Description and Adjustment of the Customer Print

Standard prints RP100 / RP150

Concerning interfaces, connector pin-outs, control signals, customer prints and electrical values the DX 808 series is compatible to the SM 801.....807 DC family. The setup operation and calibration routines are principally the same in all of H&R product lines.

-Attention- Insert or unplug the customer print only in currentless condition. Otherwise FET switches and op amps may be damaged. Use electrically isolated soldering devices! Carefully observe proper fit when inserting the print because it has no mechanical guide!

The standard customer print RP100 contains:
- tacho adjustment
- differential input amplifier A01 with filter wiring features
- speed control A05 with circuitry
- FET switch A04 /1u.2 for standstill default and by-pass of the speed control I-share
- potentiometer for adjustment of the offset, tacho calibration, P amplification and current limits.

The version RP150 of the customer print additionally contains a reference voltage integrator that consists of the op amps A02 and A03. See the wiring diagrams " Customer print RP100 and RP150 " for this.

1. Tacho adjustment

The tacho voltage is adjusted by resistor R6 (on soldering rivets) and potentiometer P1.
R6 is calculated as follows:

R6 = (VT - 10) kOhm (VT = tacho E.M.F. at reference motor speed in Volt)

Example: Tacho generator with 20 V at 1000 rpm, reference speed 1500 rpm:
R6 = (20 x 1.5 - 10) kOhm = 20 kOhm

Recommended value for R6 = 18 kOhm because the adjustment range can be increased with potentiometer P1 by 10 kOhm. A metal film resistor should be used for R6, if high speed constancy is required.
As a standard R6 has 2.2 kOhm. This value is suitable for the calibration of tacho generators with an E.M.F. of 4...7 V / 1000 rpm at a reference speed of 3000 rpm.
The tacho voltage at maximum operating speed should be at least 10 V. In this case replace resistor R6 with a short-circuit jumper and set P1 to minimum.

The tacho filter is 3-stage with 500 Hz cut-off frequency. This eliminates high frequency static on the tacho voltage as well as the tacho monitoring frequency, at negligible phase shift.

2. Input filter and differential amplifier A01

To assure linear operation of the op amp, high frequency electrical noise that may be induced on the reference voltage line must be suppressed. For this the reference voltage inputs can be wired with filter capacitors.
Observe, that the drain capacitors on both input lines must be the same, when using the differential inputs.
Cut-off frequencies of the input filter (RP100-2, RP150-3) to the inputs 6 and 7 of the customer print (2-stage)
R16a, R16b, R16c, R18a, R18b, R18c = 3.32 kOhm

C4a, C4b, C5a, C5b	Cut-off frequency fo	Phase shift at fo
1 nF	48.0 kHz	5 µs90 ° el
10 nF	4.8 kHz	52 µs "
22 nF	2.1 kHz	114 µs "
47 nF	1.0 kHz	245 µs "
100 nF	480 Hz	520 µs "

Standard equipped with 10 nF on customer print RP 100-3 /150-3.

Filter at the inputs 8 and 9 of the customer print (single stage)

R17a, R17b, R19a, R19c

C3a, C3b	Cut-off frequency fo	Phase shift at fo
1 nF	31.8 kHz	4 µs 45 ° el
10 nF	3.2 kHz	40 µs"
22 nF	1.5 kHz	86 µs"
47 nF	678 Hz	185 µs"
100 nF	318 Hz	400 µs"

Standard equipped with 10 nF on customer print RP 100-3 / 150-3.

Input filter for the suppression superimposed AC voltages (e.g. for NC's with low-frequency positioning control)

C7a, C7b	Cut-off frequency fo	Phase shift at fo
1.0 nF	15.9 kHz	8 µs45 ° el
2.2 nF	7.2 kHz	18 µs"
3.3 nF	5.0 kHz	23 µs"
4.7 nF	3.4 kHz	30 µs"
10.0 nF	1.6 kHz	78 µs"

As a standard C7a and C7b are not installed.

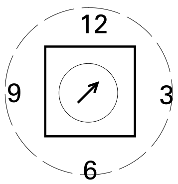
Note The effective phase shift is significantly more decisive for the stability of positioning control loops than the amplitude attenuation. Therefore the filter capacitors cannot be selected in any desireable large size. Frequencies above 1 kHz are additionally muffled by a current reference voltage filter with 24 dB/octave, that is placed between speed controller output and current controller input.

3. Speed control A05 with wiring

The speed control can be wired as P, PI, PID or PD control. It comes standard-wired as PI control. The proportional sensitivity can set with potentiometer P5 from 5.6...176.

Standard: R34 = 39,2 k R36 = 330k R38 = 220 k P5 = 10 k
The set proportional sensitivity can be read on potentiometer P5.

Drawn position: Minimum
left stop



Position	Amplification
min.	5.6
3	7
6	12
7	15
8	22
9	33
10	70
max.	176

The standard integration capacitor C10 has a value of 0,22 µF. With the feed-back resistor R38 = 221 k this results in an integration time constant of T = R38 x C10 = 50 ms. This small time constant is adapted to modern, highly dynamic servo motors. On drives with low friction and large flywheel mass the integration capacitors can be increased to approximately 0.68 µF.

4. FET switch A04/1,2 for controller interlock and standstill default

The FET switch A04/1 separates the speed control A05 from the input differential amplifier A01 on standstill default STV, controller interlock positive RSP, controller interlock negative RSN and general controller interlock RS. The speed controller input is then grounded via R33 (2.2 k) to earth. Therefore, with STV signal = Low defaults to a controlled standstill, regardless of a possibly applied reference value.

During general controller interlock RS both output stage bridge diagonals are disabled. A04/1 together with A04/2 (bypasses the I-share of the speed controller) sets the speed controller output to zero, with the motor (and tacho) at standstill.

During direction-oriented controller interlock RSN/RSP the FET switch A04/2 bypasses the I-share of the speed controller after approximately 0.2 sec. to avoid integration of the speed controller. Upon activation of RSP or RSN the amplifier generates braking current until standstill of the motor.

During end position clearance signal EFR the FET switch A04/1 is closed in priority to the STV, RSP, RSN and RS signals. This enables to drive out of the end position that was reported before by the direction-oriented controller interlock signal.

5. Offset calibration of input differential amplifier and speed controller

Potential differences between higher-priority controller and amplifier, as well as the offset voltage of the controller output (Position control output) can be compensated with the input differential amplifier A01. Observe however, that a very large offset disimproves the characteristic temperature line of the differential amplifier. Therefore, the analogue output of the higher-priority controller should be calibrated as close to 0 as possible.
The device must have operating temperature for the offset calibration.
Perform the calibration as described below:

a) Disable the amplifier with controller interlock RS (contact 14 open)
b) Set default in the higher-priority controller to "0". For instance reset or "digital control deviation = zero" can be pre-selected. In numeric controllers with automatic reset the standardised status zero is generated after switching on. In this case switch the numeric controller off and then on again. Important: Check if the standardised status "Zero" is attained (switch display table to contouring error display if possible).
c) Use an oscilloscope or isolated millivoltmeter for calibrating the output voltage of the op amp with potentiometer P2 to 0 mV. Connect the negative pole to ground of customer print (e.g. lower end R33), and positive pole of the instrument to the lower end of R20. See layout diagram "Customer print".

Note If the amplifier is disabled by RS then the condition for the calibration of the speed controller A05 is automatically fulfilled: The input is grounded to earth, the integration capacitor is bypassed.

d) Connect an oscilloscope or isolated millivoltmeter to contact 19 of the customer print (as in c) and adjust potentiometer P4 to 0 mV. This calibration should be performed at high amplification of the speed controller (turn P5 clockwise).
An AC voltage with 3.5 kHz (285 μs period) can be detected on the speed controller. These are residuals of the tacho monitoring voltage and have no influence on the speed control characteristics.
Electronic multimeters can be deceived by this AC voltage and display wrong values. If necessary, ground the tacho monitoring transmitter during the offset calibration at measuring point 1 (see layout diagram of control PCB RP203).

Offset calibration on customer print with reference voltage integrator (RP150):

For customer print with reference voltage integrator first perform steps a) to c) described above. Then calibrate the reference voltage integrator as described below:

e) Controller interlock remains active (contact 14 open)
Connect an oscilloscope or isolated millivoltmeter to output A03.6 (corresponds to integration capacitor). Connect ground of the measuring instrument as described in c). Adjust the output voltage of the integrator A03 with potentiometer P3 to 0 mV.
f) Calibration of the speed controller according to section d) above.

6. Optimisation of the speed control circuit

For optimal adjustment of the speed control circuit to the controlled system reference pre-select voltage steps on the speed control circuit and observe the behaviour of the tacho voltage. The voltage steps can be generated by a low-frequency square-wave generator. The amplitude should be set as to avoid that the amplifier is driven into current limit during control operations.

Reference voltage step generation without square-wave generator:
Connect a potentiometer (approximately 5...10 k) to +15 V ext. and earth (contacts 19/20 of the input terminal panels). Connect the sliding contact of the potentiometers to contact 4. Connect the standstill default signal STV via a n/o contact to +15 V.
When the n/o contact is operated the FET switch enables the speed controller input and switches to the speed reference voltage that is pre-selected by the potentiometer.

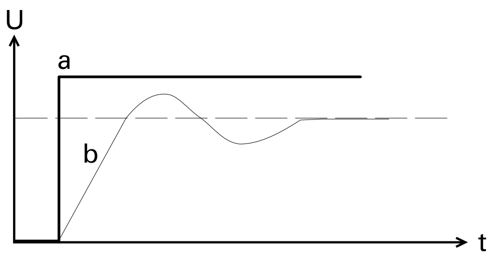
Note A monitoring voltage of 3.5 kHz is superimposed on the tacho voltage. It should therefore be measured in the tacho filter e.g. at R14a or R14b. A reduction of the tacho voltage in relation to the drop resistors R6, P1 and R14a must be taken into account.

Frequently, a suitable adjustment of the proportional amplification with potentiometer P5 is sufficient for optimising the speed control circuit. If a satisfactory result cannot be obtained then the integration capacitor C10 must be adapted. The integration constant is

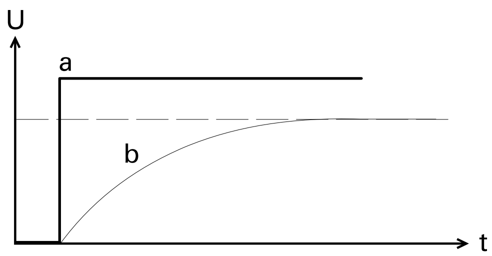
$$T_{IN} = R34 \times C10 = 39.2k \times C10$$

Step reaction from the speed control circuit at various adjustments:

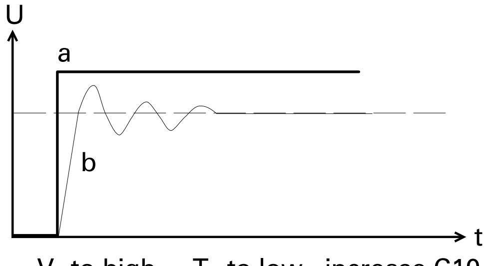
a = reference voltage step measured at R33
b = tacho feedback measured at R14a



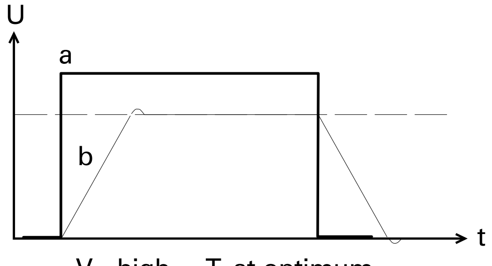
V_p to low T_I to high



V_p to low T_I very high, reduce C10



V_p to high T_I to low, increase C10



V_p high T_I at optimum

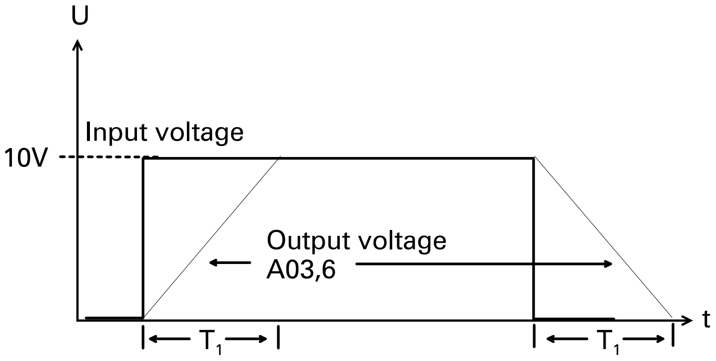
7. Adjustments on the reference voltage integrator (RP150-8)

Adjustment of the ramp increase:
See also wiring diagram RP150. The time constant of the reference voltage integrator is

T = 0.75 x C9 x RS

whereby RS corresponds to the parallel circuit R29 and R30 respectively R31 and R32.

Standard component: C9 = 1 μF
R29 = R31 = 1 MOhm
R30 and R32 not installed
T1 = 0.75s



Time constants with unchanged integration capacitor (C9 = 1μF):

T1	R30 = R32
0,75 s	open
0,5 s	2,2 M
0,2 s	390 k
0,1 s	150 k
50 ms	68 k

Capacitor values with unchanged resistors (R29 = R31 = 1 MOhm, R30 and R32 not installed):

T1	C9
0,75 s	1 μF
0,5 s	0,68 μF
0,165 s	0,22 μF
75 ms	0,1 μF

Installing R30 and R32 with different values result in differences increases of the positive and negative ramp. By this the ramp increase for start-up in positive rotation and braking out of negative rotation corresponds with the ramp increase for start-up in negative rotation and braking out of positive rotation.