

KM13 User's Manual

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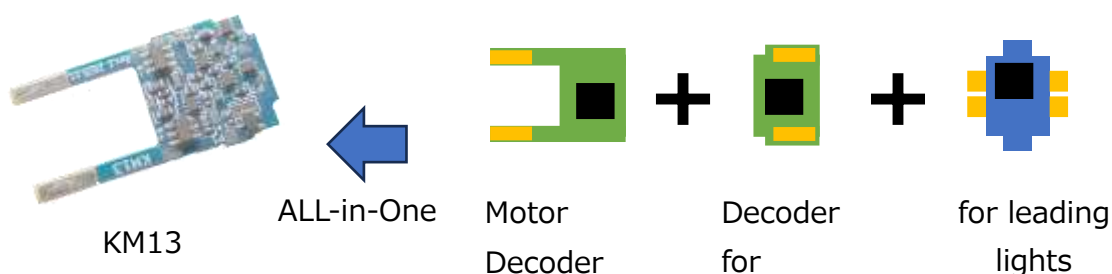
gist

The KM13 is a high-performance DCC decoder with RailCom support, ABC brake function, simple analog driving support, 3-function output, and light dimming. It is compatible with KATO's friendly decoder for power vehicles, allowing for freer and more precise control of model trains.

KM13 is a jointly developed product between Desktop Station Co., Ltd. and Circle MT40. Manufacturing, sales, and support are provided by Desktop Station Co., Ltd. **This product has no relationship with Sekisui Metals (brand name KATO). Please do not make any inquiries to KATO regarding this product or any problems, problems, or events that occur in combination with this product and the vehicle.**

[Features of KM13]

- Can be mounted directly on KATO-friendly vehicles
- 3FX compatible. Optional assignment of function numbers F0-F28
- Equipped with a function to dim the headlights when stopped
- Support for vehicle address response by BiDi (RailCom)
- Supports feedback control by BEMF of the motor
- Supports automatic braking with ABC
- It supports the operation of not only DCC but also pure DC/PWM power packs.¹
- Source code is open and can be modified by users (no warranty and no support)



Products Supported by this Manual

- KM13 (developed by MT40/manufactured and sold by DesktopStation)

Desktop Station Co., Ltd
. Nerima, Tokyo, JAPAN



¹ In some power packs, the speed and direction of travel may be unstable.

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1.Precautions and Prohibitions

Please observe the following precautions and prohibitions and use KM13 appropriately. If you do not observe the following, you risk injury or harm to your health. You or the management of the device are responsible for its use.

	Do not use in outdoor use, chemicals, liquids, high humidity, oil, dust, sealing, environments with flammable or flammable substances, or in high or cryogenic environments
	Do not use in an environment that uses medical devices or other equipment that poses a risk of affecting the human body. There is a risk of malfunction due to the harmonic noise contained in the DCC.
	When mounting, insulate wires, conductive parts, and exposed parts. Insufficient insulation work may cause destruction, damage, or failure of the vehicle.
	There is a risk of short circuit, electric shock, smoke, capacitor rupture. Do not touch rails, wiring, conductive parts of the vehicle, wheels, etc. while energized.
	Use only with products that comply with the Digital Command Control (DCC) specification
	Age of use is 13 years or older. Use by infants and children must be under the supervision and responsibility of a parent or guardian
	In the event of abnormal noise, odor, or smoke, stop using it immediately and request repairs from the manufacturer. No continued use.
	Comply with the operating voltage and current range. To be used in the range of DC12-18V. Use a genuine power adapter with the PSE mark that is approved for use in Japan. Use a power adapter with a voltage that matches the specifications of the scale, vehicle, and decoder.
	Always be monitored by the user during power on/use. Regardless of whether the power is turned on or not, it is prohibited to leave the command station with the AC adapter connected, and to operate unmanned or unmanned. When leaving the equipment, disconnect the AC adapter from the

	outlet so that the command station does not turn on and power cannot be supplied to the vehicle.
	It is prohibited to use it in applications that require long-term continuous operation, high durability, and stable operation in business and industry, as well as in aviation, space, and military.



2. Warranty Provisions

[Warranty provisions for KM13 decoders are listed here]

1. Warranty Coverage

We warrant the products described in this document.

2. Warranty period

The warranty period is one month from the date of purchase.

3. Warranty

If a defect occurs due to a defect attributable to the Company within the warranty period, we will replace or repair it with a substitute free of charge. If the warranty period has passed, you will be charged.

If the sale of the product is no longer available, we may replace it with a replacement product.

If you want to get a warranty, please contact the store where you purchased it. Purchases made from the Desktop Station Online Store are available at the Desktop Station Online Store.

4. Paid repair and replacement

Even within the warranty period, if the following items apply, it will be repaired or replaced for a fee.

- If you do not present information proving the place of purchase and the date of purchase (order email, order number, delivery note, receipt, etc.)
- Defects or malfunctions caused by installation work by the user or processor (e.g., short circuit failure due to insulation defects during installation, faults due to incorrect wiring, derailment, contact with conductive materials, etc.)
- Defects when used for applications that exceed the performance of the product indicated (e.g., HO products used for G gauge, No. 1 gauge, etc.)
- Aging of the product or parts (wear and tear due to use, etc.), deterioration over time, or other defects associated with these
 - Factors caused by the environment of the storage and loading location. Dust, hair, pet hair, dust, high temperature and humidity, condensation, corrosion or other defects
 - Specifications related to the material properties of the product or component (processing of board end faces, connectors, etc.)
 - Defects caused by natural disasters or other force majeure (e.g., storms, storms, earthquakes, lightning strikes, floods, land subsidence, fires, etc.) or in the event of a situation where the performance of the product exceeds the performance of the product.
- Defects caused by incorrect operation, poor adjustment, or failure to perform proper maintenance (e.g., cleaning of wheels and rails, maintenance of command stations, etc.)

- Defects caused by the user's own installation, repair, or modification (including installation and removal of necessary parts)
- Use for business applications (e.g., museum dioramas) or industrial applications (factories, museums, museums, event venues) that require operation in severe conditions such as long or long periods of time, continuous operation, frequent stops, and driving.

5. Subject to repair and replacement

If the following items apply, you will not be eligible for warranty, paid repair, or paid replacement.

- If you want to receive warranty or paid repairs at a store other than the store where you purchased it.
- When obtained through illegal acts such as crimes
- When purchased or received by means other than our company or our agents.
- When a competitor or individual purchases or modifies the product for analysis
- When products intended for Japan are used overseas
- When writing or using firmware other than the firmware provided by the Company
- When the product itself is processed, soldered, cut, etc.
- Imitation of our products, products modified without our permission
- When used for business or industrial purposes without a paid business support contract, whether indirectly or directly with our company.
- When it is sold, provided, or received or purchased as a second-hand or junk item.

6. Revision of Warranty Provisions

This warranty is subject to change without notice.

- KM13 DCC decoder x1
- Simple manual (with QR code for this manual)

4.Key Specifications

Here are the key specifications of the KM13:

Specification	Value
Model	KM13
Material	Aluminum
Weight	1.2 kg
Dimensions (L x W x H)	150 x 100 x 50 mm
Power Consumption	5W
Operating Temperature	-20°C to 60°C
Humidity Tolerance	10% to 90% RH
IP Rating	IP67
Connectivity	Wi-Fi, Bluetooth, USB
Compliance	CE, FCC, RoHS

Specification	specification	remarks
Connector Standards	KATO Friendly Compatible	
Supported voltage	12~16V	
Absolute Maximum Voltage Rating	22V	
Maximum output current	Motor: 1.0A Function: 100mA × 3	
Supported Protocols	NMRA DCC, BiDi(RailCom)	
DCC SpeedStep	14, 28, 128	
Motor output PWM frequency	40kHz (Fundamental Wave) + 30Hz/60Hz/120Hz (assist)	The low-frequency component can be enabled, disabled, or changed at the set value of the CV60.
Function Output	3 systems (P1, P2, P7) It can be assigned to headlights, taillights, interior lights, etc.	
BiDi(RailCom)	Equipped with bidirectional communication function BiDi (RailCom)	
ABC Brakes	Asymmetrical DCC for automatic braking	
Analog driving	Analog power pack (PWM included) for easy operation	
Dimming control	Light dimming control of functions is possible.	
Protection features	Not equipped	Take advantage of the command station side protection.
size	26 x 13mm	

5.Compatible vehicles and installation procedures

5.1.Supported vehicles

Compatible vehicles are as follows.

- Among KATO N-gauge vehicles, products listed as friendly

On the KATO website, there is a description of "friendly" in the list of main features of the vehicle. If this statement is not present, consider that it is most likely not compatible with KM13. Even if it is not listed on the website, please check the ASSY table (PDF) posted on the page as it may indicate friendly support.

For your reference, we have published a table of whether or not we are friendly on the following site.

https://desktopstation.net/wiki/doku.php/dcc_ready_locos#kato1

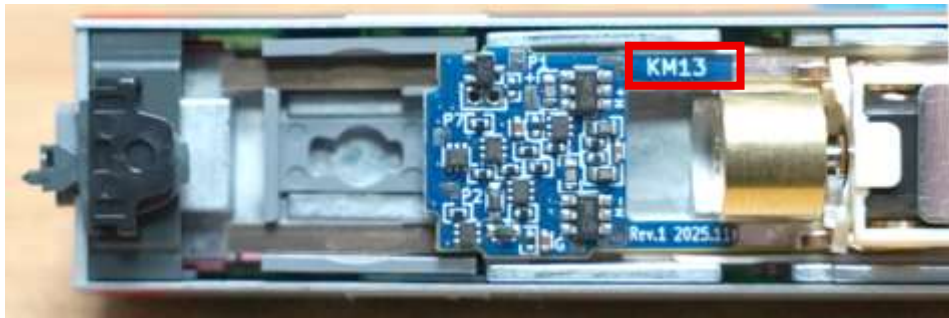
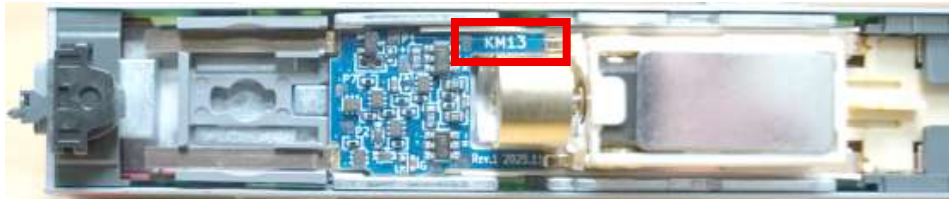
5.2.Installation Procedure

The precautions that can be placed on the mount are as follows.

- This product is for model train only. Do not use for any other purpose.
- Among the N-gauge vehicles made by KATO, it is exclusively for vehicles that are friendly and compatible. We also do not guarantee that it can be installed on all friendly vehicles.
- It cannot be used on anything other than friendly vehicles.
- Be sure to check the wiring before connecting the power supply.

table 5.2.1 Installation Procedure

1	Carefully remove the vehicle's underfloor cover. 
2	Disconnect the wheeled trolley and shaft on the decoder insertion side.

	
3	Make sure you have a motor terminal. After several removals, it may come off and be lost.
4	Plug the KM13 into the designated slot. When plugging in, make sure that the letters "KM13" are clearly visible. The decoder KM13 is a character notation to prevent reverse insertion. 
5	Check whether the electronic components of the KM13 and the body are in contact or short circuit. If there is contact, please take measures with insulating tape. Also, make sure that the letters "KM13" are clearly visible. <u>If you can't see the letters KM13, Omoteura is inserted backwards.</u> 
6	Return the wheeled trolley and shaft to their original position 
7	Insert the underfloor covering, slide it in, and put it back on.
8	Connect to the program track at the command station and check if the CV loading is successful. If you see 1 when you read CV3 and when you read CV8 and 140,

then the decoder is normal.

*CV reading mode sends DCC pulses to the decoder for a short period of time. Therefore, even if the DCC decoder installation fails, the damage can be minimized.

*If the command station fails or the power is cut off immediately after the CV loading starts, it is highly likely that the KM13 is reversed.

5.3.Board pad description

The KM13 has pads for function output, in addition to pads for use as a friend.

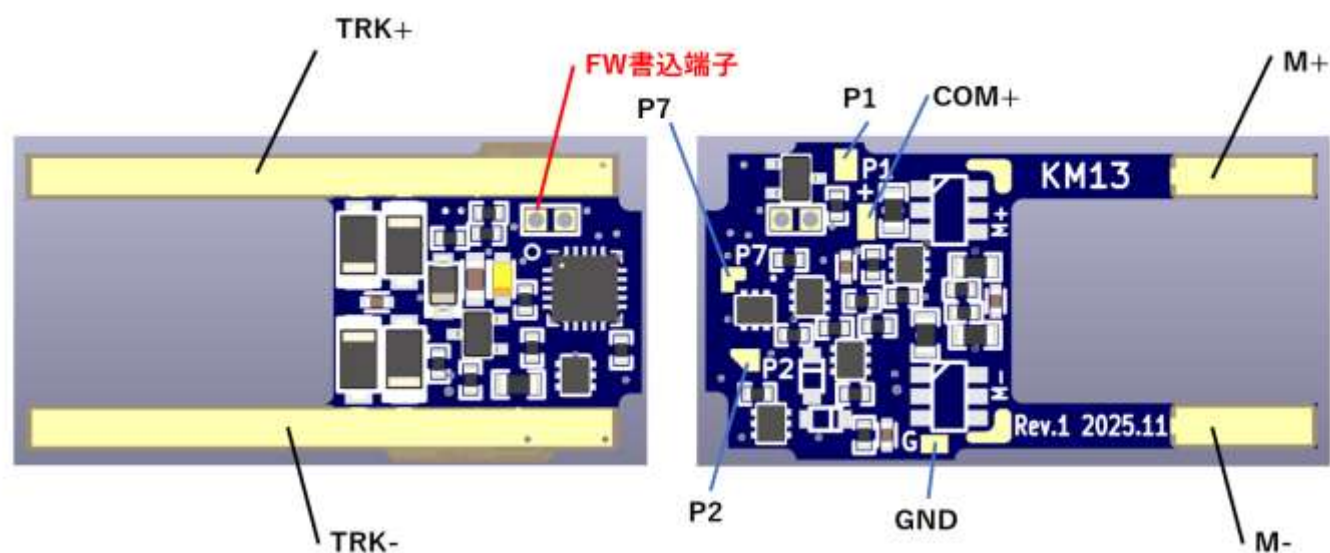


illustration 5.3.1 Pad Description for KM13

table 5.3.1 KM13 Pad List

Pad Name	Pad Description
COM+	This is a common power terminal used for the function outputs of P1, P2, and P7.
GND	This is the GND inside the decoder. It can be used to augment with tomalan capacitors, etc., but basically it is not necessary.
P1(Func1)	The default can be used as a headlight that can be operated with F0.
P2(Func2)	Since the default is different, write CV36=128 and use it as a taillight that can be operated with F0.
P7(Func7)	The default can be used as an interior light that can be operated at F3.

5.4.AUX wiring method

P1, P2, and P7 are pads for the AUX outputs and are associated with function outputs 1, 2, and 7. By default, P1 = HeadLight, P2 = TailLight, P3 = Interior Light. If you want to assign it as a default, P1 and P7 can be supported by the default CV, but to change the settings of P2, please write CV36=128.

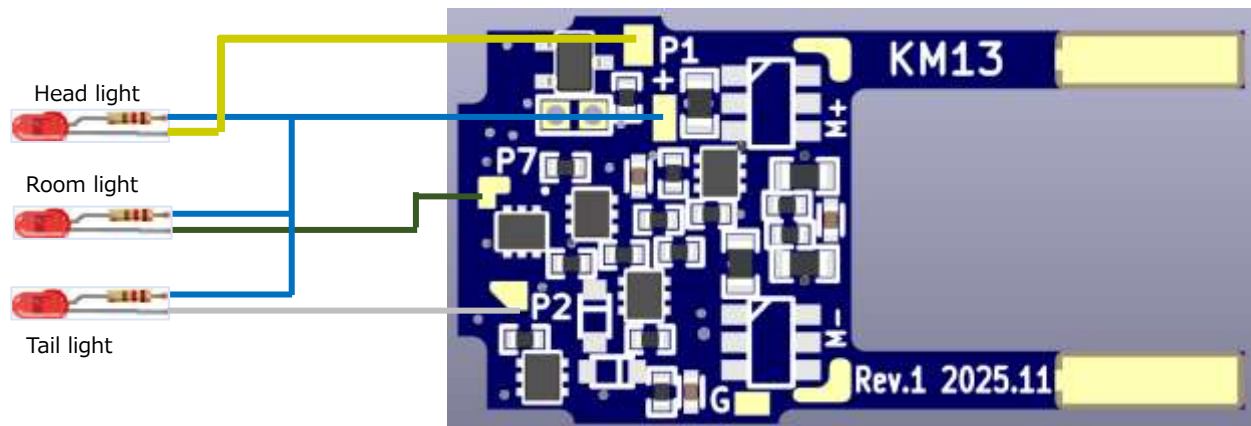


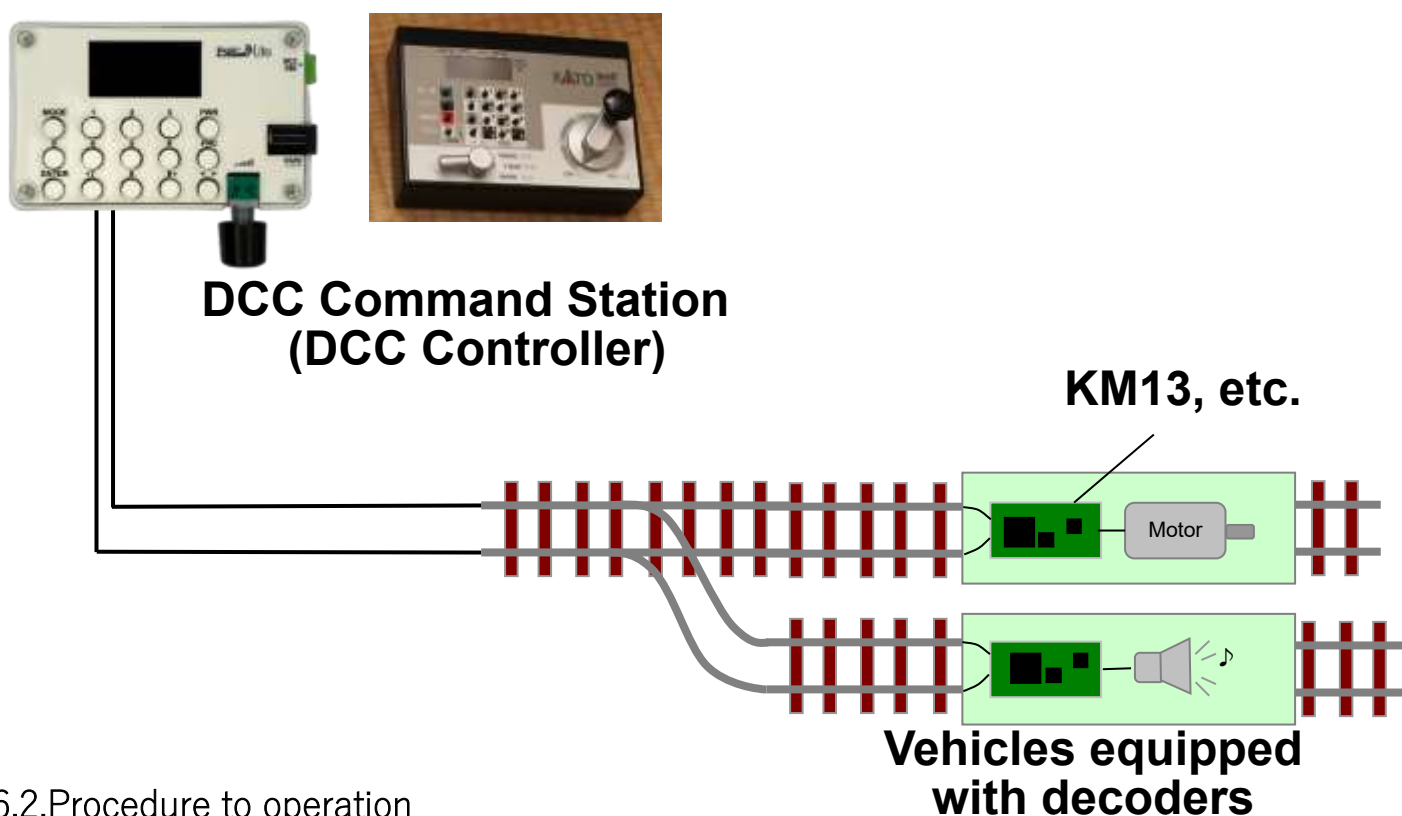
illustration 5.4.1 Example of AUX wiring

6.How to operate and use

6.1.How to drive

The KM13 takes commands from the DCC command station and performs its operations. Based on the behavior set in advance in the CV, the KM13 performs speed control and function control. For specific vehicle operation instructions, please refer to the instructions of the DCC command station.

The KM13 is compatible with operation by a DCC command station in accordance with the NMRA DCC standard. It can be operated with DSairLite, D101, D102, D103, DSair2, and other products.



6.2.Procedure to operation

The method of driving depends on the command station. The general flow is to operate the DCC vehicle as follows.

- ① Prepare the track and connect the command station to the track with a feeder line
- ② Operate the command station and turn on the power supply to the track
- ③ Select the address of the vehicle (default value is 3), set the direction of travel, operate the volume/speed adjustment, and perform the operation
- ④ Operate functions as needed (F0 for headlights, taillights, etc.)

6.3.Change of address

DCC decoders like KM13 have a number called an address, which can be freely configured by the user in the range of 1-9999. By setting a separate address for each vehicle, it is possible to operate independently on the same track.

Normally, the factory address is 3. The same is true for other manufacturers, so it is useful to remember.

Address changes use the CV programming function of the command station.

[Short address (1-127)]

Using CV:

- **CV1:** Short Address Body
- **CV29:** Address mode selection

Setup Steps:

1. CV1 has the desired address (1~127).
2. Clear bit 5 (value 32) of CV29 to put it in short address mode.

Example:

- CV1 = 3 (address 3)
- CV29 = 6 (bit 5 is 0 → short address)

[Long address (128-9999)]

Using CV:

- **CV17:** Top Bytes for Long Addresses
- **CV18:** Long address subordinate bytes
- **CV29:** Address Mode Selection

Setup Steps:

1. Decompose the desired long address (128-10239) as a 16-bit value.
2. Set the top bytes (0xC0 to 0xE7) for CV17.
3. Set the lower bytes (0x00 to 0xFF) for CV18.
4. **Set bit 5 (value 32) of CV29 to long address mode.**

Address Calculation Formula:

$$\text{LongAddress}(128\sim 9999) = (\text{CV17} - 192) * 256 + \text{CV18}$$

Example: If you set the address 257

- CV17 = 193 (0xC1)
- CV18 = 1 (0x01)
- CV29 = 38 (1 → long address with 5 bits)

Calculating address changes is a bit tricky. As a command station that is very easy to change addresses, we recommend DSairLite, a desktop station.

6.4.How to restore to factory condition

To restore the KM13 to its factory state, write 1 command station to CV8. The following is an example of how to use DSairLite. Check the manual of your command station before working.

6.5.Function Settings

The CV values associated with the function are assigned two CV numbers for each output from Function 1 to Function 7, which are used to set the function key and direction, and to set the LED illuminance and function type, respectively.

For Function8, it is specially assigned because it works using a motor driver and uses four CV numbers. (Address control, enablement, function type control x 2)

For virtual functions that do not have an output port (headlight dimming control, switching indicator light, headlight constant on), one or two CV numbers are assigned.

CV Number Assignment Table

Output Port Name/Virtual Function Name	Function support direction	key	Illuminance and type	Default Value	
				Function Number Corresponding Direction	Illuminance and function type
P1 (Function1)	CV35		CV114	64 (F0 / Forward)	241 (illuminance 15 / headlight)
P2 (Function2)	CV36		CV115	129 (F1 / Reverse)	243 (illumination 15 / taillight left)
P7 (Function7)	CV41		CV120	3 (F3)	244 (Illuminance 15 / Fluorescent Lamp Type 1)
Headlight dimming	CV33		CV112 (LED illumination only)	4 (F4)	64 (Illuminance 4)
Disabling the automatic braking function	CV51		-	255 (Invalid)	-
Speed control during transfer	CV63		CV131 (Upper Speed Limit)	7 (F7)	63 (Maximum speed: 1/4)

Setting the function number and direction

The CV values for function keys and direction control are as shown below.

Bit7	Bit6	Bit5	Bit4-Bit0
Reverse only (1/0)	Forward only (1/0)	Reserved for future expansion	Function Numbers (0-28, 30, 31)

If you want to control by direction, set Bit7 or Bit6 to 1. For the function number, set it from 0 to 28 to any number.

If it is set to 30, the function will be disabled, and if it is set to 31, it will always work. Even if the function number is set to 31, the direction control using Bit7 or Bit6 will work, so it is possible to set the light to light up according to the direction of travel without operating the function button, for example, while the vehicle is in operation.

The following are some examples of settings.

Behavior in example configuration	Decimal	Binary
Works only when moving forward at F0	64	0100 0000
Works only when reversing at F0	128	1000 0000
Works in F3 regardless of driving direction	3	0000 0011
Works only when moving forward in F1	65	0100 0001
Constant light when moving forward regardless of the operation of the Func Button	95	0101 1111
Always on when reversing regardless of the operation of the Func Button	159	1001 1111

Setting Function Type and Illuminance

Function Type Settings set the illuminance and operation type of the LEDs connected to each function port. The illuminance can be set in 16 levels from 0 to 15. There are headlights, taillights, left and right, fluorescent lights, etc., and you can apply effects according to each of them.

Bit7 - Bit4	Bit3 - Bit0
Illuminance (100Hz PWM / 16 levels)	Function Type

List of function types

The effects that can be selected as function types are as follows.

Bit3 - Bit0 Settings	Binary value	Function Type
0	0000	Normal output (no effects)
1	0001	Headlight (fade-in / dimmed)
2	0010	Taillight right
3	0011	Taillight left
4	0100	Fluorescent lamp type 1 (interior light / flashing light)
5	0101	Fluorescent lamp type 2 (interior light / flashing light)
6	0110	Light bulb (interior light / fade in on)

[Example of setting]

The following is an example of setting the function type and illuminance. You can change the behavior by writing these values from CV112 to CV122 to the CV that corresponds to the function port you want to change the configuration of.

What works in the example configuration	Decimal	Binary
Headlight / Illumination 15 (Max)	241	1111 0001
Taillight right / illuminance 15 (max)	242	1111 0010
Taillight left / illumination 15 (maximum)	243	1111 0011
fluorescent interior light / illuminance 15 (max)	244	1111 0100
Bulb Indoor Light / Illuminance 15 (Max)	246	1111 0110
No effect / Illuminance 8 (about 1/2)	128	1000 0000

6.6.Adjustment of acceleration and deceleration

TBD

6.7.Adjusting the starting voltage and maximum speed

TBD

6.8.Slow-speed rotation assist function (pulse assist)

TBD

6.9.BEMF Adjustment

TBD

6.10. Automatic Braking (ABC)

TBD

6.11. How to use it

The KM13 is mainly used for DCC use in motor vehicles (M cars), but since it has three function outputs, it is also possible to control the lead car. It uses bipolar boards and can also be used for vehicles that are integrated with the first car and the M car.

When using a competing product, you need to combine two types of motor decoders and function decoders, and there are cases where the list price exceeds 5,000 yen.

Once you are familiar with the KM13, please take advantage of the function output function of the KM13.



Example of installing KM13 in a friendly vehicle

7.analog operation

The KM13 is easy to drive in an analog environment (non-DCC environment). You can easily enjoy driving a vehicle equipped with the KM13 even if you bring it to a place where a DCC environment is not available or where the use of DCC is prohibited.

Since it is operated through a DCC decoder, the operating feeling is different from that of ordinary analog vehicles. The KM13 can be set to suppress the speed even when the volume is turned to the maximum, and to set the acceleration during acceleration, so you can enjoy driving in an analog environment depending on the adjustment. Below are the environments and products that have been confirmed to operate with this function. Please note that even in the environments listed here, there is no guarantee that the KM13's analog driving capabilities will perform on a par with regular analog vehicles.

- TOMIX PowerUnit (5001), TCS PowerUnit N-1000CL (5502)
- KATO Power Pack Standard S (22-012), Power Pack Hyper DX (22-017), Power Pack Standard SX (22-018)
- DesktopStation DSairLite PWM Analog Operation
- TRAINO MagicBox
- Commercially available bench power supply (pure DC output)

7.1.Analog driving method

To perform analog operation, perform the following methods.

1. **Turn the volume of the power pack to about 80% Even if you turn the power pack volume, it will not start moving immediately with the acceleration settings described later, so there is no problem. It also does not run out of control near the top speed.**
2. **The KM13 decoder, which waits for the vehicle to start moving**
determines the track voltage and travel direction and starts operating in analog driving mode.
3. **Adjust the speed Move the volume of the power pack to fine-tune the speed. Unlike normal analog vehicle driving, if the power pack volume is squeezed too much, the power supply to the KM13 will be interrupted and the vehicle will stop.**

Note:

When switching the direction of FWD/REV, set the volume to 0 before switching directions. If you switch instantaneously, you may not be able to respond well to the switch and continue driving.

7.2.Settings for analog driving

The CV number and settings related to analog driving are as follows. Change the settings as needed and use it.

table 7.2.1 CV-related settings for analog driving

CV Number	Initial value	Settings when driving analogue
29	6	bit2: Enable or disable analog driving *Analog driving is enabled when bit2 = 1. Invalid with Bit2=0.
50	255	Function Activation Flag When Driving Analogue (bit8: Func8, bit7: Func7, ..., bit0: Func0)
58	127	Maximum speed when driving in analogue. Set the upper limit of speed from 0-255 (with an initial value of 127, $127/255 = \text{about } 50\%$)
59	3	Acceleration during analog driving Acceleration used during acceleration operation after the determination of line voltage and travel direction is completed

8.support

8.1.Environmental conditions for operation assurance

The support provided by Desktop Station Co., Ltd. to users is based on the following environment. If we have repaired or adjusted it and confirmed the operation, and if we are using a usage environment, conditions, or settings that do not meet these conditions, we will be deemed to have been able to confirm the operation in the user environment. Please note.

table 8.1 Operating Assurance Environmental Conditions

	Warranty Compatible Equipment	Other conditions
Command Station	DSair2, DSairLite	The firmware must be the latest version.
decoder	KM13	The firmware must be the latest version.
Decoder Tester OR Friendly Vehicles	ESU 53900 Decoder Tester or LaisDcc 860033 Decoder Tester Pro KATO friendly vehicles	Even if the user makes his own equivalent equipment, it is not guaranteed to work.
AC Adapter	AC adapter sold by Akizuki Electronics DC12V or DC15V, DC16V	Only AC adapters within 3 years of purchase are guaranteed to operate. We do not guarantee other equipment-based products.
Tracks and vehicles	The track is not used, and the command station and decoder tester are directly connected by the feeder wire. The decoder does not guarantee operation when it is installed in the vehicle.	

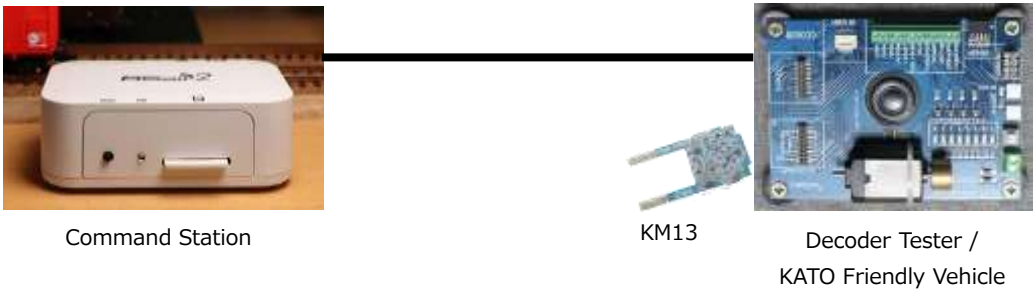


illustration 8.1 Example of an operation assurance environment

8.2.About the support system

Desktop Station Co., Ltd. is an internet-only system and does not have a physical store or direct support desk. We do not provide any support by phone. In addition, we are strongly promoting business simplification to keep sales prices down. For this reason, unlike ordinary stores, product development, sales, and business operations are carried out with a very small number of people, so various services are omitted. Thank you for your understanding.

table 8.2.1 Support Inquiries and Contact Points

Support Inquiry Details	Support Contacts
Consultation and questions before purchase Questions and consultations after purchase Consultation on how to use equipment and software Consultation on kit assembly Consultation and questions about installation Compatibility consultation with other companies' equipment When it is not possible to determine whether it is a defect	Digital Model Train Forum https://desktopstation.net/bb/ • Registration and usage fees are completely free • Operated by Desktop Station Co., Ltd.
In the event of initial failure In the event of equipment failure (regardless of the free repair period) Inquiries about inventory and delivery dates before purchase Inquiry for missing parts Changing the payment method when placing an order Inquiries about parts distribution, parts replacement, and provision of replacement parts for kit assembly	Please consult with the store where you purchased it. For the Desktop Station Online Store, please contact us via the contact form or email with your order number. We will support you by matching your order number with your purchase history. Desktop Station Online Store https://desktopstation.net/shop/contact Desktop Station Mail Counter support @ desktopstation.net
Inquiries other than those listed above	Desktop Station Mail Counter support @ desktopstation.net *We will not reply to sales emails or inquiries unrelated to our products.

8.3. Questions & Answers

Here are some frequently asked questions. If you have any other questions or consultations, please use the Digital Model Train Forum. We only provide individual support in the event of a breakdown or initial failure, and do not provide support to users for normal use.

Even if you receive an inquiry, we may not respond. Please note.

Please note that any failure caused by the user will be replaced for a fee in accordance with the warranty provisions (Chapter 2).

[Digital Model Railway Forum]

<https://desktopstation.net/bb/>

Q. What is the initial address number of KM13?

The initial address is 3 of the short addresses. You can use CV1 to change settings between 1-127. If you use more than 128 addresses, you can change to long address mode, and you can use up to 128-9999 with the combination of CV17 and CV18.

The address setting and confirmation function of DSairLite is very convenient for address setting.

Q. How do I connect the KM13 to a DCC system?

The KM13 works by receiving DCC signals. It is installed and used in KATO's N-gauge vehicle series of friendly compatible products. In advance, connect to the track that uses the DCC output (rail track output) of the DCC command station. After connecting, you can operate it from the command station screen by setting the CV and registering the address.

The initial address of KM13 is 3. Set 3 in the command station and try to move it.

Q. A vehicle equipped with KM13 did not run or suddenly stopped moving and broke down.

There are various possible causes. Please check the following points one by one.

- Is the feeder wire connected to the track correctly? Are there any broken wires or poor contact?
- Are your wheels dirty? Is there any dust or hair tangled in it?
- Are the rails dirty?
- Is the vehicle address correct? Please perform an address check.
- The contact spring with the vehicle is bent, curved, or disconnected
- Is the installed decoder misaligned?
- Are the photos and trolleys dirty, or do you get hair or dust involved?
- Is the decoder component and the die cast misaligned so that they come into contact?
- Please load the CV via the program track at the command station
- If you have other command stations, change them
- Check if there is a short circuit or problem with another vehicle on the same track.

Q. Fails to read CV.

If the current consumption of the motor is small or due to compatibility with the command station, the CV readout may fail. The KM13 decoder is recommended for use in Direct mode.

In addition, if there are electronic components such as LED-related components and resistors on the track or in the vehicle, it may not be possible to read them well.

Q. If you run it on the tracks, it will stop immediately.

Check the following:

- Is it a vehicle that can run normally in analog? A vehicle that cannot run stably in analog will not work normally in DCC.
- Some vehicles have few current collection points, and some vehicles are not originally strong in current collection due to their design. Brass vehicles generally have a single-axle current collector. It is most effective to modify it to a two-axis current collector or to collect current for the whole vehicle using a live coupler. In addition, please use measures against current collection defects, such as strengthening the capacitor and reviewing the wiring.
- Sometimes the cause is not the vehicle, but the track, feeder line, or track voltage. N gauge uses 12-14V, but if the line voltage drops due to voltage drop, consider strengthening the wire by thickening it or increasing the feeder wire.

Q. Can I contact KATO for instructions on how to use it?

This product is a third-party product that has no affiliation with KATO in any way. Please do not contact KATO about problems caused by this product or the combination of this product and the vehicle. If you inquire about a problem with the vehicle itself, please remove the product from the vehicle and respond to it.

If you would like to see the opinions of a third party, please use the Digital Model Train Forum.

Q. Can I update or modify the firmware?

It is possible for users to perform firmware updates themselves. However, they require specialized fixtures and software for professional use. We do not provide support because it requires specialized knowledge and deviates from the scope of normal use of this product. Please carry out the update and modification work under your own responsibility and supervision.

Q. If you move with a large number of vehicles in a large layout, it will become unstable

Due to the influence of the contact resistance caused by the track and joiner caused by large-scale layout and the wiring resistance due to insufficient thickness of the feeder wire, voltage drop may occur, and the current collection of the vehicle itself may increase, resulting in a further increase in voltage drop due to the operation of a large number of vehicles, resulting in insufficient capacitor effectiveness.

The problem can be mitigated by taking the following measures:

- If your command station has an output voltage regulation function, use the adjustment function to increase the output voltage
- Thicker and shorter feeder lines between the command station and the track
- Improve the contact resistance of the joiner

Based on 1A at 0.1sq (AWG27), consider 5A (AWG20) or higher in HO class and 3A (AWG22) or higher in N class.

9.Configuration Functions and CV

The DCC decoder has a "CV (Configuration Variables)" defined as a configuration function. Here are some settings that can be changed in the CV.

9.1.CV List

The following is a list of CVs that are standard in KM13.

table 9.1.1 CV List

CV Number	category	Function Description	Initial value
CV1	indispensability	Short address	3
CV2	indispensability	Starting Voltage (0-255)	0
CV3	indispensability	Acceleration Time (0-31)	0
CV4	indispensability	Deceleration Time (0-31)	0
CV5	indispensability	Maximum Voltage (0-255)	255
CV6	indispensability	Intermediate Voltage (0-255)	127
CV7		Version Number	-
CV8		Manufacturer ID	140
CV15		Decoder Lock Number	0
CV16		Decoder Lock Number	0
CV17	indispensability	Long Address LSB	192
CV18	indispensability	Long Address MSB	0
CV19		Consist Address	0
CV27	indispensability	Enabling Auto Braking Bit1: When Reverse / Bit0: When Forward (0: Disabled / 1: Enabled)	3
CV29	indispensability	Decoder Settings	14
CV33	Function	Bit0-Bit6: Headlight Dimming Function Number (Default: F4) Bit7 = 1: Manual dimming mode	4
CV34	Function	Replacement Beacon Light (Default: F7)	7
CV35	Function	Func1 Address Direction Settings (Default: F0/Forward)	64
CV36	Function	Func2 Address Direction Settings (Default: F1/Reverse)	129
CV37	Function	reservation	129
CV38	Function	reservation	128
CV39	Function	reservation	65
CV40	Function	reservation	65
CV41	Function	Func7 Address Direction Settings (Default: F3)	3
CV42	Function	Func8 (Motor Driver) Address Settings (Default: F0)	0
CV43	Function	Func8 Motor Driver Operation Setting 0: Disabled (Motor Control, Default) 1: Motor Driver Function Operation	0
CV44	Function	Always-on Headlight Mode (Front Side) (Default: Disabled)	30

CV45	Function	Always-on Headlight Mode (Rear Side) (Default: Disabled)	30
CV47	Motor control	KickstartBit0-5: Timing, Bit6: Freq (0: 120Hz / 1: 60Hz), Bit7: Enable	202
CV48	ABC	Asymmetric DCC Internal Circuit Thresholds	7
CV50	analog	Function Activation Flag When Driving Analogue (bit8: Func8, bit7: Func7, ..., bit0: Func0)	255
CV51	ABC	Auto Brake Disable Mode (Function) 0-28: F0-F28 / Others: Disabled	255
CV52	ABC	Time to automatically start winding operation after automatic braking operation 0: Disabled / 1-255: Windback starts after a specified number of seconds	0
CV53	ABC	Acceleration after automatic braking release	10
CV54	ABC	Deceleration during automatic braking operation	3
CV55	Motor control	BEMF Parameter (Kp)	30
CV56	Motor control	BEMF Parameter (Ki)	10
CV57	Motor control	BEMF Parameter (Kd)	40
CV58	analog	Maximum speed when driving in analogue (0-255)	127
CV59	analog	Acceleration and deceleration speed during analog driving	3
CV60	Motor control	Motor Control Function Settings bit8: Enabling BEMF bit1-bit0: Motor Low Speed Rotation Assist Function (0: Disable / 1: 60Hz / 2: 120Hz / 3: 30Hz)	131
CV61	Motor control	Motor low-speed rotation assist function (pulse assist) Minimum duty at start	95
CV62	Motor control	Motor Low Speed Rotation Support Function (Pulse Assist) Release Speed Value	192
CV63	Motor control	Maximum speed suppression function 0-28 for replacement: F0-F28 / 30: Disabled	7
CV64	RailCom	RailCom Forced Enabling on CV29 Rewrite 0: Disabled / 1: Enabled	1
CV67-94	Motor control	Speed curve	-
CV112	Function	Illuminance when the headlight dimming function is activated (7-4bit)	64
CV114	Function	Func1 Illuminance and Function Type Default: Illuminance 15 (Max) / Headlight	241
CV115	Function	Func2 Illuminance and Function Type Default: Illuminance 15 (Max) / Taillight Left	243
CV116	Function	reservation	242
CV117	Function	reservation	241
CV118	Function	reservation	243
CV119	Function	reservation	242
CV120	Function	Func7 Illuminance and Function Type Default: Illuminance 15 (Max) / Interior Light Type 1 (Fluorescent)	244
CV121	Function	Func8 (Forward) Illuminance and Function Type Default: Illuminance 15 (Max) / Headlight	241
CV122	Function	Func8 (Reverse) Illuminance and Function Type Default: Illuminance 15 (Max) / Taillight Right	242
CV131	Function	Maximum speed when swapping mode is enabled (0-255)	63
CV138	Motor control	BEMF PID Feedback ADC Scaler MAX Value	100

CV140	Motor control	Start-up time from zero speed to start energizing when starting to move (Specified at 1/10th of a second, from 0.1 seconds to 25.5 seconds / Value=0 is invalid)	0
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9.2.CV Description

Here, we will explain how to set up each CV and what to keep in mind.

CV1 Short Address

Set the address to be used in the basic address mode called short address. This is usually the default value of 3. Set a value of 1-127. In addition, in the European style command station, it is in the range of 1-99. In the American style command station, it will be 1-127. Numbers greater than this range must be set as long addresses (address modes using CV17 and CV18).

CV2 Starting Voltage

Specifies the amount of voltage at which the vehicle will start moving. 255 is the maximum voltage, 0 is no voltage, and 127 is exactly half the voltage. Values around 10~70 are selected. In many cases, the N-gauge value is 20 or less. Large vehicles tend to choose large numbers. It also depends on the weight of the vehicle and the gear ratio.

CV3 Acceleration

Set the moderation of acceleration. Set a value from 0-31. The higher the value, the slower the acceleration.

CV4 Deceleration

Set the severity of the deceleration. Set a value from 0-31. The higher the value, the slower it slows down.

CV5 Maximum Voltage

When the maximum speed is set at the command station, the amount of voltage applied to the motor is determined. By daring to make it smaller, you can also adjust it so that it does not go at a dangerous speed. If you set 255, it will output the same voltage as the voltage applied to the track. It is generally about 150 for N gauge and about 200 for HO or higher. If you want to use a speedometer to match the scale speed, you will mainly adjust this CV5.

CV6 Intermediate Voltage

Specifies the magnitude of the voltage between CV2 and CV5. If there is no particular reason, set the value of (CV2+CV5)/2. If you want to adjust to a strict scale speed, you can adjust this CV6 to match the scale speed over a wide range. Note that this CV value is ignored when using the speed curve.

CV8 Manufacturer ID and Factory Initialization Settings

If you write "8" in CV8, it will revert to the initial CV value.
 When the CV8 is read, the desktop station's manufacturer ID 140 can be read.

CV17 Long Address LSB

CV for long addresses.
 The value range is 192-230. It is used in conjunction with CV29 and CV18.

CV18 Long Address MSB

CV for long addresses.
 The value range is 128-255. It is used in conjunction with CV29 and CV17.

CV27 Automatic Brake (ABC)

Activate the automatic braking by the asymmetry DCC. The default is 3 (Bit0=1, Bit1=1).

Bit0: On Forward (0: Disabled / 1: Enabled)
 Bit1: Reverse (0: Disabled / 1: Enabled)

CV29 Decoder Configuration

Perform the standard settings for the decoder. The formula for setting CV29 is as follows, but it is difficult to understand, so you should usually use DSSP to make the basic settings. Also, please use DSairLite to change your address. You can easily and automatically change the contents of CV29 appropriately without any special operation.

$$CV29 = Bit0 * 2^0 + Bit1 * 2^1 + Bit2 * 2^2 + Bit3 * 2^3 + Bit4 * 2^4 + Bit5 * 2^5 + Bit6 * 2^6 + Bit7 * 2^7$$

table 9.2.1Meaning of CV29 decoder settings

Bit	function	Meaning of value
0	Setting the reference direction of travel. FWD and REV can be swapped. 0: Direction of travel remains the same When 1: Reverse the reference of the vehicle's direction of travel.	0: FWD, 1:REV
1	Speed step. smoothness of speed changes; Usually set to 1. 0: Works with older 14-step signals 1: Enables 28 or 128 step speed resolution.	0: 14steps, 1: 28/128steps
2	Analog operation function.	0: Unused, 1: Used
3	Using RailCom/Bidi (In-Flight Communication)	0: Unused, 1: Used

	When 0: RailCom/Bidi does not use 1: Reacts with RailCom/Bidi signal	
4	Use of speed tables. 0: CV2, CV5, CV6 are used for the speed curve. 1: Use the speed curve defined in CV67~CV94	0: Unused, 1: Used
5	Specifying Short/Long Addresses At 0: Use CV1 as the address of the loco. 1: Use CV17, CV18 as Loco address	0: Short, 1: Long
6	reservation	
7	reservation	

CV33 Headlight Auto Dimming

Specify the function number that automatically dims the headlights. The default is F4. For example, if you want to auto-dim F0, specify CV33=0.

Bit0-Bit6: Headlight Dimming Function Number (Default: F4)

Bit7 = 1: Manual dimming mode

CV35,36,41,114,115,120 Func Address Direction Settings

The CV values related to the function are assigned two CV numbers for each output from Function1 to Function7, respectively for controlling the address and direction, and for controlling the LED illuminance and function type.

Function 8 is specially assigned because it uses a motor driver to operate, and uses four CV numbers. (Address control, enablement, function type control x2)

In addition, virtual functions that do not have an output port (headlight dimming control, replacement indicator light, headlight constant on) are assigned one or two CV numbers.

To make P2 light up in reverse at F0, you need to set Bit7=1, Bit0-4 to 0(=F0), so set 128.

table 9.2.2 List of CVs related to function settings

number	Address and direction	Illuminance and type
Function 1(P1)	CV35	CV114
Function 2(P2)	CV36	CV115
Function 7(P7)	CV41	CV120
Function 8 (motor output)	CV42 (setting) CV43 (enabled/disabled)	CV121 (Forward) CV122 (Reverse)
Headlight dimming	CV33	CV112 (LED illumination only)
Replacement Indicator Light	CV34	-
Headlights are always on	CV45	-
Disabling the automatic	CV51	-

braking function		
Speed control during replacement	CV63	CV131 (Upper Speed Limit)

table 9.2.3 CV35,36,41,Set Bit Assignment

Bit7	Bit6	Bit5	Bit4 - Bit0
Reverse only	Forward only	Reserved for future expansion	Function Numbers (0-28, 30, 31)

CV50 Analog Operation Function Settings

Set the function activation flag when driving analogue. The default is 255 (all bits are 1: active).

bit8: Func8 (0: disabled / 1: enabled)

bit7: Func7 (0: disabled / 1: enabled)

...

bit0: Func0 (0: disabled / 1: enabled)

CV60 Operation Settings for Low Speed Rotation Assist

This is a setting related to the compensation function at low speeds, such as pulse assist kick start. Use it when you want to run more smoothly at low speeds. However, if set to excessive strength, it may cause knocking at low speeds. It also greatly depends on the habits and personality of the vehicle itself.

The settings are specified by calculating the setting bits of the CV60's Bit0 and Bit1 for the Slow Rotation Assist function. The settings of each bit will behave differently.

The default is 131 (Bit7=1, Bit1=1, Bit0=1). The low-speed rotation support function is effective, and the low-frequency component is 30Hz, and there is BEMF control.

table 9.2.4 CV60 configuration table

Bit7	Bit1	Bit0	CV60	BEMF	Operation of the slow rotation assist function
0	0	0	0	invalid	Disabled (normal control with 40kHz PWM only)
0	0	1	1		Low Frequency Component: 60Hz
0	1	0	2		Low Frequency Component: 120Hz
0	1	1	3		Low Frequency Component: 30Hz
1	0	0	128	valid	Disabled (normal control with 40kHz PWM only)
1	0	1	129		Low Frequency Component: 60Hz
1	1	0	130		Low Frequency Component: 120Hz
1	1	1	131		Low Frequency Component: 30Hz

CV61 Minimum Duty at Startup

[Can be used when the CV60 low-speed rotation assist function is enabled]

Sets the lowest value of high-frequency PWM duty when the throttle specification is 1. Set a

duty large enough to overcome the static friction of the vehicle. If it is too large, it will cause a knocking behavior at low speeds. If it's too small, it won't start running.

The default value is 95.

CV62 Release Speed When Starting

[Can be used when the CV60 low-speed rotation assist function is enabled]

Set the value of the speed (throttle) to disable the slow rotation assist function. When driving at medium to high speeds, smooth rotation is possible even without the pulse assist function. On the other hand, it may cause problems such as speed disturbances, so it is necessary to disable the slow rotation assist function at an appropriate speed.

The default value is 192.

CV64 RailCom Forced Activation on CV29 Rewrite

Any CV29 rewrite will turn Bit3 into 1.

0: Invalid / 1: Enabled

CV67-94 Speed Table

This is a parameter that fine-tunes the speed increase that can be used when the speed table is enabled in CV29.

10.About firmware rewriting

The source code for the KM13 firmware is available on the MT40 GitHub, which also contains the necessary information for software development. Therefore, users are free to rewrite the firmware of KM13 and use it themselves.

If the user rewrites the firmware to the product, the right to receive support and operation guarantee will end at that time. Please work at your own risk, your own research, and trial.

Desktop Station Co., Ltd. Circle MT40 does not accept any support or consultation.

[Source code release location]

<https://github.com/ytsurui/dcc-decoder2-firmware>

[Write terminal position]

The write terminals are available in the position shown in the figure below, with UPDI and GND terminals. In addition, when 5V is applied to the left and right rail pads, it is powered to the MCU inside the KM13 and can be written. Therefore, it is possible to write from the emulator if you prepare three wires: 5V, GND, and UPDI.

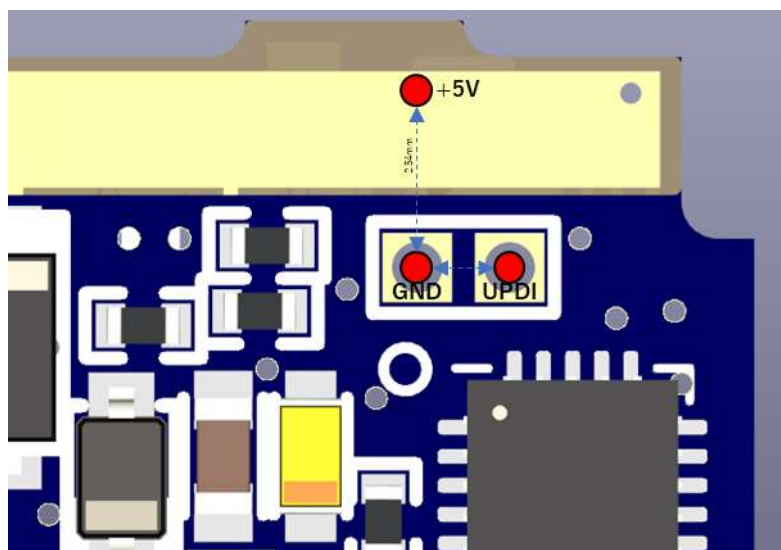


illustration 10.1Firmware Write Terminal Position

[Fuse bit]

When building and writing source code, make sure to use the following fuse bit settings: We are not responsible for the content of the settings. Also, the settings and content vary greatly depending on the writing tool. Please work on your own and refer to the instructions for the tool.

table 10.1 ATtiny1606 Fuse Bit Settings

Settings	Set value	Remarks
Fuse0 /wdtcfg	0b00000000	
Fuse1 /bodcfg	0b01000110	BOD 2.6V
Fuse2 /osccfg	0x02	

Fuse5 /syscfg0	0b11000100	
Fuse6 /syscfg1	0x04	startup 8ms
Fuse7 /append	0x00	
Fuse8 /bootend	0x00	

11.bibliography

The KM13 was developed using the following references, OSS, software, specifications, etc.
Thank you.

- NMRA DCC Standard
- RailCommunity Open Data Sheet (RCN)
- DCCwiki (<https://dccwiki.com/>)
- Arduino, Arduino IDE, Arduino eco system
<https://www.arduino.cc/>
- ATtiny1606 / ATtiny806 DCC Decoder Firmware
<https://github.com/ytsurui/dcc-decoder2-firmware>
- megaTinyCore (mTC) - Arduino support for all tinyAVR 0/1/2-Series
<https://github.com/SpenceKonde/megaTinyCore>

12.thanks

KM13 has been developed and debugged by the following companies and development members: We would also like to thank the volunteer development collaborators and users who provided information that are not listed here.

- Circle MT40
- Desktop Station Inc.
- DCC Hall
- Nucky
- HMX
- Fujigaya2





Desktop Station