

Instruction Manual

IoT Connection with the Triaxial Vibration Monitor

VM40C

Valid from version xxx.017



Manfred Weber

Metra Mess- und Frequenztechnik in Radebeul e.K.

Meißner Str. 58 - D-01445 Radebeul

Tel. +49-351 836 2191 Fax +49-351 836 2940

Email: Info@MMF.de Internet: www.MMF.de

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Manfred Weber

Metra Mess- und Frequenztechnik in Radebeul e.K.

Meißner Str. 58

D-01445 Radebeul

Tel. +49-351-836 2191

Fax +49-351-836 2940

Email Info@MMF.de

Internet www.MMF.de

Note: The latest version of this manual can be found at
http://www.mmf.de/product_literature.htm

Specification subject to change.

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These instructions apply in addition to the VM40C operating manual, which can be downloaded from our website https://mmf.de/building_vibration.htm.

1. Introduction

The technologies of the "Internet of Things" (IoT) make measurement data available worldwide. This also has advantages for the VM40C structural vibration monitor. Structural measurements often take place in remote or difficult-to-access locations. The VM40C in conjunction with the modem available as an accessory can send its measurement data to a sensor data platform on the Internet. This makes it possible to follow the vibration history both currently and in retrospect remotely via an Internet browser.

The following IoT platforms are supported:

- **AskSensors**, an easy to use Internet data visualization platform.
- **ThingSpeak**, an Internet data interface for collecting, visualizing and analyzing measurement data that is part of MathWorks' MATLAB software.

Both platforms offer a comparable range of functions in terms of visualization. While ThingSpeak should mainly be interesting for users of the MATLAB software, AskSensors is significantly less expensive.

The data usage in IoT mode is below 1 kilobyte per record sent.



Figure 1: Vibration monitor VM40C



Figure 2: VM40 modem

2. AskSensors

2.1. General

AskSensors is an internet platform for storing and visualizing sensor data. At <https://asksensors.com/> you start with setting up a user account.

Then you select a suitable license type. AskSensors offers a flexible licensing model on a monthly or yearly basis. The license type "SIMPLE" is recommended. For testing, AskSensors can be used for 14 days free of charge.

After licensing, select "My Workspace" in the menu. The view shown in Figure 3 opens.

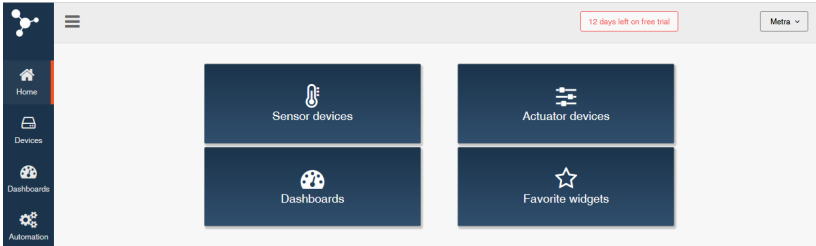


Figure 3: Main menu of AskSensors

2.2. Setting up a Device Channel

First, set up the connection to the device from which data is to be received. This is done under "Sensor devices" (Figure 4).

Click "New Sensor". The menu for entering the device data opens (Figure 5). Under "Name" enter a designation for the VM40C.

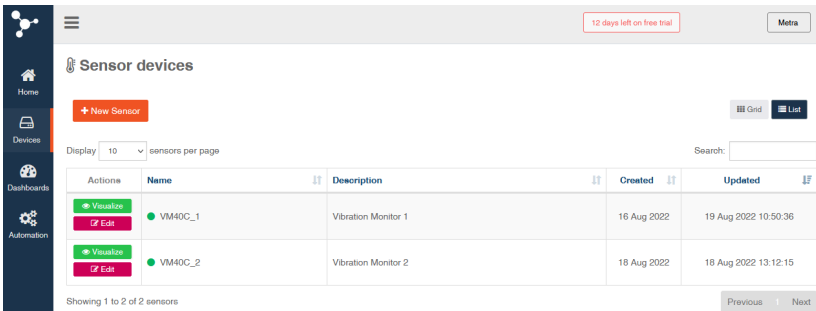





Figure 4: Devices, example with two VM40C units







Home



Devices



Dashboards



Automation

12 days left on free trialMeta

New Sensor

Sensor details

Name *

Description

Add modules

+ Add Module

Actions	Module	Name	Description
No data available			

Sensor Location (in Decimal degree, example: 48.855071, 2.350138)

Latitude

Longitude

Show Sensor Location No Yes

Save Exit

Figure 5: Setting up a device channel

2.3. Entering Measuring Channels

In the next step information about the measuring channels of the device needs to be entered. The following channels are sent by the VM40C:

- Amplitude values for X, Y and Z in mm/s or m/s².
- Main frequency in Hz
- Battery charge level in percent
- Current status (0 = heartbeat; 1 = warning; 2 = alarm)

Click "Add Module." Add six modules and name them as shown in Figure 6. Further down you can enter the longitude and latitude of the measuring point. This will then be displayed on an interactive map. With "Save sensor" you save your entries.

[+ Add Module](#)

Actions	Module	Name	Description
Edit Remove	module1	X	
Edit Remove	module2	Y	
Edit Remove	module3	Z	
Edit Remove	module4	Frequency	
Edit Remove	module5	Battery	
Edit Remove	module6	Warning/Alarm	0 = Heartbeat; 1 = Warning; 2 = Alarm

API keys

API Key In : zcauockDkbFRo60aSODpgs3L9pWedXYa [Generate new API Key In](#)

API Key Out : BFVOLTIEgNEuuxfaj3lqBXSklle5b0 [Generate new API Key Out](#)

Sensor Location (in Decimal degree, example: 48.855071, 2.350138)

Latitude Longitude

Show Sensor Location No Yes

[Save sensor](#) [Exit](#)

Figure 6: Setting up measuring channels

By clicking on the device channel (Figure 4) you can check the settings of device and measuring channels.

Here you will also find the key "API Key In", which must be entered in the VM40C (cf. page 9) to establish the connection to AskSensors.

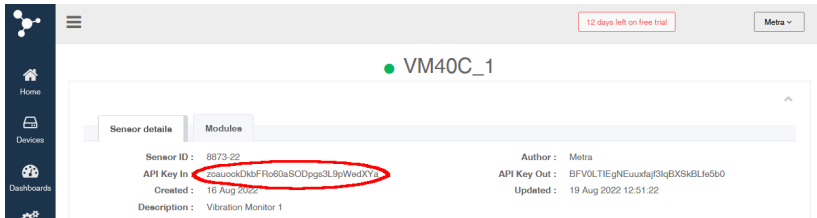


Figure 7: API Key In

2.4. Dashboard

Now switch to the menu item "Dashboards" (Figure 8). Here the settings for the measurement data visualization are made. A dashboard is an arrangement of diagrams or other visualization elements, here called "widget". Clicking on the device channel opens the dashboard.

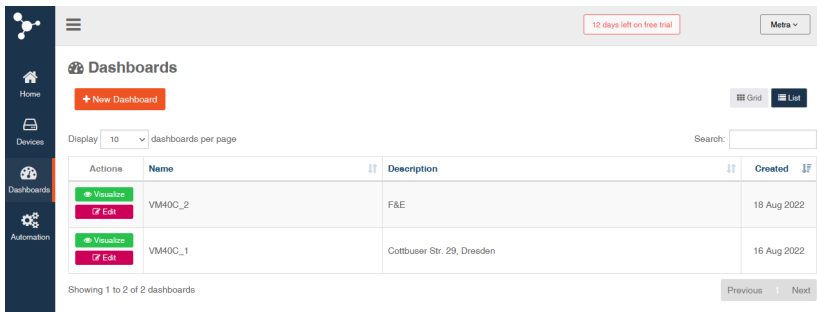


Figure 8: Dashboards

Click "Add new widget" to add a visualization element (Figure 9).

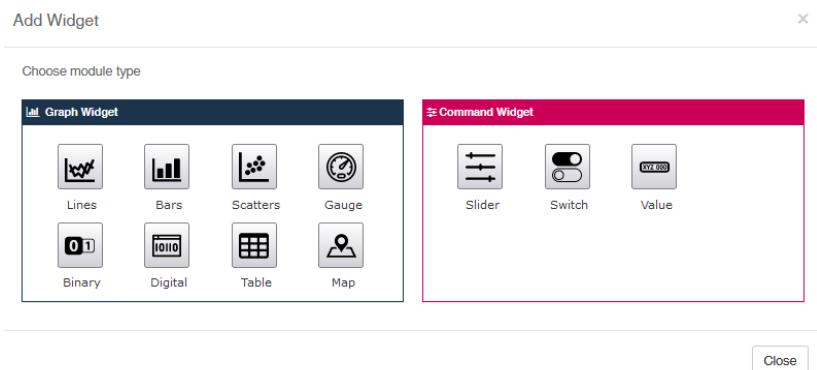


Figure 9: Adding visualization elements

Line charts (Lines) for the measured values and bar charts (Bars) for the status display are particularly useful. However, you can also use all other elements.

"Command widgets" are not supported by the VM40C.

Figure 10 shows an example for the output of the amplitudes of X/Y/Z over time as a line chart. Under "Sensor" you select the device and under "Module" the channel.

Under "Results" you specify how many measured values are displayed in the diagram. The maximum value is 50.

Add Widget : Lines ×

Data set (1)

Sensor * Module *

➖ Data set (2)

Sensor Module

➖ Data set (3)

Sensor Module

Widget settings

Name*	<input type="text" value="Amplitude"/>	Title	<input type="text"/>
X Axis	<input type="text"/>	Y Axis	<input type="text" value="mm/s"/>
Min	<input type="text" value="0"/>	Max	<input type="text" value="0"/>
Results	<input type="text" value="50"/>		

Figure 10: Settings for an X/Y/Z line chart

Figure 11 shows an example of a dashboard for displaying amplitudes X/Y/Z, warning/alarm status, main frequency and battery status.

Note: A battery charge value of 110 % indicates that the battery is being charged.

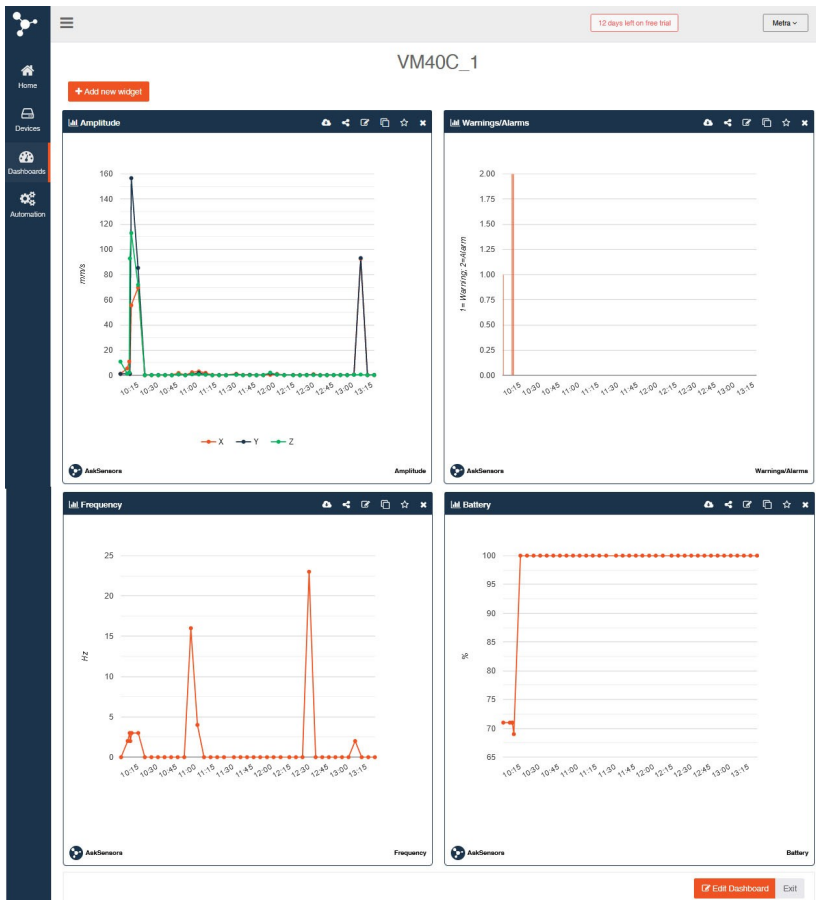



Figure 11: Example of a configured dashboard

The number of messages already sent and possible connection errors can be checked up in measurement mode by pressing F2.

The AskSensors connection is deactivated by switching off the VM40C.

2.5. Data Export

In the header of the display elements you will find the symbol . It is used to export the saved data to a file (Figure 12).

CSV and JSON are available as output formats. The export must be done individually for each measuring channel.

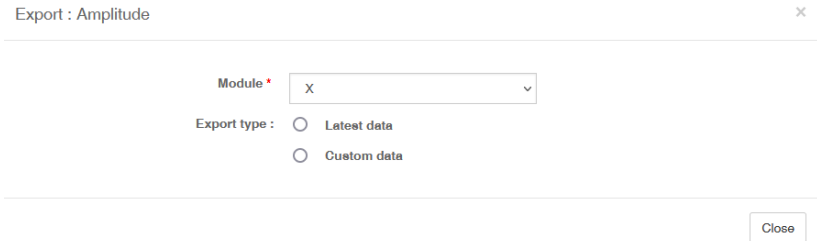


Figure 12: Data export

2.6. Email Alerts

AskSensors can send alert messages by email when thresholds are exceeded. To enable this function, click "Devices" in the AskSensors menu, then on the name of the device, select the tab "Modules" and "Add alert" for the desired module (Figure 14). Useful is, for example, "module6" with the warning/alarm status. If you enter "1" under "Max value", a message will be sent in the event of an alarm (Figure 13).

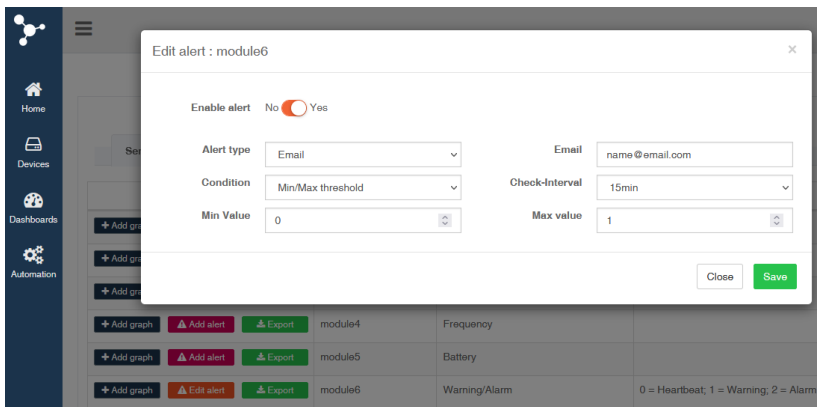


Figure 14: Setting up email alerts

Select "Min/Max threshold" as criterion and enter the email address. "Check interval" determines how often emails are sent. Selectable are 15 minutes to 1 week. The sender is admin@asksensors.com.

The data read on your sensor has exceeded the alert threshold:

```
Sensor : VM40C_1
Module : module6
minThreshold :
maxThreshold : 1
Value : 2
Date : 01 Sep 2022 06:16:45 UTC
```

Figure 13: Email alert example

2.7. Settings at the VM40C

To set up a connection between the VM40C and AskSensors, select "IoT/SMS/Alarms" in the VM40C main menu, then "AskSensors" and there "Settings".

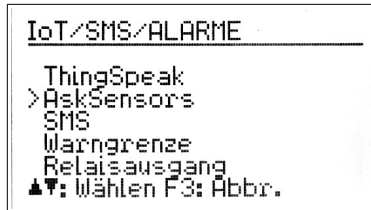


Figure 15: IoT menu

First, you specify the Access Point Name (APN). This is the name of the gateway through which the mobile network operator provides access to the Internet. You can find it on the mobile network operator's website. Use the arrow keys to enter the APN. Press F1 to switch between upper and lower case letters and digits (Figure 16). Press OK to switch to the next line or save the entry after the fourth line. Press F3 to skip the entry.

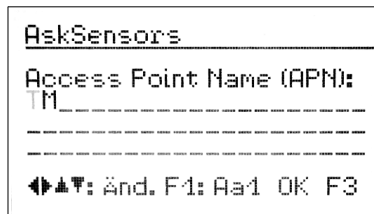


Figure 16: APN input

If required by the network operator, enter the APN User and APN Password in the same way. You can find both entries also on the network operator's web pages. In most cases you can skip these two entries.

Next, specify the "API Key In" of AskSensors. This code is used to assign the measurement data sent to AskSensors to a specific AskSensors channel. In AskSensors you will find the API Key under "Devices" after clicking on the relevant device channel (cf. page 4). Press F1 to switch between upper and lower case letters and numbers (Figure 17). Press OK to switch to the next line or save the entry after the fourth line. Press F3 to skip the entry.

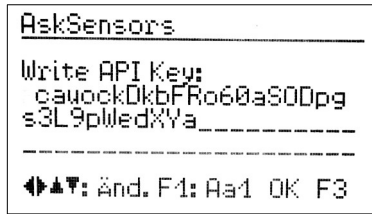


Figure 17: Entering API Key

As a last step, you specify the time cycle ("Heartbeat") in which the VM40C reports to AskSensors if no oscillation events are present (Figure 18). This will allow you to check if the connection still exists. The shortest selectable interval is 5 minutes. Please note that each modem connection causes an increased current consumption.

Note: The longer the interval, the longer the operating time per battery charge.

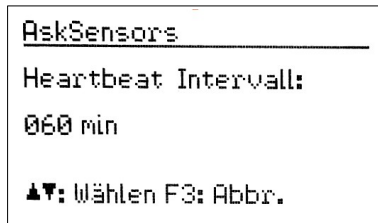


Figure 18: Heartbeat interval input

The VM40C is now ready for connection with AskSensors. The entries only need to be made once. The data remains stored even when the device is switched off.

Now select "AskSensors connection" in the AskSensors menu with the modem connected. Switching on the modem and establishing a connection to the mobile network takes a few seconds. Meanwhile, the type and version of the modem, the network operator and the network are displayed.

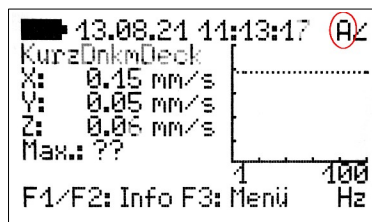


Figure 19: AskSensors indications

After the display "Ready for AskSensors" AskSensors receives data from the VM40C in case of warnings and alarms as well as in the time cycle. You can recognize the active AskSensors function in measurement mode by an "A" at the top right of the display (Figure 19). AskSensors communication is enabled after a delay of 10 seconds after the start of the measurement. Before this, the wait symbol ⌘ appears.

3. ThingSpeak

3.1. General

The ThingSpeak data interface is integrated into the MATLAB mathematics software, which offers many possibilities for further processing.

Information about the license models can be found at <https://thingspeak.com/>.

3.2. Setting up ThingSpeak

After creating a ThingSpeak user account, log in and create a channel for the VM40C (Figures 20 and 21).

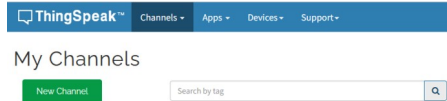


Figure 20: ThingSpeak channel menu

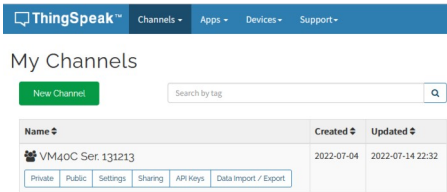


Figure 21: Entered channel

A ThingSpeak channel consists of a maximum of eight data fields, of which the VM40C uses six in the following manner:

- Field 1: Current status; OK/Warning/Alarm (0/1/2).
- Field 2: Measured value X in mm/s or m/s² (for SN 640312a the vector sum)
- Field 3: Measured value Y in mm/s or m/s² (for SN 640312a zero)
- Field 4: Measured value Z in mm/s or m/s² (for SN 640312a zero)
- Field 5: Main frequency in Hz
- Field 6: Battery charge in percent

For now you can accept the newly created channel without any settings. The settings are explained later in chapter 3.4.

3.3. ThingSpeak Settings at the VM40C

To set up a connection between the VM40C and ThingSpeak, select "IoT/SMS/Alarms" in the VM40C main menu, then "ThingSpeak" and there "Settings".

First, specify the access point name (APN). This is the name of the gateway through which the mobile network operator provides access to the Internet. You can find it on the mobile network operator's website. Use the arrow keys to enter it. Press F1 to switch between upper and lower case letters and digits (Figure 22). Press OK to switch to the next line or save the entry after the fourth line. Press F3 to skip the entry.

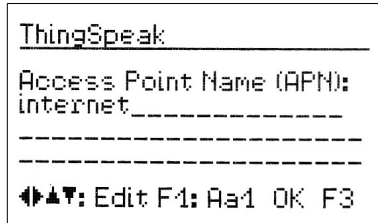


Figure 22: Entering the APN

If required by the network operator, enter the APN User and APN Password in the same way. You can find both entries also on the network operator's web pages. In most cases you can skip these two entries.

Next, specify the Write API Key from ThingSpeak. This code is used to assign the measurement data sent to ThingSpeak to a specific data channel. You will find the Write API Key under "API Keys" in the newly created channel (Figures 21 and 23).



Figure 23: Write API Key of a ThingSpeak channel

Enter this letter/digit combination using the arrow keys in the VM40C (Figure 24).

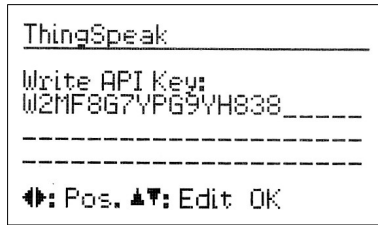


Figure 24: Entering the Write API Key

As a last step, you specify the time cycle ("heartbeat") in which the VM40C reports to ThingSpeak when there are no vibration events (Figure Fehler: Verweis nicht gefunden). This will allow you to check if the connection still exists. The shortest selectable interval is 5 minutes. Please note that each modem connection causes an increased current consumption.

Note: The longer the interval, the longer the operating time per battery charge.

The VM40C is now ready to connect to ThingSpeak. The entries only need to be made once. The data remains stored even when the device is switched off.

Now, with the modem connected, select "ThingSpeak Connection" in the ThingSpeak menu (Figure 25). Switching on the modem and establishing a connection to the mobile network will take a few seconds. Meanwhile, the type and version of the modem, the network operator and the network are displayed.

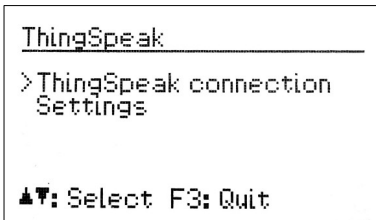


Figure 25: ThingSpeak connection

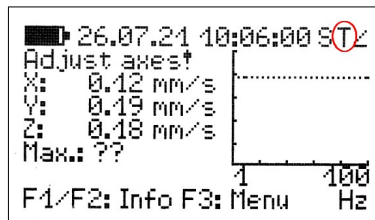


Figure 26: ThingSpeak indication

After the display "Ready for ThingSpeak" the platform receives data from the VM40C in case of warnings and alarms as well as in the heartbeat intervals. You can recognize the active ThingSpeak function in measurement mode by a "T" at the top right of the display (Figure 26). The ThingSpeak connection is enabled 10 seconds after the start of the measurement. Before this, the wait symbol ⌂ appears.

3.4. Channel Settings in ThingSpeak

To display the data correctly, some settings are necessary in the "Channel Settings" menu of the ThingSpeak channel (Figure 27).

VM40C Ser. 131213

Channel ID: 1788559
Author: [MetraSensors](#)
Access: Private

Dresden, Cottbusser Str.

[Private View](#) [Public View](#) **Channel Settings** [Sharing](#) [API Keys](#)

Channel Settings

Percentage complete 50%

Channel ID 1788559

Name

Description

Field 1

Field 2

Field 3

Field 4

Field 5

Field 6

Show Channel Location

Latitude

Longitude

Show Video
 YouTube
 Vimeo

Video URL

Show Status

Figure 27: Channel settings

The texts entered under “Name” and “Description” appear later above the measurement data.

Activate the fields 1 to 6 by clicking the check boxes and enter a name for each field. The entered field names will later be displayed above the time histories.

Further down you can activate “Show Channel Location” and enter the longitude and latitude of the measuring point. The position will then be displayed on an interactive map.

With “Show Status” a text window will be shown in which the last events are listed.

Click “Save Channel” to finish the settings.

The entered channel can be found in the menu “My Channels”/“Private”. Figure 28 shows an example.

ThingSpeak™ Channels - Apps - Devices - Support - Commercial Use - How to Buy

VM40C Ser. 131213

Channel ID: 1788559 | Dresden, Cottbuser Str.
 Author: [MetraSensors](#)
 Access: Private

Private View | **Public View** | Channel Settings | Sharing | API Keys | Data Import / Export

Add Visualizations
 Add Widgets
 Export recent data

MATLAB Analysis | MATLAB Visualization

Channel 1 of 2 <

Channel Stats

Created: 16 days ago
 Last entry: about a minute ago
 Entries: 138



Figure 28: Example of a measuring channel view in ThingSpeak

The “Channel Status Updates” window displays the operating mode that the VM40C transmits once after startup. Furthermore you will find the last warning and alarm events with timestamp. Figure 29 shows an example.

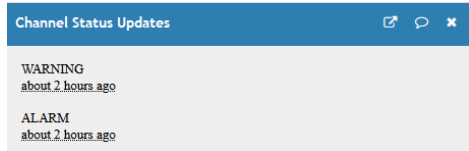



Figure 29: Channel Status Updates

The graphs headed with “Field ...” show the data of the fields 1 to 6 (cf. page 11). By clicking on  you can label and scale the axes and change the style of the graphs.

By clicking on “MATLAB Visualization” you can create additional visualizations. Various templates are available for this purpose.

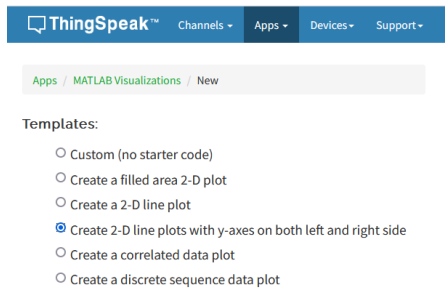


Figure 30: MATLAB visualization templates

After selecting the template, you can create the desired visualization in the MATLAB scripting language. The following script example generates a diagram with the curves of the amplitudes $X/Y/Z$ and the frequency according to the example in Figure 28 on the basis of the template “2-D line plots with y-axes on both left and right side”.

To connect the script with the data of your measuring channel you only need to enter the channel ID for $x...x$ and the Read API key for $y...y$. Both can be found in the “Private View” of your channel.

Note: A battery charge value of 110 % indicates that the battery is being charged.

```

ReadChannelID = xxxxxxx;
fieldID1 = 2;
fieldID2 = 3;
fieldID3 = 4;
fieldID4 = 5;
readAPIKey = 'yyyyyyyyyyyyyyyy';
[x, time] = thingSpeakRead(readChannelID, 'Field', fieldID1,
'NumPoints', 600, 'ReadKey', readAPIKey);
[y, time] = thingSpeakRead(readChannelID, 'Field', fieldID2,
'NumPoints', 600, 'ReadKey', readAPIKey);
[z, time] = thingSpeakRead(readChannelID, 'Field', fieldID3,
'NumPoints', 600, 'ReadKey', readAPIKey);
[f, time] = thingSpeakRead(readChannelID, 'Field', fieldID4,
'NumPoints', 600, 'ReadKey', readAPIKey);
plot(time, x, 'Color',[0, 1, 0], 'LineWidth', 2);
hold on
plot(time, y, 'Color',[0, 0, 1], 'LineWidth', 2);
hold on
plot(time, z, 'Color',[1, 0.5, 0], 'LineWidth', 2);
hold on
yyaxis right
plot(time, f, 'Color',[1, 0, 0.5]);
yyaxis left
ylim([0 inf])
ylabel('mm/s')
yyaxis right
ylim([0 inf])
ylabel('Hz')
title('Vibration (X/Y/Z); Main Frequency')

```

Under “Data Import/Export” you can download the measurement data stored in the channel in a CSV file.

In measurement mode you can check the number of sent messages and possible errors by pressing F2.

For further questions ThingSpeak and MATLAB offer extensive help.

4. Troubleshooting

The following instructions apply equally to the connection to AskSensors and ThingSpeak. If no connection can be established after selecting the menu item "AskSensors connection" or "ThingSpeak connection", no letter "A" or "T" will be displayed at the top right of the measurement display. In this case, restart the connection and observe the display. This process can take up to three minutes.

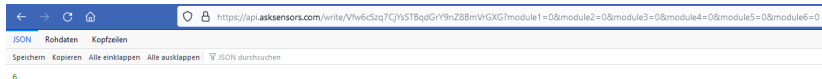
Error pattern	Error display	Possible cause / elimination
No connection to modem	ERROR 2	<ul style="list-style-type: none"> • Modem cable interrupted
SIM card error	ERROR 3	<ul style="list-style-type: none"> • No SIM card in modem
„Searching network...“ displayed for three minutes, then „No network found“	ERROR 3	<ul style="list-style-type: none"> • Invalid or expired SIM card • No reception, place the modem in a suited position
No internet connection	ERROR 6	<ul style="list-style-type: none"> • Wrong APN, contact the mobile network provider
No IoT connection	ERROR 8 ERROR 9	<ul style="list-style-type: none"> • Wrong API Key, compare the key you have entered in the menu with the Write/In API key of your AskSensors/ThingSpeak account

You can test the function of the API key in AskSensors by entering the following link into the address line of an internet browser:

```
https://api.asksensors.com/write/x...x?module1=0&module2=0&module3=0&module4=0&module5=0&module6=0
```

Please insert the AskSensors API key instead of x...x.

The answer is “6” for the number of values sent and you will see a new data point in the AskSensors dashboard.



In the case of questions or problems concerning the IoT sensor data platforms, please use their respective support forum or contact their support.

AskSensors Forum: <https://forum.asksensors.com/>

AskSensors Support: <https://asksensors.com/contact.html>

ThingSpeak Forum: <https://de.mathworks.com/matlabcentral/topics/thingspeak.html>

ThingSpeak Support: https://de.mathworks.com/support/contact_us.html