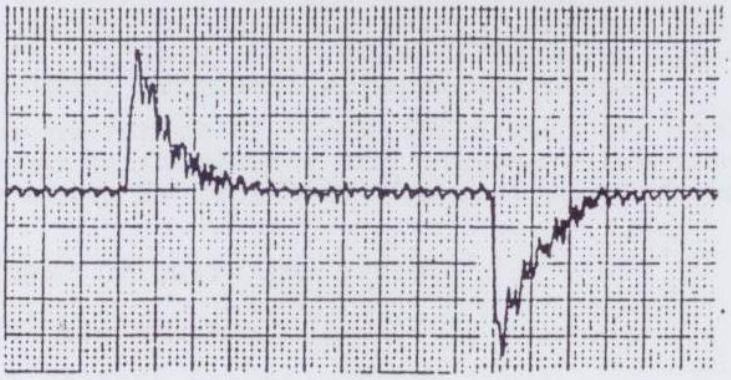
- If the P-portion is too small the speed regulator is also unstable, but at very low frequency.



- When the I-portion is too large the speed regulator is stable but, because of the high time constant and simultaneous low P-amplification, it reacts too sluggishly.

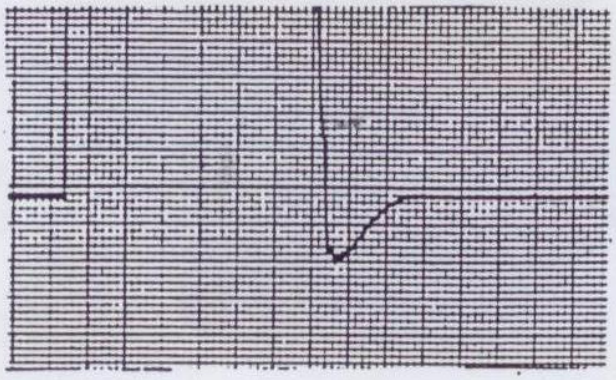


- When the speed regulator is adjusted to optimum the signal is as follows:

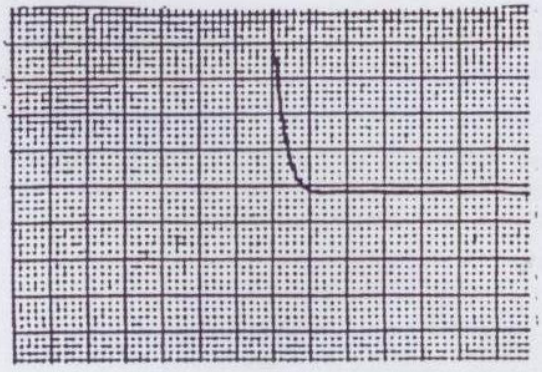


2.9.1 D-PORTION

- Accelerate motor to max. speed and decelerate (command value function as in 2.9)
- Measure tacho signal with the storage scope (TP1). Set scope to high resolution, so that only the low section of the tacho signal appears.
- Observe the tacho signal during the deceleration.
- If there is a bad relation between inertia, motor power and acceleration or deceleration time the tacho signal will overshoot:



- This overshoot can be reduced or eliminated with a D-portion in the tacho input
- If some overshoot is found, connect a C-decade in pos. C13.
- Increase C13 from the minimum value (approx. 4.7 nF) in steps, until the overshoot is eliminated.



- measure the speed regulator output again with the scope. If C13 is too large it it possible that the speed regulator becomes unstable, because the tacho roughness has more effect on it. In this case: make C13 smaller again, until the signal roughness appears acceptable.
- Any further overshoot of the tacho signal can then only be eliminated by increasing the command value time constant (smaller = worse KV factor in the positional servo loop).

2.10 FINE ADJUSTMENT OF DRIFT AND SPEED

- Switch off main switch
- Disconnect battery box at command input
- Remove bridge between X11/6 and 0V
- Connect final command source (e.g. CNC)
- Switch on main switch and power contactor
- Select axis
- Carry out fine adjustment of the motor drift with speed input "0". or symetry with pot. R22
- Introduce speed
- On installations without positional servo loop:

  Use a manual speed meter to set the actual speed to the command speed (pot R19)
- On installations with positional servo loop

  Set required KV factor with pot. R19

$$KV = \left|\frac{V}{S}\right| \qquad V = \text{axis velocity} \left[\frac{m}{min}\right]$$

$$S = \text{lag}$$

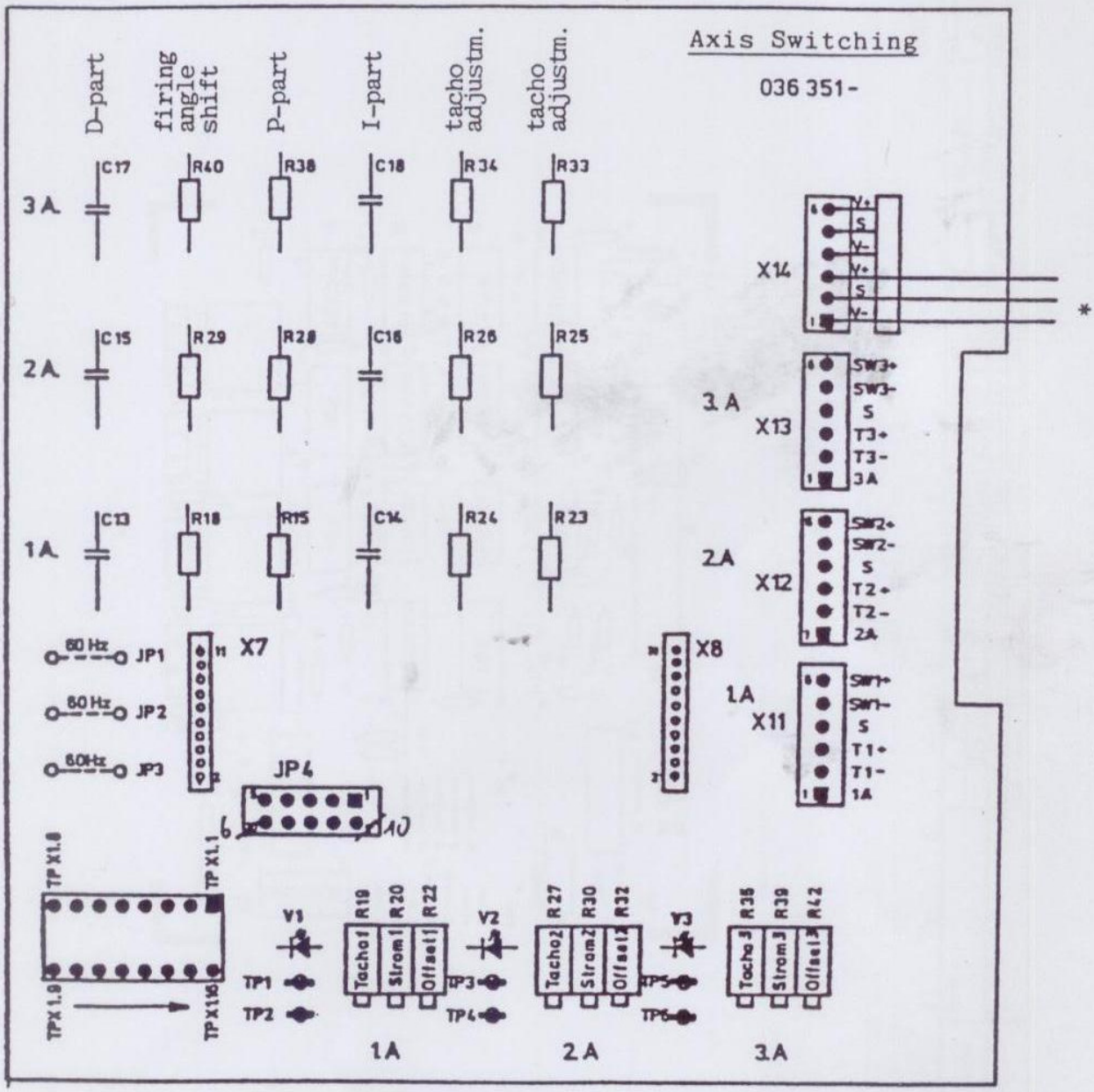
Example: V = 10 m/min
S = 10 mm

$$KV = \frac{10}{10} = \underline{\underline{1}}$$

2.11 CONCLUSION OF THE INTEGRATION

- Switch off main switch
- Solder in all resistance and capacitance values determined with the RC-Decade in the amplifier as fixed values.
- Seal all potentiometers
- Note down all optimisation details not coinciding with the details given in the specification and send the list to PSV1-A (for pre-optimisation of future units).

ADJUSTING ELEMENTS



* regulator & logic 2-pulse
X6 PIN 10-12