Z24. Suspend Driving 6 Resonant Periods

1 Coil Signal

2 U5 Output

3 U4 Output

Number of Periods	1	2	3	4	5
Measurement Value	1000	984	968	952	936
Attenuation Rate		124	122	120	118
Post-weighting Critical Value		180	170	160	150

It shows that there are metalic foreign objects.
Finally, the calculated slope of [4][5] is 118 which is lower than the critical line 150.
It can be judged that there is a metal foreign object, but the power supply will not be cut off immediately. The result of the measurement will be added to the value of the scalar counter. If the value is added to the rated value or more, it is judged that a metal foreign object cuts off the power supply.

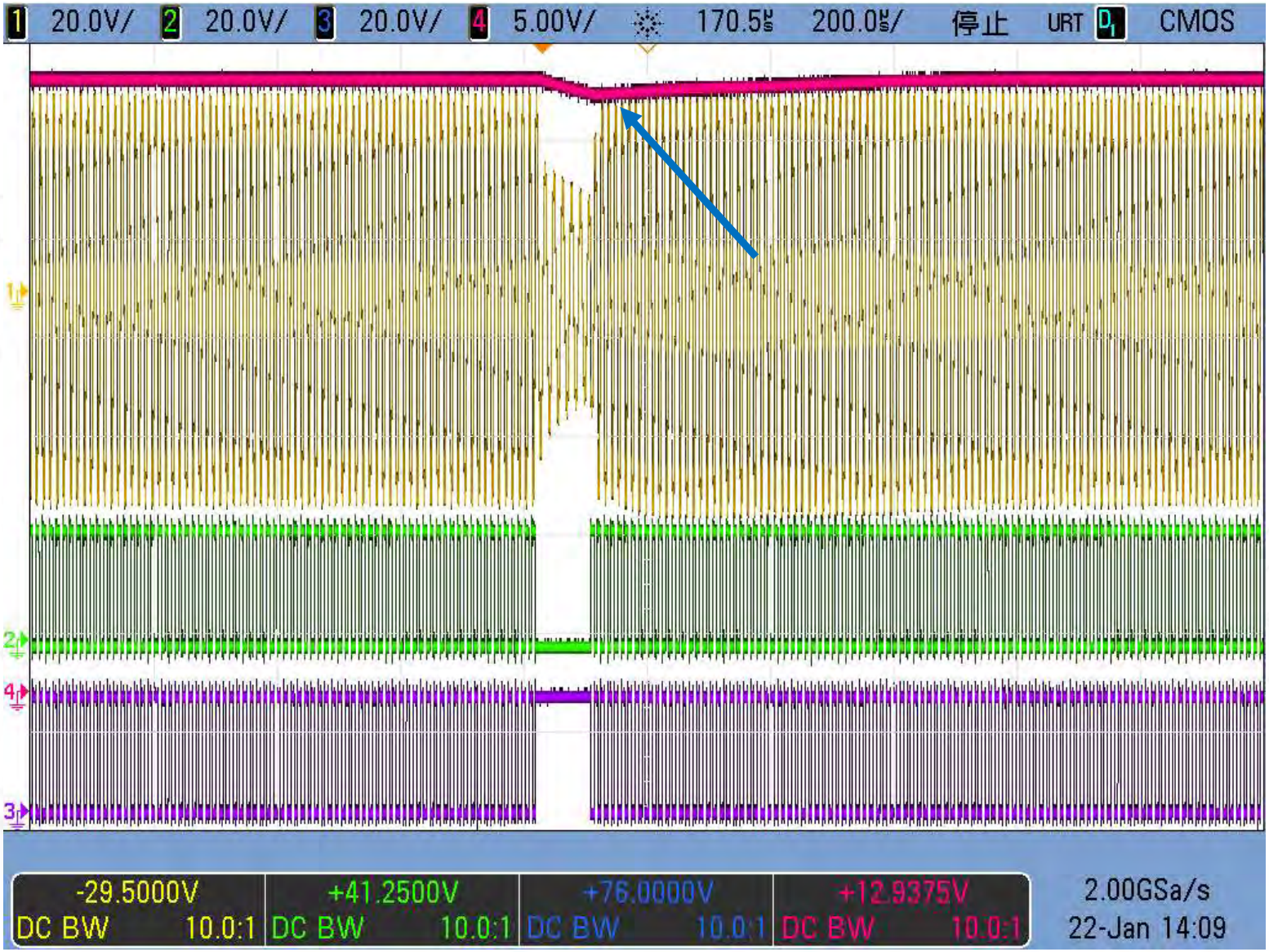
Z25. Long Length of Time of the Suspending on Drive

1 Coil Signal

2 U5 Output

3 U4 Output

4 Voltage of RX



Suspending the PWM drive will stop the power supply from TX to RX. The voltage behind the RX rectifier will also drop.

The longer the suspending time is, the greater the voltage drops

The impact of rejoining will also increase

This zone-pause action is not good for the performance of wireless power transmission.

High-performance system should reduce the time to interrupt power supply as much as possible

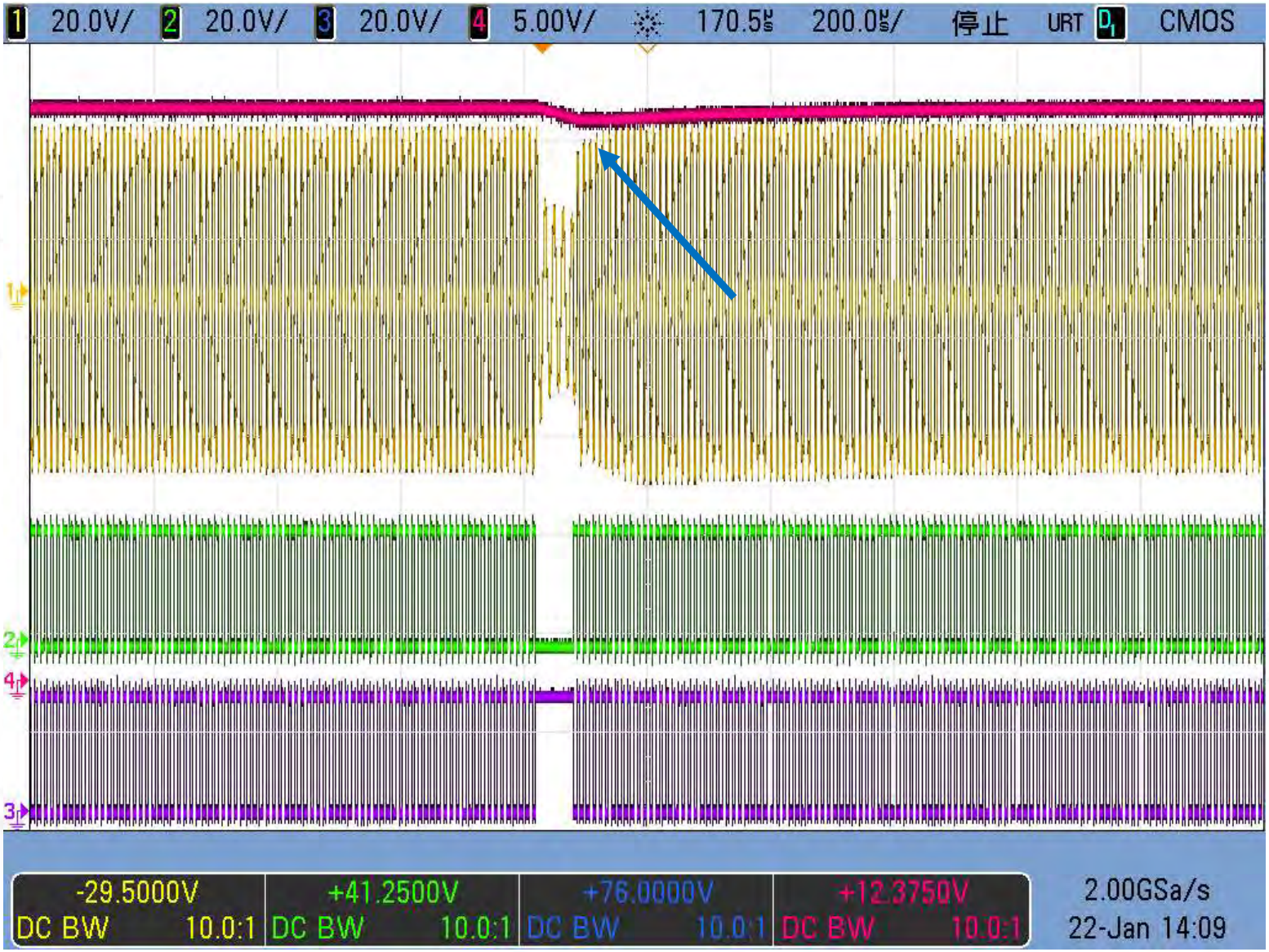
Z26. Short Length of Time of the Suspending on Drive

1 Coil Signal

2 U5 Output

3 U4 Output

4 Voltage of RX

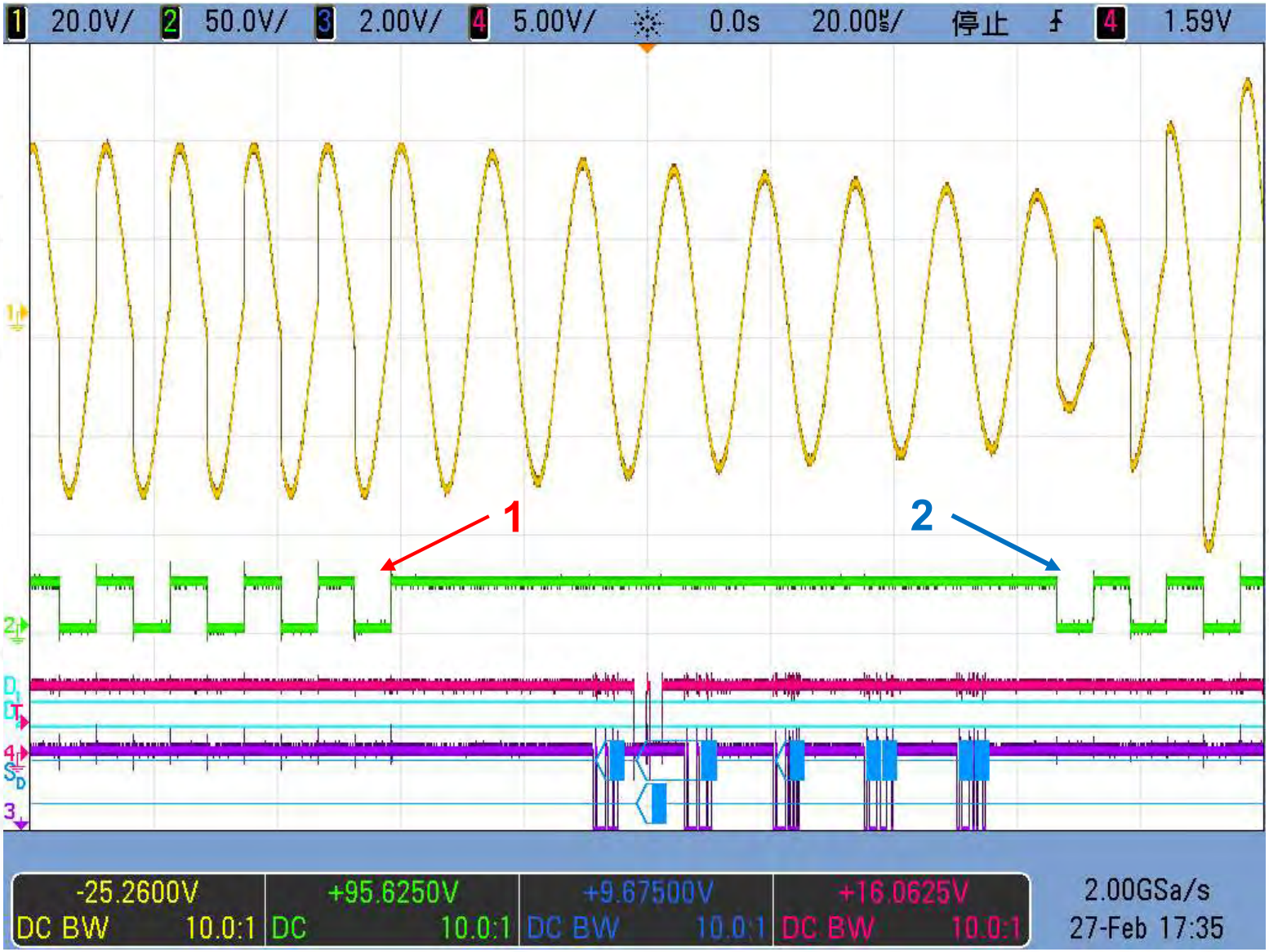


Shorter length of time of the suspending on driving PWM will cause a smaller increase of RX`s voltage

Z27. PWM`s Rejoining

1 Coil Signal

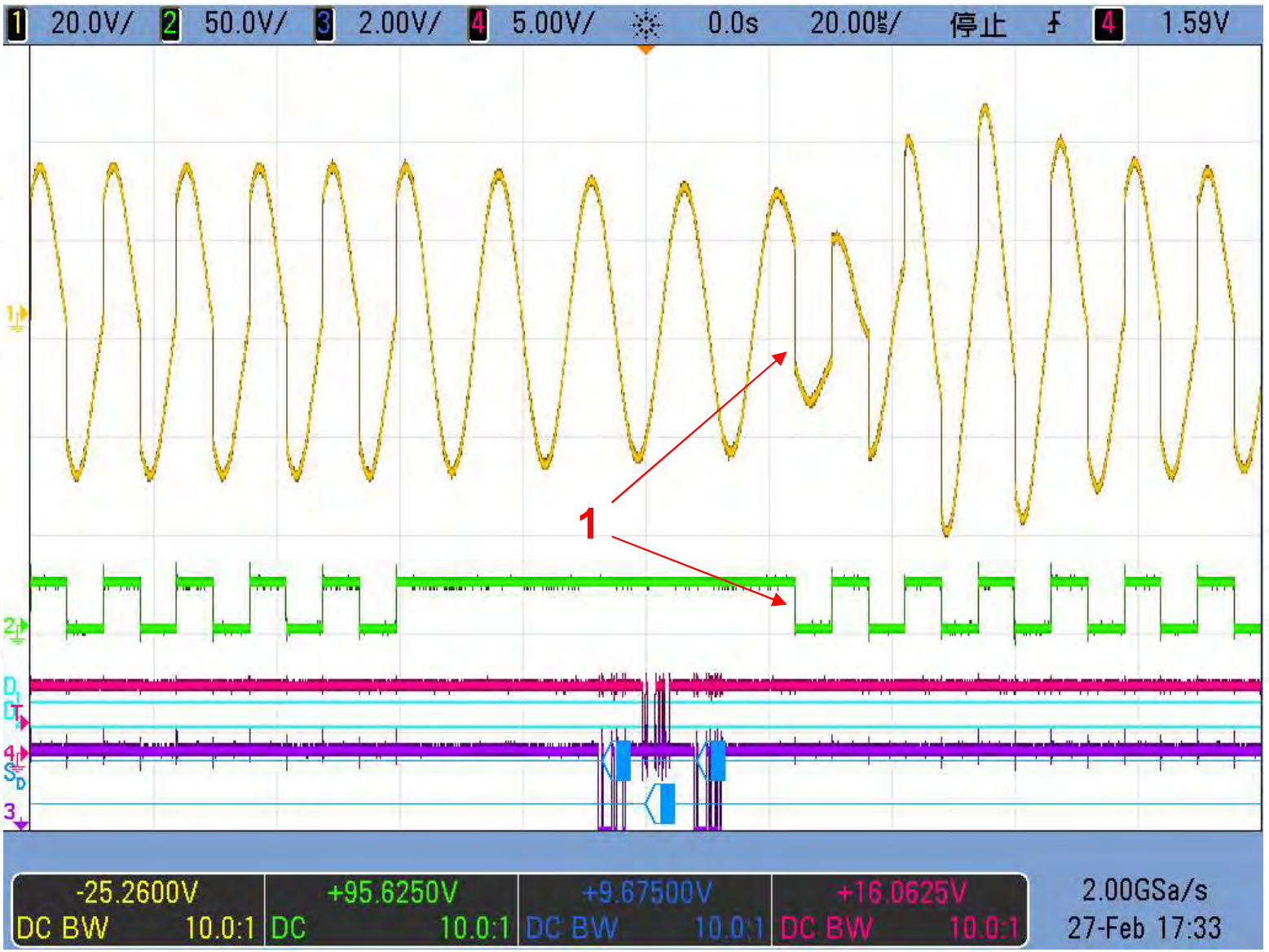
2 U5 Output



[1]Stop PWM
[2]Rejoin PWM

In the [1] place, before stopping the PWM parameters will be stored firstly. Then they will be taken out again in the [2] place.

Z28. Less Suspending time Causes Smaller Impact of Joint

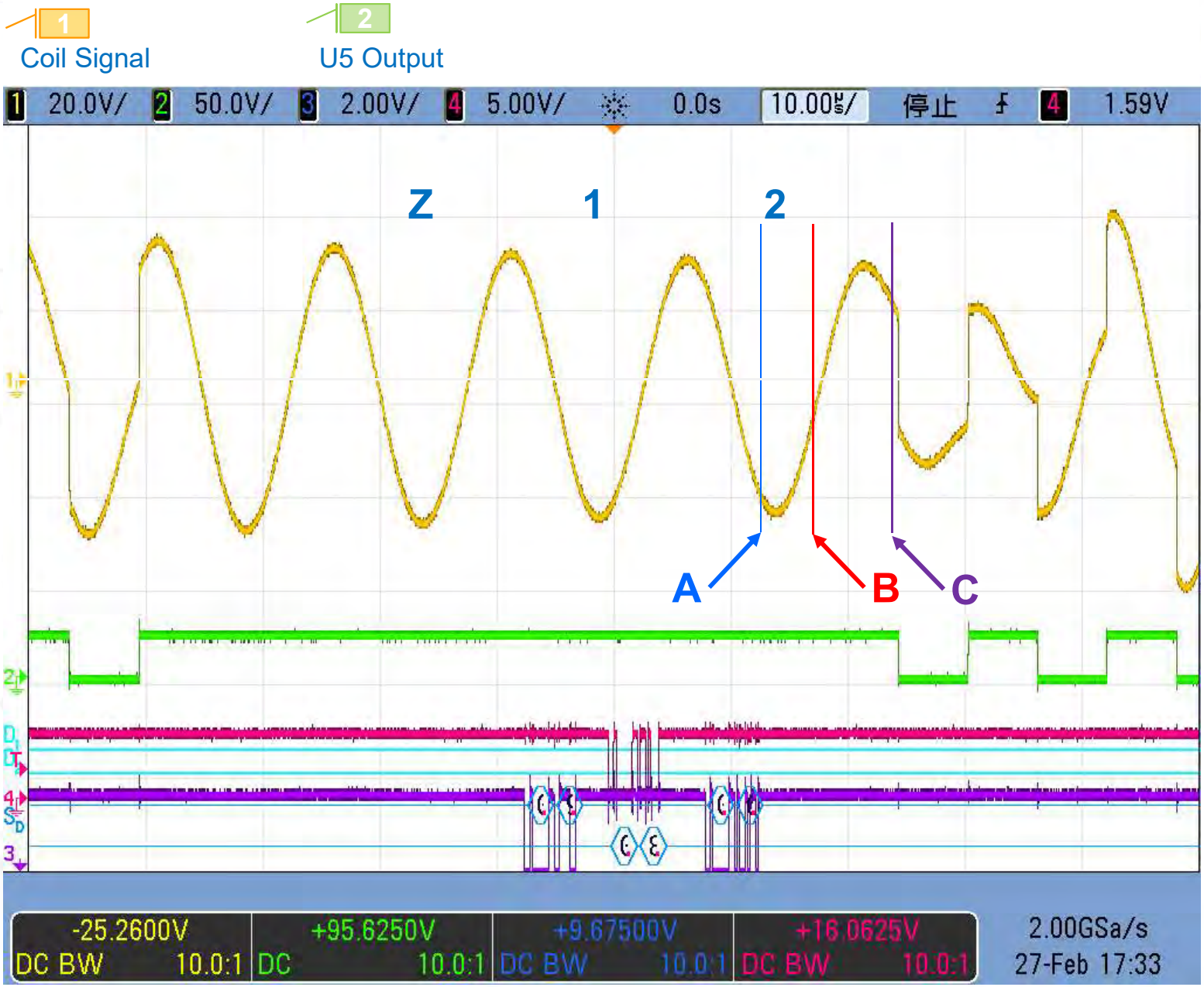


The focus of the joint is that the drive signal goes down along the waveform [1]

The coil measurement signal is near the end of U4. When the U4 potential is decreased by 10, the coil signal will also be decreased.

The difficulty of this technique is that the coil signal has been out of control after the PWM is suspended. Therefore, it is necessary to perform the joint at the crossover point re-capturing the drop of the coil signal.

Z29. Joint and Lock Program

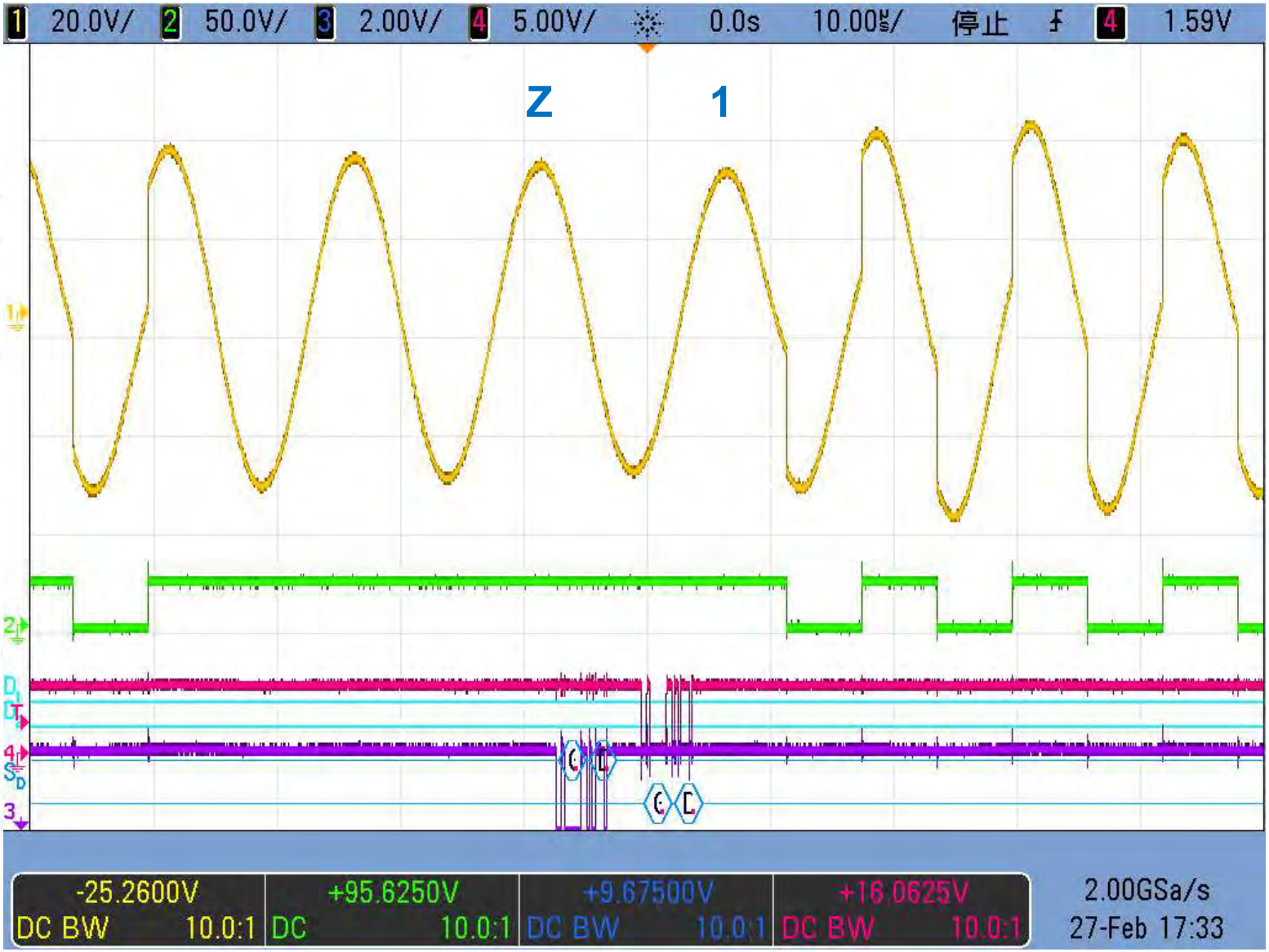


Actual Program Operation
[A] time point After the measurement value of [1][2] has been obtained, the slope is determined and no metalic foreign object is found based on the measurements, it is decided to joint the PWM.
To recapture the coil signal, comparator 1 should be set to be interrupted. Level voltage of DAC1 is set to 0. When the resonant signal crosses 0V, an interrupt will be generated. Restart the PWM on the interrupt program. Since the PWM internal timer cannot be cleared separately, the entire PWM can only be closed for restart.
Complete the PWM restart at [B], the first PWM output switching occurs at [C]. Then the whole joint is completed.

Z30. The Shortest Length of Time of Suspending on Drive

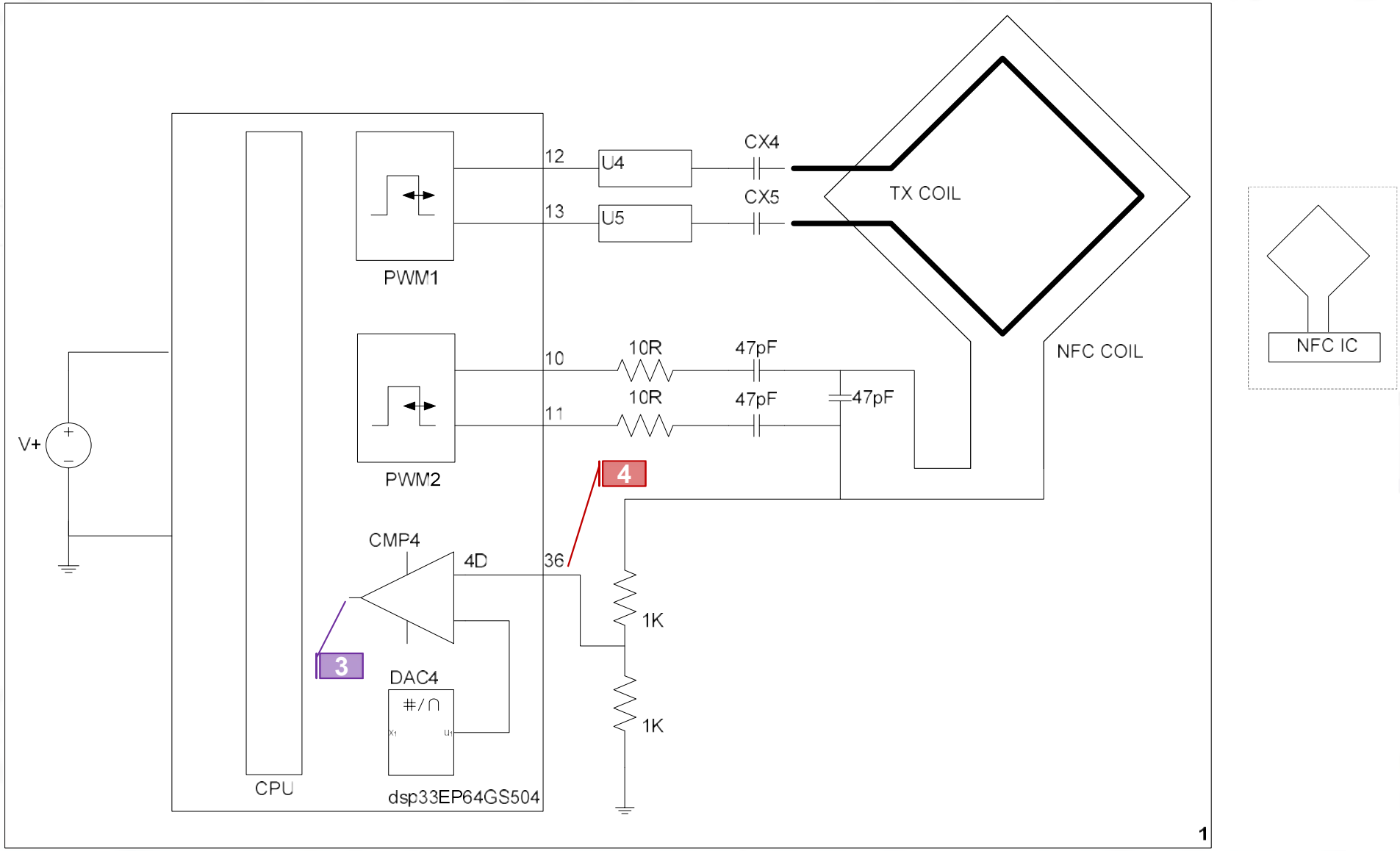
1 Coil Signal

2 U5 Output



This is an application example of limiting the PWM pause time to an extreme value.
Measuring the slope requires at least two points [1][2] but if the slope of the previous measurement [1][2] is within the safe range without metalic foreign objects, and the value of this measurement [1] is close to the previous [1], then it can be considered that the system is stable and there is no metalic foreign object. This design can minimize the interruption of power supply time.
For the sake of safety, even if mreasurement values of continuous [1] are similar in this design. It will also measure the slope of the [1][2] at a fixed time to confirm the detection status of the metalic foreign object again.

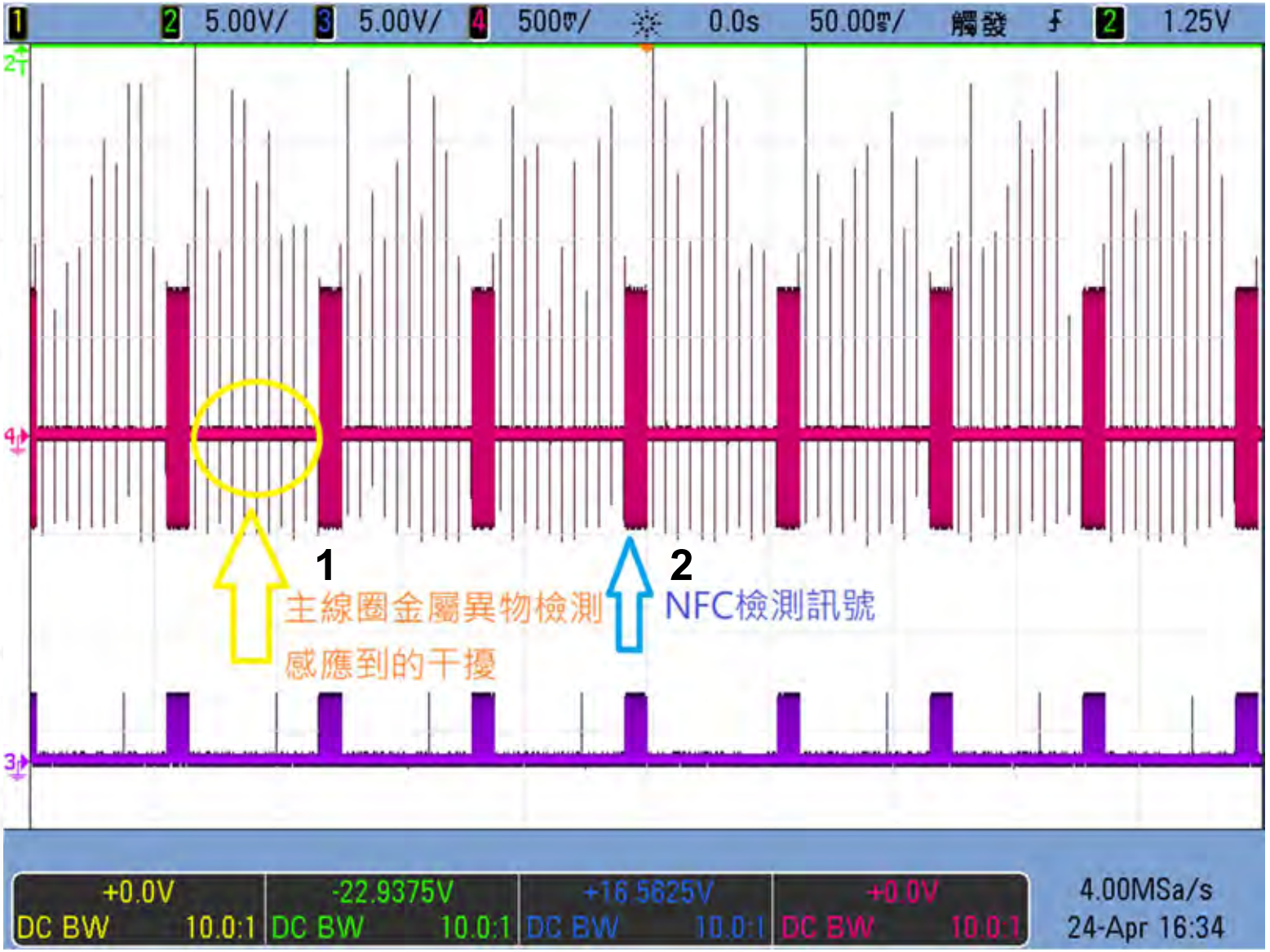
Z31. Detection of Auxiliary NFC Coils



Z32. Detection Program on Auxiliary NFC Coils

3 Comparator4 Output

4 Comparator4 Input D



The NFC detection method is to periodically transmit a 13.56 MHz signal on the auxiliary coil.

Arrange the action period to be staggered from the detection on the metalic foreign objects on main coil.

The power of the main coil can interfere with the signal on the auxiliary coil. Because the time of the operation is staggered, the signal can be accurately interpreted.

NFC is a type of special metalic foreign object. Its absorbed power is too small to be detected by metal identification.

It can generate modulation signals by itself, but a special card reader device is required to read the code.

The purpose of this design is to detect the presence of an NFC device through a simple detection method.

Z33. Signal Configuration of the Simulated NFC Card Reader

3 Comparator4 Output

4 Comparator4 Input D

To detect an NFC device, you must firstly simulate a signal similar to NFC.

[1] After starting the PWM drive, the coil starts to resonate. Because the driving force is small, the signal on the coil is not too large. The coil starts to transmit power then. If there is an NFC device above, it will start receiving power and prepare for startup.

[2] The detection time is over and the PWM drive is stopped.

[3] NFC device does not directly feed back the data code. The data request must be sent from TX before the feedback signal is started.

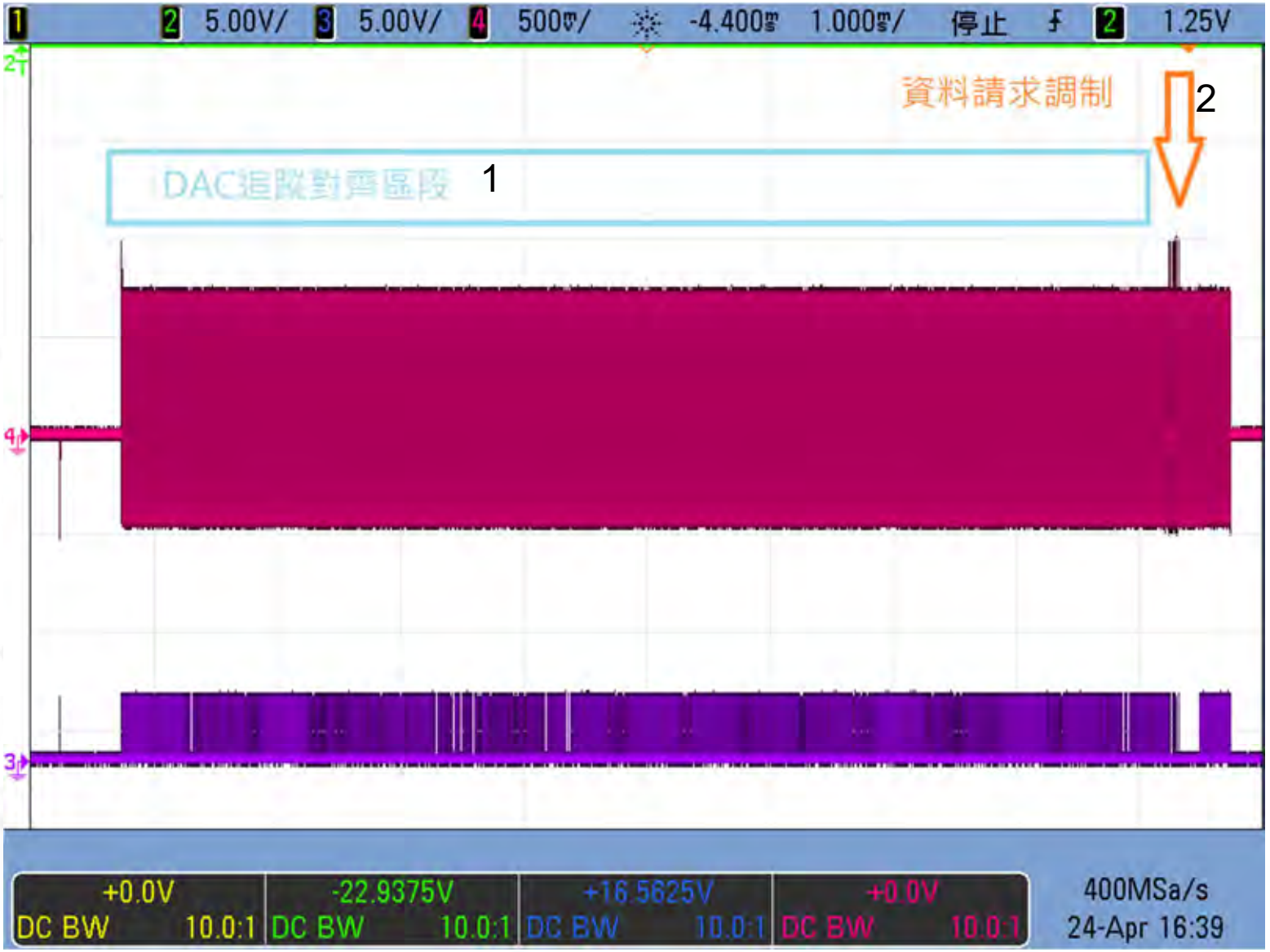
In practice, it is difficult for the PWM to produce 13.56MHz which is an accurate frequency, so only the frequency with similar output can be used to drive the coil.

In addition, the driving force of the IC port is limited.

Z34. Set DAC Section and Simulate to Request Data Signal Section

3 Comparator4 Output

4 Comparator4 Input D

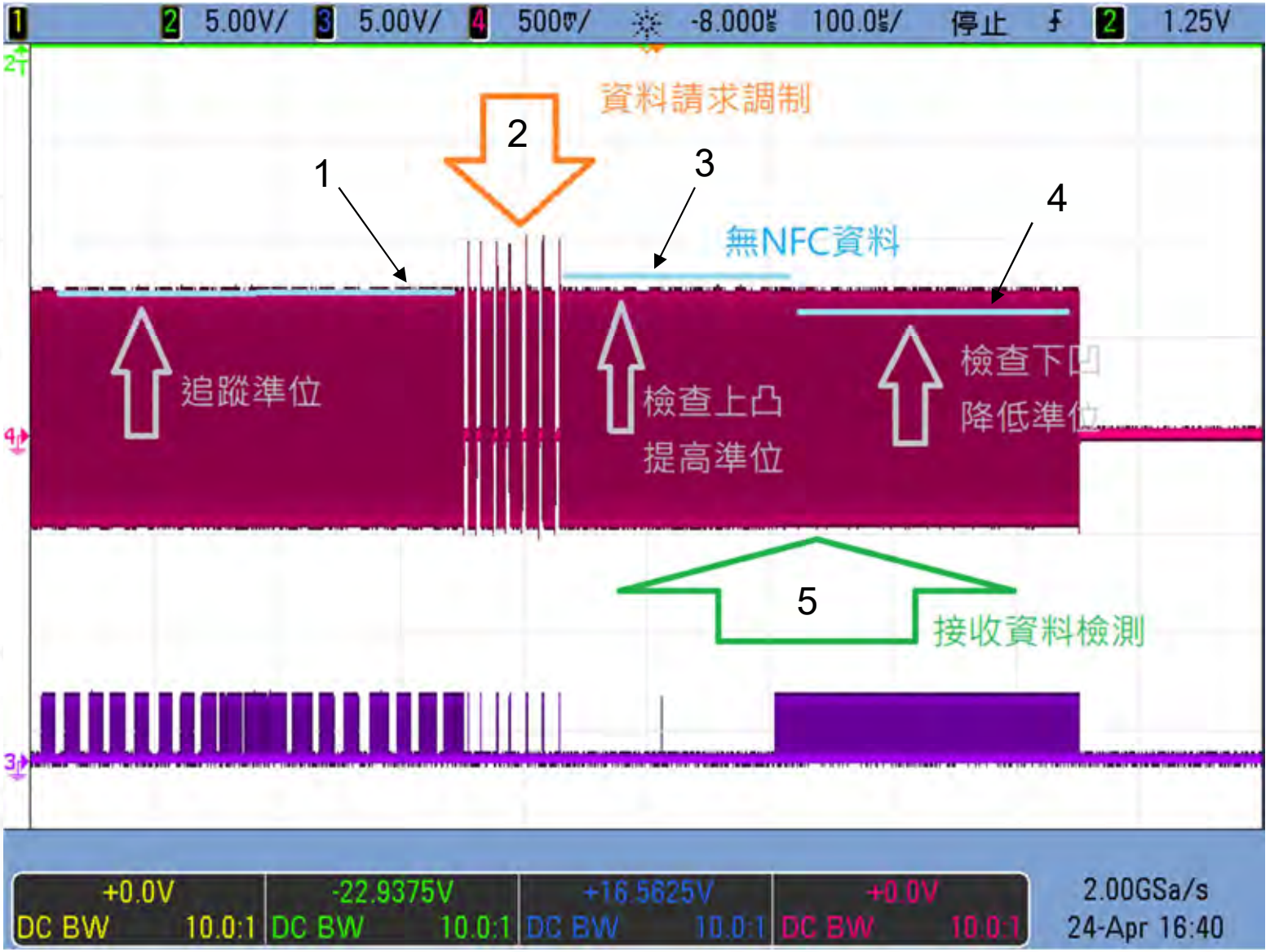


After the drive, the NFC coil starts to resonate and its amplitude will not be fixed. Because the match between inductance of the coil and the capacitance is not fixed.
In order to lock the voltage, the detected DAC4 starts to track the signal peak in the previous stage. When the comparator 4 has a trigger, the DAC4 voltage shuold be raised. Otherwise, the voltage should be reduced without a trigger.
After the section [1] is passed through, the DAC4 voltage and amplitude can be locked to section [2].
The PWM signal is generated by suspending the drive to simulate the data request signal of the NFC reader.

Z35. Discrimination on Signals After Data Request

3 Comparator4 Output

4 Comparator4 Input D

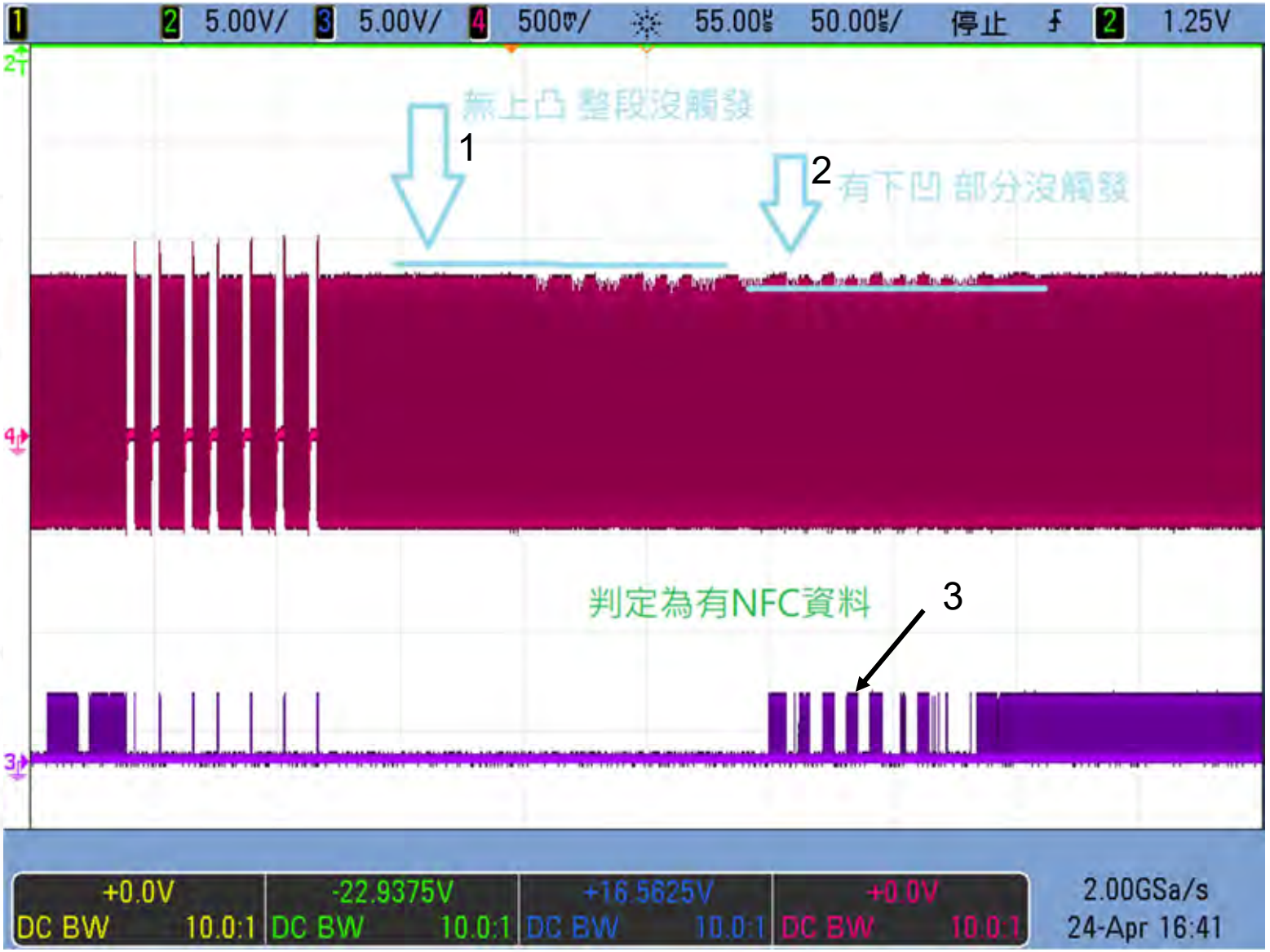


[1] track level section; DAC4 voltage will be close to the peak
[2] Data request is modulated to the NFC standard specification. The output is produced by simulation by suspending the drive.
[3] Check the signal of the bulge; increase the DAC4 voltage
[4]Check the signal of the fovea; increase the DAC4 voltage
NFC modulation signals may be affected by factors such as location, label and card type. The data signal may be bulge or fovea. The purpose here is mainly to find the NFC signal features. The data which can completely decode the NFC data content is not required, so the discriminating method is to discriminate the forepart and rear part, and find out the bulge firstly and then find the fovea.
[5] Stop the PWM drive after the data-detection time is over.

Z36. Fovea of Detection Signal Section

3 Comparator4 Output

4 Comparator4 Input D



[1] Check the fovea with a higher DAC4 voltage. No trigger indicates that there is no NFC
[2] Check the fovea with the lower DAC4 voltage. If some parts have no trigger, it can be judged that there are NFC signal features.
[3]

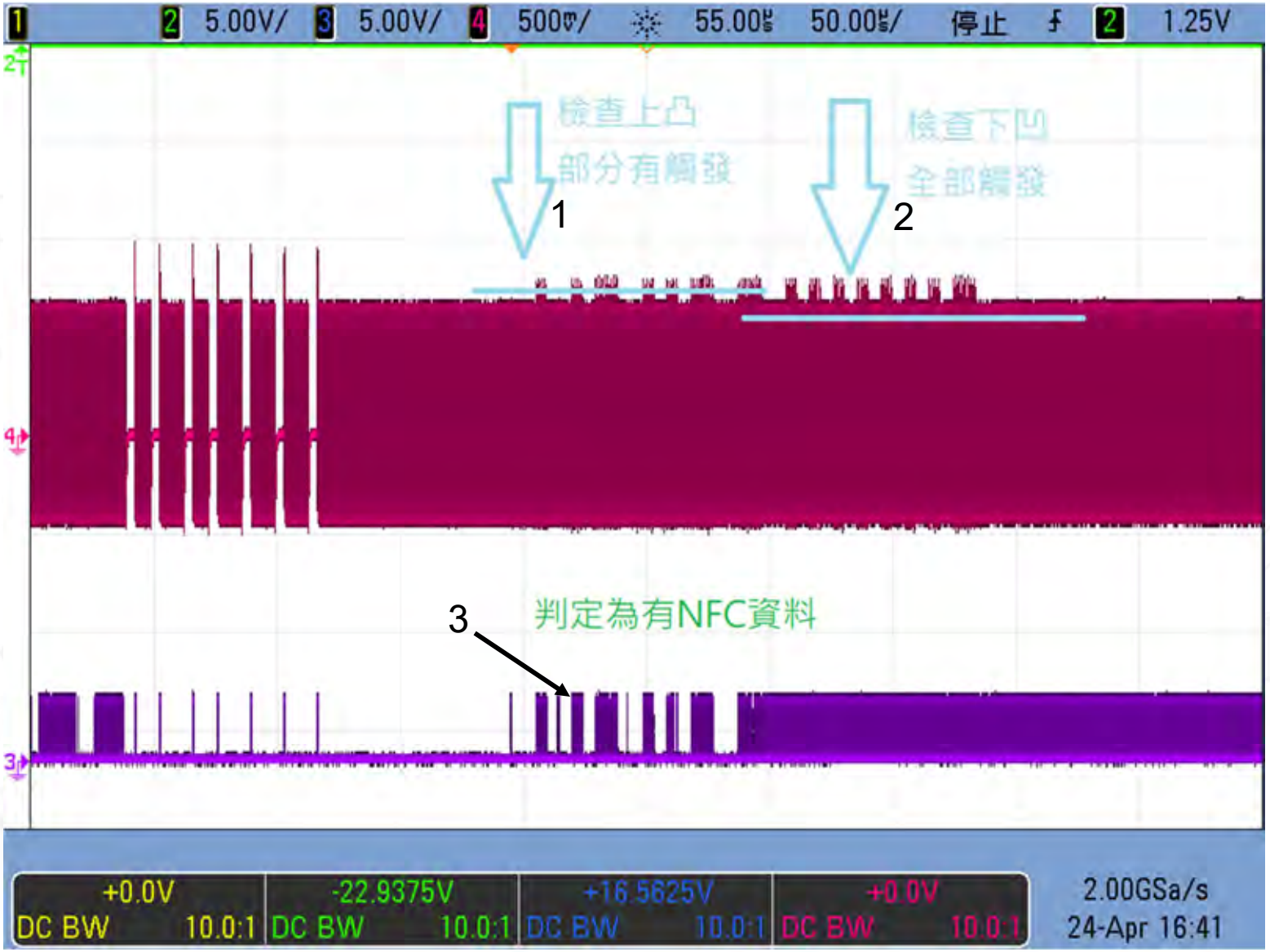
In either section [1] or section [2], the NFC signal features are found, it can be judged that there is an NFC device. Do not turn on the wireless charging

This action is only detected before the RX is not sensed. After the RX sensor is used for power transmission, the inserted NFC will be immediately burned by the power from the wireless charging. Detection is unnecessary.

Z37. Bulge of Detection Signal Section

3 Comparator4 Output

4 Comparator4 Input D



[1] Check the bulge with a higher DAC4 voltage. Some triggers are found to indicate the presence of NFC signal features [3]
[2] Check the fovea with the lower DAC4 voltage. If the entire segment is not triggered, it can be judged as NFC-free.

The NFC device will feedback the data code within a fixed time after receiving the data request modulation signal. The modulation signal will change on the coil. After the data request, the design confirms whether there is NFC signal feature in the time during a wait for the signal modulation. After the scheduled time for receiving data, the detection ends.

Z38.Practical Requirements of FOD on Products

1. The FOD function is a standard accessory of every product instead of an optional one. As long as the power is transmitted through the coil, there will be problems with foreign matters being heated.

2. The FOD function requires that the power for wireless charging should prevent the foreign matters from being heated to the point where it is dangerous.

3. The standard for foreign object detection can help turn off wireless power transmission when an object is that heated to a dangerous level is detected.

4. The detection is fast during power transmission, so that the the power transmission can be turned off before an inserted metalic foreign object is heated to a dangerous level.

5G FWA (CPE) wireless power transmission application

Coil size : 100mm*100mm

Induction distance: 5mm~30mm

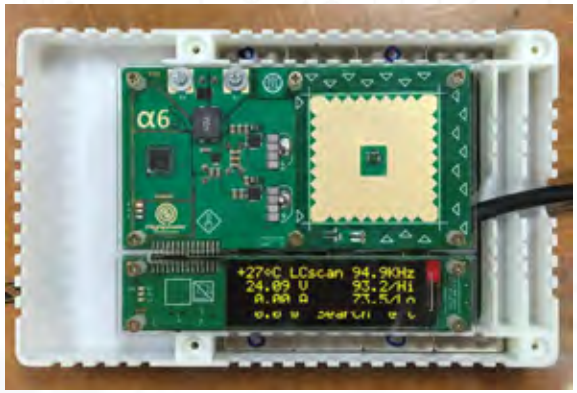
Power transmission performance:

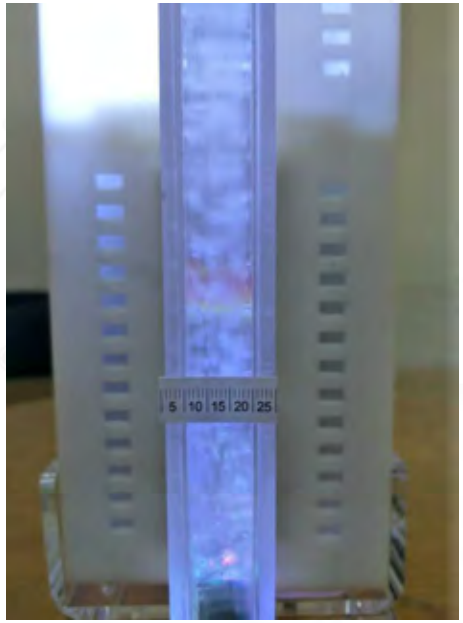
Distance 5mm / efficiency 92%

Distance 25mm / efficiency 85%

Maximum transmission power: 100W

Standard operating voltage DC 24V





US PATENT LIST

20090267561	INDUCTION TYPE POWER SUPPLY DEVICE
20110199046	FREQUENCY MODULATION TYPE WIRELSS POWER SUPPLY AND CHARGER SYSTEM
20110264945	Power supplying and data transmitting method for induction type power supply system
20110278949	HIGH-POWER INDUCTION-TYPE POWER SUPPLY SYSTEM AND ITS DATA TRANSMISSION METHOD
20110291489	POWER TRANSMISSION METHOD OF HIGH-POWER WIRELESS INDUCTION POWER SUPPLY SYSTEM
20110298419	METHOD FOR IDENTIFICATION OF A LIGHT INDUCTIVE CHARGER
20110299636	HIGH-POWER INDUCTION-TYPE POWER SUPPLY SYSTEM AND ITS BI-PHASE DECODING METHOD
20120007443	METHOD FOR POWER SELF-REGULATION IN A HIGH-POWER INDUCTION TYPE POWER SOURCE
20120074899	WIRELESS CHARGING COIL STRUCTURE IN ELECTRONIC DEVICES
20120193998	LOW-LOSS DATA TRANSMISSION METHOD FOR HIGH-POWER INDUCTION-TYPE POWER SUPPLY SYSTEM
20120272076	INDUCTION TYPE POWER SUPPLY SYSTEM WITH SYNCHRONOUS RECTIFICATION CONTROL FOR DATA TRANSMISSION
20120286724	Mobile wireless charger system
20120314745	METHOD OF TIME-SYNCHRONIZED DATA TRANSMISSION IN INDUCTION TYPE POWER SUPPLY SYSTEM
20130038277	INDUCTIVE CHARGING METHOD FOR VEHICLES
20130093386	SLOT-TYPE INDUCTION CHARGER
20130187476	Inductive power supply system and intruding metal detection method thereof
20130254570	OPERATING CLOCK SYNCHRONIZATION ADJUSTING METHOD FOR INDUCTION TYPE POWER SUPPLY SYSTEM
20130342027	METHOD OF AUTOMATICALLY ADJUSTING DETERMINATION VOLTAGE AND VOLTAGE ADJUSTING DEVICE THEREOF
20140203822	CURRENT SIGNAL SENSING METHOD FOR SUPPLYING-END MODULE OF INDUCTION TYPE POWER SUPPLY SYSTEM
20140347010	Inductive Charging Method for Vehicles
20150065045	Data Determination Method for Supplying-End Module of Induction Type Power Supply System and Related Supplying-End Module
20150270722	Signal Modulation Method and Signal Rectification and Modulation Device
20150349546	Supplying-End Module of Induction Type Power Supply System and Voltage Measurement Method Thereof
20150364244	Induction Coil Structure for Wireless Charging Device
20160028247	Supplying-end module for induction-type power supply system and signal analysis circuit therein
20160139618	Induction type power supply system and intruding metal detection method thereof
20160308404	Signal analysis method and circuit
20160349782	Induction type power supply system and intruding metal detection method thereof
20170003706	OPERATING CLOCK SYNCHRONIZATION ADJUSTING METHOD FOR INDUCTION TYPE POWER SUPPLY SYSTEM
20170126072	Method for adjusting output power for induction type power supply system and related supplying-end module
20180034281	Signal Modulation Method and Signal Rectification and Modulation Device
20180102677	Method and Supplying-End Module for Detecting Receiving-End Module
20180190420	Induction Type Power Supply System and Coil Module Thereof
20180261384	Induction Type Power Supply System and Coil Module Thereof
20180316227	Supplying-end module of induction type power supply system and signal detection method thereof
20180375386	Intruding metal detection method for induction type power supply system and related supplying-end module
20190013701	Intruding metal detection method for induction type power supply system and related supplying-end module
20190020222	POWER SUPPLY DEVICE OF INDUCTION TYPE POWER SUPPLY SYSTEM AND NFC DEVICE IDENTIFICATION METHOD OF THE SAME
20190027971	POWER SUPPLY DEVICE OF INDUCTION TYPE POWER SUPPLY SYSTEM AND RF MAGNETIC CARD IDENTIFICATION METHOD OF THE SAME
20190140491	Decoding method for signal processing circuit and signal processing circuit using the same
20190148993	Method and Supplying-End Module for Detecting Receiving-End Module
20190206616	Induction Type Power Supply System and Coil Module Thereof

Data current through August 8, 2019.

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