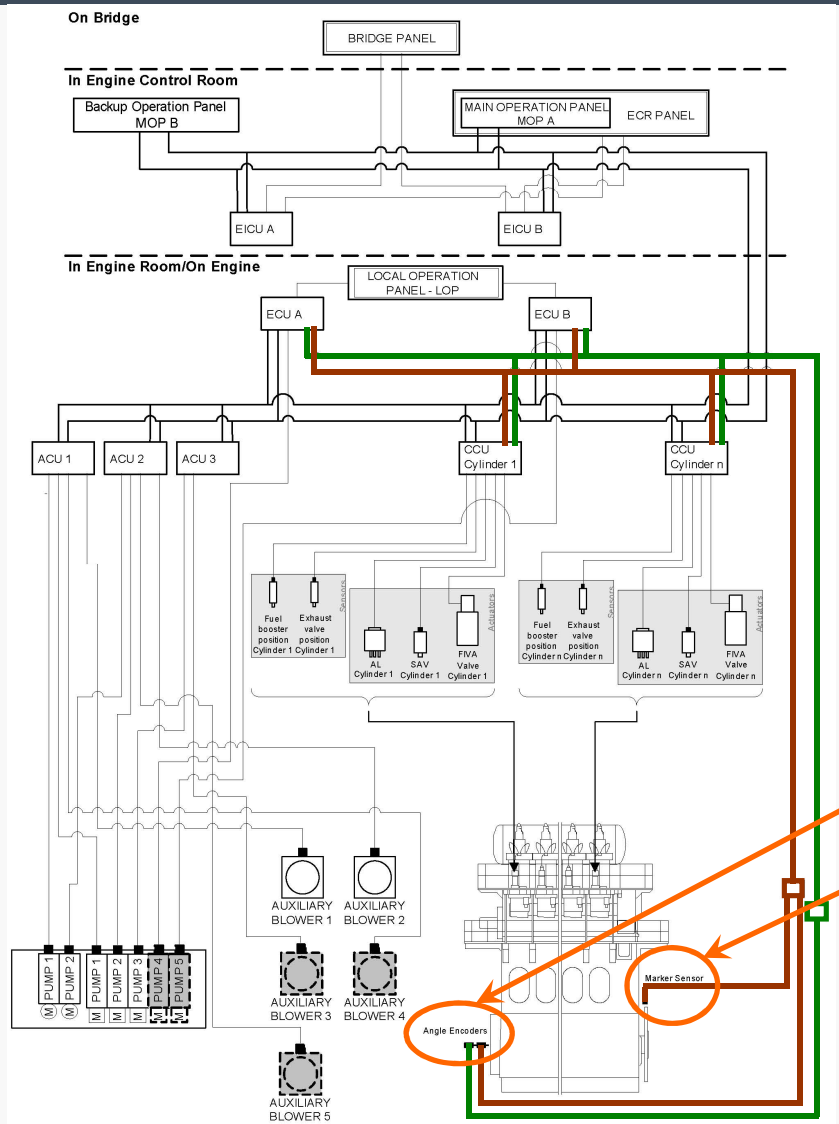
Engine Control System
Tacho System



There are two redundant Tacho systems:

- **System A**
- **System B**

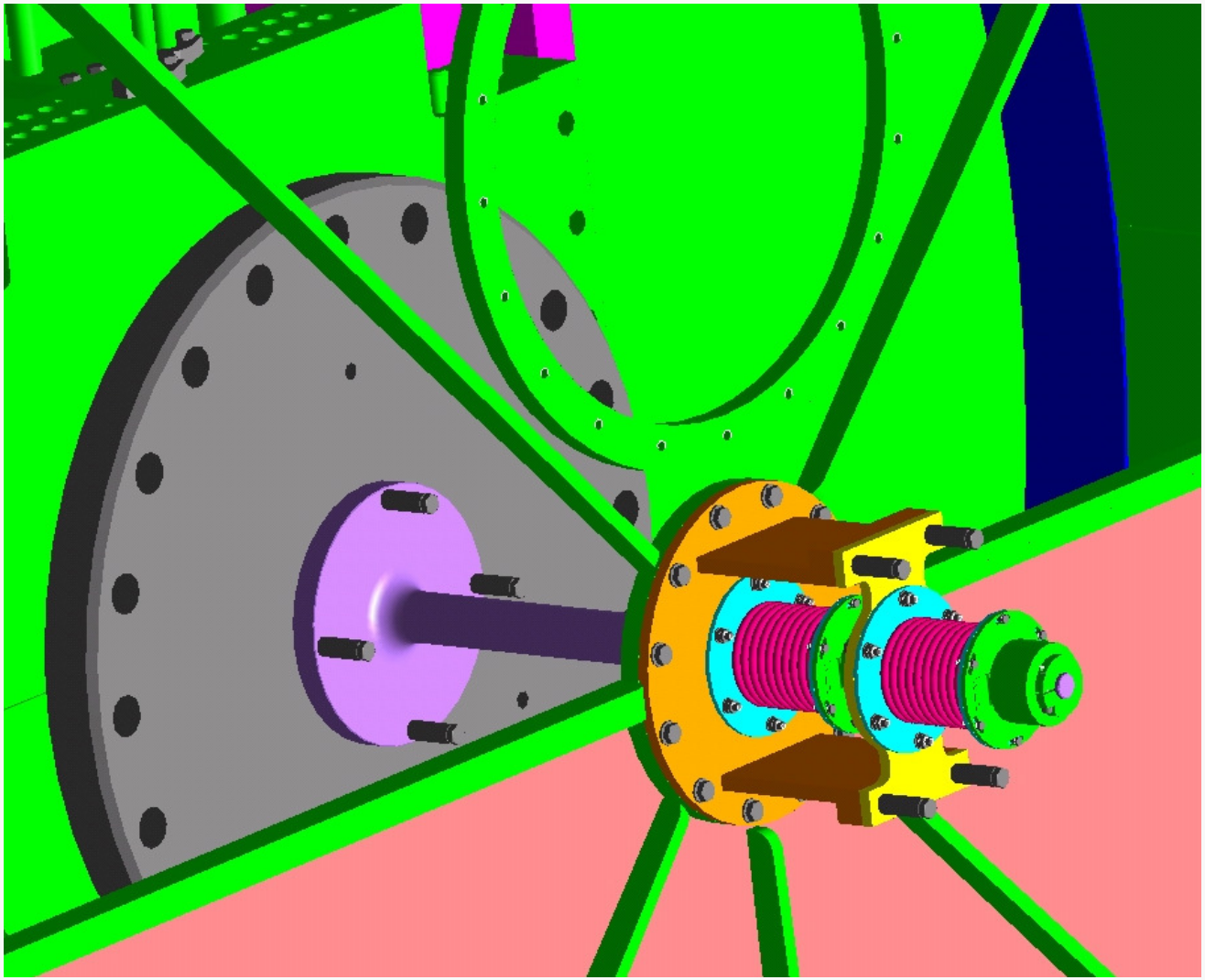
Standard is:

angle encoders with one

reference sensor on the turning wheel (A-system)

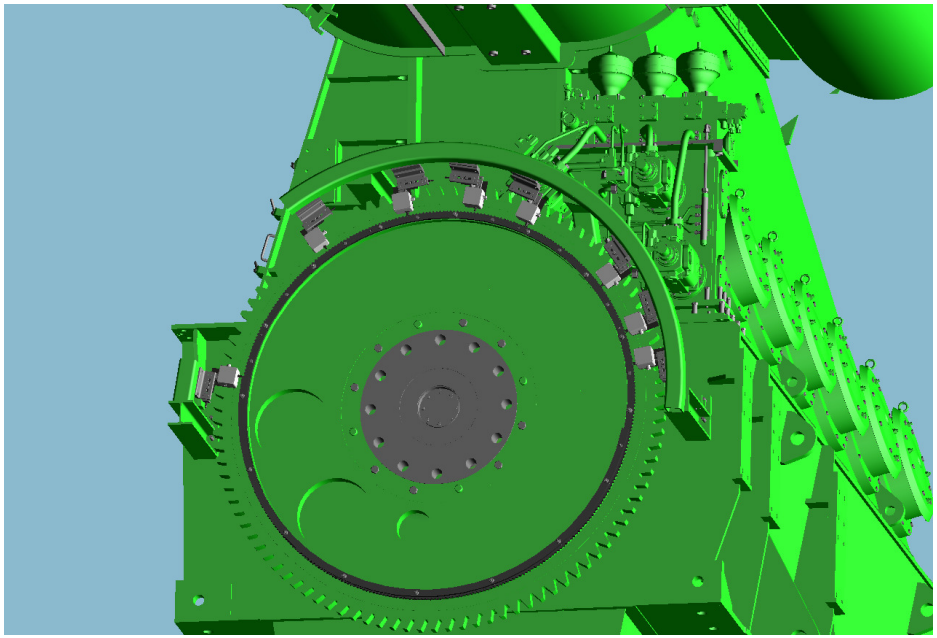
Option is sensors at the turning wheel

ME Tacho System

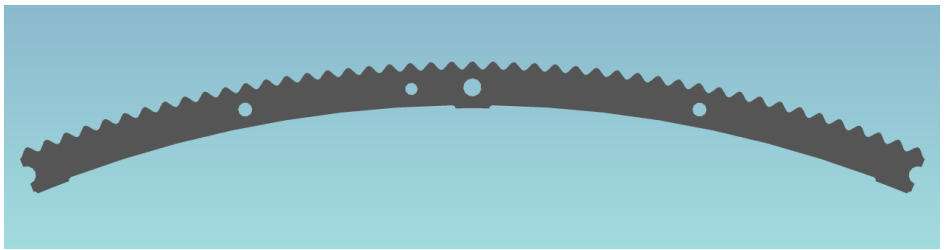


Tacho System
Angle Encoder, 12K98ME-C

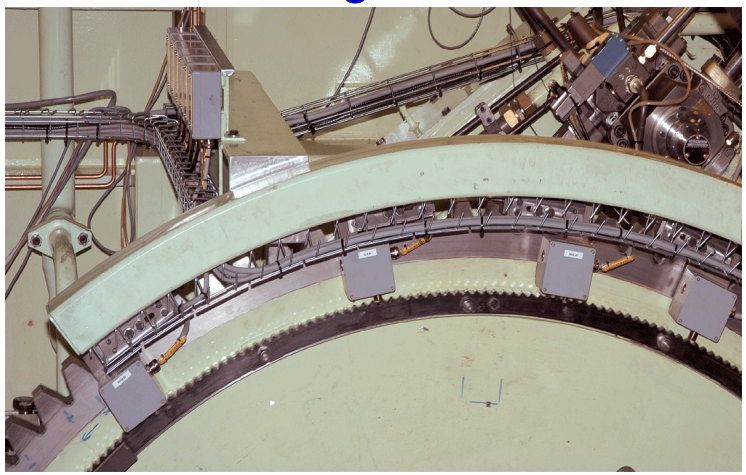
ME Tacho system



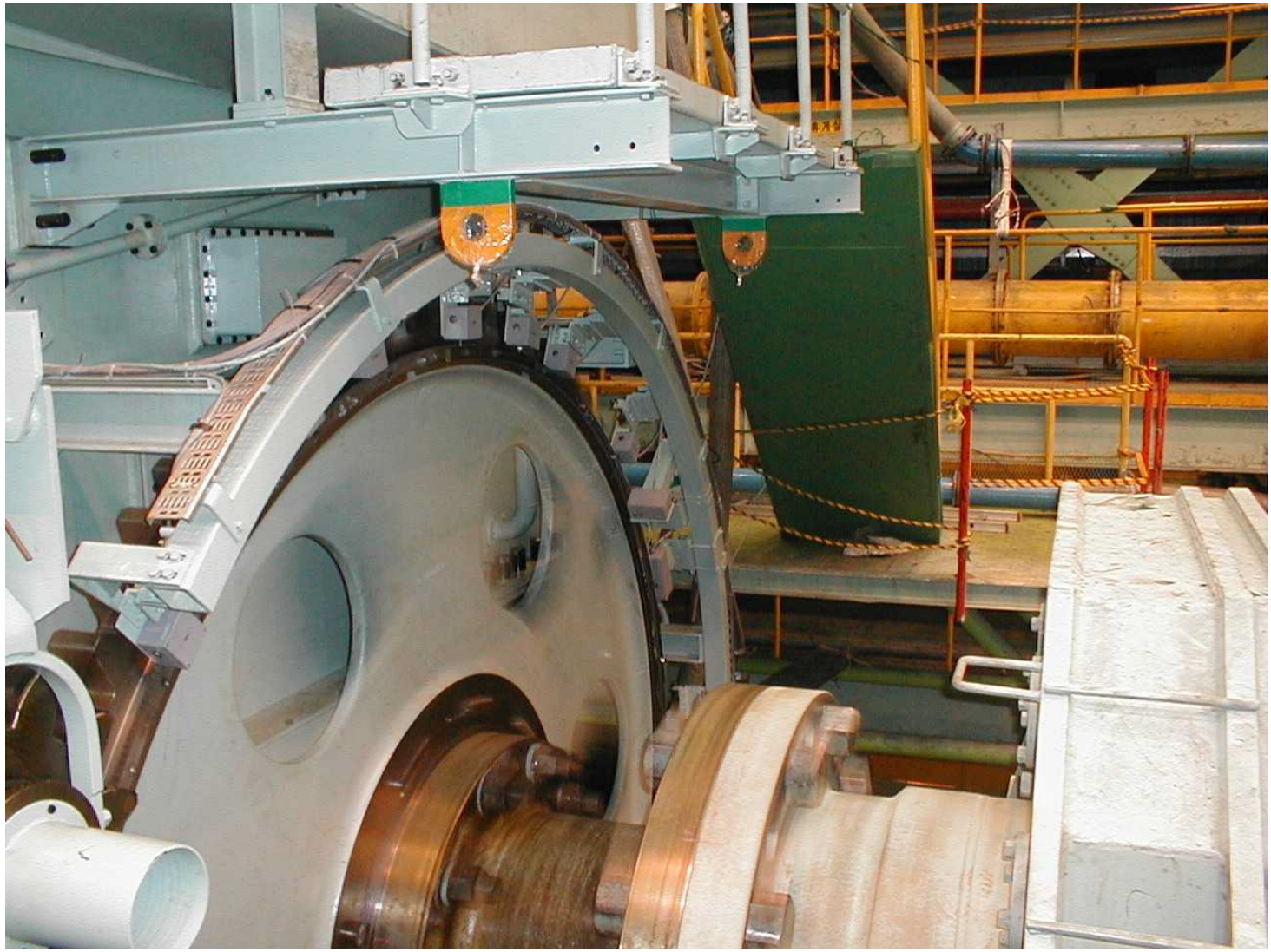
Trigger ring segment with a sine-curved tooth-profile. The total trigger ring is built by eight equal segments.



- Two redundant set of sensors.
- Each set measure engine speed and crankshaft position for synchronization of the control events.
- Each set consist of four sensors. Two quadrature sensors measure on a trigger ring with 360 teeth and two marker sensors measures on a semicircular ring.

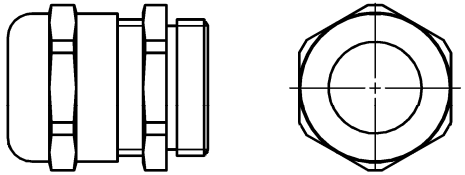


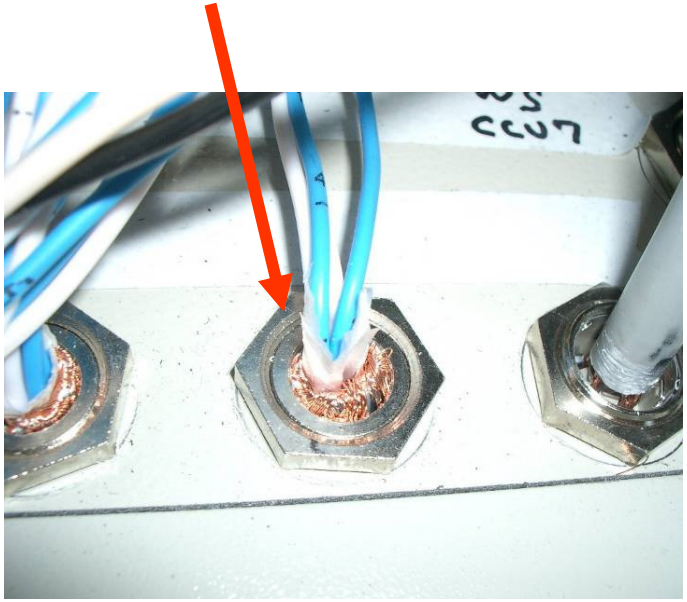
Tacho Sensors
Nordic Brasilia – 6S70ME-C

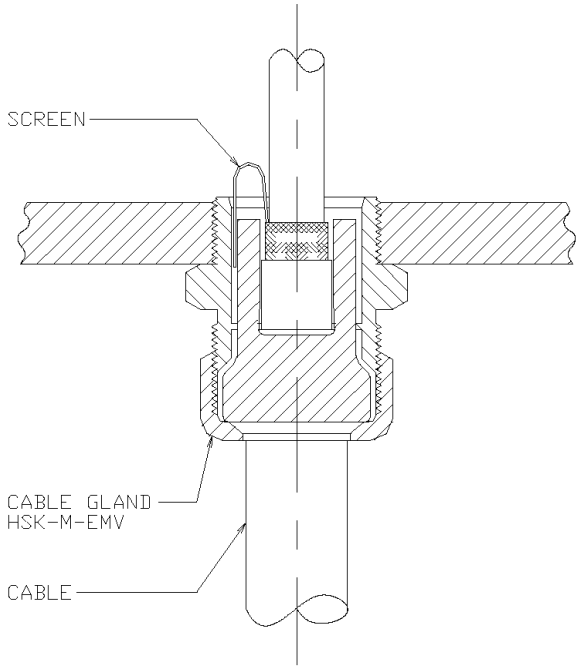


ME Engine
Installation of cables, notice screen

- Cable gland with screen fold-back inset

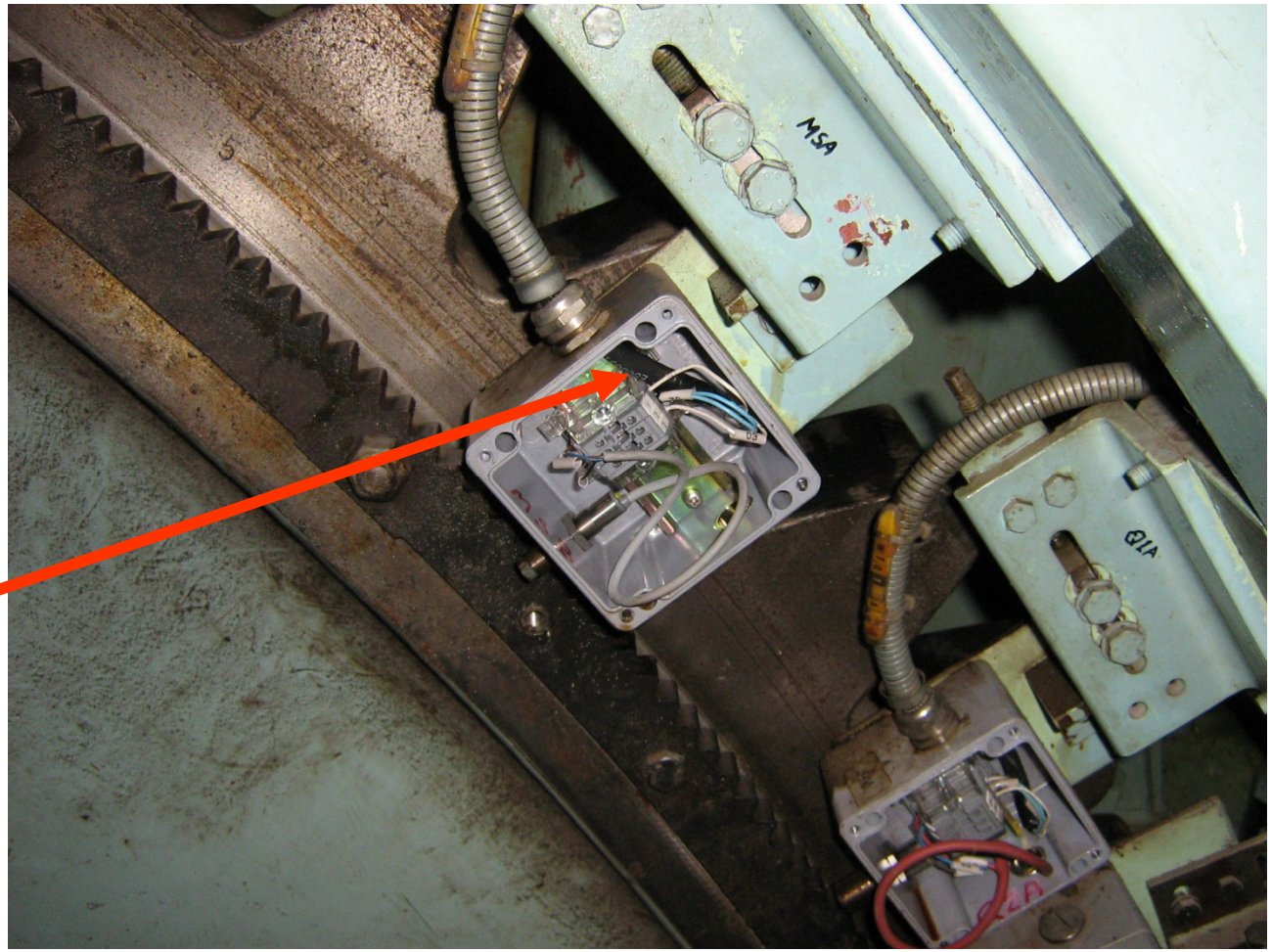




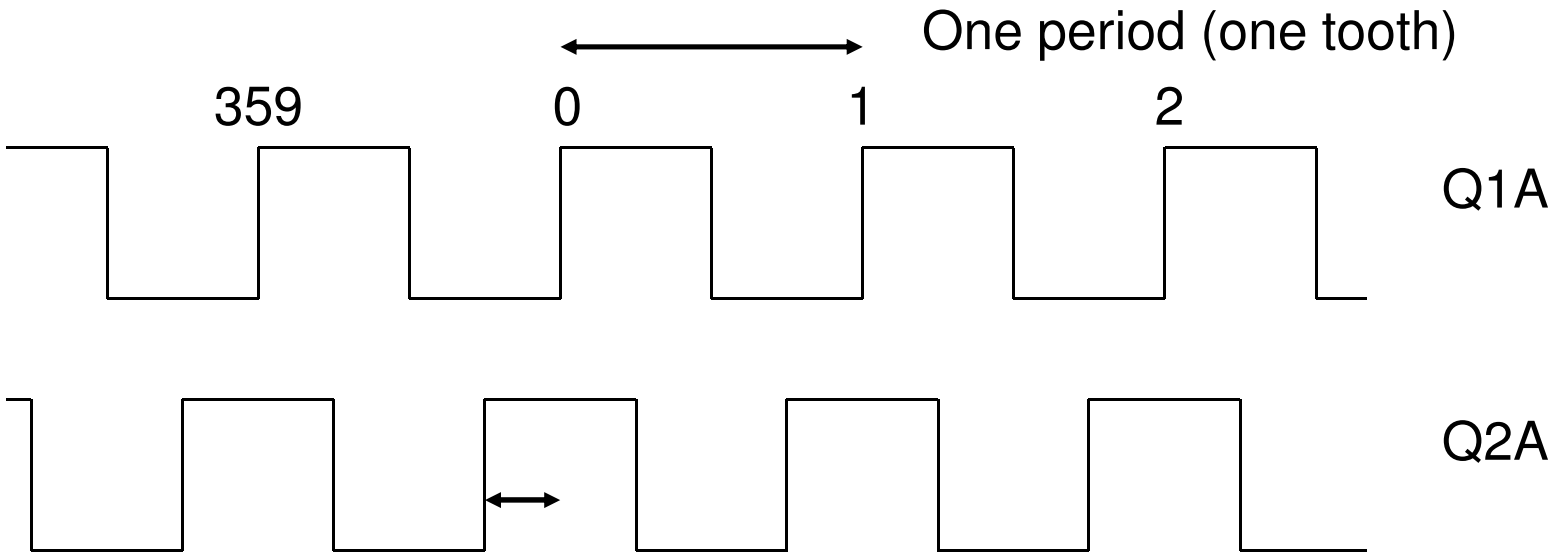


ME Installation of Cables
A typical error – this is WRONG

- ERROR:
- Screen not connected!



ME Engine
- How does the tacho count?

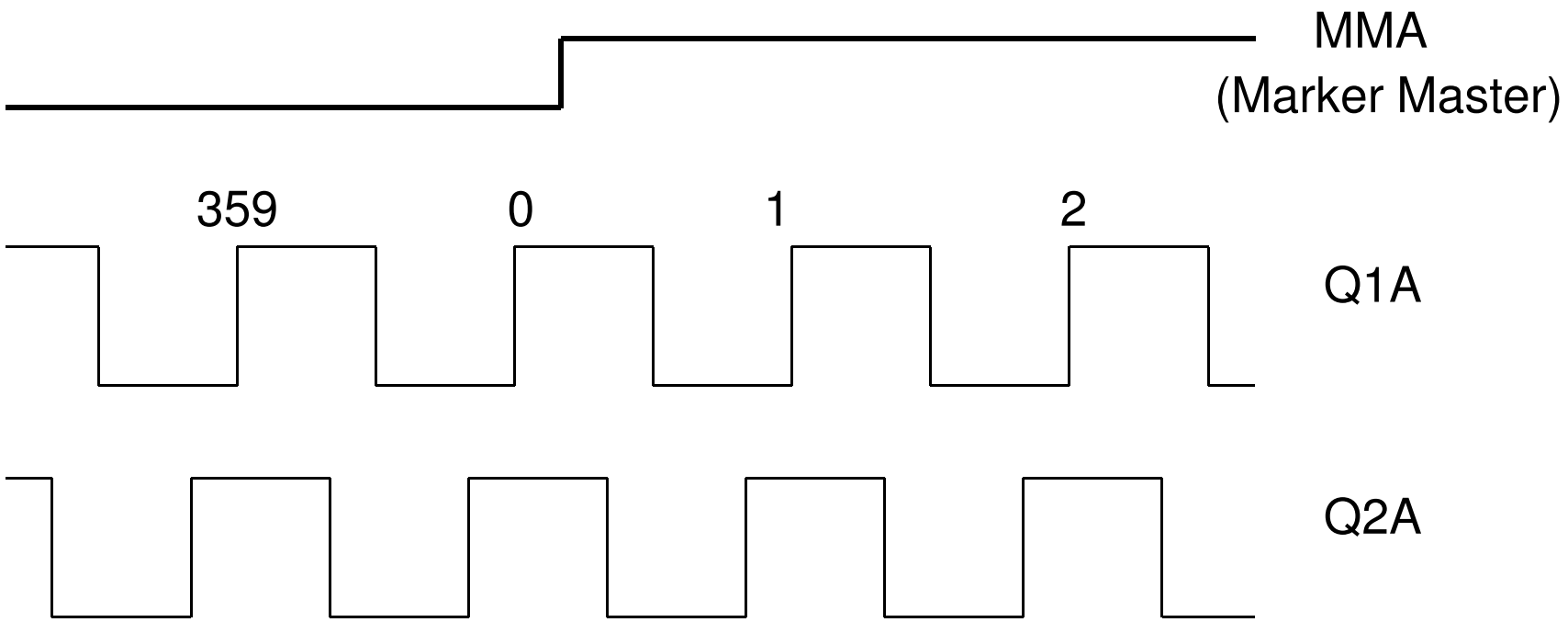


Distance between flanks is 25% period = a quarter => ”Quadrature ”

If Q2A is high when Q1A goes high: count up

If Q2A is high when Q1A goes low: count down

ME Engine
- Markers check the counters

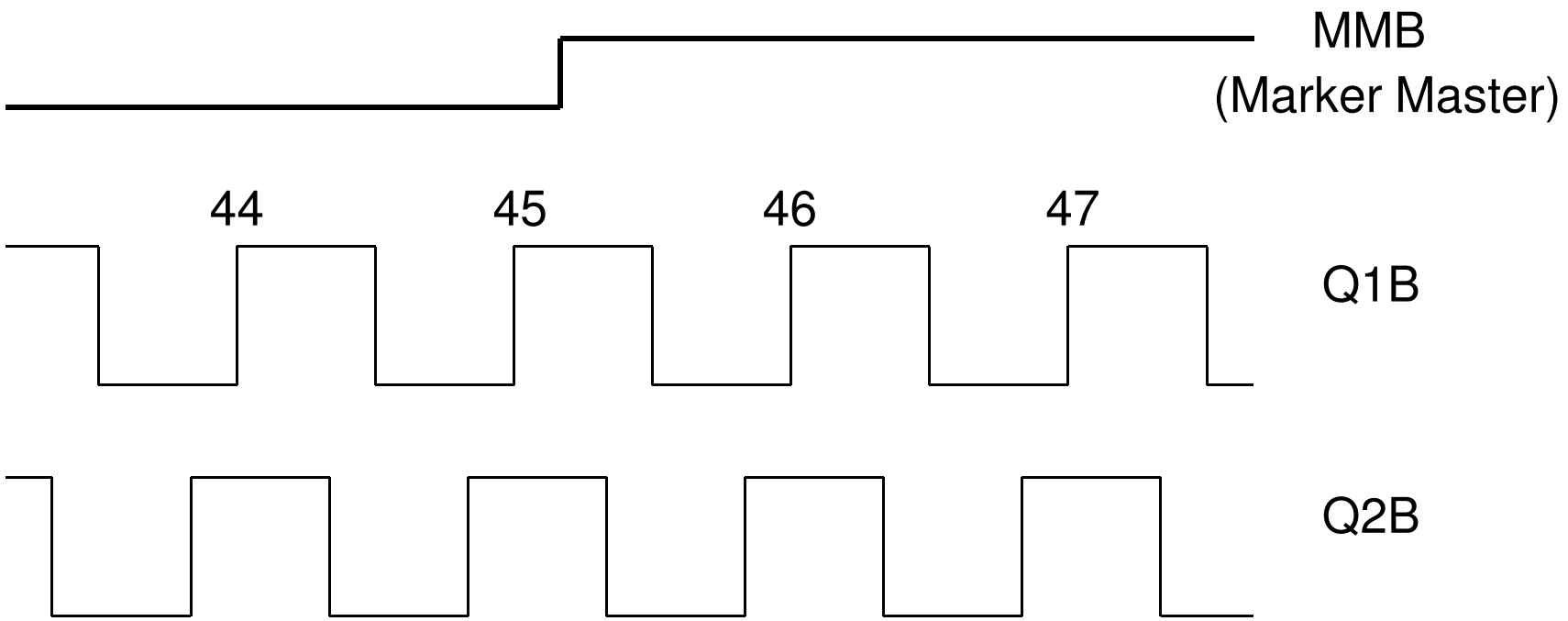


The Marker signals are only used for verification during normal running

Example above:

The Tacho verifies that quadrature counter has reached ”0” when MMA shift

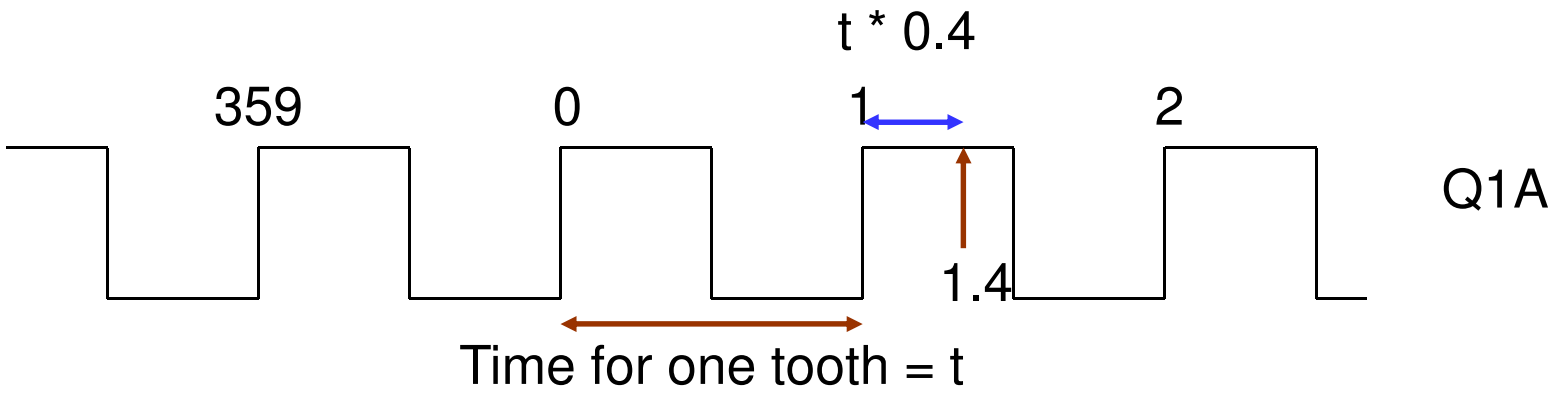
ME Engine
- Tacho B is similar



Example above:

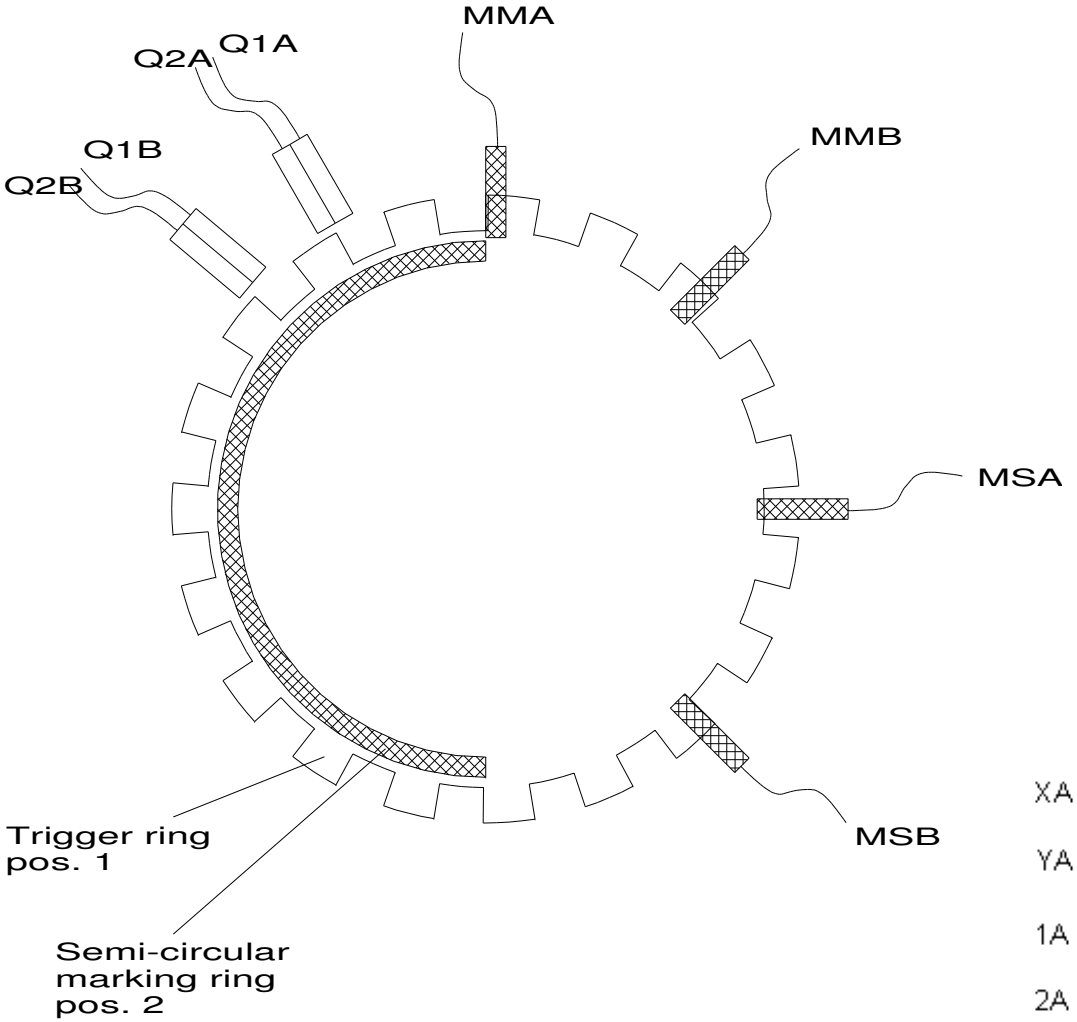
The Tacho verifies that quadrature counter has reached ”45” when MMB shift

ME Engine
- The tacho can do fractions: Ex. 1.4



- If the Tacho must send an event on position 1.4, it will first find position ”1” and then wait 0.4 multiplied with the time it took to pass the previous tooth. The red arrow is the time of a full tooth, the blue arrow is the fraction (interpolated in time)

Tacho System – signal names



System A (powered from ECU A)

MMA = Marker Master A

MSA = Marker Slave A

Q1A = Quadrature 1A

Q2A = Quadrature 2A

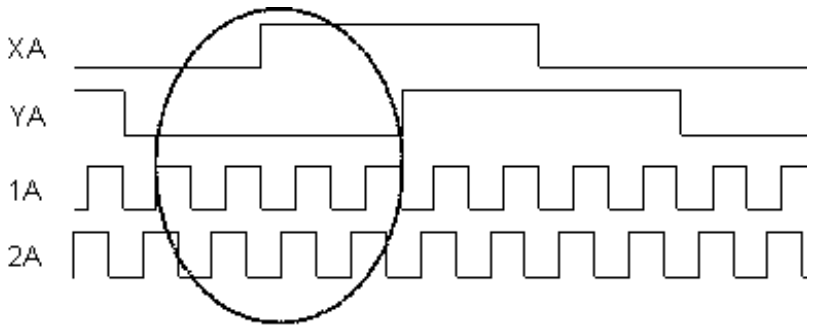
System B (powered from ECU B)

MMB = Marker Master B

MSB = Marker Slave B

Q1B = Quadrature 1B

Q2B = Quadrature 2B



ME Engine
- starting air timing after power-up

- Same signals are generated by encoder and flywheel systems.
- The four marker sensors triggered by a semi-circular ring (or MMA from encoder A, MSA sensor from turn wheel and MMB/MSB from encoder B) are used to be able to start the engine after power up.
- The next slide animation shows the semi-circular in different crank shaft positions (grey), and in the table it can be seen which sensors are activated in the different positions of the semi circular ring.
- An accuracy of ±22.5 degrees is achieved by the marker signal evaluation at power-up. This is sufficient for starting air.
- Final accuracy is achieved when a marker signal shifts.

ME Engine
- Problems just after power-up

- If only one Tacho set (A or B) is active at the moment of power-up, initial position may be wrong up to 45 degrees
- 45 degrees may be too much so that starting air cannot turn the engine
- In case starting air does not turn the engine, try to start in the other direction
- In case the other direction does not work either, do electrical turning until the MOP ”detailed” picture shows approximately the same angle as the turn wheel scale. Then start can be performed.

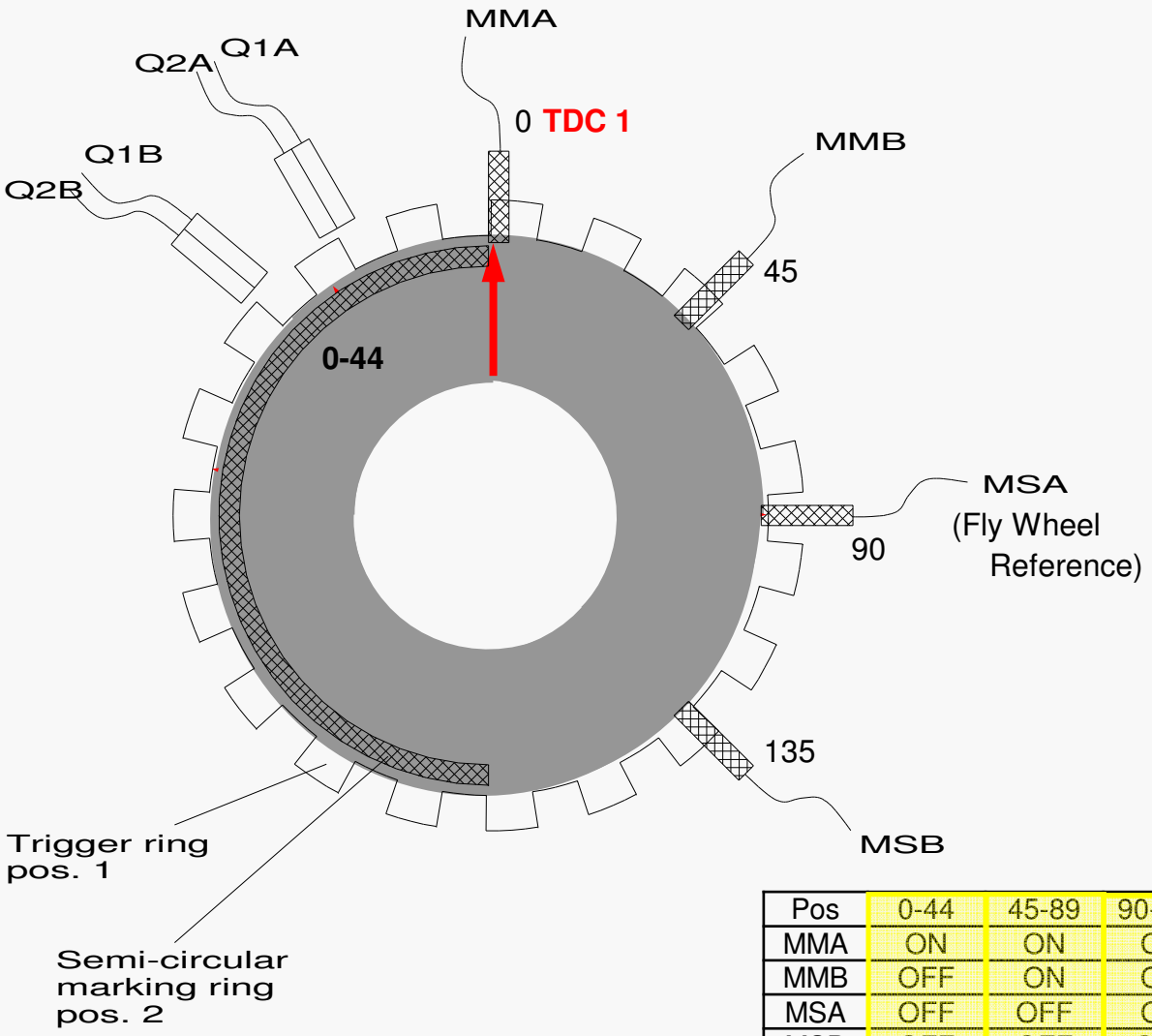
- Please note that this problem is only seen in case of power up with only one Tacho set active.

ME Engine
- Problems just after power-up

- If quadrature signals for Tacho sets A and B are ”crossed”, Tacho A may count up when Tacho B counts down!
- This can be seen on the MOP screen during electrical turning, Tacho A and B do not follow each other.
- If starting air is used and the engine starts to turn, MPCs may be overloaded (out of CPU power) and therefore end up in ”halt” state

- Please note that this problem is only seen if cabling to encoders/turn wheel has been changed or newly installed. Diagnosis is easy using the ”detail” picture on the MOP.

Assembled (complete)
Tacho system overview



System A (powered from ECU A)

MMA = Marker Master A

MSA = Marker Slave A

Q1A = Quadrature 1A

Q2A = Quadrature 2A

System B (powered from ECU B)

MMB = Marker Master B

MSB = Marker Slave B

Q1B = Quadrature 1B

Q2B = Quadrature 2B

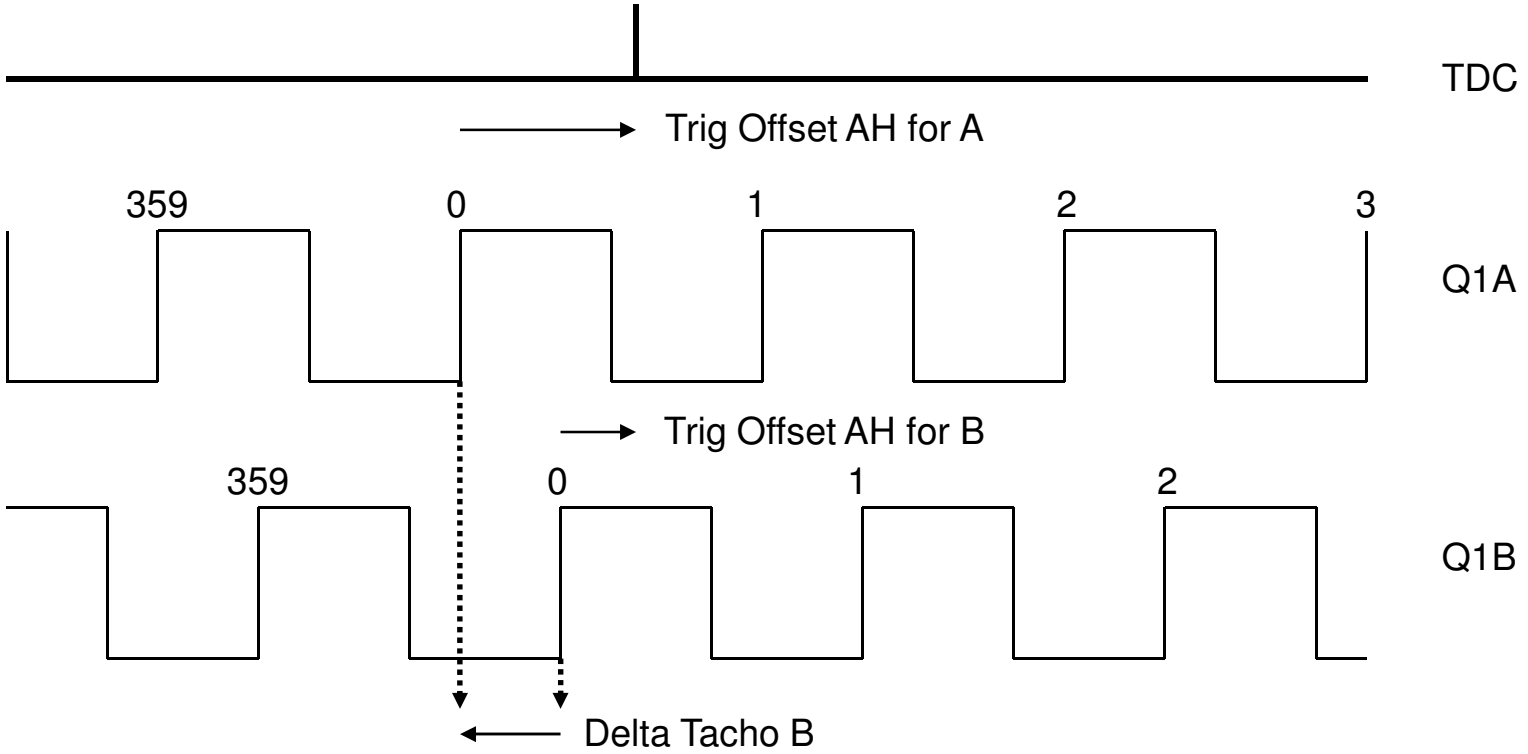
Pos	0-44	45-89	90-134	135-179	180-224	225-269	270-314	315-359
MMA	ON	ON	ON	ON	OFF	OFF	OFF	OFF
MMB	OFF	ON	ON	ON	ON	OFF	OFF	OFF
MSA	OFF	OFF	ON	ON	ON	ON	OFF	OFF
MSB	OFF	OFF	OFF	ON	ON	ON	ON	OFF

ME Engine
- When power fails or another failure

- The signals must arrive in the correct sequence (both Q- and M-sign.)
- The signals must arrive at a minimum speed (this handles power failure where all signals stay at zero)
- The quadrature signals are used for ”counting” the angle, this must match the marker positions
- No counting error is allowed when the Marker Master signal shifts
- Signals are checked for noise (= very short signals)

- Any of the above errors will cause ME control system to:
- 1) Select the other Tacho set
- 2) Set alarm ”Tacho set A failure” or ”Tacho set B failure”

ME Engine
- Trig Offset AH and Delta Tacho B

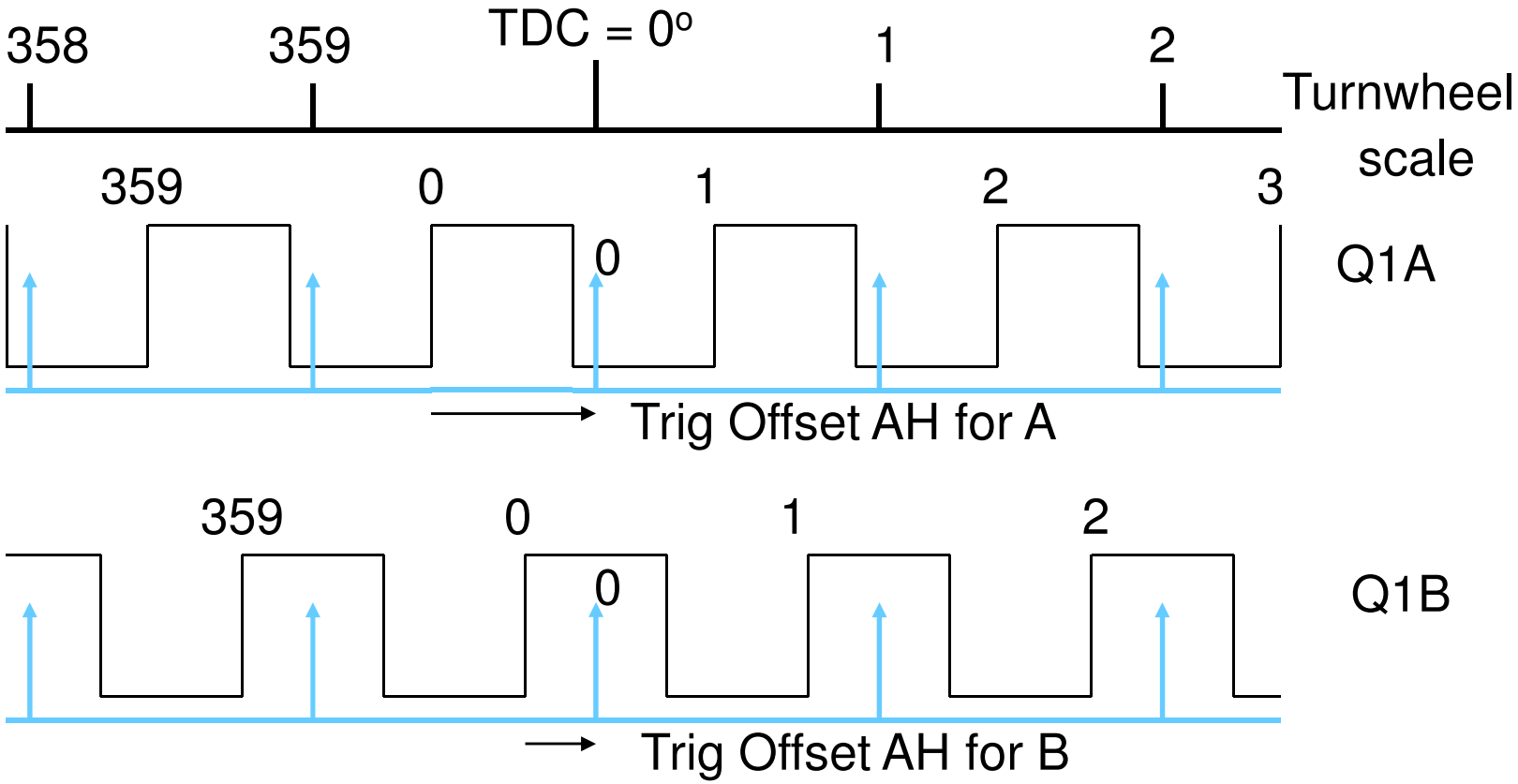


Trig Offset AH for A is measured by PMI system

”Delta Tacho B” is measured by the ME Tacho. It is read in the service terminal.

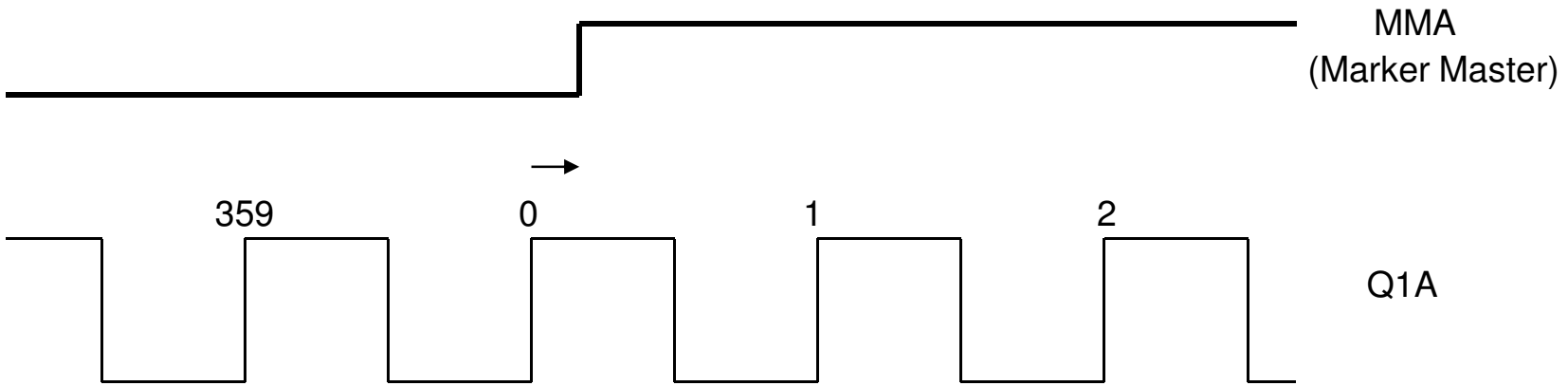
Corresponding Alarm: ”Delta Tacho B too big”

ME Engine
- Result of “Trig Offset AH”



Tacho Alignment Error is now zero; else ”Tacho Alignment Err” alarm will appear

ME Engine
- Marker Edge Adjustment



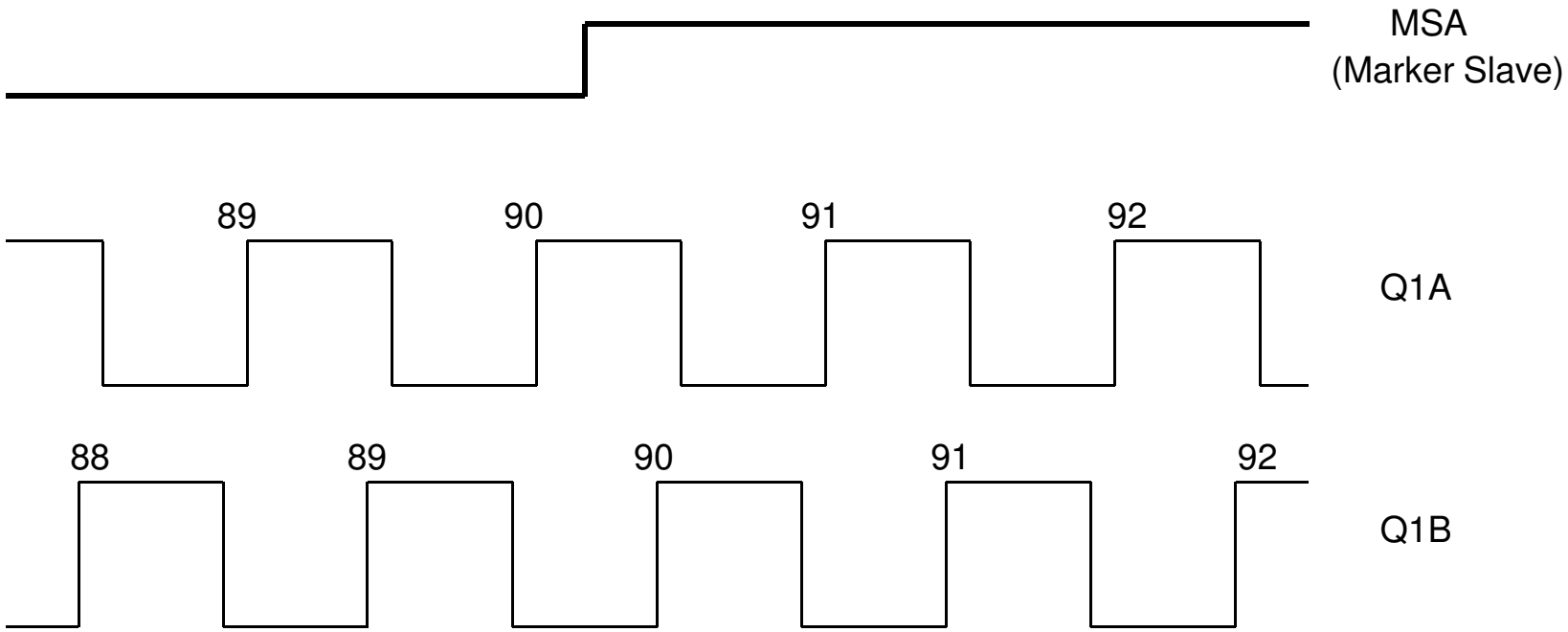
”Marker Edge Adjustment” ideal value is 0.5 (encoders always show this)

The value shown above is close to 0.16

The value shows the position where MMA is shifting in the reference interval (0 for A, 45 for B). If the value gets too close to 0.0 or 1.0 the next intervals may be called ”0” – which introduce a position error of 1 tooth

There is no alarm on this value

ME Engine
- “Slip” alarms

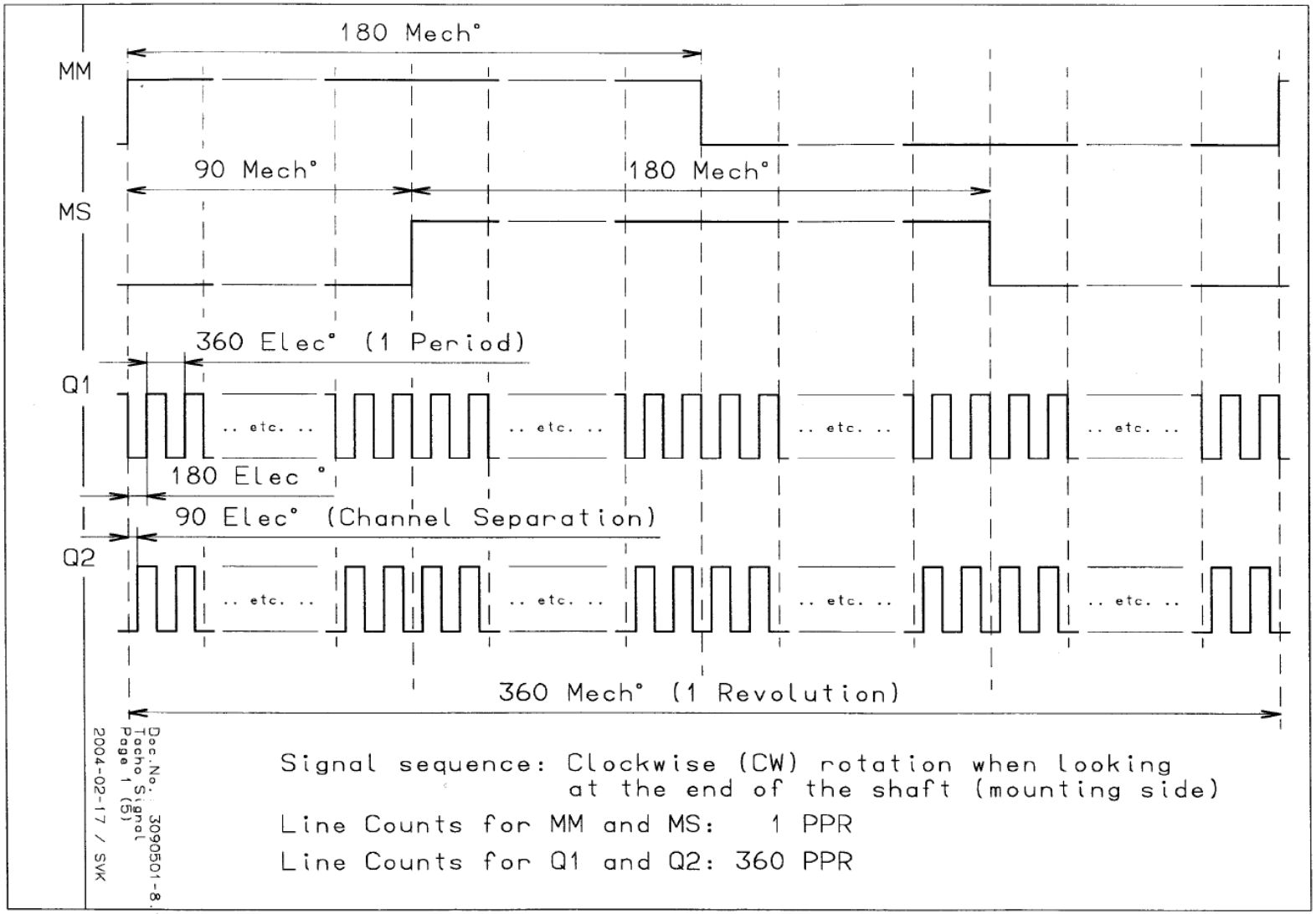


Alarms: Tacho Input A slip, Tacho Input B slip, Marker A Input slip

When MSA shifts, the Tacho system knows what position Tacho A and Tacho B should have. If one of the three does not agree with the two others, the corresponding ”slip” alarm will be set

PLEASE NOTE… ”Tacho Set A/B Failure” must be NORMAL

ME Engine
- Reference sheet for signals



Tacho commissioning

The two Tacho encoders are adjusted mechanically

- Tacho A with Marker Master going high at TDC cylinder 1
- Tacho B with Marker Master going high 45 degrees after TDC cylinder 1

During initial running the alarm “Tacho Alignment Err” may occur. This alarm will disappear after proper parameter adjustment.

If the alarm "Delta Tacho B too big" also appears the mechanical adjustment of the Tacho system is not correct. The engine must be stopped and the mechanical adjustment corrected before further adjustment of the engine.

- Make 0 –diagrams with the PMI equipment (= commissioning the PMI equipment)
- Before stop for feel over, load the parameters from the engine to ArcEdit and enter the Tacho data.
- When engine is stopped, load the edited parameters to the engine