



# Ultra-low Power

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# Batteries

coin cell = 3V @ 200 mAh

3x AA = 3.6/4.5V @ 2000 mAh

1 year  $\approx$  10,000 hours, so:

coin cell @ 10  $\mu$ A  $\rightarrow$  2 years

3x AA @ 100  $\mu$ A  $\rightarrow$  2 years

# Microcontroller

Sleep mode is perfect:

ATmega → 5  $\mu$ A

MSP430 → under 1  $\mu$ A

ARM Cortex

M0 → 3  $\mu$ A

M0+ → under 1  $\mu$ A

Be sure it knows how to wake up again!

# Sensors

Switch or reed contact → 0  $\mu\text{A}$

LDR → 0  $\mu\text{A}$  (using three-state)

SHT11 temperature + humidity → 3  $\mu\text{A}$

PIR motion → 50..300  $\mu\text{A}$

# Transmit packets

RFM12B transmitter draws 23 mA

... but only for a few milliseconds

2 years on 3x AA @ one packet/minute

a million packets, easy!

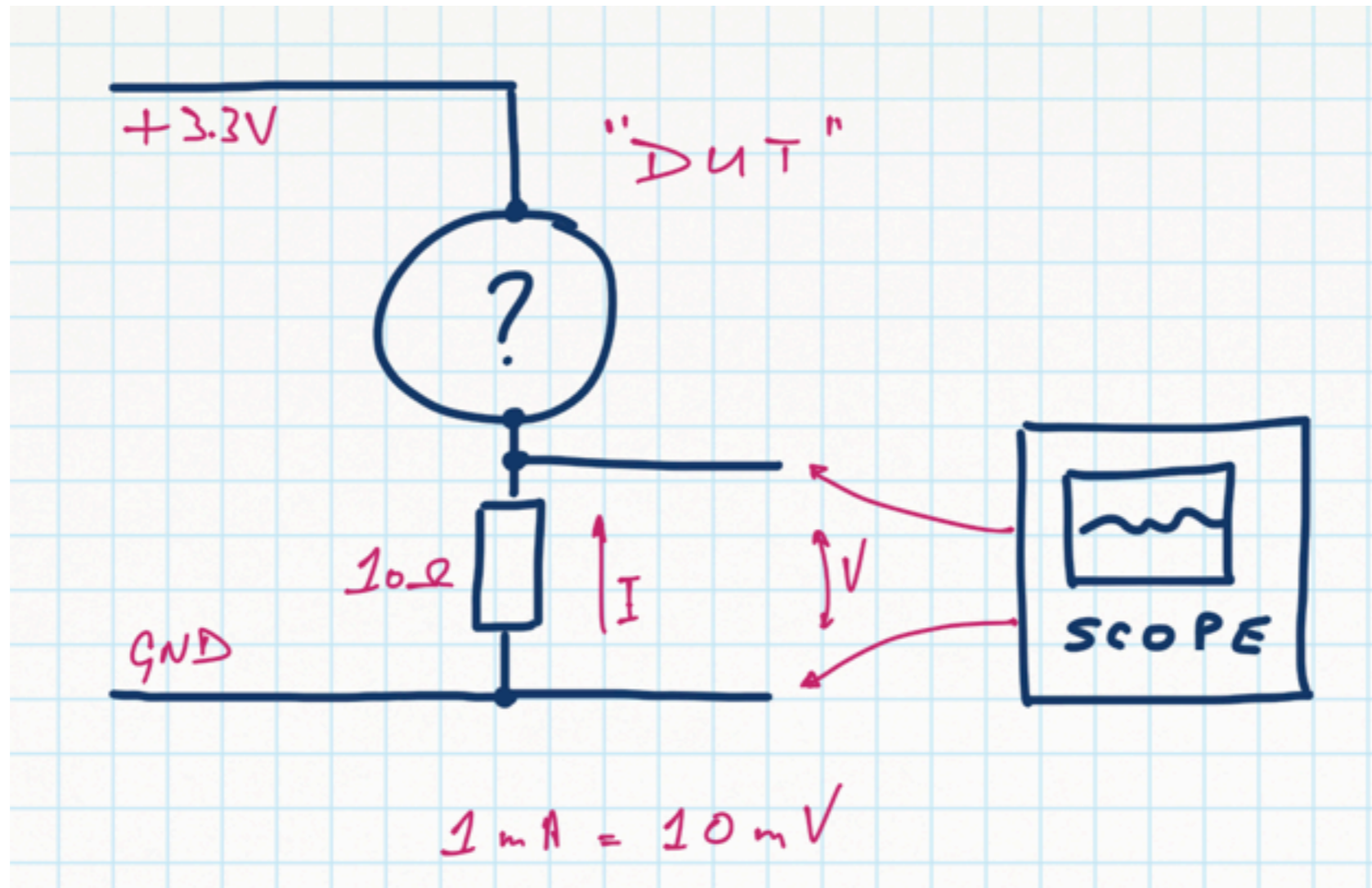
# Receive packets

RFM12B receiver draws 12 mA

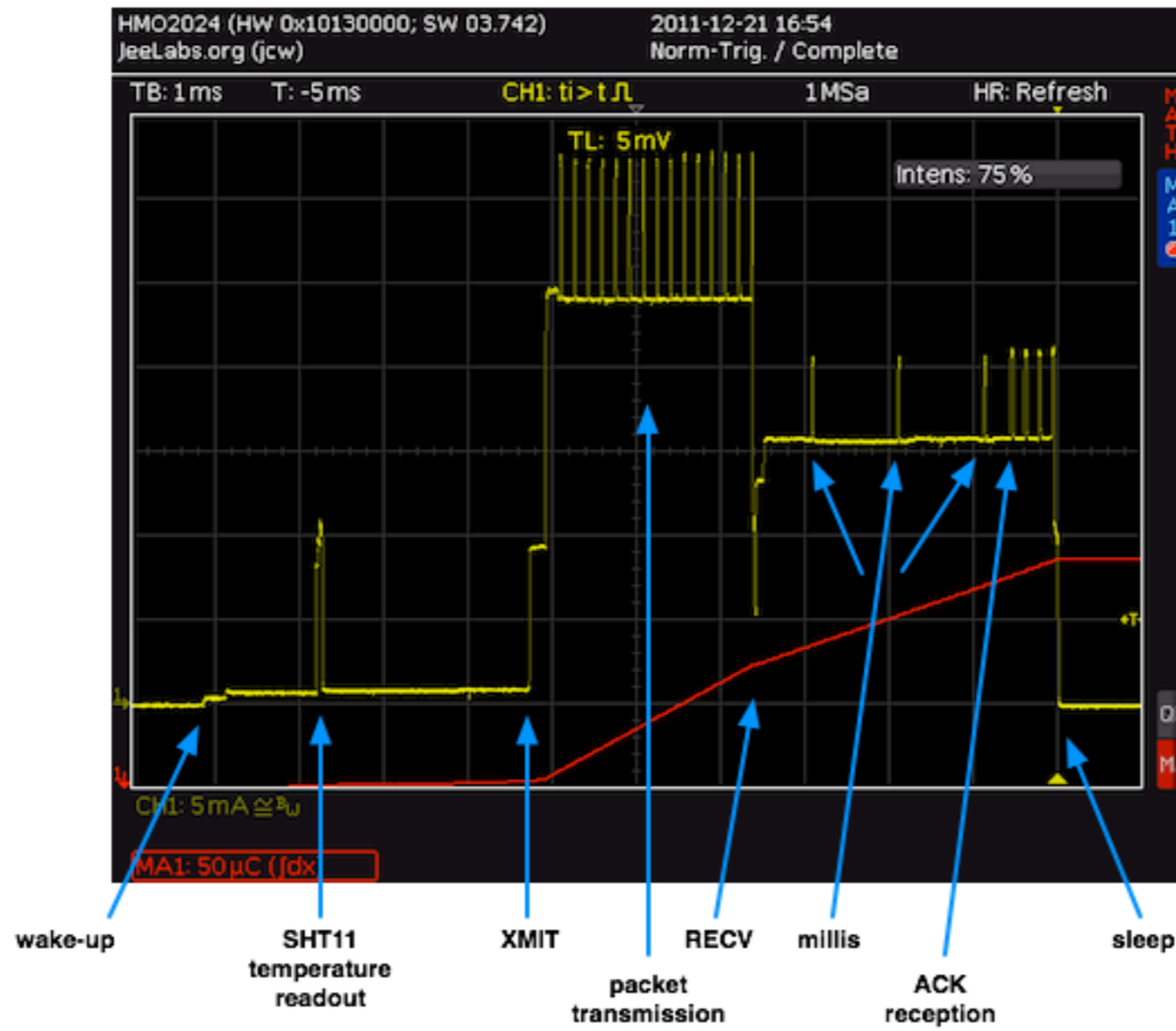
always on: 1 week on 3x AA

forget it!

# Measuring Current

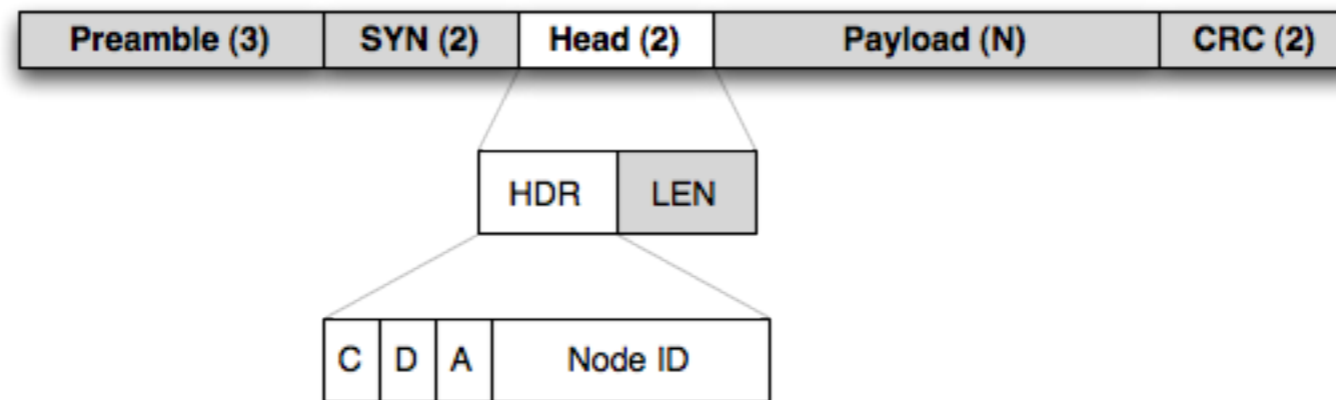


# An example





# RF12 packet format



Node ID: source **OR** destination !

most packets are broadcasts

# Solve the RX problem

Receive only when a packet is expected

Solution #1 → poll and wait for ACK

Solution #2 → keep clocks in sync

Solution #3 → poll from a replay node

